AEROSPACE QUALITY MANAGEMENT SYSTEM STANDARDS - AS 9100 SERIES

ליפתחי שולמית
מנדל גיורא האירופית במענה התעשיות האירופיות בע"מ
יר"ר מנהל תעשיית במטויכים, תעופה ולהל ה CURL במענה לארכניצ"ל

28/1/2005 S.Lichtenstein
Background - Early to mid-1990s

Quality Control ("Inspect In” Quality at end of line)
MIL-I-45208
1940’s-60’s

Quality Assurance ("Inspect In” Quality In Process)
MIL-Q-9858
1960’s-80’s

Quality Assurance Management ("Manufacture In Quality”)
ISO 9001,2,3
1980’s-end 90’s

- Regulations (FAA, JAA, ESA, etc)
- Customers Specific Requirements
Background - Early to mid-1990s

- DOD (US Department of Defense) canceled quality system specifications (MIL-Q-9858)
- FAA (Federal Aviation Administration) lacks a definitive description of a quality system (FAR 21 & FAR145)
- Defense Customers and Aerospace Primes (mainly in Europe) began to flow ISO 9000 series plus unique requirements to suppliers
- Suppliers asked industry to standardize
  - Needed to operate a single quality system
  - Already adopting ISO 9000 series
U.S. Industry Response - 1995

Supplier Management and Quality Assurance professionals from:

- AlliedSignal
- Boeing
- GE Engines
- Lockheed Martin
- McDonnell Douglas
- Pratt & Whitney
- Rockwell Collins
- Rolls-Royce Allison
- Sundstrand
- Northrop Grumman

Sponsors

- Aviation/Space & Defense Division of American Society for Quality
- SAE Aerospace Council
“Where aerospace quality and safety is concerned... there is no competitive advantage”
Aerospace Standard birth

Inputs

D1-9000
ISO-9001
DoD
FAA
MIL-Q
Company Specific Req’mts
NASA
MIL-I

AS9100

S. Lichtenstein

28/1/2005
Global Quality Standard Activity
Implement initiatives that make significant improvements in Quality and reduction in cost, throughout the value stream, by establishing and maintaining dynamic cooperation, based on trust, between international aerospace companies.
Global Approach to Improvement

- Over 50 major aerospace companies across three global sectors
- Improvement through implementation of effective quality management systems and practices
- System and product integrity initiatives driven with constancy of purpose
- Co-operation, consultation and communication with:
  - partners and suppliers
  - airworthiness authorities
  - customers across all sectors of business
### An Organization of Co-operation

#### Americas
- The Boeing Company
- Bombardier
- CAE
- Embraer
- GE Aircraft Engines
- Goodrich Corporation
- Gulfstream
- Honeywell Aerospace
- Lockheed Martin
- Northrop Grumman
- Orbital
- Parker Aerospace
- Raytheon
- Rockwell Collins
- Rolls-Royce Corporation
- Textron
- United Technologies Corp.
- Vought
- PRI
- SAE

#### Europe
- Airbus
- ALENIA
- BAE Systems
- Dassault Aviation
- EADS
- EADS – CASA
- EADS Military
- Eurocopter
- (Fiat) Avio
- Fokker Aerostructures
- Westlands
- Hegan
- Hispano-Suiza
- Israel Aircraft Industries
- Messier-Bugatti
- Messier-Dowty
- MTU Aero engine
- Rolls-Royce
- SAAB Aerospace
- Smiths Industries
- SNECMA Moteurs
- Sonaca
- Sukhoi
- Thales Avionics

#### Europe – Continued
- Turbomeca
- Volvo – Aero
- Westland Helicopters
- Zodiac
- AECMA

#### Asia
- Aerospace Industrial Development Corp.
- Aviation Industries of China
- Fuji Heavy Industries
- Ishikawajima Harima Heavy Industries
- Kawasaki Heavy Ind
- Korea Aerospace Ind
- Korean Air Aerospace
- Mitsubishi Heavy Ind
- Shin Mayawa Ind
- SJAC

---

28/1/2005
International Quality System
Standard Creation 1998

Americas Standard
AS9000

ISO 9001
1994

World Aerospace Quality
Standard; AS/EN/JIS Q 9100

ISO TC 20
WG11

EN 9100

European Standard
prEN 9000-1
Why 9100?

