Reference Structure Design Principles – the basis for A350XWB design

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Head of A350 NSDW Structure Design
## Contents

### Introduction
- Requirement cascade
- Focus of the Presentation and Definition of “Design Principles”

### Why do we need Design Principles?

### Design Principles

### Summary and Conclusion
Introduction

Requirement cascade

Aircraft level

Major component level

Section level

Design Principle

Transverse Activities

TLAR

TLStrRD

StRD/SRD

RSDP/SIDP

Design Principle
Introduction

Requirements

• Starting with the customer needs, **Top Level Aircraft Requirements (TLAR)** are formulated, e.g.
  • Number of passengers/seats
  • Weight
  • Payload
  • Range, etc.

• These requirements are broken down into requirements for **Major Components** of the A/C, **Top Level Structure Requirements Dossier (TLSrRD)** e.g. for:
  • Fuselage
  • Wing
  • Empennage
  • Systems

• **Section Level requirements (StRD)** for structural components e.g. for
  • Skins
  • Stringers
  • Floor Structure

• **Design Principles** (**Reference Structure Design Principles and System Installation Design Principles**)
Introduction

Focus of the Presentation

Reference Structure Design Principles

System Installation Design Principles

Detailed Design

Specific Design Work teams at Airbus and at Risk Share Partners

Non-Specific Design Work Team at Airbus Core Engineering

• An **SIDP** is a set of DPs that guide the systems design engineer when designing the aircraft systems

• An **RSDP** is a set of DPs that guide the structures design engineer when designing the structure of the airframe

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Why and when do we need Design Principles?

Goals and Approach

Ensure a good design, taking into account robustness, inspection, repair...

Avoid the “Harlequin Aircraft”
Why and when do we need Design Principles?

Goals and Approach

The following aspects have to be taken into account when designing an aircraft:

- avoid the "Harlequin Aircraft"
- guarantee **Consistency** across the aircraft
- secure **Interfaces**
- standardize **Solutions**

This is even more important since the introduction of extended enterprise i.e. working with Risk Share Partners

Consequences:

- homogeneous section approach
- even if more than one design solution will work, it is not Airbus' intention to implement different solutions for one and the same application in the aircraft
Why and when do we need Design Principles?

Design Process

Why and when do we need Design Principles?
Why and when do we need Design Principles?

Schedule Overview

RSDPs availability for A350-900

Mat A in mid 2008
Mat B in mid 2009, since MG5/Mat B the RSDP is mandatory for A350 design
Mat C in mid 2010, further updates issued under a strictly controlled change process
Contents

Introduction

Why do we need Design Principles?

Design Principles

Design Principle Documents

RSDP content

Summary and Conclusion
Reference Structure Design Principles sources

Content of RSDP is generated from various sources:

- Experience from previous aircraft programmes
- Latest technology progress derived from tests and R&T programmes
- Significant design optimization
- Recent in-service and manufacturing experience

RSDPs must not outline any rational, why the DPs are as they are!
Design Principle Documents

RSDP: Description & Content

Generic Design Principles

• General design principles (volume 1)
• Composite design principles (volume 2)
• Metallic design principles (volume 3)

Component Specific Design Principles

• Fuselage (volume 4)
• Wing (volume 5)
• Empennage (volume 6)
Applicable Restrictions for External Distribution

Export rules towards A350XWB Risk Sharing Partners (RSPs) are as follows:

• **Volume 0 (Introduction):** available for all RSPs
• **Volumes 1, 2 & 3 (Generic):** available for all RSPs
• **Volume 4 (Fuselage):** available for Fuselage section RSPs only
• **Volume 5 (Wing):** available for Wing RSPs only
• **Volume 6 (Rear Fuselage and Empennage):** available for Empennage RSPs only
Design Principles

**RSDP: Vol 1 - Generic Design Principles**

- Mechanically Fastened Joints in composite, metal, hybrid structures
- Specific Design Rules for Damage Prone Areas
- Shimming
- Sealing Principles
- Surface Protection DP
- Lightning Strike Protection
- Design for Erosion Protection
- Installation DP for A-Brackets
- Bushing Installation
- Lubrication, Drainage
- Design for Accessibility and Inspectability
RSDP Vol. 1 Generic Design Principles - example mechanical joints

