SECTION : 4 (b) (iv)

Norms set for the discharge of functions

QA during design & development

There are three major phases in the life cycle of any equipment i.e., Design / development, Production & Service / exploitation . Though the Quality, Reliability and performance of any eqpt depends upon design, production and exploitation practices, the major contribution for the same is derived from the D&D phase. The quality management during the design/development process is more important than the quality management during production. This is because any shortcoming at the design & development stage would have implications affecting bulk quantities, rectification likely to be expensive and sometimes even impossible in addition to poor quality. The consequences of an incorrect choice early on become increasingly difficult and expensive to rectify. The quality plan / system must cope with the above and must prevent or lessen the risk of incorrect choice being made.

The association of QA agencies during the design and development of indigenous developed military aircraft, aero-engine and accessories, towards achieving the quality and reliability of the product is therefore very significant. The DGAQA have been associated with the QA of D&D of programs / projects and have contributed towards the objective of Quality of Design & its verification / validation. DGAQA generally associates with the QA of a development project right from the initial stages of design and development and provide necessary advice / inputs to the designer during the course of development.

The procedure for design and development of aeronautical stores and the role of different agencies has been defined in the DDPMAS, outlining the following stages:

a. Project Definition
b. Preliminary Design
c. Detail Design
d. Technical/Design Review
e. Test and Analysis (including various analyses, Simulation, Software verification validation & Ground Test)
f. Integration Testing
g. Design SOP
h. COD/ Documentation
i. First Flight Clearance
j. Flight Tests and Analysis
k. Type Record & Type Approval

Preliminary Design:

During this phase, design parameters are established based on various inputs like QR, Feasibility study report, wind tunnel tests for aerodynamic configuration etc. The specification for various systems and sub systems that are to be used are also finalised. The data of relevance, among other things, includes the following:-

a. Performance Characteristics
b. Environmental operating conditions
c. Details of stresses likely to be imposed
d. Relevant specifications and Military Standards
e. Input / output requirements
f. Alternatives available for detail design
g. Hardware / Software requirements

Detail Design:

Engineering design has the responsibility for development of a low risk design as also for specification of test requirements and design for production and product support. During the detailed design phase the detailed design of all components, sub systems, systems including their process parameters are carried out. Concurrent with the design phase, development and fabrication of prototype samples, testing and analysis of test results of several components, sub systems and systems may be undertaken for validation purposes. It includes testing, simulation exercise, software verification and validation and ground tests on

a. Components / Equipment / Line Replaceable Unit
b. Sub systems / systems
c. Structural Coupling

Design Reviews:

Design review is a management process, a formal, systematic study of design. Review is undertaken by a suitable team conversant with the item under development and a representative from DGAQA is normally a member of such teams. At the commencement of a design, a programme of reviews for the appropriate design stage is prepared. The object of design reviews is to provide assurance that the specified requirements (performance, environment, quality, reliability, maintainability, safety etc) are likely to be met.

Prototype Inspection:

The necessity for conformance of a prototype to the approved drawing / specification, and a record of the exact status thereof cannot be over-emphasised. Accordingly, a high importance needs to be attached for the inspection of the prototypes at all stages – components, sub-assys, LRUs, subsystem & system. Any deviation from the standard could vitiate the testing / functional results in a major development programme. As such, special attention needs to be paid for coupling of structures, installation/ testing of LRUs, integration testing, weighing etc. While adequate documentation availability to facilitate conformance to the process will concern all stages, it would be of special relevance during integration when the various A/C systems will be under actual evaluation. This needs adequate approved integration plan, compliance with the plan, record of all inspection / testing results, with aspects like accessibility for installation / maintenance, installation neatness etc. receiving due attention. All bought out items should be subject to an adequate QA plan covering the different stages inspection / test at the suppliers premises, QT / AT completion as per test schedule.

Nonconformance:

The prototype samples which are subjected to type approval tests, should be first inspected by DGAQA to ensure that the prototype has been manufactured as per the build standard and the drawings, prepared by the developing agency and provisionally cleared by the airworthiness authority. The acceptance of non-conformance of requirements (concession/ waiver) during the development phase rests with the waiver board. Concerned DGAQA representative is a member of the waiver board and should critically study the deviation and comment upon the merit of acceptability of the deviation.

Software Development:

When a software is planned to be developed, its quality assurance activities at various stages of development should be worked out. The approach for software quality assurance depends on the criticality of the system and should be as per the guidelines given in DDPMAS. The RDAQA should scrutinise and forward his comments if any on Software Quality Assurance Plan (SQAP), prepared by the developing agency.

