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Service  
Engineering

**DESIGN SERVICE OBJECTIVE**

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- **Design Service Objective (DSO) definition**
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# The DSO

- **Minimum period of service during which primary structure is designed to be essentially free of detectable fatigue cracks, with a high degree of reliability and confidence**
  - **A concept useful for assessing economics of maintaining structure**
  - **Not directly tied to structural airworthiness**

# The Boeing DSO

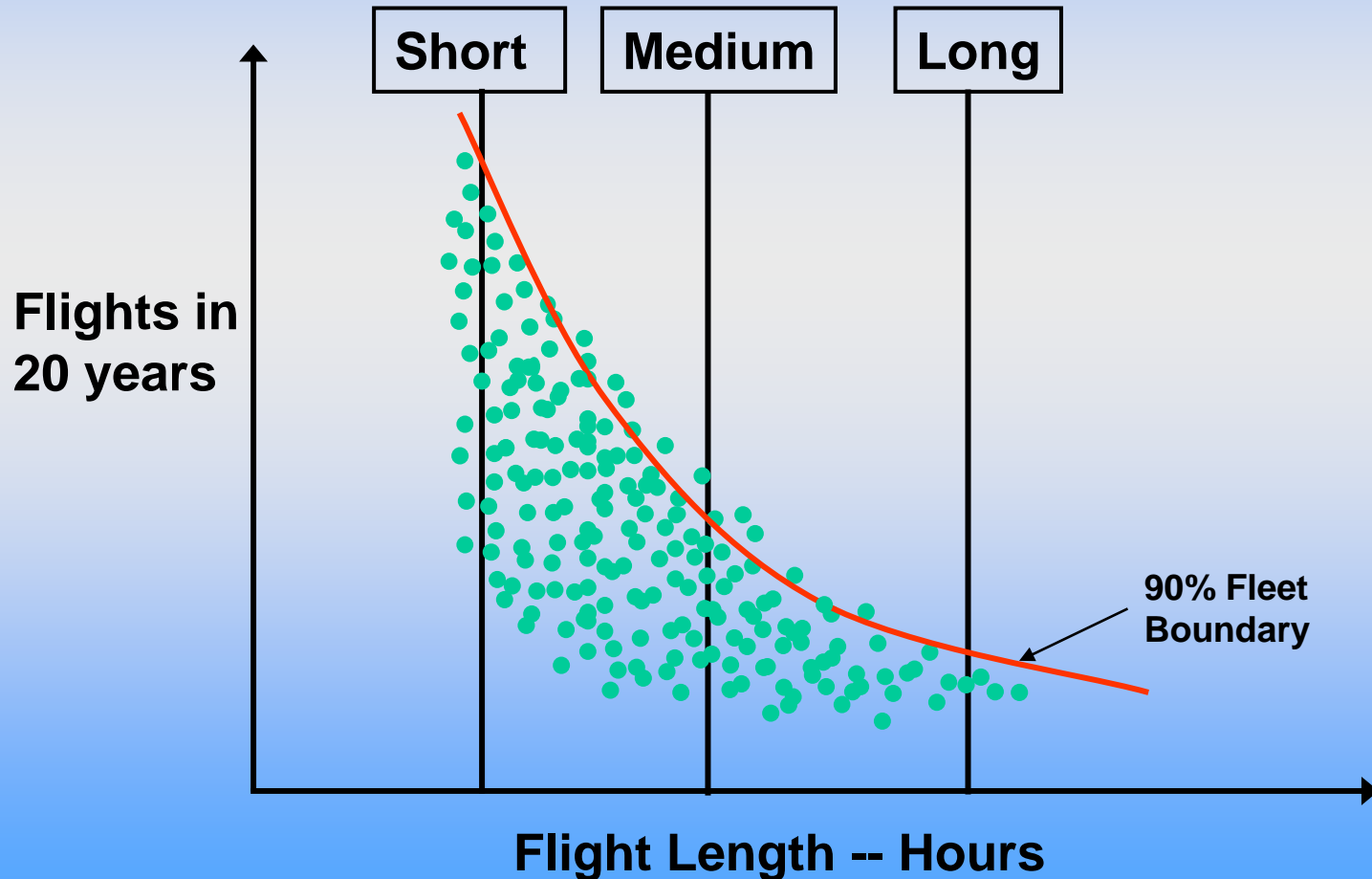
- **Minimum period of detectable crack free service with most critical of three anticipated flights – short, medium or long**
  - **For a minimum of 20 years**
    - **At least 99% of fleet primary structural details to remain free of fatigue cracking, with 95% confidence**
  - **For a minimum of 30 years**
    - **At least 95% of fleet primary structural details to remain free of fatigue cracking, with 95% confidence**