- To standardize Aerospace quality expectations on a global level
- To achieve improvements in quality and reduce costs throughout the value stream
- ISO 9000 model for quality does not capture regulatory requirements or importance of safety, reliability or maintainability
- Captures aerospace supplements agreed to at an international level
AEROSPACE SUPPLY CHAIN

Tier 1
Vehicle / Airframe / Propulsion Manufacture

Variation Reduction
FAI Process Proving

9100
Tier 2
Integrators / Source Control / Software Dev. / Major Assemblies

Special Processes

Tier 3 - Integrators / Source Control / Specialty Electronics / Wiring / Compts

9110 for Repair Stations

Tier 4 - Make to Print / Machine Shops / Processors

Tier 5 - Distributors (Fasteners, Raw Materials, Commodities, Adhesives, Special Materials)

Tier 6 - Raw Materials (Castings, Forgings, Sheet, etc)

Company Specific or NADCAP

S.Lichtenstein 28/1/2005
Aerospace Quality Standards Numbering System

- **International Standards - 91xx**
  - Harmonized across all 3 aerospace sectors and recognized globally
- **“AS” Standards - Americas**
  - Published by Society of Automotive Engineers
- **“EN” Standards - Europe**
  - Published in Europe by ASD (former AECMA)
- **“JIS Q” or “SJAC” is the Japan / Asia Equivalent**
Aerospace Quality System Standards

- INTERNATIONAL STANDARDS
  - 9100 - Quality System for Aerospace Manufacturers
  - 9101 - Check sheet for 9100
  - 9110 - Quality System for Aerospace Repair Stations
  - 9111 - Check sheet for 9110
  - 9120 - Quality System for Distributors
  - 9121 - Check sheet for 9120
Aerospace Quality System 9100
Standard versus ISO 9001

- 9100 added 83 additional and specific requirements to the 20 elements of ISO 9001
  - 11 amplifications of ISO 9001 paragraphs are also inserted
- Emphasis is placed on Design Control, Process Control, Purchasing, Inspection & Testing and Control of Non conformances
  - All areas that have the greatest impact on safety and reliability for aerospace products
ISO 9001:
- Generic quality management system standard - applicable to shoes as well as to airplanes

9100:
- Includes all ISO 9001 requirements
- Adds the expectations of the aerospace industry for a robust quality management system for aerospace products

Continuous Improvement:
- Continuous improvement processes shall include provision for using the quality policy, quality objectives, audit results, measurement and analysis of data, variability reduction, corrective and preventive action, and management review (all but variability reduction are part of 9001:2000 requirements)
ISO9001 versus 9100

- 9100 version is formatted to match ISO 9001:2000 and added "requirements" that provide for:
  - Regulatory organizations interfaces
  - Configuration Management
  - Design and Development V&V, & V&V 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 enable a standardized approach to supplier flow down requirements
● Requirements of regulatory authorities must be included in documentation
  – Including access by authorities to the records, documentation and change approval (as req’d)

● Must show relationship of 9100 standard to lower level procedures

● Documented procedure for records control

● Requires Configuration Management for the product / process
Design and Development output includes:
- Identification of Key Characteristics (FMECA)
- All necessary data to manufacture the product
- Gated Design Reviews
- Documentation of both Design Verification and Design Validation (reports / calculations / etc.)
- Design Verification and Validation testing

Design Change Control
- Includes customer and regulatory approval as necessary
Purchasing

