Introduction to Aging Aircraft Program

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

AGING AIRCRAFT

TRAINING OBJECTIVES

The objective of this subject matter is to share the knowledge and experience of PT. Dirgantara Indonesia in defining, developing and establishing of Aging Aircraft Program by lesson learned which had been done in overseas;

By the end of the course, the participant would have knowledge and understand of background, description and developing Aging Aircraft to maintain safe for flight of the Aircraft.

AGING AIRCRAFT

Aging Aircraft Definition

AGING AIRCRAFT

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

GENERAL

DEFINITION

"AGING AIRCRAFT" is :

"*aircraft which have exceeded their design service life goal*"

AGING AIRCRAFT

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INDONESIAN AEROSPACE (Ae)

GENERAL

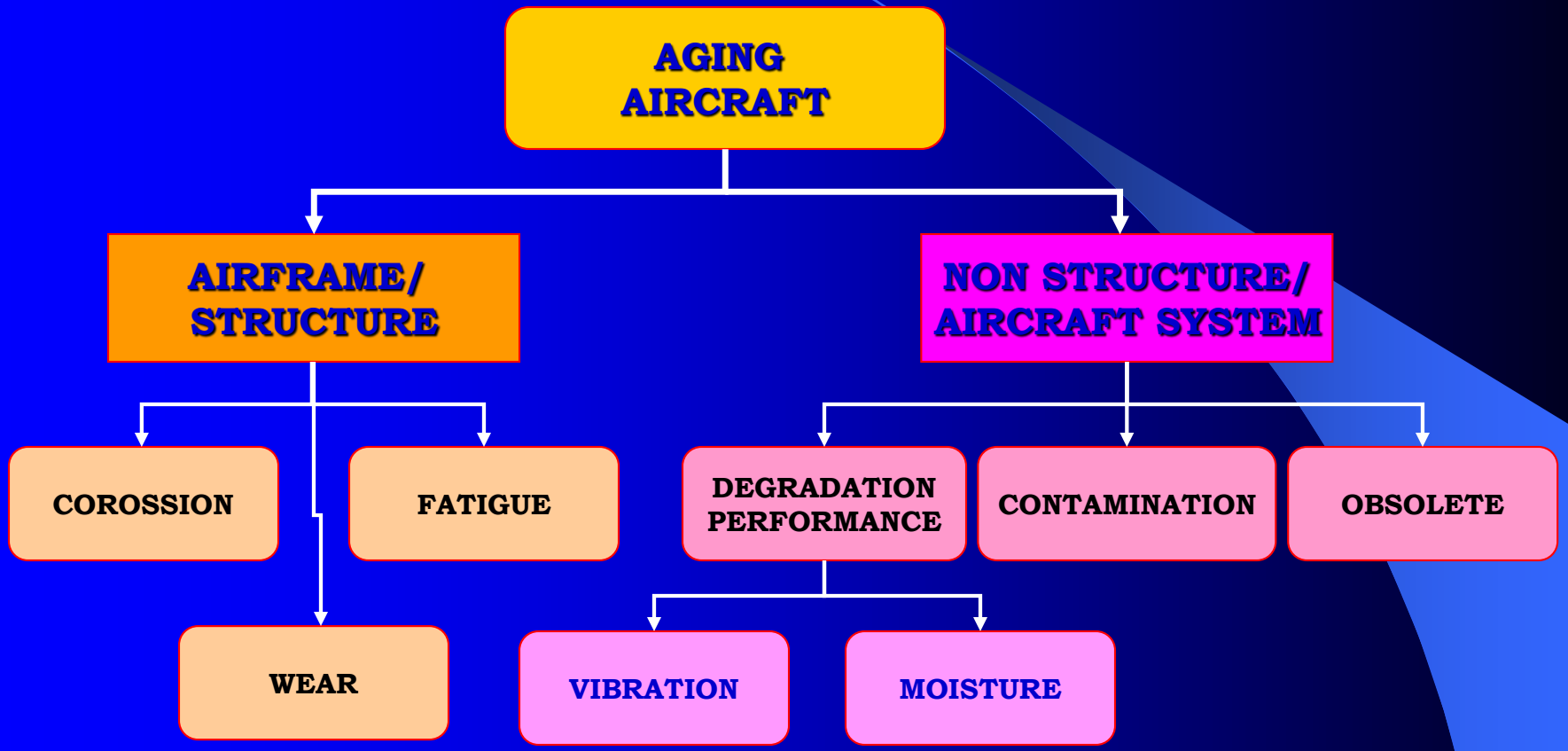
DEFINITION

The process of *aircraft aging* and *aging of the aircraft equipment* is the process when the integrity of structure or the integrity of equipment functionality is continually degraded due to the exposure to environment in which the aircraft is in use

AGING AIRCRAFT

GENERAL

DEFINITION



AGING AIRCRAFT Classification & Sources

Note : Sources may also be occurred as a combination of each sources

AGING AIRCRAFT

Aging source mechanisms:

- Exposure to normal atmosphere conditions or to atmosphere with a higher degree of salinity, temperature, different chemical compounds, water/vapors, oils, fuel vapors or solutions, grease, and/or UV radiations that can lead to aging, corrosion, increasing brittleness, swelling, overheating, melting or any other degradation of material characteristics.
- Exposure to vibrations and environment with negative acoustic characteristics may cause a damage due to fatigue, wear, fracture, etc.
- Maintenance of aircraft, storing or conserving of aircraft with the influence of store conditions according to the proposed manufacture procedure or proposed work practice,
- Activities provided for aircraft maintenance and equipment maintenance can cause an incidental and unwanted damage of airframe and other equipment components.

AGING AIRCRAFT

GENERAL

DEFINITION

'AGING AIRCRAFT PROGRAM' vs *'SERVICE LIFE EXTENSION PROGRAM (SLEP)'*

AGING AIRCRAFT

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GENERAL

DEFINITION

AGING AIRCRAFT PROGRAM	SLEP
- Ensure the continued airworthiness and safe operation of aircraft as they age (design service life)	- Extend the operational lifespan of an aircraft beyond its original design specifications
- Focus on the overall safety and airworthiness of older aircraft.	- Specifically aims to extend the usable life of an aircraft beyond its original design specifications.
- Objectives: inspection, maintenance, monitoring, regulatory compliance	- Objectives: upgrades, modifications, life extension, cost effectiveness
- Scope: broad and encompasses various activities to keep aging aircraft safe and operational	- Scope: typically involves more extensive work than routine aging aircraft maintenance, often requiring significant investment and engineering changes

AGING AIRCRAFT

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INDONESIAN AEROSPACE (Ae)

GENERAL

DEFINITION

AGING AIRCRAFT PROGRAM	SLEP
- Firstly introduced: In 1991, Congress mandated that the Federal Aviation Administration (FAA) establish an Aging Airplane Program. (Source : In 1991, Congress mandated that the Federal Aviation Administration (FAA) establish an Aging Airplane Program).	- Firstly introduced: the late 1979 by the United States military, particularly the U.S. Air Force and Navy. *(Source : http://archive.gao.gov/f0302/108611.pdf)*
- Rule Application: Flight Hours - Flight Cycles - Calendar Time (20 years) Whichever coming first	- Rule Application: before design service life goal reached
- Implementation: Boeing SB 737-53A1177, Nov. 8, 1994 (Fuselage – Skin – Repair Methods For Cracks In Lower Skins at Lap Joints.	- Implementation: United State's Navy Service Life Extension Program (SLEP), February 9, 1979.

AGING AIRCRAFT

GENERAL

DEFINITION

"Aging Aircraft" (Structure) is :

"*aircraft which have exceeded their certified airframe design life*"

Source : 'ATSB Transport Safety Report B20050205, February 2007"

- **Airframe design life : is the period of time (in flight cycles/hours) established at design and/or certification during which the principal structure will be reasonably free from significant cracking including widespread fatigue damage**

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GENERAL

DEFINITION

"Aging Aircraft" (Non-Structure) is :
"*aircraft which have exceeded their non-structure (electric wire) design service objective life*"

- **Wire, it seems, may not last as long as the 20 or 30-year design service objective of the airplane (DSO). (*Air Safety Week, September 27, 1999*)**
- **There appears to be a near linear relationship between aircraft (structure) age and the degradation of wiring due to chafing (*Mark Brown, GRC International, Air Safety Week, September 27, 1999*)**
- **For wire, service life is influenced by a variety of factors:**
  - *** As temperature increases, age decreases.**
  - *** As humidity increases, age decreases.**
  - *** Vibration accelerates aging.**
  - *** Poor installation can accelerate aging**

Aging Aircraft [Non Structure] under development by FAA, NASA, Aircraft Manufacturer and others science & research institutes

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INDONESIAN AEROSPACE (Ae)

GENERAL

DEFINITION

Aging of an aircraft can be an airworthiness and safety issue.

