Swiss Society of Systems Engineering SWISSED15

"The challenges of Systems Engineering within a Maintenance and Repair Organisation."

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SR Technics

Abstract

From its inception as the maintenance, repair and overhaul arm of Swissair, SR Technics has now become a leading independent airline maintenance provider with around 3300 FTE and CHF bn 1.1 revenue in 2014.

To respond to the continuing challenges of the business environment and ever competitive MRO market, SR Technics seeks continually to differentiate its products and service offering. One key approach has been to diversify into more complex cabin modifications which draws on the strength of its Aircraft Services Engineering business unit combined to its all round capabilities in production and maintenance.

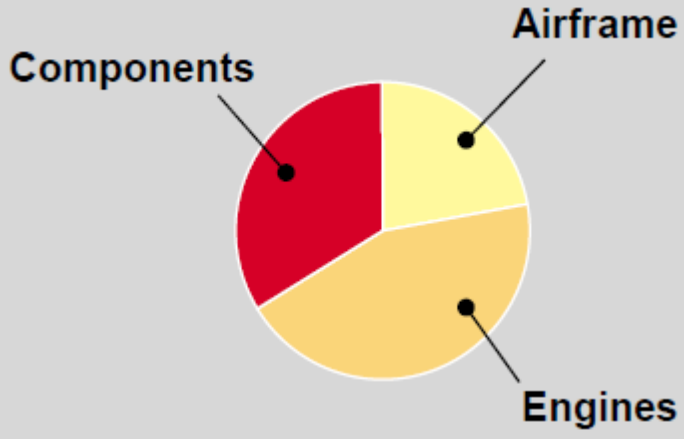
This presentation shall highlight the challenges faced by SR Technics as it continues to advance in that area and show the benefits that can be drawn from adopting sound systems engineering approach and principles to its design for complex cabin modifications.

SR Technics at a glance

Key figures

Financials

- By product segment:



Operative presence

- Employees: average number of FTEs in 2014 was 3,300 – thereof 2,200 employees in Zurich
- Facilities: Seven hangars totaling 68,950 sqm
- Main facilities Zurich (full MRO services & VIP completion), Malta (Centre of Excellence for narrow body aircraft), Kuala Lumpur (component repairs), Cork (piece part repairs)

SR Technics is a leading independent airline maintenance provider with around 3,300 employees globally in 2014

Mubadala Development Company Ownership
Main Place of Business at Zurich Airport

Overview service portfolio

Full spectrum of repair and overhaul services

Airframes

- Comprehensive maintenance and modification solutions for line, base and heavy maintenance of Airbus and Boeing fleets
- VIP completion / refurbishment services

Components

- Over 50,000 part numbers on Airbus and Boeing fleets
- Management of entire component MRO program
- Rotable inventory management

Engines

- CFM 56-5B/5C/7B (more than 1,500 engine shop visits in total)
- PW4000 94”/100” (over 2,200 shop visits in total)
- Piece part repair

- Wide range of integrated solutions combining MRO activities
- Component and engine finance, sale and leaseback
- Engineering services
- Fleet technical management
- Technical training

SR Technics provides the full spectrum of MRO services to its customers and is well positioned for the long term

