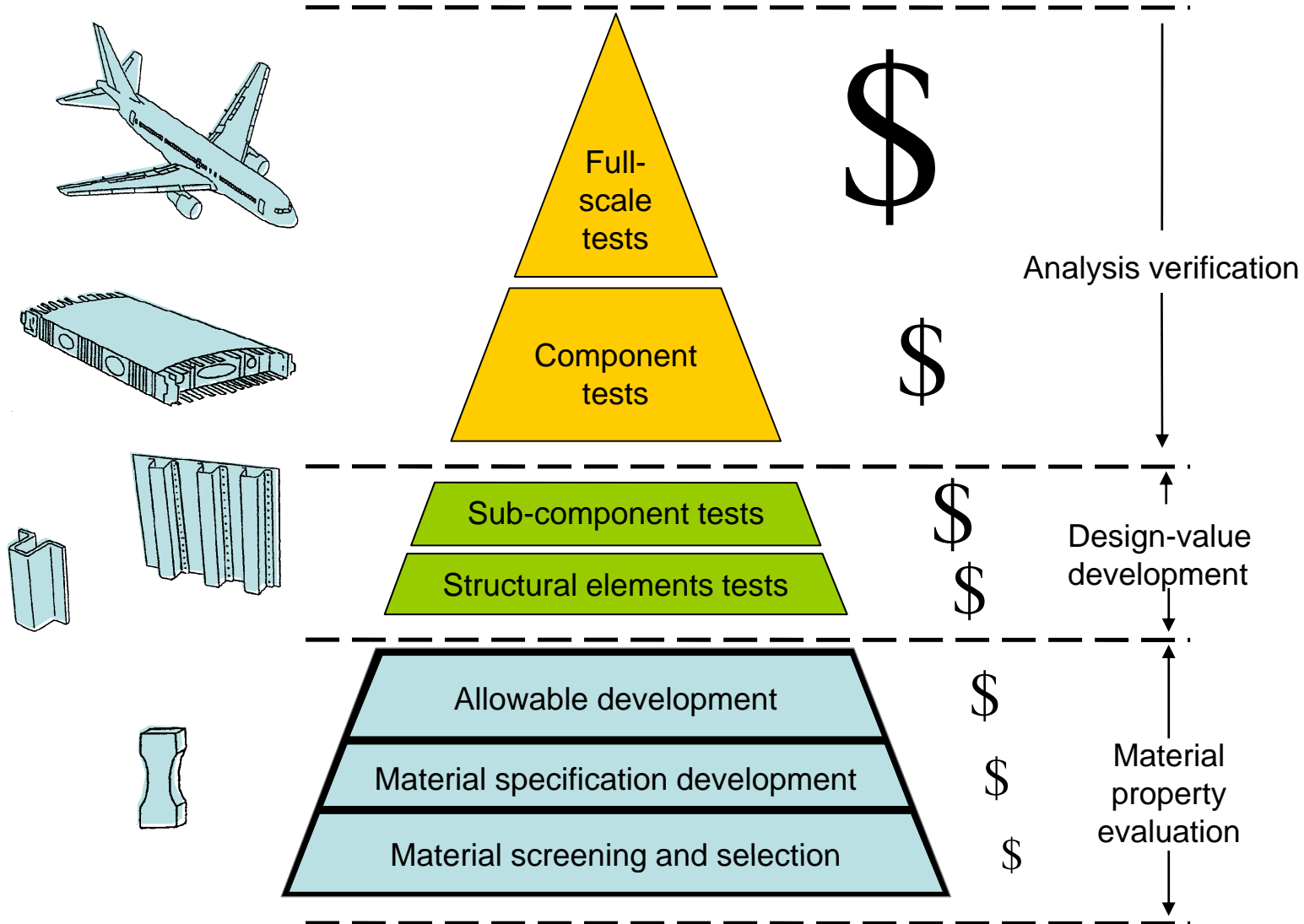


# Design Allowables

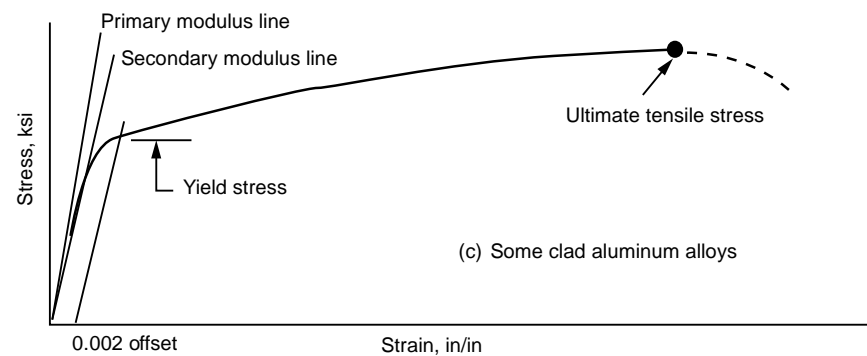
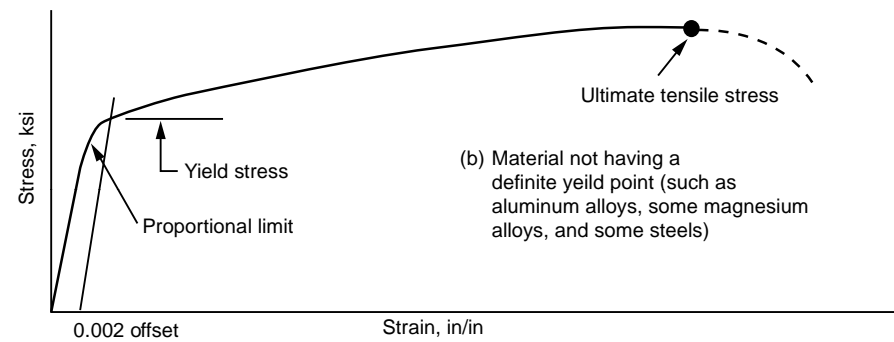