**Figure 3: Countersunk fastener**

**Table 6: Edge distance**

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<th>Dia (mm)</th>
<th>Tensile (mm)</th>
<th>Compressive (mm)</th>
<th>Perpendicular (mm)</th>
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Environmental categories definition

Surface protection schemes depending on environmental categories

[Diagram showing various categories and protection schemes]
Allowed and forbidden locations on the structure for system installation brackets

Allowed area for bracket installation on frames
Design Principles

RSDP: Vol 2 - Composite Design Principles

Structural Analysis Categories

• Structural Critical Classification
• Composite classification for primary/secondary structure

Rules for Laminate Design

• Stacking/staggering rules
• Manufacturing rules
• Design Principles for sandwich components

Bonded Joints

• Co-curing/ Co-bonding / Secondary Bonding
Interleaved plies

Ply drop-off

Ramp ratios in load direction and perpendicular
Automated Fibre Placement/
Automated Tape Laying process

Minimum strip length
for AFP and ATL
Processes to be
considered in ply
boundaries

Lap and gap
limits
Ply location, chamfer angle
For sandwich component design

Extension of potting/filler materials in sandwich components around attachment elements
Design Principles

RSDP: Vol 3 - Metallic Design Principles

Manufacturing Technologies

- Forming, machining, …
- Description & constraints
- Design rules

Welded joints

- Process
- Design recommendations

Design for Static, Fatigue & DT

- Guidelines
Examples of Vol. 3 content:

- **Metallic Materials specific items**
  - Aluminum, Ti, Steel, new alloys ... description of specific features to be considered e.g. bend radii and machining radii, thickness steps

- **Environment Friendly Design**
  - Substances not allowed/banned materials
  - Surface protection code management
Design Principles

RSDP: Vol 4 – Fuselage Design Principles

Fuselage component DPs

- Skins and stringers
- Frames
- Frame to skin connection – clips
- Cabin window frames
- Door surround structure
- PAX floor
- Bilge area Design Principles

Fuselage joints DPs

- Longitudinal joints
- Orbital joints
- Nodes of orbital/longitudinal joints

Miscellaneous

- Lightning strike protection
- Electric Structure Network
- Design for repairability/damage prone areas
RSDP Vol. 4 Fuselage Design Principles - example orbital joints
Definition of distances

Positioning of the fasteners
RSDP Vol. 4 Fuselage Design Principles - example ramps under Omega-stringers

**Figure 65:** Basic rules for slopes under stringer

- Centred ramp
- Ramp shifted to thicker part of the panel
RSDP Vol. 4 Fuselage Design Principles - example lightning strike protection at longitudinal joints

Design principles for Al/CFRP junctions with Al/clip

design principles for CFRP/CFRP junctions for C areas with Al part
Design Principles

RSDP: Vol. 5  - Wing/Pylon Design Principles

Wing component DPs

• Fastener systems
• Wing covers
• Wing spars
• Wing ribs
• Leading&Trailing edge attachment
• Man-hole cut-outs and doors
• Root joint
• Lightning strike protection
Fastener types

Assembly details
spar to wing cover

Surface protection /LSP
RSDP Vol. 5 Wing Design Principle - example T-stringer geometry and ply build-up

T-stringer geometry and build-up

Ply run-out in radius

Figure 31: Interleaved ply drop in stringer radius
RSDP Vol. 5 Wing Design Principles- example of a wing stringer run-out configuration

Double angle configuration of stringer run-out (one out of several Options)
RSDP Vol. 5 Wing Design Principle - example root joint

Root joint general view

Design details
Design Principles

RSDP: Vol. 6 – Empennage Design Principles

Empennage component DPs

- HTP/VTP overview
- Covers
- Spars
- Ribs
- Leading edge protection
- HTP root joint
- VTP attachment
- Surface protection
- Drainage
- Rudder & elevator
- Fuselage rear end
Summary and Conclusion

RSDP aims at **achievement of a proof design**, in compliance with
- best practices,
- applicable regulations,
- weight & cost optimization,
- manufacturing processes
- economical/environmental constraints.

RSDPs are **mandatory** and must be followed by design offices!
- In case of significant deviation from these Design Principles the originator must justify his solution by test or analysis
- Deviation must be authorized by Airbus

RSDPs are **needed to ensure a proof design taking into account**
robustness, inspection, repairability, etc
- a good way to avoid the “harlequin aircraft” and secure a harmonized design
Thank you for your attention