SR Technics

Overview service portfolio

Spectrum of design and production services in Zurich and Dublin

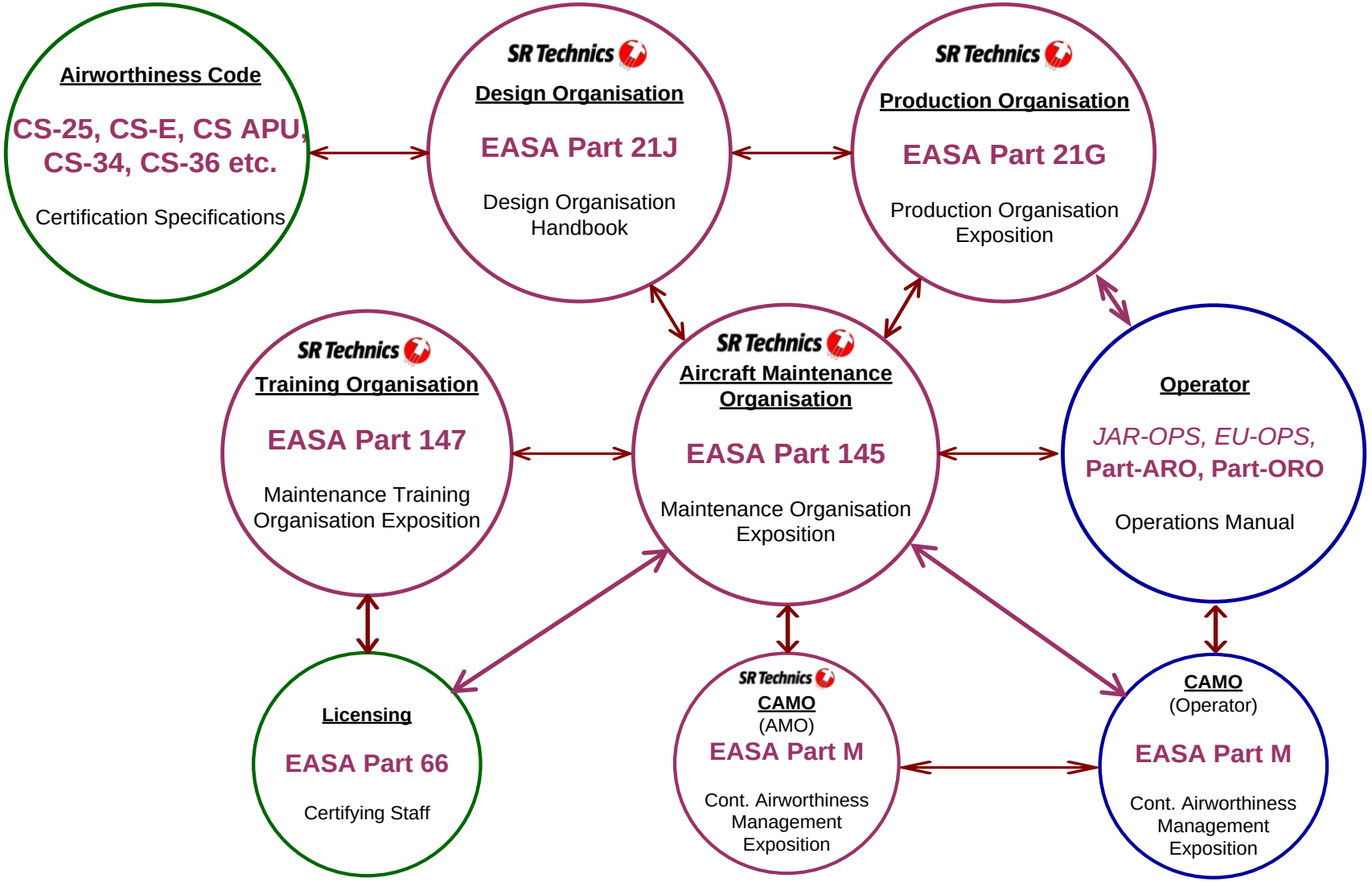
Design

- Changes to large aero planes in the following areas:
  - Cabin interiors and associated systems
  - Installation of avionics equipment
- Minor changes to large aero planes in the following areas:
  - Cockpit, Cargo Compartment
  - Structures
  - Systems (e.g. Electrical, Mechanical, Hydraulic, Pneumatic, Air-Conditioning, Oxygen)
- Minor repairs to large aero planes in the following areas:
  - Avionic systems
  - Electrical systems
  - Structures
  - Cabin interiors
  - Systems
- Minor changes and repairs to turbine engines excluding design changes and repairs to systems components and disks, shafts and spacers defined as critical parts or life limited parts

Production

- C1 Appliances to aircraft interiors
- C2 Parts for aircraft outfitting
- Parts for appliances listed under C1

EASA regulation overview for SR Technics



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Design Organisation – EASA Part 21J

- Design organization (DO) means an approved organization designing and certifying aeronautical products, systems, appliances and parts as well as changes and repairs to them
- Aeronautical products are aircraft, engine and propellers certified by means of Type Certificates
- DO tasks and activities shall be performed in accordance with EASA requirements (Part 21 & Certification Specifications) by appropriately trained DO personnel
- A design organization produces approved data to be used by maintenance organizations, production organizations and operators
- Independent Design Organizations (SRT, LHT), Original Equipment Manufacturers (Airbus, Boeing) and Aviation Authorities (EASA, FAA) produce approved data and have the same legal status

SR Technics Design Process

1. **Design Engineer (DE)**
   - Defines (type) design
   - Performs classification (minor/major)
   - Establishes and demonstrates compliance (using the Classification & Certification sheet)
   - Prepares implementation documents (Engineering Disposition/Drawings)

Design

2. **Design Review Engineer (DRE)**
   - Reviews the classification
   - Reviews the compliance demonstration
   - Reviews the technical content