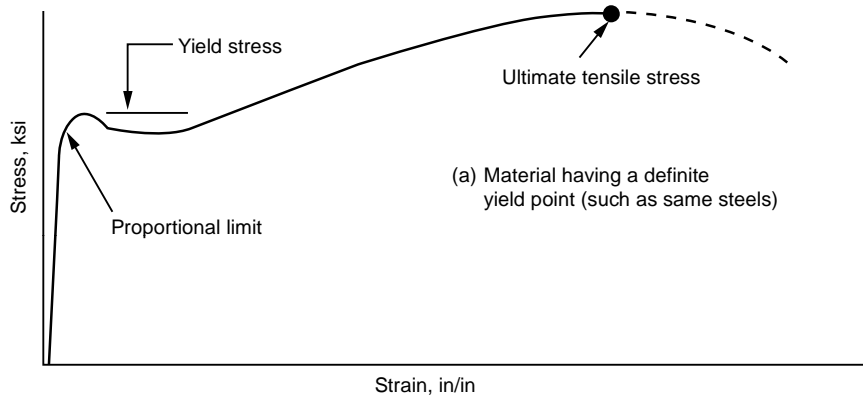
# Building Block Approach



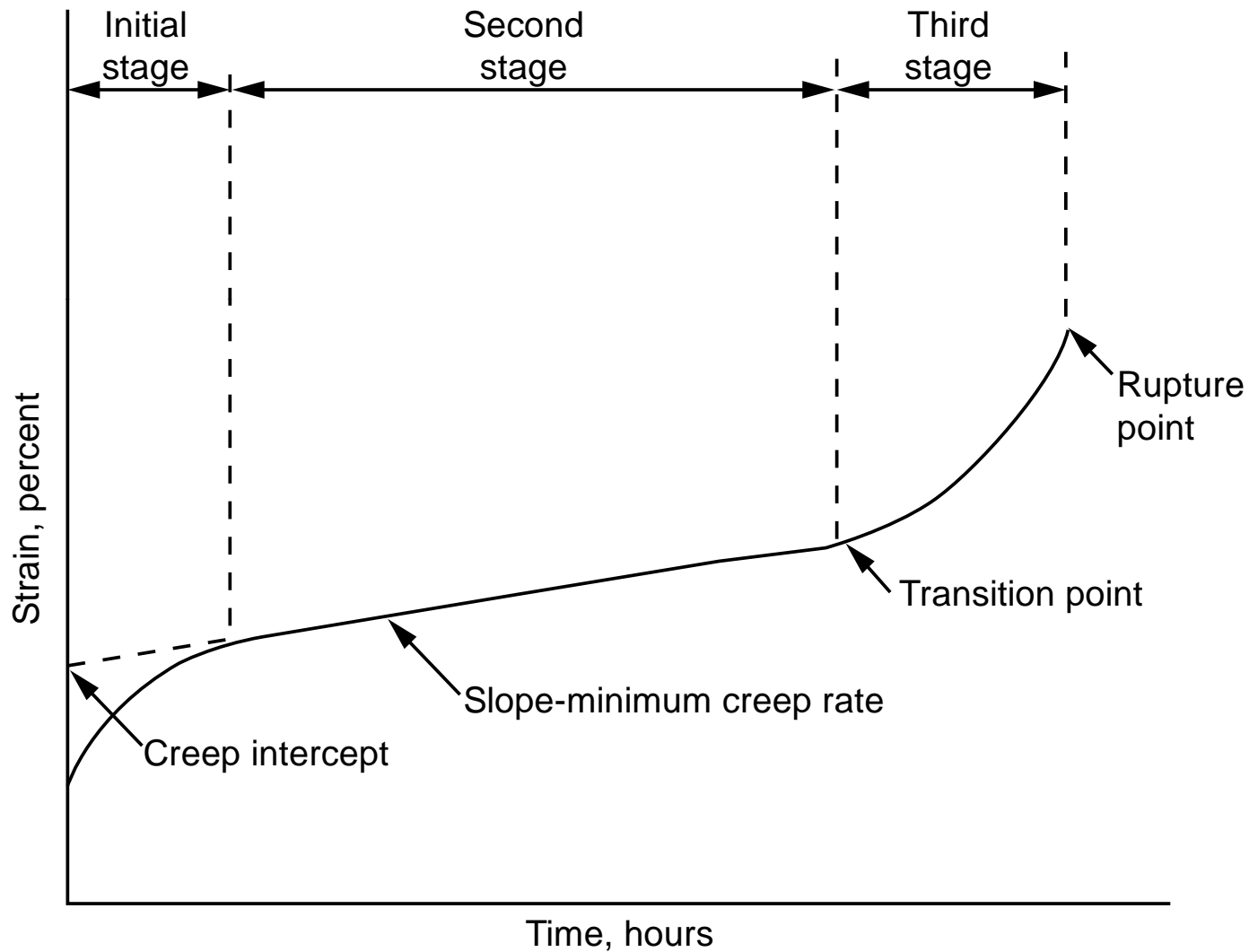
# Typical Allowables Test Program for Metallic Materials

