# वैमानिकी दर्पण

9th Edition

## DGAQA MAGAZINE ON AVIATION QUALITY ASSURANCE


MAKE IN INDIA

**ENSURING FLIGHT SAFETY THROUGH QUALITY ASSURANCE**

आज़ादी का अमृत महोत्सव

# Inside



Articles/ suggestions may be sent to Senior Editor on email ID-dirtc.dgaqa@gov.in.
Every Article forwarded may be accompanied by a brief bio data and passport size photograph of the author.

The opinions expressed in this magazine are the personal views of the authors and do not reflect the official policies of DGAQA. The Editorial Board reserves the right to make any improvements/ changes in the manuscripts.

# सम्पादकीय

As we enter the third year of publication of "Vaimaniki Darpan", we find ourselves on the cusp of the advent of aircraft manufacturing by private sector in India - an event, developments on which are being closely monitored by even the Top Most Levels in MoD since its success will herald a new era in Defence Aviation Manufacturing in our country. The onus of transforming DPSUs centric procedures to the enabling regulatory provisions for private sector, encompassing the best global practices, has fallen on the shoulders of DGAQA. And, we, in DGAQA are wholeheartedly committed to support the 'Make in India' initiative of GoI. Against this backdrop, under the able guidance of Shri Sanjay Chawla, Director General AQA, initial meetings were held by DGAQA with Airbus and TASL for 'Make in India' portion of C-295 aircraft project. This edition's photo gallery carries the photograph of the exchange of greetings between DGAQA & AIRBUS and DGAQA & TASL, and the photograph of C-295 aircraft model adorns the cover page of this edition.

As Quality Assurance specialists in Defence Aviation manufacturing our officers deal with the activities as diverse as "documentation, procedures, Quality Management System etc." and as specialised as "inspection of precision components, electronics, PPFOL etc". This edition carries a good mix of articles on varied subjects like Documentation, UAVs, PPFOL, ESS, COTS, IPR etc.

Shri A Chandrasekaran, Director (Aircraft & Aeromed) has, for the past 03 editions, been enriching our readers with his enlightening articles on his AQA experiences of last 25 years. In this edition, he has come out with his AQA experience on the helicopter projects, a must read for all those interested in the Rotary Wing Platforms.

By the time this edition reaches our readers, our country will be in the midst of patriotic fervour with हर घर तिरंगा Programme of GoI :

"विजयी विश्व तिरंगा प्यारा, झंडा ऊँचा रहे हमारा"

राजेश यादव
निदेशक

# 25 YEARS (1996-2021) REWIND 4.... MY QA PATH

**A Chandrasekaran**
Dir (A/c & AeroMed)
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My HQ posting at New Delhi (2013-2017) added to my past practical experiences in various ToT projects and it was useful for the procurement of Aircraft/ Helicopters in the Capital acquisition through FET, CNC etc. These facilitated more interaction with IAF project/plan team and other customers such as Army Aviation, Naval Aviation and Indian Coast Guard.

**Helicopter Projects (2017-2019)**

As I acquired more technical expertise from the OEM ToT projects, I became more interested in working on Indian projects and got an opportunity to work on ALH and LCH projects.

When I was posted to ORDAQA, Bengaluru from Head Quarter DGAQA, my choice was to work in the Indian fighter project i.e. LCA, but ADG(SZ) decided to post me to the Indian helicopter projects as there were a lot of issues with multiple customers. My HQ experience also added to my exposure with all customers and I took it as a challenge to work on Indian helicopter projects.

During my QA path, I observed that no one rejects Quality but they only ignore it. I am delighted to share some of my key observations brought out during re-verification stages(Memo), Surveillance/Spot checks and Quality Audits.

**Chetak Helicopter:**

During Surveillance inspection, I observed that the newly built cockpit structure of Chetak was kept over sand bags instead of a trestle to take the load and keep it in its shape. I issued a Level 1 enforcement action as CAR. Additional trestles were procured by the shop to correct the deficiencies highlighted by me. Using the requisite infrastructure builds the Quality of the product itself.

On another inspection, I instructed my junior to find out the rejections of parts/components during servicing of Chetak helicopters from various shops. One day, a junior officer (SSA) brought a lower arm bracket that was rejected due to a deep cut mark when the helicopter was inducted for servicing. In Chetak, the cockpit and tail boom are mainly connected with two upper arm brackets at the top and one lower arm bracket at the centre of the bottom. The main contractor didn't carry out any study on the rejection but simply changed it while the helicopter is brought for servicing. As a QA person, it was quite alarming to me, so I carried out a detailed study and observed that unauthorized repair of panels lead to dimensional discrepancies and did not meet the gap requirement which further resulted in less clearance and rubbing between panel and lower arm during service exploitation. Based on this study, a STI was issued to carry out One Time Check (OTC) on all Chetak helicopters and all defective brackets and panels were replaced. Continuous vigilance yielded the results which averted one of the most serious flight safety ramifications.

**Cheetal Helicopter:**

I was always attracted by any unsafe practices inside the factory premises which affects the product quality and I would issue a spot check observation in the form of level 1 enforcement action. One such incident was when I noticed a fully finished tubular structure tail boom (has nitrogen filled tubes) of Cheetal in an overhanging position being transported in a Jumbo vehicle to the Store. Due to the bad road condition the Jumbo vehicle and the tubular structure would undergo vibration and may get

damaged before packing and despatched to the User. I advised the shop people to transit the critical structure in the fixture so as to achieve the desired product quality.

One day, there was a ferry of New Cheetal helicopters to Army Aviation. I went to the flight hangar and saw the Army pilots were waiting. I quickly verified the flight documents and walked around the helicopter to see the tail blade and structure area of the helicopter that was to be taken on a ferry flight. Suddenly, one of the fork strutsin the bottom structure attracted me and I observed that there was less thread safety in it. When I verified it further, a few more areas also had less thread safety. So, I didn't issue a 1090 for the ferry flight. I called the operator/ Inspector to confirm the correct size bolt was only used. On further examination, it was observed that the bolt was the correct size but the bracket step was not maintained correctly at the machine shop to achieve the safety thread at final assembly.

**Advanced Light Helicopter (ALH):**

I observed that ALH has comparatively more avionics LRUs than Cheetal and Chetak helicopters. ALH is a completely Indian project compared to Cheetal and Chetak which were built under ToT. There were multiple deficiencies in various aspects of aircraft manufacturing like design, infrastructure, processes and documentation.

**Establishment of new LRU storage:**

Generally, I select areas for audit where improvement is really necessary. The audit in LRU Storage attracted me after I completed a couple of spot checks and found many non-conformances, which resulted in a detailed audit. I learnt from the Hawk project that M/s BAE Systems, UK made a detailed Storage Matrix for all types of LRUs viz., Mechanical, Electrical, Avionics etc. I prepared an audit questionnaire to aid the shop and QC with the audit process. After the audit, it was observed that the LRUs storage setup was created for Cheetah, Cheetal and Chetak but it was not upgraded to accommodate LRUs in respect of ALH. The audit recommended augmenting the storage facilities of LRUs so that the same can be used for future projects also. This yielded good results to have a new LRU storage facility at the main contractor premises. I always believe that better preservation and storage of LRUs

**ii) Introduction of Alignment fixture:**

I was always very interested in investigating the defects raised by the User. I used to study the problem and prepare the necessary material before participating in any DI committee. One day, I was going through a letter received from EME Aviation insisting on further study on the case of bracket cracking in ALH. STI calls for crack checks at every 50hr on this bracket (LH & RH) and cracks are observed in many cases. I started digging the old DIR and saw that the

finding was concluded as crack due to crimping during sheet metal work. Further, a crack check was introduced in the process. On verification of documents and interaction with shop personnel, no crack check is generally called for at this stage as it will not get cracked. Then, I asked the DI Committee to reopen the case considering the further fitment of brackets on the structure by riveting which was not addressed by DI Committee on the earlier DI report. Brackets (LH & RH) fitment on the structure was studied at the structure shop by the DI team. It was observed that there was no alignment tool or fixture used to rivet both the brackets on the critical structure where the bell crank lever is placed in between the brackets (LH & RH). It is obvious that such mounting brackets generally come with a single piece in a machined part fitted with a bolt mechanism whereas in ALH, it is a sheet metal part.

The process deficiency was deliberated in detail and the designer finally proposed an alignment fixture for brackets (LH & RH) to avoid misalignment which was the cause for the bracket getting cracked after 50 hr. This investigation brought out that valid tooling and processes are of prime importance to achieve the desired product quality.

**iii) Full revision of water tightness test schedule:**

The re-verification stage of this test was offered but instead it was found out that the development schedule was only followed so far during production. I was shocked to see that will certainly yield assigned design life and further avoid premature withdrawal to certain extent.

