Documentation
Class Objectives

- Understand the analysts and designers job role better
- Understand why we document our analysis and design notes
- Know what makes good notes
There are Three Major Reasons to Thoroughly Document Analysis and Design

Regulatory requirements
- shows compliance
- basis for formal documentation

Internal Boeing use
- liaison
- in-service issues
- weight reductions
- derivatives
- new airplane programs

Your performance will be measured by its quality and availability.
The FAA is the federal agency that regulates the manufacture and operation of all flight vehicles.

Boeing deals mainly with the FAA Northwest Regional Office in south Renton.

Official communication with the FAA is handled through the Airworthiness group, who keeps a record of all official correspondence.

DER’s are licensed to act as the FAA representative on specific subjects.

No aircraft design can be flown without FAA approval.

Documentation for the craft must show that the design meets all the requirements of the appropriate FAR’s to be certified for its specific flight certificate.
When an aircraft design is approved, it is given a type certificate, which allows production of exact duplicates without further approval.

No changes in design or build processes are permitted without further FAA approval, most changes are approved by DER’s.

As a stress analysts, you will be required to show the DER analysis the verifies compliance with the FAR’s for all designs and changes on an existing design.

This analysis becomes part of the certification documentation and must be maintained as long as the aircraft is in service or the company is in business.

If the company goes out of business, all drawings and documentation are turned over to the FAA.

The FAA has the right to inspect all analysis at any time.
Good Strength Check Notes are Important

Because the FAA has the right to inspect our analysis at any time:

• Documentation showing that an aircraft meets all required FAR’s must exist
• Stress analysts must provide DER’s with analysis verifying compliance with the FAR’s
• Analysis documentation must be maintained as long at the aircraft is in service

Notes will be reviewed by internal Boeing auditors
Why should we document our design?

- To maintain a historical record of past problems and resolutions
- To maintain a record of past and current structural configurations
- For use when reviewing design improvements
  - weight reductions, performance enhancements, producibility, and cost savings
- For comparison with our competitors and the evolution of structure over time
Guidelines for Good Notes

• Notes must be legible
• Sign, date, and number all pages
• Use only pages with title blocks
• If used, a copy of any personal spreadsheets or programs and explanation of their use must be notes
• Flag all Margins of Safety (MS) in right hand margins
• Remove or mark out all analysis that no longer applies
• Reference source of analysis methods, allowables, loads, and load case numbers
• Notes must be complete and signed off before drawing is signed off
• Organize and file with group notes at completion

M.S. = .01
Outline for Strength Check Notes

For New Design or PRR
Reference SIRP Sheet (D6-42525)

Section
1. Table of Contents
2. Discussion
   Include any assumptions, special methods, or special factors used and reference their source
   Should include anything which will help someone understand the location, function, and analysis of the part
3. Margin of Safety Summary
4. Description of Part
   Sketch or reduced drawing
   Material types and allowables, include extrusion, forging, casting numbers, etc.
5. External Loads
   A free body and specific reference to origin of loads such as ELFINI run or coordination sheet
6. Internal Loads
   Includes loads on all elements of the part
7. Analysis
## Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page No</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Discussion</td>
<td>2.1</td>
</tr>
<tr>
<td>3. Margin Of Safety Summary</td>
<td>3.1</td>
</tr>
<tr>
<td>4. Description Of Rib</td>
<td>4.1</td>
</tr>
<tr>
<td>4.1. Materials</td>
<td>4.2</td>
</tr>
<tr>
<td>5. External Loads</td>
<td>5.1</td>
</tr>
<tr>
<td>6. Internal Loads</td>
<td>6.1</td>
</tr>
<tr>
<td>7. Analysis</td>
<td>7.1</td>
</tr>
</tbody>
</table>
2. Discussion

- The WBL 117.1 Rib supports the center track. This track is the highest loaded of the three tracks, and carries both shear and moment into the mid flap. This is the most important rib in the fore flap because the loss of this rib would cause the loss of the fore flap. The loss of this rib would triple the bending in the flap.

- The loads for this rib were derived from STRU-B8633-C85-091 Rev A. and are shown in loads Sheet 3100.1. (See Torque Tube Ribs For Copy)
## Margin Of Safety Summary

<table>
<thead>
<tr>
<th>Location</th>
<th>Condition</th>
<th>Mode</th>
<th>Page</th>
<th>M.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasteners Rib to Upper Cap</td>
<td>40° Detent</td>
<td>Nas1399 Blind Shear Crit. 3/16</td>
<td>7.2.</td>
<td>+.46</td>
</tr>
<tr>
<td>Fasteners Rib Cap to Skin</td>
<td>40° Detent</td>
<td>Nas1399 (D) Blind Bearing Crit. 3/16</td>
<td>7.1.</td>
<td>+.04</td>
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<tr>
<td>Web-Aft. Panel</td>
<td>40° Detent</td>
<td>(min. gage) Shear Resistant</td>
<td>7.3.</td>
<td>+.70</td>
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<tr>
<td>Fwd. Stiffener</td>
<td>40° Detent</td>
<td>Compression yield</td>
<td>7.5</td>
<td>+.27</td>
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<tr>
<td>Aft Attach Bolt Tension Fitting</td>
<td>40° Detent</td>
<td>Tension In Aft Wall at c of Barrel Nut</td>
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<td>+.40</td>
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<td>RIB Chord-Fwd</td>
<td>40° Detent</td>
<td>Compression Crippling</td>
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<td>40° Detent</td>
<td>Bearing critical Rib Bearing Critical Clip</td>
<td>7.10.</td>
<td>.46</td>
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<td>Cylindrical Nut For Aft Bolt</td>
<td>40°</td>
<td>Bearing Yield In Rib</td>
<td>7.19</td>
<td>+.35</td>
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<tr>
<td>Tension Fitting Sect. A-A</td>
<td>GAG</td>
<td>Fatigue</td>
<td>7.8.</td>
<td>+.41</td>
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</table>

