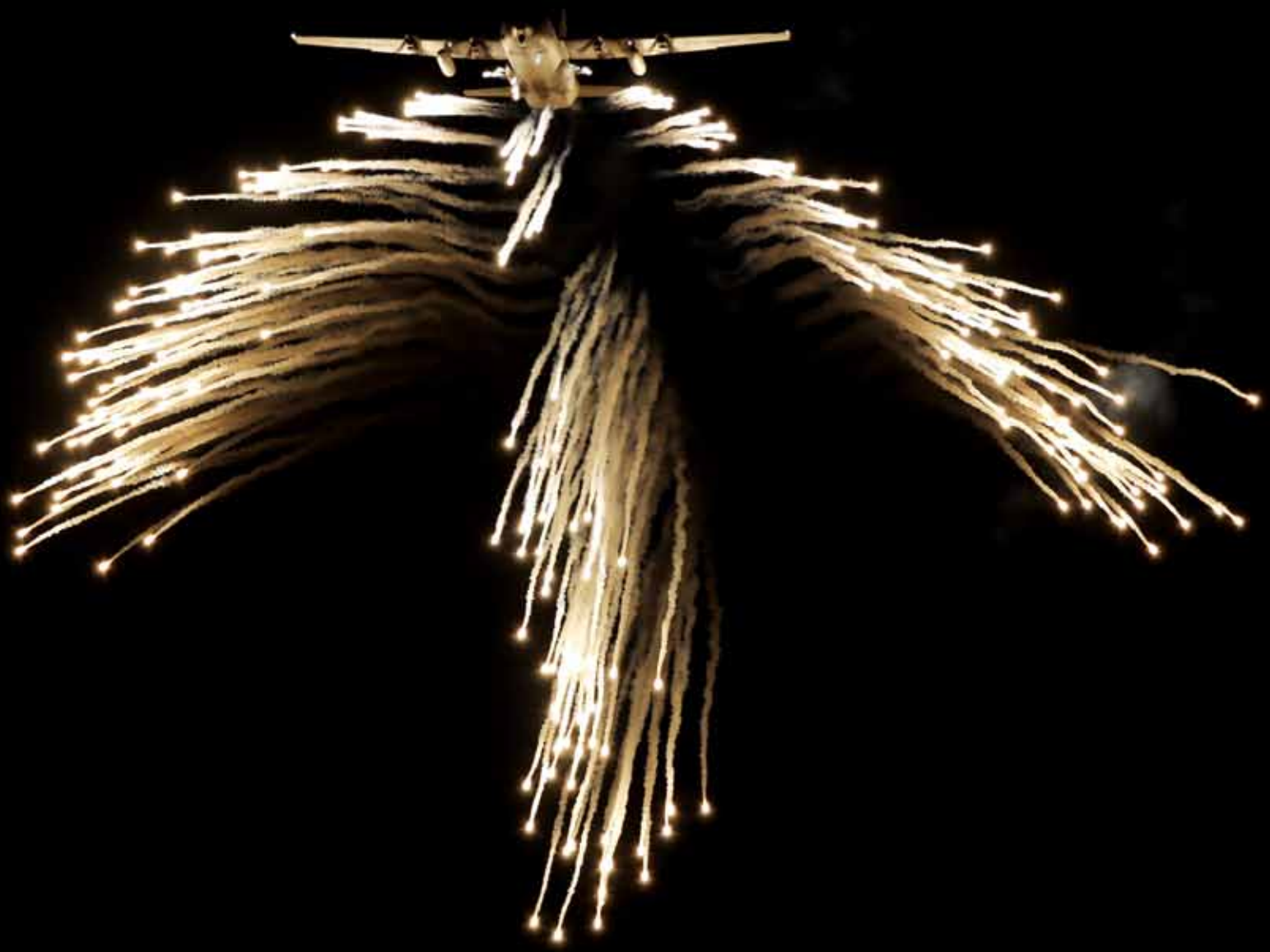
VAYU

Aerospace & Defence Review

II/2019



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Cover : Spectacular display of anti-missile flares fired from IAF C-130J Hercules during Vayu Shakti 2019.
Courtesy : Major VK Singh, Photo Division, DPR Ministry of Defence

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The month of February 2019 will be recalled for several "live" matters concerning air power in the region, these being highlighted in this Issue, including the IAF's precision strikes against terrorist targets in Khyber Pakhtunkhwa, that preceded by the IAF's 'routine' fire power demonstration at the Pokhran ranges, in between which was the biennial Aero India Show at Bangalore. All these actions and more, are covered.

Regular features :
Commentary, Viewpoint, Opinion, National Interest, Aviation & Defence in India, World Aviation & Defence News, Ancient Aviator Anecdotes, Vayu 25 Years Back, Tale Spin.

Don't play politics with the IAF

Probably because he is a former Army Chief, Gen VK Singh (Retd), now a Union minister, understands better the importance of national unity when relations with Pakistan are strained to the point of military hostility. This is why he ticked off B.S. Yeddyruppa, a former Karnataka chief minister, on whom rests the saffron party's hopes of reclaiming power in the state. The minister of state for external affairs responded sharply to Mr Yeddyurappa's public observation that the IAF's Balakot airstrike and the return by Pakistan of Wing Commander Abhinandan Vartaman would help the BJP win 22 of the 28 Lok Sabha seats in Karnataka.

A time of military tension is not for playing partisan politics, the retired Army Chief reminded the top-flight politician. He also underlined the need for emotional and political unity. But it seems Gen. VK Singh's viewpoint has few takers at the top tiers of the ruling party and government. BJP president Amit Shah had said that the coming Lok Sabha election was going to be about how to give Pakistan a fitting reply. After Mr Yeddyurappa's statement, this appears to be the most flagrant display of partisanship.

From the very start of the recent cycle of hostility with Pakistan, as various elements of the government at top levels sought to hog the credit for what the Air Force had done, 21 Opposition parties met to criticise the "blatant politicisation" of the airstrike by ruling party politicians. This was attacked by two Cabinet ministers, Prakash Javedkar and Arun Jaitley. The former said the observations of the BJP's opponents were being picked up by Pakistani politicians to embarrass India. The latter spoke of the Opposition's statement being "ill-advised". In effect, both were asking Opposition parties to join the jingoistic chorus which has been unleashed by the television news channels, apparently at the government's goading.

The self-congratulation following the Balakot strike flowed from the figure put out in the news stream that around 300 Jaish-e-Mohammed top guns, trainers and recruits had been killed in the IAF attack. This figure was not cooked up by journalists, but obviously fed to them in a calculated act of circulating propaganda to squeeze out political benefit from the military action.

However, answering pointed questions later, Air Vice-Marshal RGK Kapoor, the assistant chief of air staff, who briefed the media as a part of a tri-services group, was categorical that information on fatalities at Balakot was yet to be ascertained. All details of the impact of this IAF action appear murky, with respected Western news platforms suggesting no serious damage had been done at the Balakot facility of JeM. Contrary claims also exist. It might be best if the government released "before and after" satellite imagery for the sake of an informed public discussion.

From *The Asian Age*

Rafale and the DPP

After India's surgical strike on a Jaish-e-Muhammed terror camp in Pakistan's Balakot, the conversation over the Rafale fighter jet deal has moved from questioning the deal itself to the urgent need for such modern aircraft. The aerial dogfight that ensued when the Pakistani air force decided to respond to Balakot saw the Indian air force's ageing MiG-21 Bisons go up against Pakistan's F-16s. This disparity in air power quality is unacceptable if India is to pursue a new security paradigm where it reserves the right to undertake pre-emptive strikes against Pakistan-based terror targets.

Yet, India's defence procurement policy leaves a lot to be desired. In some ways Rafale is reminiscent of the previous acquisition of Bofors field guns which was tainted by a scam, but nevertheless the key question moved quickly from why Bofors guns to why there was so much delay in acquiring them when they proved instrumental to dislodging Pakistani intruders during the 1999 Kargil war. In case of Rafale the government has been unnecessarily evasive in answering some legitimate questions, perhaps in a misguided attempt to head off controversy in a manner which has only elicited more controversy.

The Supreme Court has, for example, rightly questioned the government when the latter argued, somewhat late in the day, that Rafale documents published by a newspaper were "stolen" from the defence ministry and hence shouldn't be taken on record. Earlier, the government had to seek a correction in the SC judgment on a basic premise: that CAG had apparently already submitted its report on the Rafale deal to Parliament's PAC and the latter had examined the report, at a time when such a report was still in the works. Such slippages have caused SC to reopen the Rafale case.

If the government wishes to argue it has been so proactive in acquiring Rafale that it doesn't have time to answer questions, that too doesn't stand: it won't get even a single Rafale delivered by the end of its tenure. From Congress president Rahul Gandhi's perspective, he may be using Rafale as a weapon to neutralise Bofors corruption charges. This strategy won't get much traction either given the urgent necessity of acquiring advanced fighter jets. While defence acquisition in India remain mired in political controversies, there are reports that Pakistan is collaborating with China to develop a fifth-generation fighter. If India's post-Balakot strategy is to succeed it must urgently work out a quick, clean, transparent and efficient mode of defence acquisition.

From *The Times of India*

Grain and Chaff in Balakot Strikes

Nitpicking fetches up nits. The point is to look at the big picture, when it comes to things like the recent Indian Air Force strike inside Pakistani territory. Quibbles are being aired about the precise number of terrorists killed in the attack. There are charges of politicisation of the attack, and counter-charges. Whether Pakistan's decision to release prisoner of war Abhinandan Varthaman was an act of magnanimity on the part of the country's prime minister, who, till the other day, used to be called Im the Dim, or the result of Islamabad buckling under international pressure, as some hawks within Pakistan allege, is another question vexing habitués of social media. It is time to focus on what really counts.

The significant achievement of the air strike within Pakistan carried out on 26 February in response to the terror attack at Pulwama on 14 February is that India has finally called Islamabad's nuclear bluff. Pakistan has been posturing that it is immune from India's vast superiority in terms of conventional war-fighting capability, because it has nuclear weapons and a first-use doctrine.

India refrained from using its conventional arms might to punish Pakistan for attacks on India by its terrorist proxies, whether the attack on Parliament in December 2001 or the attack on Mumbai in November 2008, on the rational ground that the result might well be to trigger a nuclear exchange. This paradigm has been broken, with the attack on Balakot. This is so, regardless of how many people were killed in the strike, how many minutes Indian planes stayed within Pakistan airspace and how far inside the country's territory Indian planes intruded. It took political will to take the calculated risk. The move has paid off. The proposition that India will always be compelled to pull its punches because of Pakistan's nuclear weapons stands smashed by the air strike. The rest is detail.

War is a serious matter with potential for untold misery and economic loss. To use talk of it to quench the blood thirst of TV studio warriors is profane, on par with partisan politicking with the martyrdom of our soldiers.

From *The Economic Times*

CAG on IAF purchases

The Rafale tender stole the political thunder in the Comptroller and Auditor General of India's (CAG) assessment of 11 capital acquisitions by the Indian Air Force over a time period that spanned both the UPA and Modi governments. Considering that previous CAG reports on coal and 2G had irrevocably damaged the credibility of the UPA government, the Modi government can consider itself fortunate to have escaped unscathed because of the inventiveness of the auditors. The CAG used a never-used formula (called alignment pricing) to declare the Modi tender cheaper than the UPA era's now-cancelled 126 aircraft bid. An audit basically evaluates four criteria in a defence platform: quality, cost-effectiveness, delivery and objectivity. The CAG report gives conditional thumbs up on only two: cost-effectiveness and the delivery schedule. Even these are up for debate.

But the benchmark of objectivity, which includes intangibles such as transparency, fair play and integrity, stands in a grey zone. For instance, the comparison of UPA and NDA-era prices on the basis of a French index is debatable when payments are made in dollars. A dissent note alleging parallel negotiations (dismissed by then Defence Minister Parrikar as an overreaction) went unchallenged, while there was just a mild rap for not signing an integrity pact and succumbing to French refusal on opening an Escrow account. The Modi government was also easily let off the hook for failing to respond to a 20 per cent price cut by a Rafale competitor. Who knows whether Rafale would have still played tough if it had not been the single vendor.

Rafale was one of the 11 purchases studied by CAG and the common tale that emerges is of overambitious services whose requirements are frequently changed, leading to several vendors dropping out; the contract negotiations committee that rarely establishes the benchmark price, which, in turn, makes it difficult to establish the reasonability of the price. Complex and multi-level approval processes further add to the delays. Overall, the existing capital acquisition system is unlikely to effectively support the IAF in its war preparedness and modernisation.

From *The Tribune*

Aero India: A passable jamboree

The 12st edition of the four-day Aero India 2019 was one of the most under-whelming since the biennial show began in 1996. A ghastly mid-air collusion between two Hawk aircraft from the IAF's *Surya Kiran* aerobatic team killed one pilot the day before the formal 20 February inaugural. Then, on 23 February a day before the show closing, a fire in an improvised parking lot torched over 300 parked cars, fortunately with no loss of life.

But the show was generally lacklustre for several other reasons: Prime Minister Narendra Modi, earlier scheduled to inaugurate the show, steered clear, ostensibly for political reasons (and, perhaps as was being speculated, the presence of three Rafale aircraft on display). The biggest let down was the utter lack of significant military aviation deals or even major announcements, a *sine qua non* for any major air show.

There are also bureaucratic and budgetary reasons coupled with stagnant defence budgets and political uncertainty : the event was too close to the upcoming general elections and the government is in election mode. A gigantic deal for 110 combat aircraft worth an estimated $20 billion is still paperbound. The second iteration of the MMRCA project, scrapped in 2015, will see Russia's MiG-35, Sweden's Gripen, the F-16 (rebranded the F-21 for India), Boeing F/A-18 and Dassault Rafale re-compete.

The ministry of defence (MoD) has yet to take a call on the bid from the Tata-Airbus offer for the C295 as a replacement for the IAF's fleet of Avro transport aircraft worth an estimated $2.5 billion. Delegates, meanwhile, wrinkled their nose at the mounds of uncleared garbage which – like the appalling idea of allowing hundreds of visitors' cars to be parked on dry grass – suggested poor organisation.

"Even after so many editions of Aero India, the air show remains symbolic of an incapability to manage access or organise shuttle services from the entrance to the show," said Saurabh Joshi who runs defence website Stratpost.com. If the show organisers, the MoD's Department of Defence Production, wanted to showcase a packed event, they had certainly succeeded. Aviation industry officials say they were appalled by the stampede of civilian visitors on trade show days with one CEO saying he had to depute employees to clear the way for important delegates past crowds of selfie-takers.

There were some silver linings though. India's homegrown Light Combat Aircraft got its Final Operational Clearance (FOC) which clears it for induction into the Air Force and serial production. A large turnout of aerospace MSMEs and a robust presence from rising Tier 1 suppliers like the Tata Group testify that the Indian aerospace sector holds great potential. Hopefully these will be showcased in Aero India 2021.

From *Mail Today*

Air Marshal Brijesh Jayal urges that India must

Tap potential of Air Power

The Balakot air strike by IAF Mirage 2000 aircraft has strategic security implications that transcend its immediate tactical significance. A formation of the IAF aircraft penetrated Pakistan's air defences and successfully completed its mission despite the fact that the neighbouring country was on high alert after the Pulwama attack. Clearly, the IAF's mission planning, tactics and execution proved too good for Pakistan's air defence system. This is not for the first time that Pakistan's air defences have been found wanting. They were also caught by surprise when US commandos neutralised Osama bin Laden in 2011, virtually in the backyard of Pakistan's military establishment. The question arises: why would the Pakistan Air Force, which is professionally recognised, neglect its air defences when it considers India as an enemy with a strong air force?

Let's rewind to the 1962 war when the Chinese army was threatening the Assam valley. At that time, White House intelligence reports had concluded that if India were to use combat air power, this would have a significant impact on the ground war. Yet US Ambassador John Galbraith advised India's Defence Minister and the Prime Minister against the use of offensive air power, for fear of Chinese air force retaliation on Indian cities (such as Calcutta) and economic targets. Based on this advice, India failed to commit the IAF to an offensive role. The IAF top brass, too, failed to prevail upon the political leadership, even though air combat forces were available, joint structures with the Army were in place and there were the obvious limitations of the Chinese air force operating out of high-altitude airfields in Tibet.

This diffidence to use air power, anticipating retaliation, has somehow embedded itself in the psyche of the Indian security establishment. The mindset that the use of air power is escalatory manifested itself again during the Kargil conflict when the IAF was limited to operating within our own airspace and specifically forbidden from crossing the Line of Control (LoC). One keeps hearing similar sentiments expressed by security experts during debates in the electronic media.

The Pakistani military establishment has been quick to exploit this defensive Indian mindset and the window of opportunity it affords them. Knowing well, especially after the 1971 war, that India will always have an edge in conventional warfare, it has chosen the proxy war route to bleed India in Jammu and Kashmir "with a thousand cuts". As this approach has paid them dividends and the Indian security establishment has come to live with the inevitability of the proxy war, Pakistan has built considerable 'assets' in the form of separatists and radical groups in J&K and other parts of the country. That it has well established training facilities like Balakot shows that this security template is there to stay. Indeed, it has used this template in Afghanistan as well. Going nuclear has added to Pakistan's confidence of being able to deter India while relentlessly pursuing their objective of targeting India and keeping its security forces tied up through the proxy war.

The strategic import of the Balakot mission will not be lost on the Pakistan army's GHQ in Rawalpindi as India's willingness to use air power to further its national security interests compels the former to rethink its strategy. It also puts a burden on them to commit resources and professionalise their air defences.

There are lessons for us as well. For the first time in decades, the Indian security establishment has overcome its hesitation to commit air power in the proxy war waged by Pakistan. One can only hope that having overcome this psychological barrier, the national security establishment will now be open to tapping the full potential and flexibility of air power in the interests of national security and not try to confine it to the Theatre Commands.

Even as Wg Cdr Abhinandan Varthaman was released, there are three questions the nation must ask itself and not be satisfied with woolly answers: Why was the IAF pilot flying a dated MiG-21 when his adversary was in a contemporary F-16? Why is the IAF so hopelessly short of its combat strength with many squadrons equipped with aged and obsolete aircraft? And can we stop politicising the Rafale purchase and let the induction process move ahead so that the morale of the IAF is not dented?

Admiral Arun Prakash cautions that

"India's national interests must not be subsumed by politically-motivated, competitive machismo masquerading as patriotism"

Hyper-nationalism at the political hustings and war-mongering in TV studios could not only damage India's delicate social fabric but also drive the nation into an unwanted conflict. For the first time ever, the air forces of two nuclear-armed neighbours, India and Pakistan, crossed national boundaries and carried out kinetic attacks on each other's soil. Aerial combat therefore resulted in casualties and losses on both sides.

Although an inevitable sequel to the 14 February Pulwama car-bomb attack by the Pakistan-based Jaish-e Mohammad (JeM), India's air-strike inside Pakistan did carry the risk of tit-for-tat hostilities spiralling into a full-scale war with nuclear connotations. This is not an alarmist view because the current environment, on both sides of the India-Pakistan border, remains fraught for two reasons.

Pakistan has been turned into a neurotic theological state by the military and its cohort of jihadi proxies. Pakistan's shadowy "deep state" comprising the army and its Inter-Service Intelligence (ISI) directorate, has also kept alive the myth of an ever-present "existential threat" from "Hindu India". This mythology is vital for the survival of the "deep state" and its jihadi allies. The Pakistan Prime Minister, beholden to the army for his survival, has been blowing hot and cold in the past few days and his "peace overtures" must be treated with caution.

On our side, the Pulwama attack was the last straw for the long-suffering Indian public. The loss of 40 CRPF jawans served to focus the deep anguish and humiliation that Indians have endured over the decades from Pakistan-inspired insurgencies and Pakistan-initiated terror strikes. There was unanimity across India that a strong message needed to be sent to the Pakistani instigators and abettors of jihadi terror.

The Pulwama car-bombing, occurring in the run-up to India's 17th general election, has added a bitter edge of xenophobia and religious bigotry to an already acrimonious election campaign. Extreme caution is called for to ensure that India's vital national interests are not subsumed by politically-motivated and competitive machismo masquerading as patriotism. Hyper-nationalism at the hustings and war-mongering in TV studios could not only damage India's delicate social fabric but also drive the nation into an unwanted conflict.

Here it must be pointed out that phrases such as "revenge", "retribution" and "martyrdom" are not part of our military's lexicon and must not be foisted on the armed forces. At the same time, there is a dire need for India's national security establishment to learn how to employ India's military as an instrument of state policy by acquiring an understanding of concepts like "deterrence", "compellence" and "coercion" for attaining political aims.

In this context, we must face up to the intelligence failures, lack of civil-military coordination and poor state-craft on India's part that have allowed the ISI to torment this nation for many decades. The litany of assaults on India's sovereignty and citizenry is long but in every case, we have been caught unprepared and wanting in terms of a consistent policy and coherent response. Three instances in our recent past demand introspection because they point to a lack of resolve and even pusillanimity on the part of the Indian state.

Two decades back, in December 1999, Indian Airlines flight IC-814 was hijacked to Kandahar where the hijackers demanded the release of JeM terrorists. Most democracies have a declared policy of "no negotiations with terrorists" for the simple reason that negotiations give legitimacy to terrorists and are perceived as condoning violence. In the absence of such a policy, this hijacking saw the government caving in to public pressure and capitulating abjectly to the hijackers' demands. India has paid a dear price in lives for the release of Masood Azhar in Kandahar.

Following the December 2001 JeM attack on India's Parliament, the public was encouraged to observe the government ordering an unprecedented general mobilisation, presumably for inflicting suitable punishment on Pakistan. However, when the then army chief sought orders regarding the political objectives for *Operation Parakram*, he was told by the then prime minister, *"Baad mein batayengey"* (we will tell you later). Ten months later, the chief was no wiser as he demobilised a million men after a dangerous but futile face-off with Pakistan resulting in 900 army casualties owing to accidents and attrition.

In 2008, within hours of the seaborne terror assault on Mumbai, the nation was uplifted when a cabinet minister signalled the government's intentions: "All options are open to us." A day later, morale plummeted when after a cabinet meeting, the minister announced, "War is not an option." India had, once again, exercised "strategic restraint" gaining universal applause but allowing the instigators of the 26/11 outrage to go unpunished.

Against this backdrop, we must consider if India's timorous past postures and conduct have served to embolden its adversaries. From our unilateral undertaking of "no first use" of nuclear weapons (post-Pokhran II) to declarations that "war is not an option", have we conveyed an unintentional guarantee of immunity to those contemplating inimical actions against us? However, two resolute actions – the launching of cross-border commando raids in September 2016 and February 2019 air-strikes on Pakistan-based terror hubs – have, at long last, demolished such delusions. Simultaneously, they have also shattered the myth of a "nuclear overhang", crafted by Pakistan, to deter a robust Indian response to cross-border terrorism.

No sane South Asian wants war and if Kashmir continues to remain a *casus belli*, we must undertake an agonising policy re-appraisal. While the army continues to guard J&K against external intrusions, India needs to evolve a long-term strategy, "civilian" in nature, to restore peace.

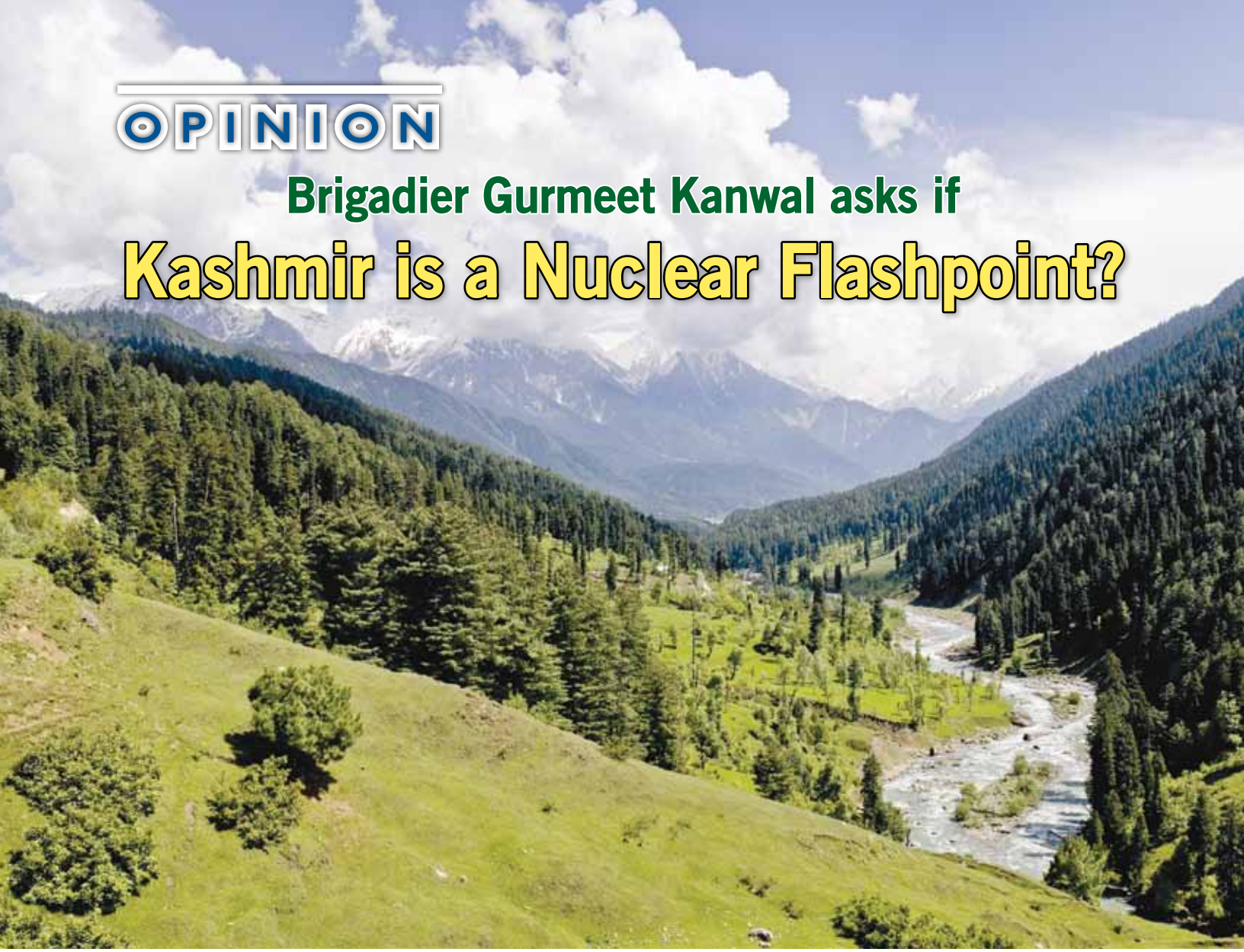
There are also other measures available to discourage neighbours from interfering. At the strategic level, we need to urgently revise and introduce a degree of ambiguity in India's nuclear doctrine. At the operational level, India must convey clarity and resolve by openly declaring: First a "no negotiations" policy vis-a-vis terrorists and hijackers; two, its right to respond suitably to cross-border terrorist attacks at their source and three, that while the response may not be instant, it will be certain.

In order to implement this policy, military units with suitable capabilities should be earmarked and kept in the requisite state of readiness at all times.

OPINION

Brigadier Gurmeet Kanwal asks if

Kashmir is a Nuclear Flashpoint?



Now that the war clouds which had appeared on the horizon in aftermath of the Pulwama suicide attack appear to be drifting away, it is necessary to carry out an assessment of the dangers inherent if a similar crisis occurs in future. Clearly, Pakistan's deep state (army and ISI) will not give up its employment of terrorism as an instrument of state policy and India has begun to carry the fight back on to Pakistan-controlled territory.

The primary source of danger ahead is the fact that India and Pakistan are both nuclear-armed with a long-standing territorial dispute over Kashmir and an active LoC. Former US President Bill Clinton had called Kashmir a "nuclear flashpoint". In the mid-1990s, Ashley Tellis, a senior scholar at the Carnegie Endowment for International Peace, Washington (then with the RAND Corporation), had used the term "ugly stability" to describe the strategic environment in South Asia.

When the war bugles begin to sound in South Asia, the world fears that it will once again witness the spectre of mushroom fireballs lighting up the sky and radiation clouds polluting large swathes of land. Are these fears well founded, or can escalation of conflict to the level of nuclear exchanges be controlled?

For three decades since 1989-90, Pakistan has been waging a proxy war to "bleed India through a thousand cuts". Pakistan's deep state employs the military-jihadi complex comprising state-sponsored mujahideen of the LeT, JeM and HM (originally of Kashmiri origin) to launch terrorist strikes against sensitive targets in Kashmir and urban centres in India, often through suicide bombers.

Other weapons of choice in this asymmetric conflict include support to several home-grown militant outfits like the Naxals, creating a Hindu-Muslim divide through information operations and social media and economic destabilisation through measures like the circulation of fake Indian currency.

The stated aim of the deep state is to wrest Kashmir from India and finish what Pakistan calls the "unfinished agenda of the Partition". In the interest of avoiding large-scale conflict to give its people and economy an unfeterred opportunity to grow, India has shown strategic restraint and unbounded patience with Pakistan's shenanigans. India opted to confine its counter-insurgency and counter-terrorism fight back to its own territory. It has been clear for some time that this strategy has failed to impose sufficient costs on the deep state.

At least twice in the recent past India and Pakistan had come close to war – when the Indian Parliament was attacked by JeM

operatives in December 2001 and multiple strikes were launched by the LeT's sea-borne terrorists in Mumbai in November 2008. The latest round in Pakistan's game of brinkmanship has been the suicide bombing attack on a CRPF convoy in Pulwama by the JeM. Before that, armed forces bases at Pathankot and Uri had been struck.

Public opinion is India had been inflamed by the attack at Pulwama and Prime Minister Narendra Modi said that full freedom had been given to the armed forces to retaliate appropriately. Imran Khan, the Prime Minister of Pakistan, denied any involvement and General Javed Bajwa, the COAS, warned India against any kind of retaliation. India's response came in the shape of trans-LoC air strikes with precision-guided munitions (PGMs) on terrorist training camps.

India claimed that substantial damage had been inflicted on 'non-military' targets and the battle lines once again appeared to be drawn. Pakistan then retaliated with air strikes, both sides lost an aircraft each and, after an Indian pilot who had ejected, was returned two days, the crisis blew over.

How will India handle the next major attack emanating from Pakistani soil? While India may be definitely expected to respond to the attack, the retaliation is likely to be limited to areas across the LoC in POK and Gilgit-Baltistan. Operations will in all likelihood once again include air-to-ground strikes with PGMs against terrorist training camps and critical infrastructure across the LoC from stand-off ranges on own side of the LoC.

Artillery bombardment of Pakistani army posts, battalion, brigade and division HQ, communications centres, ammunition and FOL dumps, key bridges, terrorist infrastructure and forward helipads may also be expected. These will be supplemented by Special Forces operations and trans-LoC forays by infantry border action teams (BAT).

Offensive operations to capture objectives across the LoC, for example to eliminate terrorist launch pads and deny the use of the most dangerous routes of infiltration, are likely to be limited to brigade-level attacks. These limited operations are unlikely to escalate to war across the international boundary. Division and higher-level offensive operations and fighter aircraft crossing the LoC to attack targets in depth run the risk of escalation.

Public opinion will be assuaged by a proportionate response sustained over a few days that inflicts visible punishment on the Pakistan army, terrorist launch pads and infrastructure. However, escalation is a product of the political guidance given to the armed forces, intelligence assessments, the options open and the means available to the adversary and his senior commander's personality and much will depend on the response of the Pakistan army and the PAF.

During the Kargil conflict, India had opted to limit its operations to throw out the Pakistani intruders to its own side of the LoC, as directed by Prime Minister Vajpayee. The Pakistan army had avoided escalating the conflict. The PAF had stayed out of the fighting altogether as, in any case, it has few viable options to retaliate in Kashmir. If the PAF responds to the IAF strikes across the LoC by choosing to hit targets across the international boundary, or, if the Pakistan army crosses the international boundary anywhere into Indian territory, similar Indian retaliation is guaranteed.

Retaliatory military operations by India across the international boundary are likely to comprise deep offensive strikes at the level of Strike Corps operations or operations conforming to the Cold Start doctrine – large number of shallow strikes by division-sized integrated battle groups (IGB) into West Punjab and Sind. These will be accompanied by IAF and attack helicopter strikes across the international boundary on the Pakistan army's strategic reserves, PAF airfields, missile launchers, HQ, communications centres, logistics infrastructure and terrorist training centres.

Naval operations may be launched against the Pakistan navy. The aim of military operations across the international boundary will be to inflict maximum possible damage on Pakistan's military machine through the employment of massive firepower (artillery, missile, air-to-ground, naval).

Large-scale conventional conflict undoubtedly carries the risk of escalation to nuclear exchanges if Pakistan's nuclear redlines are crossed. Pakistan will not lightly opt for nuclear first use as India is likely to retaliate in accordance with its declared nuclear doctrine, which is massive retaliation. Such retaliation will finish Pakistan as a functional nation state and the Pakistani Generals are smart enough to understand this certainty.

Hence, if Pakistan finds itself in a hopeless situation on the battlefield – a situation that the Indian armed forces will refrain from putting it in – and chooses to escalate to nuclear levels, its response is likely to be graduated. Pakistan may threaten the first use of nuclear weapons against Indian troops that have violated its space redline by penetrating deep inside. This can happen in the fog of war due to wrong assessment of what the redlines are. A bolt-out-of-the-blue counter-force nuclear first strike on targets in the Indian heartland is most unlikely.

However, Pakistan would hope that the UNSC and the international community will intervene well before nuclear thresholds are reached. And, India will carefully calibrate both its initial retaliation and subsequent responses so as not to up the ante to large-scale conventional war-fighting, which would subsequently run the risk of nuclear exchanges.

"Operational Readiness"

Even as this issue goes to press, the Indian Armed Forces remain on full operational alert which began in mid-February 2019 after the terrorist attack on a CRPF convoy at Pulwama in the Kashmir Valley on 14 February 2019. Two days later, India's Prime Minister Narendra Modi made a forceful statement on India's reaction to the terrorist attack. "Security forces have been given permission to take decisions about the timing, place and nature of their response...this is an India of new convention and policy."

Later the same day, 16 February, the Indian Air Force conducted its much earlier planned day-night fire power demonstration at the Pokhran ranges in Rajasthan where some 140 aircraft, including 81 fighters took part. To a pointed question, Chief of the Air Staff Air Chief Marshal BS Dhanoa then replied "what are we showcasing today? We are showcasing our ability to hit hard, hit fast and hit with precision, hit during day and hit during night and hit under adverse weather conditions through our autonomous bombing capability" (*see article in this Issue*).

The Air Chief's *sangfroid* remained very much in public view during the biennial Air Show at Yelahanka a few days later where he interacted with both officials and participants from India and abroad who were showcasing their products and services (*see articles in this Issue*). He shrugged off sarcastic remarks made by some that "the IAF had missed their targets at Pokhran–when the real ones were some 450 kms north-north east" (perhaps alluding to Bahawalpur, in southern Pakistani-Punjab, where the J-e-M are concentrated).

The sarcasm was premature. Two days after end of the *Aero India Show,* the Indian Air Force carried out precision attacks on 26 February 2019 when 12 Mirage 2000s armed with standoff precision-guided missiles targeted J-e-M targets in northern Pakistan, near the frontier town of Balakot in Khyber-Pakhtunkhwa.

The jury is out as to what casualties were inflicted on Jaba Top that morning (*see articles in this Issue*) and the subsequent air combat the next day when IAF fighters tangled with PAF fighters over Kashmir (an analysis in *Vayu's Issue III/2019*).

CNS reviews TROPEX 2019

The CNS Admiral Sunil Lanba visited Kochi on 18 March 2019 for the debrief following the recently concluded annual Theatre Level Readiness and Operational Exercise (TROPEX). Commanders-in-Chief of all the three naval Commands, along with a number of senior operational commanders and representatives from Indian Army, Air Force and Indian Coast Guard participated in the discussions held at the Naval Base, Kochi. The day long review of TROPEX 2019 was to examine conduct of the exercise and to assess operational readiness of the Indian Navy. A realistic audit of the Indian Navy's deployment philosophy and fighting capability was undertaken during the review.

This Annual Integrated Theatre Level Operational Readiness Exercise (TROPEX 2019), the largest maritime exercise of the Indian Navy was conducted in the critical month of February 2019 in the Arabian Sea and North Indian Ocean, beginning from early January and graduating to assuming a full operational readiness posture post the 'Pulwama' attack on 14 February 2019. About 60 ships of Indian Navy, 12 ships of the Indian Coast Guard and 60 aircraft participated in TROPEX 2019, which included a Tri-Services amphibious exercise, which had participation of Army units and Air Force assets. As prelude to TROPEX, the largest coastal defence exercise codenamed *Sea Vigil,* had been conducted on 22-23 January 2019 with participation of all coastal states and union territories along with all maritime stake holders.

