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1. Pakistan's budget allocation for 'Defence Affairs and Services' for 2016-17 stands at Rs 860 Billion, a 'usual' 11.3% increase over the previous year's allocation of Rs 780 billion. As media reports elaborated, the Defence Budget will be divided in the following manner: $3.12 billion will go sustain the salaries of personnel; $1 billion towards the maintenance of buildings; $2.06 billion will be used for operational expenses; and $2.02 billion towards arms and ammunition procurement. The Army has been allocated 47% of the budget, whereas the Air Force given 20%, and Navy 10%. **Military pensions, the nuclear program, and the cost of the operations in the Federally Administered Tribal Areas (FATA) are not part of the Defence budget and separate allocations are made towards these**.

2. Interestingly, media reports state that at its peak in 2014-2015, Zarb-e-Azb had cost the Pakistani exchequer $1.8 billion U.S. Director-General (DG) Inter-Services Public Relations (ISPR) AsimBajwa on 2nd September 2016 while giving a rundown of progress made during Operation Zarb-i-Azb, stated that War against terror has cost Pakistan a total of $107bn besides the loss of 536 soldiers killed and 2,272 injured during IBOs. In terms of budgeted procurements, there are several major programs in progress, mainly Pakistan Air Force (PAF)'s JF-17 Thunder, which is gradually becoming the new mainstay fighter of the PAF fighter fleet; the Pakistan Navy may begin implementing its next generation submarine program; the Pakistan Army will begin to gear up for the induction of its new attack helicopters.

3. A core issue that has challenged Pakistan's Defence Administrators and its Defence Strategists is the management of expenditures, particularly of those towards expensive imports. It is increasingly being realised that greater dependence on the domestic industry would enable the Pakistani military to take advantage of local labour and material costs and this is amongst the key objectives today for the Ministry of Defence Production, which is aiming to indigenize and domestically source as much as possible of the Pakistan Defence Forces' armament requirements.

4. Justifying the budgetary increase, Pakistan's Defence Analysts argue that in the previous year (2015-16), the maximum budget allocated for the army was spent on non-development expenses such as pay and allowances and that only 6% was left for development schemes. They also point out that in stark comparison, while on the average, Pakistan spends $8,077 per soldier annually, India in comparison allocates $17,554, Turkey $31,184, Saudi Arabia $269,060 and the USA spends $426,814 per each of their respective soldiers.

5. There is besides a pertinent accounting aspect, unlike as in India, of pensions of ex-servicemen, that does not form a part of allocations for defence. Two other interesting features of the Pakistani defence budget are an allocation of Rs192 billion towards 'contingent liability' and of Rs100 billion out of the Rs170 billion received under the Coalition Support Fund (CSF).

6. American civilian and military aid to Pakistan, once the third-largest recipient of US foreign assistance, is expected to decline to less than $1 billion in 2016, down from a 2011 peak of more than $3.5 billion. In June 2016, the US Senate had passed its draft of the National Defense Authorization Bill, which includes provision to set up a new fund to reimburse Pakistan for its efforts in war against terrorism with $800 million has been authorized under a provision called the 'Pakistan Security Enhancement Authorisation'. The draft also fences $300m behind a similar Haqqani network provision that has

existed in the annual defence authorization acts since the fiscal year 2015.In August 2016 however, the Pentagon withheld the $300 million in military assistance for reasons of its frustration for Pakistan not acting against militants fuelling violence in Afghanistan.

7. Adam Stump, a Pentagon spokesman, stated that the Defense Secretary Ashton B. Carter had *"decided against making a certification to Congress stating that Pakistan is taking sufficient action against the Haqqani network, a Taliban affiliate blamed for attacks on U.S. and allied personnel in Afghanistan" and that this decision "means Pakistan will not receive the $300 million in military reimbursement funding, was based on the continuing operations of the Afghan Taliban and Haqqani militants on Pakistani soil".*[1] The cancelled $300 million payments were in the form of Coalition Support Funds (CSF) under which Pakistan has received over $14 billion since 2002 and accounted for "as much as one-fifth of Pakistan's total military expenditures" from 2002 to 2014, which is a measure of how important they were for cash-strapped Pakistan.

8. CSF accounts for 43% of $32.2 billion worth of US government financial transfers to Pakistan from 2002 to 2015, according to the CRS. Economic aid comprises 33% of transfers at $10.6 billion followed by 24% in security aid at $7.6 billion. It needs emphasis however that the CSF is not the same as economic and security aid, of which Pakistan still remains a major – even if shrinking – recipient. Pakistan has used CSF payments to support the deployment of over 100,000 troops in its insurgency-hit north-west region. The Pentagon has reported that nearly half the funds are used for food and ammunition.[2]

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[1]The Indian Express, 04 Aug 2016 at http://indianexpress.com/article/world/world-news/us-defence-secretary-ashton-carter-blocks-300-million-military-aid-to-pakistan-2953216/

[2]THE WIRE 20 Aug 2016 at http://thewire.in/60417/will-diminishing-us-military-bring-pakistan-closer-to-china/

US Arms Grants and Sales

9. In this backdrop, the details of Military hardware transferred from the US to Pakistan through grants / sales are as follows:-

US Military supplies made under FMF:-

(a) Eight P-3C Orion maritime patrol aircraft and their refurbishment (valued at $ 474 million). (Four were delivered of which three were destroyed in an Islamic Militants Attack in 2011)

(b) Six C-130E Hercules transport aircraft and their refurbishment ($76 million).

(c) 20 AH-1F Cobra attack helicopters via EDA ($48 million for refurbishment).

(d) 15 Scan Eagle reconnaissance unmanned aerial vehicles ($30 million).

(e) Perry-class missile frigate USS McInerney, via special EDA authorization and relaunched as PNS Alamgir). ($ 65 million for refurbishment).

(f) Six AN/TPS-77 Surveillance Radars ($ 100 million).

(g) 2007 TOW Anti-armour Missiles ($ 186 million).

(h) 5750 Military Radio Sets ($ 212 million).

10. **Supplies paid for with a mix of Pakistani national funds and FMF:-**

(a) 60 Mid-Life Update kits for F-16A/B combat aircraft (valued at $891 million ($477 million of this in FMF).

(b) 115 M-109 self-propelled howitzers ($87 million, with $53 million in FMF).

11. **Items paid or to be paid for entirely with Pakistani National Funds:-**

(a) 18 x new F-16C/D Block 52 Fighting Falcon Combat Aircraft (valued at $1.43 billion).

(b) F-16 armaments including 500 x AMRAAM air-to-air missiles; 1,450 x 2,000-pound bombs; 500 x JDAM Tail Kits for gravity bombs ($629 million).

(c) 1,600 x Enhanced Paveway laser-guided kits, also for gravity bombs ($629 million).

(d) 100 x Harpoon anti-ship missiles ($298 million).

(e) 500 x Sidewinder air-to-air missiles ($95 million).

(f) 7 x Phalanx Close-in Weapons System naval guns ($80 million).

12. **Major articles transferred via EDA:-**

(a) 14 x F-16A/B Fighting Falcon combat aircraft.

(b) 59 x T-37 Tweet military trainer jets.

(c) 374 x M113 Armoured Personnel Carriers.

13. **Under Coalition Support Funds.** (in the Pentagon budget), Pakistan received 26 Bell 412EP utility helicopters along with related parts and maintenance, valued at $235 million.

14. **Under Section 1208 of the US National Defense Authorization Act (NDAA).** That provides the Secretary of Defense with authority to train and equip foreign military forces for two specified purposes (counterterrorism and stability), Pakistan has been provided:-

(a) 4 Mi-17 multirole helicopters (with another 6 were provided temporarily at no cost),

(b) 4 King Air 350 surveillance aircraft,

(c) 450 vehicles for the Frontier Corps,

(d) 20 Buffalo explosives detection and disposal vehicles, helicopter spare parts, explosives detectors, night vision devices, radios, body armour, helmets, first aid kits, litters, and other individual soldier equipment.

15. In April 2015, the State Department approved a $952 million FMS deal with Pakistan for:-

(a) 15 AH-1Z Viper attack helicopters and

(b) 1,000 Hellfire II missiles, along with helicopter engines, avionics, training, and support.

16. **Through International Military Education and Training and other programs**. The United States has already funded and provided training for more than 2,000 Pakistani military officers. In an interesting recent development of relevance to this Study, Assistant US Trade Representative for South and Central Asia Michael J Delaney said the United States had agreed to allow Pakistani companies participation in bidding for US Department of Defense procurements for operationsin Afghanistan. The statement followed a meeting of the US-Pakistan Trade and Investment Framework Agreement (TIFA) Council on October 18, 2016 that was co-hosted by US trade representative Michael B. Froman and Pakistan's Minister for Commerce Khurram Dastgir Khan wherein *'the two sides emphasised that the US and Pakistan remained committed to working together and with the private sector to expand bilateral trade and investment ties, as part of an enduring, multifaceted bilateral relationship' which 'was in the interest of both countries'and 'our respective business communities'.*[3]

Chinese Military Assistance, Sales and Support

[3] "PAKISTANI COMPANIES ALLOWED TO PARTICIPATE IN AFGHANISTAN DEFENCE PROCUREMENTS' Pakistan Today (Karachi) • 21 Oct 2016.

17. Since 1962, China has been a steady source of military equipment to the Pakistani Army, helping establish munition factories, providing technological assistance and modernizing existing facilities. China and Pakistan have several co-development / co-production programmes to strengthen the latter's Military capabilities with China even having designed tailor made advanced weapons to meet Pakistan's requirements. According to Stockholm International Peace Research Institute (SIPRI) Pakistan is China's biggest arms buyer, counting for nearly 47% of Chinese arms exports.

In an assessment of China's policy towards the South Asian region, Rayment Lee of the Aljazeera Centre for Studies writes that *"China is now engaged in an unprecedented close bilateral cooperation with Pakistan across a range of areas. From a domestic, regional, or international political perspective, China has shown a willingness to continue strengthening its relations with China. Aside from India, regional powers such as the United States, Arab countries, and Iran, are positive about China taking responsibility for maintaining regional order in Afghanistan and Pakistan. Therefore, for the foreseeable future, China-Pakistan relations as well as the expansion of Chinese influence in Central and South Asia will develop further as China pursues the "One Belt and One Road" initiative, gradually replacing the U.S. dominated status-quo. Following his rise to power, Xi Jinping has made major adjustments to China's international strategy. China is no longer prepared to play a passive and low-key role, and has sought great power status consistent with its own strength that can influence the international system. With the current situation in Afghanistan and Pakistan, China is able to take on responsibility for filling the power vacuum in a way that is generally acceptable to all parties involved".*[4]

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[4]"The Strategic Importance of Chinese-Pakistani Relations" by Raymond Lee at http://studies.aljazeera.net/en/reports/2016/08/strategic-importance-chinese-pakistani-relations-160803101555719.html

18. Joint development of the JF-17 Thunder fighter aircraft, K-8 Karakorum advance training aircraft, a tailor made training aircraft for the Pakistan Air Force based on the Chinese Hongdu L-15; Al-Khalid tanks, which China granted license production and tailor made modifications based on the initial Chinese Type 90 and/or MBT-2000; AWACS systems.

19. The two countries also collaborate in Space Technology and their Armies have a scheduled joint training programme.

20. China has made heavy investments in the development of Pakistan's Gwadar Deep Sea Port (total estimated cost over $ 40 billion), which could provide the **Chinese Navy, of a launchpad for submarines and warships in the Indian Ocean. China has pledged to invest nearly $ 46 billion on various projects that form the China-Pakistan Economic Corridor.**

The SIPRI Database Trade Registers details the following Military hardware supplies from China to Pakistan:-

(a) 22850xRed Arrow-8 Anti-tank missiles (Pakistani designation Baktar Shikan).

(b) 500xType-90-2/MBT-2000 Tank MBT-2000 (Al Khalid or P-90) version.

(c) 6xK-8 Karakorum-8 Trainer/combat Aircaft (Incl production of components and assembly in Pakistan).

(d) 4xF-22 Frigate F-22P version; incl 1 produced in Pakistan; Pakistani designation Zulfiquar.

(e) 27xK-8Karakorum-8Trainer/combatAircraft(K-8P version)

(f) 48 xA-100 300mm Self-propelled MRL (2008)

(g) 2xAzmat FAC Incl 1 produced in Pakistan.

(h) 50xJF-17Thunder/FC-1FGAaircraftJF-17Block-2 version

(j) 6xCSTC OPV Designation uncertain (reported as 'patrol vessel' from Chinese company CSTC; incl 4 produced in Pakistan).

(k) 8xType-041/Yuan Submarine Probably S-20 version; incl 4 produced in Pakistan.

Meeting Pakistan's Defence Requirements

21. There is however, a high dependence on imports to meet Pakistan's military requirements. Pakistan spent $735 million on import of arms in 2015, making it the tenth largest arms importer in the world. According to the Stockholm International Peace Research Institute (SIPRI) report, Pakistan slipped one place on the list of global arms importers as imports fell from $752 million in 2014 to $735 million last year. It nevertheless remains amongst the leading importers of military stores with over 50% of its imports being sourced from China and around 27% from the USA.