Tension	(L)	90 + 10
	(LT)	10
Compression	(L)	10
	(LT)	10
Shear	(L)	10
	(LT)	10
Bearing, $e/D = 1.5$	(L)	10
	(LT)	10
jBearing, $e/D = 2.0$	(L)	10
	(LT)	10

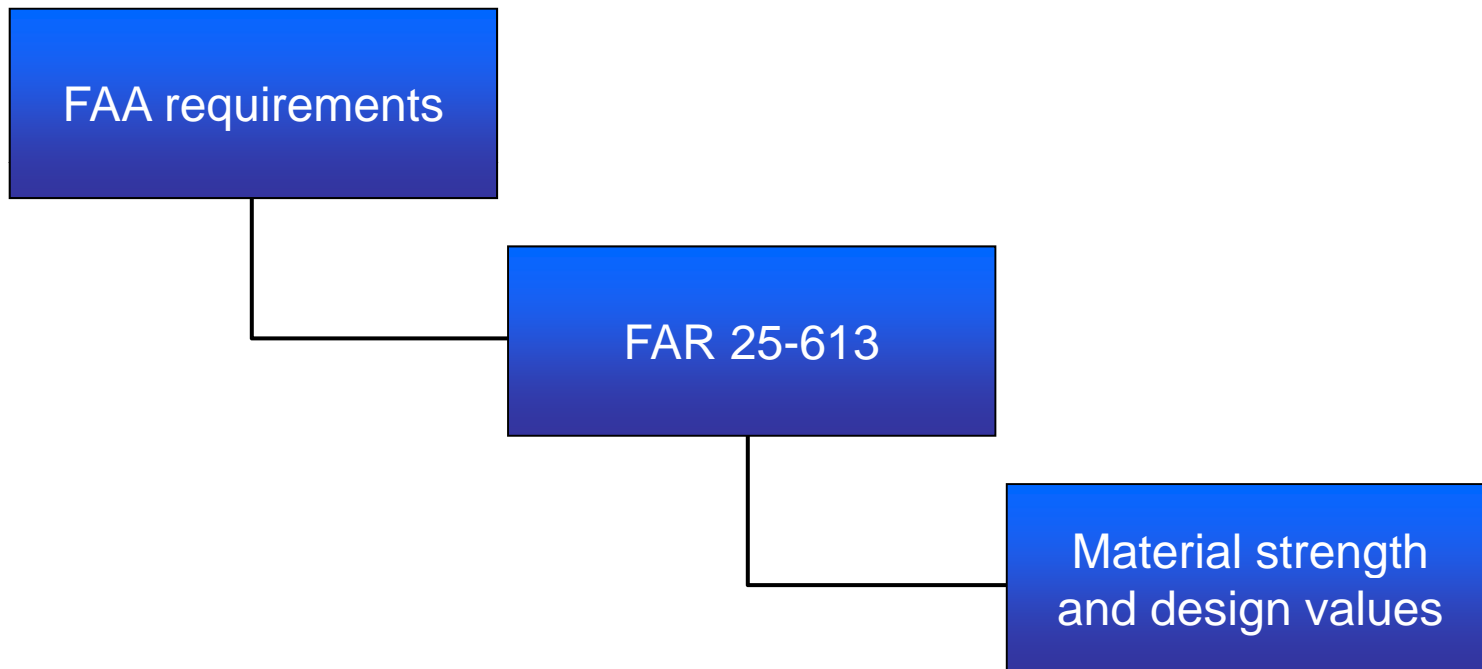
# Typical Tensile Stress-Strain Diagrams