HAL delivers all LCA Mk.I (IOC) to IAF

Meeting its target of delivering all Tejas LCA Mk.I in IOC configuration to the Indian Air Force during the FY 2018-19, the 16th series production LCA (LA-5016) made its first flight at HAL's Bangalore Complex on 25 March 2016. After clearance, SP-16 will join the IAF's No.45 Squadron at Sulur to bring it up to unit establishment. As recorded by *Vayu* over the past several years, the first series production aircraft (LA-5001) made its first flight on 1 October 2014, flown by Air Commodore KA Muthanna, was followed by SP-2 on 22 March 2016, with series production aircraft steadily delivered thereafter and earlier this year, SP-13 (LA-5013) flew on 30 January 2019, flown by Gp Capt KK Venugopal. SP-15 (*in picture below*) and SP-16 were the final IOC standard series production aircraft.

Following CEMILAC clearance of FOC standard LCA Mk.Is, HAL has received all drawings and documentation from ADA and has begun production of the first FOC standard LCA which is to be delivered to the IAF's second LCA squadron (reportedly No.18) thereafter. As for the two-seat LCA operational conversion trainers, HAL Chairman R Madhavan has stated that "Of the 20 in IOC configuration, the IAF has advised us to make the four remaining as trainers in FOC configuration with four more from the second order of 20 and 16 for operational fleet".

Tejas LCAs at LIMA Show 2019

The Indian Air Force participated at the Langkawi International Maritime Aero Expo in Malaysia on 26-30 March 2019. Two LCAs were flown to Malaysia for static and flight display during the event, the IAF contingent of 27 officers, 42 airmen with 11 supporting AL personnel, having departed from AFS Kalaikunda to Langkawi, staging via Yangon in Myanmar, with equipment and spares flown on board one each C-130J and Il-76. (*Report in Vayu Issue III/2019).*

EOI for 111 Naval Utility Helicopters

On 12 February 2019, a week before inaugural of Aero India 2019, the Ministry of Defence issued the *Expression of Interest(s)* for shortlisting of potential Indian Strategic Partners (SP) and foreign OEMs for the 'Procurement of 111 Naval Utility Helicopters (NUH) for the Indian Navy, these helicopters will replace the obsolescent HAL Chetak helicopters and tasked for SAR, CASEVAC, LIMO, personnel transport as also torpedo launch. The first six helicopters would be procured 'fly away', the balance 95 to be manufactured in India by the selected SP.

The OEMs have been mandated to establish dedicated manufacturing facilities, with design, integration and manufacturing processes for the NUH in India to make this as a "global exclusive facility." Amongst the Indian Companies shortlisted as potential strategic partners are Tata Advanced Systems, Mahindra Defence, Adani Defence, L&T, Bharat Forge and Reliance Infrastructure. The foreign OEMs likely to participate in the project are Lockheed Martin, Airbus Helicopters, Bell Helicopters and RoE.

Strategic Partners for NUH programme

In order to meet the Indian Navy's urgent and long pending requirement for Naval Utility Helicopters (NUH), as replacement for the obsolescent HAL-built Chetaks (*image below*), it is learnt that the Ministry of Defence is to invite private sector companies to participate in the project for 111 helicopters under the strategic partnership (SP) policy of the 'Make in India' initiative. An expression of interest (EoI) will first be issued to identified companies who would thereafter team up with the concerned OEM.

The Navy's specification for the NUH is that it should be twin-engined, under 5-tonnes AUW have flotation gear, wheeled landing gear with folding blades and able to carry a torpedo. Helicopter types being considered include the AS565 MBe Panther, Bell 429, Super Lynx 300, S-76D and the Ka-226 while the SPs reportedly include the Tatas, M&M and L&T, although HAL could also participate.

Expanding force of HAL-Dornier 228s

Increasing the inventory of, and number of units operating the HAL-Dornier 228 maritime patrol aircraft, the Government of India have recently sanctioned setting up of three new Naval Air Squadrons in Gujarat and Tamil Nadu. Besides this, the Central Government has also sanctioned manpower towards manning additional aircraft in existing Dornier squadrons in Kerala and the Andaman Islands. This contract for procurement of 12 additional Dornier 228 aircraft was signed on 29 December 2016 with delivery commencing in January 2019.

The new Dornier 228 aircraft being delivered under this contract are fitted with improved 'state-of-the-art' sensors and equipment which include glass cockpit, advanced surveillance radar, ELINT, optical sensors and networking features. The aircraft would enhance Maritime Domain Awareness of the Indian Navy through round the clock sensor based surveillance and provide targeting data in areas of operation to monitor and neutralise various threats and other hostile activity in the seas around the Indian peninsula and the long coastline of over 7000 kilometres.

Over 200 Su-30MKIs delivered to IAF

With 272 Sukhoi Su-30MKIs on order by the Indian Air Force, this aircraft type already equips some 40% of the IAF's frontline fighter squadrons, with 222 of these being delivered by HAL's Nasik Division. By early January 2019, HAL had delivered 202 Su-30MKIs and the last of those on order would be completed during FY 2020-21, equipping some dozen squadrons.

According to reliable sources, ordering of additional Su-30MKIs for the IAF has been considered, both to augment the reducing combat aircraft numbers as also maintain industrial activity at one of HAL's largest manufacturing Divisions, even as a major upgrade programme (the 'Super' Sukhoi) is planned. The additional orders vary from 8 (to make up attrition) to 18 (for one additional squadron) to 40 aircraft for two more squadrons.

21 'mothballed' MiG-29s offered to IAF

An IAF team has reportedly visited Russia to examine a batch of 21 MiG-29s originally built for the Soviet Air Force and remaining in storage at a Russian air base over the past three decades. According to an IAF officer, these were found to be in "excellent condition and could well supplement the current MiG-29 fleet of the IAF". The IAF's present inventory of some 69 MiG-29s are being upgraded and will have multirole capabilities, with increased internal fuel capacity. If the additional 21 MiG-29s are procured, reportedly at a price of Rs. 285 crore per aircraft, these too would subsequently be upgraded to the UPG standard.

Boeing Chinooks join the IAF

On 25 March 2019, the IAF formally inducted CH 47F(I) Chinook heavy lift helicopters into its service at Air Force Station Chandigarh. Air Chief Marshal BS Dhanoa, Chief of the Air Staff was handed over the symbolic key at the ceremony.

The Government of India had contracted with Boeing in September 2015 for 15 Chinook helicopters, the first batch of four helicopters being delivered on schedule with the last expected by March 2020. The first batch of Chinooks will join No.126 Helicopter Unit who still have some Mi-26s in their inventory while the second unit will reportedly equip a new unit at Dinjan in Assam. In October 2018, the IAF had seconded 4 pilots and 4 flight engineers to Boeing for conversion training on type.

Lockheed offers the F-21 to India

In a major move, US giant Lockheed Martin unveiled its F-21 multi-role fighter, specially configured for the Indian Air Force and offered as '*For India. From India*'. The formal announcement on 20 February 2019 was on first day of the Aero India Show, the Company stating that it would partner Tata Advanced Systems as part of its *Make in India* initiative "which no other firm has offered" and that this opportunity combines "the strength of the world's largest defence contractor with India's premier industrial house to deliver a win-win situation for India and the US". In their earlier proposal Lockheed Martin had offered the F-16 Block 70 to meet the IAF's MMRCA requirement.

India-US defence sales "at all time high"

"Defence sales between India and the US are at an all-time high and bilateral strategic partnership continues to advance at an historic pace", stated Admiral Philips Davidson, Commander of the US Indo-Pacific Command (USINDOPACOM). He was addressing members of the Senate Armed Services Committee during a recent Congressional hearing in Washington DC. He referred to recent programmes including P-8(I) maritime surveillance aircraft for the Indian Navy, C-17 Globemaster III and C-130J transport aircraft as also Chinook and Apache helicopters for the Indian Air Force and M777 howitzers for the Indian Army.

The Signing of the COMCASA (Communications Compatibility and Security Agreement) and LEMOA (Logistics Exchange Memorandum of Agreement) was cited by the Admiral to illustrate importance of interoperability and information sharing.

Indian Defence Minister in Germany and Sweden

On the eve of Aero India 2019, Defence Minister Nirmala Sitharaman made an official, albeit short, visit to Germany and Sweden from 11 February 2019. Prime Minister Narendra Modi had earlier visited the two countries in April 2018 "to hold high level discussions especially focussing on strategic and defence relations". According to sources, her visit to the two west European countries was significant as industries of both had participated in the erstwhile MMRCA tender, and reportedly both Saab and Eurofighter have responded to the RFI of April 2018 for 114 new fighters. The Indian Defence Minister also visited the Swedish Air Force F21 Wing (Norrbotten) in northern Sweden which houses two squadrons of the Gripen multirole fighter (*see representative image*).

More ALH Mk.IIIs for Indian Army

HAL has handed over the first batch of ALHs as part of 22 additional ALH MK.IIIs ordered by the Indian Army during Aero India 2019. HAL had entered into an additional contract with the Indian Army for 40 ALH (22 ALH Mk III and 18 Mk/IV Rudra) in August 2017.

All–women crew demonstrate Dornier 228 PTT operations

No.41 Squadron ('Otters') flying Dornier 228s have recently demonstrated Parallel Taxi Track (PTT) operations with a full women crew. The pilots, Sqn Ldr Kamaljeet Kaur and her co-pilot Sqn Ldr Rakhi Bhandari carried out successful parallel taxi track landing and take-off operations at AFS Sirsa. PTT Operations are challenging as the crew are required to land and take off from the taxi track, considerably smaller in width than the main runway, with proximity to obstructions as compared to the main runway.

First S-400 air defence system by 2020

Indian armed forces will receive their first tranche of Almaz-Antei S-400 Triumf air defence systems in October 2020, according to a senior Indian defence official. Delivery of all five S-400 air defence squadrons (regiments) from Russia is expected to be completed by April 2023, the Government of India having signed the $5.43 billion (Rs 40, 000 crore) contract for the S-400 systems with Russia in 2018. Commenting on US financial sanctions over

the S-400 deal under CAATSA (*Countering America's Adversaries Through Sanctions Act*), which seeks to prevent countries from buying Russian weapons or Iranian oil, the Indian government spokesman said, "we are aware of all developments that may impact procurement of weapon systems".

HAL's 3D printed parts for Su-30MKI

IAF's Su-30MKI are to be fitted with indigenously certified 3D printed fuel system elbow part using additive manufacturing technology, the 3D printed fuel system elbow parts now certified by CEMILAC. As part of the Phase-IV Su-30MKI manufacturing programme, there reportedly have been shortage of some castings for manufacturing of components owing to which HAL has selected the fuel system elbow for fabrication through additive manufacturing processes.

HAL orders Thales 2.75" rocket launchers

HAL has awarded Thales a contract to supply 135 2.75-inch (70-mm) rocket launchers which use composite material, making them some 50% lighter than metal launchers, and eliminating corrosion issues. "This new collaboration between Thales and HAL in the field of air-launched weaponry opens up new opportunities for the supply of equipment to the Indian armed forces, and consolidates Thales's position in the Indian market. With this, helicopter crews will see a significant improvement in their tactical capabilities during missions," stated Emmanuel de Roquefeuil, VP and Country Director, Thales in India.

Thales launches 'Engineering Competence Centre' in Bengaluru

Thales continues its developments in India with launch of the Global Engineering Competence Centre (ECC) in Bengaluru. The centre aims to accelerate innovation and digital transformation to serve the needs of both the Indian market and the Group's global objectives. With the ECC, Thales seeks to play a major role in job creation and skill development in India as it targets to hire 3,000 engineers in the next three-five years along with its partners. It is a first-of-its-kind Engineering Competence Centre in India focusing on software and hardware capabilities in the areas of civil as well as defence businesses, serving Thales's global needs. P Satish Menon has been appointed to head this Centre and brings with him 30 years of expertise in the fields of engineering, R&D, and programme management.

First cockpit assembly of Falcon 2000 by DRAL for Dassault Aviation

The first cockpit front section of the Falcon 2000 series, produced by Dassault Reliance Aerospace Limited (DRAL) at its manufacturing facility at MIHAN, Nagpur, has been handed-over to Dassault Aviation. Matching the highest quality standards, this first front section is to be delivered to Dassault Aviation's Falcon final assembly line in France. "In parallel, larger infrastructures are being developed and will soon be completed allowing the ramp-up of DRAL capabilities toward the taking-off of an entire Falcon 2000 fully manufactured and assembled in India."

Airbus opens pilot and maintenance training centre

Airbus has inaugurated a training centre for commercial pilots and maintenance engineers in the National Capital Region of Delhi, as part of its continuing efforts to support the exponential growth of the civil aviation sector in the country. The training centre incorporates an A320 flight simulator for full-flight simulation,

along with programmes on aircraft procedure training, computer-based classroom training, and standard pilot transition training, including an 'Upgrade to Command' course aimed at improving skills and maturity of co-pilots as they transition to commandership. "Providing a robust training infrastructure to support our customers' businesses is a priority for us. One pillar of our customer services mission is proximity to the customer, and another one is safety. In that respect, having a training centre located in the country is proof of our commitment towards both," stated Anand E. Stanley, President and Managing Director, Airbus India & South Asia.

TLMAL delivers 100th C-130J Super Hercules Empennage

Tata Lockheed Martin Aerostructures Limited (TLMAL) recently delivered the 100th C-130J Super Hercules empennage from its manufacturing facility located in Hyderabad, India. The delivery milestone highlights the ongoing success of Lockheed Martin's hallmark *Make in India* partnership with Tata. TLMAL–a joint venture between Tata Advanced Systems Limited (TASL) and Lockheed Martin Aeronautics–was established in 2010 in Hyderabad, and "has the distinction of being the single global source of C-130J empennage assemblies that are installed on all new Super Hercules aircraft produced in Marietta, Georgia, in the United States", stated company officials.

Empennage assemblies produced by TLMAL include the aircraft's horizontal and vertical stabilisers along with leading edges and tip assemblies. The TLMAL team also previously manufactured sets of C-130J centre wing box components, and introduced a new cutting-edge 4,700 square-metre metal-to-metal bonding facility in May 2018. TLMAL currently employs 500 people.

US/India FMS for Boeing 777 Large Aircraft Infrared Countermeasures SPS

The US State Department has made "a determination" for approving a possible Foreign Military Sale to India of two Boeing 777 *Large Aircraft Infrared Countermeasures* (LAIRCM) *Self-Protection* Suites (SPS) for an estimated cost of $190 million. The Defense Security Cooperation Agency has delivered the required certification notifying Congress of this possible sale.

The Government of India requested to buy two Self-Protection Suites (SPS) consisting of AN/AAQ 24(V)N Large Aircraft Infrared Countermeasures (LAIRCM), ALQ-211(V)8 Advanced Integrated Defensive Electronic Warfare Suite (AIDEWS), and AN/ALE-47 Counter-Measures Dispensing System (CMDS) to protect two Boeing-777 Head-of-State aircraft.

Rolls-Royce collaborate with Indian start-ups for data innovation

R^2 Data Labs, the data innovation catalyst of Rolls-Royce, are to develop a collaborative ecosystem of digital partners in India. This will enable Rolls-Royce to use data to spark innovation in

all of its businesses and collaborate more effectively with partners and customers. Rolls-Royce will provide mentoring and technical support to start-ups specialising in the areas of Advanced Analytics, Artificial Intelligence (AI), Internet of Things (IoT), Blockchain, Quantum Computing, Autonomous and Sensing.

General Atomics collaboration with Sankhya Infotech

General Atomics Aeronautical Systems, Inc. (GA-ASI) have announced collaboration with Sankhya Infotech Limited to produce Simulation & Training Solutions for their SeaGuardian Remotely Piloted Aircraft (RPA) programme. "GA-ASI anticipates working with Sankhya to provide simulation and training solutions in compliance with global standards and to deliver cutting-edge training to pilots, sensor operators and maintenance crew, first of its kind collaboration with GA-ASI."

According to Linden Blue, CEO, GA-ASI, "GA-ASI is excited to explore collaborations with various companies in India, our role as the world's leading manufacturer of RPA systems, radars, electro-optic and related mission systems, provides opportunities to build long-term relationships in India, especially in the Small-Medium Enterprise (SME) sector. GA-ASI is committed to building long-term relationships with Indian businesses. As part of any anticipated contract in India, GA-ASI would look to deliver an affordable, high-quality training platform, while adding growth momentum to the Indian defence ecosystem."

Dynamatic delivers 100th shipset to Airbus

Dynamatic has recently handed over the 100th shipset of Airbus A330 Family flap-track-beams to Airbus. Dynamatic is a Tier 1 supplier for Airbus A330 Family flap-track-beams and has worked closely with major aircraft manufacturers to establish advanced manufacturing capabilities in India. Dynamatic currently delivers

some 800 aircraft ship sets annually, making it the largest producer of flap-track-beams globally. These flap-track-beams are class-1 flight critical assemblies connected to the wings.

HAL's green field helicopter factory in Tumakuru

Infrastructure development work at HAL's green field helicopter factory in Tumakuru has progressed with an MoU recently signed at Bangalore. The stage 2 works include development of infrastructure for structural assembly and equipping of helicopters at Tumakuru, the project to be executed in phased manner. The new Helicopter factory is coming up on the 615 acres green field campus which would eventually be self-sufficient for manufacturing a full range of helicopters from 3 ton to 12 tons category. These would comprise state-of-the-art manufacturing, structural assembly, final assembly-line facilities, heli-runway, aerodrome, residential township recreational facilities, a well-equipped training and development centre and so on.

Safran and Maini in long term supply agreement

Safran Helicopter Engines (previously Turbomeca), have signed a Memorandum of Understanding (MoU) with Maini Precision Products to develop long-term industrial strategic relationship,

involving potential manufacture by Maini Precision Products for the Safran Helicopter Engines supply chain. The MoU was signed between Frederic Rascouailles, VP Purchasing from Safran Helicopter Engines and Gautam Maini, Executive Director, Maini Group at Aero India 2019, Yelahanka. Present on the occasion were Arnaud Labourdet, International Co-operation Manager and Satish Kirtikar, Managing Director, India from Safran Helicopter Engines, Sandeep Maini, Chairman, Sharan Mehta, Senior VP, Strategy & Business Development and Naresh Palta, CEO (Aerospace and Aviation) from the Maini Group.

Blighter's E-scan radar for Border Security

Blighter Surveillance Systems Ltd, the British manufacturer of electronic-scanning (E-scan) radars and surveillance solutions, is supplying its Blighter B400 series E-scan micro Doppler ground surveillance radar to Dat-Con Defence for deployment along Indian borders, as part of the Government's *Comprehensive Integrated Border Management System* (CIBMS). This will establish a multi-tier security ring–ground surveillance radar, thermal cameras, unattended ground sensors, seismic vibration systems, fences and fence protection systems–to protect India's extensive international borders. The solid-state passive electronically scanned array (PESA) radar detects small and slow-moving targets even in cluttered environment, thanks to the radar's coactive frequency modulated continuous wave (FMCW) micro Doppler fast-scan processing.

BEL and Elbit sign TCA for HMDS

Bharat Electronics Limited and Elbit Systems Limited of Israel, have signed a Technical Collaboration Agreement (TCA) for licensed manufacture of Helmet Mounted Display System (HMDS) / Helmet Pointing System (HPS) Version 02. The HMDS/HPS provides capability to display helicopter's flight and platform information, mission data, target information as well as additional enhanced application capabilities such as low visibility landing and take-off, flight within degraded visibility environment, optional weapons management and synthetic vision during day and night flying. The 'Heads Up - Eyes Out' concept minimises the need for 'Heads Down' in-cockpit instrumentation observation for critical information such as altitude, velocity, engine performance, warning indications and allows the crew to concentrate on mission performance, thus increasing situational awareness and survivability in all naval missions.

FSTC Level D Q400 simulator services

Flight Simulation Technique Centre (FSTC) are to meet Spice Jet airlines requirement for training of pilots on the Bombardier Q400 simulator. This will be the country's first Level D Q400 simulator for providing simulator training to Q400 operators in India and the entire South East Asia region operating Dash8 aircraft. The new Level DFS1000 simulator is scheduled to begin operations at FSTC's newly opened training centre at Rajiv Gandhi International airport, Hyderabad from March 2019.

SpiceJet first Indian LCC to join IATA

SpiceJet has become the first Indian LCC to join the International Air Transport Association (IATA), as a full member. Ajay Singh,

C/MD SpiceJet stated that "the membership will further enable us to inculcate global best practices and innovations and provide our passengers with world class experience each and every time they fly with us. IATA also provides us a platform to closely work and collaborate with other airline members and expand our network through code shares and agreements with partner airlines." SpiceJet operates 516 average daily flights to 59 destinations, including 51 domestic and 8 international ones, with fleet of 50 Boeing 737s, 27 Bombardier Q-400s and one B737 freighter.

AirAsia India expansion plans

AirAsia India has reportedly finalised expansion plans with 40% of its capacity to be deployed overseas in the next few years, even as the airline awaits approval from the government for international flying rights. The plan also reportedly presents cost cutting and revenue optimisation measures to bring the airline to making profits. It also aims to treble fleet size of the airline to 60 aircraft in five years through a mix of owned and leased planes. The airline initially aims to fly to Kuala Lumpur and Bangkok and may subsequently use the locations as hubs for its overseas flights.

100 expat pilots for IndiGo

There are plans for IndiGo airlines to hire as many as 100 expatriate pilots in 2019 to add to its roster of flight captains and make up for continuing shortages that have forced the airline to cancel many flights. IndiGo has more than 200 aircraft with a pilot strength of over 3,000, which includes some 1,200 commanders of whom currently 50 are expats. However, IndiGo's flight crew additions have lagged behind their relentless capacity growth.

IndiGo's cockpit crew situation exemplifies the broader issue facing the country's aviation industry, a paucity of experienced commanders to fly its rapidly expanding fleet. Indian airlines are adding close to 1,000 airliners in the next decade. IndiGo, with an order book of more than 400 aircraft, leads this capacity addition and hence challenges before it are more acute than those for its competitors.

TrueNoord leases five new ATR 72-600s to IndiGo

TrueNoord, the specialist regional aircraft lessor, has leased five new ATR 72-600s to InterGlobe Aviation Limited (IndiGo), the first two aircraft having been delivered at end December 2018 with the remaining three expected in the coming months. Financing was provided under *TrueNoord*'s recent term loan warehouse facility supported by Morgan Stanley, NORD/LB Norddeutsche Landesbank and Barclays.

Star Air launched

Rolls-Royce has welcomed Star Air as the first commercial Indian operator of the Embraer ERJ 145 aircraft, powered by the company's AE 3007 engine. Star Air is the newest startup airline in India and is backed by the Sanjay Ghodawat Group. To support its ambitious growth strategy, Star Air has chosen Rolls-Royce's flagship TotalCare long-term service support for the Rolls-Royce engines on its current two aircraft, and for the expansion of the fleet in the coming year.

As Captain Simran Singh Tiwana, Star Air's Chief Executive Officer, stated, "As a rapidly growing airline, it is key that we meet customers' demands for the best travel experience through providing the best product and service offerings at the right price. By partnering with Rolls-Royce and signing onto the TotalCare engine service package, we will maximise engine reliability to ensure excellence in delivery."

InterGlobe MRO at Devanahalli

InterGlobe Aviation, the parent company of IndiGo Airlines and Bangalore International Airport Limited (BIAL), operators of Kempegowda International Airport, Bengaluru (KIAB), have entered into a 20-year agreement to sub-lease land at the Devanahalli area for a state-of-the-art Maintenance Repair & Overhaul (MRO) facility. The 13,000-sq mts hangar, to be built on five acres in the Airport campus, would accommodate two narrow body aircraft and have comprehensive support infrastructure, including an engine QEC shop, warehouse and engineering offices for all repair and maintenance.

Regional air services from AFS Hindon

On 6 March 2019, Prime Minister Narendra Modi inaugurated the new civil enclave at Air Force Station Hindon from where commercial flights would be operated under the UDAN scheme. These would include Lucknow-Hindon-Kolkata-Jorhat; Hindon-Bhopal Ozar (Nasik); Hindon-Jaisalmer-Udaipur, Hindon-Gorakhpur-Allahabad; Hindon-Allahabad-Kolkata; Hindon-Kannur, Ozar (Nasik)-Hindon and Tirupati-Hubli-Hindon. Most of the new flights would be operated by IndiGo airlines and possibly other new players. The existing air traffic control operations for regional flights at Hindon will be handled by the Indian Air Force.

Arkia to launch Tel Aviv-Goa direct flights

Israeli airline Arkia plan to launch direct flights between Tel Aviv and Goa, as also Cochin, from September 2019, using their recently acquired Airbus A320neo aircraft. This announcement comes in the wake of record Indian tourists travelling to Israel, with a 21% growth during 2018.

Heligo receives Airbus H145 helicopter from Milestone Aviation

Heligo Charters Private Limited (HCPL), a Mumbai-based non-scheduled helicopter operator has taken delivery of its first Airbus H145 helicopter, to be operated in the state of Jharkhand.

HCPL is a leading onshore and offshore helicopter services provider to the oil & gas industry, corporate and VIP travel in India. The company currently operates 10 helicopters, including four Airbus AS365 N3 Dauphins. "HCPL will use the versatile H145 helicopter for a variety of missions. With enhanced safety features and a reputation for reduced maintenance, the H145 is an ideal craft for performing diverse roles," said Capt K Padmanabhan, CEO, Heligo Charters Pvt Ltd.

GVHL contract for Airbus H145

Global Vectra Helicorp Limited (GVHL), has signed contract for an H145 helicopter in a multi-utility configuration with an option for a second H145 helicopter in similar configuration, the first aircraft to be delivered by mid-2020. The helicopter's eight-seat, multirole configuration will allow the operator to rapidly change the aircraft for a variety of missions, from VIP transport and offshore operations to emergency medical services.

In the picture on the previous page are seen, left-to-right : Philippe Monteux, Managing Director, Airbus Helicopters, South East Asia & Pacific; Ashish Saraf, Head of Airbus Helicopters, India & South Asia; A J Baker, CEO of GVHL; Regis Antomarchi, Commercial Director, Airbus Helicopters, India & South Asia; Gaurav Adhikari, Sales Manager, Airbus Helicopters, India & South Asia.

Elbit orders on BEL

Bharat Electronics Ltd (BEL) has received orders valued about $ 33 million from Elbit Systems Electro-Optics Ltd (ELOP), a subsidiary of Elbit Systems Ltd, Israel for the manufacture and supply of state-of-the-art next generation EOIR payloads (CoMPASS Rev III) and another variant of EOIR payload (CoMPASS III, Trade Mark of ELOP) for Airborne applications. As part of 'Make in India' initiatives, BEL had entered into Technical Collaboration Agreement (TCA) with ELOP for transfer of technology for the manufacture of these EOIR payloads and for providing lifetime maintenance support at its manufacturing facility at Chennai.

Goa Shipyard contracted for two additional Project 1135.6 ships

An Inter-Governmental Agreement (IGA) between the Governments of India and the Russian Federation has been signed for construction of additional Project 1135.6 follow-on ships at Goa Shipyard Limited (GSL). Scheduled delivery is in June 2026 and December 2026 respectively. The follow-on P 1135.6 series of frigates, customised to meet the Indian Navy's specific requirements, are multi-role covering the entire spectrum of naval warfare : air, surface and sub-surface. Advanced features of stealth include a special hull design "to limit radar cross-section, low electromagnetic, infrared and under water noise signatures, the ships carrying highly sophisticated and state-of-art weapon systems and sensors".

NBC Training Facility at INS *Shivaji*

The CNS Admiral Sunil Lanba commissioned a state-of-the-art *Nuclear, Biological, Chemical Training Facility* ABHEDYA, at INS *Shivaji*, Lonavla on 25 March 2019. GSL had signed the contract with Indian Navy for construction of the NBCTF on 31 March 2016 handing over the facility to Indian Navy on 28 September 2018, well ahead of schedule.

The steel structure of the simulator represents the relevant NBC compartment of the ship such as upper decks, citadels, cleansing stations, DCHQ, etc., the upper deck compartment equipped with live agents along with NBC equipment such as SIRS, SICADS and other NBC detection and monitoring equipment.

Induction of 2nd Scorpene–class submarine

The Indian Navy is to shortly commission its second *Scorpene*-class submarine, INS *Khanderi* which will join the first, INS *Kalvari* with the western naval fleet. The *Kalvari* and *Khanderi* are the first two of six *Scorpene*-class submarines being built at Mazagon Dock Ship-builders Limited (MDL) in Mumbai, under licence from French firm Naval Group, previously called DCNS, under a Rs 23,562-crore programme known as Project-75. The officials said the third diesel-electric submarine would be inducted next year and the remaining three vessels by the end of 2021.

India and Saudi Arabia plan joint naval exercises

The joint statement issued at end of Saudi Arabian crown prince Mohammed bin Salman's visit to India in February also made references to joint naval exercises between the two Navy's "at the earliest". They also agreed to cooperate and collaborate in joint production of spare parts for naval and land systems as well as supply chain development, in line with the 'Make in India' and 'Vision 2030' programmes. With Saudi Arabia reportedly eyeing a role in the Indian Ocean Region, where India is a traditional power, the two sides agreed to work together with other Indian Ocean Rim Countries for enhancing maritime security.

Lease of *Akula*-class attack submarine from Russia

The Government of India have formalised a $ 3.3 billion contract with Russia for an *Akula*-class nuclear-powered submarine on lease for 10 years, the submarine expected to join the Indian Navy by 2025. This inter-governmental agreement on leasing of the submarine to be named *Chakra-III* will be the third Russian nuclear-powered submarine that the Indian Navy would be operating and replace the *Chakra-II* that was transferred on lease to India in April 2012 for a period of 10 years. *Chakra-III* is one of the several incomplete Soviet-era *Akula*-class hulls that remained mothballed at the Zvezdochka shipyard in Severodvinsk. The hull would undergo a deep refit and fitted with Indian sensors, operation room electronics, and communication equipment before being delivered to India.

CG *Sachet* OPV launched

The first of five Offshore Patrol Vessels for the Indian Coast Guard was launched by Nirmala Sitharaman on 21 February 2019 at Goa Shipyard Limited and named 'Sachet'. The ongoing shipbuilding project for five Offshore Patrol Vessels is one of the largest contracts being executed by GSL for the Indian Coast Guard. The vessel is in advanced stage of outfitting and will be ready for delivery by January 2020, as per the contractual schedule. The vessels are to be fitted with modern and technologically advanced machinery and computerised controls systems, these 2400-ton vessels to be equipped with Quick Response Boats for rescue and anti piracy, tasks, gunnery simulators and other advanced features.

CNES and ISRO agreement on maritime surveillance centre

CNES President Jean-Yves Le Gall and Sivan K, Chairman of ISRO have signed an agreement to implement short-term plans for the French-Indian programme to develop a maritime surveillance system. The CNES-ISRO agreement, intended to supply an operational system for detecting, identifying and tracking ships in the Indian Ocean, provides for a maritime surveillance centre to be set up in India by May 2019, sharing of capacity to process existing satellite data and joint development of associated algorithms. For the next phase of the programme, studies for an orbital infrastructure to be operated jointly by the two countries are ongoing. A team of experts from ISRO will start receiving training this month at the Toulouse Space Centre, the CADMOS centre for the development of microgravity applications and space operations and the MEDES space clinic.

Arjun Mk.1A MBTs

The Indian Army has accepted an upgraded version of the Arjun main battle tank, designated Mk.1A for service following validation trials in Rajasthan, which were completed end December 2018. Series production of this variant is to commence within 2019 at the Ordnance Factory's production facility at Avadi in Tamil Nadu. The Arjun Mk.1A incorporates some 14 upgrades, including an auto-target tracker, automatic gear system and improvement in suspension.

Only the missile firing ability remains to be validated, which will be done once the missiles, being developed by the DRDO, are cleared for acceptance. Fitted with a 120 millimetre gun and displacing a weight of 68 tons, the new Arjun Mk.1-A is however still considered to be "too heavy" by the Indian Army.

Pinaka guided extended-range rocket tested

The Defence Research and Development Organisation (DRDO) tested two Pinaka guided extended range rockets from Pokhran ranges on 11 March. In both tests, "the weapon systems impacted the intended targets with high precision and achieved desired accuracies". Telemetry Systems had tracked and monitored the vehicle all through the flight path.

DRDO: successful flight test of SFDR

Defence Research and Development Organisation (DRDO) of India successfully flight tested the second indigenously developed 'Solid Fuel Ducted Ramjet (SFDR)' propulsion

based missile system from ITR, Chandipur, Odisha on 8 February 2019. Ground booster, separation of ground booster and Nozzle-less-booster performance were found satisfactory. The missile was guided to high altitude to simulate aircraft release conditions and subsequently nozzle-less-booster was ignited. SFDR based missile accelerated to achieve ramjet Mach number successfully. The trajectory was tracked by telemetry and radar stations till touchdown. "The success of SFDR propulsion technology is a significant milestone and will pave the way for development of long range air-to-air missiles in the country."

MPATGH tested

DRDO have also successfully test fired the indigenously developed, low weight, fire-and-forget Man Portable Anti-Tank Guided Missile (MPATGM) at the ranges in Rajasthan desert. MPATGM has advanced features including state-of-the-art Imaging Infrared Radar (IIR) Seeker with integrated avionics. The first test was conducted on 13th March 2019 and in both tests, "the missiles hit the designated targets precisely."

India-Myanmar in Joint Ops

India's far eastern frontiers also witnessed armed actions during two-week long joint operations from mid-February when, with Myanmar Army units, Indian special forces targeted militant camps to avert possible threats to the ambitious Kaladan transit and transport project. Apart from camps of the Arakan Army, a score of NSCN-K faction leaders were taken into custody at their base at Taga in Sagaing Division.

AK203 production in India

On 3 March 2019, PM Narendra Modi inaugurated the plant for production of 200-series Kalashnikov assault rifles, which is at Corva in Uttar Pradesh. Partners of the JV *Indo-Russian Rifles Private Limited* are India's Ordnance Factory Board (OFB) and Russia's Rosoboronexport and Kalashnikov Group parented by Rostec.

The plant in Corva is one of the most advanced of OFB's small arms enterprises extant. With production of 750,000 numbers approved, major components for these will be mostly sourced from India. "The capacity of the plant is sufficient to equip the personnel of all security agencies in India" stated Alexander Mikheev, Rosoboronexport's CEO.

Activities of Indo-Russian Rifles Private Limited are consistent with India's laws and regulations, major milestones including a Government-to-Government Agreement, shareholders' agreement, approval of the JV Charter, as well as registration of the enterprise in India.

SiG Sauer SIG716 rifles for Indian Army

On 12 February 2019, the Indian government signed a contract with US company SiG Sauer to equip the Indian Army with new assault rifles, under the *fast track procurement* (FTP) route. The deal is for 72,400 rifles for around Rs 700 crore. The SiG Sauer SIG716 7.62x51 mm assault rifles will replace the indigenous 5.56x45mm INSAS rifles, which have equipped bulk of the Indian Army's 382 infantry battalion over the past few decades.

Cyient-BlueBird JV launches new UAS

Cyient Solutions & Systems Pvt. Ltd. (CSS), a joint venture between Cyient Ltd. and BlueBird Aero Systems, Israel, has launched its latest offering, the WanderB Vertical Take-Off & Landing (VTOL) Unmanned Aerial System. The WanderB VTOL

is an 'exciting and technologically advanced solution' for military, peacekeeping, low-intensity conflict resolution, law enforcement, disaster management, and commercial applications.

Alpha Design Technologies win big Elbit order

Bezhalel Machl, President & CEO, Elbit Systems Ltd., handed over the first export order worth a million dollars, which is expected to grow to millions of dollars in the next 4-5 Years to Col. HS Shankar, Chairman & Managing Director, Alpha Design Technologies, Bangalore at Alpha's Stall at Aero India 2019. Bezhalel Machl said that ELBIT had chosen Alpha Design as their technology and production partner for manufacturing of new generation Jammer Power Amplifiers needed by Elbit's company Elisra to meet worldwide requirements.

BEL MoU with Elettronica SpA (ELT)

Bharat Electronics Limited (BEL) and Elettronica SpA (ELT), Italy, entered into an MoU for Joint Development, Commercialisation and Production of new generation EW Surveillance Systems. Mrs Anandi Ramalingam, Director (Marketing), BEL, Mr Domitilla Benigni, Chief Operating Officer, ELT, and Mr Irmin Menscher, Vice President, Elisra, Israel, signed the MoU documents in the presence of Mr Gowtama M V, CMD, BEL, and other senior officers of BEL. The MoU will enable BEL and ELT to jointly develop new generation EW Surveillance Systems to meet the Global requirements.