The acceptable limit of water accumulation at various areas was not given, instead it is stated to check and report the value to the design department. Then, I raised why we should report something to design when we are in the production stage. Ideally, the leak data should have been mapped during the design phase which appeared to not be done. Based on my queries, the entire test schedule was revised by the Airworthiness authority. This test schedule revision was helpful to identify and arrest the leak so as to achieve the desired Quality.

**iv) FOD Prevention and Control:**

Repeated observations of FOD inside the helicopter during re-verification stage alerted me for a surveillance inspection to the operator tool box which revealed that it was holding excess fasteners and unauthorised tools. This necessitated me to introduce a FOD display board for every production helicopter to create awareness among operators and inspectors. Further, the operator's tool box was properly indexed with available tools.

This surveillance activity improved the workmanship and created awareness to control/ curtail the FOD inside the ALH.

**Light Combat Helicopter (LCH):**

I was very much proud to be working in the initial phase of Production LCH and successfully complete the first LCH structure during the end of the tenure at helicopter projects.

This concludes my four part series of my experiences throughout my career from 1996 to date. I thank our Director General for giving me the opportunity to share my experiences and inspire the next generation of officers at DGAQA.

Lapses in following the process or ensuring quality at the QC and shop stages can be discovered easily if DGAQA officers perform the mandated activities sincerely.

DGAQA Officers must always see that defined infrastructure is established& used; defined environment conditions are met; defined procedures followed; defined tools used; approved QC carry out adequate inspection; documents are filled by shop & QC; reports are in order and thus assure product quality.

**About the Author:** Shri A Chandrasekaran Dir (A/C & AeroMed) is posted at HQrs New Delhi and joined service in Nov 1996.

# SIGNIFICANCE OF ESS IN ENHANCING RELIABILITY OF ELECTRONIC EQUIPMENTS

**P Aneesh Babu,** Director
ORDAQA (MRO & RWRDC), BENGALURU

## 1. INTRODUCTION

Reliability of a product is mandatory in military aviation for ensuring every time operational preparedness of aircraft/airborne equipments. On many occasions, the electronic equipments delivered to the customer/user services are experiencing early field failures in spite of defined acceptance/functional testing. This is basically due to latent defects which are inherent in the system but not detected during conventional testing .This article brings out the significance of environmental stress screening of electronic equipments so that the latent defects are precipitated at manufacturing stage which will in turn eliminate the early field failures and enhance the reliability of the product at customer end.

## 2. BATH TUB CURVE

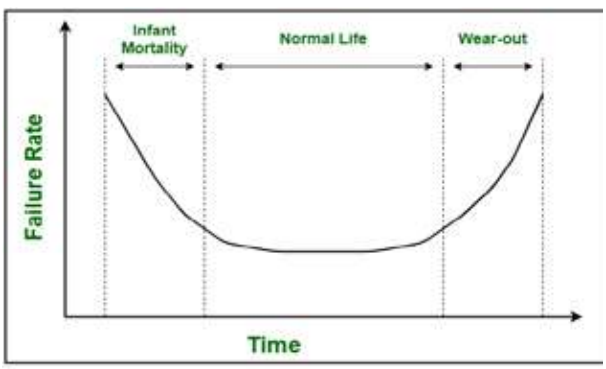
A Bath tub curve as shown below indicates the product life in three stages namely infant mortality stage, normal life /useful life and wear out stage. The infant mortality is mainly due to latent defects and if an effective programme is adopted to precipitate these defects at manufacturing stage itself, then the early field failures can be eliminated to a greater extent.

## 3. ENVIRONMENTAL STRESS SCREENING (ESS)

ESS is a programme or series of processes in which electronic assemblies/equipments are subjected to accelerated stress in order to precipitate latent defects during manufacturing stage. A properly applied ESS programme will significantly improve the quality and reliability of electronic products delivered to the customer. Manufacturing techniques for modern electronic hardware involves a lot of individual operations and processes through which defects are creeped in to the system. Many of these defects can be detected by visual examination, functional tests and other conventional quality assurance measures. The latent defects which are undetected during conventional QA methods will lead to an early failure during manufacturing stage itself so that initial field failures are reduced.

An optimised ESS programme during development stage of the product will significantly improve the quality and reliability of the product while entering in production stage. ESS being a closed loop programme, the manufacturer has to give proper attention for its planning, implementation, monitoring and control.

Historically, a number of experiments and analysis have been carried out with various types of stresses for an effective ESS programme during manufacturing of electronic equipments. This includes voltage, temperature, sinusoidal vibration, random




Bathtub Curve

vibration, humidity, thermal cycling etc. The following table brings out the effectiveness of screening to various type of stresses from which it is clearly evident that thermal cycling and random vibration are most effective in precipitating the latent defects. Normally it is observed that 80% of the defects are susceptible for detection during thermal screen and remaining 20% during random vibrations. Therefore more importance must be given to thermal screen.

**4. Random Vibration**

As part of ESS, the random vibration at assembly/LRU level is carried out in all the three axes before and after thermal cycling. Performance checks before, during and after vibration (PREET, INSET & POET) will bring out the assembly defects. A Typical spectrum followed during vibration, if no field data exists, is as given below :

- 20-80 Hz at 3dB/octave up to 0.04g2/Hz (6g r.m.s)
- 80-350 Hz at 0.04g2/Hz
- 350-2000Hz at 3dB octave rolling off

The duration will be 5 minutes /axis.

| LEVEL OF ASSY | SELECTION | | | | PLACEMENTS | |
|---|---|---|---|---|---|---|
| | Temp cycle | Constant temp | Random vibration | Sinusoidal vibration | Advantages | Disadvantages |
| ASSEMBLY | E | M | M | N | Cost per flaw precipitated is lowest (unpowered screens) | Test detection efficiency is relatively low |
| UNIT | E | M | E | M | Higher test detection efficiency than assembly level | Cost per flaw is significantly higher than assembly level |
| SYSTEM | E | M | E | M | Highest test detection efficiency | Cost per flaw is highest |

**The following table brings out the Assembly defect types precipitated by thermal and vibration screens :**

| DEFECT TYPE | THERMAL SCREEN | VIBRATION SCREEN | THERMAL OR VIBRATION SCREEN |
|---|---|---|---|
| Defective part, Broken part, Solder connection | x | x | x |
| Improperly installed part, PCB etc, Shorts and Opens, Loose contact, Loose wire termination, | x | x | - |
| Wire insulation, Contamination, Component or parameter drift, Hermetic seal failure, PWB opens/ shorts, Component incorrectly installed, Wrong component, Chemical contamination, Defective wire termination | x | - | - |
| Improper crimp or mating, Debris, Chafed/Pinched wires, Adjacent boards rubbing/parts shorting, Poorly bonded component, Mechanical flaw, Inadequate secured high mass components,Particle contamination | - | x | - |

| DEFECT TYPE | THERMAL SCREEN | VIBRATION SCREEN | THERMAL OR VIBRATION SCREEN |
|---|---|---|---|
| Loose hardware | - | x | x |
| Fasteners, Etching Defects | - | - | x |

### 5. Thermal cycling

Thermal cycling plays an important role in precipitation of latent defects inherent in the product. It is known that 80% of latent defects are precipitated during thermal screen. Rate of change of temperature, Delta temperature (range between both extremes) and number of cycles play an important role in determining the precipitation efficiency. The present profile followed during initial implementation is as given below

| | |
|---|---|
| Temperature range | -30 degree C to +70 degree C (to be tailored as per design/operational requirements) |
| Temp. rate of change | 5/10 degree per minute |
| Number of cycles | 10 |
| Dwell | until stabilisation (minimum 01 hour) followed by 10 minutes soaking time |
| Performance checks | during soaking at both extremes in every cycle |

### 6. APPROACH TO FAILURES DURING ESS

Defects precipitated during vibration and thermal screens need to be analysed as part of ESS programme. On identification of the root cause and implementation of remedial measures the screens need to be continued from where it is failed by ensuring the defect free thermal cycling and post vibration requirements. As far as thermal cycling is concerned, last three cycles out of 10 cycles are considered as defect free cycles even though guidelines prefer 50% defect free cycles.