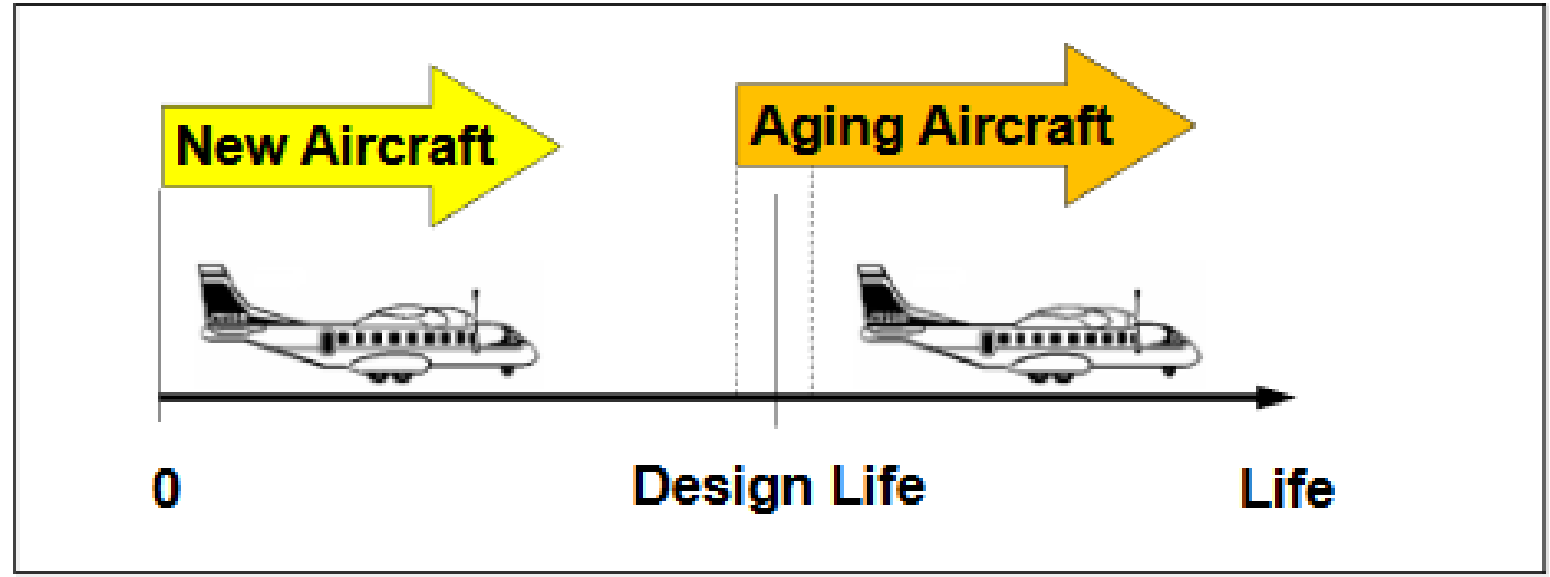
Aging aircraft can be managed by adequately maintaining through additional and specific maintenance, such as with an aging aircraft program.

The age of an aircraft depends on factors including the chronological age, number of flight cycles, and number of flight hours.

AGING AIRCRAFT

DEFINITION

Aging aircraft is an aircraft which have operated exceeded or closely their certified aircraft design life



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DEFINITION

- Refer to The 2nd International Symposium on Aircraft Airworthiness (ISAA), 2011 – Summary and Analysis of the Aging Aircraft's Failure:

  "Aging aircraft is that the use time of aircraft is more than 75% of the designed using time".

- According to Civil Aviation Administration of China (CAAC), ISAA, 2011:

  "The aircraft which has been more than 14 years is defined as aging aircraft"

- Refer to FAR 121.1105, Aging Airplane Inspection and Records Reviews, December 06, 2022:

  "An airplane must have its first aging airplane inspection and records review within 5 years after the start of its 15th years in service. Sub-sequent inspections and record review are required at no more than 7 years interval after the initial inspection and record review".

AGING AIRCRAFT

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INDONESIAN AEROSPACE (Ae)

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DEFINITION

AIRCRAFT AGE (DESIGN SERVICE LIFE GOAL)

- **Aircraft Age will depend on :**
  - ✓ **Calendar year**
  - ✓ **Flight Cycles**
  - ✓ **Flight Hours**

- **Design Goal of the Aircraft :**
  - ✓ **NC212 : 20 years or 40,000 FC**
  - ✓ **CN235 : 20 years or 60,000 FC or 50,000 FH**
  - ✓ **B707 : 20 years or 20,000 FC or 60,000 FH**
  - ✓ **B727 : 20 years or 60,000 FC or 50,000 FH**
  - ✓ **B737 : 20 years or 75,000 FC or 51,000 FH**
  - ✓ **B747 : 20 years or 20,000 FC or 60,000 FH**
  - ✓ **DC8 : 20 years or 25,000 FC or 50,000 FH**
  - ✓ **DC9 : 20 years or 40,000 FC or 30,000 FH**
  - ✓ **DC10 : 20 years or 42,000 FC or 60,000 FH**

Source :
IAE and http://www.boeing.com/commercial/aeromagazine/aero_02/textonly/textonly.html

AGING AIRCRAFT

CN235 DESIGN SERVICE LIFE GOAL

- 50,000 FLIGHT HOURS
- 60,000 FLIGHT CYCLES
- 20-YEARS

(stated in document “CN235 Technical Description”)

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GENERAL

DEFINITION

CN235 DESIGN SERVICE LIFE GOAL

1.4 Airworthiness

The CN-235 shall be certified per the following Regulations:

- U.S. FAR Part. 25
- U.S. FAR Part. 36
- ICAO Annex 16

Even though any additional certification must be subject to further consideration, one of the aims of the CN-235 design is to meet JAR-25 Certification requirements for European countries.

1.5 Structural Design Criteria

The CN-235 structure has been designed with the following concepts:

- Damage Tolerant Structure: Fail-safe principals such as multiple load path construction and crack stoppers to control the rate growth and to provide adequate residual static strength have been used, or materials and stress levels that provide a controlled slow rate of crack propagation combined with high residual strength.
- Safe life structure: Fatigue design to ensure that catastrophic fatigue failure is extremely improbable throughout the operational life of the structure.

  The structure endurance free from fatigue cracks is 25.000 flying hours (or 30.000 cycles or about 10 years).
- The structure fatigue life for an economical repair is 50.000 flying hours (or 60.000 cycles or about 20 years).
- Provisions for stretched aircraft versions with a minimum of structural changes.
- Application of modular design, together with a high degree of interchangeability.
- Complete protection of all structure against corrosion.

Aging Aircraft
Background

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AGING AIRCRAFT

BACKGROUND

HISTORY…

Aging Aircraft accidents :

- Aloha flight 243 B737-200 (28/04/1988)
  - 19 years old; 89,680fc; 35,496fh
  - Root cause : fatigue corrosion at upper fuselage
- TWA flight 800 B747-100 (17/07/1996)
  - 25 years old; 18,000fc; 90,000fh
  - Root cause : wiring deterioration on Wing centre lead to Fuel Tank explosion
- Swissair flight 111 (SR 111) MD-11 (02/09/1998)
  - 7 years old; 36,041fh
  - Root cause : faulty (arcing) wiring in the cockpit ignited flammable covering and insulation blanket and then cause fire in the cockpit
- CN235 PK-MNM “Ventral Door Separation” (25/01/2000)
  - 11 years old; 12,216fc; 5,914.20fh
  - Root cause : stress corrosion cracking and exfoliation corrosion on Ventral Door Port Fitting
- PUMA HT3305 (25/12/2000)
  - 22 years old; 5,380fh
  - Root cause : wear on Tail Rotor Bearing followed by the broken of Pitch Link by fatigue affected to the unbalance of the related Rotor Blade where then this will hit and cut the pylon skin such that the pylon structure broken in the air, followed by the twist and falling down of the helicopter in the ground
- China Airlines CI611 B747-200 (25/02/2002
  - 22 years old; 21,398fc; 64,810fh
  - Root cause : initial damage on tail section since 1980 then growing to be fatigue crack and did not repair properly according to manual
- …etc

AGING AIRCRAFT

BOEING 737 "ALOHA" ACCIDENT (April 28, 1988)

The aircraft lost 1/3 of its roof due to a stress fracture while cruising at 24,000 feet. One Flight Attendant was sucked from the airplane, which subsequently made a safe emergency landing.

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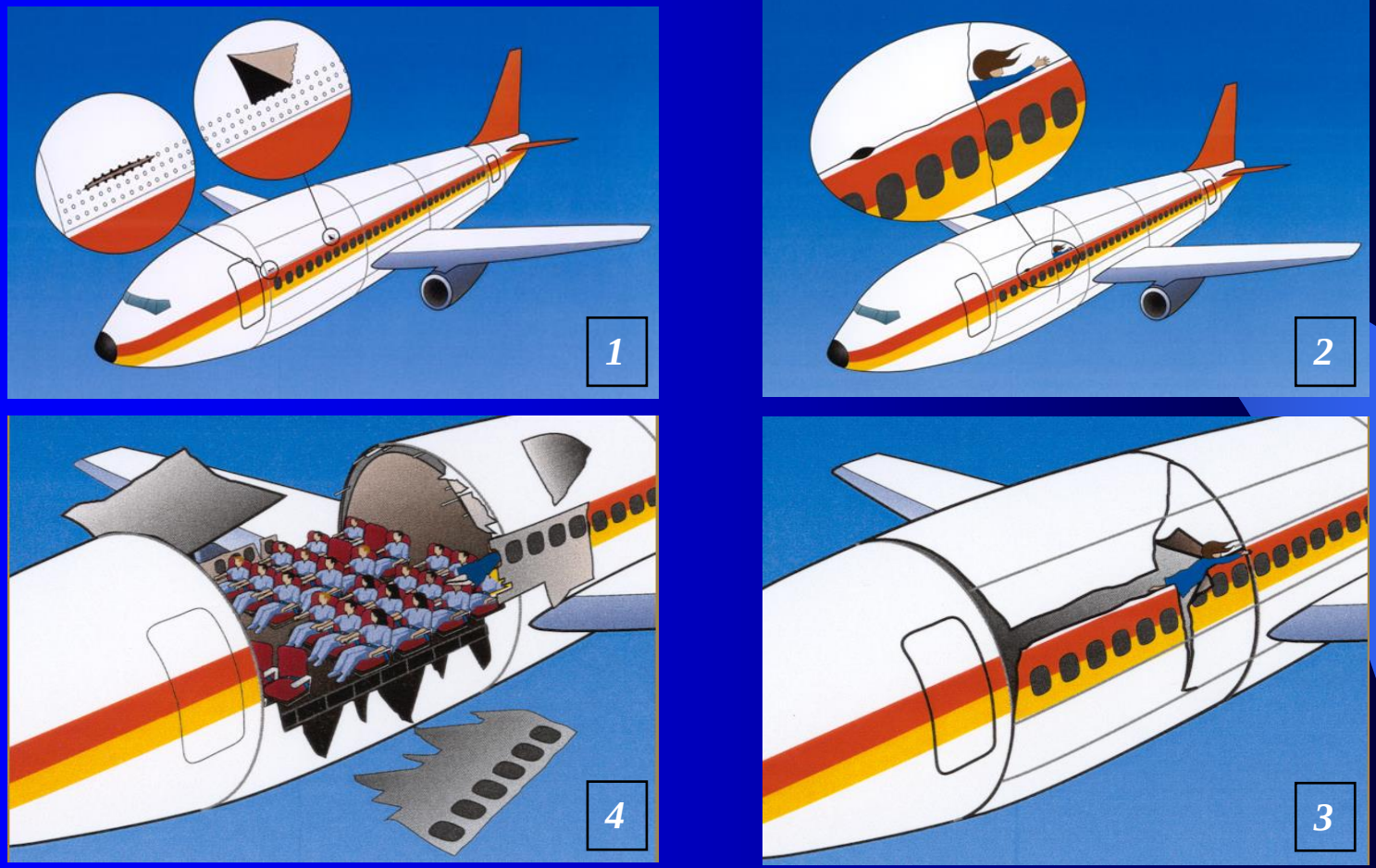
AGING AIRCRAFT