Review

3. **Compliance Verification Engineer (CVE)**
   - Checks the design for completeness
   - Verifies the classification
   - Verifies the compliance demonstration
   - Performs the independent checking function.
   - Approves the design on behalf of the Office of Airworthiness

Approval

Challenges

- External Factors
  - Unfavorable exchange rate
  - Most expensive location to do engineering from
  - Established competitors able to take advantage of cross-borders workers
- Internal Factors
  - An MRO focuses on using approved data produced by various DOs,
  - There is a tendency for segmentation whereby work become compartmentalized
  - The existence of a DO, PO and MO within the same company tends to create a working relation where things are passed on from organization to the other
  - In addition, approved data does not originate necessarily from the MRO own DO, it comes in majority from OEM or other DOs
  - Corporate culture – from being linked to an airline in the past providing a steady workload
  - Most MRO personnel have been educated and trained within the company (from FTS school transitioning later to Enginieering providing hangar support for maintenance activities -> highly skilled competent workforce within their trade areas

Other Considerations

- When considering P21J activities for cabin modifications, the MRO DO is faced with the challenge to produce appropriate design data for use on an existing product which must remain airworthy.
- P21J desing activities in this context is akin to what the aircraft OEM do but with the aim to produce an STC.
- Such design activities require a high degree of collaboration from production and maintenance personnel with design engineering and supply chain to produce the required work
- Potential Consequences if work not succesfully carried out:
  - Cost overrun
  - Schedule overrun
  - Demotivated workforce
  - Unhappy customer

A Systems Engineering Approach: can it help?

Systems engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem: operations, cost and schedule, performance, training and support, test, manufacturing, and disposal. SE considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs.

From INCOSE Systems Engineering Handbook v. 3.2.1

A Systems Engineering Approach: Keywords & Ideas

- Interdiciplinary
- Iterative
- Socio-technical
- Wholeness
- The SE process has an iterative nature that supports learning and continuous improvement.
- Complexity can lead to unexpected and unpredictable behavior of systems;
- SE includes both technical and management processes
- Decisions made early in the life cycle of a system, whose consequences are not clearly understood, can have enormous implications later in the life of a system
- It is the task of the systems engineer to explore these issues and make the critical decisions in a timely manner.

From INCOSE Systems Engineering Handbook v. 3.2.1

Using a Systems Engineering Approach

- Based on the key ideas at the heart of systems engineering, a number of tools can be deployed to address the challenges faced by such MRO organization
- SE has emerged as effective way to manage complexity and change
- Complexity and changes are precisely faced by SR Technics as an MRO doing cabin modifications

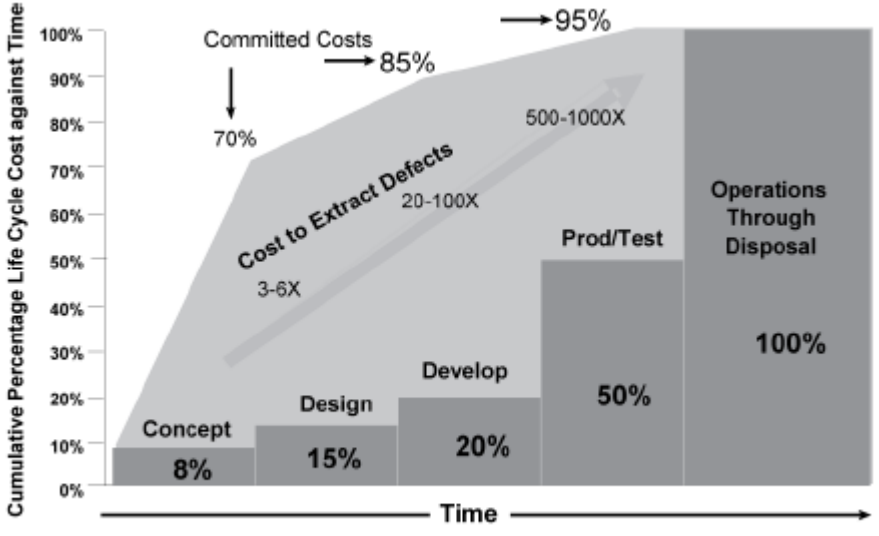
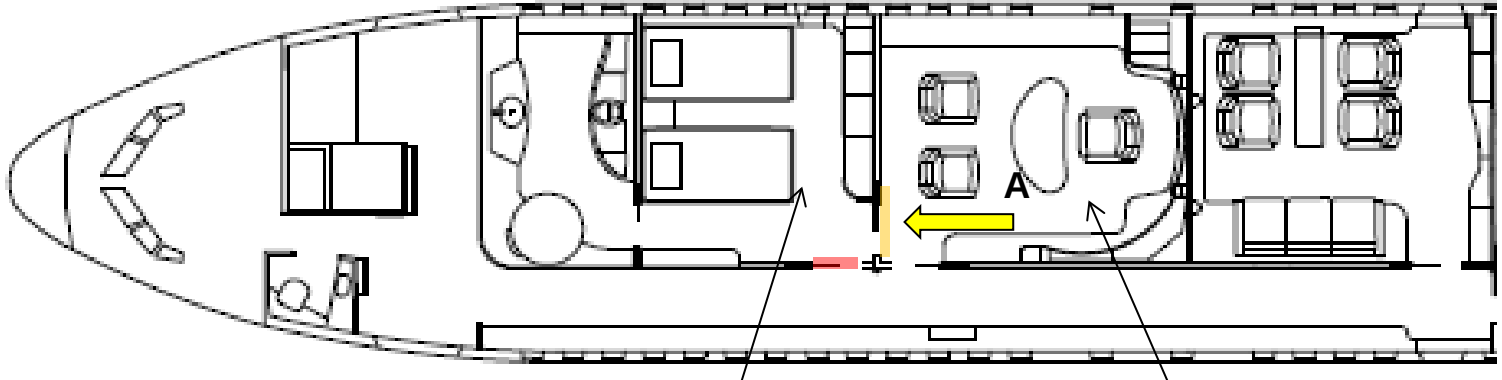