- Responsible for all suppliers (incl. customer designated ones)
- Must have a list of suppliers
- Supplier performance review process
- Control of special process sources
- Whoever approves a supplier, can disapprove them as well
- Stringent flow down requirements - sub-tier
- Notification of nonconformance / process change
- Right of access by customer and regulatory personnel
9100: Product Realization (ISO Clause 7)

- Planning for Production and Service:
  - Control plans and process controls
  - In-process verification for hidden features
  - Design of tooling for variable measurements

- Controlled Production
  - Accountability of product during manufacture
  - Evidence all operations are complete
  - FOD control
  - Monitoring of environmental influences
  - Criteria for workmanship
  - Use of approved data and specified tooling with instructions
7.5.2 Validation of processes for production and service

...processes ...where the resulting output cannot be verified by subsequent monitoring or measurement.

NOTE: *These processes are frequently referred to as special processes.*

...demonstrate the ability of these processes to achieve planned results.

...establish arrangements for these processes including, as applicable

a) defined criteria for review and approval of the processes,

qualification and approval of special processes prior to use,

b) approval of equipment and qualification of personnel,

c) use of specific methods and procedures,

control of the significant operations and parameters of special processes in accordance with documented process specifications and changes thereto,

d) requirements for records (see 4.2.4), and

e) revalidation.
Special Process Approval Objectives

- To put in place industry controlled process for meeting requirements of 9100 clause 7.5.2
  - Supplier processes are an extension of the OEM processes
- To reduce redundant audits for the special process at suppliers and improve the global quality level
  - Common requirements (auditors and audit questionnaires)
  - Harmonized assessment process
  - Data exchange
  - Demonstrated industry managed process
  - Process oversight
  - Mutual system recognition

NADCAP/ASD PRO
9100 Introduces Two important Concepts for Aerospace

- **First Article Inspections**
  - Always required
  - 9102 is mentioned for Guidance
  - 9102 is only mandatory when specifically required in contracts

- **Key Characteristics**
  - When specified
  - 9103 is referenced for guidance
  - 9103 is only mandatory when specifically required in contracts and key characteristics are identified
9102 First Article Inspection

- FAIs apply:
  - to assemblies and all levels of parts within an assembly, including castings and forgings
  - Suppliers responsible for ensuring that characteristics conform to Customer requirements
  - Sub-tier suppliers and processors of parts and materials for suppliers
What is Included in First Article Inspection?

- **Verification of All Design Characteristics:**
  - Dimensional Verification via Marked-up (or “Balloonered”) Drawings that Correlate Characteristic Number from FAI to the Drawing.
  - Part Marking

- **Material and Special Process Certifications**
  - Including Operator Certifications (e.g. NDT, Welding)

- **Manufacturing Process Verifications**
  - Manufacturing Routing Sheets.
  - Referenced Exhibits Supporting the FAI (e.g. CMM Data Printouts, Test Data, Acceptance Test Procedures, Process Certifications, etc.).
  - Process Capability Studies, As Applicable.
  - Gauge Correlation, As Applicable.
  - Tooling Traceability, If Tooling Is Used to Verify Design Characteristics

- **Nonconformance Resolutions**
9102 First Article Inspection

- Any 9100 compliant organization in absence of a contractual requirement to use 9102 or other specific FAI customer requirement, can devise any methods and processes it chooses to meet the requirements of this clause and the "extent" of an FAI is also at the discretion of the organization as along as it is applied to each "new part" and subsequent changes thereto.

- New part means – Parts, sub-assemblies and assemblies, however FAI’s are progressive
Variation Management of Key Characteristics will provide a common standard for expectations for KC’s within the aerospace industry.

**Key Characteristic (9100):** The features of a material or part whose variation has a significant influence on the fit, performance, service life, or manufacturability.