# Selecting the DSO

- Anticipated conservative airplane utilization
- Optimization of operational costs

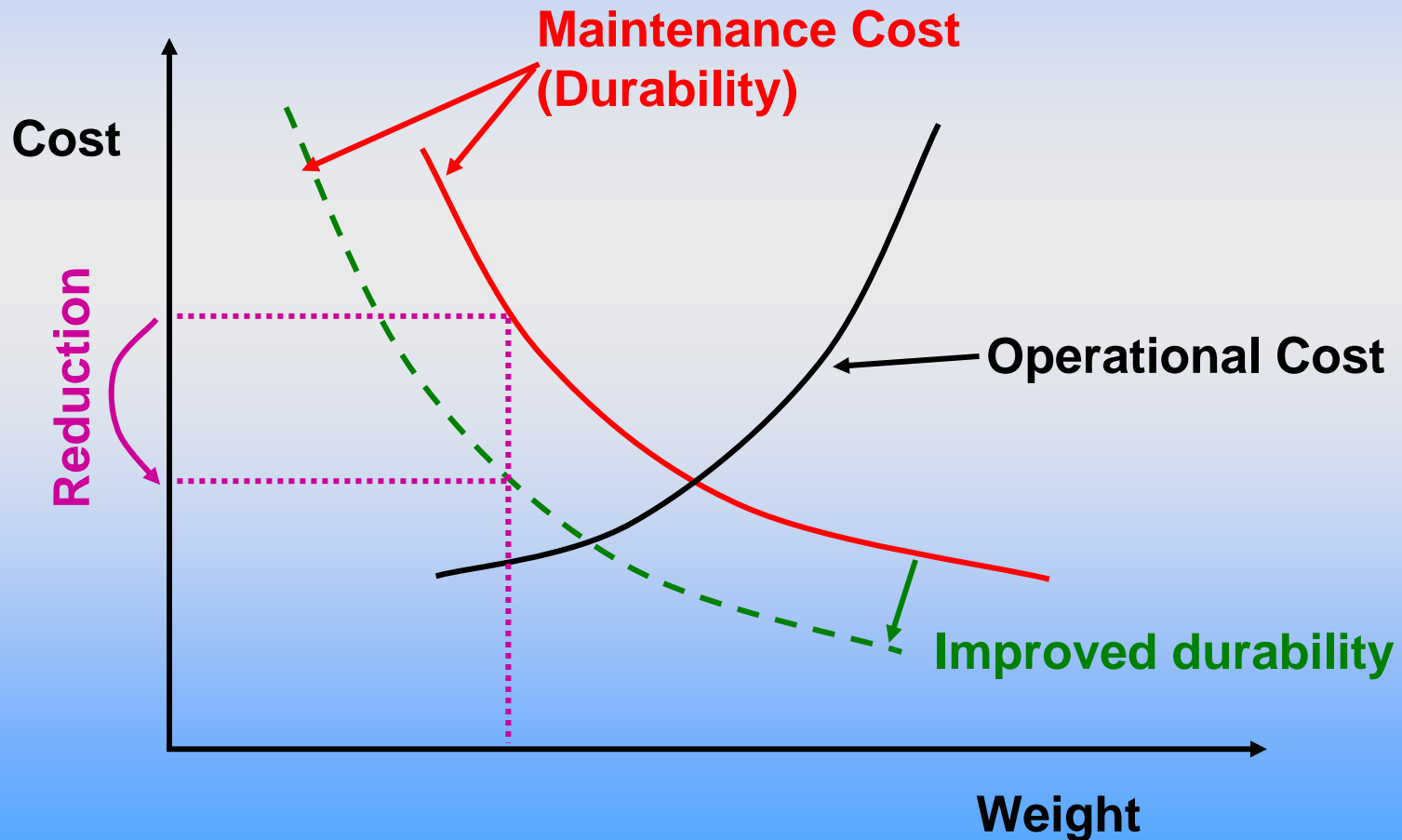
# Selecting the DSO

- Anticipated conservative airplane utilization



# Selecting the DSO

- Optimization of operational costs



# Achieving and Validating the DSO

- **Selection of materials and finishes**
- **Application of durability design and analysis standards**
- **Full scale fatigue test evidence**



# Materials and Finishes

- **New and improved alloys and tempers**
  - **Low susceptibility to corrosion and stress**
  - **Slow crack growth**
  - **High fracture toughness**
- **Finishes**
  - **Corrosion inhibition**
  - **Corrosion control**
- **Advanced composites**

# Designing for Durability

- **Structure is designed to exceed the DSO with modest increase in maintenance costs**
- **Detail design based on lessons learned from past design practices**
- **Durability and damage tolerance assessments before drawing release using proven technology**

# Full-Scale Fatigue Test Programs

Model	DSO Flight Cycles	Major Fatigue Test Cycles	Remarks