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Example Page 3.1
Material: 7075-T7651
Plate
### BOEING DESIGN MANUAL 83.1-3

#### 83.1-3 STATIC MECHANICAL PROPERTIES (Continued)

#### ROOM TEMPERATURE MECHANICAL PROPERTIES

**Bare Sheet and Plate**

<table>
<thead>
<tr>
<th>Material and Condition</th>
<th>733</th>
<th>73351</th>
<th>73351</th>
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<td>Ax-bolted Thickness, Inches</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Heat Treated Thickness, Inches</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

#### Prior Environmental Conditioning: none

#### Strain Rate: .002 - .005 in./in./min.

<table>
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<th>Form and Specification</th>
<th>Bare Sheet and Plate</th>
<th>Bare Sheet and Plate</th>
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<tr>
<td>2014</td>
<td>7075 (3)</td>
<td>7075 (3)</td>
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</tbody>
</table>

#### Preliminary Design Allowables

#### Figure 83.1-3-2

- **1/BOARD Foreflap**
- **737-300/400**
- **TRK Support Rib 3-FL, PAR 34131**

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**Notes:**
1. See Section 1, paragraph 1.4 for definitions and usage limitations.
2. L, LT, and ST refer to longitudinal, long transverse and short transverse grain, directions respectively.
3. For material purchased in the -7H or -7653 condition and subsequently aged to the -733, -73351, -776 or -77653 condition, the -733, -73351, -776 or -77653 mechanical properties applicable to the original thickness shall apply regardless of the thickness when aged to the -733, -73351, -776 or -77653 condition.
4. When the axis of the fastener or pin hole in plate over one inch is in the short transverse direction to the bearing properties must be reduced as shown in Figure 83.1-3-3.
External Loads

This load case gives the max loading on the rib the moment and shear on the track is from loads sheets 31100.1 for fore flap.

Ref: Torque Tube ribs page 5.1 for copy of external loads

Load case - 40° detent,

\[ V = 177 \text{ KTS} \]

**Tension In Bolt At Point B**

\[ P_{z8} = \frac{-23,160}{(17.15)(2235) + (2.72)(338)} / 2.32 \]

\[ P_{t8} = 6935 \text{ #} \]

**Compression On Point C**

\[ P_{cc} = -6935 + 2235 \cos 17.5° - 338 \sin 17.5° \]

\[ P_{cc} = -4905 \text{ #} \]

**Shear On Pins**

\[ P_s = 338 \cos 17.5° + 2235 \sin 17.5° = 994.4 \text{ #} \]

Ref: STRU – B8633 – C85 – 091 Rev A For Loads
Load Case - 40° Detent, $V = 177$ KTS

Ref: Page 5.1

Reactions
$q_1 = \frac{527 \#/\text{in} + \frac{994}{(2 \times 3.8)}}{2} = 657.6 \#/\text{in}$
$q_2 = \frac{527 \#/\text{in} + \frac{6935-4905}{3}}{2} = 1204 \#/\text{in}$
$q_3 = \frac{527 \#/\text{in} + \frac{994}{(2)(3.8)}}{2} = 396 \#/\text{in}$
Load Case - 40° Detent, 
V = 177 KSI
**Design and Analysis of Aircraft Structures**

**Page 7.1**

**Example**

**LOAD CASE 40° DETENT, V = 177 KTS**

**FASTENERS - SKIN TO RIB**

No. 3 – 9 See A-42

3/16 – NAS 1399 D BLIND FASTENERS

\[ P_{3u} = 1090 \quad \text{REF 285.2.1-1. BDM} \]

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**BEARING IN RIB**

\[ F_{brv} = 123 \text{ kips} \]

\[ P_{brv} = (123 \times 0.08) \text{ ksi} = 144 \text{ kip} \]

\[ P_{rih} = (123 \times 0.06) \text{ ksi} = 145 \text{ kip} \]

**BEARING IN SKIN**

\[ P_{fvy} = 114 \text{ kips} \]

\[ P_{sv} = 695 \text{ #} \quad \text{REF BDM 291.1.4} \]

**LOADING**

\[ 473 + 377 = 604 \text{ #} = \text{ FAST NO. 3 REF F-47.2} \]

\[ M.S. = \frac{695}{604} - 1 = -0.15 \quad \text{MS} = -0.15 \]

**FASTENER NO. 9**

\[ P = 538 + 440 = 670 \text{ #} \]

\[ M.S. = \frac{695}{670} - 1 = +0.04 \quad \text{MS} = 0.04 \]