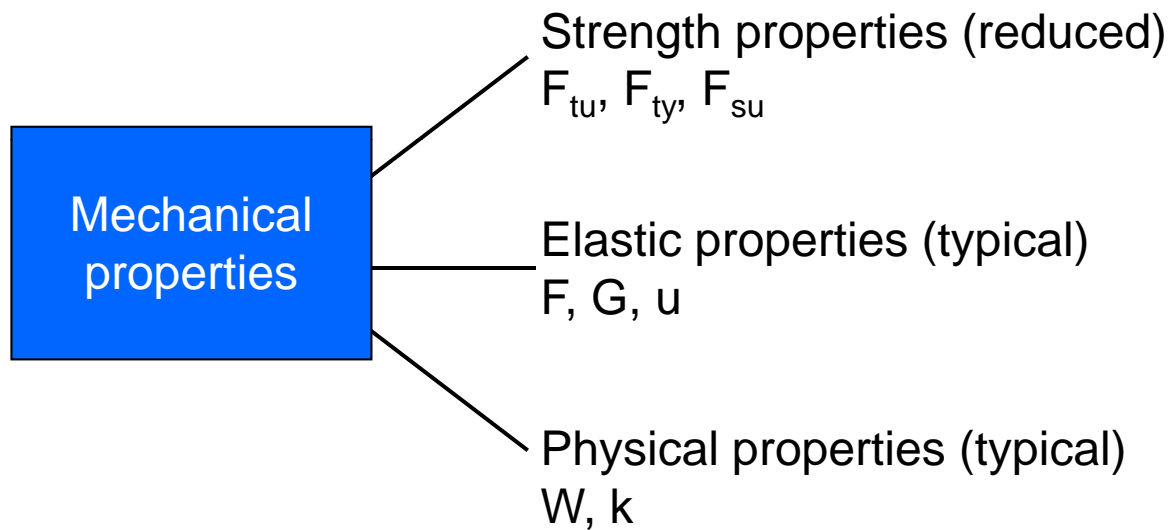
# Typical Creep-Rupture Curve



# Allowables are Required by FAA to Certify all Aircraft Structures



# Material Design Allowables



# Allowable Classifications

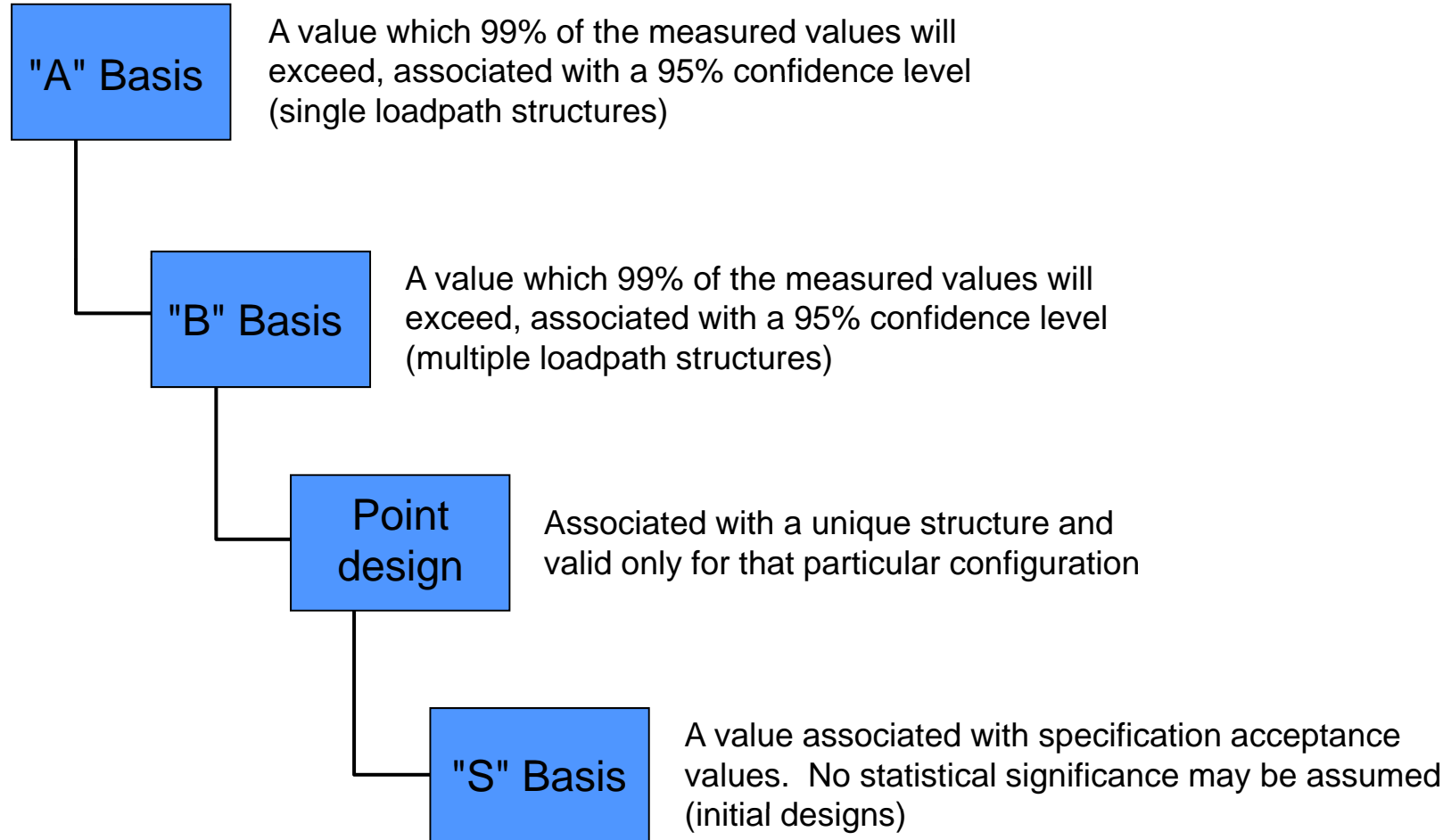
<b>Term</b>	<b>Description</b>	<b>Sub Group ID</b>
Class	Identifies level of approval associated with an allowable	I, II, III
Basis	Defines an allowables statistical basis	A, B, S
Maturity	Defines an allowables level of development	Firm, Preliminary, Estimated