### 7. CONCLUSION

It is pertinent to mention that a well-planned and tailored ESS programme brings out the latent defects at manufacturing stage itself. As a result, early field failures are eliminated which in turn enhances the operational reliability during its useful life. Even though ESS is a manufacturing process, now a days it is being widely used as part of acceptance tests. A closed loop ESS programme will certainly accrue the following benefits:

- Better operational reliability due to elimination of early failures.
- Fewer warranty period failure.
- Helps in planning for spare parts.
- Better economy through fault detection and correction during the product development.
- Improved overall quality of the process and product.
- Helps in streamlining the process to weed out infant mortality failures.
- Improved productivity.
- Lower repair cost.
- Better image with customers

### 8. Way Ahead

By Adopting HASS (Highly Accelerated Stress Screening) derived from HALT (Highly Accelerated Life Testing) will definitely reduce the testing time. However, the testing labs and industries are required to be equipped with testing facilities which is a constraint at present.

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# IMPORTANCE OF DOCUMENTATION IN QUALITY ASSURANCE

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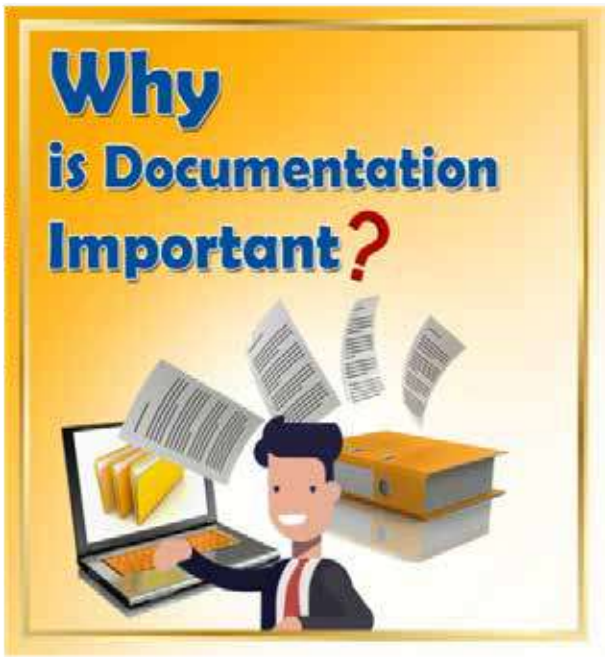



Technical Documentation is any communicable material that is used to describe, explain or instruct regarding some attributes of an object, system or procedure, such as its parts, assembly, installation, testing, maintenance and use. A good Technical Document has the following qualities:-

(i) Accurate

(ii) Complete

(iii) Consistent

(iv) Clear

(v) Useful

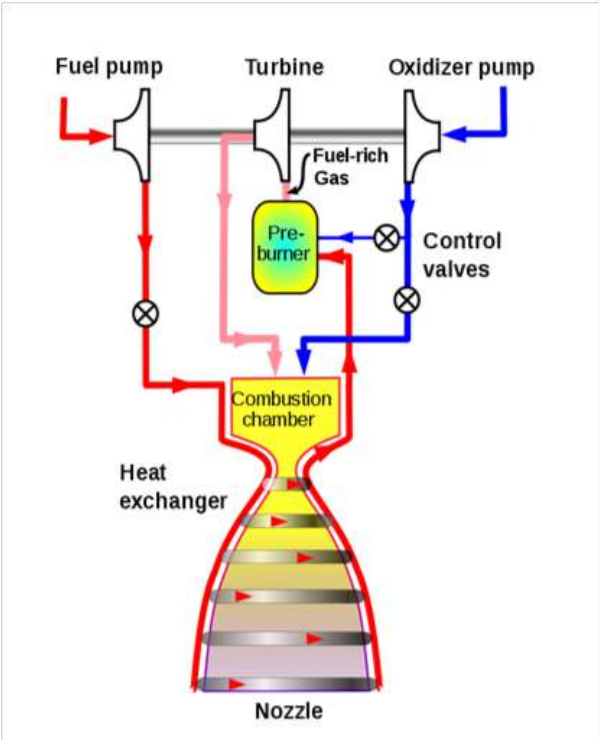
**2.** Technical Documentation is an absolute necessity in the aeronautical field. Each and every activity up to the minute detail needs to be specified and also the activity carried out has to be clearly recorded. The recorded reports play a very predominant role in analyzing and arriving at the correct interpretation of things so that fruitful improvements can be made in case of incidents or accidents. Process documentation is an essential and integral part in the manufacture of missiles systems as they are fire and forget systems. An incident that happened during LP Engine production of a missile is narrated in the following paragraphs.

**3.** In one of the development trials of a missile, there was a mission failure as the missile couldn't take off.

Preliminary analysis identified the cause of missile not lifting off was due to failure of LP Engine.

Further examination of the missile revealed that the fuel and oxidizer couldn't reach the engine.

Liquid Propellant Engine works on the principle of exothermic reaction wherein fuel mixes with oxidiser to form combustion. This happens in a convergent and divergent Thrust Chamber to produce the thrust for the missile.




The fuel and oxidation to the thrust chamber is supplied through a turbo pump which has a rotor assembly and con

**4.** Since, missiles are one time devices, it is only through documentation, most of the causes of failures can be analysed. In the present case also, it was observed that the diaphragm failed to shear off. Further analysis of the raw material used for the trial missile revealed that the hardness of diaphragm was quite high than the intended value and hence could not be sheared by the piston. On verification of the documents it revealed that the diaphragm of that engine was sourced from a local vendor. The hardness value was not checked prior to fitment of the same in the starting valve assembly.

**5.** Based on the investigation report, the documentation procedure was revised to include the hardness check of the material of the diaphragm.

Since some LP Engines were already being manufactured and fitted to missiles, there raises a question whether to recall all the earlier supplied engines. However, due to good engineering practice and documentation of recording the hardness value of the diaphragm in the route card prevented from recalling all the earlier delivered LP Engines of M/s HAL at that point of time.

**6.** In view of the above defect investigation, it is emphasized that documentation plays an important role and helps in taking decisions on judicious recall for rework, if any manufacturing errors occur inadvertently at a later stage. It's always a good practice to have record of basic engineering parameters recorded in the test reports, so that it helps us on a later date for correct evaluation or interpretation of the failure and adopt suitable remedial action.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# COTS IN MILITARY AVIATION : CHALLENGES AND MITIGATION

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**1. Introduction:**

COTS (commercial off-the-shelf) is now a familiar name to offer designers of military and aerospace electronics systems, access to low-cost alternatives to full mil-spec parts. Commercial-off-the-shelf components enable the systematic and cost-effective reuse of prefabricated tested parts, a characteristic approach of mature engineering disciplines. This reuse necessitates a thorough test of these components to make sure that each works as specified in a real context.In recent years, the use of commercial off-the-shelf (COTS) devices represents an attractive alternative to radiation-hardended components in applications working in harsh military environments. By using COTS devices, it is possible to significantly reduce both costs and development time of systems. In addition, there is a high availability of such devices on the market which offer lower power consumption and higher effectiveness than the radiation protected counterparts .

**2. Definition of COTS as per DO-254:**

"Commercial Off-The-Shelf (COTS) components are the Component, integrated circuit, or sub-system developed by a supplier for multiple customers, whose design and configuration is controlled by the supplier's or an industry specification.

**Note:** Examples of COTS components may include resistors, capacitors, microprocessors, un-programmed Field Programmable Gate Array and Erasable Programmable Logic Devices, other integrated circuit types and their implementable models, printed wiring

**Table 1: common continuous operating temperature ranges for electronic components**

| Temperature Range | Designation | Typical Application |
|---|---|---|
| 0 to 70 ° C | Commercial grade | Consumer electronics, e.g. Toys, radios, televisions, computers |
| −40 to 85 ° C | Industrial grade | Industrial electronics, e.g. industrial controls and regulations |
| −40 to 125 ° C | Automotive grade | Engine-related electronics in the automotive sector, e.g. engine control unit, air conditioning control units, sensors |
| −55 to 125 ° C | Military grade | Military applications, aerospace industry, e.g. aircraft, ships, measuring devices, radios |

assemblies and complete LRUs which are typically available from a supplier as a catalog item."

**3. COTS components versus commercial grade components:**

Often it is noticed that COTS and commercial grade components are treated as same. The following table lists the various grades of components based on operating environments in respect of temperature. The commercial grade components are the ones that operate between 0° and 70°C whereas COTS components (components/ICs/ modules) are those readily available in market by various manufacturers for which the availability of data is restricted to manufacturer only.

The following table lists the most common continuous operating temperature ranges for electronic components:

**4. COTS in military aviation:**

Non-availability of MIL grade components, fast change in technology of avionics design and economic pressures are driving many commercial and governmental operators within the aviation system toward purchase of COTS products. Although these products may have a favorable cost-to-performance ratio, they may not have been subject to the verification and validation rigor required to maintain safe, dependable operation of the aviation system.

Examples include microprocessors (from PC industry), operating systems (e.g., Windows and LINUX), and graphics processors (from video game industry).