Elettronica is a leader in electronic warfare with a complete portfolio of state-of-the-art solutions: designed and manufactured by Elettronica to cover a wide range of applications and missions such as ELINT, COMINT (SIGINT), ISR, Infrared, Self-Protection and Electronic Attack.

Rafael places $30 million order on ARC, India

Rafael Advanced Defense Systems CEO, Major General Yoav Har-Even, gave Chief Operations Officer of Astra Rafael Comsys Pvt Ltd (ARC), Brigadier Ravi Hariharan $30 million purchase order for the manufacture, test-before-integration, and lifecycle support management for a complete set of the BNet Software Defined Radio system for the Indian Air Force. This order is the first contract for ARC, the joint venture between Rafael and India's Astra Microwave Products Ltd. In 2017, Rafael was awarded a contract to supply the BNet advanced Software-Defined Radios (SDR) to the Indian Air Force (IAF).

Saab MoUs for Gripen aerostructures

Saab has expanded its footprint and aerospace ecosystem in India by signing new Memorandums of Understanding (MoUs) with three of the country's leading aerospace manufacturers: Dynamatic Technologies Limited, CIM Tools Private Limited and Sansera Engineering Private Limited.The MoUs with CIM Tools and Sansera expand the existing working relationships with Saab on commercial aerostructures to the Gripen fighter and other defence-related products in the Saab portfolio. The MoU with Dynamatic is a starting point to explore future joint opportunities in commercial and defence-related aerostructures work, including Gripen.

Appointments

Vice Admiral Karambir Singh appointed as next CNS

Vice Admiral Karambir Singh has been appointed as the next Chief of the Naval Staff (CNS) on superannuation of Admiral Sunil Lanba on 31 May 2019. Vice Admiral Karambir Singh would be the first helicopter pilot of the Indian Navy to be appointed as the CNS.

From Jalandhar in the Punjab, he graduated from Barnes School in Deolali before joining the NDA at Khadakwasla. Commissioned into the Indian Navy in July 1980, he earned his wings as a helicopter pilot in 1982 and thereafter extensively flew Chetak and Kamov helicopters in support of Fleet Operations.

In his career spanning over 39 years, the Admiral has commanded Indian Coast Guard Ship *Chandbibi*, Missile Corvette INS *Vijaydurg* as well as two Guided Missile Destroyers INS *Rana* and INS *Delhi* and also served as Fleet Operations Officer of the Western Fleet. Ashore, the Admiral has served at Naval Headquarters as Joint Director Naval Air Staff, and as Captain Air and Officer-in-Charge of the Naval Air Station at Mumbai. He has also served as a member of the Aircrew Instrument Rating and Categorisation Board (AIRCATS).

On promotion to flag rank, the Admiral was Chief of Staff, ENC. His other important flag appointments including Chief of Staff of the Tri-Services Command at Andaman & Nicobar Islands and Flag Officer Commanding Maharashtra and Gujarat Naval Area (FOMAG).

In the rank of Vice Admiral, he was Director General Project *Seabird*, in-charge of infrastructure development of the Navy's modern base at Karwar. He was later Deputy Chief of Naval Staff and Vice Chief of the Naval Staff at IHQ MoD (Navy) and presently Flag Officer Commanding-in-Chief ENC since 31 October 2017.

Vice Admiral Ajit Kumar P takes over as FOC-in-C WNC

Vice Admiral Ajit Kumar P took over as Flag Officer Commanding-in-Chief of the Western Naval Command on 31 January 2019 at Mumbai, succeeding Vice Admiral Girish Luthra, at an impressive ceremonial parade at the Naval Air Station *Shikra*.

Vice Admiral Ajit Kumar P is specialist in Missiles and Gunnery, the Flag Officer having served onboard frontline warships of the IN with the rare distinction of commanding six warships, including two foreign warships. These include guided missile corvette INS *Kulish*, guided missile frigate INS *Talwar*, guided missile destroyers INS *Mumbai* and INS *Mysore*. The officer has completed the Naval Higher Command Course and is also an alumnus of the prestigious Naval War College, Newport, USA.

Vice Admiral Ajit Kumar P has also been the Flag Officer Commanding of the Eastern Fleet, Commanding Officer of Gunnery and Missiles Training School INS *Dronacharya*, served as ACMS (Human Resources Development) at IHQ MoD (Navy) and was Chief of Staff of Southern Naval Command.

Vice Admiral SN Ghormade appointed Chief of Staff, ENC

Vice Admiral SN Ghormade, assumed charge as Chief of Staff, Eastern Naval Command, Visakhapatnam on 14 February 2019. He is a graduate of National Defence Academy (NDA), Khadakwasla, Pune, United States Naval Staff College at Naval War College, Newport, Rhode Island and the Naval War College, Mumbai. His operational appointments include commands of the Guided Missile Frigate INS *Brahmaputra*, Submarine Rescue Vessel INS *Nireekshak* and Minesweeper INS *Allepey* and second in command Guided Missile Frigate INS *Ganga.* He later became Flag Officer Commanding Karnataka Naval Area and was then appointed as Flag Officer Commanding Maharashtra Naval Area. Prior taking over as Chief of Staff he was Director General Naval Operations.

Rear Admiral Sanjay Jasjit Singh is Western Fleet Commander

Rear Admiral Sanjay Jasjit Singh took over charge of Western Fleet on 22 March 2019. Commissioned into the Indian Navy in 1986, he is specialist in Navigation and Direction has held a range of command, training and staff appointments during his

AVIATION & DEFENCE In India

career. His sea command appointments include that of the ASW and UAV-control Frigate INS *Taragiri*, and the multi-role frigate INS *Trishul*. He also has the distinction of being lead drafter for the Indian Navy's Maritime Doctrine in 2009, *Indian Maritime Security Strategy* and *Strategic Guidance to Transformation* in 2015.

Air Marshal R Nambiar assumes command of WAC

Air Marshal Raghunath Nambiar took over as Air Officer Commanding-in-Chief Western Air Command, Indian Air Force on 1 March 2019. The Air Marshal is an Experimental Test Pilot and has flown 42 types of aircraft and has the distinction of having the highest number of flying hours on Mirage 2000s in the IAF. He is a member of the *Society of Experimental Test Pilots* and was the Project Test Pilot for the Tejas Light Combat Aircraft.

He was Director of Space Applications at Air HQ, Principal Director of Offensive Operations and the Chief Operations Officer at Air Force Station Gwalior. The Air Marshal has also been AOC Air Force Station Jamnagar, Commandant ASTE, Air Defence Commander Western Air Command and Senior Air Staff Officer (SASO) of Southern Air Command, Training Command and Eastern Air Command. He was earlier Deputy Chief of the Air Staff at Air HQ, before taking over as AOC-in-C, Eastern Air Command.

Rear Admiral Krishna Swaminathan is Flag Officer Sea Training (FOST)

Rear Admiral Krishna Swaminathan has assumed charge as Flag Officer Sea Training (FOST) at Kochi He is a specialist in Communication and Electronic Warfare, has commanded five frontline ships of the Indian Navy including the missile vessels INS *Vidyut* and INS *Vinash*; the missile corvette INS *Kulish*; the guided missile destroyer INS *Mysore*; and the aircraft carrier INS *Vikramaditya*. Prior to assuming charge as FOST, the Admiral was the Chief Staff Officer (Training) at Headquarters Southern Naval Command and played a key role in conduct of all training in the Indian Navy.

FOST functions under the operational and administrative jurisdiction of Flag Officer Commanding-in–Chief, Southern Naval Command which charter includes conduct of operational sea training for ships of the Indian Navy and Coast Guard by enhancing crew proficiency in all aspects, including safe navigation practices, damage control and firefighting drills, weapon firings as well as seamanship training.

Salil Gupte is Boeing Business Leader in India

Salil Gupte has been appointed as President of Boeing India, effective 18 March, based in New Delhi and reporting to Marc Allen, President of Boeing International. Gupte, who earlier was Vice President of Boeing Capital Corporation, a wholly-owned subsidiary of The Boeing Company, succeeds Prat Kumar, who was appointed vice president and programme manager of Boeing's F-15 fighter aircraft programme in November 2018.

Ravi Nirgudkar is President, Raytheon India

Raytheon Company has appointed Ravi Nirgudkar as President of Raytheon India, based at the company's New Delhi office. He has over 25 years of experience in international business development and programme management, including 19 years with Raytheon's Intelligence, Information and Services and Space and Airborne Systems businesses.

National War Memorial inaugurated

On 25 February 2019, Prime Minister Narendra Modi unveiled the National War Memorial near the India Gate Complex to pay homage to over 26,000 Indian servicemen who laid down their lives in defence of the country since 1947. The central obelisk is topped with an Ashokan Capital and stands at a height of 15.5 metres and the base bears the famous couplet '*Shaheed ki Mazaron Par*' by poet Jagdamba Prasad Mishra *Hitaishi*. Six bronze murals made by noted sculptor Ram Sutar depicting famous battles fought by the Army, Air Force, Navy, have been put up in the *Veerta Chakra* zone.

Flexing Muscles in Space
The ASAT success

On 27 March 2019 as part of 'Mission Shakti', Indian Scientists destroyed a Low Earth Orbit (LEO) satellite with an Anti-Satellite (ASAT) missile based on Defence Research & Development Organisation (DRDO) Ballistic Missile Defence (BMD) interceptor. Following the successful test, Prime Minster Narendra Modi announced in a televised address to the nation that "India can now defend itself in space, and not just on land, water, and air, after the success of *Mission Shakti*". He further stated that the ASAT missile had shot down the Low Earth Orbit satellite within "three minutes of launch", with remarkable precision and technical capability, and India has emerged as the fourth country to have tested such an ASAT weapon after the United States, Russia and China.

A technological mission carried out by DRDO, the 18-tonne ASAT weapon consisting of two solid rocket boosters plus a 'terminal stage' was launched from the complex on Wheeler Island, off the Odisha Coast, the target being one of India's existing LEO satellites. The test, which required an extremely high degree of precision and technical capability was "fully successful and achieved all parameters as per plans and successfully demonstrated its capability to interdict and intercept a satellite in outer space based on complete indigenous technology". The ASAT weapon lifted off at 11:09:30 hrs, the first stage separated at 45 km altitude at 11:10:45 hrs, the second stage separated at 110 km height at 11:11:17 hrs, followed by highly challenging Imaging Infra-Red (IIR) lock on to the target 740 kg Microsat-R satellite at 11:12:10 hrs. The target was eliminated by the Kinetic Kill Vehicle (KKV) at 11:15 hrs at a height of 274 km in hit-to-kill mode. The specific interceptor is reported to be lethal as far as 1,000 km.

Although not specifically stated, valuable telemetry data was possibly contributed by Israel Aerospace Industries (IAI) - developed EL/M-2080 Green Pine (Swordfish) and Super Green Pine radar systems. Developed from the ELTA Music phased-array radar, Green Pine is a dual mode, electronically scanned, solid state, phased array radar operating at L-band in the range 500 MHz to 1,000 MHz, which weighs 60 tonnes and comprises 2,000 transmit-receive modules.

As India's space programme is a critical backbone of the nation's security, economic and social infrastructure, India has undertaken 102 spacecraft missions consisting of Communication Satellites (COMSAT), earth observation satellites,

experimental satellites, navigation satellites, apart from satellites meant for scientific research and exploration, academic studies plus micro satellites. Against this backdrop, such successful engagement of the target satellite at LEO ensured proven capability against hostile Intelligence, Surveillance & Reconnaissance (ISR) satellites, hostile armed satellites aimed at our space based assets, and incoming ballistic missiles. As the interception was made at lower orbit, the problem of space debris will also be minimal since the particles will quickly burn out after entering Earth's atmosphere.

India, which is a signatory to the 1967 Outer Space Treaty (ratified it in 1982), however supports the substantive consideration of the issue of *Prevention of an Arms Race in Outer Space* (PAROS) in the Conference on Disarmament where it has been on the agenda since 1982. A party to all the major international treaties relating to Outer Space, India already implements a number of Transparency & Confidence Building Measures (TCBM) including registering space objects with the UN register, prelaunch notifications, measures in harmony with the UN Space Mitigation Guidelines, participation in Inter Agency Space Debris Coordination (IADC) activities with regard to space debris management, undertaking Space Object Proximity Awareness (SOPA) and Collision Avoidance (COLA) Analysis and numerous international cooperation activities, including hosting the UN affiliated Centre for Space and Science Technology Education in Asia and Pacific.

India has been participating in all sessions of the UN Committee on the Peaceful Uses of Outer Space. In future, India expects to play a role in the drafting of international law on prevention of an arms race in outer space including inter alia on the prevention of the placement of weapons in outer space in its capacity as a major space faring nation with proven space technology.

Sayan Majumdar

Vayu Shakti 2019

Prelude to the 'Real Thing'

16 February 2019 : Exercise at Pokhran

Exercise Vayu Shakti 2019 was conducted by the Indian Air Force at the Pokhran ranges near Jaisalmer on 16 February 2019. It was a day and night exercise, conducted in two phases to showcase operational prowess of the IAF with various simulated targets to demonstrate the lethality and effectiveness of the IAF. A range of munitions were employed as appropriate to meet operational requirements and destruction of targets with precision and cost-effectiveness.

Air Chief Marshal BS Dhanoa flew in directly to the range in a C-130J Super Hercules, also demonstrating this tactical transport's unique STOL attributes, and was received by Air Marshal HS Arora AOC-in-C, South Western Air Command. Soon followed was release of a Coffee Table book titled '*1971 Indo-Pak War : An Aerial Account*'.

As precursor to the Fire Power Display itself, three Mi-17 helicopters flying the national flag and the IAF ensign flew past the grandstand, followed immediately by a Jaguar recce aircraft at low level taking images of the grandstand followed by the supersonic run by a MiG-29 fighter leaving a loud sonic boom in its wake.

The event was attended by Air Chief Marshal BS Dhanoa, Chief of the Air Staff, General Bipin Rawat, Chief of the Army Staff and a large number of diplomats and senior officers of the Army, Navy and the Indian Air Force

Mirage 2000 releases a stick of iron bombs over the Pokhran range the 'real thing' involved SPICE 2000 pgms fired by Mirage 2000s in earnest (see accompanying article)

Some 137 aircraft participated in the fire power demonstration and consisted of the Su-30MKI, MiG-27UPG, MiG-29 UPG Tejas LCA, Mirage 2000, MiG-21 Bison, Hawk Mk.132, An-32, C-130 Hercules, Mi-17 and the ALH Rudra. Among the 'enemy targets' destroyed with precision strikes were simulated transporter erector launchers of surface-to-surface missiles, troops and supply convoys, AFVs, radar sites, railway yards and military headquarters.

During the pre-sunset phase, a Netra Airborne Early Warning & Control (AEW&C) aircraft flew past, dispensing anti-missile flares, making a spectacular scene in the sky.

The second phase of *Exercise Vayu Shakti* began at sundown and highlighted the IAF's capability of conducting special heliborne operations, including induction of troops by low hover jumps and rappelling with Garud Special Forces carrying out anti-insurgency operations in an urban setting. An Mi-17 with 'Bambi bucket' showed the extinguishing of fires.

Highlight of the third phase, even as darkness enveloped the desert, was launch of an Akash SAM destroying a designed target. In an impressive sequel, Mi-17V5 and Mi-35 helicopters fired a barrage of rockets on simulated enemy targets and thereafter Su-30s, Jaguars and MiG-27s resumed air-to-ground firing to destroy remaining targets.

Exactly ten days later, the IAF launched air strikes in earnest, against <u>real</u> enemy targets in the eastern edge of Khyber-Pakhtunkhwa of Pakistan.

Air Marshal Harish Masand on

The 'Real Thing'

Representative picture of IAF Mirage 2000 releasing free fall bombs

26 February 2019 : Strike on J-e-M at Balakot

12 days after the terror attack on Indian security forces at Pulwama in the Kashmir Valley on 14 February 2019, the Indian Government decided that enough was enough and responded with air strikes on key J-e-M terrorist camps reportedly located at Jaba Top near Balakot in Khyber Pakhtunkhwa, in "mainland Pakistan" itself. What was significant about these strikes was not the body count nor confirmation on the number of terrorists actually eliminated but that, for the first time, Indian forces had not only crossed the LoC but also went into Pakistan itself for carrying out this particular strike. Even during Kargil 1999, where clear aggression by the Pakistani military had been established India had fought with one hand tied behind its back with the *Lakshman Rekha* regarded as the LoC in Kashmir. There can be little debate on the argument that if then the LoC was not kept

From the internet

The spearhead: there are three squadrons of Mirage 2000s with the Indian Air Force, currently being upgraded by Dassault/HAL

sacrosanct and the armed forces given the liberty of attacking from the flanks or rear through an indirect approach, the casualties, both on ground and in the air, would have been substantially less and the Army would have evicted the intruders from occupied posts earlier than was done.

Viewed in this context, along with the minor incursions across the LoC in past retaliatory actions, true significance of the Balakot strike is the message this nation has sent through its Air Force in that it is capable and determined to strike at terror bases wherever they may be. Fortunately, there were no reported IAF losses in these pre-dawn strikes of 26 February. The Pakistanis did not claim interception of any IAF aircraft that took part in these raids. However, even if there had been some losses, these would – and should – have been acceptable to the nation considering importance of the message sent out not just to Pakistan but also the international community of India's resolve to combat terror and the manner of retaliation.

There was meticulous planning and execution of operations by the Indian Air Force, making the nation proud. I will not go into guesswork or try to focus on which aircraft types took part in these strikes nor where they took off from on how they conducted the planned strike, as some others found important to discuss and debate on TV channels for days thereafter. Personally, I want to commend the IAF for being reticent on details since these are not for public consumption, no matter how much the temptation to get some limelight. After all, even the minutest information on plans can adversely affect future operations of such nature. In that context, for some to claim credit in having planned such strikes a decade or more ago was also perhaps unnecessary.

As a matter of fact, I would be disappointed if current leadership of the IAF had just dusted and used such dated plans since with acquisition of new technology, knowledge, expertise as well current intelligence, operational plans must inevitably change and be innovative to surprise the enemy every time. Neither the IAF nor the foreign secretary, who made the official announcement in the forenoon of 26 February, mentioned which aircraft, how many or from where, as also the weapons were used and the exact or even the estimated casualties inflicted. I have not been able to figure out where our media picked up details on the Mirages, Mid-Air Refuellers and AWACS and so on.

Despite such clear restraint on part of the officials concerned, it is disturbing to witness some persons making claims on the numbers killed while others are asking for evidence of the strikes or even the exact number of casualties. Such detractors, whatever their compulsions, do not seem to understand the main objective of the strikes or the fact that in air actions, the number of casualties cannot be estimated with any degree of accuracy without having persons on ground immediately thereafter, particularly when the adversary is in a denial mode and all damage would be cleared or covered post-haste. All that can be done is to project the numbers likely to have been in the target complex based on latest intelligence. Also, it would be incorrect to even ask the Air Force to put out in public domain any imagery from the strike aircraft or its other assets.

In counter intelligence, even such imagery gives away the type of assets used

and attack pattern employed, the resolution of the imagery and many other aspects can be used to deduce capabilities and likely future employment of assets. In any event, such evidence on the strike having been successfully carried out has slowly emerged from unofficial sources. Pakistan itself admitted the intrusion with some outrage, with an audio of J-e-M warning of rebirth of Jehad, while an Italian journalist, Francesca Marino, wrote of extensive damage with eyewitness accounts of 40-50 killed and another 35-40 wounded. Later, YouTube posted a video giving satellite imagery of the terrorist complex at Balakot before – and after – the strike. More details would surely emerge with the passage of time. Even the IAF may eventually put out some evidence once these phase of operations are over and when the information is not considered sensitive.

In the meantime, the political storm being created for evidence, without patience, may result in confusion, even demoralising the warfighters. One can be certain that senior leadership in the armed forces are taking suitable steps to ensure that attention of the fighting elements is not distracted by such political controversies, an unnecessary and wasteful drain on time and resources.

Immediately after the strikes, while the nation was waking up, one can be certain that the armed forces remained in high state of alert for possible retaliatory action from the other side. Thus, air intrusions by PAF aircraft the very next day should not have surprised anyone, least of all the Indian Air Force. Without detracting from Wing Commander Abhinandan's bravery, and his later conduct in captivity which we all salute, it is surprising that the Air Force decided to pit MiG-21s, perhaps mixed with some Su-30s, against incoming F-16s. I was in charge of the MiG-21 upgrade to Bison standards from initial evaluation of proposals in 1993 till after contract conclusion in 1996 so I know exactly what the Bison is capable of in terms of its combat capability, including avionics and weaponry. The MiG-21 Bison has performed admirably against later generation aircraft in various international exercises in which they took part. However, the airframe and power plant of the Bison remains almost the same as earlier variants limiting its maneuverability and close combat capabilities against more modern aircraft such as the F-16. It was known that the Bison would not be able to hold its own against superior aircraft types except when in a large and coordinated group where numbers overcome limitation in individual maneuverability.

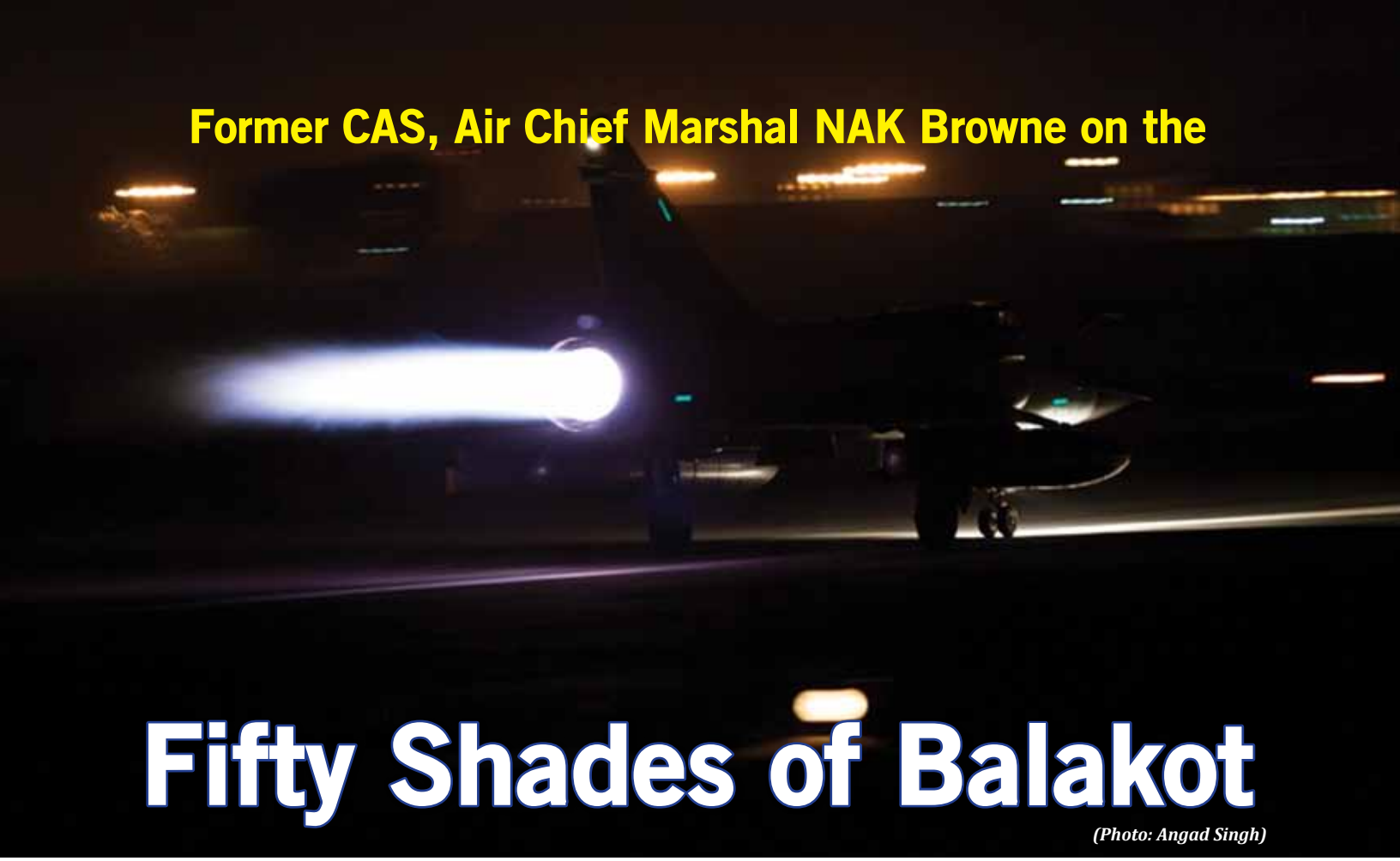
Signboard of the Madrasa Taleem al-Quran, run by Maulana Masood Azhar near Balakot.

An edit piece in the NY Times is already questioning the IAF's vintage hardware and inability to face future challenges as a strategic partner of the USA. I am also hoping that the Indian Air Force will to get some imagery of the F-16 crash site, reportedly just across the LOC before it was cleaned up, through various means available to it, instead of some tidbids on TV about a drop tank here and engine casing there being examined by Pakistan soldiers. Despite the reportedly heartening performance of this old work-horse against an F-16 as reported elsewhere ["Fishbed vs Falcon : Why the ancient MiG-21s F-16 kills no fluke"] the claim would someday need to be substantiated by more than just conjectures. It would certainly strengthen our case on "misuse" of the F-16 which reportedly is against US laws and conditions of sale.

Finally, I also hope the IAF has post-analysed this engagement and examine why more of the intruding force, if not all, were engaged in this very first aerial faceoff between the two air forces after almost five decades. That would have sent a powerful message to Pakistan – and we certainly have the assets to be able to do this.

Some 125 MiG-21bis were upgraded to the 'Bison' standard in the late 1990s

Former CAS, Air Chief Marshal NAK Browne on the



Fifty Shades of Balakot

(Photo: Angad Singh)

The tragic loss of 40 CRPF lives on 14 February in the Pulwama suicide bombing attack engineered by the JeM, presented a unique but justifiable cause in shaping India's kinetic response which was delivered 12 days later, on a half-moon night. The IAF's pre- emptive precision strikes on JeM training camp at Balakot in Khyber-Pakhtunwa marked a perceptible strategic shift in addressing some, if not all, terrorist-related issues emanating from across the borders, nurtured and supported by the Pak deep state. It is not the case that similar response and policy options were not available earlier; but perhaps they were not employed based on certain existential capabilities, constraints of the regional and international environment, challenges of escalatory dynamics and so on. As a consequence, during the intervening years we not only tip-toed around the elephant in the room but in the process emboldened the Pak military-jihadi establishment in truly believing that the LoC/IB was psychologically impregnable in minds of the Indian security establishment. This, despite our self-imposed moratorium of not crossing the LoC during Kargil and strictly enforced by the IAF through the Rules of Engagement (ROE).

Compelling evidence notwithstanding, the Pak establishment continued to adopt the 'revolving door concept' with safe sanctuaries not only in PoK but in the hinterland as well. Balakot was one such jihadi training hub infested with hundreds of such radical elements when the IAF struck on 26 February. While Pakistan, as expected, continues to be in a state of denial-- and understandably so--the shock effect combined with the strategic surprise has had a salutary effect on few agencies both within and abroad-- still searching for palpable evidence.

The fine print though will indicate that the Mirage 2000 core strike force comprised only six aircraft with a number of other aircraft embedded as support elements including AEW, AWACS and Flight Refueling aircraft. The entire operation was tactically choreographed in time and space in the hours of darkness to deliver strategic outcomes on what constituted as the 'jihadi centres of gravity' residing in Pak. And this was made possible only through effects based targeting for creating strategic effects with precision weapons delivered from substantial stand-off ranges.

While the Government has clarified on more than one occasion that these were non-military targets and the elements at Balakot were indeed being trained for terrorist activities, it is fair to assume that these could be broadly classified as 'jihadi leadership targeting system'. The targeteers therefore had planned to select a weapon system whose accuracy would enable a strike within a few feet of the target(s) which would then create the first and second - order effects to eliminate a broad cross section of these elements, instead of merely destroying the buildings resulting in collateral damage. It has been widely reported that the Israeli Spice 2000 (980kg) was selected as the weapon of choice (contracted by the IAF in April 2012 as part of a broader plan to widen the template for response options). While the post- strike debates on casualty details etc., appear raucous and somewhat unnecessary, it is clear however, that there were five direct weapon hits on the three building structures. It is assessed that the possibility of anyone walking out of those buildings unharmed appears highly remote.

It may be recalled that for the past several years IAF leadership has been alluding to the aspect of full spectrum capability for credible deterrence alongside doctrinal and technological developments. That some of these were tested at night for the first time in

a hostile environment deserves credit for it's audacious planning and flawless execution. More importantly, it is for the first time that the Indian security establishment successfully leveraged the fusion of electronic and imagery intelligence data with high quality precision weapons for the purpose of formulating a counter terrorism strategy—albeit with limited objectives.

But make no mistake : a one-off Balakot strike now or in the near future may not totally deter or compel a behavioural change nor will it eradicate this type of malignant behavior in our neighbourhood. It would be extremely naïve to even consider such a possibility as Pak institutions, structures and their inter se relationships are hard wired quite differently. Nor can the IAFs demonstrated aerospace capabilities function in isolation without the necessary underpinning of the political, diplomatic and economic counter strategies. And yet, these recent exertions have broadened the strategic landscape and will no doubt, inspire some new strategic approaches while dealing with a recalcitrant adversary. At the most, the security establishment along with key interlocutors can expect a number of such well-calibrated hard and soft response options. These formulations must necessarily be a part of a consistent and an over arching policy in the hope that it may discourage Pakistan from overt state sponsorship of terrorist groups and assist in making regional aggression unattractive in the long term.

There is also no denying that the challenge of escalatory dynamics will continue to remain a highly complex and a 'live' issue for the security establishment, more so when the use of offensive airpower is being contemplated in the context of an adversary who exhibits rational behavior at one level and totally emotive and irrational at another-- with the inherent risks involved in squaring off under a nuclear overhang. As an aside, an aspect worth noting is that the mere employment of offensive airpower is not escalatory; it becomes escalatory when it is employed indiscriminately leading to a situation when things can spin quickly out of control. To the credit of the security establishment, it appears the escalation was reasonably well controlled by limiting the operational objectives and by studiously avoiding military, civil or economic targeting clusters. In this case, the larger cause of taking out the terrorist training centres post-Pulwama far outweighed the risk factors entailed in the operation.

As events unfolded on 26-27 February, it appears the PAF's air defence elements were far too slow to react and were thus in no position to interfere with IAF's Balakot strike mission (PAF faced a similar situation on 02 May 2011 when Osama bin Laden was virtually plucked out by US Navy Seals from deep inside Abbotabad and the Force had then been severely criticised for nodding off on the wheel!). Ironically, both events share a common terrorist heritage tag. Taken together, PAF's riposte the next morning was very much anticipated and is considered significant from two aspects. First, their stand-off precision strikes had clearly targeted Northern Command military, installations in the Rajauri and Naushera sectors and secondly, as a result of IAF's robust air defence response, the strikes failed to hit any of their intended targets clearly demonstrating lack of will and capability. The above narrative however needs to be viewed from the larger aspect of escalation dynamics. For instance, if PAF strikes had indeed been successful in terms of large extent of damage including military/civilian casualties, what then should have been our response? In the fog of war, it is quite easy to take the first shot off the bow; the real test comes in the fourth or fifth reload when response options would have to be quickly evaluated and actions taken based on assessments and deliberations factored into the equation, not during but well prior to the event.

Lastly, Rules of Engagement (ROEs) provide the directives for engaging the adversary in a hostile situation and are clearly aimed at preventing untoward escalation. We can safely assume that unlike the Kargil conflict in which the PAF stayed away while the IAF strictly adhered to the ROE of not violating the LoC, a similar template for Balakot or any other future operation may not hold true. It follows therefore that the ROEs would need to be carefully structured and altered if need be as the situation evolves. The planners would have to project a clear understanding of not only the implications but also capabilities of own forces, lest they be disadvantaged in certain dynamic situations. At the tactical level for example, technological developments have now made it possible for a quantum jump in detection ranges of fighter aircraft airborne radars where these are integrated with highly effective Beyond Visual Range (BVR) missiles. This would permit an interceptor to acquire, lock-on and launch a BVR missile at extraordinary ranges with continuous tracking of the target aircraft till the missile achieves a hit. Incidentally, this capability is now available to both sides.

So if India has to be defended from the third dimension, the offensive air defence operations of own fighters would have to be exploited to the hilt by successfully engaging the adversary in head-on BVR engagements, a move that could entail minor LoC incursions, if necessary. Failure to do so will hobble our air defence operations in an uneven fight akin to entering the combat zone from a position of disadvantage. Once again, the implications would have to be factored into our ROE calculus accordingly, while ensuring that these are consistent with the overall game plan.

Air Chief Marshal NAK Browne was Chief of the Air Staff, IAF during 31 July 2011 to 31 December 2013, later serving as India's Ambassador to Norway

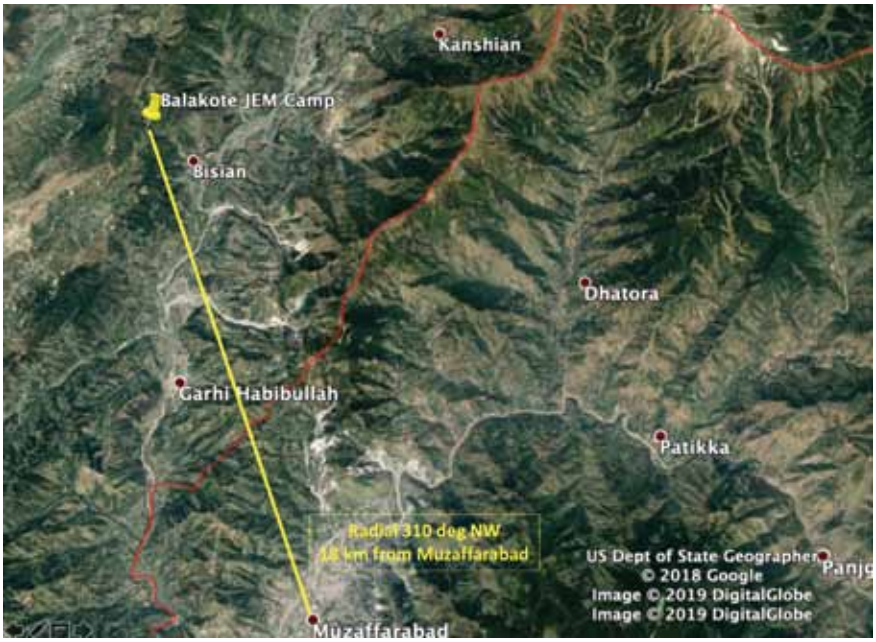
Almost a month has now lapsed since that fateful night of 26 February and while the dust over Balakot has not yet fully settled, there is no doubt that India's best interests would be served through prevention of an armed conflict. Nevertheless, it is reassuring that the recent IAFs air operations, though limited, has only reinforced deterrence and provided a new strategic window. This opportunity must not be wasted.

Spice of the Matter

A former Mirage 2000 pilot himself, Sameer Joshi takes forensic clues to analyse technical efficacy of the Indian Air Force's use of Spice 2000 smart bombs to target Pakistan-based Jaish-e-Mohammad's (JeM) terror camp at Jaba Hill top, Balakot on 26 February 2019

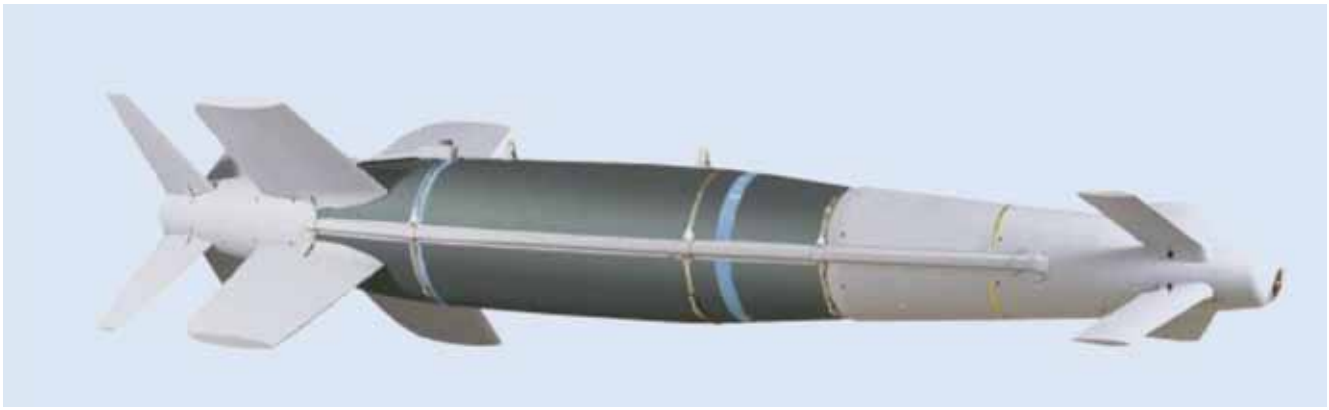
At around 0330 hrs on 26 February 2019, Mirage 2000s of the Indian Air Force made shallow incursions inside Pakistan occupied Kashmir (POK) and targeted JeM camps at Muzaffarabad, Chakoti in POK and Balakot in Pakistan itself. The strike on the Markaz Syed Ahmad Shaheed madrassa complex located on Jaba hill top at Balakot was the most significant amongst them, especially considering that the Indian Air Force had struck a target inside Pakistan for the first time since the 1971 war. The strikes were a direct response to the attack by Pakistan-based terror proxy Jaish-e-Mohammad, on a CRPF convoy at Pulwama in the Kashmir Valley on 14 February where over 40 Indian jawans had lost their lives.