22. A concerted effort to reduce the high dependence on foreign sources is a guiding principle for the development of Pakistan's Defence Industry. According to Rana Tanveer Hussain, Pakistan's Minister for Defence Production, military imports has significantly reduced in recent years as the country's defence industry continues to develop. In a statement reported by the government-run Associated Press of Pakistan on 28 July, Rana Tanveer Hussain said that *'the government has reduced by 90% the number of 'no-objection certificates' (NOCs) that it has issued in support of defence imports over the past three years'.*[5]

[5] 'Pakistan Reduced Defense Equipment Imports By 90 Percent In Last Three Years: Minister ' – Defenceworld.net at http://www.defenseworld.net/news/16723/Pakistan_Reduced_Defense_Equipment_Imports_By_90_Percent_In_Last_Three_Years__Minister#.WAqwTuB96hc

Pakistan's Indigenous Defence Sector

23. At the time of independence, there was hardly any industrial base, let alone a defence Industrial base in Pakistan. **The contribution of the industrial sector to the GNP in 1949-50 was only 5.8%**, out of which, 4.8% was attributed to small scale industries. With virtually no defence industry, the entire needs of the Armed Forces were met through purchases, at that time, mostly from U.K.

24. With all the then sixteen British India Ordnance Factories being inherited by India, Pakistan had to commence its military Industrial sector from scratch. Its first Prime Minister, Liaquat Ali Khan, amongst his early decisions directed the setting up of an Ordnance Factory to produce .303 Rifles in collaboration with the British Royal Ordnance Factory with who it entered into a joint venture in 1951 and set up the first plant for production of .303 ammunition and the corresponding weapons. Later M/s Heckler &Koch and M/s Rheinmetal of Germany set up Small Arms production facilities for 7.62 Calibre Ammunitions to match NATO Standards. This was followed by many other joint ventures with China and Czechoslovakia. As an immediate step towards meeting the requirements of the Armed Forces, **Pakistan Ordnance Factories (POFs) was established at Wah in 1951**.

25. Initially, it was assigned the responsibility of manufacturing small arms/ammunitions for the British Weapons Systems. But with the induction of US weapons systems, it had to switch over to the production of related ammunition. Embargoes placed on Pakistan post the 1965 War brought about a consciousness on the need for achieving greater self-reliance in production of military hardware and also of diversifying sources of purchase of military equipment. The task of ammunition production relatively more difficult because of the large variety of weapon systems that had been inducted.

26. After the 1971 war and dismemberment of the nation, it was decided to initiate a programme of relatively greater self-reliance towards which a Defence Production Division was created in 1972 with a mandate to lay-down policy, formulate plans, and coordinate between procurement and developmental activities and to accelerate the pace of technological development to achieve greater self-reliance through indigenization. In 2004, this Division was re-designated as Ministry of Defence Production. Over the years, Pakistan's MoDP has worked towards this assigned goal, not only to achieve indigenisation but also to enhance the export of defence equipment and munitions.

Pakistan Ordnance Factories (POF)

27. **Today, POF is the largest defence industrial complex under the Ministry of Defence Production, producing conventional arms & ammunition for Pakistan's Armed Forces and comprises of 14 Ordnance Factories and three commercial subsidiaries.** The mainstream factories are the Weapon Factory, Machine Gun Factory, Small Arms Ammunition Factory, Medium Artillery Ammunition Factory, Heavy Artillery Ammunition Factory, Tank and Anti-Tank Ammunition Factory, Explosive Factory, Filling Factory, Propellants Factory, Tungsten Alloy Factory, Tungsten Carbide Factory, the Steel Foundry, the Brass Mills, the Garments Factory and the Metallurgical Laboratory.

28. POF's three subsidiary Industries are the **Wah Industries Ltd,** established in 1958 as a commercial enterprise and appointed as sole selling agent of POF, to utilize maximum spare production capacity of POFs men, machinery, materials and to dispose off the waste, scrap & unserviceable store of POF, **The Hi-Tech Plastics (Pvt)** Ltd established in the late 1960s as a plastic moulding facility for providing high precision plastic parts and the **Wah Nobel (Pvt) Ltd**, founded in 1962, a joint venture between Pakistan Ordnance Factories, Saab (Sweden) and Almisehal (Saudi Arabia) as a multinational

group comprising six companies and engaged in production of commercial explosives, industrial chemicals and acetates.

29. Together, they produce conventional arms and ammunition with R&D projects to achieve self-reliance through innovation and indigenization using technology and equipment acquired from the United States, United Kingdom, France, Germany and China. POF presently has a joint venture with M/s SAAB of Sweden for the production of commercial explosives such as dynamite.

30. The surplus capacity is utilized for exporting its products to various countries in Asia and the Far East, Africa and the Middle East, North America, the Central Asian States and Europe. All the fourteen factories of POF are ISO-9001 certified.

31. There is a Central Quality Assurance Organization, which is independent of the factory management. This central organization has its own permanent Works Inspection Departments in each factory. **An interesting aspect that has bearing on user satisfaction is that over and above this Quality Assurance Organization, the Armed Forces have their own independent full time resident Inspectors who apply rigorous inspection procedures both during production in the factories and also at final proofing which is conducted at their own Proof Ranges.**

32. POF Products, as at present, are as the following:-[6]

(a) **Infantry Weapons**. Sub Machine Gun MP5A2 and MP5A3, Automatic Rifle G3A3 and G3P4, Machine_Gun_MG3_(MG1A3), Anti-Aircraft Machine Gun 12.7MM Type 54, Semi-Automatic Precision Sniper Rifle PSR 90.

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[6]Extracted from Pakistan Ordnance Factories website at http://www.pof.gov.pk/products.php?catid=1

(b) **Ammunition**. 5.56 x 45 mm M-193 Ball and M-855 Penetrator, 7.62 x 51 mm Ball and Tracer, 9 x 19 mm Ball (1Z and 2Z), 7.62 x 54 mm Ball and Tracer, 7.62 x 39 mm Ball, 7.62 x mm Blank (Star), 7.62 x 51 mm Rifle Grenade.

(c) **Artillery Ammunition**. 203 mm HOW HE M 106(8), 155mm HOW HE M107,130mm HE, 122 mm HOW HE,105 mm HOW QF 25 PDR Mk_2/1, 122 mm HOW HE-D30.

(d) **Mortar Bombs**. 81 Illuminating Signal (Red & Green), 81 HE M 57 D A2, 81 mm Smoke WP, 120 mm Smoke WP M44A1, 120 mm Smoke HE M44A2, 60 mm Mortar Bomb HE, 60 mm Smoke WP P2A2.

(e) **Aircraft & Anti-Aircraft Ammunition**. 37 mm HEAT, 30x113MM HEI, API and Ball 23mm, 20 mm x 102 Phalanx Ammunition, 12.7 x 108 mm API and APIT, Bomb HE AC 500 lbs.

(f) **Tank & Anti-Tank Ammunition**. 125 mm H.E.FS TK, 125mm APFSDS/T, 106 mm HEAT M344A3, 105 mm APFSDS P1A1, 105 mm HE/TK P1 A1, 105 mm TK HESH L 35 A3, 100 mm TK HESH100 mm HE/TK P1A1, 100 mm APFSDS/T, Tungsten Alloy Penetrators, 73 mm FSRA HEAT SPG9 (RAAD), 40 mm HEAT P1 K1 (RPG-7P).

(g) **Grenades**. Hand Grenade ARGES 84 P2A1, Grenade target Indication, Smoke Discharge /Grenade WP P3 Mk1, Charge Demolition No.1 6" Beehive Mk-1, Demolition 1 Oz CE Primer, Flare trip Wire Mk 2/2, Cartridge Signal Shooting Type, Fuzes, Detonators and Primers.

(h) **Military Explosives & Propellants**. Explosives, Propellants (Mortar Bombs and Rockets), Propellants-Small Arms Ammunition.

(j) **Rockets**. 122 mm HE (MBRL) YARMUK, 73 mm FSRA HEAT SPG9 (RAAD), 40 mm HEAT P1 Mk1

(RPG-7P), Calibre 40 mm RPG 7AP and Grenade Rifle HEAT P-2 Mk1 (RG-1).

(k) **Commercial Explosives**. Powder Explosives, Emulsion Explosives, Blasting Accessories, Detonators, the 'Leher' Ignition System and Chemical Polymers.

(i) **New Commercial Products**. 308 Win Sporter Rifle, POF 4 Pistol 9x19mm, POF 5 Pistol 9x19mm, and the 308 Win Ball(150_grains) Sport Ammo, the .308 Win Ball (155_grains) Match Ammo, and the .308 Win Ball (165_grains) Hunting Ammo and the .308 Win Ball(175_grains) Super match Ammo.

33. Even though it manufactures variants of legacy firearms, such as the German Heckler and Koch G-3, POF's achievements of export have been creditable. It has emerged as a dependable supplier of small arms and ammunition not just to Pakistan's Armed Forces and its law enforcement agencies, but also to Forces of other countries. **Pakistan Ordnance Factories (POF) has recorded a four-fold increase in exports over the past two fiscal years, according to POF chairman Lt Gen Omar Mehmood Hayat who, on 19 October 2016 stated that the company (POF) "had expanded international sales from USD 22 million in 2013-2014 to USD 93.7 million in 2015-2016"[7]. In the statement, Lt Gen Hayat - a serving general in the Pakistan Army also said "the POF had received funds worth around PKR25 billion (USD239 million) from the Pakistan Government**. He added that this investment has been used to "meet the demands of the armed forces" and to replace the POF's "obsolete machinery".

34. A concerted effort to upgrade POF manufacturing facilities has been planned and is proposed to be implemented in a phased manner.

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[7]Jane's Defence Industry, 21 October 2016 at http://www.janes.com/article/64824/pakistan-ordnance-factories-posts-four-fold-increase-in-exports

Heavy Industries, Taxila (HIT)

35. Heavy Industries, Taxila was envisaged in the early 70s and its first production unit i.e. Heavy Rebuild Factory (T-series) went into production in 1980. This was followed in the early 90's by a number of other factories. Today, HIT has grown into a military industrial complex which consists of Six Major Production Units, Support Facilities and Administrative Establishment. HIT's mission is to manufacture, rebuild, upgrade & develop Tanks, Tank Guns & APCs and to utilize surplus capacity of factories to meet requirements of civil sector and friendly countries.

36. HIT's mission is to "Manufacture, Rebuild, Upgrade & Develop Tanks and Tank Guns & APCs" and to "Utilize surplus capacity of factories to meet requirements of civil sector and friendly countries".[8]

HIT is governed through a Board and its Headquarters comprise of following three Main Directorates, Rebuild Facilities/Factories, Manufacturing Facilities/Factories and

[8]Quoted from HIT website at http://www.hit.gov.pk/aboutus.html

Allied Facilities.The Budget, Marketing and Procurement Directorate plans and executes budget, procurement and conducts marketing sale (Export/domestic) of HIT products, The Administrative Directorate controls the administrative facilities and personnel management of HIT whereas the Technical Directorates=controls the production, training, and quality assurance.

37. The Rebuild Facilities/Factories are the Heavy Rebuild Factory (T-Series), Heavy Rebuild Factory (M Series) and the Advance System Rebuild Factory (ASRF):-

(a) **Heavy Rebuild Factory (T-Series)**. Is designed to rebuild and modernize Tanks / ARV's of Chinese/East European origin.

(b) **Heavy Rebuild Factory (M-Series)**. Has the expertise of carrying out quality rebuild of tracked vehicles of US origin. The factory specializes in M113 Series vehicles which are given new life after rebuild strictly in accordance with OEM specifications.

(c) **Advance Systems Rebuild Factory**. Established to carry out rebuild of Hi Tech Opto electronics systems employed in the armoured vehicles of Pakistan army to include tanks T-80UD, Al-Khalid, Al-Zarrar, T-85 IIAP and T-69 IIMP.

HIT's Manufacturing Facilities/Factories are the APC Factory, the Gun Factory and the Tank Factory.

(d) **APC Factory**. Most M113 family of vehicles are manufactured in this factory using state-of-the art CNC machines, CAD/CAM system and manufacturing technology unique in the world on MIG and TIG aluminium welding, radiographic inspection chemical cleaning, coating and painting accordance to military specifications.

(e) **Gun Factory**. Has the capability of producing barrels ranging 105 mm to 203 mm calibre. It has a long standing experience in manufacture of 105 mm Gun Barrel for upgraded T-59 & T-69 IIMP tanks and 125 mm Guns/Barrels for the ongoing programmes of Tank Al-Khalid and Al-Zarrar. The auto frettaged barrels are manufactured from very high quality electro slag refined steel. Each barrel is processed through precision machining operations and subjected to stringent quality control parameters.

(f) **Tank Factory**. Equipped with latest tank manufacturing facilities which includes seven axis CNC machines for heavy duty flexible machining operations and a complete infrastructure for hull and turret manufacture.

Allied Facilities:-

(i) **Advanced Research Development and Information Centre (ARDIC)**. Established as the Centre of Excellence for advanced systems to handle future challenges of manufacturing and applied R&D.