5. Challenges and risks in using COTS:

COTS items are increasingly penetrating into both the commercial and the military segments of the aerospace market. Normally airworthiness for an avionics system is ensured through the requirements in respect of its intended function, operating environment and safety aspects. Challenges faced during airworthiness of COTS are listed below:

Usage of MIL grade components in a system along with design qualification requirements instill reliability confidence on customer/user, whereas usage of COTS does not provide such confidence level due to non-availability of data to customer against being used.

With technology changing at faster rate, obsolescence risk is a concern while using COTS in Close correspondence with the vendor of COTS and updated and trained team to take

care of market trends. During the requirements analysis, it is necessary to have knowledge of the existing marketplace with respect to functional features.

Understand the capability of the "as-received" COTS assembly, with respect to the allocated System requirements and prepare a System risk analysis. Document appropriate risk mitigation methods available for use to assure that the COTS assembly accomplishes its allocated System requirements reliably throughout the specified system lifetime.

Avoid material defects, design blunders, errors in assembly and handling using statistical process control to bring down infant mortality.

Identification of root cause and implementation of suitable corrective measures and documentation of same. The move from Qualified Product List (QPL) to Qualified Manufacturers List (QML) concept in the military components system gave component manufacturers the authority to modify the MIL-SPEC (now MIL-PRF performance specifications) requirements for screening, based on their own data-supported engineering judgment.

Elimination of non-value adding screens/ tests based on data and experience by qualified manufacturers.

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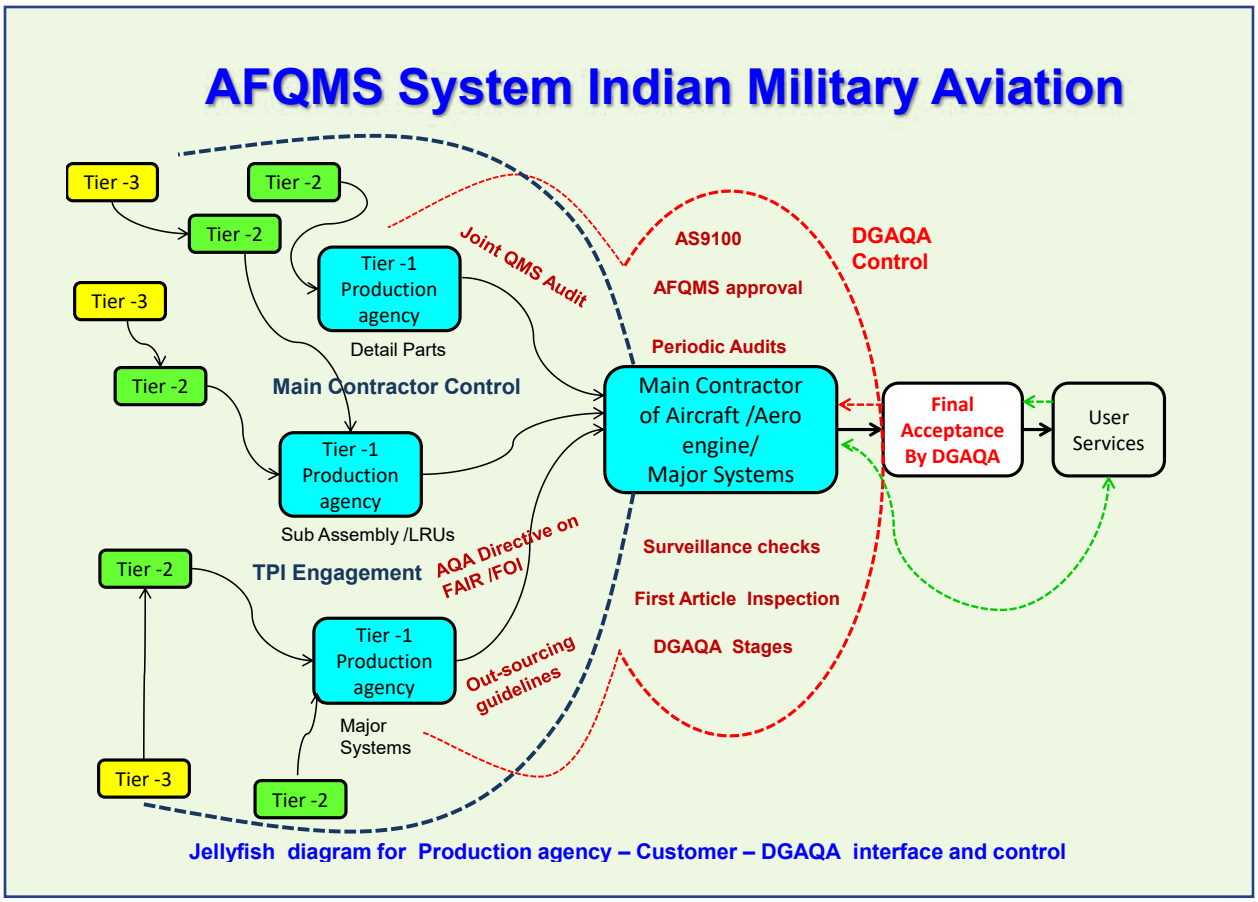

# THE UAS , FUTURE OR PRESENT OF COMBAT FORCES

**Sanjay Kumar Sharma,**
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The UAVs are class of aerial vehicle with no pilot to control on board. With the advancement of technology the UAVs have become more sophisticated and complex and hence become UAS (Unmanned Aircraft System). This complex system includes ground station, satellite connectivity, sometimes on board weapon and other components. The UAS are having enormous qualities which makes them more lucrative in combat force e.g. no/minimum RCS. (Normal radars are unable to detect low RCS), Very high precision, No danger to valuable pilots life and many more.

The main application of UAS is surveillance, tactical planning, gathering electronic intelligence (ELINT) information, lasing targets for fighter aircraft and post-strike damage assessment (PSDA) but militarily the weaponised UAS are gaining tremendous importance known as Unmanned Combat Aerial Vehicles (UCAVs), as having the capability to destroy the far-away targets in precision manner without creating collateral damage.

The payload determines the function of a UAV as is directly related to the task. The surveillance task is performed by integrating a Charged Couple Device (CCD) camera with Multi Optronic Software payload. To facilitate pinpoint attack by Bird the Laser designator is used as payload. Similarly, a UAV would carry an ELINT payload for ELINT mission, and for hunter killer missions, appropriate munitions which it can either launch or crash with them into a designated target in an attack and self-destruction mode.

**Classification of UAVs:**

In the US Armed Forces the tier system is followed for classification of UAS.

- Tier I: Low altitude long endurance. Example Gnat 750.
- Tier II: Medium Altitude, long endurance (MALE). Example MQ-1 Predator and MQ-9 Reaper.
- Tier II +: High Altitude, Long Endurance (HALE). Example RQ-4 Global Hawk.
- Tier III: high altitude, long endurance low observable. The parameters are similar to the Tier II+: RQ 170 Sentinel is in this class of UAVs.

For Indian Defence application, UAS Categorisation is based on MTOW (Maximum take Off Weight) along with other aggravating and mitigating factors:

- Micro: Less than 1 kg.
- Mini: Between 1 Kg to 10 Kg.
- Light: Between 10 Kg to 100 Kg.
- Heavy: Greater than 100 Kg.

**India's Acquisition of UAVs:**

The Indian Armed Forces have been operating UAVs since long. In late 1990s, The Indian Army procured first time UAS from Israel, and the Indian Air Force and Indian Navy followed.

Initial acquisition was of Searcher Mk I, followed by the Searcher Mk II having an altitude ceiling of 15,000 ft. Later on the Heron, having an altitude ceiling of 30,000 ft were procured.

**Employment of UAVs in India:**

The UAVs have the capability to replace

manned aircrafts for certain tasks such as helicopters and class of transport aircrafts and the armed supersonic UAS can also replace the fighter aircraft also.

Presently, the three Indian Services have limited numbers of these UAS, notwithstanding each Service is looking towards improving the numbers. There should be exponential rise in their numbers in the coming years.

The Herons are capable to perform surveillance task at high altitude hilly regions and also able to provide critical information.

The Searcher Mark I, the short range UAV being used in the hilly regions and plains. The Nishant, an indigenously developed by DRDO is launched from a vehicle and recovered by parachute, is possibly under induction and may be utilised in the plains. All UAVs presently held by the Armed forces are being controlled at the operational level and serve the needs at the higher level.