BACKGROUND

HISTORY



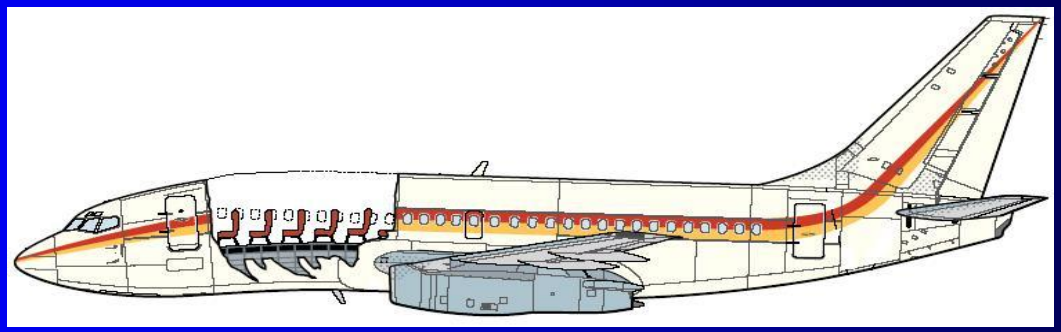
BOEING 737 "ALOHA" INCIDENT *(April 28, 1988)*

AGING AIRCRAFT

ALOHA CAUSE OF ACCIDENT

B737 MANUFACTURING HISTORY

- **1967 – 1972 : menggunakan teknologi 'cold bonding' dan rivet (dengan *knife edge*) untuk proses upper dan lower lap joint skin**
- **1972 up : menggunakan 'fay surface seal' dan rivet (tanpa *knife edge*) untuk proses upper dan lower lap joint skin**

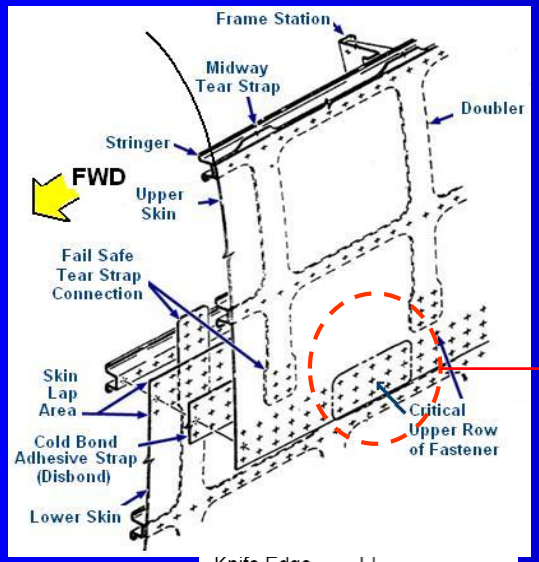


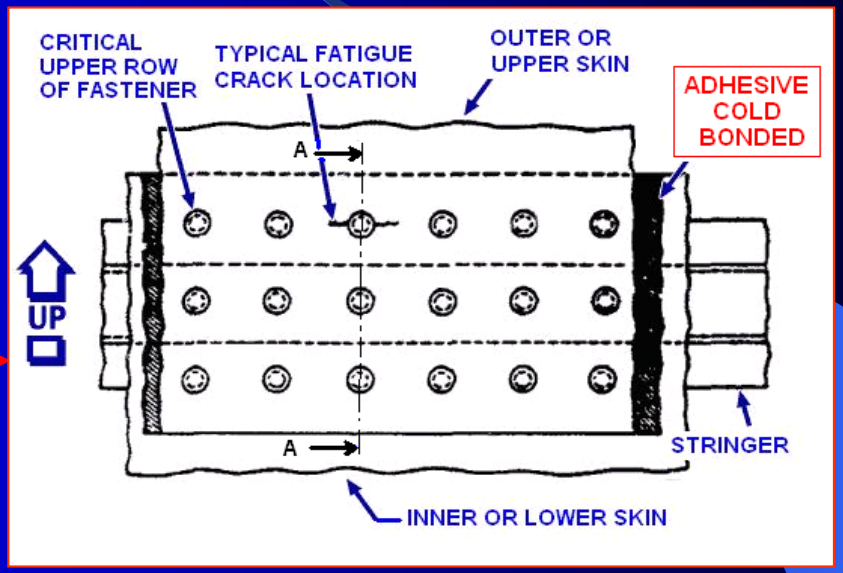
AGING AIRCRAFT

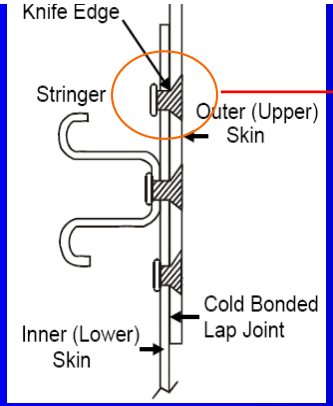
BACKGROUND

HISTORY

ALOHA CAUSE OF ACCIDENT







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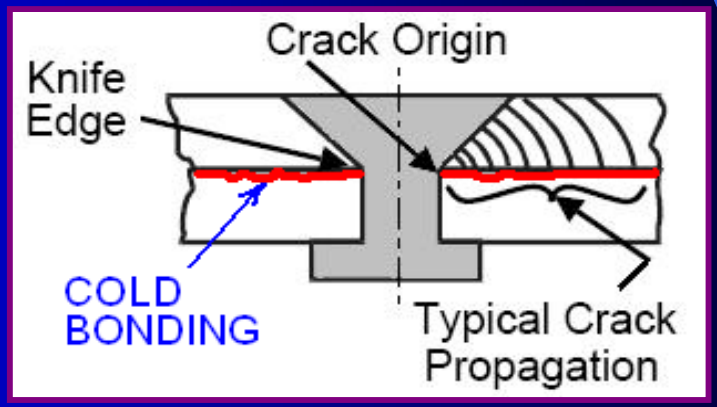
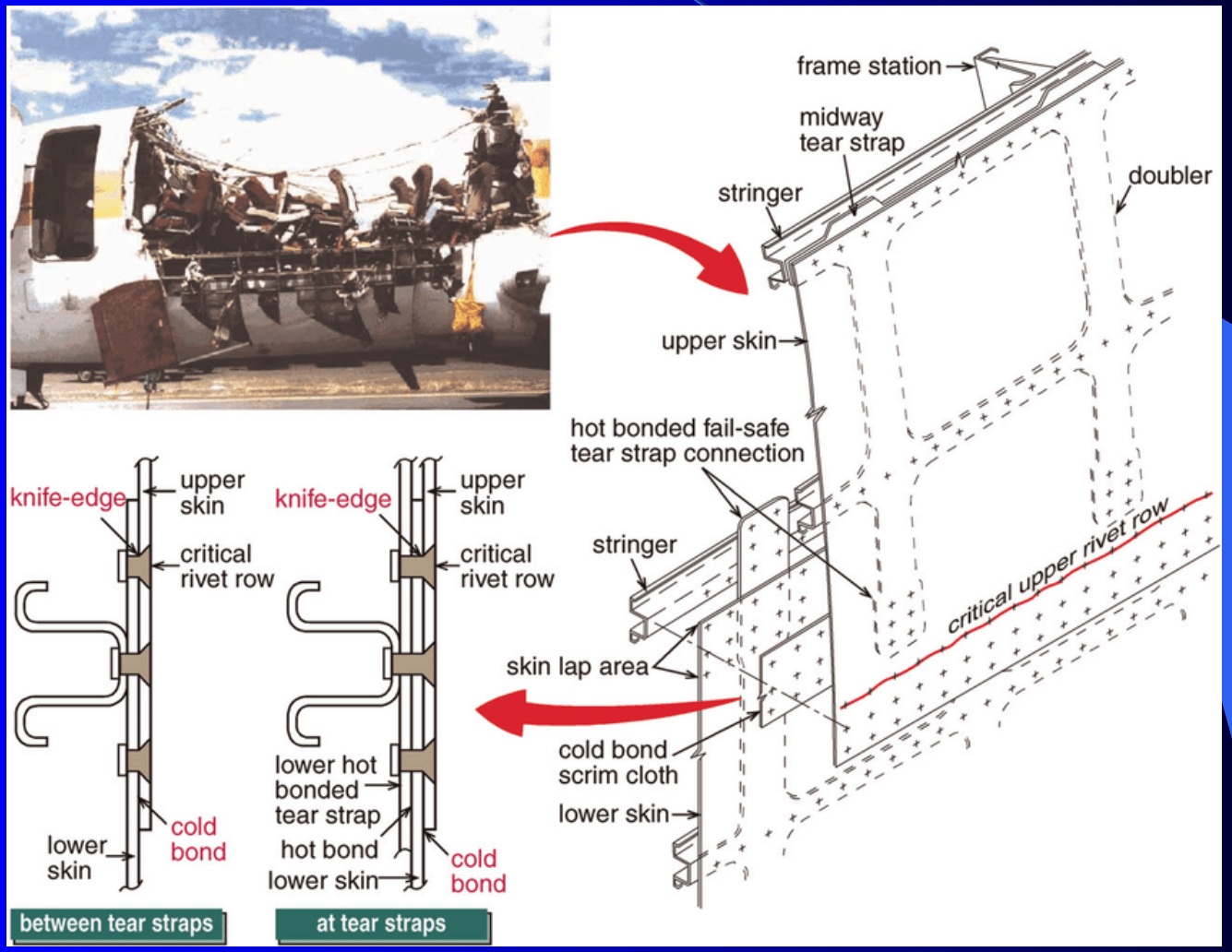