According to reliable sources, the IAF used the Israeli-origin made SPICE 2000 stand-off glide bomb to target the camp at Balakot. The SPICE 2000 is a glide bomb kit, fitted on a 2000 lb (907 kg) bomb, the IAF using both SPICE 1000 and 2000 kits. As per Indian Air Force sources, 5 x SPICE 2000s were utilised for targets at Balakot, while one bomb was brought back. These bombs fell within 2 metres of their designated mean points of impact (DMPI) in the targeted area. The Indian Air Force has publicly stated that it has synthetic image radar (SAR) imagery of the post-strike battle damage analysis, which confirms its claim that all targets were accurately hit.



Representative photo of IAF Mirage 2000TH before a night sortie (Angad Singh)

Predictably Pakistan denied any damage or casualties at Balakot and said the IAF payloads had impacted in the



nearby forest area, "missing the targets completely". International satellite experts based on their reading of data available with private satellite networks post-strike, even ridiculed Indian claims that the bombs fell anywhere on the target, and were widely supported by a large section of the western media, who have been sceptical about accuracy of the Indian attack. Pakistan on its part thereafter completely sealed off the targeted camp in Balakot, discouraging any independent verification of the damage.

What has baffled the world is why the 2000 lb bombs which hit the madrassa complex, did not cause widespread explosive damage over the target? George William Herbert, an international weapon's expert tweeted that a 2000 lb/907 kg bomb like the Mk.84 made of 428 kg trinitol high explosive core and a 479 kg of metal casing, would have obliterated the building, destroying it completely due to the shock waves travelling at over 1.83–2.13 km/s. Typically it would double the pressure inside a standard three storey building around 25 meters wide, further contributing to the damage.

Latest OSINT data reveals that while at least two of the targeted structures were still standing, with dark smudges or holes visible on the rooftop of the biggest target, suggesting that SPICE bombs indeed penetrated the building. While the imagery is synonymous with SPICE strikes seen in Syria, this does not match up to the damage assessment for a Mk 84 or equivalent bomb carried as part of the SPICE 2000 glide kit and as brought out by George Herbert. In addition, suspected use of Fuel Air Explosive (FAE) through the SPICE 2000 mission, supported by dark smudges seen in the target area imagery is also seen as a possibility by some experts. In addition, there is indication that a deep penetration SPICE bomb hit north of the big hall, where a seeming heap of soil is present.

Possible targets in the JeM camp: Google Earth Pre-Strike Imagery

IAF sources have confirmed that the Mirages had used the 'penetrator' version of the SPICE 2000 glide bomb, which has a 907 kg hard metal reinforced casing with an embedded 'low mass' TNT warhead of 70–80 kg of net explosive quantity (NEQ). This version is designed to target reinforced concrete installations like C2 centres, penetrating deep before carrying out a low mass explosion to eliminate all with shrapnel, with a blast over pressure wave, not necessarily collapsing the targeted installation.

The IAF is sanguine that this is what happened at Balakot. This theory is reinforced by the statement of Maulana Ammar, younger brother of the JEM boss Masood Azhar, that the madrassa complex at Jabba Top had indeed been hit by Indian bombs, as well as through discreet interviews with eyewitnesses as in the area who confirm that at least 35 bodies of killed JEM militants and ISI operatives were taken out post-strike. Indian intelligence had estimated more than 250 -300 individuals were active inside the camp before the strike. There remain sceptics of the actual number of casualties as of present.

However, rather than being taken at face value, such revelation has further given unwarranted spin within the media – and intersecting theories–because even a 70–80 kg low mass TNT explosion would send shrapnel and corresponding shock waves upward of 1 km/s as dictated by the Gurney equation out to around 14 meters, enough to cause very significant damage to the targeted structure. Let us therefore diagnostically analyse the usefulness of the penetrator version of the SPICE 2000 as ordinance used by the IAF in its strike at Balakot.

The Right Bomb at the Right Place ?

The weapon for target matching suggests that the IAF was specifically looking to carry out precision strikes and avoid large area collateral damage. As described after the strike by the Indian Foreign Secretary, the 'Non-military pre-emptive strikes' were aimed at targeting the JeM cadre while avoiding civilian and Pak military casualties. Hence the 'penetrator' version of the Spice 2000, with a low mass TNT warhead was the right fit for the mission as compared with the high mass Mk 84 bomb equivalent version, which would have inflicted significantly more area damage.

The SPICE 2000 is an all weather 1000 kg glide bomb kit which uses 12 control surface to have a definitive range of 60 kilometres. It navigates with the help of IN/GPS and approaching the target reduces the GPS errors using its electro optical/ infra-red terminal attack sensor. This matches what it sees with pre-loaded satellite/ drone imagery of the target through 'scene matching', rapidly reducing the margin of errors and impacting the target within a CEP of less than 3 metres.

The SPICE 2000s used by the IAF have an advanced electrical fuze, which accurately predicts the impact sequence and delay required to activate. This is especially useful when penetrating multiple floors of a building, before exploding at the right level. A microphone embedded with a microcontroller in the smart fuze is used, for measuring the number of impacts and the microcontroller counting the floors, until the bomb breaks through the desired number of floors. Used extensively by the Israeli Air Force in Lebanon and Syria against tactical battlefield targets and in urban areas, the SPICE 2000 has a near perfect operational reliability record. These fuses would be critical in penetrating the various targeted buildings with at least 2 levels.

Focus of the SPICE 2000 strike was the Madrassa complex at northern edge of Jabba top, dominated by a huge 30 meters (length) x 30 meters (width) x 8 meters (max height) white/gray main Madrassa building, mostly used for imparting lessons by instructors to their trainees. This would possibly be the target for a solitary Spice 2000 bomb. Connected to this main hall is a set of buildings. Another concrete structure with two storeys 12 meters (length) x 10 meters (width) x 8 meters (height) is located to the north of the big hall, which housed the under training ab-initio cadre of the JeM. This building would have been targeted with a SPICE 2000 bomb. There was a twin storey mosque to the right of this building and a shed further to the north. To south of the big hall, across the training ground was a robust 'U' shaped concrete structure with roof, housing the instructors, senior trainees and a guest house in each component.

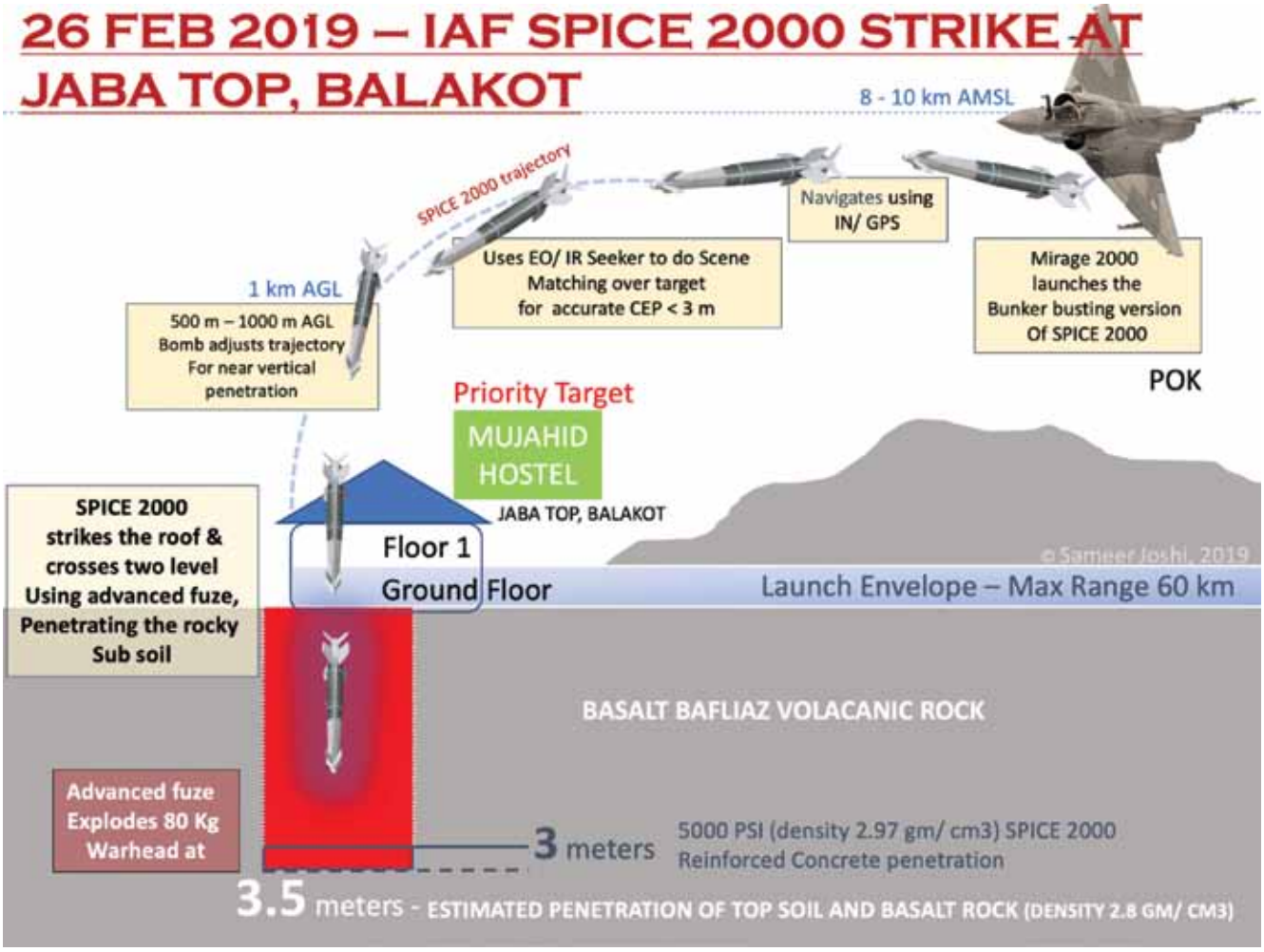
One SPICE 2000 bomb each would certainly have been earmarked for the Guest House, the Instructor's quarter and the senior trainee accommodation. The last target was the house of Umar Ghouri, the JeM Chief at Jaba Top, who lived across the dirt track. This would be a certain target for a single SPICE 2000 bomb. It is believed that one of the SPICE 2000s malfunctioned and could not be launched by the Mirage 2000s. Hence in all probability, one of the targets out of the GH, instructors and senior trainee buildings, would not have been engaged.

Pre-strike vintage images of the buildings shows thin metal roofs, with light concrete layer and two storeys. The walls would be a mix of concrete, local bricks and mortar, reinforced by rough iron pillars and concrete for support as is common in the construction characteristics found in Balakot region. While viewing historic satellite imagery of the place, it's interesting to note the camp mostly survived an earlier earthquake which caused widespread devastation in the area.

Post-strike imagery analysis done using the images available, has revealed that all bombs impacted roofs of the various targets at near vertical position. This would have been tactically planned by the IAF to achieve maximum penetration, before the bombs exploded. This may also explain the reason behind the IAF's shallow incursions in Pakistan occupied Kashmir, aiming to launch the SPICE 2000 well within its launch envelope to achieve optimal vertical trajectory over the target, rather than launch it at the fringe range of 60 kilometres while still over Indian territory.

Using Physics

Let us analyse the science of what happened post impact on 26 February at Jabba Top, Balakot. If we compare the Israeli-made SPICE 2000's penetrator casing volume and weight, it is closest to the USAF's BLU 116 penetrator used on the GBU 24/27 series of 2000 lb bunker busting munition. As per information, the BLU 116 can penetrate 3.4 meters of reinforced steel (or 15 meters of earth) using a nickel cobalt steel alloy core. The Spice 2000 penetrator bomb has similar capabilities. Assuming that the SPICE 2000 hit the target at near nadir point, it would have easily sliced through the thin metal/ light concrete roof and at least one semi concrete floor to hit the base floor with a decent foundation in the ground, which is largely made up of Bafliaz volcanic rock in the Balakot region. For the sake of calculating the impact force on a bunker class target, we will assume the SPICE 2000 is able to penetrate at least 3 metres of 500 PSI reinforced concrete (a figure which is certainly less than the actual) and 10m



of earth. We reverse calculate the average impact force on a reinforced concrete target as follows:

Average impact force = mgh ÷d

m–Weight of the penetrator (907 kg)

g–Acceleration due to gravity (9.81 m/s)

h–AGL height where the bomb transitioned from glide mode to vertical drop trajectory (a minimal 500 meters estimated for the Balakot attack)

d–Depth of penetration

Therefore, average impact force of the SPICE 2000 on reinforced concrete is 1474 kN and on earth is 442 kN. Incidentally, the more a bomb penetrates into the ground, the lesser will be its average impact force. The Bafliaz volcanic rock at Balakot is composed of at least three quarters of alkaline basalt, which has a density of 2.8 g/cm3. The approximate density value for 500 PSI reinforced concrete is 2.9 g/ cm3, which is close to basalt. Taking the margins in error and chemistry of basalt, it can safely be assumed that after penetrating the roof and another possible floor, the impact value would have increased from the 442 kN on the roof and the first level to (taking an approx. 15 percent jump within margin of error) to 508 kN. However with the penetrator intact and no major loss in momentum, the same 15 % error margin can be applied to the 1474 kN standard 500 PSI reinforced concrete penetration figure, this time reducing the average impact force to 1253 kN, giving a penetration distance of 3.5 meters in the Bafliaz rock geology at Jaba Top.

Nature of the Beast

The smart fuze of the SPICE 2000 would have been set to explode after penetrating two layers as per the intelligence available before the strike. After digging 3.5 meters deep below the big hall, it would have triggered the explosion of 80 kilograms of TNT, with the Gurney equation estimating shrapnel release at nearly 1 km/ sec for an explosive equivalent of the TNT. At the same time, expansion of the intensely hot gases at extremely high pressures in the fireball would have caused a shock wave to form, moving upwards out of the dug in silo at nearly the same velocity out to an effective range of 14 meters. The main characteristic of this wave is that pressure rises very sharply at the moving front, and falls off toward the interior region of the explosion. Variation of the pressure with distance from the centre of the fireball, at a given instant, is ideal for (instantaneously rising) shock front, which will eliminate any soft target in the region and cause significant damage to the structure and depending on the distance, will cause the structure to collapse.

Now let's calculate the overpressure caused by the explosion of the 80 kg warhead: Overpressure in an enclosed space is determined using Weibull's formula

Overpressure Δp=2410(m/V) to the power 0.72

where: 2410 is a constant based on 1 bar (100 kPa; 15 psi)

Possible targets hit by the IAF as assessed by the author (Reuters High Res Post Strike Imagery)

M = Net explosive mass calculated using all explosive materials and their relative effectiveness

V = Volume of given area (primarily used to determine volume within an enclosed space).

We have two zones to measure the overpressure, the first inside the 3.5 m silo created by the SPICE 2000 penetrator. This gives us a value of approx. 12631 kPA for the overpressure wave within the dug up silo. This overpressure wave would have resonated through the rocky side, ejecting upward at a high velocity towards the single/twin floors of the targets. Post expansion, the shrapnel and the overpressure wave would have killed all soft tissue targets and penetrated the walls and roofs with deadly effect.

But was that enough to collapse the buildings? As per experimental data, a minimal overpressure of around 14 kPA is required to cause the collapse of a non-concrete structure. Since the volume of the building was very large with two floors inside the building, the overpressure blast wave from the 80 TNT kg warhead, had it exploded at the base of the building (not accounting for the penetration to 3.5 metres), would be in the tune of 19.28 kPA. This overpressure would probably have brought down the buildings to implode and collapse. However, the explosion of the warhead 3.5 meters below the surface, with the rocky sides, walls bearing partial explosion and blast overpressure effects; would significantly dropped the overpressure value inside the compartmentalised hall. What would also be noteworthy is that the foundation and support beams would have been dug in the solid basalt rock, hence would require a significantly greater charge to knock down core load bearing members, than the low mass 80 kg TNT of the penetrator version.

Though not basing assumptions on an empirical relationship and keeping well within the error margin, it can safely be assumed that the value of the blast overpressure wave would have fallen far below 14 kPA, which, while causing extensive kinetic energy based shrapnel and overpressure pressure damage to the roof and the sides, would not have been sufficient to break open or collapse the side walls with intermixed concrete, and the main roofs of the building. Compartmentalised damage would have occurred in the individual bomb's sphere of influence.

Thus, there would be significant casualties within the confines of the targets due to shrapnel, heat and overpressure waves.

A puzzle still

One piece of the "puzzle" is still not clear, as to why multiple entry points are visible on roof of the big hall, when the building may have been targeted only by a single SPICE 2000 as per the data available on the number of bombs and the speculated targets. In all

probability, these would be the result of inside to outside blast incursions. One can however clearly see the result of the attack on the estimated trainee accommodation north of the main hall (refer Target 1), where the building has been destroyed with deep ingestion marks and a lot of loose soil unearthed : the classic tell tale signs of a penetrator warhead entering the ground and making a mould of earth around it. This either indicates that there was more sub soil present than basalt rock underneath the structure, or the Pakistan Army may have intentionally taken down the building in a cover up operation.

Post Scripts

13 March 0900hrs : After scrutinising the same image at different hours of the day from fresh post-strike imagery, it appears the so called entry marks on roof of the big hall may actually be permanent marks on the metallic roof.

13 March 2100hrs : NDTV Vishnu Som confirms access to IAF post strike imagery, which is in sync with what was written earlier in this piece about the positive destruction of the target north of the big hall, that is Target 1, as well as confirms that the Guest House, Instructors accommodations were legit targets. Details at *https://www.ndtv.com/india-news/balakot-air-strike-what-unreleased-satellite-images-of-the-balakot-air-strikes-show-2006941?pfrom=home-livetv)*

14 March : The IAF has confirmed through sources that the main hall (the biggest target seen) was not targeted by the SPICE Bombs. The trainee accommodation (a very recent construction), which was incorrectly marked on the pre-strike vintage imagery (in above photos) of April 2018 on Google Maps, updated with latest Worldview2 High Res post-strike imagery, is seen on the extreme north edge (Ref Target 1 below) on Jaba Top. Possible incursions of SPICE bombs is visible on the roof. This had two storeys and the bombs would have penetrated to dig in approx. 3.5 metres below the base floor, activating the low mass explosive. The building would easily survive the blast due its size, however most of the inhabitants would most probably have been eliminated by the effects of blast overpressure.

'Confirmed' targets hit by the IAF. High Res Imagery Worldview 2 dated 27 February, 2019

So did the IAF SPICE 2000s strike the targets : Yes, they did !

Representative image of IAF Mirage 2000 at low level (Angad Singh)

So when the Indian Air Chief says "We hit the targets," believe him, we did !

This assessment is based on the science of it all, which can be debated by explosive experts for all their worth. The Indian Air Force has done its job; let's not overreact to anything and everything. One day we will surely know what happened below that roof.

Satellite images from Google Earth

The psychological impact of Balakot

From the Internet

Balakot in the Khyber-Pakhtunkhwa province of Pakistan has become 'world famous' after the IAF precision air strike on the nearby Jaba Top where Jaish-e-Mohammed chief Maulana Masood Azar had established training camps. This area is not only infamous for training of Taliban cadres preparing for infiltration into Afghanisatan, but earlier was one of the launch pads for tribals invading the Kashmir Valley in 1947-48.

Balakot is historically where the Army of Maharaja Ranjit Singh smashed the designs of Syed Ahmed Barelvi who was imbibed by fanatical Wahabi Sunni Islamic ideology. A deeply religious man, Barelvi was born in UP's Rae-Bareli in 1786, was an ardent admirer of the Mughal ruler Aurangzeb and perturbed by decline of the Mughals and rise of the "infidel rulers", both Marathas and Sikhs. Syed Barelvi wanted to establish an Islamic caliphate in the Indian sub-continent and decided to wage a Jihad against the then rulers of north India.

With total faith in his mission, he moved to Balakot to wage jihad against Maharaja Ranjit Singh of the Punjab, whose kingdom included the NWFP and Kashmir. Syed Barelvi thought that the Muslims in that region, aided by citizens of a Muslim nation in the neighbourhood (Afghanistan) would support his mission of establishing an Islamic state, overthrowing the Sikh rule. Syed Barelvi reached Balakot in 1831 when he was 46, formed an army of Mujahideen forces, hoped to defeat Maharaja Ranjit Singh and then move into Kashmir. The Sikhs were aware of his plans and sent a force against towards Barelvi's men in Balakot.

Syed Barelvi had conceived a trap for the Sikh forces, preparing marshy fields where he expected Sikh forces to get bogged down. However, the shrewd commander of Sikh forces, Sher Singh, waited for Barelvi's men to make the first move and fall into their own trap, which they did and were completely ensnared in the slush.

Sikh forces then moved in and annihilated about 1300 Mujahideen in the day long battle. Along with the end of Syed Barelvi, that battle of Balakot also saw the end of Shah Ismail Saeed who came from a family influenced by Sheikh Sirhindi, the religious fanatic who had long persecuted the Sikhs.

Maulana Mazood Azar considers Syed Barelvi as his hero and feels an emotional connection with Balakot where that jihad inspired by the Wahabi Sunni ideology was first fought. The Indian Air Forces strike on Balakot is therefore doubly significant.


Image posted by Sunil Kumar Jha, in Daily Jagran, Jallandhar

The Year (Show) of the Tejas

Aero India 2019 meant many things to many people but surely top of the list was the show of India's light combat aircraft, the Tejas, which was not only dominant in the air, on the ground but, whats more, got its FOC certificate even as the earlier IOC variant was displayed with aplomb by service pilots during inauguration of the event on 20 February. In the composite image above, the logo of Aero India 2019 incorporates profile of the Tejas LCA, even as 'the real thing' carries out an aerial display over Yelahanka.

The FOC ceremony took place in full public view, near the limited series production eight (LSP-8) LCA Mk.I (KH 2018) on static display on 20 February when Air Chief Marshal BS Dhanoa, Chief of the Air Staff was handed over the facsimile certificate formally declaring 'Final Operational Clearance' (FOC) by Dr G Satheesh Reddy, Secretary Defence R&D and Chairman DRDO. The Air Chief was flanked by Defence Secretary Sanjay Mithra, Chairman/Managing Director HAL R Madhavan and Director Engineering Arup Chaterjee. Also, handed over was the 'Release to Service Document' (RSD) which formalises the capabilities, features and technologies that FOC standard Tejas has on induction to the IAF.

While FOC standard aircraft documentation have reportedly been given to HAL to begin production of the next tranche of 20 LCAs after incorporation of key changes, the FOC confers key capabilities after the IOC which includes integration of beyond visual range (BVR) missiles, 'smart' air-to-ground weaponry, air-to-air refueling capability and general flight envelope expansion.

The Indian Air Force will begin receiving the Tejas FOC block aircraft from the last quarter of 2019, and these will steadily equip No.18 Squadron which has been number plated for several years after phasing out of its earlier MiG-27MLs.

The first squadron with the Tejas is No.45 which has been operating IOC standard aircraft since July 2016 and had half a dozen aircraft on display at Aero India 2019. Their CO, Gp Capt Samrat Dhankhar, formerly flying MiG-21bisons,

The static display at Yelahanka had HAL types dominating, including four Tejas LCAs

carried out a scintillating display just after inauguration of the Aero India Show on 20 February 2019 while other squadron pilots continued to show the Tejas attributes to an admiring audience several times a day through the Show.

The LCA Mk.II a.k.a Medium Weight Fighter (MWF)

Mark II version of the Light Combat Aircraft has been subject of some speculation over the past few years and its essential attributes were shown for the first time by ADA in Hall 'B', which was virtually dedicated to DRDO programmes and aspirations, including the model above of the medium weight fighter (MWF), markedly also incorporating canards or foreplane much as by the Rafale, Typhoon or Gripen.

The Mk.II (MWF) model was shown with full load on under wing and fuselage hard points, its max takeoff weight (MTOW) given as 17,500 kg as compared with the 13,500kg of the LCA Mk.I, and to be powered by a General Electric F404-GE-IN20 turbofan of 89.8 kN thrust (afterburner). The Mk.II would have a higher thrust engine, the GE-F414-INS6 giving a thrust of 98 kN.

War load of the LCA Mk.II is stated to be 6,500 kg and comprises a mix of

CCMs and BVR missies for the air defence role as also heavy stand-off precision guided munitions (PGM) and free fall bombs, giving it multirole capability. Repositioning of the main landing gear, somewhat as Saab did with their Gripen E, has also given space for increased internal fuel.

As per ADA, the LCA Mk.II will have an Active Electronically Scanned Array (AESA) radar, its smart cockpit incorporating large MFDs, and upgraded Digital Flight Control Computer (DFCC) & Indigenous Actuators; Advanced Avionics, an Internal Unified

File picture of the Air Chief making a sortie in the Tejas LCA two-seater

Electronic Warfare Suite (UEWS), Infra Red Search and Track (IRST) system along with a Missile Approach Warning System (MAWS), and an On-Board Oxygen Generation system (OBOGS).

Development of the LCA Mk.II has vigorously been sought by the Indian Air Force which projects this aircraft as a 4+ generation type which will replace the current 12 squadrons of 'legacy fighters' in the IAF order of battle, comprising 6 squadrons of Jaguars, and 3 each of Mirage 2000s and MiG-29s, all these types having been upgraded to keep them in frontline service till the next decade. As Dr Girish Deodhare, Director of ADA stated, "The LCA was designed to replace the MiG-21 aircraft, whereas the Mk.II is being designed to replace the Mirage 2000 and redesignated as a medium weight fighter".

Air Chief gives "full marks to the Tejas"

In his address at an earlier CAPS Seminar in New Delhi, the CAS Air Chief Marshal Birender Singh Dhanoa clearly stated that the IAF expects to induct over 200 LCA Mk.IIs, which will in turn be supplemented by the Advanced Medium Combat Aircraft (AMCA) which is simultaneously under development at ADA.

General Bipin Rawat, Chief of the Army Staff also flew in the two-seater LCA at Aero India 2019.

During his interaction with media at Aero India 2019, the Air Chief gave full marks to the Tejas LCA Mk.I, stating that the aircraft was ready for frontline service, reinforcing his stance with the statement that 'Didn't you see them perform at *Vayu Shakti*" ? … further, "the proof of the pudding is in eating … you saw how much the aircraft to fly and the number of sorties it could generate during *Gagan Shakti* in April 2018. During *Vayu Shakti* we showed how accurately this aircraft could dispense weapons on target…. so that is the proof, … because it's a fighter it has to behave like a fighter and it did well in both air-to-air and air-to-ground mode".

Of the 123 LCA Mk.Is to be inducted by the IAF, 16 of the IOC standard are already with No.45 Squadron, the next 16 in FOC-standard will form equipment of No.18 Squadron to be followed by 83 LCA Mk.IAs for which the RFP is to be issued shortly. All two-seat operational trainer versions will be to FOC-standard including the 8 from the initial batch.

On Home Turf

HAL at Aero India 2019

Pair of HAL light utility helicopters (LUH) on the flight line as ALH Mk.IV (Rudra) of Army Aviation gets airborne.

Unlike the past, this (12th) edition of Aero India was under new 'Management', with the Defence Exhibitions Organisation (DEO) having been unceremoniously ousted (writing was on the wall at DefExpo 2018). Hindustan Aeronautics Limited (HAL), with their Corporate Office and several complexes in Bangalore, were given the 'honour' of organising this Show which was inaugurated on 20 February and continued till the last (public) day, 24 February. Even though Air Force Station Yelahanka is not HAL 'territory', it operates a score or more HAL-built aircraft, essentially the Dornier 228 which imparts multi-engine conversion training to every future transport pilot of the Air Force, Navy and Coast Guard.

Aero India 2019 certainly provided an opportunity for HAL not only to showcase its range of products and services but also became a platform for the Chairman to stand up against the barrage of criticism it has had to face over the past year, much of it unreasonable and unfair (see *Vayu* Issue I/2019: *In Defence of HAL*).

HAL Chairman R Madhavan with image of Dassaut Rafale aircraft

HAL Chairman R Madhavan came out strongly that HAL was the only Company in India capable of manufacturing the 110/114 MMRCAs, as and when the orders are placed. He continued that HAL was not interested in 'offsets' but in 'actual manufacturing'. HAL's Bangalore Complex is steadily producing Tejas LCAs, and by end-March 2019, would have delivered the 16th (and last) LCA Mk.I (IOC standard).

With issue of FOC certification, production of the next standard aircraft will have begun with deliveries to the Air Force from late 2019 onwards. HAL will also be responsible for production of 83 LCA Mk.IAs which will then keep its Bangalore factories busy for many years, and will hopefully continue activity with the Mk.II from the second half of the 2020s. And of course, when the futuristic AMCA goes into production.

Series production Tejas LCA Mk.Is of No.45 Squadron at Yelahanka flight line

Prashant Bhadoria who leads the design team in development of the HAL HTT-40

Meanwhile, the indigenous HTT-40 basic turboprop trainer continues flight testing and with spinning trials hopefully over later this year, expects clearance for production thereafter. In fact after certain design issues that have dogged progress of the HJT-36 have been resolved, series production of this intermediate jet trainer (informally called *Sitara*) will also resume at the Aircraft Division at Bangalore.

Meanwhile, in other HAL-Complexes, the Dornier 228 light transport aircraft is being steadily produced at Kanpur, and following first deliveries of a new batch of 12 Dornier 228s with glass cockpit, another 17 aircraft will receive mid-life upgrades.

HAL also displayed a mockup of its new Dornier 228 glass cockpit which features four large LCD displays, two of which serve as primary flight displays, with the other two being multifunction displays. The reworked avionics suite includes integrated standby instruments, a dual flight management system (FMS), a dual engine data concentrator unit, a dual attitude and heading reference system, a dual digital air data computer, and an engine indication and crew alerting system. Optional equipment will include a surveillance/weather radar,

HAL has now produced some 150 Dornier 228s, with further orders expected

HAL are producing 222 Sukhoi Su-30MKIs and could well receive further incremental orders

forward-looking infrared and video cameras. All of these systems are integrated through a new Arinc 429 data bus interface.

Mr Madhavan was not quite forthcoming about production of more Su-30MKIs at its Nasik facility even as the last batches of this combat aircraft are being completed for delivery.

HAL's Helicopters

Hindustan Aeronautics Limited are certainly consolidating their reputation of being rotary wing aircraft experts and at Aero India 2019, showcased technology demonstrator of the Dhruv Mk III Advanced Light Helicopter with folding tail boom and main rotor blades, designated Naval Utility Helicopter in their bid to meet the Indian Navy's requirement for the Chetak replacement.

This helicopter variant primarily designed to meet the requirements of the Indian Navy and Coast Guard for shipborne operations and was given pride of place at HAL's exhibition in Hall 'E'. The helicopter is to meet varied requirements at sea, including surveillance, staff transportation, search and rescue (SAR), medical evacuation (medevac), anti-piracy and anti-terrorism, humanitarian assistance and for disaster relief.

HAL ALH with folding blades

Dornier 228s are steadily being built at HAL's Kanpur Division, with the largest number serving with the Indian Air Force, including for multi-engine conversion training at Yelahanka itself

This ALH variant is in the final stages of development and is expected to fly later this year, its overall integration being carried out in conjunction with the Navy's Project Office to conform with stowage, take-off, and landing requirements of ship-based operations.

Helicopter with fangs

The light combat helicopter (LCH) is now poised for series production with initial orders received from the Indian Army and Air Force. There is an additional projection of 65 LCHs for the IAF and 97 for the Indian Army. Post-completion of trials at various altitudes and terrain and temperatures, the LCA has obtained initial operational clearance (IOC). To meet the Indian Army's unique requirement for operation from extreme altitudes, the LCH (nicknamed 'Tigerbird') has performed very well at the world's highest battlefield, the Siachen Glacier in north east Ladakh. The LCH can also hold its own against aerial threats, having successfully fired a Mistral-2 air-to-air missile against an airborne target during weapon trials held at the Integrated Test Range at Chandipur in Odisha.

Jaguar MAX and SPORT

In a new approach, HAL has created a 'Supersonic Omni Role Trainer Aircraft' (SPORT) simulator based on the two-seat LCA trainer to "bridge the gap in pilot training to command front line fighters", according to HAL Chairman R Madhavan. The SPORT would be utilised for lead in fighter training after the advanced jet training stage and before posting of pilots to operational fighter squadrons.

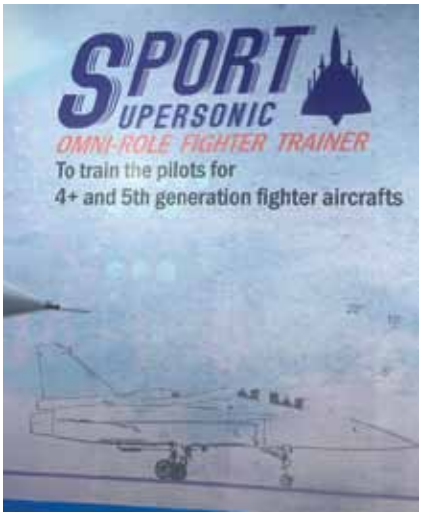
Also revealed at the HAL exhibition was the Jaguar MAX (*Mothership for Augmented Xploitation*) which is certainly an initiative by the Company which has manufactured over 100 Jaguars since the mid-1980s and progressively upgraded them to DARIN (Display Attack Ranging Inertial Navigation) standards, the latest (III +) including new avionics, glass cockpit, AESA radar and modern armaments.

The Jaguar MAX essentially incorporates an EL/M-2052 active electronically scanned array (AESA) radar from Elta, an AESA-based wide-band jammer, a combined interrogator transponder, a flight management system, a configurable cockpit with a larger area display, a voice command system, a helmet-mounted display, an L-band datalink for long-range missions, a GAGAN/GPS/GLONASS-aided INS (with IRNSS optional), a software defined V/UHF radio, and modernised engines (optional).

The aircraft can be configured with a Radar Targeting Pod (2 seat-variant)/Laser Pod/Synthetic Aperture Radar (SAR) Pod/ Electro-Optical (EO) Pod to meet various mission requirements.

The Jaguar MAX is envisioned to carry and launch various next-generation air-launched weapons, including gliding heavy-weight new-generation precision-guided munition; five sensor-based, multi-warhead, anti-tank smart bombs; a new-generation laser-guided bomb; 16 gliding, lightweight smart anti-airfield weapons; a sea skimming anti-ship missile; two new-generation short-range air-to-air missiles; four next-generation beyond visual-range air-to-air missiles; five advanced medium-range cruise missiles or, indeed, 12 swarming unmanned air vehicles.

HAL's Light Combat Helicopter (LCH) is cleared for limited series production



Sharing the space : Tejas twin-seater takes off as Rafale twin-seater is prepared for flight

With '114' on their minds !

MMRCA 2.0 reflected at Aero India 2019

Once more with feeling ! It is nearly a year since April 2018 when the IAF issued an RFI to procure 110 (actually 114) fighters of which 18 would be procured as flyaways and the balance to be built in India by a strategic partner/Indian production agency (SP/IPA). Three quarters of these would be single-seaters and the rest twin-seat aircraft. International companies who reportedly responded to the RFI are Boeing (F-18 Super Hornet) ; Lockheed Martin (F-16); Saab (Gripen); Dassault Aviation (Rafale), the European Consortium (Typhoon); Mikoyan (MiG-35) and Sukhoi (Su-35), the latter having newly entered the fray.

These 114 fighters are being described by officials of the Indian Air Force as "filling the gap" between the present and times ahead when the Indian Air Force starts receiving the LCA Mk.IA and Mk.II in quantity (*see separate article on the Tejas*).

The hopeful contenders to meet the IAFs requirement for new fighters were at Aero India 2019, in one form or the other. While Dassault brought its Rafales and Lockheed Martin showed off their F-16s, the Swedes had a full scale mockup of the Gripen outside Hall 'C' which had long lines of visitors patiently waiting to take a look. Saab also had a Gripen simulator amongst their exhibition which too attracted much attention.