There was dire requirement of UAVs at the tactical level to undertake the missions at ground level with accurate intelligence, which was fulfilled recently by a Indigenously developed Mini category of UAS having main specifications as follows:

Endurance : 120 minutes at MSL (Mean Sea Level)

Range , more than 15 kilometres

Maximum launch altitude 4500m AMSL (Above Mean Sea Level)

Payload : HD daylight camera 1280×720 pixels , 25× optical zoom and thermal camera 640×480 pixels

Simultaneous real time map tracking and video streaming

Encrypted uplink and downlink.

Further, in the Indian environment, there is an immediate need to weaponise these unmanned aerial platforms to destroy hostile targets with precision. The UCAVs are operating in Russia and Ukraine war and causing accurate destruction of pinpoint targets.

**Planning for the Future:**

The UK Royal Air Force (RAF) is planning to replace 30 per cent of the present strength of fighter aircraft by UCAVs. The United States

Navy already has plans for deploying autonomous unmanned aircraft with a low observable platform having capability to undertake autonomous aerial refuelling. The future would also see the entry of directed energy weapons. And they would also get mounted on UAVs for effective usage.

This indicates the direction the world is heading with regard to UAVs and UCAVs. Further, India has to note that China has already featured its Chang Hong-3 UCAV platforms in various defence exhibitions in recent years.

The Indian Armed Forces have to judiciously examine their future requirements of UAVs. In as much as the Army is concerned at the strategic and operational levels, there is a requirement for UCAVs and short range loitering missiles. The UCAVs could be formed on the Herons each of them mounted with two Fire and Forget missiles. Each divisional artillery brigade must have a battery of UCAVs comprising eight aerial systems.

The Air Force must acquire additional UCAVs and also work towards developing a fighter UCAV. The Navy must look at Rotary UAVs and UCAVs.

The Indian navy is also planning to acquire NSUAS (Naval Ship borne Unmanned Aerial System) which will be positioned on ship and land as well, to meet the emergent requirement of surveillance and reccce during day and night.

The feasibility study by the Indian navy and other stake holders i.e. DRDO, DGAQA and PSUs/Private organisations for developing of SWIFT (Supersonic Weapon Imitating Flying

Target) is in progress. The SWIFT will be recoverable and reusable , an will simulate the supersonic anti ship missile as close to as the real threat as possible to provide near realistic training to Ships' crew in handling weapon system during AMD/AA engagements . Some of its features are:

Range : Not less than 70 kilometres

Speed : Not less than 1.5 Mach

Maximum weight : Not more than 30 kilograms

While the requirements are clear, the moot point is what is the road map for their procurement. DRDO has developed Nishant and is presently developing Rustam, a Medium Altitude Long Endurance (MALE) UAV. Any process undertaken must meet timelines, as inordinate delay is operationally never acceptable. Particularly, as technology keeps changing and then, so do the requirements.

In recent past to address the emerging need of armed forces IAF had organised the Mehear Baba Challenge at pan India level to shortlist the indigenous talent having capability to develop the multipurpose swan drones , with the intention to use the weaponised swan drones for military application. Out of good number of start-ups the top 5 technologically capable private companies were shortlisted. This is well appreciated step towards Atmnirbhar Bharat in terms of development of UAS/Swarm UAS.

The UCAV and the loitering missile are being produced by Israel which is willing to set up joint ventures with DRDO. It would be prudent if our inescapable requirements are fine-tuned in cooperation with the selected Original Equipment Manufacturers (OEMs) and then subsequent requirements are delivered by Joint Ventures. The private sector could be encouraged for participation in their manufacture as well as research.

Various development issues, including technology milestones, could be examined by the three Services in conjunction with DRDO.

**Conclusion:**

The UAVs have played a crucial role in recent conflicts between the countries. The UAVs have emerged as game changers in certain cases. Their effective, timely and diversified application will show the clear direction.

The Indian Armed Forces now have a clear road map and are moving fastly towards equipping their inventories to fulfil the present and future requirements of Country.


**About the Author:-** Shri. Sanjay Kumar Sharma, Dy. Director (E&I) is posted at HQrs, New Delhi and joined DAQAS service in Dec 2014.

# INTELLECTUAL PROPERTY RIGHTS IN THE INDIAN DEFENCE SECTOR

**Shivendra K Duklan**
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HQrs New Delhi

**Abstract**

Intellectual property (IP) is a critical consideration of most acquisitions that require sophisticated items or components and performance. Preparation of an intellectual property strategy is now a required element in Defence acquisition. The IP Strategy serves as a plan for competitive and affordable acquisition and sustainment of license rights in IP over the entire item or component lifecycle. This article is intended to provide a short coverage of the concept of Intellectual Property and associated rights, the progression of IP laws in India and capture the IPR initiatives being undertaken by the Department of Defence Production, Ministry of Defence.

**Introduction to Intellectual Property Rights (IPRs)**

IP broadly refers to intangible "creations of the mind"—inventions, literary and artistic works, unique business names and symbols, and internal secret information. Items and components that embody intellectual property are most likely a tangible item, e.g., a tank, a missile, a radar system, or an IT system. The protections granted to owners of intellectual property embodied in the item or component could be a patent, a copyright, a trademark, or a trade secret.

**Categorizations of IPs**

**(i) Patent**

A patent is a category of intellectual property rights that is granted to an inventor for a limited time in exchange for public disclosure of the invention. It has been ruled that "whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent thereof, subject to the conditions and requirements of this title." In these times of constant technological innovation, the Defence Departments across the globe acquire many patented items and also own many patents.

**(ii) Copyright**

Copyright is a form of protection for authors of "original works of authorship." Subject matter protected by copyright is "original works of authorship fixed in any tangible medium of expression" so that it is perceptible either directly or with the aid of a machine or device. Works could include literary, dramatic, musical, and artistic works, such as poetry, novels, movies, songs, computer software, drawings, and architecture.

A copyright owner has the exclusive right to reproduce, distribute, perform, and display the work in question, as well as the right to prepare derivative works. Length of protection is complicated due to changes in the law, but currently is 70 years after the death of author. If there is corporate authorship of the work, the protection is for 95 years from publication or 120 years from creation, whichever expires first. The copyright "protects the form of expression rather than the subject matter of the writing. For example, a description of a machine could be copyrighted, but this would only prevent others from copying the description. It would not prevent others from writing a description of their own or from making and using the machine"

**(iii) Trademark**

A trademark or service mark includes any word, name, symbol, device, or any combination, used or intended to be used to identify and distinguish the goods/services of one seller or provider from

those of others, and to indicate the source of the goods/services. A trademark includes any device, brand, label, name, signature, word, letter, numerical, shape of goods, packaging, color or combination of colors, smell, sound, movement, or any combination thereof, so long as it identifies the source of goods and services and distinguishes them from the goods and services of others.

**(iv) Trade Secret**

"Trade Secret" is defined as "all forms and types of financial, business, scientific, technical, economic, or engineering information, including patterns, plans, compilations, program devices, formulas, designs, prototypes, methods, techniques, processes, procedures, programs, or codes, whether tangible or intangible, and whether or how stored, compiled, or memorialized physically, electronically, graphically, photographically, or in writing if—

(i) the owner thereof has taken reasonable measures to keep such information secret; and

(ii) the information derives independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable through proper means by, the public."

**Intellectual Property as a Strategic Resource**

Intellectual Property (IP) is a critical consideration of most acquisitions that require delivery of technological items, components, or software. Modern military systems are evolving at a rapid pace and need to be quickly revamped. Discovering ways to rapidly field new capabilities with greater military advantage is a primary driver for looking for innovations from a variety of sources. Intellectual property refers to "creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used in commerce".

It is embodied in a form that is shared or can be recreated, emulated, or manufactured.

As the Defence Forces acquires and upgrades war-fighting systems using transformational product innovations, appreciation for intellectual property as a strategic resource that can generate greater performance for the money is acknowledged and established. However, a better understanding of how to obtain and manage non-government IP is necessary to improve competition and invigorate a marketplace for businesses that want to innovate and sell to the Defence Forces.

It is necessary for acquisition teams comprising of the user and the GQA agencies to "assess program needs, and acquire competitively whenever possible, the deliverables and associated license rights in IP [that are] necessary for competitive and affordable acquisition, and sustainment over the entire product life cycle". In the current Global IP Scenario, the Government Quality Assurance agencies must now establish and maintain an IP Strategy to encompass all aspects of IP and related issues from the inception of a program and throughout the lifecycle. Requirements for the IP Strategy include development of the strategy itself, a summary for inclusion in the Acquisition Strategy, updates throughout the entire lifecycle, and inclusion in the Lifecycle Sustainment Plan during the operations and support phase.