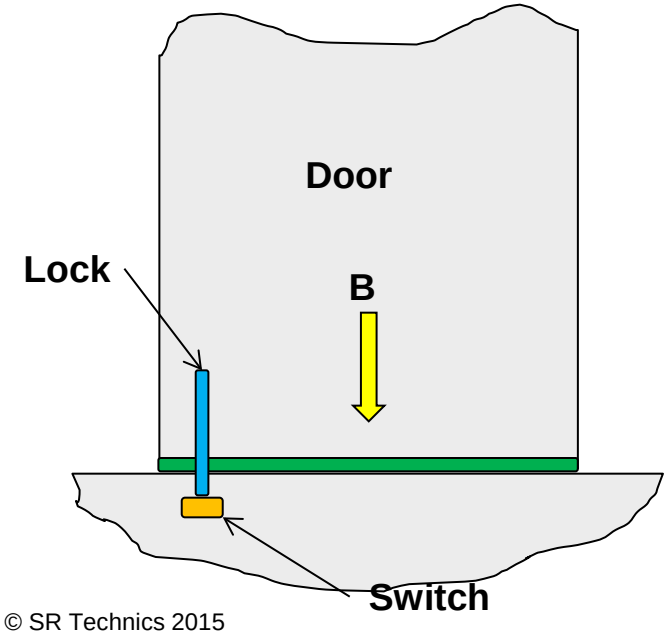
Figure 2-4 Committed Life-cycle Cost against Time[13]

From INCOSE Systems Engineering Handbook v. 3.2.1

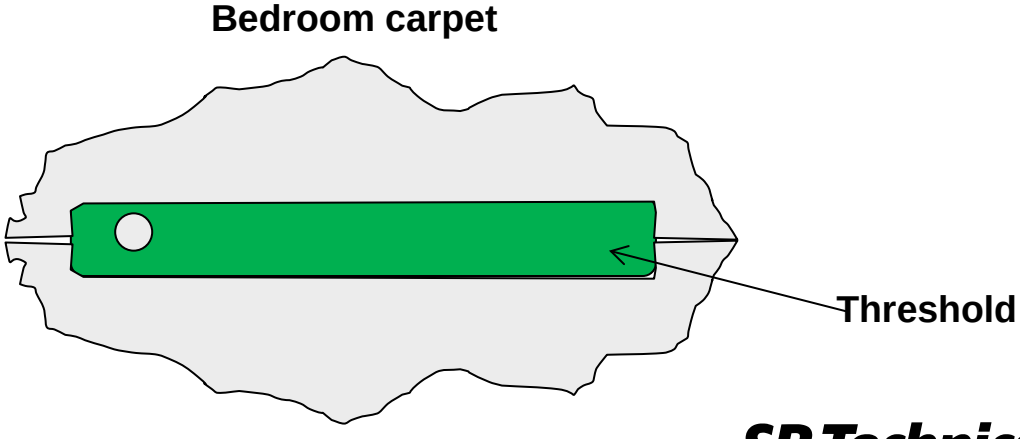
Example - Bedroom Door Switch Relocation