(ii) **Development Engineering Support and Components Manufacture (DESCOM)**. Provides engineering support to all factories of HIT. Equipped with CNC machines it undertake manufacture of components, assemblies, tools, dies, gauges and arranges development of spare parts through the vendor industry. It also provides repair/maintenance support to machinery/ equipment installed in HIT.

38. HIT's major products are the following:-

(a) **Defence Products**

(i) **Tank Al-Khalid**. Designed with a 125 mm (length: 48 calibres) smoothbore, auto-frettaged and chrome-plated gun barrel which is manufactured with highly stiff electroslagremelting steel. This gun provides very high internal chamber pressures for APFSDS, HEAT FS and guided missile and can fire the following types of conventional ammunition: APFSDS, HEAT-FS and HE-FS. It is a modified variant of both the ZPT-98 and KBA-3 series of 125 mm smooth bore gun for Al-Khalid MBT which provided compatibility with Ukrainian ATGMs such as Kombat. The tank is also equipped with a 7.62 mm-coaxial machine gun, a 12.7 mm externally mounted air-defence machine gun that can be aimed and fired from within the tank, and smoke grenade launchers.

Effective range. 200 to 7,000 metres

Sensor. laser ranging from 200 to 9,990 metres

French Auto-tracking, interfaced with gunner station, firing four types of munitions, gunner's thermal imaging sight, commander's image intensification night vision sight, gyro-stabilised and UPS power supply system.

(ii) Tank Al-Khalid-I. Upgraded variant with Ammunition capacity increased to 49 125 mm rounds, 1,500 12.7 mm rounds and 7,100 7.62 mm rounds.[3][6] Incorporates modifications made to the fire-control system which is now a more advanced multi process fire control computer with up to 7 km effective identification range. The engagement range is also improved which is up to 3.5 km, digital driver panel, IBMS, side-skirts, track pads, digitally controlled FPGA based solid state auto-loader with bidirectional

tray movement and ammo availability info on screen, info on empty and full trays and types of available rounds, bigger carousel for longer rounds, (rate of fire increased to 9 rounds per minute), Ukrainian Varta electro-optical jammer (disrupts laser rangefinders, laser designators and anti-tank guided missile tracking systems), Sagem third-generation thermal imagers and improved air conditioning system. It is the most heavily weaponised tank by tonnage. It is fitted with a 1,200 hp Ukrainian engine. Al-Khalid II's top speed is 72 km/h, and it weighs 47 tonnes.

(iii) **Al-Khalid-II**. Upgraded variant incorporating redesigned turret, increased weight, upgraded modular armour package and sensors, improved ammunition and a new power pack developing 1,500 hp.

(iv) **Tank Al-Zarrar**. A modern main battle tank is an upgraded variant of the Chinese Type 59 tank and is cost-effective modern replacement for the Type 59 fleet of the Pakistan Army. Equipped with modern armament, fire control and ballistic protection, the Al-Zarrar upgrade is also offered by HIT to the armies of foreign countries to upgrade their T-54/T-55 or Type 59 tanks to Al-Zarrar standard. 54 modifications made to the Type 59 make the Al-Zarrar effectively a new tank.Al-Zarrar's primary armament is a 125 mm smoothbore tank gun with achrome-plated gun barrel. It is capable of firing APFSDS, HEAT-FS and HE-FS rounds as well as anti-tank guided missiles and a Pakistani DU (depleted uranium) round, the 125 mm Naiza. The Al-Zarrar is powered by a liquid-cooled 12-cylinder diesel engine, giving a power output of 730 hp (540 kW)

and torque output of 305 kg.m at 1300–1400 rpm. A combat weight of 40 tonnes gives Al-Zarrar a power-to-weight ratio of 18.3 hp/tonne and a top speed of 65 km/h. Crew comfort is improved over the Type 59 by a modified torsion bar suspension system.

(v) **APCs**. APCs rebuilt at HRF (M) involves a complete rebuild of APCs back to its original manufacturer's specifications entails elaborate rebuild facilities, professionalism and highest quality standards which have been achieved with the help of sophisticated machinery, skilled manpower and latest test equipment / procedures. Most economical rebuild is accomplished through macro reclamation, sound engineering management systems and computerized inventory control. The quality product rolled out is comparable with brand new APCs. APC Talha (With 12.7 mm Protection), 125 mm Smooth Bore Tank Gun, Command Vehicle (SAKB).

(vi) **Armoured Personnel Carrier APC M113 A2 MK-1**. belongs to the family of most widely used combat vehicles in the world today. The economical upgrading of M113 A2 is highly suitable to meet battlefield challenges now and into the future. An improved cooling system has enhanced engine life whereas greater mobility and better ride characteristics are the result of improved suspension system currently available in APC M113 A2 MK - 1. The M113 A2 MK - 1 has a 265 HP Detroit Diesel Corporation (DDC) 6V53T turbocharged diesel engine replacing the DDC 6V53 212 HP engine found in earlier M113s. Teamed with the new engine is an Allison TX 100 - 1A transmission. Survivability is enhanced through use of external fuel tanks. Various forms

of bolt-on armor can be added to increase the Armour protection of the vehicle.

(vii) **APC 'Talha'.** An all terrain, amphibious infantry support vehicle with Ukrainian engines and 12.7 mm Machine Gun as its main armament. Survivability has been enhanced through use of external fuel tanks. Various forms of armour can be added for protection of the vehicle.

(viii) **APC 'Saad'.** Has a 350-400 Horse Power engine, which conforms to the dictates of future battlefield environments

(ix) **APC (RBS-70) 'Mauz'.** Is a Talha based APC Carrying RBS-70 Weapon System along with its crew of 4 persons

(x) **Baktar Shikan 'Maaz'.** Is a Talha based APC carrying Baktar Shikan Weapon System along with its crew of 4 persons.

(xi) **Logistic Vehicle 'Al-Qaswa'.** Is a the variant of APC capable of enhancing the logistic support to operational echelons. It can be used for carrying fuel, ration, ammunition and supplies across all types of terrain. The vehicle platform can also be used for other adaptations such as weapon station, refrigeration unit, radar, ambulance, etc.

(xii) **Infantry Fighting Vehicle 'Al Hamza'.** Has been developed with a Chinese one-man turret and 25 mm cannon.

(xiii) **Recovery Vehicle 'Al-Hadeed'.** A maintenance / recovery vehicle that is a Talha APC modified by installing a crane which can lift and place heavy loads. It also has a hydraulic winch with a fair lead assembly for retrieving disabled vehicles. A crew of three can operate the vehicle

and its equipment. It has mini workshop including lathe, welding plant, compressor, grinder, battery chargerand towing and illumination equipment

(xiv) **UR-416.** Is a four-wheeled APC that has a chassis of a Mercedes-Benz UNIMOG (4 × 4) cross-country vehicle fitted with an armoured body.The hull of the UR-416 M is of all-welded steel armour construction which protects the crew against small arms fire, shell splinters and anti-personnel mines. Armoured flaps covering the commander and driver front windows are lowered by gas pressure. The side windows are protected by swivelling armoured flaps. Forward observation is maintained by two single day periscopes in the forward part of the roof.

(b) **Commercial Products.** Armour Land Rover Defender 110,Mohafiz, Protector, Armoured Guard Post (AAHAN), APC Talha (Commercial), Logistic Vehicle (Al-Qaswa), BPJ NIJ Level III, BPJ NIJ Level IV, BP Vest NIJ Level III A

(c) **Joint Venture Products.** Dragoon Armoured Security Vehicle, APC Saad, North Benz 6 x 4 LED Lights & Accessories, Portable Shelters.

Karachi Shipyard & Engineering Works Ltd (KS&EW)

39. At the time of its creation, Pakistan's Navy was a small flotilla of ships. Over the years however, this fleet has grown to be a modern fleet including submarines, MCMVs, indigenously built missile boats, fast patrol crafts and midget submarines.

40. Karachi Shipyard and Engineering Works was established in the mid-1950s as a project of Pakistan Industrial Development Corporation (PIDC) and incorporated as a public limited company in 1957, managed by a Board of Directors with Managing Director as the Chief Executive.

41. KS&EW is Pakistan's premier ISO-9002 Certified Shipbuilding, Submarine & Warship Construction and General Engineering Works establishment with capability to build ships of all types upto 26,000 TDW. These include Frigates, Fast Attack Crafts, Logistic Support Ships, Bulk carriers, Oil Tankers, Seagoing and Harbour Tugs, Dredgers, Hopper Barges, Passenger Ferries, Fishing Trawlers, and special purpose crafts, small submarines and warship / support craft like Missile Craft, Patrol Craft, Diving Boats, Towed Array Barge, Floating Docks, Berthing / Pusher Tugs, Oil / Water carriers, boats etc.

42. Underwater repairs of ships of up to 26,000 TDW and above water repairs for vessels of any type or size are also undertaken at KS&EW. It also produces a wide variety of engineering plants and machinery like tankages, pressure vessels, LPG storage tanks, overhead, luffing and other types of electrically operated cranes, equipment of oil, gas, petrochemical industries, steel structures for dams, barrages, thermal power plants and similar other industrial plants, components for cement mills, complete sugar plants, Fire tube boilers, water tube boilers etc and Iron castings of up to 15 tons a piece, steel castings of up to 3 tons a piece and non-ferrous / alloy castings of up to 750 kg a piece. KS&EW also undertakes physical, chemical, metallographic and non-destructive testing of various raw materials and components.

43. KS&EW also undertakes steel renewal, major structure repairs, machinery overhauls and repairs for Pakistan Navy, Pakistan Maritime Security Agency, Karachi Port Trust, Port

Qasim Authority and a number of foreign clients. Likewise, works for alterations and conversion on hull / super structure are undertaken and facilities exist for repairs of Steam and Motor Vessels both Main and Auxiliary Machinery and all types of marine and stationary boilers. **In a recent demonstration of its capabilities, KE&SW successfully carried out emergency repairs at outer anchorage on a 250,000 TDW vessel that could not enter Karachi Harbour due to its size**.

44. Karachi Shipyard is situated at west wharf Karachi and spread over an area of 71 acres. It has a large shipbuilding hall, two block fabrication areas, three shipbuilding berths, two dry docks, a well-equipped machine shop and a large grit blasting and painting facility with modern machinery for paint application under controlled environment as per international standards. A ship lift and transfer system with a lifting capacity of 7881 tons and 13 in number parking stations is being installed which is planned to complete by end 2016.

45. KS&EW has the following major Workshops:-

(a) **Pre-fabrication Workshop**. Equipped with automatic and semi-automatic Electric Welding machines. The crane capacities and heights are designed to build small size ship blocks, frames and other small parts inside the workshop.

(b) **Block Fabrication Workshop**. Open fabrication areas equipped with all support facilities like compressed air, various gases, suitable electrical connections for lighting and welding and two gentry cranes up to 50 Tons capacity to build the large ship blocks in sections.

(c) **Light Steel Fabrication Workshop**. Closed fabrication area, well equipped in accordance with the small thickness material, involved for cutting, shearing, bending, rolling, welding and fabrication. The workshop has a number of automatic and semi-automatic Electric

Welding machines and is designed to build the light steel structures, aluminium structures and panels, air ducting, manhole covers, hatch covers, foundations and ladders inside the workshop.

(d) **Pipe Bending and Fabricating Workshop**. The pipe bending and fabricating workshop has a facility to fabricate steel, stainless and copper pipes for cargo, ballast, heating and hydraulic systems. The workshop is capable of bending pipes with newly installed machines with the capacity of up to 200 mm diameter.

(e) **Painting and Blasting Workshops**. The painting and blasting workshops area includes the most modern equipments providing painting, blasting, scraping facilities without being affected by dust, humidity and temperature.

46. Two closed blasting and painting facilities enable blasting and painting processes to carry out simultaneously regardless of the weather conditions. The Shipyard has comprehensive facilities and experienced team of workers for all kind of blasting works, painting, hydro-jetting and internal tank blasting/coating.

(a) **Joinery Workshop**. The workshop services include provision of all the requisite furniture, panelling and ceiling works on board the vessels. The workshop is fully equipped with all essential machinery like circular and cross cut saws, planners, thickness sanders, presses and drilling machines.

(b) **Mechanical Workshop / Machine Shop**. A well-equipped mechanical / machine shop is designed to undertake all possible machining activities. A total of 140 light / heavy duty machines and 5 furnaces installed for completion of production activities by machining and heat treatment processes, including lathes machines

(centre, heavy, capstan and turret), milling machines (horizontal, vertical and universal), horizontal and vertical boring machines, radial and horizontal drill machines, gear cutters, grinders, planers, shapers, circular saw machine and furnaces to carry out annealing, normalizing, hardening and tempering.