Qualification/Type Approval Testing:

A major D&D programme involves design & development of a number of parts, LRUs, sub-system & main system. This needs considerable extent of QT to validate that the proposed design is adequate for the purpose or its end use, in actual working conditions. This activity has different stages such as:-

a. Test schedules (ATP/ QTP)
b. Test facilities
c. Conduct of tests
d. Inspection of prototypes after tests
e. Test results / report

Clearance for Flight /Flight Testing:

When the Aircraft system has been tested adequately on ground and the refined / Design standard is considered acceptable, the Designer/ CEMILAC would issue a clearance for first flight / certificate for flight trials / provisional flight clearance. Such a RCMA clearance for flight trials is necessary whenever there is a change to the Aircraft standard of preparation and modification/ alteration. The RDAQA should then ensure through his stage inspection/ other methods that the Aircraft conforms to the approved specification/ drawing/ technology (except for deviations duly processed / cleared under the non-conformance management procedure authorised for the project) including all ground testing in a manner adequate for the purpose of issue of F1090 (certificate of safety for flight).

Project Committee:

When DGAQA is a member of any particular committee constituted by the Government to review the progress in the development and maintenance of major development projects, with a view to remove any technical or administrative bottlenecks, the representative should study and examine all issues especially those related to quality, reliability, maintenance and delivery schedule.

Post Flight:

Valuable feed back is obtained from the snags / defects encountered during flight tests. The flight snags need therefore to be studied closely for any such clue for drawing / process / testing / inspection improvements. The rectification / rework schemes should be scrutinised for comment if any and their implementation inspected for correctness. The above has been prepared on the basis of our experience in some D&D projects and reference to relevant specs should be made for improvement to the procedures/ system.

QA during production and overhaul of Aircraft, Helicopters, Aero-engines and Accessories

The inherent quality and reliability of a product is realised in production through a well planned system and procedure. The Chief Resident Inspectors exercise Supervisory control over the efficacy and effectiveness of the firms inspection organisation and thus ensure that all aeronautical stores conform to the stipulated requirements after manufacture/repair/overhaul. The Chief Resident Inspector is, therefore, required to monitor continued effectiveness of Firm's Inspection Organisation.

Some of the important functions to be performed by Chief Resident Inspector in order to achieve the above objectives are given below: -

Approval of Inspectors for Inspection/certification of systems/equipment / items. Also approval of operators of the firm carrying out welding, soldering jobs. Procedure for approval of inspector is outlined in document “AFQMS”.

a. By carrying out stage inspections at important stages during manufacture/repair/overhaul of aircraft and equipment in a thorough manner.
b. By carrying out Quality Audits of products / processes
c. By carrying out spot checks on processes, items and systems not normally covered by stage inspection.
d. By carrying out Defect Investigation (DI) of premature failures.
e. By scrutiny of aircraft documents.

Responsibility of RDAQA. DGAQA before issuing F-1090:

Before a Certificate of F-1090 is issued to permit an aircraft to carry out flights, RDAQA, DGAQA has to be satisfied that:

a. The aircraft has been manufactured / overhauled / repaired and ground tested in accordance with the stipulated drawings / requirements;
b. The requirements of the contract have been complied with and the inspection of the aircraft has been carried out in accordance with the relevant inspection instructions;
c. Duplicate inspection of all flying controls has been duly carried out and certified
d. All Special Technical Instructions, Servicing Instructions, Special Technical Notes, Special Notes, etc have been complied and properly recorded;
e. All modifications required by the contract plus any Class A modification subsequently issue have been satisfactorily embodied and duly recorded;

f. The aircraft has been weighed, the position of the center of gravity determined and that the aircraft is so loaded that its weight and center of gravity comply with the provisions of the Design Certificate.

NOTE: The responsibility in this regard rests with the Contractor's Approved Inspection Organisation.

In addition, RDAQA, DGAQA inspection will directly verify the following before issue of F-1090:

a. Ensure that all system checks have been carried out.
b. Functioning of all flying control system for correctness, travel and movement;
c. Any flight limitations have been ascertained and recorded on Form 1090;
d. Purpose of the flight has been ascertained and so stated in the Form 1090.

Certificate of Flight Trials:

However, in respect of prototype or modified aircraft (trial Mod etc) which are not to a production drawing standard, F-1090 can be issued only after certificate of flight trials is issued by CRE/RCMA/CEMILAC clearing that special standard for flight trial / flight.

QA During Overhaul / Servicing of Aircraft

The various procedures like QA during assembly / testing F-1090 for flight-testing, delivery etc would apply to the QA during overhaul as well. However, certain activities specific to overhaul of aircraft / systems / LRUs are outlined in the following paras. Servicing is the general term used for the work comprising of presurvey, repair / overhaul / reconditioning / salvage, to restore the equipment to an acceptable operating condition. There are generally four types under this:

Repair: This is a process involving rectification of damage or wear. This is accomplished by:

i. Replacing damaged or deteriorated part,
ii. Making parts good by using suitable tools, material build up and plating processes etc.
iii. Adjustment etc.