View A - Forward



View B - Down



Example – Bedroom Door Switch Relocation

- VIP aircraft configuration with a master bedroom adjacent to an office, and a hallway
- Customer complained that the switches on the floor kept breaking down (as flying crew went in and out of the rooms, they would step on it accidentally)
- Hence customer asked for the switch to be relocated to the top
- Aircraft was surveyed and this was thought to be possible – a straight forward task
- Design was done and drawings made with corresponding electrical circuit modifications.
- New thresholds were also designed to replace the old ones.
- After installation, customer complained the door could not be locked anymore as the bolt could not go through the threshold as before
- A design review identified that some important requirements for the switch being relocated from the floor were missed

Example – Bedroom Door Switch Relocation

- The impact of the customer request was not fully assessed
- There were in addition discrepancy on the design data between the mechanical drawings indicating one switch present and the electrical wiring diagram identifying two switches
- Furthermore, the substantiation data for the door decompression test lacked clarity with respect to the door behaviour during decompression with the lock in place – normally the lock would contain a design feature to allow the lock bolt to shear off and the door to swing open
- Clearly had the requirements been defined and fully understood, a different call would have been made: possibly advising the customer that moving the switch was not certifiable unless a new decompression test was performed on the door
- For each new project, a detailed scope of work is now written to ensure common understanding
- Further improvements could be made with a formal requirements analysis

Conclusion

- As SR Technics moves towards more complex cabin modifications to complement its traditional role as an independent MRO provider, it requires to adopt design practices that will enable the company to continue to be successful
- Systems Engineering thinking and practices are an appropriate means to achieve such a goal

Thank you for your attention

www.srtechnics.com

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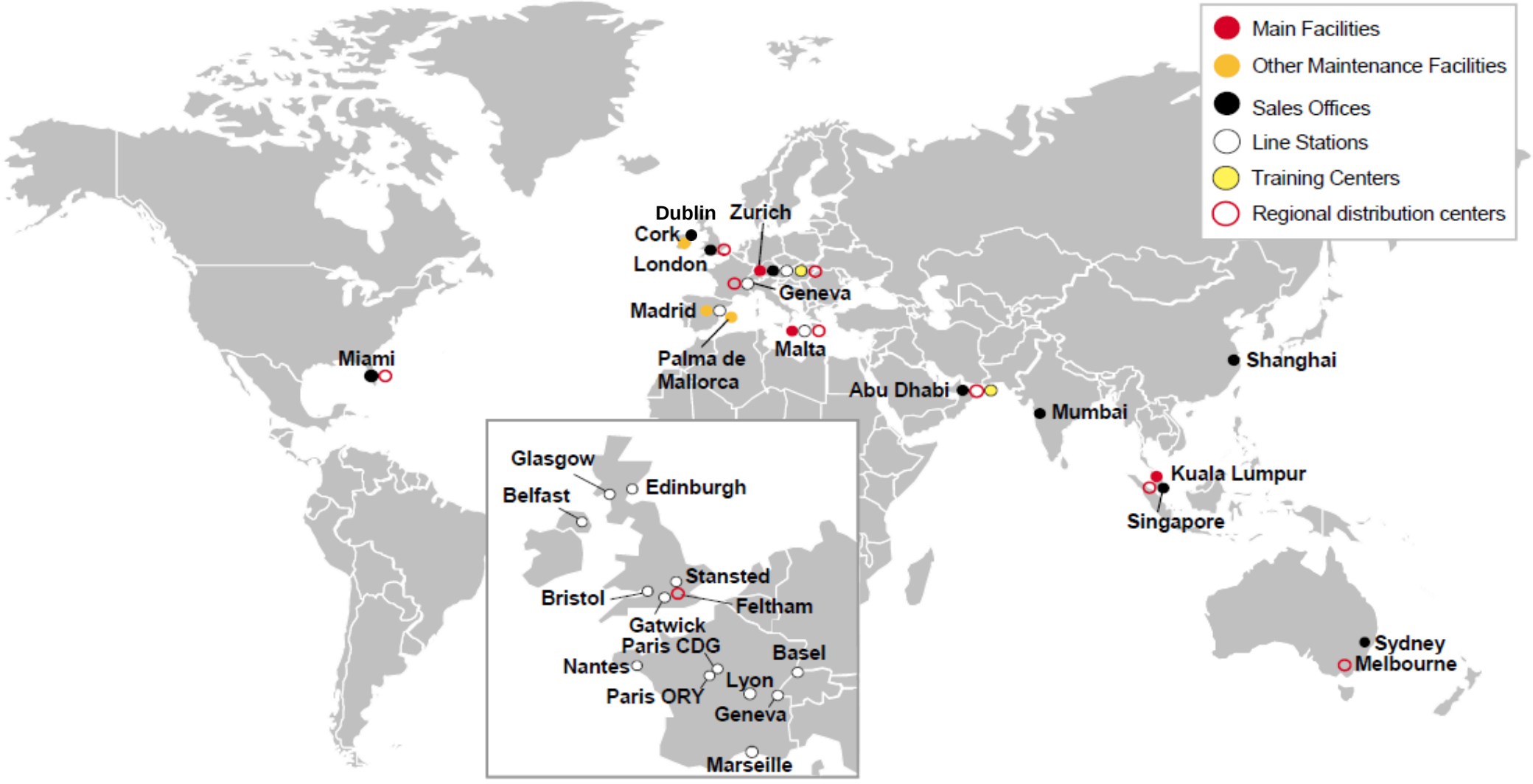
ADDITIONAL MATERIAL