(c) **Berths and Quay Walls**. Karachi Shipyard's jetties are deep enough to accommodate every kind of vessels in premises. A total of five luffing cranes capacities up to 40 tons, are available at berths and quay walls. For above water repairs quay walls with a total length of 665 meters are available served with two luffing cranes and allied facilities. The details of KS&EW Building Berths and Dry Docks are as under:

Building Berths

Berth	Capacity	Length	Width	Cranes
Berth 1	15,000 DWT	169 m	23 m	30 & 40 Tons
Berth 2	26,000 DWT	118 m	24 m	40 Tons
Berth 3	26,000 DWT	213 m	31 m	40 Tons

Dry Docks

	Type	Capacity	Overall Length	Inner width between walls	Cranes
Dock 1	Graving Dock	26,000 DWT	189m	27m	30 & 10 Tons
Dock 2	Graving Dock	18,000 DWT	171 m	24 m	15 & 10 Tons

(d) **Ship Lift and Transfer System**. In order to enhance the capacity for shipbuilding and ship repair activities installation of ship lift and transfer system is in progress to be completed by end-2016 which would enable undertaking construction and repair of multiple vessels simultaneously.

47. **General Engineering Activities**. Though designed primarily for shipbuilding, KS&EW plays a role of supporting industry and developmental engineering through diverse general engineering activities. Its major areas of business in the regard are Sugar plants / machinery, Overhead Cranes (up to 100 tons capacity), Industrial boilers and pressure vessels, Cement plants, Flood light and wind turbine towers, Equipment for petroleum and petrochemical industry, Drilling rigs, Structures for power plants and Barrage Gates. It has extensive experience and expertise in manufacturing of boilers and pressure vessels in accordance with international quality standards. So far Karachi Shipyard has manufactured more than 100 boilers up to 80 tons per hour steam generating capacity.

48. **Material Testing Laboratory**. A well equipped in-house laboratory is available to carry out all types of chemical, physical and mechanical testing of metals, minerals, ores etc, with accuracy, reliability and customer's satisfaction in accordance to the BS, ASTM and JIS methods or to any other classification rules as required by the customers. The laboratory is ISO 9001:2008 certified and has a good reputation for its expeditious test result all over Pakistan.

49. **Shipyard Institute of Technology**. Was established in 1957 as Apprentice Training School for marine engineering apprenticeship (4 years) courses. In 1994 Sindh Board of Technical Education (SBTE) approved its vocational courses and became Technical Training Center (TTC). The Institute was renamed as Shipyard Institute of Technology after affiliation with SBTE in 2004 for 3 years Diploma of Associate Engineer

(DAE) and short courses in electrical, mechanical and ship construction technologies. The institute has so far trained more than 22,000 individuals in different trades.

50. **Accommodation Area**. Karachi Shipyard has a modern 7 floor Residential block with 140 rooms available for comfortable accommodation of our foreign Technical Assistants.

51. **A comprehensive setup for repairing, rebuilding and overhauling of naval and commercial vessels with high quality and safety standards, well equipped with docks, cranes, and the best tools and machinery besides a highly qualified workforce exists at KS&EW who have undertaken above and underwater repairs with a record of having services over 5000 vessels of national and international origin**.

52. **Ongoing KS&EW Projects:-**

(a) **17,000 Tons Fleet Tanker**. The construction of PN Fleet Tanker with overall length of 158.4 m, amaximum width of 22.0 m and scantling displacement of over 17000 tonscommenced in November 2013 and launched on 19 Aug 2016. The PNFT complies with IMO and MARPOL regulations, has a double hull configuration and is propelled by two diesel driven engines. It can achieve a top speed of 20 knots at full load.

(b) **Construction of FAC(M) No 3**. The third of Azmat class missile craft has been completed and the vessel was launched on 17 Sept 2016. This is a state of the art, multi mission corvette having a length and breadth of 63 m and 8.8 m, respectively. The design draught of the ship is 2.46 m and displacement of 560 tons. The ship has maximum speed of 30 knots and a range of 1000 Nautical Miles. This ship is propelled

by 04 Diesel Engines, 04 Propulsion Shafts with Fixed Pitch Propellers.

(c) **32T Fleet Tanker**. Fleet Tanker for Pakistan Navy which on completion would be the largest ship to be built in Pakistan till date in collaborative agreement with M/s STM of Turkey, who will provide the design of the ship along with Kit of Material (KoM).

(d) **Maritime Patrol Vessels**. KS & EW is indigenously constructing two Maritime Patrol Vessels (MPVs) for PMSA of 600 and 1500 tons displacement. The 600 Tons MPV is 68 m long and has a maximum breath of 8.7 m. Propelled by four engines, the vessel has a top speed of 27 Knots while 1500 Tons MPV is 95 m long and has a maximum breath of 11 m. Propelled by two engines, the vessel has a top speed of 26 Knots. The 600 tons MPV is scheduled to be delivered by April 2018 while the 1500 tons MPV will be completed by February 2019.

(e) **32 Tons Bollard Pull Tugs**. A contract for construction of 2 x 32 Tons Bollard Pull (TBP) tugs was signed between Ministry of Defence Production (MoDP) and Karachi Shipyard & Engineering Works (KS&EW) on 10 June 2016. These tugs are distinct due to its robust design and state of the art equipment and machinery, to facilitate multi-purpose operations. Each tug has 34 meter over all length with displacement of 481 tons. It has max speed of 12 knots and Bollard Pull of 32 Tons and fitted with a very robust fendering arrangement for all round tugging operations for almost all sizes of ships and crafts.

(f) **Bridge Erection Boats**. Construction of 22x Boats Bridge Erection for the Pakistan Army. These boats are made up of Aluminum Alloy, powered with Cummins Marine Diesel Engine of 205HP, which can

push it at a speed of 13 Knots. This 5.85 meters long boat has robust design and strong enough to withstand fast river currents. The boat is capable to hold the bridge in the center line for erection against fast river currents, and is capable to push/pull upto 2 ton floating load.

Pakistan Navy Dockyard (PND)

53. The Pakistan Naval Dockyard (PND) was established in 952 and has since been undertaking repair works, modernization and rebuild of PN Ships, Submarines and Crafts besides providing technical assistance, rebuild and repair of a wide range and diversity of equipment and undertaking fleet modernization and up gradation programmes of the PN Fleet.

54. PN Dockyard has developed capability to undertake ambitious and indigenous construction projects like Missiles Boats, Mines Counter Measure Vessel (MCMV) and AGOSTA 90 – B Submarine.

Marine Systems Limited

55. The Marine Systems Limited (MSL) is a maritime engineering and marketing Organisation that provides technical solutions to complex maritime problems specifically those arising due to outright obsolescence or due to diminishing of support from OEMs.

56. MSL develops real time embedded systems, design services and analysis of acoustic or radar signatures of surface and sub-surface vessels and provide solutions for functional replacements through indigenous design. Its products include an Advanced Towed Array Sonar (ATAS) - a towed array sonar developed jointly with Maritime Technologies Complex (MTC) that would replace old systems in service.

57. MSL has also developed an Action Speed Tactical Trainer (ASTT) - programmable simulator for tactical training of operations room teams. Based on High Level Architecture.

Tactical facilities include tactical manoeuvers, fleet operations, planning and management, C3I command centre, exercise execution and monitoring, scenario generation and trainees' evaluation. A Bridge/Pilotage Simulator at advanced stage of development would have capability to replicate all features of identified ships and would be used for training of Officers for Watch-Manoeuvring, entering/leaving harbour and by Communication Staff in tactical reporting.

58. MSL can also provide design services for complex mechanical structures for various marine applications and provides services for measurement of acoustic signatures of ships and submarines. Special arrangements can be made with the user to assure security and confidentiality of data.

59. MSL Product range includes:-

(a) **Advanced Towed Array Sonar (ATAS)**. A towed array sonar developed by MSL and Maritime Technologies Complex (MTC) to replace old systems in service with the Pakistan Navy (PN) and for export.

(b) **Action Speed Tactical Trainer (ASTT)**. Programmable simulator for tactical training of operations room teams. Based on High Level Architecture. Tactical facilities include: tactical manoeuvers, fleet operations, planning and management, C3I command centre, exercise execution and monitoring, scenario generation and trainees' evaluation. ASTT provides real time simulation of operationally integrated fleet environments, weapons and sensors, different environmental conditions, true kinematics of vehicles and can handle over 100 tracks. It includes user-conifgurable libraries for weapons and sensors. The simulator is made up of a number of cubicles which are configured to represent the CIC consoles of a surface ship or submarine.

(c) **Bridge/Pilotage Simulator**. under development,

will be capable of replicating all features of identified ships. To be used for training of Officer of the Watch-Manoeuvring, entering/leaving harbour, Quarter Master duties and communication staff in tactical reporting.[4]

(d) **Ship Design**. Detailed structural design, powering calculations and analysis of: stability, sea-keeping, manoevring, radar cross-section, vulnerability.[9]

(e) **MSL Services**. Computational Fluid Dynamics, Electromagnetic Compatibility (EMC) services, Electronic system design and development, Noise signature measurement.

Pakistan Aeronautical Complex, Kamra (PAC)

60. Pakistan Aeronautical Complex comprises of four co-located factories that cater to the maintenance requirement of the operational assets of the Pakistan Air Force (PAF). so f ıs located at Kamra, 70 Kms from Islamabad near Attock city. Spread over ten sq km, the complex has four Aviation Factories that are governed by an autonomous body known as PAC Board comprising of a Chairman, who is a serving Air Marshal of the PAF and five members (Resident Members for Finance, Commercial Technical and two non-resident Members (one for Ministerial Coordination and another a Private Member). In addition to exercising executive control over the Board, the Chairman directs and guides functioning of all the four PAC factories headed by respective Managing Directors.

61. The facilities at PAC are multi-faceted and include capabilities for Aircraft structure overhaul, Aircraft component overhaul, Aircraft engine overhaul, Radar and Avionics maintenance and overhaul. The Complex has comprehensive aviation standard testing and manufacturing facilities located at one place. PAC carries the aspirations of the people of its nation to develop indigenous capability to manufacture future generation fighter aircrafts.

62. The four Factories at the PAC Complex are the Aircraft Rebuild Factory (ARF), the Mirage Rebuild Factory (MRF), the Aircraft Manufacturing Factory (AMF) and the Avionics Production Factory (APF).

63. **Aircraft Rebuild Factory (ARF)**. Established in the early 70s with Chinese collaboration, the factory initially started overhauling of F-6 aircraft. With an increasing sphere of responsibility, the factory undertook the task of overhauling of A - 5III, FT - 5, Y - 12, K - 8 and F - 7 aircraft variants. The MRO setup, which has a number of accreditations not only meets the needs of the PAF but also undertakes overhauling and repair tasks of friendly countries namely Sri Lanka, Zimbabwe, Nigeria etc.

64. The core facility has a rich experience of manufacturing and overhauling canopies and windshields of Chinese, T-37, Cessna, IL 78 Aircraft and Mirage windshield partitions. It has also acquired the technology for manufacturing single piece windshield. The major sub-verticals at the ARF are :-

(a) **Production Support Group.** At ARF is a hub of metal parts manufacturing with diversified services like CNC and conventional machining centres, forging and casting, NADCAP qualified heat and surface treatment facility.

(b) **Precision Machining Complex.** Is a Boeing Quality Management System (BQMS) certified CNC setup - capable of manufacturing aviation and military standard Aluminium, steel and titanium alloy parts by using the latest CAD / CAM software.The products are qualified by utilising the state-of-the-art Coordinate measuring machine (CMM). PMC is manufacturing parts for Chinese origin fighter and Boeing-777 aircrafts. Drop Tank Manufacturing Facility is capable of fabricating supersonic tanks along with repair and testing of metal tanks for modern fighter aircrafts. It features a wide array

of sheet metal processing and welding facilities along with expertise in Argon Arc, Seam, Spot and electric welding processes. Stringent stage wise quality control ensures achieving highest of the aviation standards.

(c) **C-130 Propeller Overhaul Facility**. Set up in collaboration with Derco Aerospace Inc. (presently a Sirosky (UTC Group) Companyproviding logistics and technical support for fixed-wing aircraft besides offering a suite of fleet management solutions, including spares distribution, logistics solutions, repair and overhaul services and technical solutions) and certified by Hamilton SundstrandPacific Aerospace Pte Ltd (also a UTC Group Company) is a recent success story. The facility has broad capability spectrum and is fully conversant with latest aviation technologies. Other than overhaul of C-130 Propellers, it is also carrying out repair, fabrication, rework and overhaul of its accessories including the Pump and Valve Housing. With addition of Quick Engine Change overhaul, it has become the state of the art facility that is being offered to friendly countries.

(d) **Harness Manufacturing & Rework Centre.** Manufactures and repairs wiring harnesses of various types of aircraft. The capability spectrum includes a wide variety of harnesses. A harness is a complex combination of wires and connectors. This task is very delicate and requires high skill levels. Elaborate testing of all the manufactured and repaired harnesses is carried out. The work centre is qualified for rewiring of used aircraft with new harnesses. Equipped with Laser marking, thermal transfer printing and automated testing facilities this work centre provides all modern technologies under one roof.

(e) **Metrological Centre, ARF.** Is one of the leading calibration and testing facility in defence sector

of Pakistan for calibration of PMEs and testing of aviation and general industry parts. It is an ISO 17025 accredited laboratory. Capabilities of this work centre includes Physical, Chemical, Metallographic and Non-Destructive testing besides calibration of PMEs related to length, Pressure, Mass, Volume, Force, Temperature and Frequency. The standard equipment used here has international traceability for its accurate functioning. It extends calibration and testing services not only to PAC and PAF but also to various reputed public and private sector Pakistani and foreign organizations.