AGING AIRCRAFT

BACKGROUND

HISTORY

ALOHA CAUSE OF ACCIDENT



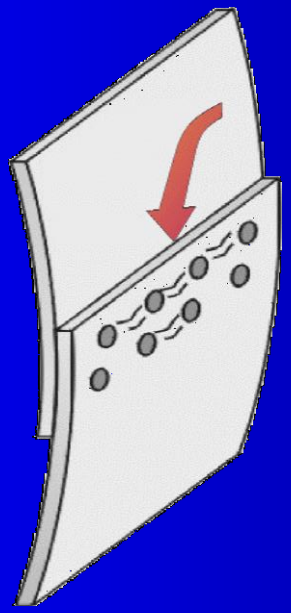
AGING AIRCRAFT

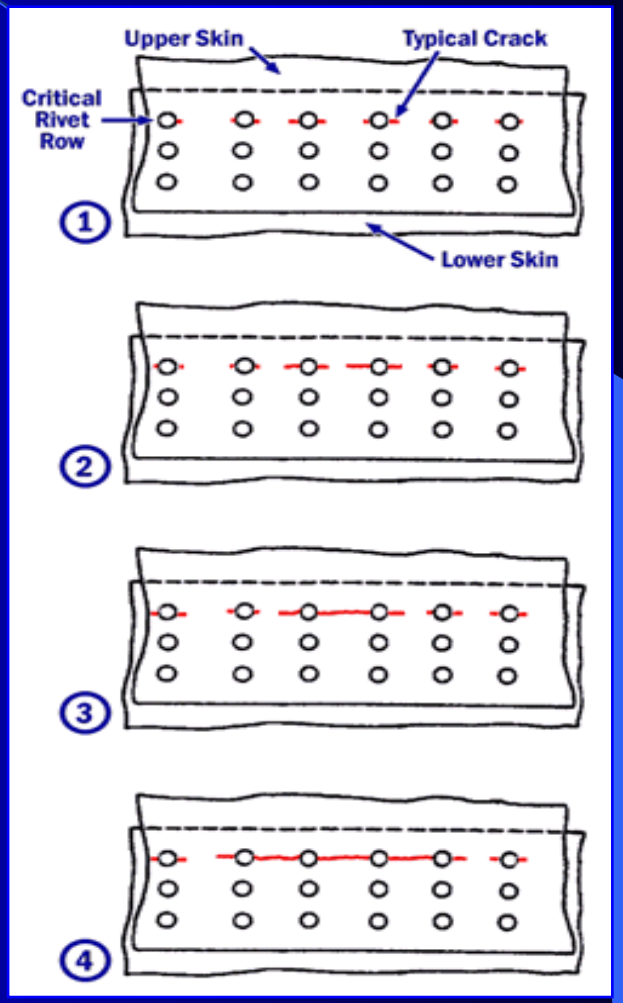
BACKGROUND

HISTORY

ALOHA CAUSE OF ACCIDENT

CRACK GROWTH





WIDESPREAD FATIGUE DAMAGE (WFD) PHENOMENA

(REF. FAR 25.571 amd.96)

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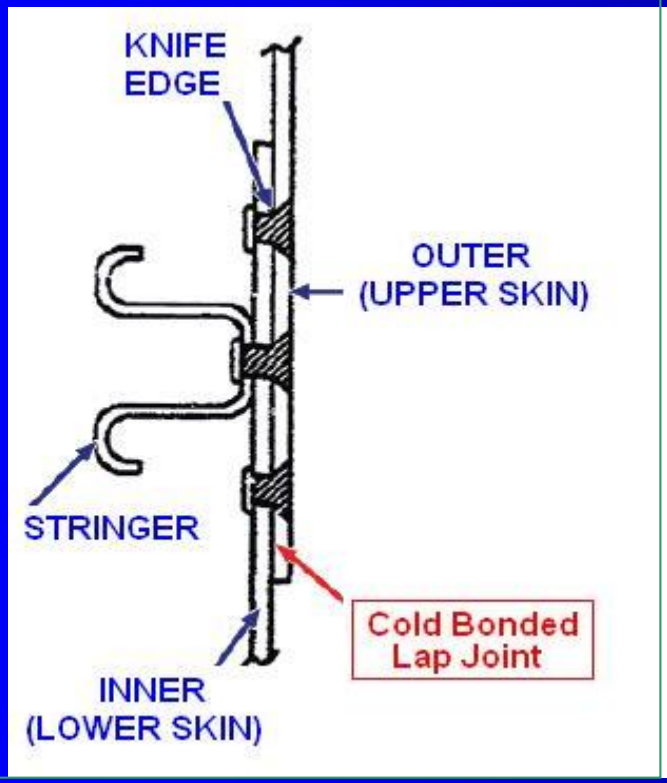
SOLUTION

(Ref. SB No. 737-53A1177 : Fuselage – Skin – Repair Methods for Cracks in Lower Skins at Lap Joints)



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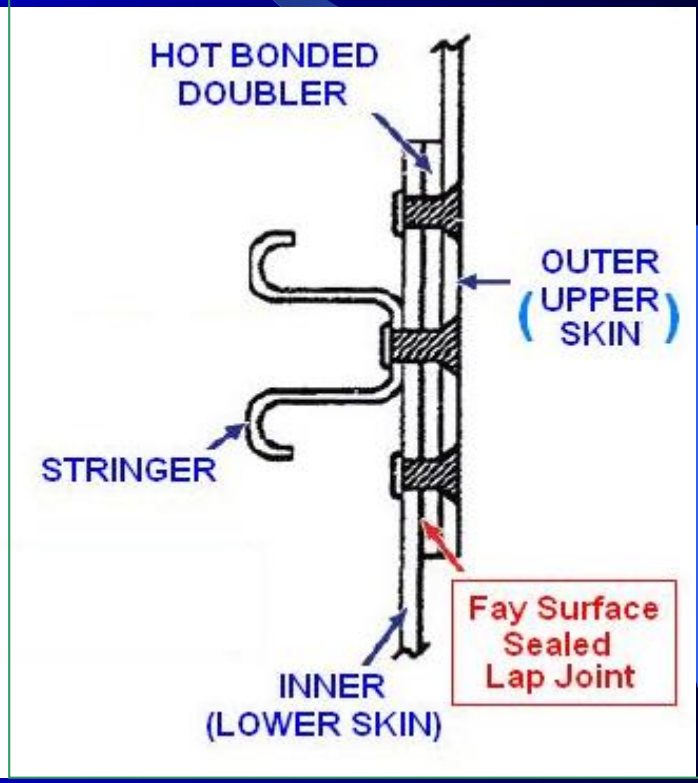

AFTER

AGING AIRCRAFT

- ***Response to Aloha accident***

  June 1988 FAA hosted "The International Conference on Aging Airplanes" resulted :

  - **Organizations of operators, manufacturers and regulators (AAWG = Airworthiness Assurance Working Group) to investigate and propose solutions to the problems evidenced as a result of the accident**
  - **The major topics are :**
    - **Review of the existing Service Bulletins (SB), Supplemental Inspection Documents and Maintenance Program**
    - **Establishment of a Corrosion Prevention and Control Program (CPCP)**
    - **Widespread Fatigue Damage evaluation**
    - **Assessment of repair**

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INDONESIAN AEROSPACE (Ae)

AGING AIRCRAFT

BACKGROUND

HISTORY

TWA flight 800 B747-100 (July 17, 1996)

The aircraft impacted the water in the Atlantic Ocean near New York after 11 minutes take off (13,700ft sea level) due to explosion of the centre wing fuel tank, killed 230 passenger and crew on-board

Response to TWA Accident

White House Commission on Aviation Safety and Security requested FAA to include Non-structural Aging Program into the existing Aging Program Research (August 22, 1996)

AGING AIRCRAFT

FAA RESEARCH FOR NON- STRUCTURAL AGING

- To assess the degradation of airplane wire and determine the point at which wire degradation may hazard safe flight
- To establish the condition of aging aircraft wiring components and validate the adequacy of visual inspection
- To develop nondestructive testing tools for inspection and testing of wiring systems
- To develop an arc-fault circuit interrupter for transport aircraft
- To perform destructive testing of flight control linkages

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INDONESIAN AEROSPACE (Ae)