NB: All the above operations are carried out to restore the equipment to Serviceable condition.

Major Inspection / Overhaul: This is a process by which the equipment is either

completely stripped or dismantled sufficiently to permit parts to be adequately inspected / repaired. The servicing cycle based on flying hours / calendar time in accordance with the appropriate servicing schedules are laid down in TSI Vol I leaflet No. Org/Serv/4 aa amended from time to time by Air Headquarters. It involves:

i. Inspection and micrometric measurements
ii. Repair
iii. Incorporation of modification, if any
iv. Re-assembly and testing.

NB: After re-conditioning the equipment starts a fresh life (TBO).

Modification: This is prompted due to Design improvement by the production agency, operational requirements and from DI findings. Modifications, bulletins, STI/SIs etc are complied as per latest standard of preparation.

Conversion: (as per user requirement): This is a process by which an equipment can be converted from one type to another as per the contract requirement to fulfill certain operational conditions. If any part / accessory is found to be damaged on receipt during initial pre-survey and the damage is beyond economical repairs, then RDAQA may, after physical verification, take decision to downgrade the part / accessory, to Cat 'E'.

Quality Assurance Functions/Procedures During Manufacture Of Air Armament Stores Including Explosives

Air armament stores manufactured in Ordnance Factories (and in some cases out sourced by them in private sector) are inspected directly by DGAQA through its resident inspectorates positioned in selected Ordnance Factories. The primary responsibility for quality assurance rests with the manufacturer. However, resident inspectors charged with regulatory functions of Quality Assurance will also undertake quality assurance roles. Air armament stores can be broadly classified as:

a. Lethal stores such as arms and ammunition, bombs rockets etc. and their components.
b. Stores for which an ordnance factory has been specifically set-up i.e., explosives. These may be lethal or non-lethal.
c. Non-lethal accessories and miscellaneous stores like packages etc.

Based on the nature/type of the stores, manufacturer's quality control/assurance facilities, (e.g. the works inspection staff maintained by the Factory) and considerations of economy, the degree and type of inspection to be carried out is assessed by the resident inspectorates. For example, in a Factory where new stores of lethal nature are under production either sampling or 100% inspection both in

stage and final has to be carried out in order to minimise rejections at a later stage and subsequent defects after issue to Service.

Examples of 1(b) are High Explosives Factory, Kirkee and Ordnance Factory Bhandara, Ordnance Factory, Itarsi. After a number of years when the inspectors are satisfied that production is well established and the quality is well maintained under control of Factory personnel, only final acceptance inspection, including testing of bulk manufacture samples, where necessary, is carried out.

General Instructions

Resident Inspectors have to inspect production lines to check processes of manufacture and assist in the maintenance of specification standards, as the inspectors are intimately concerned with the framing of specification and hence with the methods of manufacture. Any deviation from approved and correctly established methods of manufacture should be brought to the factory authorities. If they consider that the factory inspection of critical dimensions may lead to large rejections at final inspection, this fact should be taken up suitably with the factory GM.

Any final inspection which is more conveniently carried out in the factory line rather than in the inspection bond will be implemented by arrangement with the factory GM.

In cases where physical or chemical tests of materials are carried out by the factory staff, the inspector must satisfy himself that all such tests as required by the specifications, have been properly carried out.

Inspectors will look out for and take prompt action to prevent unauthorised modifications to the design during production. Delay in production will occur if the factory manufactures unacceptable stores and this will also entail avoidable waste of material and labour.

Inspectors/AHSP will bring to the notice of the Ordnance Factories any advances in manufacturing technique and inspection and trials and defect/failure reports which may be of particular interest to them from production and quality control points of view.

According to the nature of store under manufacture, the Inspector is at liberty at any time to increase his examination of components to 100% or to draw samples of components or materials under use from the shop for test.

Quality Assurance during manufacture of Avionics and Ground Electronic Equipment

The various phases of Life cycle of an equipment are Development Phase, Production Phase and Post-Production/ Maintenance Phase. The various phases of

development of electronic equipment s may be divided into the following three categories:

a. **Feasibility Study Phase:** This phase is to report on the feasibility of development of the proposed equipment and the basis is the Provisional Qualitative Requirement projected by Service HQrs based on the provisional QR, the Design Authority carries out a study of the proposed system and analysis in the feasibility report to what extent the equipment could be developed. Further details are mentioned in part I Section III of DDPIL-2000.
b. **Initial development phase:** The initial development phase is the translation of the Provisional Qualitative Requirement into a model designated as Model 'A'. This model should perform as per the Provisional Qualitative Requirement to the extent possible. Service HQrs examines this model to verify to what extent the Provisional Qualitative Requirement needs to be modified before it can be finalised as Qualitative Requirement. Further details are mentioned in Part I Section III of DDPIL-2000.
c. **Final Development Phase:** The final development phase commences when the initial development phase has been completed and QRs have been finalised. The final development phase would result in Model 'B' which will be a representative of first production run. Model 'B' is subjected to technical evaluation by Technical Coordinating Authority (TCA) and user trials by Services. For further details reference may be made to DDPIL-2000.