65. **Mirage Rebuild Factory**. Was established in 1974 for in-country overhauling of Mirage aircraft and has ever since evolved into a centre of excellence for maintenance, repair and overhaul of military aircraft and jet engines. The dream of establishing the Mirage rebuild factory came true, when the first Mirage aircraft rolled out after successful overhaul in 1980. A comprehensive setup for overhauling the Mirage aircraft, MRF is certified by Dassault Aviation of France.

66 The capability of the Mirage Rebuild Factory has been enhanced over the years to overhaul the engines of other military fighter and transport aircraft. In the same pursuit a Rolls Royce certified facility has been established for overhauling the T-56 engine of C-130 aircraft. Like the ATAR engine the overhaul journey of the T56 follows an identical process cycle for its overhauling. Overhaul facilities for TFE-731 Honeywell engine of K-8 aircraft have also been set up.

67. **Aircraft Manufacturing Factory (AMF)**. Was established in 1975 to undertake manufacturing of a primary flying trainer aircraft under license from SAAB SCANIA of Sweden. The aircraft was named Mushshak, (meaning “Proficient’) and was produced from the kits provided by SAAB. After successfully producing 92 Mushshak aircraft, AMF acquired the status of Original Equipment Manufacturer (OEM)

in 1981. AMF has since produced more than 300 Mushshak aircraft which are successfully flying not only with the PAF but also with the Forces of foreign countries such as Saudi Arabia, Oman, and South Africa. The Mushshak not only meets the requisites of international aviation standards but also conforms to Pakistan and South African civil aviation standards. Equipped with Lycoming 260 HP engine (a major American manufacturer of aircraft engines), advanced avionics package, Garmin and Dynon Glass cockpits and side by side seating for instructor and student pilot, Super Mushshak forms an ideal platform for a variety of roles. Short take-off and landing distance, higher g load bracket, excellent stall and spin recovery, enhanced structural life of 9500 hrs and above all excellent after sales spare and structural repair support are some of the key features rendering super Mushshak aircraft to be far superior then its contemporary primary trainer aircraft of same class. Over the years, AMF's stature as aircraft manufacturer grew manifold with successive capability achievement to manufacture Jet aircraft trainer K-8 in late 80s, unmanned aerial Vehicle FALCO in 2008 and the modern Jet fighter aircraft, named JF-17 Thunder. Today, AMF has the capability of manufacturing structural parts and aero-structure assemblies such as the Horizontal Stabilizer, Elevator, Vertical Stabilizer, Rudder and Front Fuselage of K-8 aircraft. The major workshops at the AMF are:-

(a) **Machining Centre.** For production of aircraft parts is equipped with state of the art conventional and CNC machines. Parts with relatively lesser accuracies are manufactured on conventional machines whereas complex parts involving higher accuracies and profiles described by higher order polynomials are manufactured utilizing CNC machines, integrated with Computer Aided Design and Computer Aided Manufacturing Systems.

(b) **Sheet Metal Workshop.** For JF-17 parts houses

an array of conventional and CNC machining facility. Machines such as Guillotine and Nibbling Shear, Conventional and CNC Stack Routers etc are utilized for processes like Shearing, Routing and Sawing techniques. Whereas CNC shot peen forming, Hydraulic Quintus Fluid Cell press, CNC Stretch Forming and CNC punching etc are used for manufacturing of parts involving sheet forming processes.

(c) **Material Testing Centre (MTC)**. Has the capability to conduct all kinds of Physical, Chemical and Non Destructive Testing (NDT) of material including testing capabilities of all heat and surface treatment equipment for periodic qualification.

(d) **Aero Structural Build up Facility**. Where the first phase of aircraft assembling starts at Hundreds of sheet metal and machine parts, pipes and components etc are put together to build aircraft sub-assemblies such as fuselage, wings, horizontal and vertical stabilizers and ailerons etc.

(e) **Flight Test Station (FTS)**. Where the assembled aircraft or stringent checks of each and every system of the aircraft. This is followed by series of aircraft ground runs and quality shake-downs before finally handing over it to the test pilot for yet another series of functional check flights (FCFs) to ascertain the airworthiness.

68. **Avionics Production Factory (APF)**. Was initially established as the Radar Maintenance Centre (RMC) in 1983 for overhaul / rebuild of ground based radar systems. In 1989, its capability was enhanced to handle avionics along with ground based radars.Today APF, with its state of the art facilities, can undertake production of different types of avionics as well as commercial electronics equipment while ensuring high quality standards as per requirements of Aerospace Standard AS9100 Rev C. The Factory has produced number avionics systems

like Grifo-7 and KLJ-7 airborne radars, radar warning receivers, Identification of Friend or Foe (IFF), Digital Audio Video and Crash Recorders, various mission computers and navigation systems. Most of these systems have been co-produced in collaboration with Chinese and Western manufacturers. It has also produced various commercial products such as PAC PAD called Takhti-7, PAC notebook and e-book reader. The avionics production facility at APF can be divided into six major segments: Design & Development, Avionics Integration, Production Line, Testing Line, Specific System Department and Environmental Stress Screening facilities.APF also provides life cycle support for these airborne avionics systems and carries out overhauling/refurbishment of low level and high level ground based radars. The Factory has so far overhauled more than 90 MPDR and TPS series of radars.

69. Major PAC products are as follows:-

(a) **JF-17 Thunder LCA**. The JF-17 Thunder is an advanced, light-weight, all weather, day / night multi-role fighter aircraft; developed as a joint venture with Chengdu Aircraft Industry Corporation (CAC) of China. It possesses excellent air-to-air and air-to-surface combat capabilities. The state-of-the art avionics, optimally integrated sub-systems, computerized flight controls and capability to employ latest weapons provides decisive advantage to JF-17 over adversaries of same class. This, all weather, multi-role light combat fighter has remarkable high combat manoeuvrability at medium and low altitudes. The JF-17 aircraft has been formally inducted in Pakistan Air Force by replacing A-5 aircraft of an Operational Squadron of PAF. The aircraft was show cased for the first time at Farnborough Air Show UK in the year 2010.

PAC holds the exclusive rights of 58% of JF-17 airframe co-production work. A comprehensive

infrastructure comprising state of the art machines and required skilled human resource has very quickly been developed at the Complex. PAC has also upgraded its quality, technology and archive management sys**tems to meet the production and management standards required for third generation fighter aircraft.**

(b) **Karakoram-8 (K-8)**. Karakoram-8 (K-8), Basic Cum Advance Jet Trainer, is co-developed by Aircraft Manufacturing Factory (AMF), Pakistan Aeronautical Complex, Kamra, and China Nanchang Aircraft Manufacturing Company (CNMC). The aircraft is being used for imparting basic and operational jet training to newly inducted pilots at PAF Academy Risalpur. Its key features are wide speed range and high manoeuvrability, Satisfactory flying qualities in accordance with the requirements set forth in MIL-F-8785C IV for highly manoeuvrable aircraft. The K-8 has a good field of view and cockpit arrangement very close to a combat aircraft.Its advanced turbofan engine with low specific fuel consumption and minimum operation and maintenance cost and its state of the art equipment (including instrumentation, communication, navigation, etc.) meet the requirements of training pilots for the future.

Other features of the K-8 are:-

- Highly reliable escape system.
- Advanced strap on environmental control system capable of providing cockpit air- conditioning both on the ground and in the air.
- Hydraulically operated wheel braking and nose wheel steering
- Multi role capability for training.

- 8000 flight hours service life for airframe structure.
- Long endurance and high service ceiling adequate for a wide range of missions.
- Low life cycle cost.
- Short turn-around time and low maintenance work load.

(c) **MFI-17 Mushshak (The Proficient)**. The MFI-17 Mushshak (The Proficient) is a light-weight, robust, two/three seats, single engine, predominantly all metal aircraft with tricycle fixed landing gear. It has been developed to meet US FAR 23 certification in categories normal, utility and aerobatics. It can operate from any short un-prepared strip and is completely independent of any kind of ground equipment. Super Mushshak (The Agile) - advanced avionics is an upgraded version of Mushshak fitted with a more powerful engine, cockpit air-conditioning, electrical instruments, and electric cum manual elevator and rudder trim.Mushshak meets the requirement of a modern primary training syllabus and is an ideal basic trainer and is ideal for Basic flight training, Instrument flying, Aerobatics, stalls and deliberate spins, Night flying, Navigation flying, Formation flying and Army Co-operation Missions. Besides primary flying training, Mushshak is also suited for a wide range of army co-operation missions including Forward air control, Forward area support with droppable supply containers, Reconnaissance, Artillery fire observation Camouflage inspection, Border patrol, Liaison, Target flying and target towing for training of ground units.

(d) **Super Mushshak (The Agile).** is an upgraded version of Mushshak fitted with a more powerful engine, cockpit air-conditioning, electrical instruments, and electric cum manual elevator and rudder trim besides

advanced avionics. In August 2016, PAC signed a deal for sale of Super Mushshak Trainer Aircraft with Qatar. The Aircraft is already in service with Saudi Arabia, Oman, Iran and South Africa. The deal comes in succession to another export deal of Super Mushshak Aircraft to Nigeria in early 2016. The deal further strengthens PAC's status as a world class aviation industry producing the supersonic JF-17 Thunder and Super Mushshak Trainer Aircraft.

(e) **Avionics Systems**. Grifo Radar (an all-weather fire control radarKLJ-7 Airborne Radar, The KLJ-7 is an X-band airborne fire-control radar (FCR) with BVR Range capability, Radar Warning Receiver (RWR), Global Attitude Heading reference System (GAHRS), Identification of Friend or Foe (IFF), Integrated Survivable Recorder (ISR), Light Warning System (LWS), Stores Management System (SMS), Smart Head Up Display (SHUD), Instrument Landing System (ILS), Back Up Acquisition Computer (BAC), Inertial Navigation System (INS), Smart Multi-Function Colour Display (SMFCD, a NVIS compatible display providing the graphical interface of the avionics & non-avionics systems to the pilot), . Central Suppression Unit (CSU), Weapon Mission Management Computer (WMMC), Electro Mechanical Management Computer (EMMC), Data Transfer Unit (DTU), Digital Video Recorder (DVR), Audio Control Box (ACB) Audio Control Box (ACB), Up Front Control Panel (UFCP), Avionics Activation Panel (AAP)

(f) **Commercial Products**. Takhti-7 is the latest version of PAC PAD being manufactured in collaboration with M/S INNAVTEK.

Other Defence Industry Establishments and Production Houses

70. There are at present over 20 major Public Sector Organizations and over 100 Private Sector firms engaged in the manufacturing of defence related products that augment Pakistan's Public Sector indigenous production. The important of these are discussed hereunder.

Margalla Electronics

71. Margalla Electronics (ME) is an electronics defence company involved in research and development for electronic equipment for Pakistan armed forces. Founded in 1984 by the noted Pakistan nuclear Scientist Dr. Samar Mubarakmand, ME is a self-reliance project under the Defence Production Division to support the Defence Services in repair and rebuild of electronic equipment and applied research to improve equipment performance and reliability. ME has co-produced and fielded sophisticated state-of-the-art radar systems and communications equipment jointly with various international companies.

72. Margalla Electronics (ME) was created in 1984 as a self-reliance project under the Defence Production Division to support the Defence Services by the manufacture of ground based radar. "The infrastructure was completed in 1987 to start work on American LAADS radar. A total of 9 radars worth $1.06 million per unit were in CBU form. Another two were procured for $ 1 million per Unit in SKD form. The final delivery of four were made at $ 0.95 million per Unit and thereafter rthe LAADS radar project was completed in 1991. In 1987, another order was placed for 14 Italan 'Skyguard' radar. These, which came at $2.56 million were financed through the US FMS program".[9]

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[9](Pakistan's Arms Procurement and Military Build Up 1979-99 Buid up 1979- 1999 In Search of a Policy by Ayesha Siddiqa Agha (Palgrave McMillan 2001)

73. In 1986, an order was placed for 17 ‘Giraffe’ fire control radar which consisted of four CBUs for a price of $ 0.84 million per unit, four SAKDs to be assembled at Sweden and four SKDs to be assembled at Margalla Electronics. The objective was that Margalla should attain 70% deletion of foreign components by 1994 but it failed to meet the required goals. This has been attributed to industrial and technological discrepancies on the one side and the strong import lobby on the other which preferred importing equipment, including radars rather than anchoring the manufacturing technology in the field of electronics. The support includes:-

- Repair and rebuild of electronic equipment used by the services
- Applied research to improve equipment performance and reliability
- Original design and production.

74. Within a short span of time ME has accumulated sophisticated skills and hardware necessary for assembling, testing, and repairing of various types of military electronics products. ME has co-produced and fielded sophisticated state-of-the-art radar systems and communications equipment jointly with various international companies.