**Progression of Intellectual Property Laws in India**

The intellectual property laws in India were developed even during the British period. The British enacted the Indian Patents and Designs Act in 1911. After independence, the Government of India appointed the Patents Enquiry Committee in 1948 in order to review the working of the patents law in India. The Patent Bill came into force on 19th September, 1970. It has been amended by the Repealing and Amending Act 1974, The Delegated Legislation Provisions Amendment Act, 1985, The Patents Amendment Act of 1999, 2002, 2005 respectively. The attempt made by the Indian Parliament to enact patent legislation was to comply with the TRIPS Agreement since it was a signatory to the Agreement.

The primary legislation dealing with the copyright laws in India is the Copyright Act of 1957 which

contains 79 sections. Being a member of the Berne, Universal Copyright Convention, and TRIPS, the Act was amended several times and the last major amendment was done in 1999. This Act provides for protections in respect of rights relating to authors, composers, artists and designers for their original works.

The law relating to trademarks in India can be traced from the Trademarks and Merchandise Act of 1958. This Act was replaced by the Trademarks Act of 1999 with a view to .simplify the Trademarks Act, to allow registration of service marks and to extend the period of protection of trademark from seven years to ten years.

The Designs Act was passed in 1911 and subsequently repealed by the Designs Act, 2000 which contains 48 sections and 11 chapters. The main aim of this Act is to protect the designs, which serve the purpose "of visual appeal. Under this Act design means only' the features of Shape, Configuration, Pattern, Ornament, Composition of lines; or Colors applied to any article.

The next major legislation .in India is the Geographical Indication of Goods (Registration and Protection) Act, 1999 which is divided into 9 chapters and 86 sections. This Act provides for the registration and better protection of geographical indications relating to goods.

Moreover, the Semiconductor Integrated Circuits Layout-Design Act, 2000 intended for the protection of the semiconductor was also introduced. Section 2 (h) of the Act defines layout-design as "a layout of transistors, and other circuitry elements and includes lead wires connecting each elements and expressed in any manner in a semiconductor integrated circuits."

In addition to these Acts the Biological Diversity Act of 2002 intended to protect the bio diversity encompasses' the variety of all life on earth. The Act also aims to regulate access to biological resources of the country with the purpose of securing equitable share in benefits arising out of the use of biological resources and associated knowledge relating to biological resources and also to conserve and sustainably use biological diversity.

Hence, as a post industrial revolution phenomena exploitation of Intellectual Property Rights has assumed new dimensions. These rights have turned to be the products of modem commercial world. The evolutions of Intellectual Property Laws are closely associated with the expansion of knowledge, industrial progress and commercial utility. The process of development, national and international, is still continuing in new areas of intellectual property such as traditional knowledge, bioinformatics etc.

**'Mission Raksha Gyan Shakti'**

Raksha Mantri formally launched 'Mission Raksha Gyan Shakti' at an event held in New Delhi on 27th Nov 2018. The Directorate General of Quality Assurance (DGQA) has been entrusted with the responsibility of coordinating and implementing the programme. As part of the Mission Raksha Gyan Shakti, DGQA has set up an an Intellectual Property Facilitation (IPF) Cell with an aim to

(i) Provide general advisory about IPRs, such as patents, trademarks, designs and copyrights etc.

(ii) Provide Services such as IP Protection, IP Awareness and Counseling & Advisory Services.

(iii) Provide training on IPR.

The mission aims to achieve the goal of self-reliance in the defense sector to generate Intellectual Property in India and marks a departure from the culture of seeking Transfer of Technology (ToT) from foreign sources.

While addressing the audience, Raksha Mantri highlighted that while India has always been a knowledge hub since ancient times, however, due to lack of awareness on modern legal framework for protection of IP rights, our knowledge and creativity have often not been utilized to its full potential. Delivering the keynote address at the event , Secretary Defence Production Dr Ajay Kumar highlighted the need to migrate from the culture of seeking Transfer of Technology (ToT) from foreign sources to generating Intellectual

Property in India, to achieve the goal of self-reliance in Defence sector.

The IPR has emerged as a key ingredient of an ecosystem which stimulates innovation and ingenuity. An IP Facilitation Cell was established in April this year which has worked tirelessly to achieve ambitious targets of training 10,000 personnel of OFB and DPSUs on IPR and to facilitate filing of at least 1,000 new IPR applications.

As part of the ongoing initiatives to enhance self-reliance in defence, the Department of Defence Production has instituted a new framework titled 'Mission Raksha GyanShakti' which aims to provide a boost to the IPR culture in indigenous defence industry. The event brought out that the end objective of 'Mission Raksha Gyan Shakti' is to inculcate IP culture in Indian defence manufacturing ecosystem.

**IPR Initiatives in Indian Defence Sector**

**(i) Policy on Creation and Management of Intellectual Property (IP) by Defence Public Sector Units & Ordnance Factories (Sep 2019)**

In pursuit of 'Mission Raksha Gyan Shakti' (MRGS) initiated by Department of Defence Production to spur creativity and stimulate innovation in Indian defence sector. Mission Raksha Gyan Shakti aims to institute an enabling framework for creation and management of Intellectual Property (IP) in Indian defence sector, an Intellectual Property Facilitation Cell (IPFC) has been set up by the Directorate General Quality Assurance (DGQA) to steer all efforts in this direction.

The IPFC was entrusted with the responsibility to formulate a comprehensive Policy on Creation and Management of Intellectual Property by Defence Public Sector Units (DPSUs) and Ordnance Factories (OFs). It is envisaged that this policy shall act as a roadmap for all DPSUs and OF s to set up a vibrant ecosystem and act as a force multiplier in the thrust towards self-reliance in the defence sector.

This Policy also addresses the aspect pertaining to IP Rights over components /sub-assemblies which are indigenized by DPSUs / OFs in accordance with the Indigenization Policy for DPSUs/ OFB promulgated vide GOI/ MoD/ DDP note No.1(18)/Indigenization/ DP(Plg) — ES/ 818 dated 08 Mar 2019.

**(ii) DRDO Intellectual Property Rights Policy 2016**

The preamble of the DRDO IPR Policy 2016 reads, "DRDO believes that a robust IPR culture Inter-woven into R&D efforts of its scientific/ technical work force is pre-requisite for realizing its mission to provide state-of-the-art sensors, weapons, platforms and allied equipment for Defence Services. The IPR Policy lays down its objective "is to create an enabling ecosystem for stimulating creativity, innovations and unleashing the full potential of its own scientific/ technical workforce".

**(iii) Defence IPR Policy For Jointly Developed Software Products (Authority: MoD, D(IT) Div ID No. 4(14)/2006/D(IT) Vol.3 dated 26 Sep 18)**

This IPR Policy will be applicable to software products developed by Defence Services jointly with a Developer (s). This IPR Policy emphasizes that it is important that the Government should have at least joint ownership of intellectual property rights over the developed computer programs or computer software with all rights including a worldwide, perpetual, unlimited, nonexclusive, irrevocable and royalty-free license to use, modify, make derivative work, translate, adapt, improve, merge with other computer programs or software, reproduce, disseminate, reverse engineer, release or disclose computer programs or computer software in whole or in part, in any manner, and for any purposes whatsoever, and to have or authorize others to do so. The aforementioned shall ensure that Government is able to exercise its ownership rights to develop and produce such technologies including computer programs and computer software, generated during the Project, to the fullest extent for the Government purposes including defence applications, free of any charge as well as free from any legal or other encumbrances/ hurdles.