- Dimensional features - thickness, diameter, length, etc.
- Chemical concentrations
- Time, Pressure, speed, rates, temperature, etc.
Variation Management of Key Characteristics Purpose (9103)

Intent to drive the improvement of the manufacturing processes through adequate planning and effective management of Key Characteristic variation.

• Methodology for component/process proving focused on Key Characteristics.
  - Understanding processes
  - Using appropriate tools
  - Demonstrating acceptable process capabilities
  - Guidelines for reporting process capability data to primes.
9100 Checklist - 9101

- IAQG developed 9101 Common Checklist to be used by industry to cover all ISO 9001 & 9100 elements - allows industry to share audit information

- **Must be used by Certification Bodies when performing 9100 audits**
EN 9110 developed and implemented in Europe for facilities that perform maintenance and repairs of aircraft and aircraft products and adopted by other sectors

- Based on 9100 requirements and FAA / JAA - JAR 145 requirements

- Corresponding 9111 checklist has also been developed and published
EN 9120 developed and implemented in Europe for “pass through” stockists / distributors that handle parts and supplies that are used in aerospace products

International harmonized standard is agreed

Checklist 9121 is also available

Based on 9100, but only applies necessary system requirements.
Industry Leaders are Listening

- Agreed to improve the overall approach to quality
- Major Aerospace Companies have agreed upon Quality Management System approval approaches
- A key objective is to reduce the number of audits
- There are significant benefits to the Aerospace Industry
- Working to develop our International processes to incorporate the new approach
- International approach is based on a single agreed standard, harmonization of system application and shared information
Summary

- A single 9100 Aerospace standard
- An agreed single International procedure of application
- Sector scheme procedures harmonised and complete
- Implementation planned aggressively during 2005
- Establish a mechanism for data exchange
- International auditor training and qualifications
- Continue to communicate to all
- Team will co-ordinate implementation programs
- Monitor and maintain progress
Nadcap

- The leading worldwide cooperative program of major companies designed to manage a cost effective consensus approach to special processes and products and provide continuous improvement within the aerospace and automotive industries.
Key Points With Respect to Nadcap

- Nadcap is an industry supported, managed and controlled program based on AS7003
- As an industry program subscribing primes and participating companies define and control the process
- Nadcap accredits suppliers of processes and products based on audit criteria developed through industry consensus
- The goal of Nadcap is to improve quality of product by ensuring suppliers are competent, capable and consistent
Nadcap Programs

- Special Processes
  - Nondestructive Testing
  - Materials Testing
  - Heat Treating
  - Coatings
  - Chemical Processing
  - Welding
  - Nonconventional Machining & Surface Enhancement

- Systems & Products
  - Sealants
  - Distributors
  - AQS (AC7004)
  - Fluid Distribution Standards
  - Elastomer Seals

- Under Development
  - Composites Fabrication & Adhesive Bonding
  - Electronics
  - Fasteners
PRI/Nadcap Organizational Structure

Senior Quality Leaders
- Develop strategic plan and vision
- Promote Nadcap among prime contractors
- Support launch of new task groups
- Promote continuous improvement

Technical Experts
- Determine requirements
- Develop documents
- Accept corrective action
- Final decision on accreditation

Task Groups
- Special Processes
- Nondestructive Testing
- Materials Testing
- Heat Treating
- Coatings
- Chemical Processing
- Welding
- NCM/Shot Peening
- Systems & Products
- Distributors
- Sealants, Elastomer Seals
- AQS (AC7004)
- Fluid Distribution Systems

Executive leaders
- Legal entity
- Fiduciary responsibility
- Set policy
- Provide the Vision

PRI Board of Directors

Nadcap Executive Strategic Planning Board (NESPB)

Nadcap Regional Advisory Bodies

Nadcap Management Council (NMC)

Administrative Staff

Supplier Support Committee

Senior quality leaders & managers
- Oversee operation of Nadcap
- Establish & implement policy & procedures
- Task group coordination & development
- Identify, develop and deploy improvement