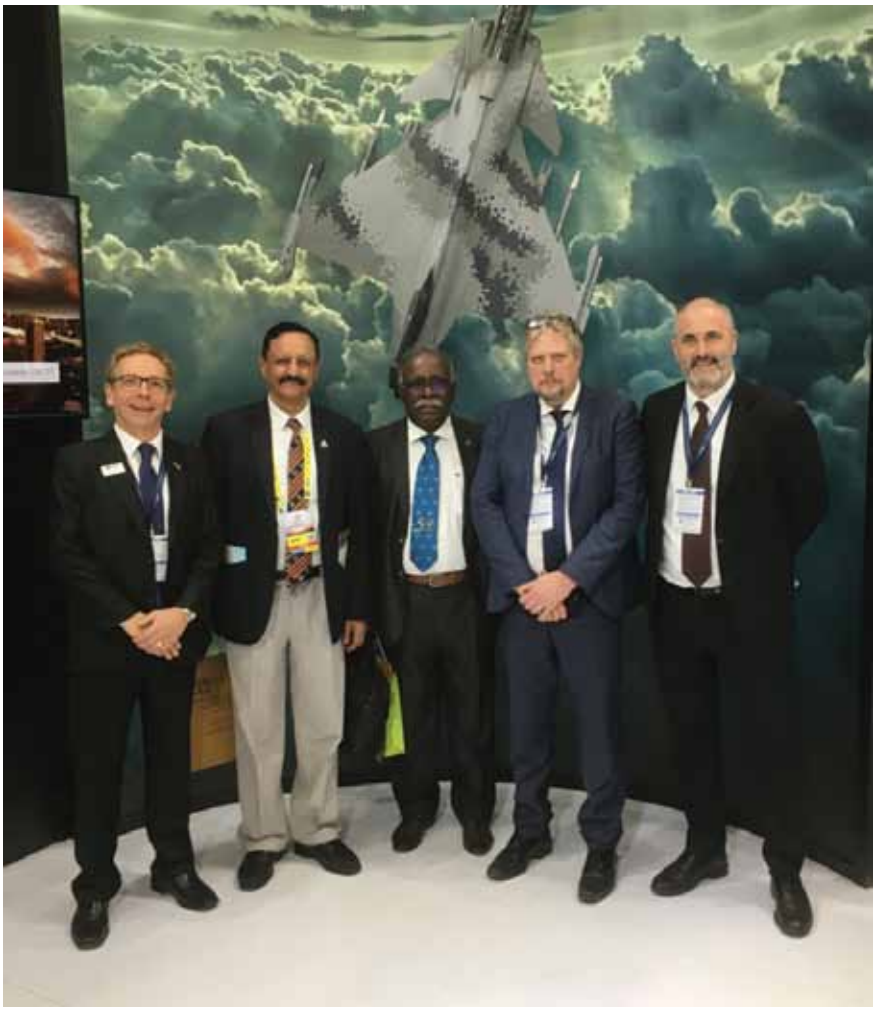
Eric Trappier, Chairman and CEO of Dassault Aviation *(photo on left)* was present at Aero India 2019 where three Rafales (a single-seat 'C' and two twin-

Rafale B of the French Air Force at Yelahanka

seat 'B's) were showcased, along with the Falcon 2000S business jet, whose nose section is being produced by Dassault Reliance Aerospace Limited at Nagpur and was also on display. The Rafale carried out thunderous flying displays over Yelahanka several times each day even as the CEO let it be known that they were looking forward to many, many more Rafales in Indian skies. "100 Rafales would be a nice number" he said !

Even as Air Headquarters have assuredly sought additional information before moving to the next steps, most of the contenders came to Aero India 2019 on the eve of which there were several statements made by senior executives. Ola Rignell, Head of Saab India said that "except the first 18 aircraft, we intend to manufacture everything in India. Saab will look to build an ecosystem of defence manufacturing inside the country". Rignell highlighted the multi-role capability of the Gripen E which is "the most advanced multirole fighter designed to meet demanding operational requirements of Air Forces today".

In a dramatic announcement on first day of the Show, Lockheed Martin officially pronounced that the F-16 for India was now labeled as the F-21, which is "different – inside and out and specifically configured for the Indian Air Force". Dr Vivek Lall, Vice President of Strategy and Business Development Lockheed Martin had also stated that "We see current demand outside



Saab executives, including Mats Palmberg (second on the right), with retired senior IAF Air Marshals at the Saab stand

Dr. Vivek Lall of Lockheed Martin

fighters. This is the case too with Dassault's Rafale, the Indian Air Force getting the F.3R Standard with the 'M' offered to the Indian Navy.

Boeing had a pair of F/A-18E Super Hornets on static display (from VFA-27 from Marine Corps Air Station, Iwakuni in Japan) and at their Press Conference reiterated their core strategy of a public-private partnership with HAL and Mahindra to build these fighters in an entirely new "factory of the future". Boeing also highlighted their other programmes in India, the P-8(I) with the Navy, the Air Force operating the C-17 Globemaster III even as first batches of the CH-47F(I) Chinook and AH-64E Apaches are arriving in country.

F-16C of the USAF Pacific Air Forces Demonstration Team

of India of more than 200 aircraft. The value of those initial acquisition programmes would likely exceed $20 billion".

Also from America, Boeing's F/A-18 Super Hornet is promoted as being the "most advanced aircraft of its kind in operation today … with a robust roadmap laid out to ensure that the F/A-18 Super Hornet is capable of dealing with future threats". The Super Hornet is being offered not only for the Indian Air Force but is a contender to meet the Indian Navy's requirement for 57 carrier borne, multirole

F/A-18E Super Hornets of the US Navy

Indian Defence Minister Nirmala Sitharaman with the RAC-MiG Director General

MiG-21bison with RVV-AE and R-73 missiles underwing, this venerable fighter going into air combat just days after the Show.

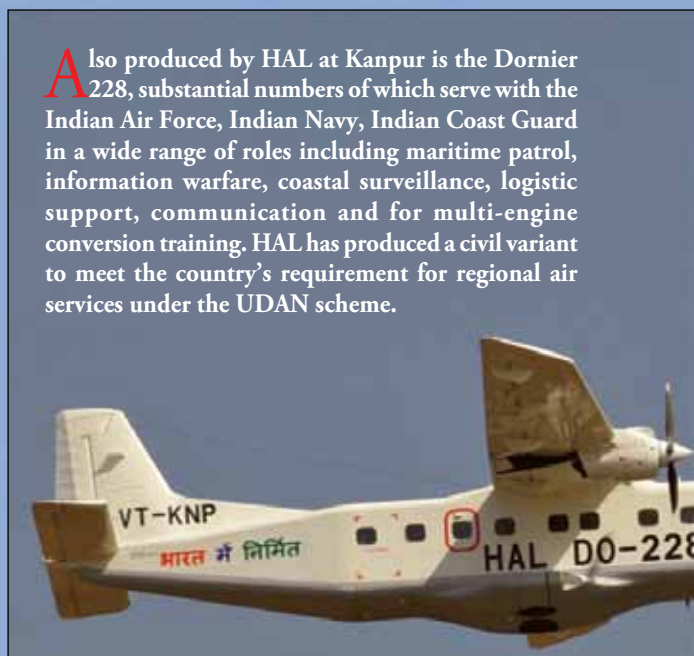
In his briefings at the Show, RAC-MiG Director General Ilya Tarasenko promoted the MiG-35 as being "the most up-to-date aircraft in the world" and said the type would be built under licence by HAL in India should it be selected. Although there were no MiG-35s at Yelahanka, the Indian Air Force had an upgraded MiG-29 on static display even as news perculated about the Indian Government negotiating to buy 21 'surplus' MiG-29s from Russia which would also be upgraded before entering service.

An upgraded MiG-29UPG of the Indian Air Force on static display during Aero India 2019.

Aero India 2019 :

The Avro (HS) 748 built by HAL at Kanpur was planned to be the Dakota's successor but this did not happen owing to a series of situations. Still, the IAF took 89 of these aircraft, most of which are still flying for varied tasks including staff transportation, training and logistic support. (This Avro is being escorted by a HAL HJT-16 Kiran basic jet trainer)

Also produced by HAL at Kanpur is the Dornier 228, substantial numbers of which serve with the Indian Air Force, Indian Navy, Indian Coast Guard in a wide range of roles including maritime patrol, information warfare, coastal surveillance, logistic support, communication and for multi-engine conversion training. HAL has produced a civil variant to meet the country's requirement for regional air services under the UDAN scheme.



through the lens of Phil Camp

Nostalgia airborne : Douglas C-47 Dakota in IAF markings led the fly past after inaugural speeches on 20 February 2019. The sound of its R-1830-90c radial engines was haunting to some of an earlier generation. The Dakota dominated in its service with the IAF from 1946 till its phase out nearly half a century later

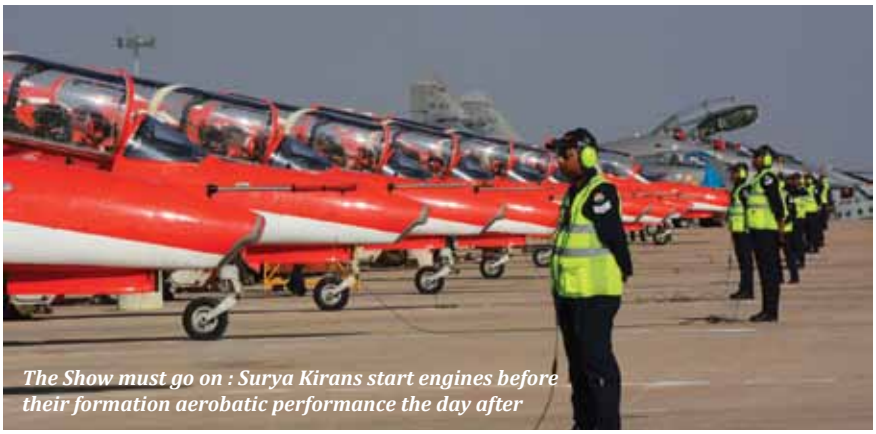
Prototype of the NAL Saras light transport aircraft (with pusher engines) makes its sedate fly past over Yelahanka. Further development of the type is planned as also a 19-seater version which is of interest to the IAF

Sole representative of the steadily expanding Indian Naval Air Arm was this Boeing P-8(I) long range maritime patrol and anti-submarine warfare aircraft from INAS 312 at Arakkonam.

First time in Indian skies was this magnificent B-52 Stratofortress of the US Air Force, operating nonstop from Guam in the Pacific to carry out its flyby over Yelahanka and returning to base without landing in between, evident of the long reach of the world's largest Air Force and arguably the most advanced.

The Surya Kiran Aerobatic Team (SKAT) were formed in 1996 and are part of No.52 Squadron IAF, based at AFS Bidar in Karnataka. Originally flying HJT-16 Kiran Mk.2s, they were reestablished with Hawk Mk.132s in 2017) and have been performing formation aerobatics in various parts of the country thereafter

Surya Kiran pilots line up before getting into their cockpits. In a tragic mid-air collision on eve of the Show, two Hawks went down and one of the crew did not survive. Next day, the Indian Air Force flew a 'missing man formation' in tribute to the gallant air warrior



The Show must go on : Surya Kirans start engines before their formation aerobatic performance the day after

The UK- based aircraft photographer and enthusiast, Phil Camp, has covered Aero India Shows for decades and officially visited many air bases, also co-authoring several books on the IAF including that on *'Squadrons, Patches, Heraldry & Artwork of the Indian Air Force, 1932-2016'.*

Some highlights from Aero India 2019

Israel Aerospace Industries: expanding collaboration

Israel Aerospace Industries (IAI) expects to expand collaboration with local leaders in integrating strategic state-of-the-art systems for the Indian MOD in a number of areas and in accordance with the Indian Government's "Make in India" policy. These collaborations are a direct continuation of IAI's business deals in India which totaled some $1.9billion in 2018. IAI has been working with India's defence industries and armed forces for the past 27 years under strategic collaboration spanning many fields. The Company collaborates with local companies and works with India's defence agencies, as well as with the Navy, Air Force, Army and Coast Guard. Joint development projects include the MRSAM air defence system, in both its maritime and land-based versions; mission aircraft; various radar systems and UAVs. Collaboration agreements

Nimrod Shefer, IAI's President and CEO

are based on transfer of technology for the benefit of local production as part of the Indian Government's "Make in India" policy.

A Nimrod Shefer, IAI's President and CEO, stated, "India is one of IAI's main partners. This important partnership is characterised by long-term collaborations, joint development and production, technology transfer and technical support over many years. We are working to nurture this relationship in the future despite growing competition. The excellent reputation that IAI has earned among its Indian partners is vitally important to continuing this tradition of successful cooperation."

At Aero India 2019, IAI presented a wide variety of strategic defence systems with an emphasis on MRSAM, TecSar Satellite, TopGun, in the loitering-munition category, featuring the Green Dragon, Mini Harpy and Rotem. Moreover, in the Unmanned Aerial Systems area IAI displayed the Heron TP and the Bird Eye 650D, which enable a broad range of intelligence gathering capabilities for various operations and NRUAV. IAI also exhibited strategic radar systems, satellite communication systems, new electro-optical systems using the new Ultra-POP high definition technology. Additional developments on display included modular and compact command and surveillance systems with stabilised gyros for nighttime and daytime observation at a competitive prices. In addition, IAI presented a selection of mission aircraft for intelligence missions, aerial control and naval surveillance on different platforms, such as AEW&C (Airborne Early Warning and Control), ELW 2090, ISTAR and ASIS mission aircraft.

ELW-2090 (AWACS) (Credit: IAI)

IAI's Heron TP (Credit: IDF Spokesperson)

IAI's MRSAM

Controp to supply BEL EO/IR systems

Controp Precision Technologies Ltd. has announced that it will supply Bharat Electronics Ltd. (BEL) with EO/IR systems for the Indian Armed Forces. "CONTROP is proud to continue collaborating with Bharat Electronics Ltd. after completing a number of successful projects with them," stated Mr. Ra'anan Shelach, CONTROP's VP of Marketing. "We welcome the opportunity to develop advanced EO systems for India's technology leader. This is another step of our growing presence in India".

Rafael "Rocks" at Yelahanka

Rafael unveiled a new long range stand-off air-to-surface missile at the Show. *Rocks* is an advanced, extended stand-off range air-to-surface missile, which may be used against high value targets, stationary and re-locatable, even in theaters where the enemy employs effective GPS countermeasures. Equipped with either a penetration or blast fragmentation warhead, the missile can destroy above-ground or well-defended underground targets in heavily surface-to-air-defended areas. *Rocks* is launched at a very significant standoff range, well outside of the enemy's air-defence coverage area, and performs a high velocity trajectory towards the target. This minimises the launch aircraft exposure to threats, as well as improves the strike success rate. "Rocks" uses its INS/GPS for midcourse navigation, while homing on to the target is performed by using its EO seeker and advanced image processing algorithms, which ensures hitting targets with great precision, overcoming GPS jamming or denial.

Rafael's SPICE 2000 was in the headlines days after Aero India 2019: see article.

The Rafales and Dassault's six decade connection with India

Rafales were pre-dominant at Aero India 2019, with three aircraft on display, including one single-seat Rafale C and two two-seat Rafale Bs. At the Rafale International booth in Hall A-B were a scale 1:5 Rafale in IAF colours, a teaser on what the actual aircraft will look like when it arrives in India later in 2019. A scale 1:10 Rafale M model was also on display, showing Dassault's intent to offer this variant for the Indian Navy. Alongside was a scale 1:10 model of the Mirage 2000 I/TI, being the upgraded version for the Indian Air Force, the actual aircraft going into action just days after the Show (*see articles*).

A holographic presentation on the long history of Dassault Aviation aircraft in India, starting with the Ouragan (Toofani), followed by the Mystere IVA, the naval Alize, the Jaguar (manufactured under licence by HAL), and the present Mirage 2000, highlighted the strategic partnership maintained between India and France, initiated in 1953 when India became Dassault Aviation›s first export customer. At the space highlighting Dassault's "Make in India" commitment, the first Falcon 2000 cockpit from the Dassault Reliance Aerospace Limited facility at MIHAN, Nagpur, was displayed before being sent to Dassault Aviation's Falcon final assembly line in France.

In the photograph above at the media conference, are seen Mr Éric Trappier*, Chairman and CEO of Dassault Aviation and Ms Nathalie Bakhos from the Company.*

Saab at Aero India 2019

At a seminar held in New Delhi on eve of Aero India 2019 are seen (left-to-right): Johan Segertoft (Manager Avionics Platform), Stefan Engstrom (Gripen Marketing Director), Group Captain Sudhir Varma (retd) (Head- Gripen & Air Power Systems), Mats Palmberg (Vice President, Industrial Partnerships, Saab + Head of Gripen India Campaign) and Ola Rignell (Chairman and Managing Director, Saab India Technologies Private Limited)

"Saab is proud to be part of Aero India 2019 where we continue to team up with India for its defence and security needs, and the development of a world-class Indian defence industry. Saab's advanced technology and innovative thinking can deliver the best solutions to India for strong national defence and an independent industrial future. Saab brings ready-for-tomorrow defence and security solutions that are always customised to the needs of India's armed forces. We have a long relationship with the Indian Air Force, HAL and many other public and private sector entities involved in aerospace for India. At Aero India 2019 we are showcasing our latest technologies that are transforming defence and security planning, military deployment, defence economics and future force readiness," stated Ola Rignell, Chairman and Managing Director, Saab India Technologies."

"Aero India 2019 comes as the Indian Air Force evaluates new fighters for its future airpower needs. We are displaying the Gripen E mission simulator which clearly demonstrates how Gripen, the most advanced multi-role fighter aircraft in the world, maximises operational effect in the future battlespace. We are also proud to present a full scale Gripen E along with the game-changing Meteor and the precision attack Taurus KEPD missiles," stated Mats Palmberg, Vice President, Industrial Partnerships, Saab, and Head of Gripen India Campaign.

Boeing strategy for 'Make in India'

At Boeings' conference are (left-to-right): Sunil Velagapudi, Boeing India; Thomas Breckenridge, VP, International Sales, Strike, Surveillance and Mobility, Boeing Defense, Space & Security (BDS); David Koopersmith, VP & GM, Vertical Lift, BDS and Michael Koch, vice president, Boeing Defense, Space & Security (BDS), India

Boeing presented its strategy and plans for 'Make in India' and also offered advanced capabilities to the Indian armed forces at Aero India. At the core of strategy is Boeing's public-private partnership with HAL and Mahindra, expected to produce next generation F/A-18 Super Hornet fighters in an entirely new 'factory-of-the-future' in India, delivering performance, affordability, and indigenisation for Indian customers. The partnership will create jobs, industrial capacity and a globally competitive Indian supply chain. " With multi-role capabilities, advanced technologies, growth potential and low acquisition and sustainment costs, the combat-proven F/A-18 is a clear choice for the Indian Navy and the Indian Air Force. Introduced in 2007, the Super Hornet is the world's leading fighter aircraft, highly capable across the full mission spectrum and continually evolving to outpace future threats", stated company officials.

In addition, Boeing revealed their future plans proposing the KC-46A aerial refueler, AH-64E Apache attack helicopter, additional P-8 long-range maritime reconnaissance/anti-submarine aircraft, and the twin-engined Airborne Early Warning and Control (AEW&C) aircraft.

Boeing has continued its discussions with partners, Mahindra Defence Systems (MDS) and Hindustan Aeronautics Limited (HAL), on the proposed F/A-18 Super Hornet 'Make in India'. The partners are developing comprehensive plans to set-up a new "**factory of the future**" to manufacture Super Hornet locally. The programme is expected to work with several Indian suppliers to grow a thriving defence aerospace base which could accelerate other programmes. "This **unique public-private partnership** is intended to bring Boeing, HAL and MDS' global scale and supply chain, its best-in-industry precision manufacturing processes, as well as the unrivalled experience in designing and optimising aerospace production facilities to expand India's aerospace ecosystem and help realise the 'Make in India' vision" stated Boeing officials.

Seen, left to right are SP Shukla, Chairman & MD, Mahindra Defence, Jeff Shockey, Vice President, Global Sales & Marketing, Boeing Defense, Space & Security, and R Madhavan, Chairman and Managing Director, Hindustan Aeronautics Limited, at the Boeing booth

Lockheed Martin unveils the 'F-21' Fighter "for India, from India"

Dr. Vivek Lall, Vice President of Strategy and Business Development for Lockheed Martin Aeronautics

Lockheed Martin have further emphasised their commitment to India in unveiling the F-21 multi-role fighter for India. Specifically configured for the Indian Air Force, the F-21 will provide "unmatched Make in India opportunities and strengthens India's path to an advanced airpower future. The F-21 addresses the Indian Air Force's unique requirements and integrates India into the world's largest fighter aircraft ecosystem with the world's pre-eminent defence company. Lockheed Martin and Tata Advanced Systems would produce the F-21 in India, for India.

The F-21 is different, inside and out," stated Dr. Vivek Lall, Vice President of Strategy and Business Development for Lockheed Martin Aeronautics. "The new [F-21] designation highlights our commitment to delivering an advanced, scalable fighter aircraft to the Indian Air Force that also provides unrivalled industrial opportunities and accelerates closer India-US cooperation on advanced technologies."

Thales's commitment to 'Make in India' and defence modernisation

With a focus on "Make in India", Thales has reaffirmed its commitment towards the development and modernisation of Indian Armed Forces. Through a series of demonstrations, Thales showcased cutting-edge capabilities across civil and defence aerospace at its stand.

"As a major player in the Indian defence and aerospace sector, Thales has been continuously supporting the Indian armed forces and the government's flagship 'Make in India' programme. Thales has a rich experience in liaising with numerous local players who are part of its global supply chain. It takes pride in onboarding Indian solutions in several worldwide product lines and creating employment opportunities for hundreds of people. The solutions being developed through several Indian companies – joint venture partners, global supply chain partners were the spotlight at Thales' stand at Aero India. This year, we would also take a step further and present our efforts supporting the "Make in India" initiative of the Indian government. We would have solutions being manufactured in the country through our local partners – global supply chain partners and joint ventures, among others. In addition, we are also highlighting our hiring plans, and skilling and upskilling endeavours through our presence at the Aero Skills Pavillion this year", stated Emmanuel de Roquefeuil, VP and Country Director, Thales in India.

Thales' strong innovation capabilities demonstrate its cutting edge of connectivity and a driving force in the digitalisation of the defence, aerospace and space markets. At Aero India, the Thales highlighted all these efforts and provided an insight into its high-technology solutions across airborne solutions, air defence, radars, optronics, radio communications, among others through special digital experiences. Some of the main highlights at Aero India were the Thales' optronic pod - TALIOS; latest generation mini-UAS - Spy'Ranger; high-velocity missile - STARStreak; tracking and illumination radar - STIR; airborne rockets and a range of products from Radio Communications among others.

Safran : powering Indian aircraft since the 1950s

Safran continues its a very long association with the Indian Army, since the 1950s, offering aerospace and land solutions. The company is the leading supplier of inertial navigation systems for Indian combat aircraft. Sigma 95N navigation systems equip the Sukhoi Su-30MKI, Tejas LCA, MiG-27, MiG-29, Jaguar and the Hawk advanced jet trainer. The company develops and supplies the Automatic Flight Control System (AFCS) of the Dhruv helicopter, comprising APIRS Attitude and Heading Reference Systems, Autopilot Computers and actuators, all of which are manufactured and maintained in India.

More than 500 combat aircraft deployed by the Indian Air Force and Indian Navy are equipped with the Inertial Navigation Systems. Safran is a major contributor to the 36 Rafale fighters acquired by India in 2016. Safran companies provide a wide variety of systems and equipment on the Rafale, including the aircraft's M88 engines, power transmission system, landing gear, wheels and carbon brakes, ring laser gyro inertial navigation system, gyros for the fly-by-wire system, the auxiliary power unit (APU) and all wiring. In addition, Safran is prime contractor for the AASM Hammer modular air-to-ground weapon.

A key element of Safran's partnership is the Shakti / Ardiden 1H1. Certified in 2009, the 1,400 shp engine was co-developed by Safran and HAL and is now built in Bangalore, under the Shakti designation, mainly with Indian-made components. This engine was first selected to power HAL's Dhruv, now in service, and powers the Light Combat Helicopter (LCH) in final stages of qualification. Today, more than 350 Shakti engines have been produced. Most recently the Ardiden 1U, a derivative of the Ardiden 1H1 specifically designed to power single-engine rotorcraft, was selected to power the Light Utility Helicopter (LUH), a new and unique three-ton, single-engine, multipurpose rotorcraft. This engine has a compact architecture featuring a gas generator made up of two centrifugal compressor stages, coupled to a single-stage high-pressure turbine and a two-stage power turbine. The first technical flight of the Ardiden 1U in the LUH took place in September 2016, in Bangalore, and met all its performance targets.

Inaugurated in October 2016 in Goa is the *Helicopter Engines MRO Pvt. Limited* (HE-MRO) a Joint Venture of Safran and HAL, dedicated to supporting of helicopter engines operated by national and international operators, and primarily the Indian Air Force and Indian Army. It will be operational by early 2020, and provide maintenance repair and overhaul (MRO) services for both TM333 and Shakti engines installed on HAL-built helicopters.

Rosoboronexport in "Meaningful Talks" at Aero India 2019

At Yelahanka, the delegation of JSC Rosoboronexport (part of the Rostec Corporation) conducted a series of "productive negotiations and consultations" with Indian partners on military and technical cooperation, which resulted in signing a number of contractual documents. On the very first day of the show the Russian national exhibit was visited by Minister of Industry and Trade of the Russian Federation Denis Manturov and Minister of Defence of the Republic of India Nirmala Sitharaman, which underscored high profile of the Russian-Indian mil-tech cooperation.

"Russia is ready to offer to India not only the state-of-the-art military equipment, but also the technologies of production, i.e. the expertise, which we can share with each other in the framework of a wide industrial partnership in line with the Make in India policy. The potential for the development of cooperation in this area is huge, and we are focused on its full achievement," stated Rosoboronexport's Director General Alexander Mikheev.

The main meetings with officials of Ministry of Defence, Air Force and Navy, were the promising projects on the supplies and production in India of various types of the Russian military equipment and on after-sale services, maintenance and modernisation. In particular, the parties went on with pro-active consultations on the project, which concerns production of Ka-226T helicopters at the Russian-Indian joint venture Indo-Russian Helicopters Limited, for which purpose the Russian Helicopters Holding signed a number of appropriate memoranda with the Indian partners.

The Russian exhibition stands, included those of the Public Joint Stock Company United Aircraft Corporation, JSC United Engine Corporation, JSC Russian Helicopters, JSC Almaz-Antey Corporation, JSC "SPC "Techmash", JSC Shvabe and others, which showed hundreds of Russia's defence products, ranging from aircraft and helicopters to air defence systems. Apart from that, the static demonstration, arranged by the organisers, hosted models of Russian-made aircraft, which are in inventory of the Indian Armed Forces, including Su-30MKI and MiG-29UPGs warplanes and Mi-17V-5 helicopters.

Controp to equip "Asian Coast Guard" with the iSea EO/IR systems

Controp Precision Technologies Ltd., a company specialising in the field of electro-optics (EO) and infrared (IR) defence and homeland security solutions, announced at Aero India 2019 that it will equip an "Asian country's Coast Guard" with its advanced iSea EO/IR maritime surveillance payloads. The systems will be deployed on several maritime vessels beginning in 2019 for territorial water protection missions. The easy-to-install, easy-to-operate systems include a long-range thermal camera, a high definition (HD) visible surveillance camera, and an eye-safe laser range finder (ELRF). In addition, the system features advanced image processing and video enhancement algorithms, automatic video tracker (AVT) and an automatic gain control (AGC).

The iSea system features a unique and stabilisation technology that enables a continuous and uninterrupted line-of-sight (LOS) to ensure clear pictures, even in the roughest of seas. This system can withstand the harshest environmental conditions including fog, salinity and moisture. The iSea system offers a full solution for naval maritime operations that easily interfaces with other on-board systems, including vessel radar systems, to provide slew-to-cue functionality.

With the 'legend' himself !

General Alexander Kharchevsky, synonymous with the Su-30SM

Major General Alexander Kharchevsky (in photo above) is arguably one of the most famous military pilots of Russia extant and his name is synonymous with that of the Sukhoi Su-30SM. General Kharcheevsky became a household name in Russia in 2000 when he piloted a Su-27UB twin-seater, with Vladmir Putin, then acting President of Russia as its second crew member.

The General was for about 20 years commander of the Russian Air Force's Centre for Combat Employment and Retraining of Personnel VVS which is a research, training and instructional centre. He also formed, trained and then led the famous aerobatic team *Russian Falcons*, first equipped with Su-27 and later with Su-30SMs, which he describes a "gift of his fate", being the latest avatar of the family of Su-30MKI super-maneuverable multi-role fighter which has out performed western fighter types in simulated combat at various air exercises.

Manufactured by IRKUT, the Su-30SM fighter was developed to meet requirements of the Russian Air Force, the prototype making its maiden flight in September 2012. The multirole Su-30SM can be deployed in counter-air strikes, counter-land and counter-sea missions, can conduct electronic counter-countermeasures and early warning tasks. The aircraft also acts as a command-and-control platform within a formation of combat aircraft in joint missions.

In 2015, General Kharchevsky formally retired from service at the age of 65 with his flying career spanning more than 45 years. Vayu's Interview with the General

VAYU : Sir, you were involved in development of the Su-30SM before this type aircraft became operational with the Russian Aerospace Forces. What is your perception of this combat aircraft?

AK: Some time back, I used to fly a Su-30MKI fighter, which became the precursor of an entire family of combat aircraft, including the Su-30SM. The aircraft made an exceptional impression on me, having all the performances that are necessary for a modern fighter. Ever since I started flying, I have dreamt of flying an aircraft that exactly fulfills one's desires : Success in air battle completely depends on this. The Su-30MKI become such an aircraft whose pilot does not need to think on how to enter combat, increase speed and altitude. The super maneuverability of the aircraft and its computerised systems permit the employment of weapons at any angle of attack, speed and altitude.

VAYU : What was your position and experience at that time ?

AK: I was in charge of the Centre for Combat Employment and Retraining of Personnel. My experience as a fighter pilot exceeded 30 years, had flown all the fighters that were in service in Russia, so could compare. It must be noted, that I and many other pilots at this Centre had experience in air combat exercising against the best foreign fighters including American ones. We knew the strengths and weaknesses of our fighters and of their rivals.

VAYU : How did Russian fighters perform against their competitors?

AK: During the 1990s, in terms of flight characteristics and accordingly, in close combat, our 4th generation fighters out performed their foreign counterparts, but their avionics at that time lagged behind the western ones. With launching of the Su-30MKI/SM family of fighters, this situation changed radically. Because of the airborne phased-array radar and armament control system, we were able to hit targets well beyond visual range. With new avionics and weapons, the aircraft became multifunctional.

VAYU: Did you follow development of the Su-30MKI in India?

AK: Of course, we were particularly pleased on receiving information about the excellent performance of Indian pilots (flying Su-30MKIs) during international exercises. We in Russia were proud of the Su-30MKI's performance and have great respect for skills of IAF pilots, many of whom we knew personally. We understand how difficult it is to operate in foreign skies, over unknown terrain, in an unfamiliar

environment after long, intercontinental flights, especially when one's opponent is resident, and familiar with his environment.

VAYU : As a commander who has trained hundreds of military pilots, how would you feel about Su-30SM fighters performance in combat environment?

AK: Both the military leadership of Russia and the pilots themselves, very well appreciate effectiveness of the Su-30SM. These aircrafts were employed for fighter escort, carrying out attacks against surface targets as also continuously maintaining surveillance against airborne aerial threats including unmanned aerial vehicles. Su-30SMs were also used for special tasks and also escorted for aircraft to Russian President Vladimir Putin during his visit to combat zones. Mr. Yuri Borisov, deputy prime minister of Russia, has particularly pointed out the effectiveness of Su-30SMs during counter-terrorist operations, exceeding the operational criteria by three to four times. It must be noted that this performance was carried out while aircraft were operating in isolation, far from their basis bases and in adverse climatic conditions.

Su-30SM : "gift of my fate", says the General

VAYU : In summary, and as such an experienced pilot, how would you improve the Su-30SM?

AK: For me, the Su-30SM was a gift of my fate. However, even the most advanced contemporary system would be improved. Earlier, one would look at means to improve the fighter's performance, working on increasing the engine thrust, inducting a range of high-precision weapons and EW systems. Today, I must say with satisfaction, that much activity in these areas is underway in Russia and we see positive results already.

Rosoboronexport launches new series of Kalashnikov assault rifles

Rosoboronexport, part of the Rostec State Corporation, has launched a global marketing campaign to promote the AK200 series of legendary Kalashnikov assault rifles manufactured by the Kalashnikov Concern. "Export permits for the newest Kalashnikov AK200 series assault rifles have been obtained. From now on, Rosoboronexport may offer its partners the AK200, AK203, AK204 and AK205 versions" stated Rosoboronexport Director General Alexander Mikheev.

The AK200 series rifles have retained all the advantages of the traditional AK pattern: reliability, durability and ease of maintenance. The rifle is equipped with integral Picatinny rail and can be fitted with necessary detachable equipment for the effective use of the weapon in various conditions, including in reduced visibility. The length-adjustable buttplate and a number of ergonomic solutions for optimising controls enable operators to fully realise their shooting skills, regardless of their anthropometric indicators and the availability of a variety of personal clothing, gear and equipment. The AK200 series has 'successfully passed the testing programme, meets all the requirements for modern small arms and is an effective small arms system'.

RUSSIAN DEFENCE EXPORT
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Rostec

AK-203

AvioHeliTronics at Yelahanka

AvioHeliTronics InfoSystems Pvt. Ltd. is a Bangalore based Aerospace Engineering MSME with D-IL, CMMI-Dev/Svc-3, AS9100D, ISO27001:2015 accreditations–and approvals of CEMILAC and DSIR as R&D Centre. Incepted in 2007, AIS started with focus on embedded avionics software testing and slowly but steadily organically grew into other niche areas like Mechanical Design and Stress Analysis for Reverse Engineering, Ada legacy Software Systems, ATE Assembly and since some 4 years, multi-axis CNC machining and assembly of aerospace and space components.

AIS is today, an engineering supplier for several overseas civil and defence aerospace OEMs as well as ISRO, MoD, HAL and DRDO in India. Relocating from Whitefield to the Aerospace SEZ at Devanahalli Airport by end-2019, the company will consolidate and expand into a larger facility required to cater expansion of mechanical design, analysis, machining and assembly as well as engineering services businesses in the pipeline. The unique capabilities at mechanical design, analysis and manufacturing, all under the same roof, give AIS an edge at reverse engineering, to aid the Indian Forces circumvent obsolescence as well as sourcing problems faced due to geo-political issues. The company's COO and Senior VP Deepika Ramesh, spearheads the expansion, process and quality improvement initiatives, in order to manage the operational issues of rapid expansion in teams and infrastructure. The company is now on SAP-ERP to streamline operations for higher efficiency and ensure tracking of schedule, quality and cost.

The CEO and Founder Sameer Sonpavde, apart from exploring newer businesses, is actively engaging with the Government, to articulate the need for better higher technical education to address and achieve the true essence of *Make in India*. He believes that "lack of innovations and skills training to engineers at our universities is the root-cause for lack of IP generation in aerospace engineering – both in the DPSU's as well as private sectors. While our children do so well abroad – the training and ecosystem to spark the dormant DNA of innovation, is being neither addressed nor seen as the root-cause, for lack of design innovation in public and/or private sectors". He believes a better offset policy would be a mix of ongoing businesses combined with skill development diplomas by OEM's to upskill technicians and engineers in MRO and Design and secondly, to bring in the best universities like Stanford-USA, SupaAero-France and Technion/TelAviv-Israel. This could be a more meaningful Make in India strategy, than the repetitive low-end works alone that are being outsourced to India under Offsets – which are not creating competence for innovation!

COO and Senior VP Deepika Ramesh

Safran and HAL strengthen partnership with helicopter autopilots

Hindustan Aeronautics Ltd and Safran Electronics & Defense have signed three new contracts for Safran-designed autopilots for various helicopters manufactured by HAL. Safran Electronics & Defense will provide HAL with state-of-the-art development and integration capabilities to replace existing test and integration benches and set up a software workshop to develop and validate control laws necessary for the use of autopilots. HAL has also selected Safran Electronics & Defense to supply the autopilot for its new Light Utility Helicopter (LUH), the development of control laws for this new 3-tonne class machine to be done jointly by Safran and Hindustan Aeronautics Ltd.

Safran has also been selected by HAL to develop the specific control laws for the Advanced Light Helicopter (ALH) maritime version for the Indian Navy and the Indian Coast Guard. The autopilot is similar to that which equips existing versions of ALH and LCH. The manufacturing and maintenance of this system is now carried out by HAL Hyderabad following a transfer of technology.