***Similarly other Govt. and other stakeholders in the Indian Defence Sector are formulating their IP Policies and making a forward thrust to capitalize on the IPs available in the country. It is expected that this thrust on IPRs would definitely be a building block of the country's defence capabilities in times ahead.***

**IPR Initiatives under the aegis of DGAQA**

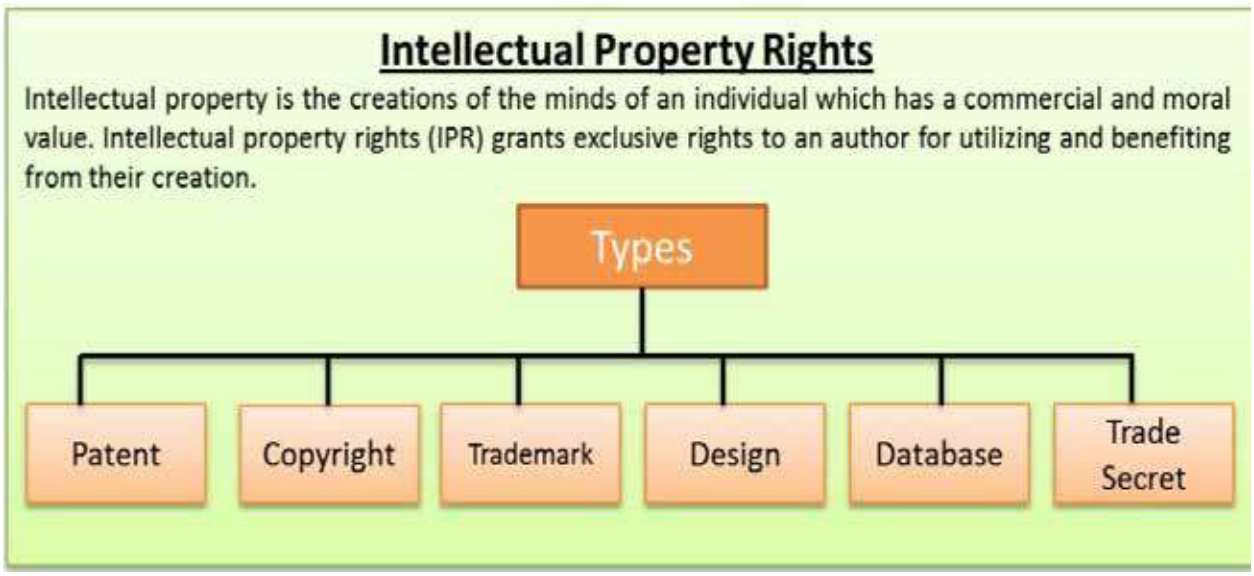
DGAQA has also embarked on the IPR mission. The Ground Support Equipment Group at HQrs, New Delhi is spearheading the IPR initiatives of the organisation. The GSE Group has been updating its specifications to bring them in line with the current User requirements and is processing copyrights of the same. It is expected that all specifications authored by the organisation will be copyrighted in the near future.

**Conclusion**

The issues of IPR protection and management are significant both when such IP is created within national defense research and development organizations as well as procured from abroad.

The management of IPR is likely to play a significant role in strengthening defence R&D and technology development, the key aspects of which include identification of technology for IP protection, disclosure of inventions in patent applications, protection of confidential information, utilizing patent information, principles of ownership and sharing IPR during collaboration, basis of naming of inventors/co–inventors, commercial exploitation of patents, and maintaining records of research. In view of increasing role of private sector in defence R&D and business, a flexible approach to IPR may be required in defining rules for knowledge sharing, protection and benefits.

With the further opening up of the Indian economy, it is becoming essential that IP related issues, particularly, for dual use materials and systems are resolved by evolving an appropriate IPR policy that balances the interests of the on-going programmes of the different stakeholders in the Indian Defence Sector. In principle, these IPR provisions, in Indian defence contracts, ensure that the equipment or technology procured by it are free from infringements or third party rights and no additional costs are made to it on account of any hidden IPR.




**About the Author:-** Shri Shivendra K Duklan, Asst. Dir (Tech-Coord) is posted at HQrs New Delhi and joined service in Oct 2009.

# ONLINE CHECKING METHOD OF FUEL CONTAMINATION USING AUTOMATED PARTICLE COUNTER

**Sachin Kumar, SSA (G)**
OADG, Koraput

**Brief background:**

Critical components going into fluid circuitry, engine components and transmission assemblies in an aircraft are to be free from particle contaminants arising from manufacturing and assembly processes. Particle contaminants beyond limit invariably affect the performance of the component throughout its life cycle.

Cleanliness tests (both Qualitative and Quantitative) performed on finished components form the integral part of quality control system of any manufacturer involved in manufacturing / overhauling of fuel accessories. Checking of cleanliness of internal cavities of items, containers, hydraulic systems of technological equipment is accomplished by indirect method, by checking purity of samples of liquids, pumped through item under test or taken from container or from hydraulic system. Foreign particles of various shapes and dimensions originate from the process such as resin formation, organic particles, present in liquids, during storage and usage and also originating on surfaces of parts, assembly units, items in the course of their manufacturing, including their assembly, testing, preservation and storage. The fuel purity analysis is done for working and preservation liquids, used for production and repair of aviation items and their constituent parts. Relevant standards specify norms of purity of liquids, procedure of sampling and methods of analysis of liquids of internal cavities of items and hydraulic systems of technological equipment. Norms of purity of liquids of internal cavities of items and methods of checking of purity is indicated by the designer in the technical specifications of item.

The OEMs of various fuel system aggregates have recommended use of high quality fuel for testing and priming of operation. The acceptance of the fuel system aggregates is based on determination of differential count of contaminants/ change in the class of fluid while passing through the aggregate. The stringent requirement specified by customer needs institution of measures for error free assessment of fuel quality. It has been established through experimental analysis that the online method of assessment of fuel quality as per ISO 11943 provides superior, consistent and error free result on fuel quality as compared bottle sampling as per ISO 11500 for the same Sampling volume(as per OEM document sampling volume is 100ml).

**Predominant errors in Fuel Quality Assessment in Particle Counters using offline method**

A sample of oil / fuel may contain a multitude of problems, which may interfere with the goal of accurately counting and sizing the solid particles. The most common problem is entrapped air bubbles and water droplets, which scatter and block light, and are erroneously counted as particles by the optical automatic particle counter.

It is learnt that without special sample preparation, an optical particle counter does not work well with fluid that are heavily contaminated with silt or soot. These conditions can produce so-called coincidence error, or in extreme cases may completely prevent the transmission of light.

While generally accurate in measuring the total concentration of solids above the pore size of the screen being used, the pore-blockage type particle counters must estimate the size distribution of particles by extrapolation.

The shape of the particle is simultaneously evaluated during the test; so in addition to classifying the particle by size, the instrument

classifies it in general terms of the wear mechanism that might have produced it.

This shape, or morphological analysis capability, enables the instrument to exclude perfectly round particles from the count, which are presumed to be air or water. Consequently, in addition to discriminating air and water from solid particles.

**Advantages of Online method using Automatic particle counter:**

**Particle Distribution Accuracy:**

*While error can result due to the orientation of the particle and other factors, the optical method is generally effective at estimating the size of each particle. A particle count requires a measure of several different sizes of particles. In a proactive onsite analysis program, where the primary objective is to measure and trend the overall cleanliness of the fluid the online method provides a fair estimate of the particle distribution in the system whereas bottle sampling method gives the classification and particle distribution for the subject sample only.*

**Fluid Types Tested:**

The optical particle counting checking is influenced by a number of factors -aeration, water, dark fluids, heavily contaminated fluids and sample preparation. Most of these factors can be corrected by sample preparation procedures. Otherwise, optical automatic particle counters are best applied to machines where the fluid is typically clean, dry and clear. Some argue that eliminating aeration is important when identifying the inclusive contamination level. As such, it may be preferable to employ an alternative method that can effectively discriminate between different sources of measurement variation (discriminant validity). Online method largely removes the problem of measurement errors due to aeration.

**Procedural Requirements:**

To obtain an accurate particle count, the particles must first be homogenously suspended in the sample, the way they are in the machine, then tested within a short few minutes of agitation (the allowable time depends upon the fluid's viscosity). To achieve this homogenous suspension, one must use a violent agitating device. With optical particle counters, it may be necessary to screen for water. If water is present, the sample must be vacuum dehydrated or treated, such as with a solution of toluene and isopropanol. The set-up parameters can be configured and they are consistently set for each application to avoid erroneous data. Once the sample has been cleared for water and air, and the instrument adequately flushed, it is ready for testing. The cleanliness requirement for sampling bottle needs to be maintained as per ISO 3722. The air ambience quality also needs to be monitored. Non usage of proper piping for suction and drain results in generation of air bubbles through capillary action and gives erroneous results. Sedimentation of contaminants at the bottom results in different fluid cleanliness results in case of slicing of samples. Bottle sampling also requires regular verification using gravimetric method as well as optical microscopy method.

**Conclusion:**

From the experimentation carried out it has been established that checking of fuel quality by offline method needs to be accompanied with gravimetric analysis (assessment of fuel contamination by weight) for real assessment while as online checking method provide accurate and consistent results, the gravimetric method of fuel analysis can be an optional requirement/ can be avoided. The real time monitoring and accurate consistent will enable the user and service provider to understand the source of contamination in better way. The unnecessary additional running time of high value test rig is avoided.

