Audits in the Aerospace Industries - Past, Present, Future

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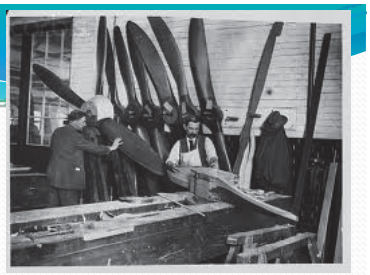
The beginning

- Inspection in the aeronautical industry started together with the manufacturing of airplanes.
- The inspection was localized and an idea of combining affords was raised.
- During the early 30th it was understood in Britain that to make a central inspection body will create a monstrous organization.
- It was found that the majority of the producers have efficient and effective inspection of their own.
- Thus it was decided in Britain that the inspection system shall be based on a policy that will require that each firm shall carry out its own inspection in a manner approved by the Air Ministry and under a system of a definite Air Ministry supervision.

AID

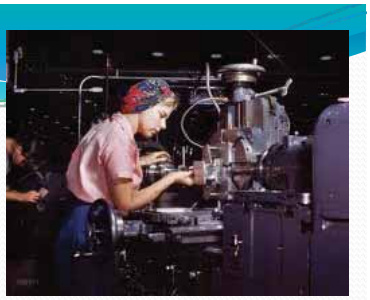


- This policy set the system that is now known as – "*Approval of Firms' Own Inspection".*
- This made it possible to extend the inspection from the raw materials, the processes, the manufacturing of parts, assemblies to the finished airplane.
- To enable the control the Aeronautical Inspection Directorate [AID] was established.
- It had 6 geographical areas with a Principal Inspection Officer [PIO] at the head of each area.
- For each manufacturer, who had his own inspection system a Inspector in Charge was nominated.

AID

- As the WW2 progressed the AID grew in strength and numbers and by the end of the war its manager was already a Director General.
- In order for the inspectors to have power in the facilities where they worked a contract was signed with each firm.
- The use of this methodology enabled the use of a small group and in total the numbers of AID members was about 1% of the total workforce in the aero-industry during WW2.

AID



- The ongoing war caused that the demand for more production grew and the result was a lot of subcontracting type of work.
- Thus the parent manufacturer could concentrate on development and assembly of the airplanes.
- The outcome was that a lot of factories from various fields [furniture, cars, etc.] started to produce aero-parts and the need for manufacturing and inspection systems with aero-plane oriented was identified.
- This also raised the issue of controlling the systems which brought the need for an auditing system

Audits

- The auditing methodology used was of Inspector in Charge allocated to each manufacturer.
- A lesson learned was to nominate a inspector for each new subcontractor immediately in the beginning of the operation with him and to examine his inspection system to assure compliance to the requirements.
- The parent manufacturer used a procedure to control the subcontractor that included:
  - ☑ Preliminary visits from the sub-contractor to the parent manufacturer before the start of the contract,
  - ☑ Visit from the parent manufacturer at the subcontractor to verify there is no risks and to aid,
  - ☑ Percentage check inspection after receipt to verify the ability of the subcontractor.

Audits

- In 1957 the inspection of aircraft equipment was transferred by AID to the Electrical Inspection Directorate (EID).
- In 1967 the Inspection Division transferred to the Aviation Group of the Ministry of Technology.

This short summary just shows the advancement in Britain as an example. The same process can be found in other countries which manufacture airplanes. The following slides will show the global process.

Time table of Quality system standards

- 1959 – USA DOD issue MIL-Std-9858 on quality program requirements.
- 1968 – UK MoD publish AvP92 for management requirements for design and production of aircraft and guided weapons.
- 1968 – NATO publish the Allied Quality Assurance Standard which is based mainly on the MIL-Std-9858.
- 1975 – Canada publish Z299 which is a Quality System Standard for non-military use.
- 1979 – British Standard Institute publish BS5750 which have 3 parts to match the 3 UK defense Std and the AQAP standards.

Time table of Quality system standards

- 1982 – UK government issue a white paper that encouraged the British industry to pursue certification to quality standards.
- 1987 – ISO issues ISO9000 for Quality system with a combined affords of over 26 countries . The Std had 6 parts.
- 1995 – US canceled the Military standards and adopted the ISO ones.

ISO9000 standard

- As you have learned by now there were several quality management standards in the industry.
- In the 80th ISO identified that even due these standards were linked there was no sufficient consistency in terminology or content.
- A technical committee 176 of the ISO started its work in 1980.
- The standard which was the base of their work was the BS5750.
- The first standard issued was the ISO 8402 which was the vocabulary standard [1986].
- The ISO 9000 standard was published in 1987
- It had 4 parts – 9001, 9002, 9003 and 9004.

From ISO web site

Vision 2000

- The ISO/TC176 Ad Hoc task force outlined in the 90th a strategy and key concepts.
- Among these they identified four generic product categories:
  - ☑Hardware
  - ☑Software
  - ☑Processed materials
  - ☑Services
- in 1994 the 9001-3 was added to cover software and 9004-2 was added to cover services and 9004-3 for processed material.