Air Enthusiasts at Aero India 2019

Spinning Magic and Winning Hearts

Aero India 2019: The anticipation for this event starts building months in advance as it opens doors to the public who are treated to some brilliant air displays. With tickets booked well in advance, we were anxiously waiting for the day to catch our pilots in action and taking control of the skies.

Unfortunately, the Aero India show started on an extremely sombre note with a terrible accident which happened just before the inauguration day when two aircraft of Surya Kiran Aerobatic Team (SKAT) collided in mid-air. We were once again exposed to the uncertainty and fragility of life. But as they say, the show must go on and the Aero India 2019 kicked off with a fitting aerial tribute being paid to the fallen.

We were slated to visit the air display on the penultimate day. Given the kind of traffic that Yelahanka experiences during these five days and our experience of the previous show, we left early and were cautious enough not to miss the entry gates as we neared the base. As we parked our cars and made our way towards the security check, we were pleasantly surprised to see the familiar red and white beauties, the Hawks of the Surya Kirans over us. Instead of their customary nine aircraft, they flew seven and performed for 15 minutes. It was heart-warming to see these men flying in the skies, which is what sets them apart from us, their grit, their commitment and their strength to bounce back within such a short span of time. Our hearts were brimming with awe and respect and even got a little teary eye too as later, we got to know that they performed as a tribute to their friend and teammate.

By this time, we had reached the viewing area which was teeming with people and aviation enthusiasts. Soon it was time for the Yakovlev Aerobatic Team from UK to take over the skies. The Yakovlevs are stunners and their thrilling manoeuvres made the crowd scream at the top of their voices. As the Yakovlevs touched down, we heard a familiar sound of set engines, India's Light Combat Aircraft the Tejas appeared out of the clear blue skies. Oh what a beauty! No wonder it sounded familiar as by now, by virtue of living close to Hindustan Aeronautics Limited we have then flying over us every day. Tejas received its final operational clearance some days earlier and will now be inducted into Indian Air Force.

As the Tejas landed amidst loud cheer from the people, a Sukhoi-30MKI fighter

took off in front of us, proudly showed off its moves and spiralled up before disappearing into the clear blue skies.

Just as we were recovering from this 'beastly' performance, HAL flew its helicopters belonging to Indian Army towards the spectators: HAL's indigenously developed Advanced Light Helicopter (Rudra), Light Utility Helicopter (LUH) and Light Combat Helicopter (LCH) showcased their features and capabilities, flying vertically and diving nose down, which enthralled the crowds.

If these displays were exciting, the US F-16 stole the show with its lightening speed, pierced the blue skies, and watching

US F-16 Falcon jet piercing the blue sky

HAL Dhruv helicopter carrying a vehicle

HAL's LCA Tejas performing

it perform was an experience. After the rather energetic performance by the fighter aircraft, it was time for a more relaxed display by a Dakota heritage aircraft.

The grand finale was highlighted by the Sarangs, the helicopter aerobatic team of Indian Air Force (IAF). The four Dhruv helicopters performed fantastic manoeuvres and it was a treat to witness them create magic in the skies. The Sarangs are regularly used for rescue and disaster operations in different parts of the country. Very recently they played a key role during the Kerala floods.

Misfortune seemed to mar this Aero India Show with a massive fire in one of the car parking lots taking the limelight away from the air display. Smoke billowing out from an adjacent area caught the attention of all visitors and with time it only became worse. The announcers allayed our fears by claiming everything was under control.

While we were bowled over by the brilliant display and performances, we cannot help but be affected by the tragedies that struck the show one after the other. We look forward to a happier event in 2021 and end with a silent prayer for the young IAF pilot who lost his life.

Text: Monami Guha Das/Photos: Debaditya Das
Lead photo by Capt. Navtej Singh, IN

The Sukhoi Su-30MKI

Magical display by the Sarang aerobatic team

The Kaveri Engine

Some Home Truths

The just concluded Aero-India 2019 held in Bengaluru saw two developments of significance for India's national security as well as for its apathetic aeronautics industry. On 20 February the IAF and the aviation community heaved a collective sigh of relief, as the Light Combat Aircraft (LCA) Tejas Mk.1, received its long-awaited Final Operational Clearance, signifying that it was combat-ready and could be exploited to the limits of its approved 'envelope'. A day later, came a, rather unwelcome, report that the DRDO had announced, at Aero India, its decision to shelve the Kaveri turbo-jet engine project (*seen in photo above at Aero India 2019*). While the authenticity of this report awaits confirmation, given the criticality of the Kaveri engine for India's aeronautical industry, this issue deserves a close look, with some home truths.

Historically, all major aerospace powers have possessed the capability to design airframes as well as power-plants. Until India can design and produce its own aero-engines, the performance and capabilities of any indigenously designed/built aircraft will be seriously limited by the technology that we are permitted to import. India has already had two bitter experiences in this regard. The sleek and elegant HF-24 Marut of the 1960s and 70s, failed to achieve its huge potential as a supersonic-fighter for want of a suitable engine. Rather than exert itself to seek alternatives, the government of the day, in a stunning display of myopia, closed this programme.

In similar fashion, most of the problems faced by the Tejas emanate from lack of engine thrust. Even as the Kaveri has failed to make an appearance, US made alternatives, namely the General Electric GE-404 engine, or even the more powerful GE-414, do not deliver adequate thrust for the Tejas Mk 1, to meet all its missions. For the Tejas Mk IA, Mk II, the LCA-Navy, and successors like the Advanced Medium Combat Aircraft, India will need turbo-jets of even greater thrust. Thus, it is vital for India to develop a family of home-grown jet-engines, to power indigenous combat aircraft and re-engine imported ones.

In this context, it is necessary to recognise that both the Tejas and Kaveri projects, which have seen more than their share of headwinds and uncertainty, form key components of India's technological aspirations. Unless carefully guided, protected and nurtured, their failure could spell the demise of India's aeronautical industry. A long production-run of 250-300 aircraft for the Tejas, and its advanced

Tejas LCA Mk.I of No.45 Squadron at Yelahanka

derivatives is essential for the industry to hone its design and production skills.

The same holds true for the Kaveri, except that the design and production of a functional turbo-jet engine is even more challenging. Hindustan Aeronautics Ltd claims to have, "manufactured" nearly 5000 aero-engines of British, French and Russian design, and overhauled 18,000 of them. Since this putative "manufacturing" process involves merely the assembly of imported components, HAL's several Engine Divisions have failed to imbibe aspects of design, metallurgy, thermodynamic and aerodynamic engineering as well as the complex tooling and machining process required for design and manufacture of aero-engines, over the past 60 years, which is a sad commentary.

In 1986, the DRDO's 17-year old Gas Turbine Research Establishment (GTRE) was tasked to develop an indigenous power-plant for the LCA, which would replace the US engines being used for the development phase of the aircraft. Having, by then, developed two experimental engines, GTRE took up a turbofan design, designated the GTX-35VS 'Kaveri' for the LCA. Full-scale development was authorised in 1989 for 17 prototypes at a cost of USD 55 million. The first complete prototype Kaveri began tests in 1996 and by 2004, it had flown in a Russian flying test-bed, albeit unsuccessfully. Over the past 35 years, the Kaveri has made sporadic progress and GTRE has been struggling with serious design and performance issues, which it was unable to resolve. As the Kaveri missed successive deadlines, the US import option was, mindlessly and gleefully resorted to.

Given the DRDO's penchant for secrecy and misplaced optimism, the true story of the Kaveri's halting progress has never been revealed to Parliament or the taxpayer. However, two details, available on the Internet, are revelatory of the organisation's *'modus operandi'*. It has, at least, on two occasions, approached French aero-engine manufacturers, SNECMA and SAFRAN for advice and consultancy. On both occasions, despite reportedly attractive offers of performance-enhancement and technology-transfer, negotiations, have stalled – reportedly on cost considerations. It is also interesting to note that in 2014, this project, of national importance, was arbitrarily shut down by DRDO, only to be subsequently revived for reasons unknown.

Without entering into an extended public debate, one can pinpoint egregious neglect, as well as absence of oversight and vision, at the political level, for repeated setbacks in these vital projects. Three other factors have contributed to the sorry state of affairs vis-a-vis the Kaveri (and the LCA): over-estimation, by DRDO, of its capabilities compounded by reluctance to seek advice; inadequate project-management and decision-making skills of its scientists and exclusion of users - the military - from all aspects of the project.

It is not too late for the government to declare both these projects as 'national missions' and initiate urgent remedial actions. Success of the Kaveri/Tejas will transform the aero-space scene, and put India in the front ranks of aeronautical nations – perhaps even ahead of China if the desired degree of resolve and professional rigor can be brought to the fore. If we miss this opportunity, we will remain abjectly import-dependent forever in this vital area.

Admiral Arun Prakash

Model of the Advanced Medium Combat Aircraft (AMCA)

2019 AERO INDIA

International Seminar on Civil Aviation

Regional Air Connectivity

As part of Aero India 2019, the Indian National Academy of Engineering (INAE) organised an international seminar on 21 February 2019 with focus on *Regional Air Connectivity,* taking place offsite at the Hotel Taj Yeshwantpur an hour away from the Air Force Station Yelahanka. Convener for the Seminar was Dr Abhay Pashilkar, Deputy Head of National Aerospace Laboratories, the programme being carefully crafted to include both senior Indian Government officials as also International participants.

The star studded speakers at the Plenary Sessions were headed by Prof Roddam

The presidential address by Dr Sanak Mishra, President, INAE was followed by that of the Chief Guest Dr VK Saraswat, Member, NITI Aayog with Mr Jitendra J Jadhav, Director, NAL giving the vote of thanks.

Dr Sanak Mishra, Mr Jitendra J Jadhav and Dr VK Saraswat after the inauguration

Professor Roddam Narasimha and Dr. BN Suresh, former President INAE

Narasimha, former Director NAL and presently DST Year of Science Professor, JNCASR, who chaired the Session, inviting Prof R John Hansman of MIT, USA to speak on *Air Transportation Trends and Implications for Regional Transport in India*. He was followed by Dr Kota Harinarayana, Honorary Advisor, CSIR-NAL on *Next Generation Turboprop Development – Challenges & Opportunities*.

Dr Kota Harinarayana, whose name is synonymous with development of the Light Combat Aircraft (LCA), which type was flavour of the Aero India Show 2019 (see separately), has his work cut out on this, India's next big aviation challenge, the Regional Transport Aircraft (RTA), whose development has been mooted by the Government over the past several years. In mid-2018, the Minister of State for Civil Aviation had announced that a Special Purpose Vehicle (SPV) was to be formed for the programme which would include HAL, ADA and NAL, the latter to be lead agency for the design and development of a 70-90 seat new generation turboprop airliner.

As background narrative, it has been accepted that "India has the potential to be amongst the top three nations in the world in terms of domestic and international passenger traffic, having an enviable geographical situation, an increasing middle class population of over 300 million with propensity for air travel amidst rapidly growing economy. IATA and other international aviation organisations, including leading airliner manufacturers, have forecast that demand for regional airliners in India will continuously increase over the next 10-15 years. India's present regional airliner fleet is expected to grow from 55 in 2011 to as many as 261 by 2025." By far the largest number of the regional airliners presently registered in India are from the ATR stable, followed by Bombardier, both these types vying to meet the demand for some 260 turboprop airliners in South Asia (essentially India) and 750 aircraft within the next two decades in the Asia-Pacific region excluding China. In addition to above, ATR also anticipates need for about 460 freighter aircraft worldwide by 2037 in view of growing worldwide trade. In addition to above there is a likely need of 100-150 aircraft for armed/paramilitary forces.

With this in view, Government of India had announced a new Civil Aviation Policy

Mrs Vandana Agarwal, Economic Advisor with the Ministry of Civil Aviation

in 2016 to promote regional air connectivity under the UDAN (*Ude Desh ka Aam Naagrik)* scheme which is steadily being implemented. Looking at the present civil aviation policy (UDAN Scheme) scenario, Indian Civil Aviation sector is expected to grow at a faster pace, which will create demand for new aircraft, air aviation service technologies and increased infrastructure. In the first phase, 70 new intra regional city pairs launched followed by another 325 in UDAN-II and 111 new intra regional city pairs are expected under UDAN-III.

Dr Kota Harinarayana

However, amidst all these projections, there remain many sobering, viability issues including the co-existence of low fares and high operational costs. Adding complications to the viability is an increasing cost of fuel and the possibility of more rigorous emission norms. It is obvious that sustaining growth in the aviation sector requires smart new technologies to lower direct operating costs and so the need for a *de novo* new design to enable lower ownership costs, fuel burn and maintenance costs. The aircraft too must have ability to operate from marginal airfields, to serve the some 400 airfields envisaged.

In his presentation, Dr Kota Harinarayana set out parameters of the new Indian Regional Air liner aimed at having some 25% lower acquisition and operating costs, reduction of emissions by 70% apart from ability to operate from marginal airports, with enhanced safety. These challenges would include optimisation of the wing-propeller configuration, extensive use of composite material for the wing and empennage but also selection of a new generation power plant as a totally new centerline engine.

The RTA 70 would have a fly-by-wire flight control system, more electric aircraft systems, open distributed modular avionics, advanced display systems, supported by concepts that reduced maintenance by 50%. Ambitious targets ? But vitally needed to create the new generation regional transport aircraft.

Operator's views

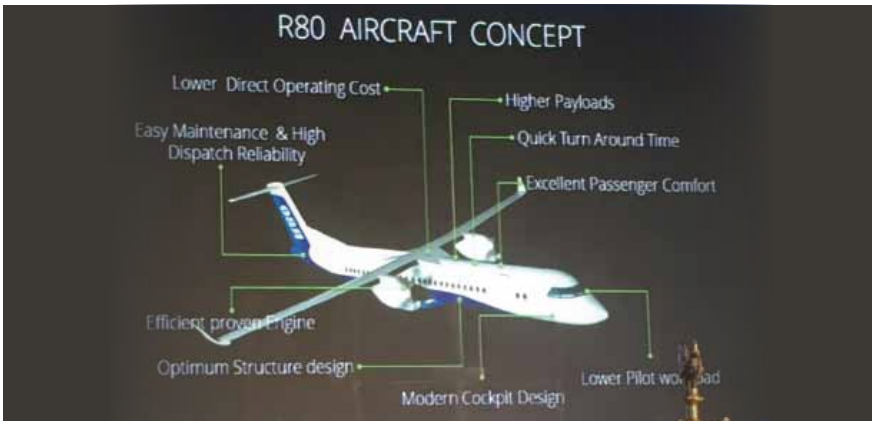
Amongst the keynote speakers were Capt Gurcharan Arora, VP (Flight Ops) of SpiceJet who have some 72 Bombardier Dash 8 Q400 and Dash 8 Q400NGs in service or order and Capt Sandip Sud of Indigo Airlines which have 50 ATR 72-600s in service or on order. These highly experienced pilots turned executives articulated on what they believe were requirements for the next generation regional turboprop airliner, their views certainly based on practical experience– and the 'wish list' was not Utopian by any manner.

Dr Ing Andreas Kloeckner, Programme Strategy Aeronautics from DLR in Germany spoke on *Electric and Hybrid Aircraft* which evoked some lively discussions with the learned audience, Mr Belyakov Vladimir from the Ilyushin Bureau in Moscow made a presentation on the range of aircraft types developed by his organisation and then it was time for presentation by Dr Agung Nugroho, President Director *Regio Aviasi Industri* (RAI) of Indonesia who spoke on the R80 regional airliner.

NAL's Dr Abhay Pashlirkar with Mr Sanjay Mittal from IIT Kanpur

The RAI R80 Regional Airliner

This Indonesian "national strategic programme" involves a new generation, high speed regional turboprop aircraft to be designed, developed and manufactured by RAI in Indonesia. This nation is the largest



From the presentation on Indonesia's R80 regional turboprop airliner

Mr Nigel Garner speaking at the event..... and Dr VK Saraswat with Dr Agung Nugraho during a break

archipelagic island state in the world and its population of 260 million vitally depends on air services. The R80 programme which was initiated some years ago follows the tradition of Nuritanio and IPTN which successfully first collaborated on the licence manufacture of 19-seater light transport aircraft and then graduated towards joint development of larger 50-60 seater commuter aircraft. The R80's first phase, preliminary design & feasibility studies has been completed and RAI are moving to full scale development in the next phase which includes detail design & prototype development. Subject to successful business planning and investor participation, the R80 will move to phase 3 for series production, sales and delivery and product support.

As in India's case for its RTA 70 programme, the new (Indonesian) aircraft will compete with existing ATR 72s and Dash 8 Q400s and thus fairly ambitious targets have been set including lower direct operating costs, quicker turnaround time plus excellent passenger comfort. The R80, designed to carry 80-90 passengers, will be powered by next generation engines, incorporate a modern cockpit layout, have fly-by-wire flight controls and be environmentally friendly.

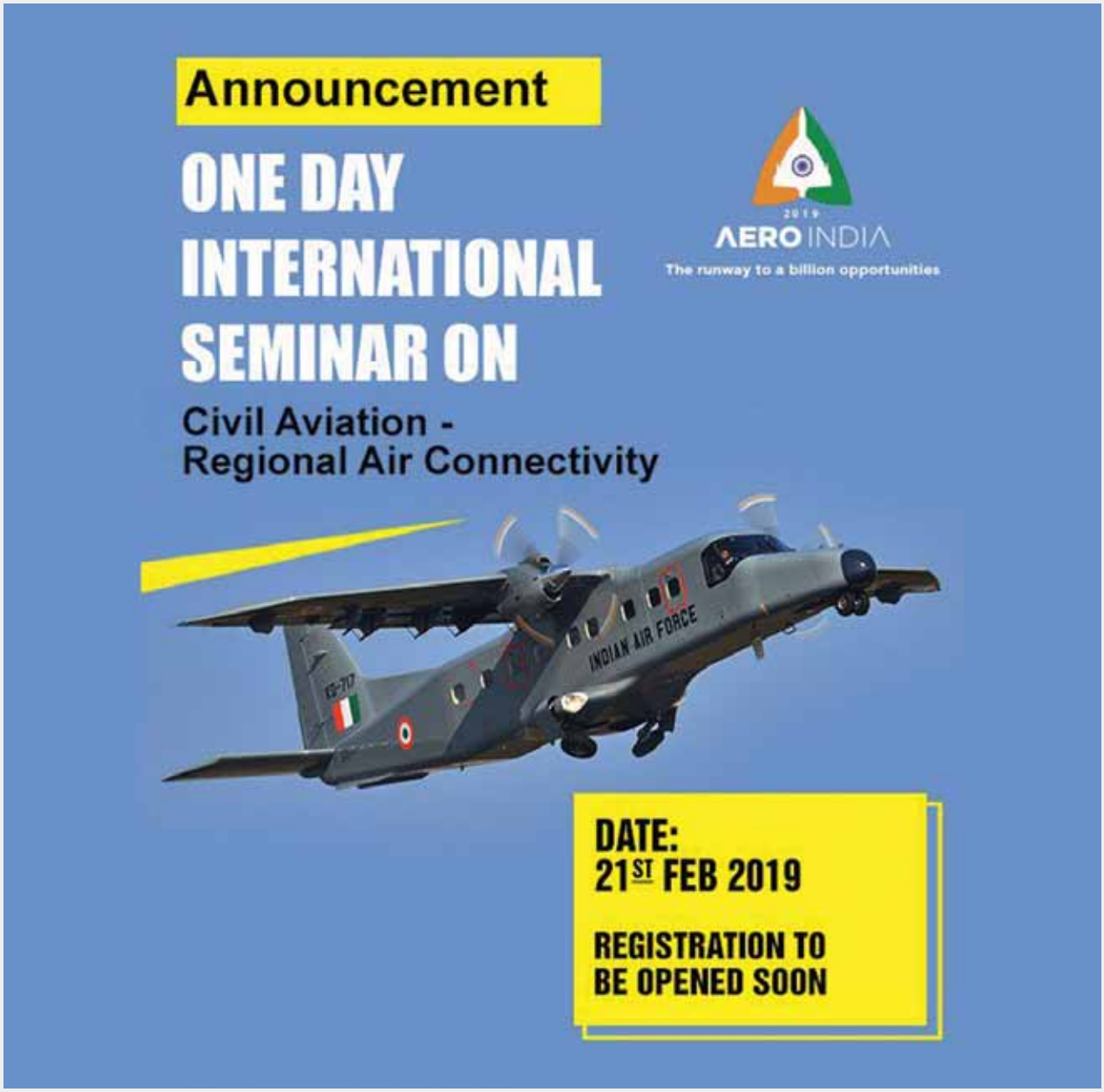
All very similar in concept with the proposed Indian RTA 70 ? It certainly seems so and perhaps in the near future, the two countries could well consider collaboration on such a programme which would not only meet aspirations of the world's second and seventh largest countries in terms of population but continue traditions of the past into the future when India's first Prime Minister Jawaharlal Nehru and Indonesia's first President 'Bung' Sukarno founded the Non-Aligned Movement in the 1950s.

Ecosystem of Manufacturing Civil Aircraft in India

The finale was a panel discussion on the above, chaired by Professor K Vijay Raghavan, Principal Scientific Advisor to the Government of India and had on the panel Mr Appasaheb Malagaudanavar of HAL; Dr Abhay Pashilkar of NAL; Ms Vandana Aggarwal of the Ministry of Civil Aviation; Mr Jayant D Patil of L&T; Mr Chris Rao of Collins Aerospace India and Mr Nigel Garner, Hawksland Associates, and formerly head of design at Fairchild Dornier.

There was much to imbibe !

Participants at the panel discussion on conclusion of the International Seminar



In run up to the Seminar, the Organisers aptly used an image of the HAL-built Dornier 228 light transport aircraft (albeit in Indian Air Force markings) which type, in fact, had ushered in the era of Indian regional air connectivity, over three decades earlier. With establishment of *Vayudoot*, the dedicated 'commuter' or 'third level' airline jointly owned by the erstwhile Air India and Indian Airlines, the then Indian Government had planned to connect "hundreds" of places throughout the vast country, opening up hitherto untouched regions. The 19-seat HAL-Dornier 228 was considered "ideal" for the purpose, with its twin-attributes of (relative) high cruise speed, short take off/landing (STOL) capability, and lowest direct operating costs.

During 1984-86, *Vayudoot* received ten HAL-Dornier 228s (but did not pay for them) and inevitably unchecked ambitions along with non-professional management, led to this 'before its time' airline folding up, and along with it, the plans for a proliferation of airlinks around the country. Thirty years later, the UDAN scheme has resurrected the earlier visions but lessons must be imbibed from the *Vayudoot* years to move in pragmatic manner into the future.

As for the HAL-Dornier 228, this "indigenous" light transport aircraft is considered ideal to open up airlinks to hitherto unconnected places in India, this aircraft type continually being in high demand in other parts of the world – but has still to find its place in the country of its manufacturing origin. As they say in the vernacular, *Ghar ki Murgi Daal Barabar !*

Remembering SR Valluri

A titan of Indian aeronautics

The name of Dr Sitaram Rao Valluri, who passed away at Bangalore on 23 January 2019, aged 94, will forever be linked with the National Aeronautical Laboratory (NAL, now National Aerospace Laboratories). Valluri ('Rao' to his close friends) had many stellar accomplishments in his distinguished career, but his 19 long years (1965-1984) as NAL's Director were so intense, passionate, and momentous that everything before and after those two decades somewhat pales in comparison.

He was born at Eluru in Andhra Pradesh on 25 June 1924, the first child in a family of ten children. From his father, a doctor, Valluri inherited a liberal attitude, the virtue of being truthful, and a short temper, which, he candidly admitted, was always a trifle embarrassing.

Student days at BHU and IISc

The young Valluri, who apparently once ran behind a light aeroplane while at school, was sure he wanted to become an aeronautical engineer. That wasn't going to be easy for someone staying in the middle of nowhere in AP, but help came from an unlikely benefactor: India's future President Sarvepalli Radhakrishnan. Then Vice-Chancellor of Banaras Hindu University (BHU), Radhakrishnan offered Valluri admission in BHU's Engineering College in 1942 after reassuring himself that the young man had the requisite ability.

After obtaining his B.Sc. (Engineering) from BHU, Valluri spent a few valuable years (1946-1949) at the Department of Aeronautical Engineering in the Indian Institute of Science (IISc), where he had the opportunity to interact with stalwarts like V M Ghatage, RG Harris and OG Tietjens. Then came the big moment: obtaining the Pauley Scholarship and joining the Guggenheim Aeronautical Laboratories at California Institute of Technology (Caltech) in September 1949.

At Caltech and Douglas

Caltech, and more generally USA, impressed and overwhelmed Valluri. There were opportunities to meet the aeronautics master and high priest Theodore von Karman; be a student of the brilliant Hans Liepmann; establish a lifelong friendship with Anatol Roshko; bond with that "extraordinary human being" Satish Dhawan (those days at Caltech); and suddenly realise that the person sitting next to you at the lunch table is Richard Feynman.

Valluri's Ph.D. adviser at Caltech was the brilliant Chinese scientist Y C Fung, but it was Ernest E Sechler's work, on design practices for aircraft structures, that excited Valluri the most. Sechler went on to become a mentor of sorts: he also probably opened doors that allowed Valluri to work as a design consultant for Douglas Aircraft Company during the late 1950s and early 1960s.

It was during this phase that Valluri established considerable reputation as an expert in aircraft fatigue and fracture. His research interests were also getting more diverse: he enjoyed designing complex experiments with high-speed cameras, making intricate measurements, pondering over the parameters that influence fatigue crack propagation, worrying about factors that could lead to catastrophic fatigue failure etc. It wasn't, therefore, a surprise when Valluri won the coveted Wright Brothers Medal in 1963. Valluri would later describe this as the "most satisfactory research period" in his life.

In this rare picture are seen Dr Valluri on the left with Professor Satish Dhawan and Professor Roddam Narsimha on the extreme right.

By end-1962, Valluri had logged in enough years with his 'green card' to become eligible for US citizenship. Before taking the final leap across the Atlantic Ocean, Valluri however decided to spend some time in India to test the waters back home. Not surprisingly, he received a lot of attractive offers: IIT Kanpur and IIT Madras wanted him; NAL's first Director, P Nilakantan, wanted Valluri to start a new division on aircraft materials and structure and Satish Dhawan, now back

at IISc., encouraged Valluri to join him and Krishnamurty Karamcheti (they were all together at Caltech) to do something truly worthwhile and valuable for Indian aeronautics. This "strong compulsion to try to do something for the country that nurtured me", eventually persuaded Valluri "to tear up (his) US green card". He accepted the IIT Madras offer to be a Senior Professor.

However, within months of joining IIT Madras, Valluri started getting disillusioned and even considered the idea of returning to the US. But a series of events intervened to completely change the course of Valluri's life: NAL's Director P Nilakantan suddenly passed away on 18 April 1964; Karamcheti, who was the first choice to succeed Nilakantan, did not wish to give up his US citizenship and Jagan P Chawla, who was the next choice, requested terms of appointment that were considered untenable. Eventually, the committee – of which Dhawan too was a member – picked Valluri, not yet 41, to become NAL's second Director.

It was an inspired choice. Valluri suddenly found himself with an enormous empty canvas that he could paint any way he liked. It helped that his boss, CSIR's Director-General S Husain Zaheer, was personally fond of Valluri (Zaheer's relation with Nilakantan had been frosty). It helped even more that the Chairman of NAL's Executive Council was the legendary JRD Tata (JRD) himself.

National Aeronautical Laboratory

Valluri officially took charge on 23 November 1965, ignoring his father's plea not to join on the inauspicious *amāvāsyā* day. His first task as NAL Director was to make sure that Nilakantan's big unfinished task, to build the 4 ft trisonic wind tunnel, never lost momentum or steam. It was a very special moment for Indian aerospace when the roar of the tunnel's first blowdown reverberated across the (then clean and serene) Bellandur Lake on 29 May 1967. With characteristic candour and honesty, Valluri shrugged off all accolades: "I only had a small role to play here. Nilakantan had set everything up beautifully".

Valluri then moved – just as Nilakantan had earlier requested him – to create the Materials Science and Structures R&D divisions at NAL. To head the Materials Science Division, Valluri invited his colleague from IIT Madras, Sivaraj Ramaseshan and virtually gave Ramaseshan *carte blanche* to grow the Division exactly as he wished. Ramaseshan was immensely capable and charismatic and proved to be a formidable and popular leader.

Given his research and consultancy experience in the US, relating to structural integrity of aircraft, one guesses that Valluri intended to play a more active personal role in the Structures Division. But as he became aware of the onerous responsibilities and challenges of leading a national R&D lab, Valluri consciously backed away from personal technical work; indeed, Valluri would, for the rest of his life, vehemently argue that hardcore research was inimical to the responsibilities of a top-flight R&D manager and leader.

By deliberately walking away from serious personal research – which entailed some risk, given how an individual's worth is evaluated even now in national labs – Valluri gave himself, instead, the opportunity to become an outstanding R&D leader and create processes and mindsets that significantly improved NAL's performance.

Valluri as the leader

Valluri ran NAL in ways that directors of most other CSIR labs – still practicing the prevalent bureaucracy of the times – couldn't even have imagined. Just as an example, Valluri started embellishing the NAL campus with a wide variety of trees. And when JRD expressed some unhappiness with NAL's buildings, Valluri decided that he would design NAL's new buildings himself. As someone who spent two decades constantly stepping in and out of these buildings, I can confirm that the buildings had pleasing and comfortable architecture, functionality and aesthetics. It seems so appropriate that NAL's biggest auditorium, conceived by Valluri, is today named after him.

But arguably Valluri's biggest game-changer in his early years as Director was to introduce project accounting at NAL. The classical CSIR budgeting schema only had account 'heads' for salaries, capital expenses, consumables, maintenance, travel etc., but didn't report expenses project-wise. "I had no clue how much money we spent on each project, or which was the division on which we spent the most money. This simply wasn't on", Valluri would later explain. It would take CSIR thirty more years to implement the project monitoring process that Valluri first introduced in 1966!

Another remarkable facet of Valluri's leadership was his relentless resolve to attract the best talent to NAL; equally, he was intolerant of what he called 'second-rate' persons. "If you appoint a second-rate person today, you would inevitably attract a third-rate person tomorrow, and the first-rate person would tend to leave", he often used to say. Valluri's benchmark for a likely first-rate person was having a Ph.D. degree, and he packed NAL with Ph.D.-degree holders (he often exulted

that NAL had more scientists with a Ph.D. than all of DRDO and ISRO put together). Considering the intellectual ferment visible at NAL, especially during the 1970s and 1980s, one would have to agree with Valluri's appraisal. Better still, there was absolutely no bias of gender, region or religion in any appointment that Valluri ever made or permitted. CSIR – NAL's parent body – considered Valluri's evaluation model to be so effective that they asked him to draft the CSIR-wide selection and appraisal criteria for all scientific and technical positions.

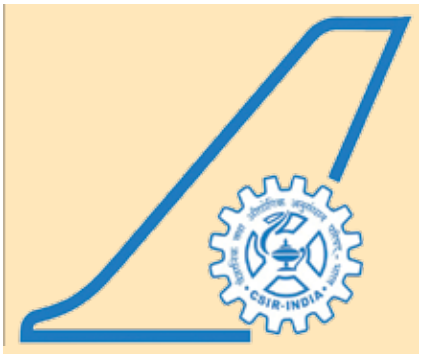
As NAL's Director, Valluri had an electric presence. He walked briskly, talked rapidly and bristled with energy. He took decisions, and made things happen. Often big decisions required the concurrence of CSIR HQ, so the impatient Valluri would fly to Delhi to argue his case and quickly close the matter. There were occasions when Valluri's decisions evoked dismay or discord, but he rarely flinched: "I'm here to run a national lab, not win a popularity contest", he would declare matter-of-factly.

Valluri also realised that, to succeed as Director, he needed to be strongly connected with NAL's natural partners: IAF, HAL, IISc and DRDO. In particular, Valluri always hit off very well with the IAF top brass, with the Air Chief often becoming a personal friend. An outstanding outcome of NAL and IAF working together was the full-scale fatigue testing facility that NAL created in the early 1970s. This facility allowed the IAF to significantly extend the service life of its operational aircraft such as the Gnat, Ajeet and, later, the MiG-21s.

As Valluri grew in stature and success, awards and distinctions started coming his way. He was elected Fellow of the Indian Academy of Sciences in circumstances that can be best described as unusual. While speaking at the Academy about crack propagation in 1970, C V Raman suddenly asked Valluri to define a crack. Raman was so impressed with his reply that he remarked that Valluri deserved to be a Fellow. The Fellowship came in 1971, just after Raman passed away. Valluri would receive the Padma Shri in 1974 and the Vasvik Award in 1978.

"He built NAL"

Making NAL the best lab in CSIR wasn't just Valluri's endeavour; it was his crusade. He created NAL's grand foundation; but, just as important, he also created a formidable supporting infrastructure.



Visiting NAL's library used to be a thing of joy, NAL's photo and printing facility was led by arguably Bangalore's best photographer of the time, and NAL's health centre offered excellent medical care. It was in the fairness of things that NAL's doctors intervened successfully to diagnose Valluri's meningitis as he collapsed into a deathly coma in February 1989.

How would one rate Valluri's performance as NAL Director? Without a doubt, it was exceptional, but, rather curiously, the Valluri years overlapped with a period when Indian aeronautics itself went into a bit of a coma. After the heady adventures of the 1950s and the 1960s, there was a lull in the 1970s following the HF-24 crash on 10 January 1970. NAL, however, continued to prosper: Valluri initiated the first moves to develop composite technologies, built remarkable capability for failure analysis and accident investigations, created even more testing and modelling infrastructure, and lobbied for funds so that NAL could build its first small aircraft. This prompted Satish Dhawan to remark that NAL looked like "a beautiful bride, all decked up, but with nowhere to go!"

So where could this beautiful bride go? The 1980s held great promise, and Valluri was eager and excited. Having been Director, NAL for over a decade, and being actively involved in every national initiative in aeronautics, Valluri held the vantage position. His big dream was to help create an Aeronautics Commission, serviced by a Department of Aeronautics, along the lines of the Space and Atomic Energy Commissions. The Aeronautics Commission would integrate aircraft research, design, development, manufacture and operations under a single umbrella.

It always seemed like a bridge too far. In an informal conversation at an awards event, Professor Roddam Narasimha, who would succeed Valluri as NAL's third Director, asked Prime Minister Indira Gandhi why her government didn't support programmes in aeronautics the way it supported programmes in space and atomic energy. The PM replied that she would "if everyone stopped quarrelling".

While the Aeronautics Commission never happened – and Valluri would regret this all his life – the next best thing did happen. Narasimha, who had taken time off from IISc to spend a few years at HAL in the late 1970s, argued that it was both feasible and desirable to build an Indian light combat aircraft (LCA) in large numbers. Narasimha's arguments achieved a rare resonance: IAF changed its perception, and Raja Ramanna, then the Scientific Adviser to the Defence Minister (SA to RM), was sufficiently enthused to ask Narasimha to lead a team of experts from IAF, HAL and DRDO to visit Germany, France, Sweden and England to obtain more insights and data. The team returned with a unanimous verdict endorsing the LCA concept. For the first time all the principal actors in Indian aeronautics appeared to be on the same page.

In response, the Government invited Valluri to head a high-level committee, which included all the big aeronautical players such as IAF, HAL and DRDO, and of course Narasimha, to make the final recommendation on the light combat aircraft (LCA) concept. The earlier Narasimha committee had said the LCA *could* be done; the new Valluri committee had to decide if the LCA *should* be done and *how*. After a detailed feasibility exercise, the Valluri committee gave the formal 'can-go-ahead' verdict – again unanimously. It took Defence Minister R Venkataraman just two minutes to clear the LCA programme!

There was never any doubt who would lead the LCA programme. It had to be S R Valluri. A new entity, the Aeronautical Development Agency (ADA), was created to fund, manage and monitor the LCA programme, and Valluri would be its Director-General (DG-ADA).