707	20,000	50,000	Fuselage hydro-fatigue test
727	60,000	60,000	Complete airframe
		170,000	Complete fuselage 47,000 cycles in service plus 123,000 pressure test cycles
737	75,000	150,000	Fuselage section pressure and shear
		129,000	Complete aft fuselage 59,000 cycles in service plus 70,000 pressure test cycles
737NG	75,000	225,000	Full fuselage pressure test

# Full-Scale Fatigue Test Programs

Model	DSO Flight Cycles	Major Fatigue Test Cycles	Remarks
747	20,000	20,000	Complete airframe
		40,000	Complete fuselage 20,000 cycles in service plus 20,000 pressure test cycles
		60,000	747-400 sections 41 and 42 pressure test cycles
757	50,000	100,000	Complete airframe
767	50,000	100,000	Complete airframe
777	40,000	120,000	Complete airframe

# Full-Scale Fatigue Test Programs

Model	DSO Flight Cycles	Major Fatigue Test Cycles	Remarks
DC-9	40,000	208,000	Full scale to DSO + 26,000, fuselage removed from service with 66,000 cycles in service + 142,000 pressure test cycles
MD-80	50,000	(See DC-9)	DC-9 baseline + component testing
MD-90	60,000	(See DC-9)	DC-9 baseline + component testing
MD-11	20,000		