Global Industrial Defence Solutions (GIDS)

75. Global Industrial Defence Solutions (abbreviated GIDS) is a private conglomerate in Pakistan that designs, manufactures and exports various types of military, industrial and technological products. GIDS represents group of companies both national and International, which are involved in research, development, delivery and support of leading edge industrial and defence systems. GIDS Companies are:-

(a) Advance Engineering Research Organization

(b) Integrated Defence Systems

(c) Marine Systems Limited

(d) Institute of Industrial Control Systems

(e) Al-Technique Corporation of Pakistan

(f) Defence Science and Technology Organization

(g) XPERT Engineering

76. GIDS supplies UAV platforms, flight control systems, C4I systems, data-links, payloads, ground support equipment along with other equipment such as laser range finders, military batteries, Naval vessels and various types of industrial and security equipment.

Systems Development

77. GIDS claims that the bulk of its defence and industrial equipments, including data and communications links, have been developed in-house. However, for its shahpar UAVs, GIDS have worked with Rotax to meet engine requirement. Development work in the tactical segment potentially allows the company to supply sub-systems and components to other manufacturers and users. This potential market is being pursued alongside full systems development.

78. GIDS also develops nuclear, biological and chemical defence systems. The GIDS conglomerate comprises of the Advance Engineering Research Organization, Integrated Defence Systems, Marine Systems Limited, Institute of Industrial Control Systems, Al-Technique Corporation of Pakistan, Defence Science and Technology Organization and XPERT Engineering. While most GIDS products are indigenous, the Shahpar UAVs that GIDS supplies have been developed in collaboration with Rotax, who supply the engines.

79. Besides the Shahpar UAV Systems, major GIDS supplies to the Pakistan Defence sector are the Shahpar UAV system, GIDS Uqab Tactical UAV system, GIDS Huma Tactical

UAV system, GIDS Scout Mini UAV System, GIDS Sentry UAV System, Rabta (C4I & Air Defence Automation System), Air Combat Manoeuvring Instrumentation System, LISA-4000 AHRS (Inertial Reference and Navigation System), Airborne Video Tape Recorder, ZUMR-1(EP) Day and Night surveillance systems.

80. GIDS Products include:-

(a) **Air Systems**. GIDS Shahpar UAV system, GIDS Uqab Tactical UAV system, GIDS Huma Tactical UAV system, GIDS Scout Mini UAV System, GIDS Sentry UAV System, Rabta (C4I & Air Defence Automation System), Air Combat Manoeuvring Instrumentation System, LISA-4000 AHRS (Inertial Reference and Navigation System), Airborne Video Tape Recorder, ZUMR-1(EP) Day and Night surveillance system, GP Series Bombs(General Purpose Steel & Pre-Frag Bombs), Conical Tail Unit, Retarded Tail Unit, AB - Series (Electronic Impact & Proximity Fuses), Sea Surge (Anti-Submarine Weapon), CMF 1 & CMF 2 Infrared Flares, Mohafiz (Chaff & Flare Dispenser System), Anza MK-II Surface to Air Guided Missile, Automatic Fire Control System for 37mm Anti-Aircraft Gun.

(b) **Naval Systems**. Slim Line Towed Array, RIBAT (ESM System), Bridge Pilotage Simulator, Action Speed Tactical Trainer, Naval Police Boat, Naval Vessel OPS Room Simulator, SIMPAS (Propulsion Simulator for Submarine), SIMDAS (Naval Vessel Operations Room Simulator).

(c) **Land Systems**. Pak-Integrated Battlefield Management System (Rehbar)PAKFIRE (Artillery Fire Control System), PAKSIM (Artillery Forward Observer Simulator), Baktar Shikan Anti-tank Guided Missile Weapon System, Nigehbaan (Day/Night Surveillance

System), Night Observation Device, AR 3 Laser Range Finder, LRH 786Q Laser Range Finder, Laser Designator & Ranger, Laser Threat Sensor, Digital GoniometerVehicle Mounted Kitchen, Mobile Field Kitchen andMilitary Batteries.

(d) **Nuclear, Biological and Chemical Defence Systems**. NBC Defence & IPE (Nuclear Biological & Chemical Defence Suit), High Efficiency Advanced Decontamination System, Water Purification Plants.

(e) **Security Products**. Ballistic Helmet, Metallic Mine Detector, Non Metallic Mine Detector, Explosive Detector, Stun Grenade, Tear Gas Shell, CS Grenade, Smoke Grenade, Body Scanners, Walk Through Scanning Gate, Bullet Proof Jacket, Industrial products: Optical Fibre Cables, Digital Signage, Three Phase Electronic Energy Meters & Remote Metering Solution, Remote Metering Solution of Gas Meters, HEPA Filters, Paintolite Paints, Un-plasticized Polyvinyl Chloride (UPVC) Windows & Doors.

(f) **Solar Solutions**: LED Lights, Cathodic Protection of Jetties

Integrated Defence Systems (ID)

81. Integrated Defence Systems was created with an objective of developing an infrastructure for the indigenous weapons development and achieving self-reliance in diverse technologies related to these areas. It has been the goal of IDS to deliver state of the art military hardware at competitive prices. Since its creation, IDS has made remarkable progress in development of tactical weapons and the functional flexibility offered by IDS products is an added value to its users.

82. The list of some of the products and services is as follows:

(a) **Weapon Systems and Defence Products**. Unmanned Aerial Vehicles (UAV's UAVs include the long range surveillance RPV "Vector" short range surveillance RPV " Hornet" and the high speed aerial target "Nishan".), Anti-Armour Bomb (HIJARA), Cluster Bomb Unit (Combined Effect Munition), Star Fish Naval Ground Mine, Warheads for Anti-Armour and Tactical Applications, Launchers, Energetic Materials and Propellants, Initiatory Devices, Telemetry Systems, Explosive Reactive Armour (ERA), • Defence Electronics, Safety & Arming Devices, Infrared Flares

(b) **Military Batteries**. IDS is the market leader in high quality power sources for military and commercial applications. Batteries manufactured by IDS are Lithium, Nickel Cadmium, Thermal, Zinc silver Oxide. These batteries are used as power sources in missiles, torpedoes, unmanned aerial vehicles, mines, communication s and aircraft.

Institute of Optronics (IOP)

83. The Institute of Optronics (IOP), is an administrative research weapons engineering institute located in Rawalpindi which is noted for its application of advanced military technologies for Pakistan Defence Forces (PDF).

84. The IOP was established in 1984 initially as a project led Ministry of Defence but subsequently handed over to civilian management. Its role and tasks include Undertaking Research & Development. IOP specializes in military specifications production and testing facilities of night vision devices, and image intensifier tubes. Its Capability list includes an Individual Served Night Vision Weapon Sight, Crew Served Night Vision Weapon Sight, High Performance Night Vision Goggles, High Performance Night Vision Binoculars, a Driver's Night Vision Periscope and an Aviator's Night Vision Goggle.

85. IOP has an aggressive indigenization programme to progressively develop and manufacture NVD components in Pakistan. Its future plans include the establishment of facilities for night vision devices based on Thermal Imaging Techniques for all types of armoured vehicles and helicopters. IOP products are also exported.

National Engineering and Scientific Commission (NESCOM)

86. Founded in 2000, the National Engineering and Scientific Commission (NESCOM) administers several Pakistani defence development programs, including the National Defense Complex (NDC) and the Air Weapons Complex (AWC) with its overarching mission being to promote Pakistani "proficiencies in nuclear and ballistic missile development and production" with a "focus on developing conventional military hardware for its military and export markets." It is a civilian controlled scientific and engineering organization carrying out research and development in many areas including information technology, fluid dynamics, aerodynamics, aerospace engineering, electrical engineering, mechanical engineering and chemical engineering, with specialties in the design and production of communication systems and aerodynamic vehicles.

87. Major NESCOM Projects are the following:-

(a) **Burraq UCAV**. The Burraq emerged due to long frustration over the US refusal to supply Predator UCAVs to Pakistan and politicization of the US UCAV strikes in the country. While the first few models of the Burraq were only capable of surveillance and intelligence gathering, and lacked any offensive combat capability, the Burraq has today a reported range of 700 km and is used against militant groups in the North-west. As noted by a leading Science magazine,: "with the Burraq, Pakistan can now do drone strikes on their own, without the United States." The name Burraq comes

from the legendary steed, described as a creature from the heavens which carriedMuhammad from Mecca to Jerusalem to the heavens, and back to Mecca during Mi'raj (lit. "Night Journey").

(b) **Shaheen-I**. Solid-fuel ballistic missile with a reported range of 700 km. The Shaheen was Pakistan's first solid-fuel missile. The missile project began in 1995 and the development and design was carried out by NESCOM's predecessor, the National Development Complex (NDC).

(c) **Shaheen-IA**. An upgraded version of the Shaheen-I with a range of 900 km. The upgrade was supposedly carried out by NESCOM in the early 2000s and supposedly included a terminal guidance system, improved radar-avoidance capability and stealth features.

(d) **Shaheen-II**. Solid-fuel ballistic missile with a reported range of 2500 km.

(e) **Shaheen-III.** Solid-fuel ballistic missile with a reported range of 2750 km

88. NESCOM oversaw the development of Pakistan's intermediate-range Ghauri-3 missile and Pakistan's first cruise missile, the Hatf-7 / Babur at the NDC and the development of the Ra'ad air-launched cruise missile at the AWC. It has also developed communication systems and electronic counter-measures systems for the Pakistani Air Force and Navy.

89. The two development and production agencies over which NESCOM has oversight are:-

(a) **The National Development Complex (NDC)**. Is a Defence and aerospace contractor and a division under the NESCOM. Founded in 1990 at the MoD, the NDC engaged in research and development in space-

based missile systems and expanded its services towards developing the land-based weapons systems for the Pakistan Army and Naval Systems for its Navy. NDC research, development and production include:-

(i) **Missiles**. Babur, Nasr and Shaheen series missiles and depleted uranium ammunition.

(ii) **105 mm anti-tank round**. Reported to have a muzzle velocity of 1,450 m/s and be capable of penetrating 450 mm of rolled homogeneous armour (RHA) at an unspecified range.

(iii) **Naiza (125 mm anti-tank round).** A DU APFSDS anti-tank round developed to be fired by T-80UD tanks in service with the Pakistan Army andstated to have a DU long rod penetrator, performance 25% greater than NDC's 105 mm DU round and a saddle-type sabot with re-arranged forward bore-rider for more accurate alignment with the T-80UD's autoloader.

(iv) **Other Products**. Starfish Naval Mine - that targets submarines and ships that can be deployed by aircraft, ships and submarines using solid state electronics. The mine's attack modes are controlled by a microprocessor which uses magnetic, acoustic and pressure sensors to analyse a potential target's signature. Sensors are mounted flush to both ends of the mine's cylindrical (barrel) shape. Weight: 767 kg, warhead: 500 kg HE (PBX charge), storage life: 20 years.

(b) **Air Weapons Complex**. Founded in 1992, the Air Weapons Complex (AWC) is one of three facilities that comprise the Wah Cantonment Ordnance Complex. It is

amongst Pakistan's leading manufacturers of airborne positioning and navigation systems, global positioning systems, and air-launched weaponry and plays a central role in the development of indigenous unmanned aerial vehicle capabilities. Air Weapons Complex (AWC) is a development and production centre for airborne weapons has more recently been involved in various commercial and other non-military projects also. Major AWC Products are as follows:-

(i) **Airborne Systems**. Airborne Video Tape Recorder (AVTR) systems, Airborne Digital Data Recorder systems, Infra-red search and track (IRST) systems, GPS navigation systems, Mechanical gyro and iFOG-based inertial navigation systems (INS), MOHAFIZ counter-measures dispensing systems, Laser guidance system for Mk 80 series bombs (under license-manufactured design from the US)

(ii) **Air-launched Weaponry**. Practice bombs (6 kg, 11 kg), 250 kg Pre-fragmented bomb, 250 kg Mk.82 general purpose bomb, 500 kg Mk.83 bomb, 1000 kg Mk.84 bomb, Mk.80 series general purpose bomb tail units (low drag or high drag speed-retarding devices), HAFR-1, HAFR-2 and RPB-1 anti-runway weapons (possibly variants of the MatraDurandal), Ra'ad ALCM.

(iii) **Electronics**. Air Defence Automation System (C4I system), Electronic fuses for air-launched weapons (impact and proximity fuses), Real-time ACMI systems and Voice/Fax/Data encryption systems.

(c) **UAV Project**. The Air Weapons Complex embarked on a project for the indigenous development of UAVs (unmanned aerial vehicles) in mid-1998. The

Sky Tracker and Sky Navigator software suites were developed for the ground-based tracking of UAVs. The software retrieves the GPS position data from the UAV via a radio data-link17 and uses it to show the position of the UAV as a 2D plot along with other essential data such as, speed, altitude, heading, etc. This plot can be overlaid onto area maps as well. This information is used by the pilot for flying the UAV from the ground-based command station.