AGING AIRCRAFT

BACKGROUND

HISTORY

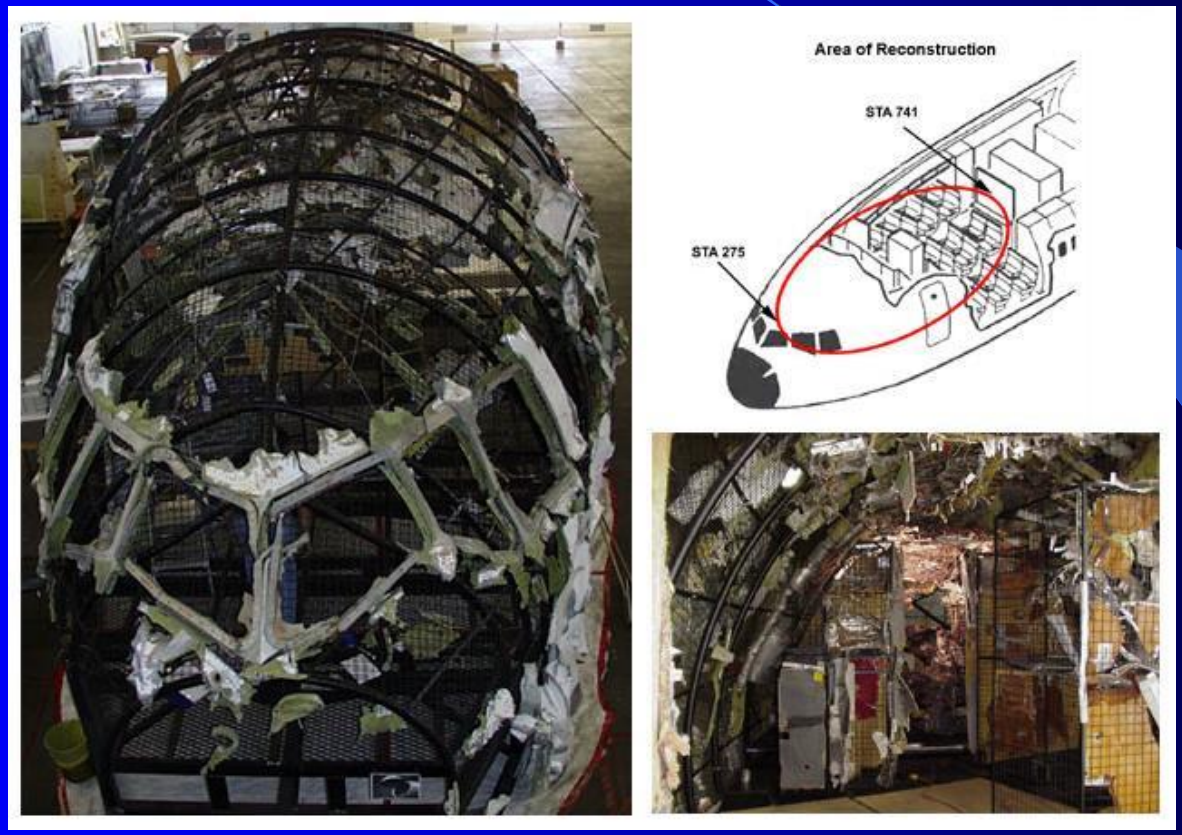
The Aging Transport Nonstructural Systems Plan calls for the FAA to add six specific tasks to the Aging Aircraft Research Program :

- *To determine if a service life for airplane* wire is appropriate, and - if appropriate - determine the service life for all types of wire used in transport aircraft.
- To establish the condition of aging systems wiring components and validate the adequacy of visual inspection.
- To develop nondestructive testing tools for inspection and testing of wiring systems.
- To establish aging effects on aircraft lightning and high-intensity radiated fields (HIRF) protection systems.
- To develop an arc-fault circuit interrupter for transport aircraft.
- To perform destructive testing of flight control linkages

AGING AIRCRAFT

BACKGROUND

HISTORY



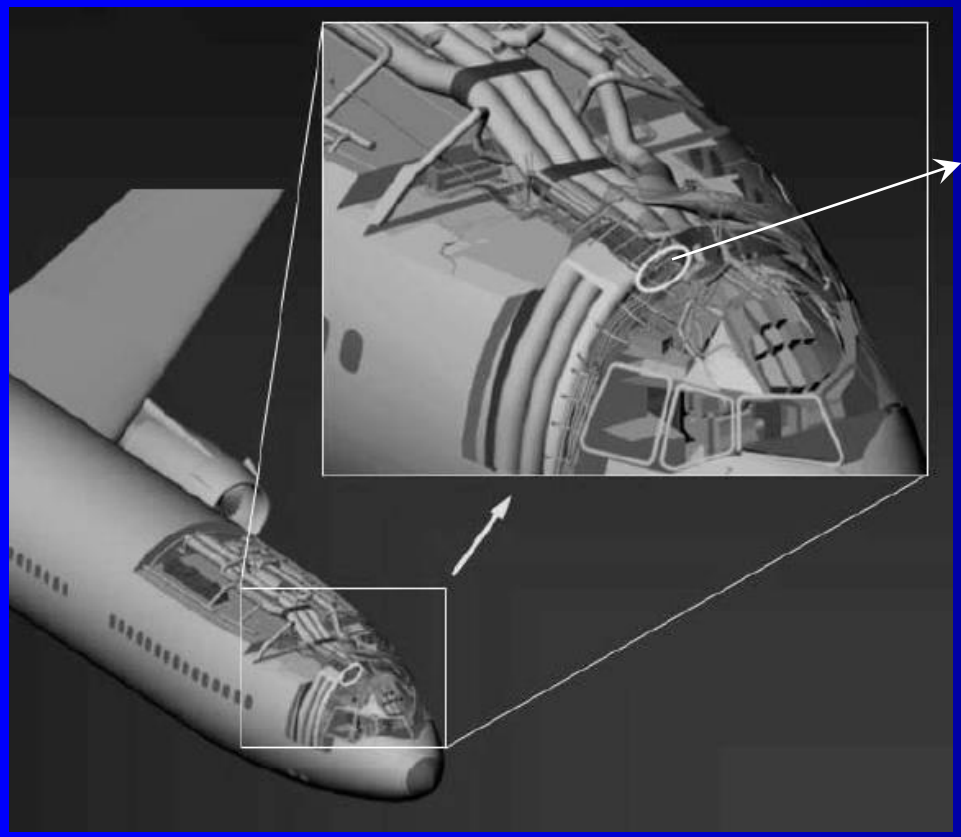
SWISSAIR flight111 MD-11 ACCIDENT (September 02, 1998)

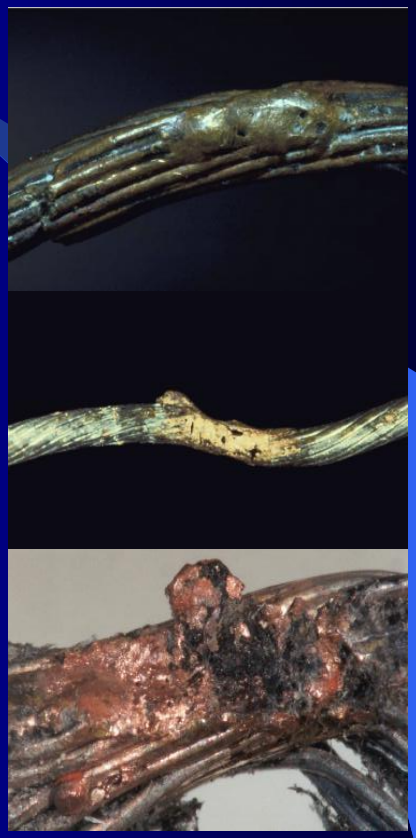
The aircraft was approximately one hour into a flight from New York to Geneva when the crew reported smoke in the cockpit. While attempting an emergency landing in Halifax, Nova Scotia, the aircraft crashed into the Atlantic Ocean. Possible ignition of the aircraft's insulation which led to a fire and loss of control and killed 229 passenger and crew.

AGING AIRCRAFT

BACKGROUND

HISTORY





Melted copper on Wire

SWISSAIR flight111 MD-11 ACCIDENT (September 02, 1998)

Response to Swissair flight 111 Accident

The Boeing Company issued a Flight Operations Bulletin (No. MD-11-99-04), which states: "Boeing advises that any time smoke has been detected and the source cannot be POSITIVELY identified and eliminated, the aircraft should be landed as soon as possible"

AGING AIRCRAFT

Background

Working with the aviation industry, FAA developed an Aging Airplane Program in response to:

- Airplanes being operated beyond original design service goals.
- Determination that original manufacturers' maintenance plans were not required to address potential age-related issues.
- 1988 Aloha B-737 accident.
  - *Probable Cause: Aloha's failure to detect structural damage*

FAA revised the Aging Airplane Program in response to:

- The Aging Aircraft Safety Act of October 1991, sponsored by Representative James L. Oberstar.
- The 1996 TWA 800 and 1998 Swissair accidents, which highlighted wiring issues related to aging aircraft.