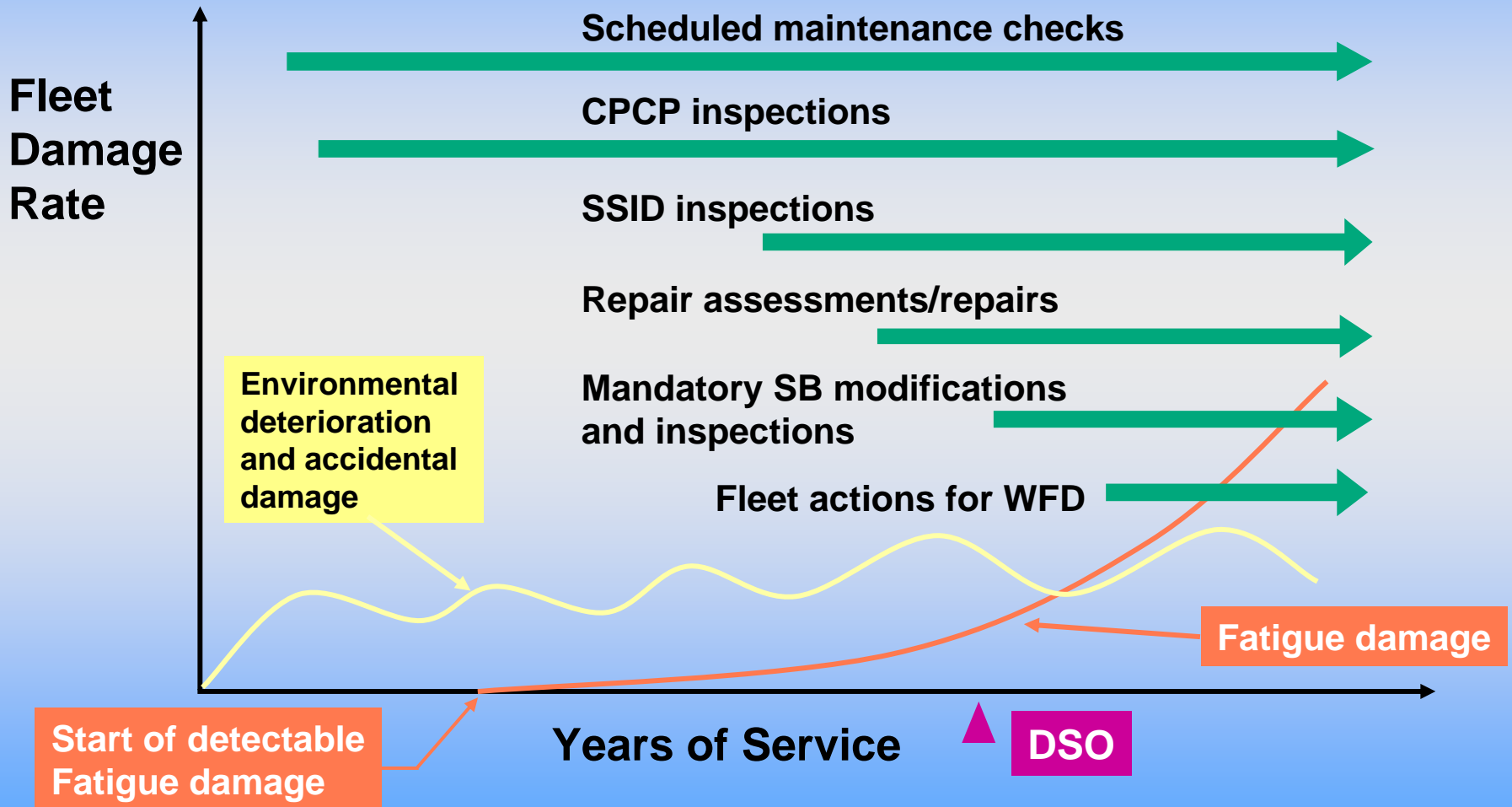
# Regulatory Issues

- **Current regulatory rules do not connect DSO to certification**
- **All in-service airplanes required to have effective scheduled maintenance programs to maintain airworthiness**
  - **DSO was selected as convenient threshold for some aging airplane programs**

# Exceeding the DSO

- **Continued airworthiness with**
  - **An effective scheduled maintenance program**
  - **Compliance with all mandated actions**
- **Cost to maintain the airframe structure will increase**

# Maintenance Activities During Service





# Summary

- **DSO is**
  - **A concept useful for assessing economics of airplane structural maintenance**
  - **Selected by optimizing operational costs for anticipated utilization**
  - **Achieved by design and validated by testing**
- **Continued airworthiness up to and beyond the DSO is assured by**
  - **Effective scheduled maintenance**
  - **Compliance with mandatory actions**