From ISO web site

Vision 2000

- Vision 2000 proposed 4 goals-
  - ☑Universal acceptance
  - ☑Current compatibility
  - ☑Forward compatibility
  - ☑Forward flexibility
- By the year 2000 the 3 9001, 9002, 9003 were combined to one – 9001.
- The 2000 version sought to make a radical change in thinking by placing the concept of process management front and center.

From ISO web site

AS9000

- 1998 – IAQG the International Aerospace Quality Group was established and it included 57 aerospace companies.
- AS9000 was developed by representatives from USA, Asia, Europe and the Americas.
- Supported by Airbus, Parker, GE, NASA, Spirit, Boeing, Lockheed Martin, Rolls Royce and Northrop Grumman.
- The intent and concept behind AS9000 are similar to Boeing's D1-9000. The standard is based on ISO9000, with 27 additional requirements unique to the aerospace industry. The intent is to standardize and streamline many of the other aerospace quality management standards.

From IAQG web site

AS9100

- In 1999, AS9100A replaced AS9000, the previous aerospace specific quality management system. The replacement of AS9000 came about because of the review and development of the ISO 9000 family of standards, where ISO 9001:2000 replaced ISO 9001:1994.
- AS9100 A was split into two sections, which set out requirements based in both the 2000 and 1994 versions of ISO 9001. The AS9100 revision B has superseded revision A.
- AS9110 and AS9120, the most recent additions to the AS family were published in January 2003 and November 2002 respectively. These two standards are based on ISO 9001:2000, and focus upon the specific quality requirements of the maintenance and stockiest distributor segments of the aerospace industry.

From IAQG web site

ISO9001 versus AS9100

- AS 9100 version is formatted to match ISO 9001:2000 and have added “requirements” that provide for -
  - ☑ Regulatory organizations interfaces
  - ☑ Configuration Management
  - ☑ Design and Development & testing
  - ☑ Control of changes in Production Process
  - ☑ Control of production equipment, tools, NC machines
  - ☑ Control of work in outside facilities
  - ☑ Control of service operations
  - ☑ First Article Inspection
  - ☑ Inspection documentation
- These added requirements enables a standardized approach to supplier flow down requirements.

From IAQG web site

Upgrade to Rev. C

- Following the upgrade of ISO9001 a change was made to the AS9100 too.
- A team of 18 members initiated the change, they represented America, Europe and Asia-Pacific.
- 16 different IAQG companies participated.
- A lot of stakeholders were involved such as the CAA, Defense industry and Authorities, the Space industry and Authorities, Certification and Registration bodies, Suppliers and IAQC teams

From IAQG presentation rev 3 May 14 2010

ISO9001 rev C

- It incorporated the ISO9001:2008 changes.
- Expanded scope to include land and sea based systems for defense applications.
- Ensured alignment with IAQG strategy for on-time delivery and quality performance.
- Improved existing requirements where stakeholders identified need for clarification, including when a documented procedure is required.
- Added issues are risk management, Special requirements, Critical items, work transfer and more.

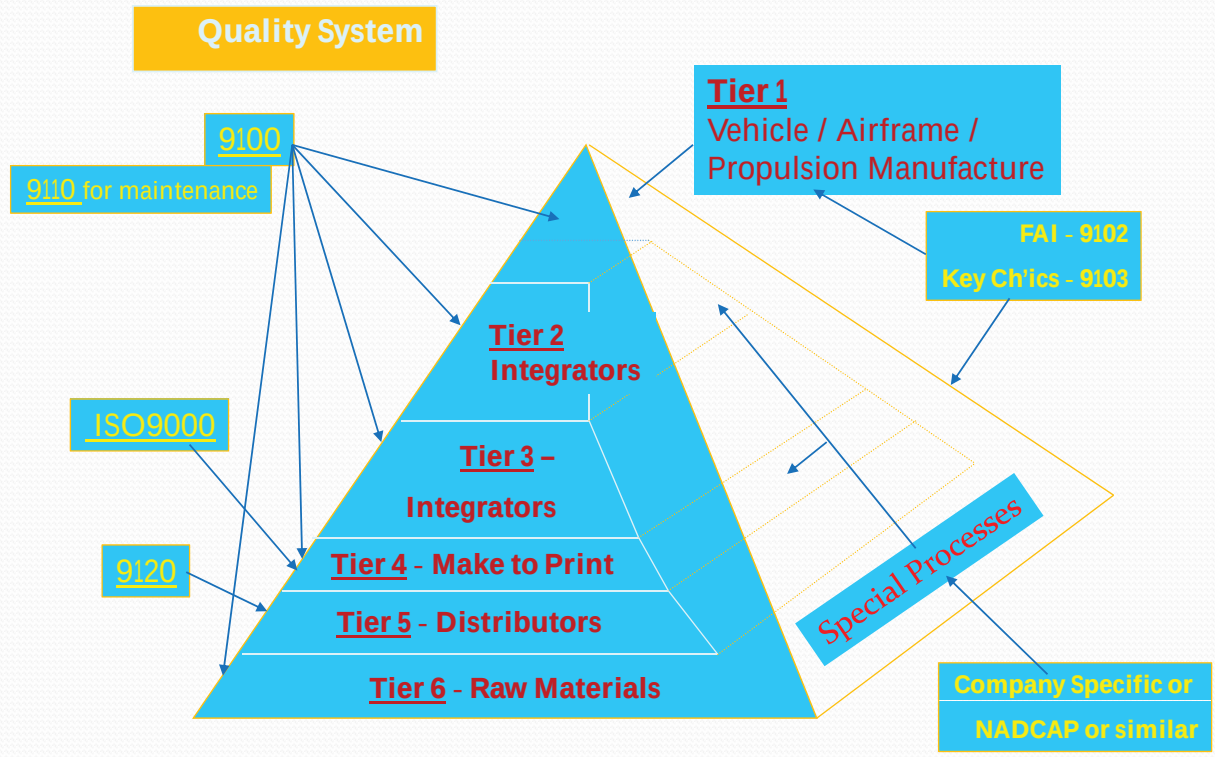
From IAQG presentation rev 3 May 14 2010