Surveillance and Target Unmanned Aircraft (SATUMA)

90. SATUMA is a privately owned designer and manufacturer of unmanned aerial vehicles (UAV) based in Islamabad, Pakistan. The company was established in 1989 and designs UAVs for the armed forces of Pakistan and for export. Its Product range of UAV systems includes the Flamingo - a medium range UAV, Jasoos II (Bravo +) - a tactical UAV system for remote sensing and reconnaissance, Mukhbar - short range UAV system, Stingray - a mini UAV system, HST - half scale trainer UAV, FST - full scale trainer UAV.

91. SATUMA also produces the Thunder SR (short range), Thunder LR (long range) Target drones besides Assault - training systems and a High speed drone (Shooting Star) and Ground Control Station (GCS) - includes automatic antenna tracker, pilot console with moving map display, real time video display panel, flight status display and joystick for payload camera control. Pathfinder GCS software includes mission planning, in-flight mission modification, real time tracking on moving map display, flight status display, live video display and post-mission analysis.

92. SATUMA has the distinction of being the only company in the private sector whose products are formally inducted in Pakistan Air Force and Pakistan Army.

93. SATUMA Products include Surveillance UAVs

(IMAG1283, Nigraan, Shikra, Super Salaar UAV, Mini UAV (Salaar), Mukhbar, Yellow Flamingo etc.), Target Drones, Trainer UAVs besides Auxiliary Equipment and Ground Control Stations.

National Radio and Telecommunication Corporation (NRTC)

94. Established in 1966, NRTC that functions under the aegis of the Ministry of Defence Production is a telecommunication and electronic equipment manufacturing facility engaged in manufacturing of telecommunication equipment. It is a pioneer in Telecommunication Equipment and leader in the field of communication producing high quality ruggedized products to be used in harsh environment. The endeavour is for continuous up-gradation and use of innovative concepts/ state of the art tools for designing for Testing, Manufacturing, Process and Experiment, continuous investment in testing equipment and skills enhancement for product development.

95. The NRTC design teams carry out R&D work on modern technologies and designing of wide array of complex telecom equipment, systems and solutions; which include:-

- Communication Security Solutions.
- Backbone Communication Solutions (microwave line of sight Systems).
- Total communication system solutions according to customers' needs.
- Software Defined Radio System.
- Integrated Land Mobile Radio Systems.
- Customized Software Applications Development.
- Switching equipment (TDM and IP based).
- Optical Communication Products.

96. **Major NRTC Products**. Radio Sets, FieldExchanges, LandMobile Radios, Microwave Solutions, Encryption Devices, Line Communication Equipment and Field Telephones.

Defence Science & Technology Organization (DESTO)

97. The Defence Science and Technology Organization (DESTO) is a multi-disciplinary programme agency under the Ministry of Defence Production, dedicated for evaluation of science and technology for use by the military.

98. **Created in 1963 in the Ministry of Defence, DESTO's 'clandestine' charter included reverse engineering of the foreign technology and to avoid technological surprise from India.**

99. DESTO's work is kept under secrecy and very little specific information on it or its Projects is available in the public domain. However, what is available in open domain is that DESTO reportedly started its work with a project to study the Wind tunnel and the applications of the fluid dynamics. It also commenced on secret programme on developing the rocket propelled 120-mm caliber high explosive mortar ammunition, variable time fuze, and free flight rockets. DESTO conducts research and development on weapon systems, military technologies, and renders technical advice on weapons–related technological issues to the government. [6] DESTO retains its expertise on variety of disciplines such as aerodynamics, propulsion, electronics, computer systems, engineering, explosives, metallurgy, chemical and biological defence.

100. Since 2001, DESTO's multi-disciplinary infrastructure base is now available to public sector industry under commercial arrangements.[1] Projects and research work at DESTO remains under strict secrecy and very few details of the projects are known to the public.

101. In 2000, DESTO is reported to have achieved a

major breakthrough in ammunition technology by developing ammunition for 120 mm mortar. DESTO's programme had ingeniously developed and manufactured ammunition for 120 mm mortar which has almost doubled the range of conventional ammunition with very less cost effect.

The Space and Upper Atmosphere Research Commission (SUPARCO)

102. The Space and Upper Atmosphere Research Commission (SUPARCO; is an executive agency of the Government of Pakistan, responsible for the nation's public and civil space programme and for aeronautics and aerospace research. Its mission statement and objective is to conduct peaceful research in space technology and promote the technology for socio-economic uplift of the country.

103. Since its creation in 1961, the SUPARCO has achieved numerous milestones, including the first successful spaceflight of country's first weather expendable launch rocket, Rehbar-I. The country's first satellite, Badr-I, was built by the SUPARCO and launched by the People's Republic of China in 1990. However, during the meantime, the space programme suffered many setbacks, difficulties, and problems that partly slowed the progress of the space programme. The bureaucratic influence and politicization further lagged the space programme and many projects were cancelled by the superior authorities.

104. Over the years, SUPARCO expanded and has several well expanded installations all over the country as assets, and cooperates in peaceful use of space technology with the international community as a part of several bilateral and multilateral agreements. SUPARCO's science and research is mainly focused and concentrated on better understanding of the Solar system,[10] Space weather, astrophysics (Big Bang Theory and Physical cosmology), astronomical observation, climatic studies, space and telemedicine, remote sensing and the Earth observation.

105. One of the most earliest and notable achievements of SUPARCO activities was its unmanned space flight programme that was recorded on 7 June 1962. SUPARCO made research in the development of first solid-fuel expandable rockets, an assistance provided by the United States. SUPARCO landed a record achievement when it launched first unmanned solid-fuel sounding rocket and took its first initial space flight from the Sonmiani Terminal Launch. The rocket was developed in a joint venture with Air force and known as Rehbar-I (lit. Teller of the way) and enabled Pakistan to become the third country in Asia and the tenth in the world to conduct successful spaceflight.

106. **SUPARCO Facilities**. The headquarters of the SUPARCO are located near the Karachi University in Karachi. As early as the 1980s, SUPARCO joined the International Cospas-Sarsat Programme of Soviet Union and in 2009 inaugurated a facility known as “Pakistan Mission Control Center”,.

(a) **SUPARCO Plant, Karachi**. Built in the mid-1980s to manufacture sounding rockets for upper atmosphere research. Pakistan’s Hatf-I and Hatf-II ballistic missiles are believed to be derivatives of French sounding rockets built by or with assistance from the ESA.

(b) **SUPARCO Institute of Technical Training (SITT)**. Inducts young talent after schooling and trains them to obtain a Diploma of Associate Engineering (D.A.E).

(c) **Instrumentation Laboratories (IL), Karachi**. Responsible for the design and fabrication of data sensors for rockets, satellites, and ground equipment.

(d) **Aerospace Institute (AI) Institute of Space Technology (IST), Islamabad**. Is Pakistan’s premier Institution for Space Technology. It also serves as a recruiting and training ground for engineers, scientists,

and personnel involved in Pakistan's space programme.

(e) **Satellite Research and Development Center (SRDC), Lahore**. Research and satellite engineering development centre responsible for the design and development of satellites.

(f) **Satellite Ground Station (SGS), Rawat, Islamabad**. SUPARCO-controlled earth observation and remote sensing satellite control space centre.

(g) **Flight Test Range (FTR), Sonmiani Beach, Balochistan**. The main launch facility of SUPARCO.

(h) **Mashhood Test Firing Range (MTFR), Jhelum City**. The second orbital launch facility.

(i) **PAKSAT Ground Control Station (PGCS-L), Lahore**. Ground control facility to control PAKSAT-1R satellite.

(j) **PAKSAT Ground Control Station (PGCS-K), Karachi**. Ground Control facility to control PAKSAT-1R satellite.

(k) **Ionosphere Research Station, Karachi**. SUPARCO operates a national balloon launching facility in Karachi to conduct studies in atmospheric sciences to determine the vertical profile of ozone up to 30–35 km. The Ionospheric Station at Karachi operates an Ionosonde Observation facility, with the first balloon flight mission being carried out in 2004. SUPARCO also has a Lunar program for observational studies on the activity of Lunar phases.

Military Vehicles Research And Development Establishment (MVRDE) Rawalpindi

107. MVRDE, set up in 1972 is a multi-disciplinary organization capable of conducting research and development pertaining

to military vehicles, Engineer equipment and defence-related mechanical systems. Its infrastructure encompasses a wide spectrum of faculities that cover the following:-

(a) **Research and Development Sections**. To carry out dsign, development and product upgradation of Armoured Vehicles – Tanks, APCs, ARVs, Wheeled Vehicles – GS and special Purpose and for Engineers equipment such as earthmoving machinery and Cranes.

(b) **Support and Quality Control Section**. For implementing production and process control, evolving military specifications, and carrying out material analysis, inspections, tests and trials.

(c) **Workshop Section**. Equipped with necessary machinery, plant and manpower for fabrication of mock-ups / models, defect investigation, product improvement besides repair and maintenance of of vehicles and equipment.

(d) **Material Testing and Analysis Labs**. maintain and preserve Technical and Manufacture data Packages.

(e) **Computer Centre**. Facilitates database management, information sharing etc.

(f) MVRDE has completed more than 120 indigenisation projects and developed a large spectrum of equipment that include the following:

(g) **Military Vehicles**. Retrofitting, reclamation and re-engineering.

(h) **Armoured Protection**. Add-on Armour Kits, ERA

(i) **GRP Technology**. Boats, water carnage packs;

(j) **Hydraulic Systems**. Cranes, hoists moble lighting trolleys

(k) **Other Areas**: Fabrication of ferrous / non-ferrou materials and alloys, railway loading ramps; Air-conditioning systems, special purpose mobile shelters and carriers, trailers, training simulators etc.

The Khan Research Laboratories, Kahuta (KRL)

108. Though in the strict sense not a Defence Industrial Enterprise, this monograph would be incomplete without a short note on the Khan Research Laboratories (KRL), one of the largest science and technology institutions in Pakistan that conducts multidisciplinary research and development in fields such as national security, space exploration, and supercomputing.

109. While the laboratories remain highly classified, the KRL is most famous for its research, development, and production of Highly-Enriched Uranium (HEU), using gas centrifuge technological methods roughly based on the model of the Urenco Group, which is the technology brought by Dr. Abdul Qadeer Khan, who worked there as a senior scientist.

110. KRL installed thousands of gas centrifuges, using the Zippe method, to run at about 65,000rpm for an average of 10 years. The U235 containing only ~0.7% enriched material is brought to more than 90.0% through three stages of enrichment, leaving the original material depleted from 0.7% to 0.2%, which then now at both civilian and military-grade.The KRL established a system of numerical control to control the centrifuges in 1983. By 1986, the KRL began producing the HEUs as well as developing the Krytron while classified work on the uranium weapon-design took place with 6UF being reduced to uranium metal and machined into weapon pits.

111. In the 1990s, KRL became a home of a number of the most high-performance supercomputer and parallel computing systems that were installed at the facility. A parallel Computational Fluid Dynamics (CFD) division was established

which specialized in conducting high performance computations on shock waves in weapons effect from the outer surface to the inner core by using the difficult differential equations of the state of the materials used in the bomb under high pressure.

112. Apart from researching on uranium and developing the uranium enrichment facilities, the KRL includes a ballistic missile-space research laboratories and competes with the PAEC to produce advanced ballistic missiles ranging for targeting enemy combatant targets and in space exploration. Its space-missile exploration projects based on producing the liquid fuel rockets in comparison to solid fuel rockets projects of the National Development Complex (NDC). The KRL's missile projects are widely believed to be based on North Korean technology; exchanges took place in the late 1990s. The missiles produced by KRL include the Ghauri I (Hatf V) and the Ghauri II, which has a range of 2,000-2,500 km.

113. The KRL performs variety of weapons science and engineering projects for Pakistan Armed Forces. Since the 1980s, the KRL is involved in numerous military equipment and conventional weaponry development projects. Systems produced based on KRL which have been inducted into the Pakistan Armed Forces as also exported inclue the following:-

(a) **Guided Missiles**. Anza series of man-portable air defence systems, Baktar-Shikan man-portable anti-tank guided missile (ATGM) system, Modules for the BGM-71 TOW ATGM.

(b) **Electrical and Electronic Equipment**. Power conditioners for the above Air Defence Systems.

(c) **Laser Equipment**. Laser range-finders, laser warning receivers, laser aiming devices, a laser actuated targeting system for training tank gunners, Reactive armour kits for armoured vehicles and APFS-DS anti-tank ammunition for MBTs.

Conclusion

114. For a nation with a relatively modest economic base, Pakistan's Defence Industrial base has developed impressively with multi-pronged focus on meeting the Ordnance requirements, development of major platforms like Aircrafts, Ships and Armoured vehicles. The focus on development of UAVs, communication systems and missiles are indicators to how it seeks to secure and take forward its strategic interests in the future.

115. Pakistan no doubt has several more miles to go to achieve substantive self-reliance. So far as intent to be self-sufficient, its action plan, within its fiscal constraints, is clearly on course. Till such time its Defence Industry develops to a level and stature that meets all its core requirements, Pakistan would need to continue relying on its deft diplomacy and political acumen to effectively leverage its locational and strategic position to form long-term diplomatic friendships with major powers.