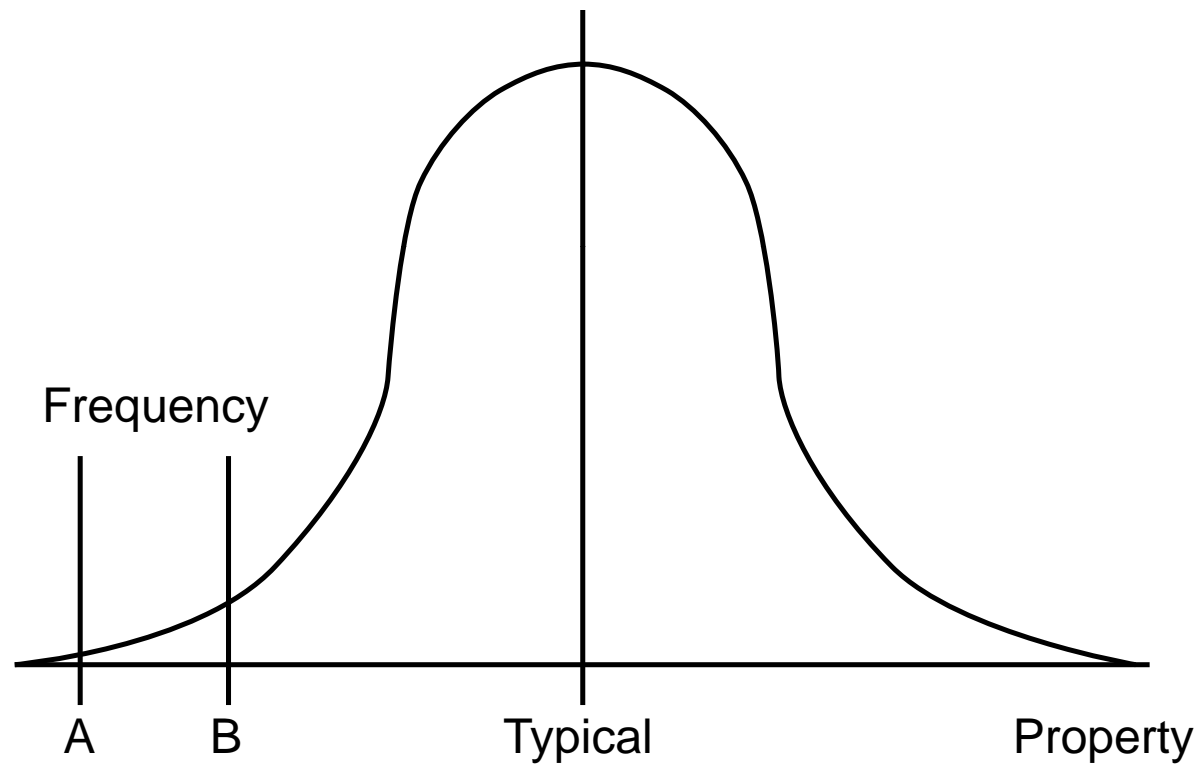
# Class Descriptions

Class	Description
I	<u>FAA Certified Allowables</u> : Values have been developed using a process where the FAA has approved the test plan and conformance to the plan has been established.
II	<u>Generic Allowables</u> : Obtained by following MMPDS-01 and 17 guidelines, support approved analysis methods, and are applicable to a range of products.
III	<u>Program Specific Point Design</u> : A value established for a specific application and is valid only for that application. May be used for similar application if validated.

# Classes of Allowables



# Material Property Population Distribution



# Maturity Description

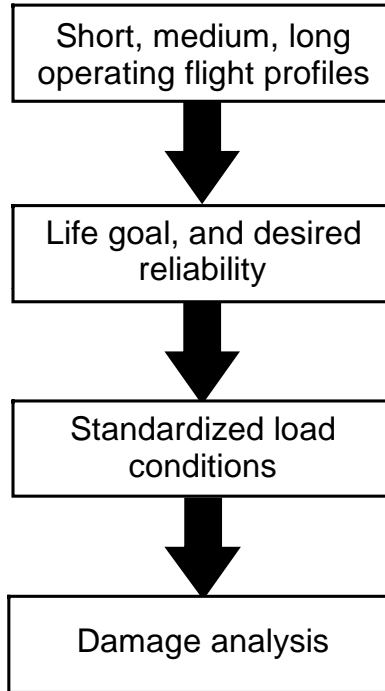
<b>Term</b>	<b>Description</b>	<b>Situation</b>
Firm	Analysis which is representative of production has been completed on material/structure.	Material specification in place Consistent product from stable, repeatable process
Preliminary	Analysis has been completed on material/structure which has not yet been brought under control per specifications. Also applies to values for which all testing requirements needed to obtain "Firm" values have not been completed.	Preliminary specifications in place Product variability; process practices continue to be optimized.
Estimated	Values provided based on little or no information which represent best estimates of firm values.	No specific requirements