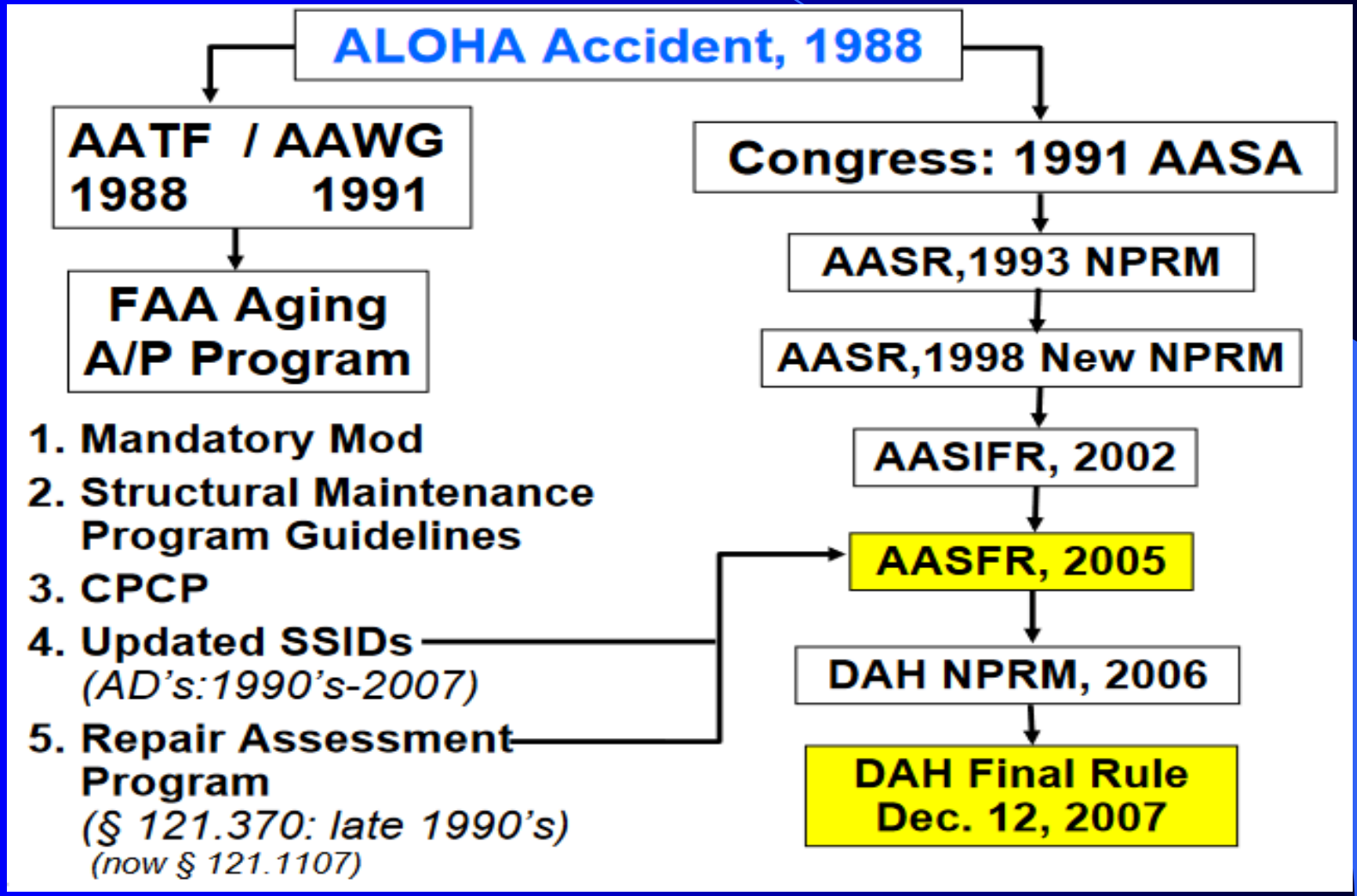
The Aging Airplane Safety Rule was issued in 2005 to implement the 1991 Oberstar Act and to require certain operators to perform supplemental inspections of their aircraft

- Ultimately, FAA decided to address wiring (i.e., non-structural) issues in a separate rulemaking to be issued at a later date.

AGING AIRCRAFT

BACKGROUND

HISTORY

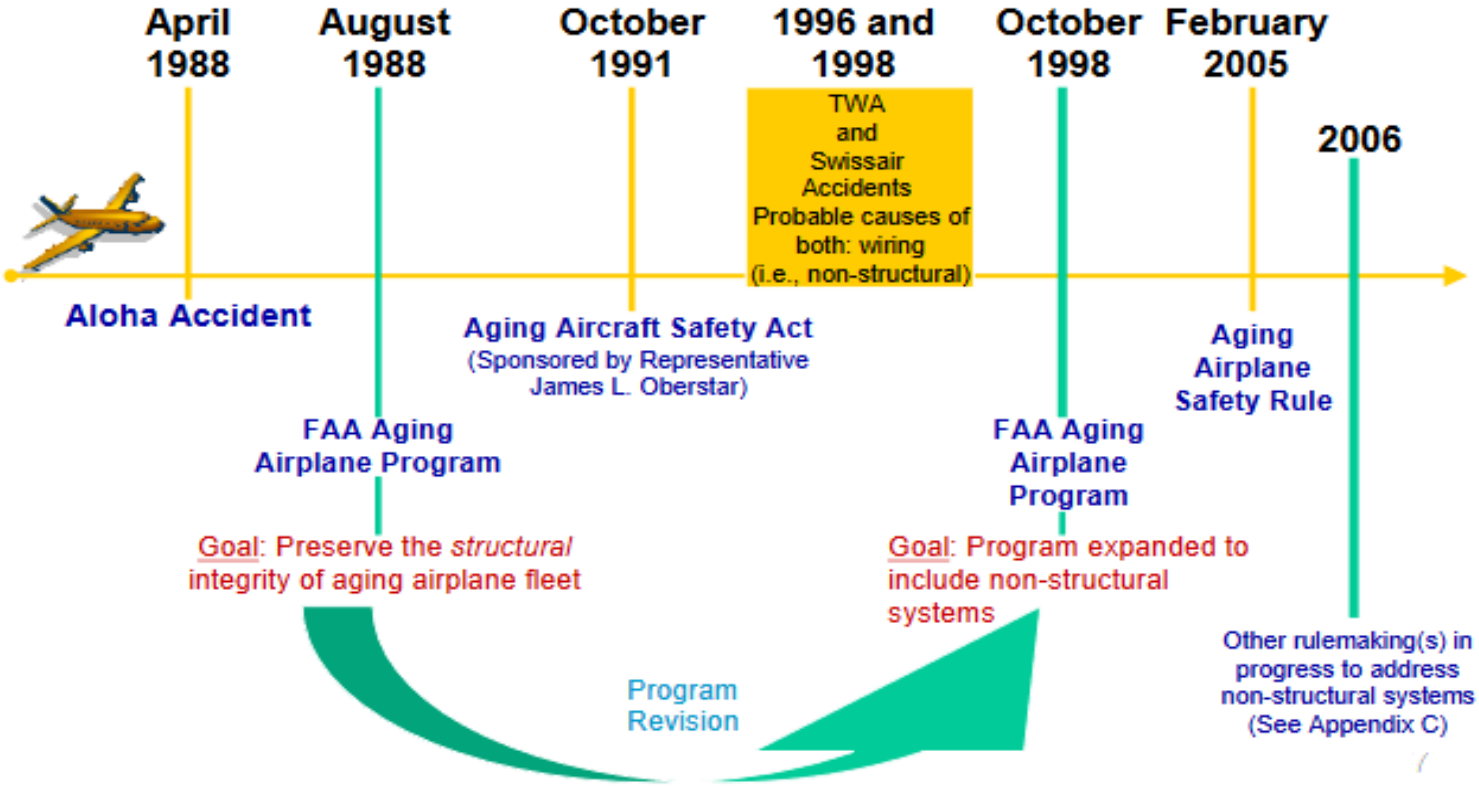


AGING AIRCRAFT

BACKGROUND

HISTORY

Timeline of the Aging Airplane Program



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Aging Aircraft Safety Act— October 1991

- **Requires FAA to initiate a rule to assure the continuing airworthiness of aging aircraft.**
- **Requires FAA to perform an Inspection and Records Review of each aircraft air carriers use to provide air transportation.**
  - Inspection must show that maintenance of the aircraft's structure, skin, and other age-sensitive parts has been adequate and timely.
  - Inspections should be conducted as part of a heavy maintenance check after 14 years of service.

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Rulemaking

Aging Airplane Safety Rule – February 2005

- **The Final Rule was issued to implement the 1991 Aging Aircraft Safety Act and to require certain operators to perform supplemental inspections on their aircraft.** (See Appendix B for Summary of Requirements)
  - Requires an FAA Inspection and Records Review of each multi-engine airplane—14 years and older—used in scheduled operation.
    - Airplanes over 24 years in service, must be inspected by 12/07.
    - Airplanes over 14 years but not yet 24 years, must be inspected by 12/08.
  - Requires operators to incorporate Damage Tolerance (DT) based inspections for airplanes with 30 or more passenger seats by specified deadlines.
    - DT inspections are based on predictive engineering analysis performed to provide early detection of fatigue cracks, including specific analysis of repairs, alterations, and modifications to the aircraft.
    - Operators must have a program in place by December 2010.

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BACKGROUND

HISTORY

B747-200 “China Airlines Flight 611” flew apart and plunged into the ocean about 50 kilometers, or 30 miles, off the coast on May 25, 2002, just as it reached cruising altitude after taking off from Taipei en-route to Hong Kong, killed all 225 passenger and crew. This 22 years old aircraft has 21,398fc and 64,810fh. Root cause : initial damage on tail section since 1980 then growing to be fatigue crack and did not repair properly according to manual

A patch on a China Airlines jet might have concealed a fatal flaw that killed 225 people. Martin Aubury reports.