Director-General of Aeronautical Development Agency

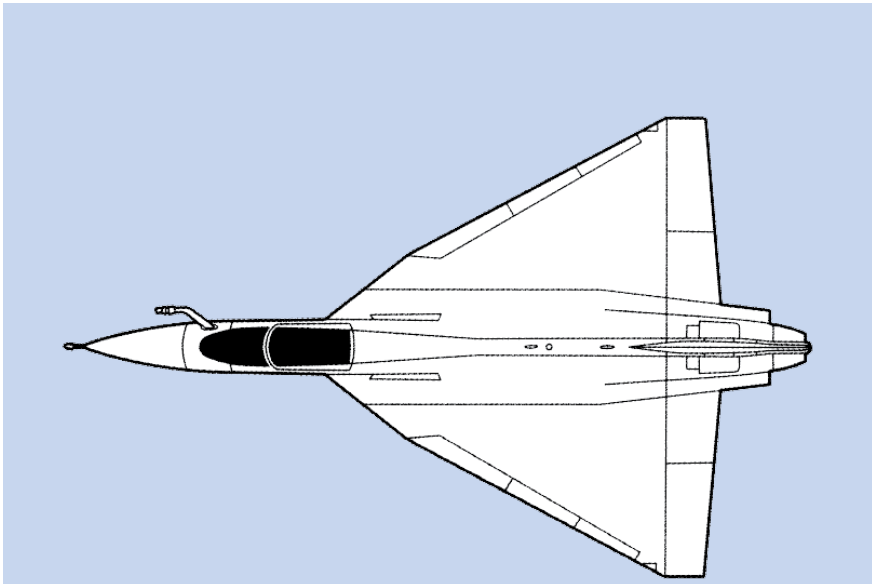
Valluri assumed office as DG-ADA on 2 July 1984, after receiving a fond and emotional farewell from NAL. I remember being chosen to hand him a bouquet at the farewell event because I was then NAL's

Dr Rao Valluri with Air Chief Marshal Idris Latif, Chief of the Air Staff

youngest scientist. Valluri didn't merely transform the contours of NAL during his 19 years, he also completely changed the context of my life by offering me a position at NAL. I shall always be immensely grateful to him for that.

ADA, which was to design develop and build India's first supersonic fighter, didn't even have four walls when it started its existence. Valluri operated out of an NAL office – that we used to fondly call the 'blue room' because of its somewhat hideous blue carpet. I have memories of some truly enjoyable conversations with Valluri in the blue room: he could be at his eloquent best when he talked of self-reliance in aeronautics or of Caltech's 'honor code'. I also became familiar with Valluri's favourite expressions: It was immediately apparent that 'apparently' was a word that he truly relished, then there was 'high-science-high-technology', and, above all, the most intriguing 'Hobson's choice with a Faustian bargain'. Valluri was such a charming and adorable old man!

It was hard to kick-start ADA – it is very hard to kick-start any new establishment with public funding – but Valluri invested all the energy and passion that he could, and NAL, now under Narasimha's tutelage, responded with commendable alacrity: The Advanced Composites Unit was off to a promising start (today's LCA, now called Tejas, has almost 45% composite structures), the wind tunnels started preparing in right earnest for the impending avalanche of tests, and 'fly-by-wire' soon became a buzzword in NAL's corridors.



The LCA planform

But all was not well with ADA's (and Valluri's) interactions with the DRDO and its leadership. It would be pointless to discuss, at this juncture, those events in 1985 that led to Valluri and Raj Mahindra's exit from ADA. Valluri felt hurt and aggrieved – and even privately speculated how the story would have panned out if he had accepted the Government's offer to become SA to RM in 1981. Raj Mahindra, on his part, cheerfully moved on to the next aircraft design adventure involving NAL's light transport aircraft (now SARAS) and passed away peacefully in his sleep in 1995 while, very probably, dreaming of some aerofoil contour.

The retirement years

Valluri's early retirement years were not the most comfortable; he must have felt like a batsman hoping to hit a century but being suddenly given out lbw for 62. To make things harder, his pension was meagre, and would stay meagre till his US Social Security benefits kicked in early 1988.

But Valluri plunged headlong into other interesting ventures: Realising that Bangalore's HAL airport would soon start choking, Valluri prepared a comprehensive plan for how and where Bangalore's new airport should be (one of Valluri's recommendations indeed was an airport beyond Yelahanka at Devanahalli; an alternate another was to 'take over' the runway at Yelahanka Air Force Base and move the IAF base elsewhere).

Valluri also proposed a scheme to revise Bangalore's house numbering. Alas this scheme never took off and Valluri lived all his life horrified how his house number 659 on Indiranagar's 100 ft Road was barely hundred feet away from house number 284.

Dr Rao Valluri with Mr C Subramaniam, the Defence Minister and Raj Mahindra, then Director Design & Development at HAL.

For some years into retirement, Valluri also readily accepted invitations to speak at public functions. His talks were always scintillating: he had great stories to tell, a commendable turn of phrase, a twinkle in the eyes, and unabashed honesty. Most of all, he had a phenomenal memory, both for names and numbers. At one of his lectures I was surprised to see him read from a prepared text. I confronted him: "Please don't ever do that again. It cramps your style!". Valluri admitted that he was "beginning to forget a few things", but promised to resume his extempore style.

All his life Valluri championed ethical professional practices and personal honesty. His criterion to judge the integrity of every action was to ask: "Would Satish (Dhawan) approve?". Valluri would be outraged every time he saw a lapse, digression or failure, and spoke out (and wrote) loudly against the misdemeanour. He could get really angry and it was hard to face his wrath. But he was always open to dialogue and debate and did not hesitate to apologise publicly if he discovered that he had erred.

I last met Valluri when U N Sinha and I went to greet him on his 93rd birthday. He seemed only slightly frail, and easily recognised both of us. He spoke for a few minutes with customary warmth, provided us a brief glimpse of the famed Valluri charm, but then lapsed into silence. We knew it was time to go and, deep down, I sensed that this would be our last meeting.

Valluri was a towering Indian. We will miss him.

Dr Srinivas Bhogle

The NAL Saras light transport aircraft (in IAF markings) on static display at Yelahanka during Aero India 2019

Airbus and Dassault Aviation sign JCS for Future Combat Air System

France and Germany have awarded the first-ever contract – a Joint Concept Study (JCS) – to Dassault Aviation and Airbus for the Future Combat Air System (FCAS) programme. The launch of the JCS was announced by the French Minister of the Armed Forces, Florence Parly, and her German counterpart, Ursula von der Leyen, at a recent meeting in Paris. The decision by both countries represents a milestone to secure European sovereignty and technological leadership in the military aviation sector for the coming decades.

Eurofighter and the future concept 'Tempest'

Eurofighter Typhoons from various European air forces were parked alongside the UK's future combat air strategy concept model 'Tempest' during the *2018 Belgian Air Force Days* at Kleine-Brogel. A Eurofighter 'show of force' formed a static display line-up on, in addition to a spectacular air display from the Royal Air Force's Eurofighter Display Pilot, Flt Lt Jim Peterson, demonstrating the power, speed and impressive agility of this multi-role combat aircraft. Displayed too was a full scale model of the 'Tempest' the future combat aircraft system concept developed by the UK Ministry of Defence with industrial partners.

Second GlobalEye flies

Saab has completed successful test flights with the second GlobalEye Airborne Early Warning & Control (AEW&C) aircraft. The second GlobalEye aircraft took off for the first time on 3 January 2019 from Saab's airfield in Linköping. GlobalEye, which is based on a modified Bombardier Global 6000 aircraft with a suite of advanced sensors including the Erieye ER airborne radar, undertook a test flight collecting flight-test data. GlobalEye brings extended detection range, endurance and the ability to perform multiple roles, including tasks such as search and rescue, border surveillance and military operations. The launch customer for GlobalEye is the United Arab Emirates, where the solution is known as the *Swing Role Surveillance System* (SRSS).

Saab offers Gripen E to Switzerland

Supported by the Swedish Government, Saab has submitted its proposal for the Swiss *New Fighter Aircraft* procurement to Armasuisse, the Swiss defence procurement agency. "Saab offers Gripen E and a comprehensive industrial participation programme for Swiss industry corresponding to 100 percent of the contract value." The proposal includes of options for 30, and 40, new build Gripen E fighter aircraft in response to the Request for Proposal (RFP), which Armasuisse issued on 6 July 2018. Switzerland has a need to replace its fighter fleet of F/A-18 Hornets and F-5 E/F Tigers.

Safran and MTU partner for the next-gen European fighter engine

In the presence of the French and German Ministers of Defence, Florence Parly and Ursula von der Leyen respectively, Safran and MTU Aero Engines have officially announced their partnership to jointly lead the development, the production and the after-sales support activities of the new engine that will power the next generation combat aircraft, as part of the Franco-German *Future Combat Air System (FCAS)*. The aircraft will enter into service by 2040 to complement the current generation of Eurofighter and Rafale fighter aircraft. Both partners are "willing to ensure a strong and effective management of the programme, and to supply the Forces with their longstanding experience in military engines, the best technologies and innovative engine architecture'."

Rafale Standard F4 launched

Meanwhile, a contract worth around €1.9bn to develop and integrate the Rafale Standard F4, the next configuration of the `omni-role' combat aircraft has been awarded to Dassault Aviation. The evolving Rafale programme implements successive standards, the most recent being standard F3-R, which was officially qualified on 31 October by the *Direction generale de l'armement* (DGA, the French defence procurement agency) . Standard F3-R provides new software and hardware to support full integration of the Meteor beyond visual range air-to-air missile (BVRAAM), Talios laser targeting pod and the SBU54 Hammer air-to-ground modular weapon with laser terminal guidance. There will also be a new control unit for the Safran M88 engine.

Rafale Standard F4 will go into production during the 2022-25 timeframe and France's 30 final aircraft (to be ordered in 2023) will all be in F4 configuration, the earlier aircraft also planned to be upgraded to this standard. By end January 2019, 152 production Rafales had been delivered to the French Air Force and Navy (58 Rafale Bs, 48 Cs and 46 Ms) with 23 more to Egypt. The first Rafale for Qatar was handed over at Merignac on 6 February and those for the Indian Air Force are expected in late 2019.

First Rafale F3-R for French Navy

The first Rafale F3-R for the *Marine Nationale* (French Navy) has been officially accepted at Landivisiau naval air base. The naval Rafale M variant made its first post-upgrade flight at the base on 17 December 2018. Rafale M30 was upgraded to F3-R configuration by the *Atelier Industriel de l'Aeronautique* (AIA) Bretagne facility co-located at the Brittany base after which the Rafale was prepared for handover to the fighter detachment of the *Centre d'Experimentations Pratiques et de reception de l'Aeronautique navale* (CEPA)/10S. This unit will conduct operational trials of the variant after which it will enter service, with Flottille 11F earmarked as the French Navy's first frontline operator of the Rafale F3-R version.

Egyptian Rafales delivered

The final Rafale DMs to the Egyptian Air Force 34th Squadron (*Wild Wolves*) based at Gebel El Basur Air Base outside Cairo have been delivered. The last three two-seaters were part of an order for 16 two and eight single-seaters announced in February 2015, which deal included an option to buy 12 more Rafales.

Twelve Su-30SMs now with Kazakhstan

By end December 2018, another four Su-30SM fighters were handed over to the Kazakhstan Air Defence Force (KADF) to serve with the 604th Air Base at Taidykogan, bringing the total now in service to 12, with another eight jets due to arrive in 2019.The KADF has ordered 26 of the type, but eventually plans to acquire 36.

Armenia orders Su-30SMs

Armenia has signed a contract to acquire Su-30SMs. The Agreement was initially reached in 2012 to supply 12 Su-30SMs to the Armenian Air Force, but this had been delayed owing to funding problems. It is now learnt that the Russian Government has offered credit to finance the acquisition of these aircraft and other military equipment.

One hundred Su-35s produced

During an event at Sukhoi's Komsomolsk-na-Amur (KnAAZ) production facility on 11 December 2018, the final production Su-35s of the year were handed over to the Russian Ministry of Defence, the aircraft also being the 100th fighter of the type to be produced till then. Currently, the Su-35s in VKS service are with the 22nd IAP (Fighter Aviation Regiment) at Tsentralnaya Uglovay-Artem, 23rd IAP at Dzemgi/Komsomolsk-on-Amur, 159th IAP at Besovets-Petrozavodsk and 968Th IISAP (Instructor-Research Composite Aviation Regiment) at Lipetsk.

RAAF as a 'fifth-gen' Air Force

With formal delivery of Lockheed Martin F-35A Lightning IIs to the Royal Australian Air Force at its Williamtown Air Force base, the RAAF is poised to become the world's first fully-networked 'fifth-generation' air arm. "The [F-35A] Joint Strike Fighter replaces nothing, but changes everything", RAAF chief Air Marshal Geoff Brown stated and further added, "it requires a new way of thinking and a new way of operating". The Lightning II is seen as the future lynchpin of a multi-facetted and thoroughly advanced air force, working alongside the F/A-18F Super Hornet and EA-18G Growler; the Gulfstream G550 intelligence, surveillance, reconnaissance and electronic warfare (ISREW) aircraft, plus MQ-4c Triton and MQ-9 Reaper unmanned aerial vehicles (UAVs).

F-35 IOT&E phase

Meanwhile, the USAF's 31st Test and Evaluation Squadron (TES) began F-35 initial operational test and evaluation (IOT&E) at Edwards Air Force Base California in December, the

effort starting with a large-force employment mission from the air base on the same day. During the IOT&E phase, 31st TES F-35 pilots flew more than 30 missions designed to fully evaluate the complete air system as well as identify technical and operational areas for improvement.

The Joint Strike Fighter Operational Test Team (JOTT), under the oversight of the independent Director of Operational Test and Evaluation (DOT&E) was to execute formal IOT&E with participation of international partners.

US Navy F-35C carrier qualifications

The US Navy's Strike Fighter Squadron (VFA) 147 has been fully cleared as "safe for flight" with F-35Cs after the squadron completed carrier qualifications abroad USS *Carl Vinson* (CVN 70). The safe-for-flight operations certification SFFOC) marks the final step for VFA-147's transition from the F/A-18E to the F-35C. As VFA-147 commanding officer CDR Patrick Corrigan explained, "with this certification we are announcing that we have the right skills, training and people to take this mission and execute it to its fullest potential".

Japan to be second largest operator of F-35s

The Japanese Government plans to add 105 Lockheed Martin F-35s to its already ordered 42 numbers, which will make them the world's second-largest F-35 operator. Plans outlined under the country's Mid-Term Defense Programme (MTDP) which covers 2019-2023 takes Japan's F-35 inventory to comprise 107 conventional take-off and landing (CTOL) F-35As and 40 short take-off and vertical landing (STOVL) F-35Bs. It is likely that some will be built in the United States at Lockheed Martin's Fort Worth plant and the rest at Mitsubishi Heavy Industries' (MHI) F-35 final assembly and check-out facility at Nagoya, Aichi Prefecture. The Nagoya plant has so far delivered ten of 42 F-35As ordered for the Japanese Air Self Defence Force (JASDF) with four others built in Fort Worth. The F-35A is to supplant the JASDF's F-4 Phantoms as well as the older F-15 Eagles, around 100 of which need replacement urgently.

As earlier reported in *Vayu*, the Japan Maritime Self-Defense Force's (JMDSF) will operate F-35Bs from its two *Izumo*-class helicopter carriers, JS *Izumo* and JS *Kaga,* the vessels to be designated as *multi-purpose escort destroyers* to comply with Japan's pacifist constitution that limits Japan Self Defense Force branches to self-defence.

Singapore selects the F-35

The Government of Singapore have selected the F-35 as the next generation fighter to replace its F-16C/D fleet, this making Singapore the 13th country to select the Joint Strike Fighter. A

press release from Singapore's Ministry of Defence stated that the Republic of Singapore Air Force (RSAF) and Defence Science and Technology Agency (DSTA) consider the F-35 "the most suitable replacement" for the F-16. It is however recommended that a "small number of F-35s" should be purchased for a "full evaluation of their capabilities and suitability" before committing to the full order.

The Singaporean Defence Ministry has followed such an approach earlier as well perhaps to downplay major defence acquisitions to assuage regional sensitivities. Singapore has repeatedly stressed that a new-generation fighter will need to be in service by the 2030s to replace its ageing F-16. Forming the bulk of the fleet, 42 F-16C/Ds were delivered from 1997 to 2002 while 20 of the more advanced F-16D+ entered service in 2003-04. Forty-eight F-16C/D/D+ fighters serve with three squadrons in Singapore while 12 F-16C/Ds operate with a training detachment at Luke Air Force Base, Arizona.

Slovakia formalises F-16 contract

The Slovak Government has finalised a $1.8bn contract with Lockheed Martin for 14 F-16V Block 70/72s (12 single-seaters and a pair of two-seaters). The contract includes provisions for equipment, logistic support and training of air and ground crew. Weapons in the package comprise AIM 120C-7 AMRAAMs and

AIM-9X Sidewinders. The first four aircraft will be delivered in 2022, two of which will be two-seater variants, while the remaining ten single-seaters will follow by December 2023.

Typhoons with the Meteor

RAF Typhoon FGR4s are now 'fully ops' at RAF Lossiemouth in Scotland, armed with the Meteor beyond-visual-range air-to-air missile (BVRAAM), regarded as "the most advanced air-to-air missile in the world". As Defence Secretary Gavin Williamson also said "this latest missile system demonstrates the next chapter of the Typhoon which will see the jet evolve its ability to target and destroy any airborne threat at great distances. The Meteor missile will provide an unrelenting deterrence to those who wish harm upon the UK and our armed forces."

Myanmar inducts JF-17s, Z-9 and ATR 72

As earlier reported in *Vayu,* the first batch of four Myanmar Air Force (MAF) Chengdu/Pakistan Aeronautical Complex (PAC) JF-17M Thunder fighters were recently handed over to the Myanmar Defence Force at Mandalay-Meiktila air base. Also officially handed over during the ceremony at Meiktila was an Harbin Z-9 and an ATR-72, three of the ATR-42-300 variant already in service, two having been converted as maritime patrol aircraft.

Hellenic F-16s upgradation

Lockheed Martin has been awarded a $996.77 million Foreign Military Sales (FMS) contract for F-16 upgrades, which provides for the upgrade of 85 Hellenic Air Force F -16 aircraft to F-16V or 'Viper' configuration. The work will be carried out at Fort Worth, Texas and Athens, Greece, and is expected to be completed by 30 June 2027. "The F-16V provides near fifth-generation capability at a fraction of the cost. Part of the upgrade includes the Northrop Grumman APG-83 AESA radar", according to a company spokesman. The Viper features an airborne mission role-change capability, allowing an aircraft to change between suppression of enemy air defences, air-to-ground, air-to-air combat, and deep interdiction and maritime interdiction missions. Greece originally procured 90 Block 52+ F-16s (60 F-16Cs plus 30 F-16Ds. Schedule for the work, which will take place in Greece, allows for the first two years to be spent on engineering a prototype and verifying systems and procedures. The actual work on the 84 F-16s will take place in the third year with the fourth and final year being used for training. The Hellenic Air Force will effectively end up with a fleet of new aircraft because nearly all the existing airframes, other than the fuselage, are replaced when the existing Block 52+ aircraft are converted to F-16V standard.

Colombia requests used F-16C/Ds

According to reports from South America, the Colombian government has requested purchase of 18 second hand F-16C/Ds to be supplied as *Excess Defense Articles* and could be taken either from the active US Air Force inventory or from those currently stored by the 309th Aerospace Maintenance and Regeneration Group at Davis-Monthan Air Force Base, Arizona.

RAF to re-train with Hawk T1

The RAF is to resume fast jet aircrew training on the early variant Hawk T1 operated by No. 100 Squadron at RAF Leeming North in Yorkshire, later in 2019. The measure has been taken to cope with a shortage of capacity in the service's current fast jet training provision, handled by Nos. IV and 25 (Fighter) Squadrons flying the Hawk T2 at RAF Valley, Wales. Meanwhile, the latest RAF Hawk T2 of No.25 (Fighter) Squadron was delivered to Valley, Wales on 9 January, providing advanced fast jet training (AFJT) for RAF and Royal Navy pilots alongside No. IV (Army Co-operation) Squadron at the same base. The latter has spilt into two, with the re-formed No.25(F) Squadron taking on responsibility for the first phase of AFJT. The move was prompted by increased demand for fast jet pilots on the front line to fly the Typhoon and Lightning. The Hawk T1 last served in an advanced fast jet pilot training role with No.206 (Reserve) Squadron which was disbanded at Valley in June 2016. The RAF expects to retire its last 80 Hawk T1s by 2030.

Irkut Yak-130s proliferate in South East Asia

Yak-130 combat trainer of the Laotian Air Force

Yak-130 combat training aircraft produced by Irkut Corporation of Russia, are being ordered in large numbers by operators in South East Asia, the latest deliveries being made in January 2019 to the Laotian Air Force. The Yak-130s will substantially add to the strength of this air arm, and prepare pilots to fly further advanced aircraft in the future, the Yak-130s themselves able to perform a wide range of combat missions.

Laos has became the third country in Southeast Asia to procure Yak-130s, following the Air Forces of Bangladesh and Myanmar. It is understood that Myanmar has in 2016 received another batch of six Yak-130 aircraft from Russia, taking their number to 12 units.

Dassault Aviation's first Rafale delivery to Qatar

On 6 February 2019, a ceremony hosted by Eric Trappier, Dassault's Chairman was held at Merignac for delivery of the first Rafale to the Qatari Emiri Air Force, under the patronage of Dr Khalid bin Mohamed Al Attiyah, Qatari Deputy Prime Minister and Minister of State for Defense Affairs, and Geneviève Darrieussecq, French State Secretary to the Minister of Armed Forces, and in the presence of Qatar Emiri Air Force.

This first Rafale delivery, on schedule, comes after the signature in May 2015 of the contract for the acquisition by the State of Qatar of 24 Rafales to equip its Air Force, plus an additional 12, in December 2017, for a total of 36 aircraft. In the frame of this contract, Qatari pilots as well as technicians are being trained in France both by the French Air Force and the French Industry.

Dutch F-16s return from Jordan

On 2 January 2019, six Lockheed Martin F-16s of the Royal Dutch Air Force *(Koninklijke Luchtmacht, Klu)* returned to the Netherlands from Jordan.

Between October 2014 and December 2018 (with a gap between mid 2016 and the beginning of 2018), more than 3000 missions were flown. On 31 December 2018, the last operational mission was flown against targets of IS/ISIS/DASH in the Syria/Iraq region. On the 1 January 2019 the departure was organised and the next morning, the six F-16s went back home to the Netherlands.

From: Joris van Boven and Alex van Noye. Photo:Joris van Boven

Last flight of Belgian Hercules

On 21 December 2018, the last Belgian Lockheed C-130H Hercules made its very final flight. In a couple of years, all Belgian C-130s will be replaced by the Airbus A400M aircraft. Operationally, the Belgian Air Force will remain at strength with the remaining aircraft and with the sharing capacity of the European Air Transport Command (where 7 European Air Forces share their transport assets); no problems are expected to fulfill the transportation tasks. Seven Airbus A400Ms have been ordered by the Belgian Air Force and together with the single A400M ordered by Luxemburg, all eight aircraft will be based at Melsbroek AB where they will take over the ramps and hangers of the C-130s.

From: Joris van Boven. Photo: ADJ Kris Moens, PRO 15 Wing at Melsbroek AB.

Thales TALIOS qualified by French DGA

Combining reconnaissance and targeting capability with visibility of the entire critical decision chain, from gathering intelligence to neutralising threats, is a key requirement for modern armed forces. Building on 40 years of experience in reconnaissance and identification systems, Thales has developed the TALIOS optronic pod to meet this challenge. The Initial Operational Capability (IOC) version of the new pod has now successfully completed qualification testing by the French defence procurement agency (DGA).

TALIOS combines the latest generation of high-resolution electro-optical and infrared sensors with line-of-sight stabilisation and outstanding image processing capabilities. In addition to its

"unprecedented target identification performance," the new pod provides long-range threat engagement capability to counter fixed and moving targets.

19 more Boeing P-8A Poseidon ordered

The US Navy has awarded Boeing a $2.4 billion production contract for the next 19 P-8A Poseidon aircraft. The contract includes 10 aircraft to add to the current inventory of P-8As in the US Navy fleet, all five currently under contract for Norway and four aircraft remaining for the existing United Kingdom contract, bringing the total United Kingdom acquisition to nine aircraft.

The United Kingdom and Norway are acquiring the Boeing aircraft through the Foreign Military Sales process and will receive a variant designed and produced for the US Navy as the P-8A Poseidon. The United Kingdom will receive their first aircraft in 2019 and Norway will begin receiving aircraft in 2021.

A-100 AWACS makes first flight undergoing new stage of trials

The new Russian A-100 Airborne Warning and Control System (AWACS) aircraft has made its first flight undergoing a new stage of prior test flights. The A-100 is a modified variant of the Il-76MD-90A strategic airlifter. According to the Russian Defence Ministry, the aircraft is equipped with a digital navigation system and digital control systems in the glass cockpit, along with a new two-band locator with phased antenna array manufactured by the Vega Radio Engineering Corporation. The A-100 made its first flight on 18 November 2017 to test aerodynamic characteristics, avionics and aerial target equipment.

Ivory Coast orders Airbus C295

The Ministry of Defence of Ivory Coast has ordered one C295 medium transport aircraft, "will enhance the capabilities of the Ivory Coast Air Force with its proven record of excellent performance in hot and harsh conditions, and affordable maintenance and operational costs." Bernhard Brenner, Airbus Defence and Space Head of Marketing & Sales, said: "The C295 has proven its outstanding capabilities in the exceptionally harsh sub-Saharan Africa operating environment. The aircraft will be a game changer for Ivory Coast and we feel very proud to welcome a new operator into our C295 family." With this new order Ivory Coast becomes the 28th nation worldwide to operate the C295. Airbus Defence and Space has to date sold 91 aircraft to 17 countries in Africa. There is a growing fleet of C295s in the North and West Africa region with up to 35 C295s contracted by Egypt, Algeria, Ghana and Mali.

Sea Kings and ATR 72 for Pak Navy

An ATR 72-212A, along with two Sea Kings have recently been acquired from the UK Ministry of Defence and inducted into service at Pakistan Naval Station Mehran in Karachi. The ATR-72 was converted into maritime patrol configuration by Rheinland Air Service (RAS) at Mönchengladbach, Germany and a second ATR-72-212A, is being converted to MPA configuration by RAS but currently remains at Mönchengladbach. The two Sea Kings comprise a HAR3A and a HC4+ from a batch of five shipped to Pakistan from the UK in December 2017.

French Navy Falcon 50M for SAR

The first Falcon 50M maritime surveillance aircraft equipped with a new hatch to drop search and rescue (SAR) equipment has been delivered to the French Navy. The *Marine Nationale* operates a fleet of eight Falcon 50Ms : four Falcon 50Mi ('intervention') aircraft capable of dropping SAR equipment and four Falcon 50Ms, earlier without this capability.

Boeing KC-46A for USAF

The USAF has begun operating the KC-46A Pegasus aerial refueling tanker, having previously accepted the first Pegasus from the Boeing Company on 10 January 2019. The first two KC-46s departed Everett's Paine Field, Washington for the 22nd Air Refuelling Wing (ARWO and 931st ARW at the McConnell Main Operating Base (MOB), where they will serve with the active-duty 344th Air Refueling Squadron (ARS) and the Air Force Reserves 924th ARS.

Boeing aims to deliver 36 Pegasus aircraft this year as part of the total 52 aircraft under contract. The USAF initially expected to take delivery of its first KC-46 in early 2016 with 18 aircraft to be delivered by the end of the following year. Delivery of all 179 KC-46As required under the $44bn KC-X initiative will be by the end of 2028.

A330 MRTT for South Korea

The Republic of Korea Air Force (ROKAF) formally introduced to service its first A330-200 Multi-Role Tanker Transport (MRTT) on 30 January during an event hosted by Minister of National Defence Jeong Kyeong-doo at Gimhae Air Base. The type appears to have received the local designation KC-330. South Korea ordered a total of four MRTTs in 2015. The next aircraft are scheduled to arrive in April, August and December 2019 and the recently established 261st Air Tanker Squadron should be fully operational with the type in July 2020.

Diamond DART-450 is now China's TA-20

The China Electronics Technology Corporation (CETC)/Wuhu Diamond Aircraft Manufacturing Company has announced first flight of its TA-20 basic military trainer. The TA-20 is a joint venture between CETC and the Wuhu Municipal Government, which builds aircraft under licence, this trainer being a development of Diamond's DART-450, which was first flown on 17 May 2016, powered by an Ivchenko-Progress/Motor Sich Al-450S turboprop. The TA-20 is a contender for the People's Liberation Army Air Force's requirement for a new basic turboprop trainer. The TA-20's tandem cockpit is equipped with indigenous Smart-210 avionics developed by Chengdu Hermes Technology Company Limited.

Second Mi-26 for Jordan

The Royal Jordanian Ai Force (RJAF) has received the second of four Mi-26T2 heavy-lift helicopters ordered from Russian Helicopters in April 2018. The first Jordanian Mi-26T2 was delivered to Amman in January 2018, the third made its maiden-flight in October 2018 and delivery is expected in the first half of 2019 as well as the fourth, which will be before end of the year.

More Reapers for AFSOC

A new US Air Force Special Operations Command (AFSOC) unit has been formed with MQ-9 Reapers. The 65th Special Operations Squadron (SOS) was officially activated at Hurlburt Field, Florida in December 2018 as part of the 1st Special Operations Wing/1st Special Operations Group. Meanwhile, additional MQ-9 Block 1 Reapers with the extended-range package (Block 1ER) were

recently delivered to an "undisclosed location in Southwest Asia". This was start of the transition to an updated fleet providing a 33% increase in flight time. The transition was expected to be completed in March 2019 and will consist of multiple aircraft, although the precise number has not been revealed. Existing Reapers currently deployed will be returned to their respective units and will be retrofitted with the same upgrades.

GA-ASI continues ontime development of MQ-9B

General Atomics Aeronautical Systems, Inc. (GA-ASI) continues the ontime development of its latest RPA, the MQ-9B. GA-ASI designed MQ-9B as the next generation of multi-mission Predator B fleet and named its baseline MQ-9B aircraft SkyGuardian, and the maritime surveillance variant SeaGuardian. The Royal Air Force (RAF) is acquiring SkyGuardian as part of its Protector RG Mk1 programme and is scheduled for first delivery in the early 2020s. Belgium also selected SkyGuardian for its defence needs. The RPA is being considered as an option for the Australian Defence Force, who chose GA-ASI to supply the RPA system for Project Air 7003.

Russia's Okhotnic UCAV

Russia's next-generation unmanned combat air vehicle (UCAV) has been revealed in a series of recent images. Photos of the Sukhoi-developed Okhotnic (Hunter) were first posted on a Russian internet forum showing the combat drone on ground tests at the Novosibirsk Aircraft Production Organization (NAPO). In October 2011, the Russian defence ministry had reportedly ordered Sukhoi to develop and build a prototype of a long-range high-speed strike/reconnaissance drone. The Okhotnik is being developed under the *Udamo-Razvedyvatelnyi Bespilotnyi Kompleks* (URBK, Strike-Reconnaissance Unmanned Complex) programme, and classified in Russia as a 'sixth-generation UAV. The Okhotnik is powered by a single turbofan and its maximum speed has been estimated at 621-684mph (1,000-1100km/h).

66 new F-16Vs for Taiwan

Reports from Taipei indicate that the Republic of China Air Force could begin to receive its first F-16Vs of a batch for 66 new aircraft by late 2020. Estimated cost of the new aircraft is about $ 8 billion and the reason given as to "why Taiwan is opting for F-16V jets instead of the next generation F-35s" is that the US is

unwilling to sell that advanced aircraft to Taiwan for at least the next 10 years. There continues much concern China's military build-up, including the recent stationing of PLAAF strategic bombers on the 'Taiwan front', less than an hours flight from mainland China. The new F-16s are also likely to be based at Chingchuankang Air Force Base, where the existing AIDC F-CK-1 Ching-kuo indigenous fighters would be relocated to the eastern coast, in turn replacing the obsolescent F-5E/F.

China's defence budget

China's 2019 defence budget will be 1.19 trillion yuan ($ 177.61 billion), as announced by Chinese Premier Li Keqiang at the Chinese Parliament on 5 March 2019. This makes China the world's second highest spender on defence, after the United States, while India's defence budget for 2019-20 is Rs 3.18 lakh crore, an increase of 6.87% over the previous year.

Chinese aircraft carrier for Pakistan ?

Downplaying media reports that the Chinese Government plans to sell (transfer) its first aircraft carrier the 'Liaoning' to the Pakistan Navy, the Chinese spokesman said that the country "follows certain principals while exporting its Naval ships to other countries." Earlier reports had it that the Chinese are building four modern warships for the Pakistan Navy but references to the aircraft carrier are "groundless and complete falsehood".

It is widely speculated that China will commission some five aircraft carriers, including two nuclear-powered ones, by 2030-35 and the 'Liaoning' serves as both a training carrier as also for limited combat purposes.

Black Hawks for Turkish *Jandarma*

The Turkish *Jandarma Genel Komutanlığı* (Gendarmerıe General Command) has taken delivery of its first two S-70i Black Hawks, the new general purpose helicopters built by Sikorsky subsidiary PZL Mielec in Poland. The *Jandarma* will take delivery of 30 T-70 Black Hawks, a Turkey-specific variant of the S-70i for which Tukish Aerospace Industries (TAI) is prime contractor, working in association with Sikorsky and other Turkish suppliers. The overall deal covers as order for 109 of the type (plus 12 options) for various branches of the Turkish armed forces. The new helicopters are to replace the *Jandarma's* older model S-70As, the first of which entered service in December 1988.

KAI Light Armed Helicopter

Korea Aerospace Industries (KAI) have rolled out prototype of its Light Armed Helicopter (LAH) on 19 December 2018, planned to replace the Korean Army's fleet of Bell AH-1S Cobra and McDonnell Douglas MD500 Defender helicopters. The helicopter has been developed by KAI in partnership with Airbus Helicopters and is derived from the H155B1 Dauphin. KAI plans to produce at least 200 LAHs.

Luftwaffe's Heron 1 Ops

Bundesamt für Ausrüstung, Informationstechnik und Nutzung der Bundeswehr of Germany has extended operations of its IAI Heron 1 unmanned aerial systems in Afghanistan and Mali until mid-2020. Heron 1 operators being carried out by Airbus Defence & Space Airborne Solutions on behalf of the German government. Under the service model contract, Airbus is responsible for provision of the Heron 1 system, together with maintenance and repair to meet an agreed availability. The Luftwaffe has been operating the Heron 1 in both Afghanistan and Mali, beginning in 2010 and 2016 respectively and more than 46,000 operational flying hours have been accumulated. The UAS capability is used to support German armed forces contingents in both countries in the detection of improvised explosive devices, convoy and patrol escort, route exploration and supervision and other military support tasks.

New Nigerian helicopters

The Nigerian Air Force are due to take delivery of six new helicopters including five AW109s and one Mi-35M, all being described as "helicopter gunships", which indicates they will be of the armed AW109M version. Nigeria plans to acquire a total of 12 Mi-35Ms and has included funding for a pair in each of the Fiscal Year 2016 and 2017 budgets. The first two were delivered in 2017 and the second pair arrived in April 2018.

Ukrainian Navy receives Ka-226

The *Viys'kovo-Mors'ki Syly* (VMS, Ukrainian Navy) has inducted the Ka-226 light utility helicopter, which was handed over to the 10th *Mors'ka Aviatsiyna Brihada* (naval aviation brigade) at Kul'bakino. The Ka-226 will be used for medical evacuation (medevac) and VIP transport. Because of its low 'footprint', this helicopter can also be employed for covert operations including insertion and extraction of special forces.

AS 565MBes for Indonesian Navy

The *Tentara National Indonesia Angkatan Laut (*TNI AL, Indonesian Navy) has received five more AS 565MBe Panther anti-submarine warfare helicopters. The aircraft were handed over by the state-owned PT Dirgantara Indonesia (PTDI) company on 24 January 2019 and were commissioned the same day during a ceremony at PTDI's facilities in Bandung. Also received was a CN235 which joins three airliner aircraft with *Skadon Udara* 800 at Lanudal Juanda.

More Mi-35Ms for Pakistan

Pakistan has ordered a further five Mi-35M attack helicopters from Russia. The Mi-35Ms will join four examples previously ordered, which were delivered to the Pakistan Army Aviation Corps in April 2018. The Pakistan Army's Mi-35s are operated by the 4th Army Aviation Squadron, based at Quetta Khalid in Balochistan.

Airliner deliveries from Boeing and Airbus

During 2018, both Boeing and Airbus set new company records for airliner deliveries. Boeing Commercial Airplanes delivered 806 airliners and Airbus 800 aircraft in 2018, according to results issued by the companies in early January 2019. The Boeing deliveries consisted of 580 examples of the 737, plus 145 787s, 48 777s, 27 767s and six 747-8s, while Airbus' deliveries comprised 626 A320 Family aircraft, 93 A350s, 49 A330s, 20 A220s and 12 A380s. Boeing's deliveries total surpassed 2017's total of 763 deliveries and Airbus' deliveries total likewise exceeded the company's figure for the previous year, which was 718 aircraft.

787th B-787 delivered

Boeing has handed over the 787th example of its 787 Dreamliner to come off its production line. The very first 787 was delivered to All Nippon Airlines in 2011 and since then, the entire 787 fleet has flown nearly 300 million passengers on more than 1.5 million flights. According to Boeing, the 787 has opened no fewer than 210 new non-stop routes since entering service. China Southern now operates ten 787-8s and eight 787-9s.