Full service provider – geographic footprint

Main facilities in Zurich, Malta, Kuala Lumpur and Cork

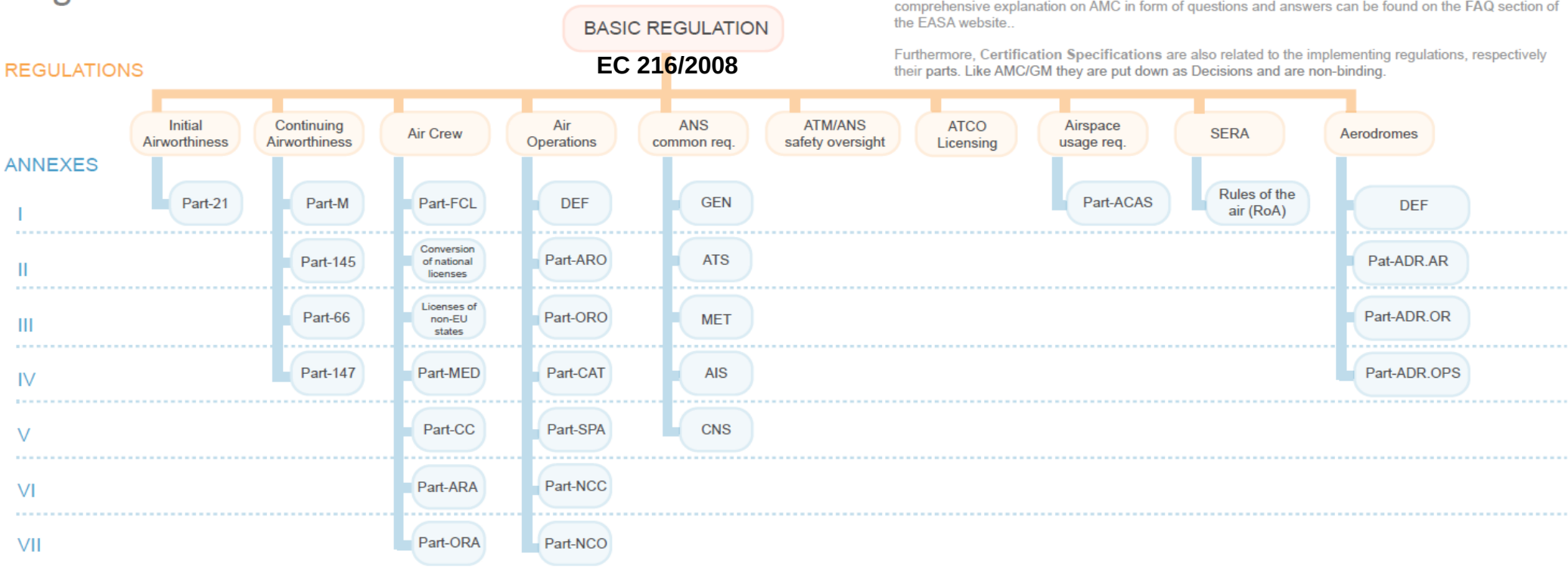


SR Technics Approvals

- EASA Maintenance and Repair Organization Approval # CH.145.0200
- EASA Design Organisation Approval # EASA.21J.358
- EASA Production Organisation Approval # CH.21G.0016
- EASA Continuing Airworthiness Management Organisation Approval # CH.MG.7005 & IE.MG.0106
- EASA Maintenance Training and Examination Organisation Approval # CH.147.0009
- FAA Foreign Repair Station Approval # SWRY322I
- ISO EN 9119:2010 Approval

EASA, European Aviation Safety Agency
European Regulatory Work Frame

Regulations Structure



Each Part to each implementing regulation has its own **Acceptable Means of Compliance and Guidance Material (AMC/GM)**. These AMC and GM are amended along with the amendments of the regulations. These AMC/GM are so-called 'soft law' (non-binding rules), and put down in form of EASA Decisions. A comprehensive explanation on AMC in form of questions and answers can be found on the FAQ section of the EASA website..