# The Allowable Need is Dependent Upon the End User

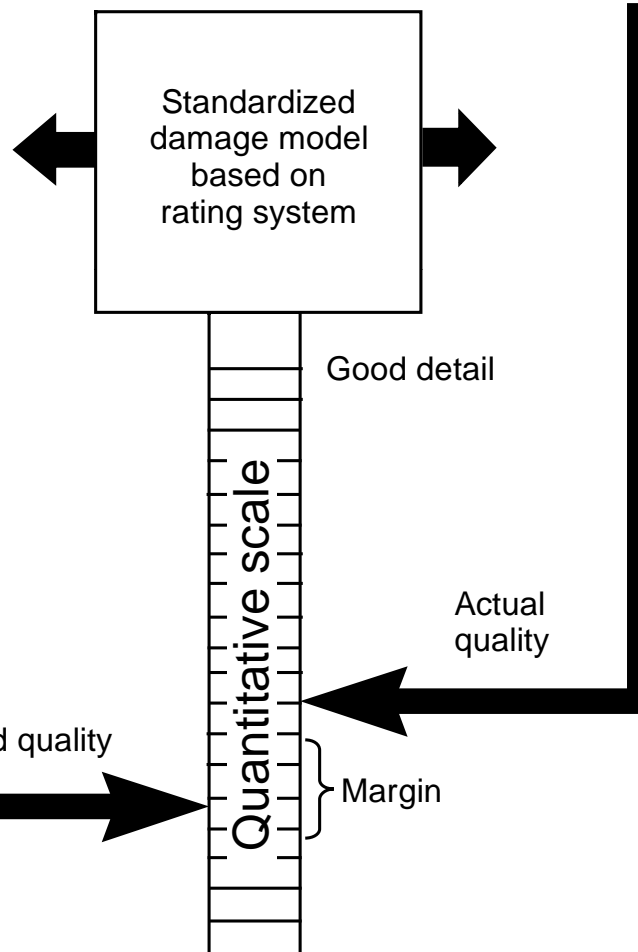
<b>Material controlled by-</b>	<b>Allowables</b>	<b>Design/analysis</b>
Vendor	Estimated design values	Trade studies initial design
Preliminary specifications	Preliminary allowables	Preliminary design
Firm specifications; AMS, MIL, QQ	Firm allowables	Firm design drawing release – hardware fabrication

# Detail Fatigue Rating (DFR) System

## Operating requirements



## Configuration capability

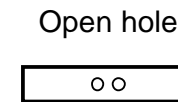


1. Catalog details based on test or service experience
  2. Test data for new details
  3. Modification of (1) and (2) using influence factors
  4. Calculated detail quality based on standard influence factors
- Material
  - Fastener fit
  - Load transfer
  - Stress concentration
  - Etc.

Required quality

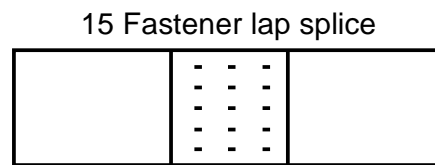
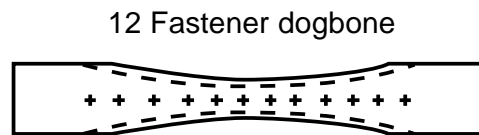
# Durability Coupon Specimens

## Basic material properties fatigue specimens

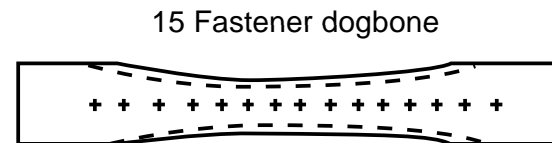
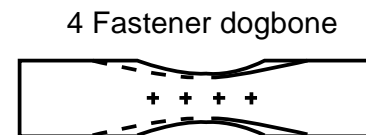
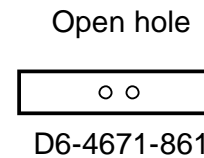