At the end of development phase, on successful completion of development of an item, the concerned authority will issue Type Approval Certificate or Qualification Approval as per DDPMAS/ DDPIL procedure and the production phase commences.

Phases of Production:

Quality Assurance support shall be provided during the various production phases of life cycle of Avionics and Ground Electronics Equipment/ Items. Environmental classification for both these categories of equipment is specified in JSS-55555 and MIL-STD-810E. The various phases of production can be broadly classified as follows -

Limited Series Production:

After the final development phase is completed and before the main production commences a limited number of equipments termed as Limited Series Production (LSP) are manufactured by the Production Agency. These are mainly to confirm the technical characteristics like parameter variations, consistency, efficacy of changes carried out on the development model before finalising the production document like Drawings, Test Methods etc. The details of tests, including environmental tests to be conducted on these units would be arrived at jointly by Design Agency, Production

Agency, Certifying Agency (as applicable) and DGAQA.

Main/ Regular Production Phase:

During this phase the equipment are manufactured as per finalised documents. The acceptance procedures for the equipment are based on the finalised Quality plan for the equipment. The Design Authority supplies the procurement drawings for the purpose of AHSP and Inspection duties, these drawings after approval by Design Authority are sealed and kept as authenticated copies by Quality Assurance Authority/AHSP.

Post Production Modification/ Improvements:

After the first production run and its introduction into service, improvements may be necessitated based on the user's feedback. Further details are mentioned in Part I Section III of DDPIL-2000.

Guidelines For Quality Audit

Quality-Audit is a systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives. It is a key management tool for achieving the objectives set out in an organization policy. It provides objective evidence concerning the need for the reduction, elimination and especially prevention of non-conformities. The results of these audits help in enhancing the realization of quality objectives.

Scope And Application:

DGAQA establishments have been employing quality audits as a part of their surveillance functions, as a valuable tool for verification of conformance of both the system and the product. These guidelines are issued to emphasize the necessity for carrying out Quality Audits regularly and also to enable the conduct of quality Audits in a uniform manner with a standard documentation/records. The Quality Audits can be applied either to quality management systems/ procedures of an organization or to a product/ process/ service in line with the respective applicable documents.

Types of Audit: There are three main categories as mentioned below: -

- **Internal Audits:** These audits are carried out by an organization to determine the degree of compliance of its own quality-management-system requirements using human resources from within the organization. This is a requirement of ISO-9000 and other Quality- System standards. This is also

required to be assessed as a part of the “Management Review” process. Such audits need to be frequent with fast follow-up action and the actions need to be recorded and documented. The records of such internal audits and the follow-up-action are necessary parts of the quality-system to demonstrate to outside organizations that the quality-system is effective. M/S. HAL conducting internal quality audit as per procedure laid down in their Quality-Manual within one of their divisions may be an example. It is a System-Audit.

- **External Audits:** These assessments are carried out by an agency on an organization external to its own. It evaluates the activities of its contractors, suppliers, agents etc. The examples are: -

    a. HQrs, DGAQA conducting an audit on the functions of one Chief Resident Inspector at a particular place.
    b. DGAQA carrying out firm’s inspection
    c. M/s HAL: one division conducting an audit on one of their vendor supplying a particular item.

- **Extrinsic Audit:** These are carried out by a Customer, Third party Organisations, Regulatory Authority etc on a company to assess its activities against specific requirements. The examples are :-

    a. RDAQA carrying out an audit on the Quality Control System of a HAL Division.
    b. An outside firm conducting the audit on the product being manufactured by HAL for them.
    c. An audit by an Accreditation Agency on M/S HAL as a pre-requisite to grant accreditation against ISO 9002.

Objectives of Audits:

The primary objective of an audit is to examine a quality system to determine the degree with which it complies with a given set of requirements (Quality Standard, Quality-Manual etc). But there are secondary objectives as mentioned below which may decide the effectiveness of the Audit: -

A. To compare two or more suppliers competing for a particular contract.
B. To identify special quality requirements for a particular contract.
C. To recommend and establish levels of purchaser quality assurance activity during the course of supply.
D. To assist regular suppliers to improve their quality systems.
E. To verify implementation of a supplier’s quality system on a given contract.
F. To confirm or amend the established level of purchaser’s inspection and test

G. To provide post-contract evidence of effective quality assurance.
H. Project related audit.
I. To update knowledge in the QA capabilities and performances of regular suppliers.