116. **While the large dollops of military hardware and stores it has received from 'friendly' countries and their active collaboration in assisting Pakistan to develop its own Industry are an index of how successfully it has been able to do so thus far, how it would cope with the challenges of the future in the context of changing geo-political ground realities, would be interesting to watch.**

(This monograph is based entirely upon open source information and literature as available on the internet including the websites of respective production and research organisations).

Appendix

MAJOR DEFENCE PRODUCTS MANUFACTURED IN PAKISTAN

Military Products

PRODUCTS	
Defence	Commercial
Tank Al-Khalid Tank Al-Zarrar APC SAAD APC TALAH Command Post Carrier (SKAB)	Armoured Land Rover Defender 110 Armoured Toyota Altis 1.8 VVTI Armour Toyota Land Cruiser Toyota Hilux VIGO Mohafiz Hybird Mohafiz-II Mohafiz-III Armoured Guard Post 1 Man Armoured Guard Post 2 Man Bomb Blanket Hifazat North Benz 6x4 Prime Move

TANKS	
Al-Khalid Tank 	Technical Specifications Combat Weight.....:46-48tons Crew.....:3 Max Speed.....:70km/h Cursing Range.....:430km Main Gun.....:125m mbore Type of Ammo.....:APFSDS, HEAT,HE Coxial Machine gun.....:7.6mm Anti Aircarft Machine Gun.....:12.7mm Grenades.....:8 smoke, 4HE

Al-Zarrar Tank 	Combat Weight.....:40tons Crew.....:4 Cross Country/Max Road Speed:.....35km/h & 55km/h Main Arnament.....: 29rds Type of Ammo.....:APFSDS,HEAT,HE Coxial Machine gun.....: 2500rds Anti Aircarft Machine Gun.....:500rds Smoke.....:8 grenades Laser Range Finder.....:Yes
APC Saad 	Length.....: 263.5inches(6.09m) Width..... : 100inches(2.54m) Height Without Gunner shield.....: 73inch (1.85m) Weight Combat loaded.....: 15.5 with add on Armour Weight, curb.....: 11.5 ton Area including roof.....: 28.97m2 Personal capacity.....: 15 including Driver Speed (level land).....: 72KMPH
APC Talha 	Length : 218.5inches Width : 100inches(2.54m) Height Without comd copula : 102inch Weight Combat loaded : 12 Ton Weight,curb : 12 ton Personal capacity : 13 including Driver Speed (level land) : Upto 40KMPH

Command Vehicle (CV): SKAB 	Length : 208 inches Width : 100inches Height Without comd copula: 111inch Weight Combat loaded : 12.5 Ton Weight,curb : 11.5 ton Personal capacity : 3 including Driver Speed (level land) : Upto 40KMPH

COMMERCIAL PRODUCTS

	Technical Specifications
Land Rover Defender 110 	Engine 2.7 v6 diesel Hp - 124 Bullet proof front, rear and door glasses Run flat tyres Improved brake and suspension system Air conditioner Protection B6 level with blast protection of floor against 3 kgs of TNT
Armoured Toyota Altis 1.8 VVTI 	Bullet proof front, rear and door glasses Run flat tyres Improved breaks and suspension Provide protection against fragmentation (DM 51) Protection level B5/B5+
Armoured Toyota Land Cruiser 	Engine- 4.5 liter twin turbo diesel Hp-240 Run flat tyres Bullet proof front, rear and door glasses Air conditioner Protection B6 level with blast protection of floor against 3 kgs of TNT – B

AIRFORCE PRODUCTS

AIR CRAFTS

JF-17 ThunderDefender 110

F-17 Thunder is an advanced, light-weight, all weather, day / night multi-role fighter aircraft; developed as a joint venture between Pakistan Aeronautical Complex (PAC), Kamra and Chengdu Aircraft Industry Corporation (CAC) of China. It possesses excellent air-to-air and air-to-surface combat capabilities. The state-of-the art avionics, optimally integrated sub-systems, computerized flight controls and capability to employ latest weapons provides decisive advantage to JF-17 over adversaries of same class. This, all weather, multi-role light combat fighter has remarkable high combat maneuverability at medium and low altitudes. With effective firepower, agility and combat survivability, the aircraft is likely to emerge as a potent platform for any air force.

Physical Parameters

Length	49 ft
Height	15.5 ft
Wingspan	31 ft
Empty Weight	14,520 lb

Performance Parameters

Maximum Take Off Weight 27,300 lb

Max Mach No 1.6

Maximum Speed	700 Knots IAS
Service Ceiling	55,500 ft
Thrust to Weight Ratio	0.95
Maximum Engine Thrust	19,000 lb
G Limit	+8,-3
Ferry Range	1,880 NM

Armament

No of Stations	07
Total Load Capacity	3400 lb

OTHER PRODUCTS

K-8 Aircraft 	Satisfactory flying qualities in accordance with the requirements set forth in MIL-F-8785C IV for highly maneuverable aircraft. Karakoram-8 (K-8), Basic Cum Advance Jet Trainer, is co-developed by Aircraft Manufacturing Factory (AMF), Pakistan Aeronautical Complex, Kamra, and China Nanchang Aircraft Manufacturing Company (CNMC). The aircraft is being used for imparting basic and operational jet training to newly inducted pilots at PAF Academy Risalpur.
MUSHSHAK Aircraft 	The MFI-17 Mushshak (The Proficient) is a light-weight, robust, two/three seats, single engine, predominantly all metal aircraft with tricycle fixed landing gear. It has been developed to meet US FAR 23 certification in categories normal, utility and aerobatics. It can operate from any short un-prepared strip and is completely independent of any kind of ground equipment. Super Mushshak (The Agile) - advanced avionics is an upgraded version of Mushshak fi tted with a more powerful engine, cockpit air-conditioning, electrical instruments, and electric cum manual elevator and rudder trim
Avionics Systems 	Avionics Systems Co-produced Projects Grifo Radar KLJ-7 Airborne Radar Radar Warning Receiver (RWR) Global Attitude Heading reference System (GAHR)

Drop Tanks Production 	PAC has capability to manufacture drop tanks. Punching, Rolling, bending and corrugating machines transform the Aluminium sheets into rolled skins which are further welded and assembled. The facility utilizes the expertise of trained welders and sheet metal fabricators to produce the drop tanks as per aviation standards. Repair of pipes for all Chinese origin drop tanks is also carried in the same facility. Pipes bending, cutting, beading, flaring, deburing and fixtures are available for pipes having diameter upto 40mm. All pipes are subjected to pressure and leak test before dispatch to ensure 100% reliability of the product.
Canopy Manufacturing 	F-7P, FT-7P , FT-7PG side wind shields and canopy is repaired, formed and assembled at ARF. F-7PG canopy glass is also formed, assembled and overhauled. K-8 canopy and windshield assembly and repair is carried out. The facility has the potential to form canopy glass for JF-17, Mirage and K-8 aircraft in future.

Telecom Products

JAMMERS	
PK-100B Jammer (FPGA Based) 	Modular Design High Speed Sweep Power output 130W nominal maintained in continuous mode Of operation Excellent power density, high efficiency And wide dynamic range Input power supply 28VDC High VSWR warning and protection High/Low Power Indication Highly rugged and Reliable
WB-200 Jammer 	Modular Design High Speed sweep jamming (VHF_low,VHF_high,UHF) High speed frequency hopped spot jamming on 10 programmable frequencies Handheld programming device Power output 200W nominal maintained in continuous Mode of operation Excellent power density, high efficiency and wide dynamic range Input Power Supply 28 VDC High VSWR warning and protection High/low Power Indication Highly rugged and reliable
Man-Pack 25-175MHz 	High speed sweep jamming (VHF_low, VHF_high) Power output 40W (VHF-low+VHF-high) nominal maintained in continuous mode of operation Excellent power density, high efficiency and wide Dynamic range Input power Supply 24 and 12 VDC High VSWR warning and protection High/low Power Indication

Man-Pack 25-175MHz	Modular design High speed sweep jamming(VHF_ low, VHF_high,UHF,GSM_900,G-SM_1800) High speed frequency hopped spot jamming on10 programmable fre-quencies DLU-VU-50”Handheld programming device” Power output 200W nominal main-tained in continuous Mode of operation Excellent power density, high effi-ciency and wide dynamic range Input Power Supply 28 VDC High VSWR warning and protection High/low Power indication Highly rugged and reliable

RADIO SETS

Software Defined Radio 	Based on its software configurable architecture, SDR ensure clear or encrypted voice and data commu-nication in VHF and UHF frequency band (30-512 MHz) as well as full automatic integration with tactical and strategic networks to provide “cellular phone” services to tactical users. The radio transceiver features a 96x 64 graphical LCD display and a 3x6 keypad for easy man machine interface. The menu structure and controls are very similar to cellular phones for ease of use and training. SDR insure increased survivability against electronic Warfare threats by providing alternative communication function compared to conventional radios.

	The SDR is equipped with highly secure communication methodology owning to its frequency hopping feature, which makes the communication immensely cumbersome to be detected on wireless channel. The SDR has the capability of creating 30 channels TDMA packet switched network
9600 Series VHF/FM Radio 	9600 family offers a cost/performance optimized total system solution to the user being compatible and interoperable with current fielded VHF/ FM radios families like PRC-77,PK/VRC Series and PRC/VRC-4600 etc, direct replacement to 4600 radios Frequency hopping Voice/ Data Encryption Burst Transmission
PRC-77 Up-Graded 	The up gradation has been carried out incorporating certain modern design techniques along with the use of SMD components. Up-graded PRC-77 radio set have all the features of modern radio like encryption, integrated circuitry, digital synthesizer at a substantial lower cost as compared to new modern radio
Personal Role Radios (PRR) 	The PRR (personal role radio) operates in 2.4GHz frequency Band using spread spectrum waveform-combination of time hopping, frequency hopping and OFDM. Duplex voice communication in a group of upto 30 users. Semi Duplex voice communication without limiting the number of users Conference call upto four users Wireless PTT keying Learning mode for wireless PTT key assigning VOX keying USB data interface

Land Mobile Radios 	LMR Base Station Radios. LMR Handheld Radios. Mobile Radio.
Field Exchanges  	PFX-6416 Digital Exchange PFX-3208 Digital Exchange. PFX-1604 Digital Exchange. Automag Field Exchange.
Microwave Solutions 	PTP SDH / PDH Digital Radio. SADMC Digital Microwave Radio. SHSPC Digital Microwave Radio. SSTM1C Digital Microwave Radio.

NAVY PRODUCTS

F22P Frigate 	Length Overall 123m Breadth 13.20m Depth 10.20m Draught (Max) 5.10m Displacement 2980ton Speed (max) 29 knots Range 4000NM Complement 183
Fast Attack Craft (Missile) 	Length Overall 60m Breadth 8m Depth 4.3m Draught 1.85m Displacement 560tons Speed (Max) 30 knots Endurance 1000NM
Small Tanker Cum Utility Ships (STUS) 	Length overall 47.2m Breadth 11m Depth 5.8m Designed draft 4.8m Speed 15knots Displacement 1600tons Range 2000NM Bollard pull 40tons
Agosta 90B Submarine 	Length overall 76.24m External diameter 6.80m Displacement 1730tons Operation depth 320m Speed (max) 20knots Endurance 68 days Complement 36+5

Jalalat Class Missile Boat 	Length Overall 39.00 m Breadth 6.70m Depth 3.60m Draught 1.64m Displacement 200tons Speed 25knots Complement 25
Fleet Tankers 	Length Overall 156m Beam (Max) 21.6m Draft (Deep) 7m Speed 20knots(Max) 15knots(Cruising) Endurance & Range 10,000NM at 15knots Propulsion and Storing system 2xDiesel engines twin screw CPP propellers Accomodation 206personal F-76/HSDO(Cargo & Bunker) 8158tons(7158-1000) JP-5(Cargo & Bunker) 150tons(120+30) Fresh Water (Cargo & Bunker) 1000tons(800+200) Dy Ration 100tons Naval stores & spares 3months
Split Hopper Barge 	Designed to be deployed with cutter suction dredgers. Cutter suction dredgers cannot store dredged sediments on board, and for some applications it is not possible to discharge the dredged sediments through pipelines. In such cases, the dredged material can be pumped directly into split hopper barges, which are moored alongside the cutter suction dredger. Split hopper barges are also loaded by means of backhoe dredgers.

Coastal Oil Tanker 	885 TDW Coastal Tanker (fuel, water and dry cargo) which can be modified to suit customers' requirements.
Floating Dock 	Floating Docks are very useful for ports that do not have graving/dry docks. Can be towed to ports where required. Provides numerous advantages including onboard repair workshops, cranes, etc. KS&EW can construct state of the art Floating Docks with lifting capacity ranging from 1000~5000 tons.
32 & 10 Ton Bollard Pull Tug 	KS&EW has constructed various tugs ranging from 10 to 40 Tons Bollard Pull; but construction of this Tug is distinct due to very robust design and state of art equipment and machinery to facilitate multi-purpose
Harbour Utility Vessels 	KS&EW has manufactured Harbour and Ocean going Tugs and other harbour utility vessels in various configurations. Many such vessels has been built for the National as well as International customer, meeting their specific needs and requirements.

Midgets Submarines