**About the Author:-** Shri Sachin Kumar, SSA(G) is posted at OADG, Koraput and joined service in Oct 2019.

# ROLE & IMPORTANCE OF ADDITIVES IN AVIATION TURBINE FUEL (JET-A1)

**Abir Bagchi**
SSA(G) (PPFOL)
HQrs New Delhi

**General:**

Aviation turbine fuel (ATF) also abbreviated as avtur is a colourless, combustible, straight-run petroleum distillate liquid used in aircraft powered by gas-turbine engines. ATF consists of variety of hydrocarbons with different molecular mass and majority of their carbon number is between 8 to 16. ATF is basically classified as JET-A1, JET-A and JET-B which are basically kerosene-based fuels. Jet-A1 is preferred because it has lower freezing point of -47 0C compared to -40 0C of JET – A and additionally less flammable. In India the major specification used to test the quality of ATF (JET - A1) is IS 1571:2018, 10th revision. This specification has been made in line with similar International Standards viz-a-viz ISO, DEF STAN, MIL etc as the product of this type is often involved in the re-fuelling of aircraft in different countries. Additionally, the defence requirements are more stringent compared to civilian aviation systems. In order to meet the defence application, the governing specification and the type approval is issued by CEMIILAC for the Airborne application.

**Standards:**

Most jet fuels in use since the end of World War II are kerosene-based. Both British and American standards for jet fuels were first established at the end of World War II. British standards derived from standards for kerosene use for lamps—known as paraffin in the UK—whereas American standards derived from aviation gasoline practices. Over the subsequent years, details of specifications were adjusted, such as minimum freezing point, to balance performance requirements and availability of fuels. Very low temperature freezing points reduce the availability of fuel. Higher flash point products required for use on aircraft carriers are more expensive to produce. In the United States, ASTM International produces standards for civilian fuel types, and the U.S. Department of Defense produces standards for military use. The British Ministry of Defence establishes standards for both civil and military jet fuels. For reasons of inter-operational ability, British and United States military standards are harmonized to a degree. In Russia and the CIS members, grades of jet fuels are covered by the State Standard (GOST), or a Technical Condition number, with the principal grade available being TS-1.

**Composition:**

Jet fuel is a complex mixture of hydrocarbons that varies depending on crude source and manufacturing process. It is impossible to define the exact composition of Jet Fuel. Hence, the governing specifications are evolved primarily as a performance specification rather than a compositional specification.

The fuel consists completely of hydrocarbon compounds derived from conventional sources including Crude Oil, Natural Gas Liquid Condensates, Heavy Oil, Oil Shale etc and the approved additives such as Antioxidants, Metal De-Activators (MDA), Static Dissipater Additives (SDA), Lubricity Improver Additives (LDA) and Fuel System Icing Inhibitor (FSII) approved by CEMILAC or adopted from DEF STAN 91-091.

**Additives:**

During the production of ATF for defence applications, doping of some of the additives are mandatory while some are optional, Some additives are added prior to the product being taken into storage (Static Dissipater Additives). Some are added after ascertaining the specific property (Metal Deactivator additive) and some are added at the time of ATF being inducted in the aircraft (Corrosion Inhibitor / Lubricity Improver and Fuel System Icing Inhibitor). General description of the additives doped in base oil are as under:-

**Antioxidants:**

Antioxidants are added to the Jet Fuel to prevent gumming, They are usually based on alkylated phenols, e.g., AO-30, AO-31, or AO-37.

An approved Antioxidant or mixture of Antioxidants shall be added to fuel which has been hydro processed to prevent peroxidation and gum formation. Some approved antioxidant are 2,6-ditertial-butyl-phenol, 2,6-ditertiary-but1-4-methylphenol etc.

**b) Metal Deactivator Additives (MDA)**

An approved Metal Deactivator, N,N'-disalicylindenel, 2-propanediamine, is added in a pre-ascertained amount on initial batching of the fuel at the refinery and then again on cumulative addition. Doping of MDA counteract the effects of metals known to be deleterious to thermal stability such as Cu, Cd, Co, Fe, Zn.

**c) Static Dissipater Additive (SDA)**

Antistatic agents are added to the Jet Fuel to dissipate static electricity and prevent sparking; Stadis 450, with dinonylnaphthylsulfonic acid (DINNSA) as a component, is an example. Wherever necessary, a qualified SDA shall be added to the fuel to impart electrical conductivity inline with the Governing Standard.

**d) Lubricity Improver Additive (LIA)**

Aircraft/ engine fuel system components and fuel control relies on the fuel to lubricate their moving parts. The effectiveness of a jet fuel as a lubricant in such equipment is referred to as its lubricity.

A qualified LIA is added to the fuel to impart improved lubricity to the fuel. Because LIA exists in equilibrium with metal surface of fuel distribution system as well as those of aircraft system, correct delivery to aircraft can be assured only by equilibration of the supply system downstream of the LIA addition or by additive injection at the point of entry to the aircraft. Wear Scar Diameter (WSD) in mm is used to determine the Lubricity property of the Fuel.

**e) Fuel System Icing Inhibitor (FSII)**

A FSII prevents the freezing of moisture within the oil. A qualified component of FSII is Di ethylene Glycol Mono methyl Ether (DGME).

**f) Leak Detection Additive**

Where necessary a Leak Detector Additive is used to the fuel to assist in detecting and locating leaks in ground based fuel storage, delivery and dispensing system.

**Conclusion:**

Additives play an important role in making the Jet Fuel suitable for its intended purpose. It can be concluded that without the necessary additives being added, Jet Fuel would not be able to deliver on its functions.

**About the Author:-** Shri Abir Bagchi, SSA(G) (PPFOL) is posted at HQrs New Delhi and joined service in Aug 2018.

# PHOTO GALLERY OF DGAQA

*International Yoga Day at HQ, DGAQA*

*International Yoga Day at OADG, Koraput*

*DG, AQA felicitating Shri U.S. Pandey, ASO*

# PHOTO GALLERY OF DGAQA

*Visit of Air Officer I/C Maintenance, IAF TO HQ, DGAQA*


*ADG, AQA (HQrs) at 27th Indian Oil Aviation Conference*


*DG, AQA at Industry Interactive Conference on Indegenisation requirements of IAF*

# PHOTO GALLERY OF DGAQA


*Interaction of DGAQA officers with M/s AIRBUS DS and TASL on C-295 project*

*Visit of ED, IOCL to HQ, DGAQA*

*Visit of CMD, Midhani to HQ, DGAQA*

# PHOTO GALLERY OF DGAQA

*Tree Plantation by DG, AQA at ORDAQA, Korwa*

*Visit of DG, AQA to ORDAQA, Korwa*



*Devansh Mani Kaushik (VII, KV OLF, Dehradun) S/O Shri R.M. Kaushik, SSO-I bagged Gold Medal in U-15 Category at Sports for all (SFA) Inter-School Championship*

## Appointments, Promotions and Superannuations during Apr-June 2022

**Shri D B Bhangale**

Shri D B Bhangale superannuated as ADG (SZ) on 31 May 2022. He had taken over the charge of ADG(SZ), Bengaluru on 04 March 2022. He joined DGAQA in DAQAS Cadre in Oct 1992.

**Shri M. Natesh**

Shri M. Natesh took over charge of ADG(SZ) on 09 June 2022. He joined DAQAS service in Feb 1994.

**Shri Ravi Prakash Bollarapu**

Shri Ravi Praksah Bollarapu superannuated as Director SSQAG, Hyderabad on 30 June 2022. He joined Service in Dec 1992.

**Shri R G Dikkar**

Shri R G Dikkar superannuated as Director ORDAQA, Kirkee Pune on 31 May 2022. He joined DGAQA in DAQAS Cadre in Feb 2002.

**Shri. M.M. Javeed**

Shri M.M. Javeed took over charge of Director at OADG, Koraput on 07 June 2022. He joined DAQAS service in Mar 2001.

### SUPERANNUATIONS:

| Sl. No. | Name of the Officer | Designation and FE/ Unit | Retired on |
|---|---|---|---|
| 1 | Shri Chand Verma | SSO-I, ORDAQA, Ghaziabad | 30 April 2022 |
| 2 | Shri Kamalkant Ramlu Mulka | SSO-I, ORDAQA(A), Kirkee, Pune | 30 June 2022 |
| 3 | Shri Janki Sahu | MCM, AQAW (A), Khamaria | 30 June 2022 |
| 4 | Shri Mohan Namdev Khude | Staff Car Driver Special Grade, ORDAQA(A), Kirkee, Pune | 31 May 2022 |

### NEW JOININGS/ APPOINTMENTS:

| Name of Officer | Designation | Date of Joining | FE / Unit |
|---|---|---|---|
| Shri Abhishek Jangir | SSO-II | 27 June 2022 | SSQAG (Hyderabad) |
| Shri Gaurav Chandra Mishra | SSA | 13 April 2022 | DGAQA/Adm-II |
| Ms Renu Mehra | LDC | 02 May 2022 | DGAQA/E&I |
| Shri Rajvir | MTS | 04 April 2022 | DGAQA/Aircraft |

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