Ethiopian Airlines to establish Ghana carrier

Ethiopian Airlines will supply four aircraft in the plans to establish a new national carrier for Ghana, and becoming the majority shareholder (49%) in the as-yet unnamed airline. The Ghanaian government and private investors will hold the remaining 51% of the airline, which will take the place of the defunct Ghana Airways and Ghana International Airlines. Operations are planned to commence during 2019.

Qatar Airways invests in China Southern Airlines

Qatar Airways are investing 5% of equity in China Southern Airlines, the sixth-largest airline worldwide by passengers carried, with 84 million passengers in 2016. The partnership clearly presents an opportunity for Qatar Airways to access the fast-growing Chinese market. This is the latest investment by the Gulf carrier in airlines worldwide after it earlier purchased a 20% stake in IAG, 9.9% of LATAM and 9.9% of Cathay Pacific Airways.

CFM: record 3,337 orders in 2018

Orders for CFM International's two product lines have achieved near-record levels in 2018, with the company booking orders for a total of 3,337 engines, including 126 CFM56 engines (commercial, military and spares) and 3,211 LEAP engines (including commitments and spares). Since receiving the first orders in 2011, CFM has garnered more than 17,275 total LEAP installed and spare engine orders and commitments (excluding options) to date at a value of more than $250 billion US at list prices.

2018 marked the production transition from CFM56 engines to the LEAP product line. CFM delivered 1,044 CFM56 installed, spare, and military engines compared to 1,118 LEAP engines, which is more than double the 2017 rate. As the ramp-up continues, CFM is on track to deliver 1,800+ LEAP engines in 2019 and will reach more than 2,000 engines per year by 2020.

Airbus and Emirates reach agreement on A380 Fleet

Following a review of its operations, and in light of developments in aircraft and engine technologies, Emirates is reducing its A380 orderbook from 162 to 123 aircraft. Emirates will take delivery of 14 further A380s over the next two years. As a consequence and given the lack of order backlog with other airlines, Airbus will cease deliveries of the A380 in 2021. Emirates has also decided to continue growing with Airbus ordering 40 A330-900 and 30 A350-900 airliners.

ATR performs on target

ATR, the Franco-Italian turboprop manufacturer, maintained its leadership in 2018, showing a solid performance. It delivered 76 aircraft, booked 52 firm orders and stabilised its annual turnover at US$ 1.8 billion. With a total of 165 orders and 154 deliveries between 2017 and 2018, ATR achieved a book to bill ratio above 1. Out of the 52 firm orders, 20 are for ATR 42-600s. With around 62% of the turboprop orders for the year, the ATR -600s continues to be the 'preferred choice' of regional airlines. The 2018 results provide ATR with a solid backlog representing almost three years of production.

Six SSJ100 for Thailand

Sukhoi Civil Aircraft Company has signed a contract with the Thai Kom Airlines Company Limited for delivery of six SSJ100 with the 100-seats layout during the period of 2019-2020. Total

value of the contract is about $300 million in catalog prices. The first SSJ100 is to be delivered to Kom Airlines in Autumn 2019. Kom Airlines plans to operate SSJ100 both inside the country and abroad.

SMBC Aviation Capital orders 65 A320neo Family aircraft

Leading aircraft lessor SMBC Aviation Capital has boosted its total order book for the A320neo Family to 181 aircraft after signing a firm order for an additional 65 A320neo Family aircraft (15 A321neo and 50 A320neo). The order was finalised in 2018 and included in the year-end order figures. In addition the agreement includes an upsizing of 15 A320neo from a pre-existing order to 15 of the largest member of the single aisle, the A321neos, taking SMBC Aviation Capital's total for the type to 30.

EASA flight tests continue on the Irkut MC-21-300

European Union Aviation Safety Agency (EASA) officials have completed the first flight session of the MC-21-300 certification programme. During the certification tests, the behavior of MC-21-300 aircraft was evaluated in various modes, including high angles of attack and stalling. Flights duration from 2.5 to 4 hours were performed at altitudes from 3 to 10 km. The airliner was piloted by an EASA test pilot. In September 2018, EASA test crew completed a special course in theoretical and practical training, as a result of which they obtained permission to fly on MC-21-300 aircraft. Irkut Corporation is conducting tests of the MC-21-300 aircraft in order to obtain Russian and European type certificates. Representatives of Russian aviation authorities and industry, as well as EASA experts, are taking part in the process.

Saab RBS 70 NG for Brazil

Saab has signed a contract with the Brazilian Army for deliveries of RBS 70 NG, the latest generation of the RBS 70 man-portable air defence system. In addition to the RBS 70 NG system, the order also includes training systems, camouflage systems and other associated equipment. This is the Brazilian Army's first order of the latest RBS 70 NG version and marks a significant upgrade to their air defence capability. Their existing RBS 70 inventory has been in service with the Brazilian Army since 2014, the system having a big role in 2016 as part of the protection of the 2016 Olympics in Rio de Janeiro, Brazil.

Contracts for Carl-Gustaf M4

Saab has received contracts for the Carl-Gustaf M4 multi-role weapon system for "an undisclosed customer," the total order value being for approximately 492 MSEK with deliveries to take place in 2019-2024. For seven decades, the Carl-Gustaf man-portable

multi-role weapon system has been supporting infantry around the world in dealing with a full range of battlefield challenges. The new Carl-Gustaf M4, has all the effectiveness and versatility of the Carl-Gustaf system but its improved and lightweight design, weighing less than 7 kg, offers significant mobility for the infantry soldier.

Raytheon/LM Javelin JV awarded contract for 2,100 F-Model Missiles

The Javelin Joint Venture was awarded a production contract for 2,100 F-Model (FGM-148F) missiles, following a successful and rigorous system qualification test programme that included 21 successful flight tests. The contract launches the initial full-rate production agreement for the Javelin F-Model missile, replacing the Javelin FGM-148E (Block I).

The Javelin FGM-148F missile features an advanced multipurpose warhead (MPWH) as part of the man portable, fire-and-forget Javelin missile system.

Rafael SPIKE NLOS launched from light buggy

Rafael Advanced Defense Systems Ltd. has released a video from a firing test of the SPIKE NLOS launched from a light buggy (TOMCAR). SPIKE NLOS is a 30 km Precision Guided Missile, part of the 5th generation electro-optical SPIKE Family, operational today in 31 countries worldwide. Last year, RAFAEL unveiled a light, modular launcher for the SPIKE NLOS missile, integrated on a light buggy (e.g. Tomcar).

Raytheon support services for Phalanx

Raytheon Co. of Tucson, Arizona has been awarded an $81 million cost-plus-fixed-fee modification to exercise an option under previously-awarded contract N00024-17-C-5405 for design agent engineering and technical support services for the Phalanx Close-In Weapon System (CIWS), SeaRAM, and Land-based Phalanx Weapon System.

Naval Group to build four replenishment tankers for France

The temporary consortium formed by Chantiers de l'Atlantique and Naval Group has been notified of an order for four Logistic Support Ships (LSS) and of their first six years of operational maintenance. This order for the French Navy is part of the Franco-Italian LSS Programme led by OCCAr1, the international Organisation for Joint Armament Co-operation, on behalf of DGA, the French Defence Procurement Agency, and of its Italian counterpart NAVARM. The delivery of these ships will take place between the end of 2022 and the beginning of 2029.

Naval Group and Australia's Attack – class submarines

Naval Group has achieved another milestone in the Future Submarine Programme with the signing of the first phase of the Submarine Design Contract. The Submarine Design Contract is the first contract workscope to be fully executed under the Strategic Partnering Agreement. The scope for this phase of work includes the ongoing maturation of the Attack Class design as it progresses into the next design phase known as the Definition phase. The Submarine Design Contract also includes ongoing preparations for the build of the Attack Class in the Osborne shipyard in South Australia, including ongoing support to Australian Naval Infrastructure (ANI) for the design and build of the Submarine Construction Yard and the ICT systems that will be employed there.

IAI's ELTA Systems contract for fire-control radars

ELTA Systems, a division and subsidiary of Israel Aerospace Industries (IAI), has been awarded a $55-million contract for the provision of Multimode Airborne ELM-2032 Fire Control Radars to be installed on newly produced advanced combat aircraft. The radar offers a broad range of operational modes, including high-resolution mapping in SAR mode, detection, tracking, and imaging of aircraft, moving ground and sea targets. The contract is a repeat order, "reflecting the customer's high satisfaction with the radar and ELTA." The radar can be installed on a variety of airborne fighters and is operational in many countries worldwide.

Lockheed Martin's Miniature Hit-to-Kill Interceptor

Lockheed Martin is developing a new air defence interceptor called *Miniature Hit-to-Kill* (MHTK), which essentially takes components from core technology the company developed for the combat-proven Patriot Advanced Capability-3 (PAC-3) and Terminal High Altitude Area Defence (THAAD) weapon systems and miniaturised this to address the Counter-Rocket, Artillery and Mortar (C-RAM) threats.

«MHTK provides unmatched levels of accuracy, lethality and assured defeat for C-RAM threats. To shrink the technology behind the missile, Lockheed Martin looked to the defence industry for inspiration, then applied the core principles of hit-to-kill capability, seeker accuracy and missile agility to focused problems."

On-the-spot report from NAS North Island

US Navy's MH-60R and MH-60S helicopters

Naval Air Station North Island is home base of US Navy West Coast MH-60R and MH-60S helicopters. Patrick Dirksen and Frank Mink were invited to two squadrons at NAS North Island to be briefed on the US Navy helicopter fleet, one flying the S or Sierra and the other flying the R or Romeo version.

The MH-60S version is successor of the CH-46D helicopter. Helicopter Sea Combat Squadron HSC-14, nicknamed *The Warriors*, are equipped with the latest model MH-60S Block 3B *Knighthawk*.

MH-60S taxies in after landing

MH-60S nose detail shot

HSC-14 is attached to the Carrier Air Wing 9 with the carrier USS *John C. Stennis*. During deployment on the carrier, the MH-60S fulfils a multitude of tasks. "We are responsible to have a plane guard airborne, whenever fixed wing operations off the carrier are ongoing; our bread and butter. Aircrew are ready to jump off the helicopter to recover downed aviators or sailors overboard" stated one of the pilots of the squadron. Apart from these missions, the MH-60S is used for vertical replenishment tasks within the strike group. It also performs medical evacuations from ships when needed.

Maritime Strike Coordination and Reconnaissance (SCAR) missions are often flown as when the carrier group sail through restricted water passages. The MH-60S is the primary defence for the carrier in a two mile zone around it. To deal with any threat, the helicopters are equipped with various weapons such as a fixed M197 20mm Gatling gun or M299 launchers with 4 pack Hellfire missiles to door mounted M240D machine guns and GAU 21 20mm guns.

For Naval Special Warfare (NSW), the spacious MH-60S cabin holds a team trained to deploy on ships or oil rigs. These teams can be inserted by a fast rope attached to the hoist. A small Combat Rubber Raiding Craft (CRRC) can be placed under the helicopter. The MH-60S is also used for paratroop operations by SEAL teams and as a sniper platform as well. During NSW missions, the MH-60S also provides close air support and casualty evacuation.

MH-60S of HSC-14 Chargers

MH-60S crewmember

At home base, HSC-14 is always ready for on–call disaster response. To fight fires, the MH-60S can be equipped with a Bambi bucket which contains up to 530 gallons of water.

Anti-surface warfare is performed by Recognised Maritime Picture (RMP) missions, often ordered by the Strike Group Admiral for a clear picture of what is around his Group. Important is the cooperation between the MH-60R and S versions. The MH-60R is packed to teeth with sensors and can direct the MH-60S to a specific target to strike.

Helicopter Maritime Strike Squadron HSM-75, called *Wolfpack*, has anti-surface, anti-subsurface, command and control, magnetic detection and early warning tasks as its missions. The SH-60B Seahawk was predecessor of the MH-60R Seahawk and was exclusively used on US Navy frigates and destroyers. With introduction of the Romeo, HSM-75 is also deployed on carriers.

The MH-60Rs of HSM-75 are equipped with the APS-153 multi-mode radar system, a huge improvement over the previous APS-147 system. The APS-153 is mounted in the radome beneath the cockpit and is the primary sensor for surface warfare, tailored for maritime operations.

Another powerful sensor is the AQS-22 Advanced Airborne Low-frequency dipping sonar, for anti-submarine warfare (ASW). The acoustic information is interpreted by the sensor operator who sits behind a workstation in the cabin. A sonobuoy launcher is situated on the aft left side in the cabin, with 25 buoys launched by an air pressure system. Depending on the mission, the sensor operator can choose from three type of buoys. The SSQ-53 is a passive buoy that has a hydrophone to locate targets. The SSQ-62 Directional Activated Sonobuoy System (DICASS) is an active buoy which can be remotely operated. The MH-60S can also carry up to three lightweight ATK Mk.46 or Mk.54 torpedoes to attack sub-surface targets.

Both the cockpit crew and the sensor operator have mission displays for all acoustic info, camera and radar images and early warning information. Apart from sharing sensor information onboard, the MH-60R can communicate via UHF, VHF, maritime radio and SATCOM, and also sensor data with others via Link 16.

The MH-60 Romeo and Sierra both have the same Lockheed Martin cockpit avionics suite. Four multi-functional displays provide flight and tactical data. The cockpit is equipped with dual hydraulically boosted flight controls. To gain situational awareness at night, the crew have helmet mounted ANVS-9 night vision goggles and the cockpit is NVG capable.

For self-defence, a Countermeasures Dispensing set contains an AAR-47 missile and laser warning set, ALQ-144 infrared jammer and ALE-39 chaff and flare dispensers. The ALQ-210 Electronic Support Measures system provides situational awareness and threat warning. Engine exhaust deflectors decrease the heat signature of the helicopter and the dull grey paint scheme also absorbs radar energy.

Text and photos: Patrick Dirksen and Frank Mink from Tristar Aviation

We would like to thank the Naval Air Force Pacific Fleet PAO, the crew of HSM-75 and HSC14 for their assistance.

MH-60R head on shot


MH-60R with radome and FLIR

Visiting

Italy's 5th Army Aviation Regiment 'Rigel'

An AH-129D provides overhead cover for an UH-90A

A cockpit view of the UH-90A clearly showing the multi-functional colour screens

19 June 2018 marked the 100th death anniversary of Francesco Baracca, the undisputed ace of Italian aviation in the First World War. In 1972, to honour this legend, the Italian Army named a small airfield after Francesco Baracca, located just west of the town of Casarsa della Delizia.

Aviation Regiment

As Cpt Marinoni, squadron commander of the 49th Attack Helicopter Squadron, explained, "The 5th Regiment was created in 1976, when the 5th Light Airplane Unit and the 5th General Purpose Helicopter Group were merged. The unit was initially called the 5th Aviation Group *Rigel* and with some changes over the years, was restructured in 2003 to the current organisation and was named 5th Army Aviation Regiment Rigel." The unit consists of three different squadrons: the 49th Attack Helicopter Group *Capricorno,* flies the AH-129C and D model and the 27th Multi-Purpose Helicopter Group *Mercurio,* flies the UH-205A and UH-90A. Third is the Support Squadron which consists of the helicopter maintenance and the general support group.

Operations

Over the years, the 5th Army Aviation Regiment "Rigel" has been involved in many national and international operations and the unit awarded with silver and bronze medals for participation in rescue operations after earthquakes that hit Italy in the Friuli

Flying in close formation is key during operations

area in 1976. An additional silver medal was awarded for its uninterrupted support in mountain rescue service during 1976 to 1984. A fourth medal, another silver one, was awarded for operations in 1991-1993 during the conflict in Yugoslavia, where the unit was intensively involved. Cpt. Marinoni stated, "During this operation, one of our UH-205s was shot down near the village of Podrute, Croatia, by a Serbian MiG-21. Unfortunately, all crew on board lost their lives".

In early 2012, the Italian Army sent five UH-90A helicopters to Afghanistan at the disposal of ISAF (International Security Assistance Force) command to replace the UH-205As which had been in theatre for some time. With Resolute Support Mission (RSM) comming down in Afghanistan, the Italian Army is slowly lowering the amount of support needed in the area. Cpt Marinoni stated, "The current deployment is not supporting Quick Reaction Alert (QRA) or resupply missions anymore, because of the progressive stabilisation of Afghanistan and the changeover from ISAF to RSM in 2015. Without Italian Forces being in forward operating bases, we haven't had any more reason for these kinds of missions". Nevertheless, the AH-129C/D and UH-90A are still involved in fire support, forward MEDEVAC, personnel recovery and airlift missions.

During deployment in Iraq, for Operation *Inherent Resolve* (OIR), the United States had asked the Italian Army to provide personnel recovery capability together with the US Forces. Cpt Marinoni stated, "We were the only foreign asset in the theatre embedded into a completely US organisation as all other personnel recovery assets were US". These missions were flown in a standard configuration of two Mangustas and two UH-90s, carrying an extraction force to rescue downed pilots. "Since 2017, we have not been

One of the UH-205's was painted in a special colour scheme which was applies for the anniversary of Francesco Baracca

The AH-129D was introduced in 2014 and includes a new targeting system incorporated in the nose turret

The gunner uses the helmet mounten sight for the M197 three-barrel Gatling-type cannon

The UH-90 and AH-129 have been operating together in the battlefield for several years

operating the Mangusta anymore in Iraq in support of OIR because after the defeat of ISIS, there was no need for the attack helicopter in the area. We are not involved in personnel recovery missions anymore, but only the airlift missions with the UH-90A," added Cpt Marinoni.

The authors would like to thank Cpt Marinoni, Maj. Colucci and all ground and flight crew from the 5th Army Aviation Regiment for their support in writing this article.

Text and photos; Erik Bruijns and Mark de Greeuw

The UH-90A is a state of the art helicopter giving a welcome boost to the Italian Army

At Flugplatz Manching

German military test flying and WTD-61

Flugplatz Manching, located north of Munich in Germany, is not known to be a heavily used air base. Having the German Defence unit "Bundeswehr Technical Center for Aircraft and Aeronautical Equipment" or so called *Wehrtechnische Dienststelle 61* (WTD 61) and the civil test unit of the Bundeswehr on its premises, there are only a few flights daily. Manching however has an Airbus Eurofighter production line and some factory maintenance facilities.

Unit and aircraft

WTD-61 test pilot Lieutenant-Colonel Rolf E., a former Luftwaffe Tornado pilot, explains that the unit has only few aircraft in its inventory, and recognised by their "98+" serials, the bright blue WTD-61 badge and/test markings. In the past, the aircraft also sported an orange livery, stressing their unique test activities. Some of these aircraft are preserved at Manching, like an F-4F Phantom and Tornado.

Depending on the test projects, additional aircraft can be temporarily assigned to the unit. Current aircraft with WTD-61 are an Eurofighter, five Tornados, an Transall, one UH-1 MAT *(Mission Ausrüstungs Träger* or Mission Equipment Carrier), one UH-1D, two CH-53Gs and one Tiger. In the future, it is expected that some latest Luftwaffe assets, the A-400M transporter and NH-90 helicopter will join the test unit. At Manching, some non-flying test aircraft exist which are used for technical education purposes at the "WTD-61 Berufsausbildung".

The single Eurofighter is Instrumented Production Aircraft (IPA) 3 and two more IPAs are expected at WTD 61, namely IPA7 and IPA8, currently operated by Airbus itself. The IPA3 Eurofighter differs from normal production aircraft by its advanced metrological flight test instrumentation recognised by the orange colored branding. To gain space for the test equipment, some operational systems have been taken out, including the integral cannon.

Test pilots

To learn more about activity WTD-61, Lieutenant-Colonel Rolf E. explained how recruitment is made to join the special unit. An applicant WTD-61 test pilot has to have the basic operational flying hours, technical qualification, preferably aviation or space orientated and age. The test pilots have to adapt on flight essentials of a new aircraft. Test pilots have to meet the Qualitative Flight Testing (QFT) principle, determining the maximum amount of information in the minimum amount of flying time in order to evaluate an aircraft with respect to its entire mission or some specific area of interest. Lt. Col. Rolf made it clear that being a test pilot, one is certified to fly aircraft prototypes, including programme

Eurofighter IPA3 prepared for new test flight

Eurofighter IPA3 prepared for new test flight

Final WTD-61 flight of F-4F Phantoms in 2013

The F-104G is a former test aircraft now used for technical education

WTD-61 testpilot Lt.Col Rolf E.

Tornado used as testbed for software upgrades in continues project ASSTA 3.1

elements that go beyond the aircrafts' technical limits. Annually, at least 70 hours have to be flown to remain qualified and not limited to a specific aircraft type. WTD-61 has about 30 test pilots and it can be difficult to achieve required annual flying hours using the few aircraft of the unit and the test projects. Therefore, pilots regularly join normal Luftwaffe units, or make "flying hour" contracts within civil companies or organisations. Furthermore, exchange agreements are made with international test pilot schools in the US, Edwards AFB as well as the US Naval Test Pilot School at NAS Patuxent River, the Empire Test Pilots School at Boscombe Down, UK and EPNER at Istres in France.

Retired Tornado still in use at the technical school

Unit roles

Some current projects include a self defence protection system for the A-400, Eurofighter Operational Developments Intime for NATO (ODIN) project and the Tornado's continuous upgrade programme *Avionics System Software Tornado Ada* (ASSTA) 3.1.

Lt.Col. Rolf also explains that WTD-61 gives inputs and advise to Luftwaffe on procurement decisions including on the recently ordered Airbus H-145 LUH SAR (Light Utility Helicopter Search and Rescue) helicopters to replace the Bell UH-1D. Last but not least, the unit has a major role in aircraft incident and accident investigation. WTD -61 can execute an identical flight by simulators for additional examination and assessment. The most recent example of such investigation can be found in the present airframe at Manching of the Norvenich Eurofighter which was involved in a mid air collision with a GFD Learjet in the summer of 2014.

Text and photos: Peter ten Berg

Tiger helicopter being tested with additional cockpit protective plating

Ancient Aviator Anecdotes

Air Vice Marshal Cecil Parker recollects...

An Exchange of Wings

As they mature and grow, most effective organisations develop their own traditions. Our air force, now in its 87th year (like this writer), grew out of the RAF, into the RIAF and finally into an independent IAF. It initially adopted many policies and procedures from its mother – service and thereafter, with experience, developed its own. Unlike policy and procedure which is normally reduced to writing, tradition is more informal and generally passed down from one generation to another, its longevity being dependant upon its value. As a young flight cadet in 1951-52, I learned about one of them pertaining to 'exchange of wings'. Here is the story.

My co-pupil (Jaypee) and I were from the same college, were in the same batch for our selection/medical boards, were selected for the same pilots' course and were pupils of the same flying instructor, Navroze Lalkaka. 'Lally', as he was known to his peers, was an absolute gem of an officer, gentleman, pilot and teacher. His USP was undoubtedly his love of flying; he inculcated this attribute in both of us while teaching us its skills. For 18 months we benefitted from his patient dedication to the imparting of skills, knowledge and attitude both inside and outside the cockpit.

As our graduation neared, we learned from our seniors that, on receiving our 'wings' we should gift them to our flying instructor who in turn would pin his 'old' wings on us. This exchange of wings was a symbol of gratitude and respect quite in line with the tradition of our guru-shishya relationship. On 30 August 1952, on the tarmac of Begumpet airfield, 30 of us from No. 58 Pilots Course were commissioned and received our wings from Air Vice Marshal Subroto Mukherjee the then DCAS. After the parade was over, Jaypee and I marched up to Flt Lt Lalkaka, handed our wings over to him, after which he pulled

out two used wings from his pocket and pinned them on us. This private little ceremony was observed by my parents (who had flown down for the POP) and a specially-invited young lady (now my wife of over 63 years). Lally explained the significance to them,

Three years later, as a flying instructor myself, I continued this tradition with my pupils. As the years passed I gradually learned more about the practice of this custom among fliers around the world. During *Ex Shiksha in* 1963 we exercised with three other air forces, being the RAF, RAAF and USAF. I was then the flight commander in a Hunter squadron based in Palam co-located with an F-100F squadron of the USAF. The USAF offered a familiarisation sortie in the Super Sabre and I was delighted to be 'detailed' to accept it. I was taken up by my counterpart and thoroughly enjoyed my very first experience of a re-heat engine and going supersonic in level flight. The next day the IAF returned the gesture and I took the same pilot up in the Hunter T.Mk.66. On landing we exchanged wings and trophies in the presence of both commanding officers.

While on a flying course in the USA in 1965, I had occasion to exchange wings with my instructor there. In 1980 while attending a course in the UK I had the opportunity for familiarisation flights in the Hawk and the Harrier T.4 in Germany; we pilots exchanged wings.

After an informal meeting at the RCDS, I received an invitation from the Israeli air attaché in London to lunch in his embassy. Though it involved no flying, we had a most useful exchange at the end of which I presented him our IAF wings. He immediately removed the wings from his uniform and presented them to me. I may add that, at that point of time, we were yet to recognise Israel!

As the Commandant of our Air Force Academy in 1983-85 I ensured that this tradition was made known to the pilot trainers and trainees. As to whether it still exists, I do not know. I sincerely hope that it continues as it is a small professional gesture that promotes understanding, friendship and goodwill, not only between individuals and organisations but also, by extension, between countries.

Wheeling Down Memory Lane

As a teenager in the 1940s, I received my first driving lessons in my father's Ford Prefect, but of course was never sent solo. Like most of the youth of my generation, my individual mode of mobility was the bicycle. It served me through school, college, 18 months as a flight cadet and thereafter 12 months as a Pilot Officer in my first unit, No 7 Squadron on Vampire aircraft 1953-54. I used to gaze with admiration and envy at the line-up

of Harley Davidsons, Triumphs, Indians, Royal Enfields and Matchless motor cycles of my seniors parked behind our flight office alongside my cycle. In 1953, as a newly promoted Flying Officer on my 21st birthday (with generous help from home) I took possession of a 3.5 hp BSA Golden Flash motor cycle. History does repeat itself as, on our son's 21 birthday (40 years ago), we also gifted him a Yezdi motor cycle.

My BSA served me well through my bachelor days and first year of marriage. In 1957 we acquired the first of three pre-owned cars that kept us mobile for the next 15 years. It was a six-year old, four door Morris Minor bought in Hyderabad (APX 2008) on which my wife got her driving license and then took over the family driving. The next was a four-year old Fiat 1100 from Delhi (DLE 2538) whose diplomatic number plate helped me out in one or two encounters with the traffic police in no-parking areas (pun intended!). The third was a two-year old Ambassador from Lucknow (UPD 6868) which 'saw action' in Pathankot in the 1971 Indo-Pak war and which, in 1973 stayed in the family as it passed on to my young brother as his first wheels.

That same year we bought the first of five new cars which were to keep us on the road for the next 45 years. It was an Ambassador from Coonoor which stayed with us for a shade over 17 years. This period covered the end of my air force years (AOC J & K 1985-86) and a decade of post-IAF activities in Mumbai and Hyderabad. With final retirement in our home in Secunderabad in the 1990s, we acquired our first Maruti 800, replaced later by its air-conditioned model and followed by the Wagon R. In 2009 we purchased our present car, the Maruti Ritz which, unarguably is the best of our eight cars. Though now nine years old, with under 22k on the clock, we are reluctant to change it for a newer model. For me personally over the years, the wheel has come full circle from two wheels to three wheels (tricycle undercarriage of all the aircraft I flew for 35 years) to four wheels and now back to two wheels as I have just had my very first ride in a wheel chair!

An update: Regular readers of this AAA column will recollect my last anecdote titled 'Reflections on a Blue Shirt' which incidentally received some heart-warming responses from friend and stranger alike. Two responses from my family might be of follow-up interest.

Till she read the article, my wife had no idea that a 66 year old, faded, frayed shirt was in my wardrobe. She unearthed it, declared it totally unhygienic and promptly disposed of it. She then kindly thanked me for solving her gift problem for my forthcoming 86th birthday. (My guess is that it will be a new blue shirt and not a new blue car!).

The Saving of Chander

December of every year takes me back to 1971 and the Indo-Pak war. I was then a wing commander in command of No.20 Squadron equipped with Hunter Mk.56A aircraft based at Pathankot and tasked primarily with counter air operations. My pilots log book reminds me of the sorties I personally led attacking PAF air bases at Peshawar, Mianwali, Murid, Chaklala, the Attock Oil Refinery plus close air support in Chhamb and Poonch sectors. To this list should have been added the PAF forward airfield at Chander; this anecdote will relate a little known story.

In the first week of December 1971, Air Cmde LM Katre who had been sent to control air operations at Pathankot, asked Wg Cdr Johnny Greene the CO of No.2 Squadron with Gnats at Amritsar and myself to a confidential briefing in his office. He had been informed that the PAF airfield at Chander had to be neutralised on a date and a time to be notified by higher authorities. My squadron had been tasked to bomb the runway at Chander with eight aircraft each carrying 2 x 1000 lb penetration bombs. Tactically, in the relatively short distance to Chander, we were required to climb to 10,000 ft, drop speed, get into line-astern about 1000 yards apart and deliver the bombs in a steep dive along the length of the runway. Since we would be highly vulnerable, four Gnats would give us top cover from Amritsar, which I would overfly enroute the target and cover us for four minutes over Chander before they would have to return to their base. For security purposes this plan was referred to as Mission 548 and restricted to a few need-to-know individuals.

Johnny and I carried out a mutual briefing covering communication, codes, tactics and I assured him that I would be over Amritsar 15 minutes before TOT (Time on Target). Midway through the second week we received the date and TOT (1630) for Mission 548 which gave my ground staff just enough time to provide 8 (+1 standby) aircraft armed as required. I had obtained some very basic intelligence on the target (R/W orientation, elevation, layout etc) but I had a good professional team both in the air and on the ground. As we taxied out and neared our own R/W at 1600 hrs, I asked for stream take-off in pairs but was told abruptly to 'Hold position'. I was deeply concerned as we had nine aircraft sitting on the taxy track though two local Gnats were capping the airfield for our take-off. Then came an authoritative voice on the radio, 'Cecil, Katre here, return to your dispersal where I will be waiting for you'. We taxied back rapidly and over a cup of tea he explained that he had just received a flash message to say that high level cease-fire talks were in progress and meanwhile no offensive actions across the border were to take place after 1600 hrs.

In his book 'In the Ring and Standing' Air Cmde Kaiser Tufail of the PAF paid a compliment to No. 20 Squadron with particular reference to our strike on Murid on 8 December where the PAF lost five aircraft on the ground. Though our RV (rendezvous) with the Gnats over Amritsar never took place, on the suggestion of my pilots soon after the war, we, along with our families, drove down to Amritsar, made our obeisance at the Golden Temple and gave thanks, though tinged with some regret at the last minute cancellation of Mission 548 which saved Chander.

25 Years Back

From Vayu Aerospace Review Issue II/1994

Successful launch of Agni

After the twin failures on 29 May 1992 and 7 January 1994, third launch of the Agni test vehicle was successful which was aimed at achieving longer range. Also tested was its advanced manoeuvrability during re-entry phase of the flight for greater accuracy in guiding the payload to a designated target at long range. This successful test-launch of the Agni missile comes at a very apt moment in India's larger national endeavours and due credit must be given to the Defence Research and Development Organisation (DRDO) for resolving last-minute snags leading to full attainment of all the mission objectives.

BSF Air Wing modernisation plans

The Ministry of Home Affairs is working on a modernisation plan involving replacement of the old Avro aircraft for the over-stretched Air Wing of the Border Security Force. The plan envisages replacement of its three Avros with 30-50 seater fuel-efficient turbo-prop aircraft. The BSF had replaced three of its six Avros sometime ago with Beechcraft King Airs, but a Committee also asked to identity a short-haul, economically viable aircraft for the BSF, with the Ministry of Civil Aviation suggesting HAL-Dornier 228s which were being operated by *Vayudoot* before its merger with Indian Airlines. Besides routine internal security duties, BSF aircraft are used occasionally to provide support to the Aviation Research Centre, attached to the cabinet secretariat.

East-West expansion plans

East West Airlines are planning to double their fleet strength to 20 by acquiring 10 more aircraft this year. The Airline, which presently operates 70 flights to 25 destinations, plans to introduce flights to new sectors such as Madras-Vizag-Calcutta, Bombay-Diu-Porbander, Bombay-Ahmedabad-Pune-Madras, Goa-Agra-Goa, Calcutta-Bangalore-Goa, Delhi-Agra-Khajurao-Varanasi and Delhi-Jammu-Leh-Jammu-Delhi.

Defence Outlay for 1994-95

The total Defence Budget for 1994-95 has been fixed at Rs 25,963.87 crore, which is about 19.88 per cent higher than the Rs 21,814.49 crore budgetary estimates for 1993-94. However, part of this increase was provided for in 1993-94 itself with the revised estimate for 1993-94 at Rs 24,291.91 crore higher than the budgetary estimate of Rs 21,814.49 crore by 11 per cent. The expenditure on the Air Force for 1994-94 has been fixed at Rs 3,618.33 crore against the budgetary estimate of Rs. 3,064.49 crore for 1993-94. The expenditure on the MoD and DPSUs has been fixed at Rs 257.87 crore in 1994-95.

"AJT decision will take time"

In a first public reference ever by the Indian Prime Minister on the BAe Hawk being considered for the IAF's Advanced Jet Trainer (AJT) programme, PV Narasimha Rao said while visiting Edinburgh that "we do not come on visits armed with decisions. These things take a certain time". Some UK media had earlier stated that Mr Rao's visit to Britain had been "tempered by India's continuing refusal to clinch a deal for the 66 Hawks, worth some one billion pounds". It was recalled that during the British Prime Minister's visit to India in early 1993, there was some lobbying done for the Hawk but "pressure did not work then and it will not work now".

"Those" F-16s for PAF cleared ?

Formal moves are afoot in Washington to clear the supply of Lockheed-Fort Worth manufactured F-16s for the Pakistan Air Force, thereby amending the 40-month-old Pressler Amendment, Pakistan Government making "verifiable capping" of its nuclear weapon material production capability. US State Department sources confirmed in Washington that although there was "no deal yet", the clearance for supply of 38 F-16s on a one-time exemption was being discussed. Congressional approval will have to be taken which will probably witness much opposition but the State Department insists that the object of supplying Pakistan with the F-16s on order was to prevent nuclear proliferation, even if India would see this as a pro-Pakistan tilt by the USA.

France orders more Rafales

Dassault Aviation has received a second production order from the French defence ministry for two single-seat Rafale M Naval fighter and one Rafale B twin-seat fighter, destined for the Air Force. The latest award follows the March 1993 production order for one M and one B variant. The first delivery a Rafale M for the navy is due in 1997, with the air force receiving its first aircraft by 2000. The French Government has come under increasing criticism from Dassault, as well as the other companies involved in the Rafale, for allowing the orders to "trickle out". They claim that small orders hamper production management and could lead to higher costs.

UK/Sweden in MoU on Gripen

The UK and Swedish Governments have signed a memorandum of understanding (MoU) which will form the framework for British Aerospace and Saab to co-operate on defence projects, initially concentrating on Saab's JAS39 Gripen fighter. With the Gripen, BAe is poised to market the aircraft in return for manufacturing and development work. Other areas of co-operation which may emerge include providing weapon systems for the Gripen. In this area, BAe Dynamics, offering its Active Skyflash, French manufacturer Matra, which is offering its Mica, compete against US firm Hughes, which is offering its AMRAAM to fulfil the medium range air-to-air missile requirement on the fighter.

Tale Spin

Life imitates art (postage stamp)

India Post issued a first day cover with stamps to mark 12th Edition of Aero India. The attractive stamps had women pilots flying civil aircraft (Airbus and Dornier) and indeed there were many young ladies at Yelahanka sporting IAF wings, having trained on the latter type (see photograph). However, there have been no women pilots flying the Sea Harrier nor the LCA Tejas (yet).

But let's wait and see !

Vayu at Bengaluru

Not only were the *Vayu Aerospace Review* and its *Show Dailies* widely distributed at Yelahanka during

the Aero Show but visitors arriving at *Kempe Gowda* international airport, Devanahalli had the option of travelling downtown in public buses called *Vayu Vajras*, or 'Air Thunderbolts', if literally translated from the vernacular.

Hope the drivers were not that thunderous !

Balakot – now the Bollywood movie

26 February 2019 saw the *Bharatiya Vayu Sena* attack terrorist camps in KPK and tangle with the *Fiza'ya* over the Pir Panjal the next morning. Wags

have it that the fighters had barely recovered to base than producers in distant Mumbai were rushing to register the title *Balakot* for their next Bollywood movie.

No guesses as to the Hero !

Pak donkeys for China

"Pakistan, which has the third largest donkey population in the world, will export donkeys to China, opening the avenue to earn millions from the trade. Donkeys

are highly prized in China, especially for their hide, which is used to manufacture traditional Chinese medicines. Gelatin made from donkey skin has been long considered to have medicinal properties in China, traditionally being thought to nourish the blood and enhance the immune system".

News item in the Hindustan Times.

Afterburner

SU-30MKI

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