Furthermore, **Certification Specifications** are also related to the implementing regulations, respectively their parts. Like AMC/GM they are put down as Decisions and are non-binding.

FULL TITLES

Commission Regulation (EU) No 748/2012 of 03/08/2012 laying down implementing rules for the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations	**Commission Regulation (EC) No 2042/2003** on the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these	**Commission Regulation (EU) No 1178/2011 of 3 November 2011** laying down technical requirements and administrative procedures related to civil aviation aircrew pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council	**Commission Regulation (EU) No 965/2012 of 5 October 2012** laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament	**Commission Implementing Regulation (EU) No 1035/2011 of 17 October 2011** laying down common requirements for the provision of air navigation services	**Commission Implementing Regulation (EU) No 1034/2011 of 17 October 2011** on safety oversight in air traffic management and air navigation services	**Commission Regulation (EU) No 805/2011** for air traffic controllers' licences and certain certificates pursuant to Regulation (EC) No 216/2008	**Commission Implementing Regulation (EU) No 1332/2011 of 16 December 2011** laying down common airspace usage requirements and operating procedures for airborne collision avoidance	**Commission Implementing Regulation (EU) No 923/2012 of 26/09/2011** laying down the common rules of the air and operational provisions regarding services and procedures in air navigation	**Commission Implementing Regulation (EU) No 139/2014 of 12/02/2014** laying down requireme/nts and administrative procedures related to aerodromes pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council

http://www.easa.eu.int

Change & Repair Definition – EASA Part 21J

- **Type Certificate**
  - Certificates issued to products if compliance to the relevant Airworthiness Code (e.g. Certification Specifications CS-25) has been demonstrated.
- **Change** (Modification, Alteration)
  - A change is defined as “alteration of any of the data included in the type design
- **Repair**
  - A repair is defined as “elimination of damage and/or restoration to an airworthy condition following initial release into service by the manufacturer of any product, part or appliance”
- **Minor / Major Classification**
  - A ‘minor change / repair’ is one that *has no appreciable effect* on the mass, balance, structural strength, reliability, operational characteristics, noise, fuel venting, exhaust emission, or other characteristics affecting the airworthiness of the product.
  - All other changes / repairs are ‘major’.
  - A major change to a product is called a Supplemental Type Certificate (STC)

SR Technics Supplemental Type Certificate Process

1. **Prerequisites for Design**
   - Sales, Engineering & Office of Airworthiness
   - Agreement with the Customer / Contract in place
   - Design is within DO scope of Approval
2. **Preliminary Design**
   - Engineering preparing the preliminary design package
   - The process runs parallel with the certification process
3. **Classification of Design**
   - Office of Airworthiness / CVEs team
   - Major Change to the type design results in a STC
4. **Establish the applicable Certification Basis / Airworthiness Code**
   - Office of Airworthiness / CVEs team
   - Choose the applicable set of requirements (certification specifications) for showing of compliance using the Type Certificate / Type Certificate Data Sheet
   - Define the appropriate Method of Compliance
   - Issue Certification Plan
5. **Application to EASA**
   - Head Office of Airworthiness

SR Technics Supplemental Type Certificate Process

6. **Certification Review Meeting**
   - Office of Airworthiness / CVEs team / EASA Project Certification Manager
   - Agreement of the Certification Basis, Certification Plan & Certification Review Items
7. **Data creation & verification / Resources management**
   - Engineering creates detailed design data and substantiation documents to show compliance according to the Certification Plan
   - CVEs verify and approve drawings, substantiation documents, compliance reports
   - Testing & witnessing / First article Inspection
   - Resources & Project management (external & internal)
   - Collaboration with Production & Maintenance (Installation)
   - Conformity Inspection & Cabin Compliance Inspection
   - Office of Airworthiness issues & approves the Classification & Certification Sheet
8. **Submission of Certification package to EASA**
   - Head of Design signs the declaration of compliance
   - Head Office of Airworthiness submits the package to EASA
9. **Verification of the Certification package & Issue of the STC**
   - If satisfied with the provided data, EASA issues the STC