AGING AIRCRAFT

BACKGROUND

HISTORY

B747-200 "CHINA AIRLINES" ACCIDENT (MAY 25, 2002)

Response to CI611 Accident

ASC (Aviation Safety Council of Taiwan, China) recommended China Airlines such the followings :

- Perform structural repairs and damage assessment according to SRM or other approved regulation
- Review the record keeping system to ensure that all maintenance activities have been properly recorded
- Access and implement safety related-airworthiness requirements
- Conduct CPCP in accordance with the approved maintenance documents
- Enhance maintenance crews' awareness with regard to the irregular shape of the aircraft structure that may indicate hidden structural damage
- Reassess the relationship with the aircraft manufacturer
- Ensure that all safety-related service documentation is received and assessed
- Consider reviewing the inspection procedure for maintenance records
- Ensure that the implementation of continuing airworthiness includes safety aspects, operational factors and uncertainty factors in workmanship and inspection

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BACKGROUND

HISTORY

CN235 "Ventral Door Separation" (January 02, 2000)

Ventral Door

Hook & Port Fitting

Baggage Compartment

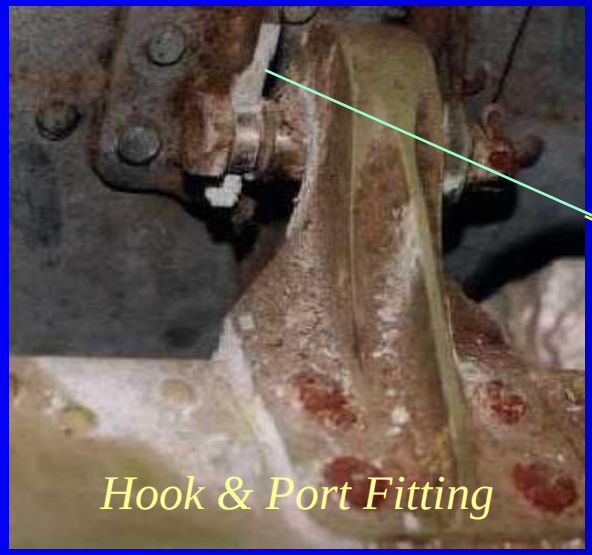
When flying a post maintenance test flight at altitude 16,000ft, speed 150kts, heading of 100° on radial 100 about 15nm from Husein Sastranegara Bandung Airport, its Ventral Door detached and separated from the aircraft

AGING AIRCRAFT

BACKGROUND

HISTORY

CN235 "Ventral Door Separation" (January 02, 2000)



SEM photo

'Mud Crack' pattern

AGING AIRCRAFT

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

BACKGROUND

HISTORY

CN235 "Ventral Door Separation" (January 02, 2000)

Response to CN235 Ventral Door Accident

- **On January 28, 2000 PT. IPTN issued Service Letter No. 00-53-01 (Inspection of Guide Hooks and Hinge Assembly of Ventral Door and Rear Fuselage Port Fitting)**
- **DGAC issued Airworthiness Directive No. 00-01-019 to conduct special inspection on all CN235 aircrafts in accordance with PT. IPTN Service Letter No. 00-53-01**
- **Service Bulletin (SB) No. N235-52-230 (Guide Hooks assy and Hinge Assy of Ventral Door and Port Fitting Assy of Rear Fuselage Inspection) issued by PT. IPTN on April 28, 2000**

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AGING AIRCRAFT

BACKGROUND

HISTORY

Tail Rotor Pitch Link

PUMA HT3305 (December 25, 2000)

On December 25, 2000 at 10.00 WIB, Helicopter PUMA HT-3305 at Kaybar, Manokwari, East Indonesia, starting by abnormal vibration at altitude 7500 ft, then the aircraft went down for landing. At altitude about 15-20 ft the pilot pushed pedal for landing and not long after that the pylon was broken and fell to the ground, meanwhile the aircraft turned uncontrolled three times before fell to the ground and injured all 7 crew

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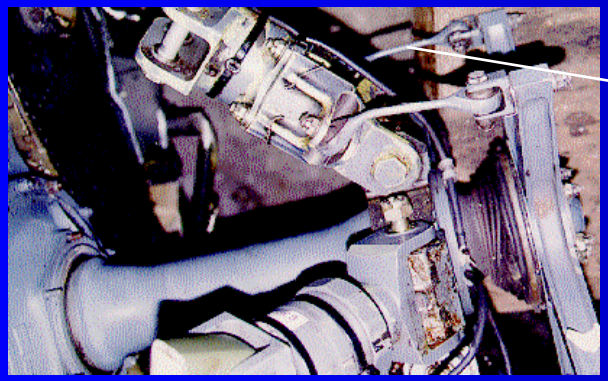
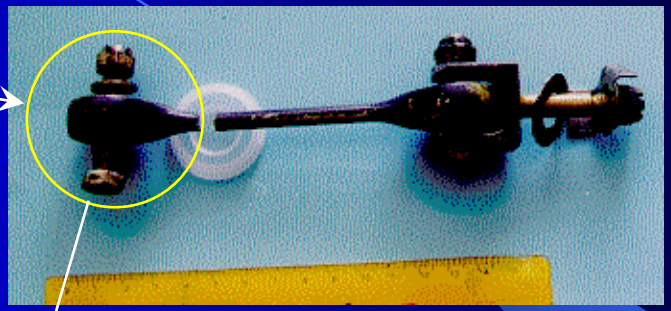
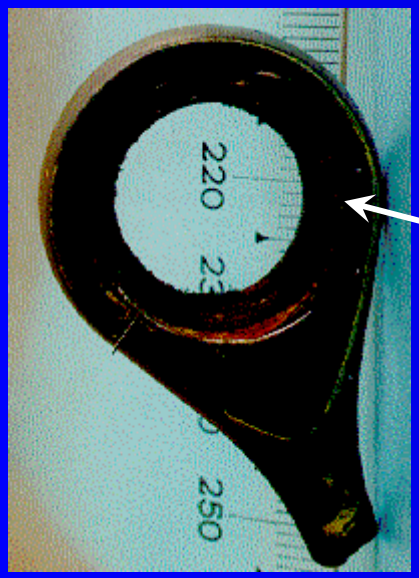
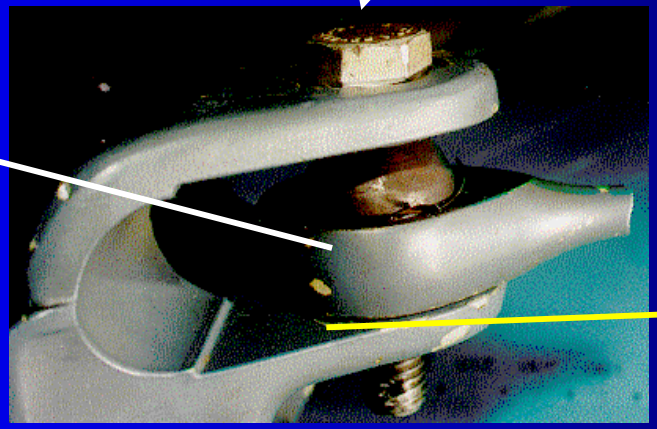
BACKGROUND

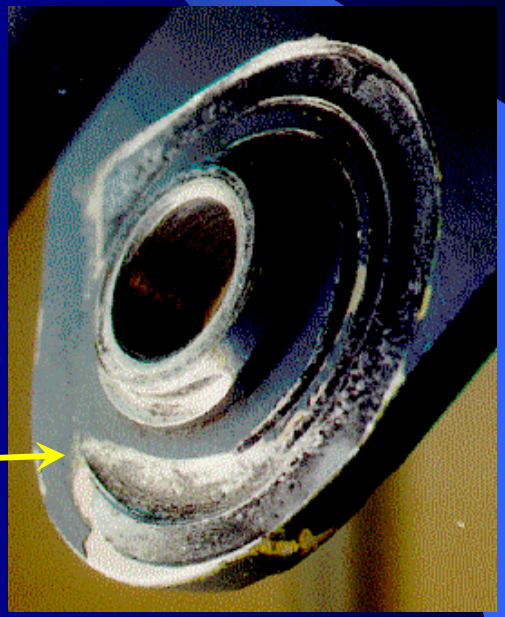
HISTORY











PUMA HT3305 (December 25, 2000)

AGING AIRCRAFT

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

BACKGROUND

INDONESIAN COMMERCIAL AIRCRAFTS AVERAGE AGE

Airline	Jml Pesawat	Usia rata2 (tahun)	Jenis pesawat
Garuda Indonesia	83	6.7	A330(14), B737(11), B737NG(55), B747(3)
Lion Air	80	6.5	B737(9), B737NG(62), B747(2), MD80/90(3)
Batavia Air	36	21.7	A320(7), A321(1), A330(2), B737(26)
Sriwijaya Air	34	23.4	B737(33), B737NG(1)
Wing Air	24	9.8	ATR42/72(17), Dash8(2), MD80/90(2)
Indonesia Air Asia	22	6.0	A320(19), B737(3)
Merpati Airlines	13	22.4	B737(11), F100(2)
Trigana Air Service	13	23.6	ATR42/72(10), B737(2)
Citilink	10	15.5	A320(5), B737(5)
SKY Aviation	5	19.5	F50(5)
Kalstar Aviation	4	19.2	ATR42/72(3), B737(1)
Pacific Royale	2	15.8	F50(2)
Mandala Air	2	0.4	A320(2)
Data per 16 Juni 2012, tidak termasuk MA60 & pesawat propeler lainnya			

https://totosp.files.wordpress.com/2012/06/usia-pesawat-16-jun-12.jpg

AGING AIRCRAFT

IAe Aircraft Products Ages:

- 70 CN235 (51 aircrafts ≥ 20 years old)
- 127 NC212 (98 aircrafts ≥ 20 years old)
- 122 NBO (±100 aircrafts ≥ 20 years old)
- 25 NAS332 (21 aircrafts ≥ 20 years old)
- 11 SA330 (11 aircrafts ≥ 20 years old)
- 73 NBell 412 (31 aircrafts ≥ 20 years old)
- 3 BK 117 (2 aircrafts ≥ 20 years old)

AGING AIRCRAFT

Aging Aircraft Requirements

AGING REGULATION (FAA)

- Refer to FAR 121.1105 and FAA AC 120-84 (Aging Airplane Inspections and Records Reviews) evaluation reference of aging aircraft is 14 years old since the first C of A issuance
  - An airplane that has passed its 14th year in service but not its 24th year in service as of December 8, 2003, must be inspected no later than December 4, 2008.
  - An airplane that has not passed its 14th year in service must have its aging airplane inspection and records review within 5 years after the start of its 15th year in service
- The meaning of the phrase "no later than 5 years after the start of the airplane's 15th year in service" as used in FAR 121.1105(b)(3) is that an initial aging airplane inspection and records review be completed "no later than 5 years after the start of the airplane's 15th year in service." We conclude that this phrase means the initial aging airplane inspection and records review must be completed before the airplane enters its 20th year in service.

(Refer to : https://www.faa.gov/about/office_org/headquarters_offices/agc/practice_areas/regulations/interpretations/Data/interps/2013/Timothy_Davis-AGL-240_2013_Legal_Interpretation.pdf).