## Structural properties fatigue specimens

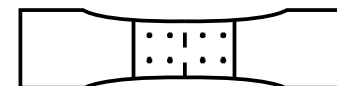
### Sheet specimens



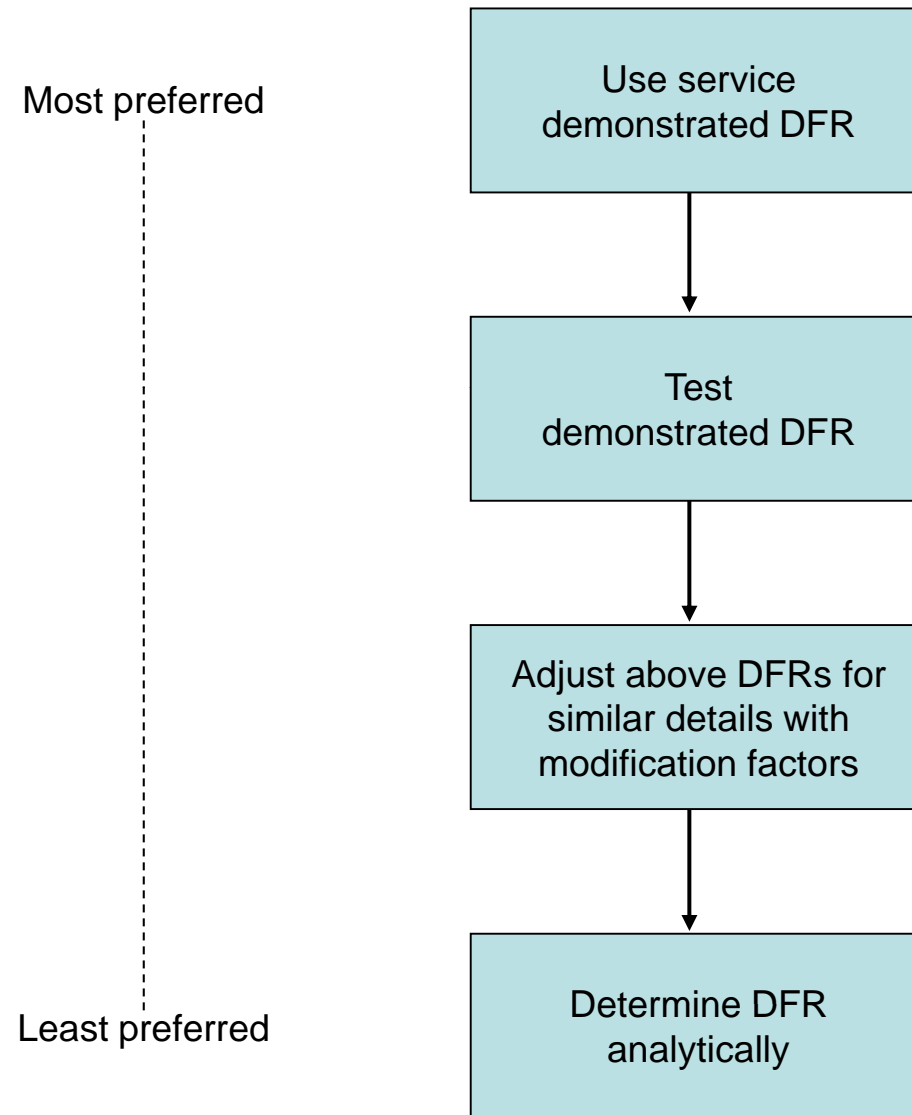
### Plate/extrusion specimens



### 8 Fastener double shear splice

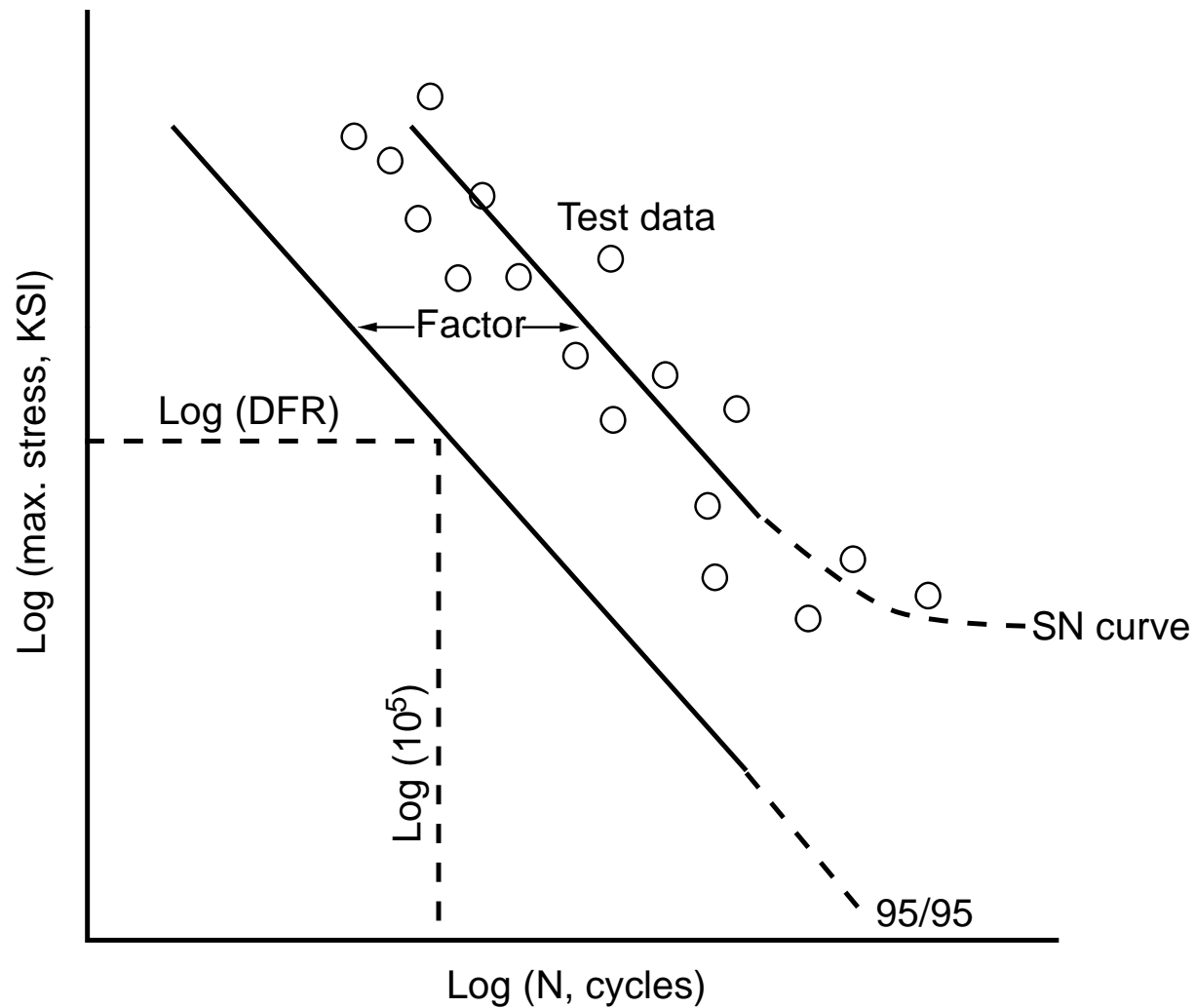


# Preferred DFR Utilization





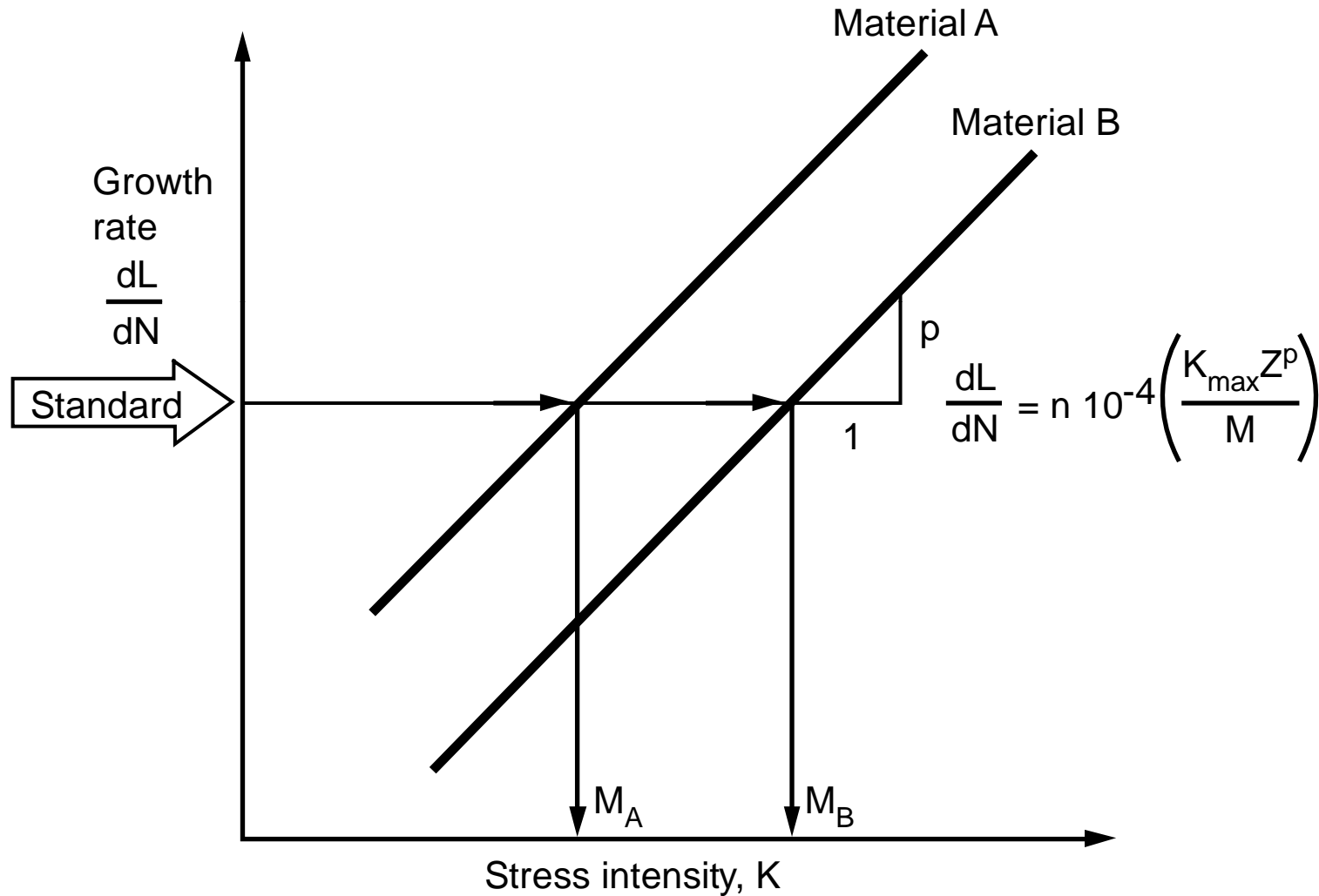
# DFR Calculation



# Damage Tolerance Coupon Specimens

Test type	Specimen	Recommended material form	Application		Primary specimen usage
			Crack growth	Residual strength	
Center cracked tension panel (CCT)	4" wide CCT	Extrusions and forgings (all forms)	●	●	<ul style="list-style-type: none"> <li>• Simulates forged and extruded structure</li> </ul>
	16" wide CCT	Plate, sheet (all forms)	●	●	<ul style="list-style-type: none"> <li>• Characterizes environmental crack growth properties</li> <li>• Fits in standard test chamber</li> </ul>
	24" wide CCT	Plate, sheet (all forms)	●	●	<ul style="list-style-type: none"> <li>• 2xxx: spectrum crack growth</li> <li>• 7xxx: constant amplitude and spectrum crack growth, residual strength</li> </ul>
	48" wide CCT	Plate, sheet (2xxx)	●	●	<ul style="list-style-type: none"> <li>• 2xxx: Reliable crack growth allowables</li> <li>• Largest practical residual strength test for high toughness alloys</li> </ul>
	92" wide CCT	Plate (2xxx)		●	<ul style="list-style-type: none"> <li>• Selected residual strength verification test for high toughness alloys</li> </ul>
Edge crack tension panel	9" wide ECT	Plate (all forms)		●	<ul style="list-style-type: none"> <li>• Simulates short crack performance of plate material</li> </ul>
Built-up	Skin/stringer panel model	Extrusion forgings, plate, sheet (all forms)	●	●	<ul style="list-style-type: none"> <li>• Verify interaction of material and geometry factors</li> </ul>

# Material Crack Growth Rating



M - Measures relative material resistance to crack growth  
 Design and Analysis of Aircraft Structures