SR Technics is holder of 10 STCs for cabin reconfigurations on CAT & VIP / Airbus & Boeing large aero planes

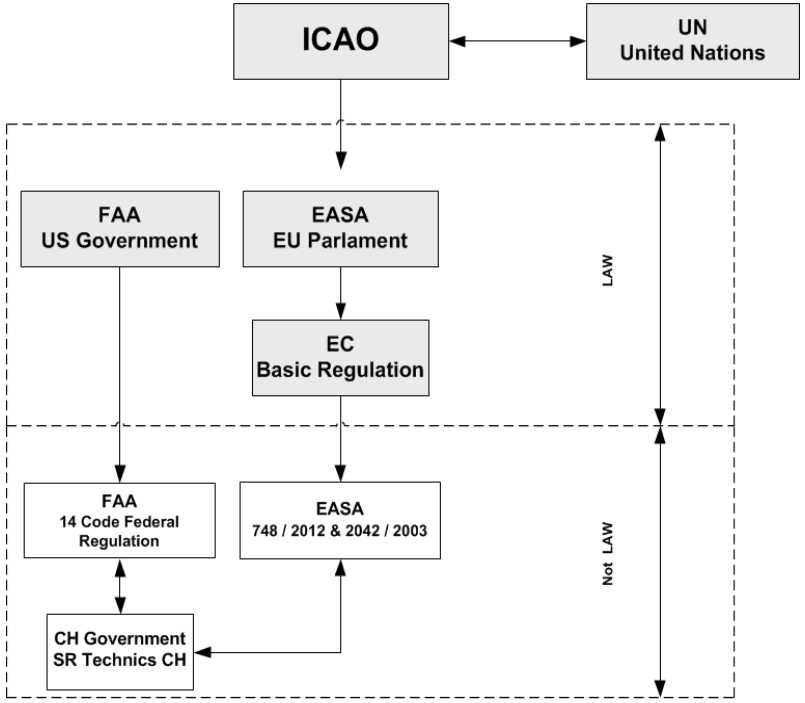
SR Technics Design Personnel and Responsibilities

- **Design Engineer (DE)**
  - Designs changes & repairs, performs classification and establishes compliance
- **Design Review Engineer (DRE)**
  - Reviews technical content of design, classification and confirms compliance
- **Compliance Verification Engineer (CVE)**
  - Verifies and approves designs on behalf of the Office of Airworthiness. *Conducts the independent checking function.*
- **Head of the Office of Airworthiness (HOoA)**
  - Is the focal point for coordination of all matters regarding airworthiness & environmental protection
  - Issues guidelines for certification
  - Reports directly to Head of Design
  - Is the primary contact for the EASA and National Aviation Authorities
- **Head of the Design Organisation (HoD)**
  - Is responsible for proper functioning and compliance with Part 21 of the DO.
- **Head of Quality Assurance (HQA)**
  - Is responsible for independent monitoring of the Design Assurance System (DAS)

Aviation Authorities – Regulatory Bodies

INTERNATIONAL CIVIL AVIATION ORGANIZATION
A United Nations Specialized Agency

- Founded in1944 in Montreal, United Nation Specialized Agency (191 States)
- Publishes International Standards and Recommended Practices (codes for A/C and countiries, traffic law / right, Personnel Licencing, Operation of Aircraft, Aircraft Nationality and Registration Marks, Airworthiness of Aircraft, Environmental Certification, Continuing Airworthiness Manual, Safety Management System)



Federal Aviation Administration

FAA, Federal Aviation Administration (US)

- Founded in 1958 in Washington
- Regulates US civil aviation, space transport and air traffic

JAA, Joint Aviation Authorities (Europe)

- Founded in 1970 with the head quarter in The Neatherlands
- No regulatory body issuing and recommending aviation regulations to the National Aviation Authorities
- JAA has been superseeded by EASA (closed in 2009)

EASA, European Safety Agency (EU)

- Founded in 2003 and full acting since 2006 with the head quarter in Cologne, Germany
- Legislative body of EU Parliament issuing civil aviation regulations legally binding for all EASA Members (EU Member States, Switzerland, Norway, Iceland)

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

FOCA, Federal Office for Civil Aviation (CH)

- Swiss regulatory body based in Bern issuing a regulations are binding for all operators with a Swiss Air Operator Certificate (AOC) and or operating an aircraft registered in Switzerland (Aircraft registered HB-ABC)