ISO9001 rev C

- The rev. C have an emphasis on product and process improvement.
- It ensures that the standard is compatible for use by all stakeholder and organizations of all types and sizes.
- It ensures that the standard is recognized by the authorities.
- It puts emphasis on the use of sub-contracting in view of the prime manufacturer use of more and more work transfer while concentrating on the aircraft assembly.

From IAQG presentation rev 3 May 14 2010

Supply chain



From IAQG presentation

NADCAP

- Quality management systems are not the only audited fields in the aerospace industry,
- Special processes have a major influence on the parts, systems and airplanes too.
- Special processes include among others – Heat treat, Non-destructive testing [NDT], Welding, Painting, Plating and more.
- The NADCAP program was created in 1990 by SAE.
- The membership is of prime contractors.
- Through the Performance Review Institute, NADCAP provides independent certification of manufacturing processes for the industry.

From NADCAP web site

NADCAP mission

- To provide international, unbiased, independent manufacturing process and product assessments and certification services for the purpose of adding value, reducing total cost, and facilitating relationships between subscribers and suppliers.

From NADCAP web site

The system

- PRI conducts periodical audits for suppliers on behalf of the prime contractors.
- For auditing a set of check lists are in use divided to specific process requirements.
- In each field there are generic checklists that have common issues for all industry and specific where each of the primes can add his specific demand.
- The audits are very methodic and are covered in several days.
- The auditors are experts in the filed that they are auditing with many years of experience.

From NADCAP web site

The system

- Upon completing an audit the supplier must address the non-conformances in a very detailed form.
- The response is checked by a field engineer who is also very experienced in his field.
- 3 cycles of response are allowed and on the forth an audit might be considered as failed.
- There is also a merit program that recognizes good suppliers and allows larger intervals between audits.
- There are periodical meeting where supplier can attend, meet the PRI staff and have a chance to comment on issues.

From NADCAP web site

The system

- PRI maintains a web site for the operation and control of the NADCAP process.
- The access is limited and a password is needed.
- In it all the audit process, schedules, status and correspondence can be found.
- The site as also a list of QML – Qualified Manufacturer List.
- A supplier can be searched per certification, location etc. for each supplier there is a listing of all his certifications and results.
- The NADCAP saves a lot of resources for both customers and suppliers, it is based on a common baseline that is agreed upon by all primes.

From NADCAP web site

Summary

- Since the beginning of airplane building sub-contracting is a basic method of operation.
- To control it a system of audits is used.
- The audit methodology is improved constantly.
- In the beginning the auditor was stationed at the supplier facility. He was using for his audits checklists that were defined by a central body.
- Then auditors were a part of a certifying body and checked several suppliers. First in the field of quality management systems and today also special processes.

Summary

- In today's aviation industry we saw that a chain of customers-suppliers is used.
- In order to work efficiently Just-In-Time methodology is used.
- Any stoppage in this suppliers chain influences the entire line and the outcome is late supplies, poor quality and unplanned expenses.
- Thus auditing the system allows proper operation, risk reducing, savings and getting the requested quality.
- Audits per AS9100C and NADCAP assures that the supplier chain shall not be broken.

Some links

- NADCAP - http://www.pri-network.org/PRI/
- Israeli Society For Quality - http://www.isq.org.il/
- American Society for Quality - http://asq.org/
- ASQ Aviation, Space and Defense division - http://asq.org/asd/
- Cabiran foundry http://www.cabiran.com/

- *You are invited to the 19th International Conference of the Israel Society for Quality in Tel-Aviv, November 26-28, 2012.*

איכות בעידן הדיגיטלי
QUALITY IN THE DIGITAL ERA
לחיות את עתיד האיכות
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Thank you.