AGING REGULATION (India)

- Airworthiness Advisory Circular (AAC) No. 4 of 2000 (4th September 2000) : guideline for the maintenance of all aircraft including private aircraft which have crossed 20 years since manufacture

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

AGING AIRCRAFT

REQUIREMENTS

REGULATION

AGING REGULATION (RI) - OBSOLETE

- Peraturan Menteri Perhubungan Nomor : KM 5 Tahun 2006 tentang Peremajaan Armada Pesawat Udara Kategori Transport Untuk Angkutan Udara Penumpang
  - Pesawat Udara kategori transport untuk angkutan udara penumpang yang dapat didaftarkan dan dioperasikan untuk pertama kali di wilayah Indonesia harus memenuhi persyaratan :
    - Berusia tidak lebih dari 20 (dua puluh) tahun
    - Jumlah pendaratan tidak lebih dari 50.000 kali (cycle)
  - Pesawat udara yang akan didaftarkan dan dioperasikan di atas harus memenuhi syarat-syarat :
    - Dilengkapi peralatan operasional sesuai dengan CASR 121, 135, 91 dan persyaratan kelaikan udara yang berlaku
    - Memiliki dokumen pesawat udara yang lengkap dan teridentifikasi
    - Untuk yang sudah masuk kategori Aging Aircraft harus telah melaksanakan *Aging Aircraft Program*

AGING AIRCRAFT

AGING REGULATION (RI) - NEW !!

- Peraturan Menteri Perhubungan Nomor : PM 155 Tahun 2016 tentang Batas Usia Pesawat Udara Yang Digunakan Untuk Kegiatan Angkutan Udara Niaga, Pasal 3 :
  1) Pesawat Terbang Kategori Transpor untuk angkutan udara penumpang yang didaftarkan dan dioperasikan untuk pertama kali di wilayah Republik Indonesia, paling tinggi berusia 15 (lima belas) tahun.
  2) Pesawat Terbang Selain Kategori Transpor untuk angkutan udara penumpang yang didaftarkan dan dioperasikan untuk pertama kali di wilayah Republik Indonesia, paling tinggi berusia 20 (dua puluh) tahun.
  3) Pesawat Terbang Kategori Transpor dan Pesawat Terbang Selain Kategori Traspor untuk angkutan udara khusus kargo (freighter) yang didaftarkan dan dioperasikan untuk pertama kali di wilayah Republik Indonesia, paling tinggi berusia 30 (tiga puluh) tahun.
  4) Helikopter yang didaftarkan dan dioperasikan untuk pertama kali di wilayah Republik Indonesia, paling tinggi berusia 20 (dua puluh) tahun.

Aging Aircraft
Description

AGING AIRCRAFT

DESCRIPTION

BASIC

- "Aging Aircraft" is :

  "*aircraft which have exceeded their certified airframe design life*"

- Airframe design life : is the period of time (in flight cycles/hours) established at design and/or certification during which the principal structure will be reasonably free from significant cracking including widespread fatigue damage

- In general, airframe design goal life is about 60,000 flight cycle or approximately similar with 20 years calendar

AGING AIRCRAFT

DESCRIPTION

BASIC

- "Aging Aircraft" (Non-Structure) is :
  "*aircraft which have exceeded their non-structure (electric wire) design service objective life*"
- Wire, it seems, may not last as long as the 20 or 30-year design service objective of the airplane (DSO). (*Air Safety Week, September 27, 1999*)
- There appears to be a near linear relationship between aircraft (structure) age and the degradation of wiring due to chafing (*Mark Brown, GRC International, Air Safety Week, September 27, 1999*)
- For wire, service life is influenced by a variety of factors:
  * As temperature increases, age decreases.
  * As humidity increases, age decreases.
  * Vibration accelerates aging.
  * Poor installation can accelerate aging

AGING AIRCRAFT

Aging mechanism sources :

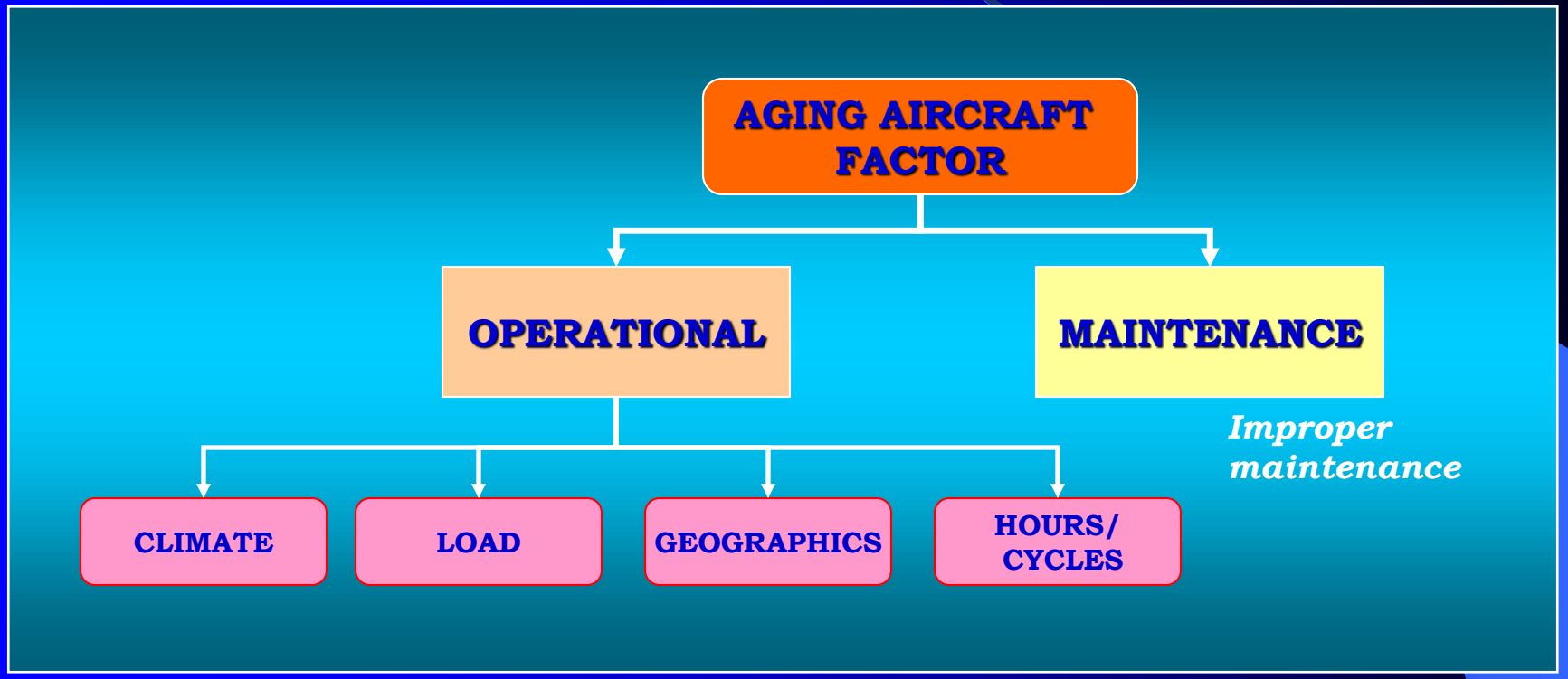
- **Fatigue** → *thru repetitive cyclic loading*
- **Corrosion**
- **Wear**
- **Deterioration**

→ *thru time*

AGING AIRCRAFT

DESCRIPTION

ACCELERATING FACTOR



FACTOR(S) ACCELERATING AGING AIRCRAFT

Note : Aging may also be occurred as a combination of each factor

Fatigue Failure

Occurs due to cyclic loading

⇒ The mechanism of failure is the initiation and propagation of cracks

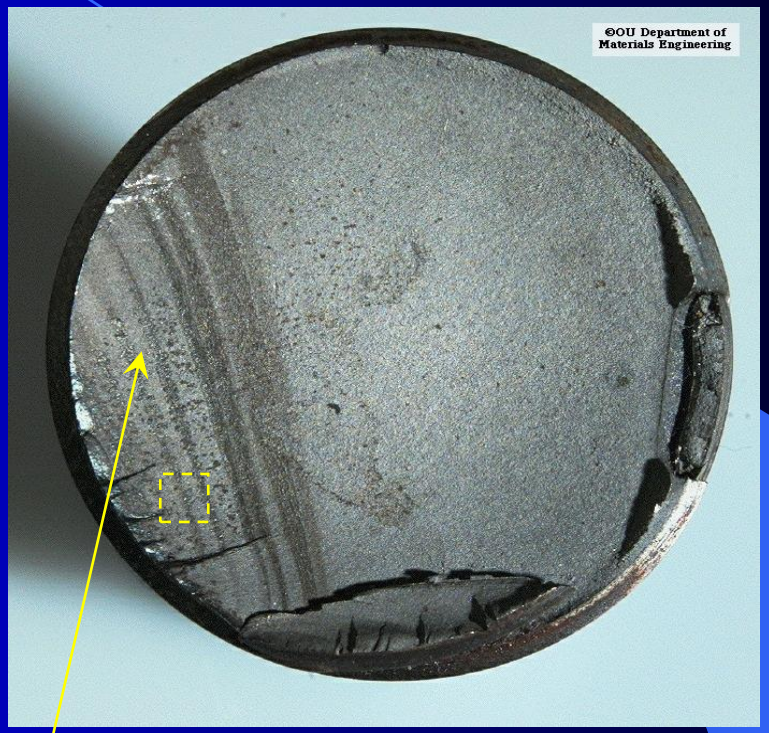
⇒ Final fast fracture will occur by either Brittle or Ductile fracture

Macroscopic Appearance :

⇒ The surface is covered with a relatively flat, smooth region where fatigue crack growth took place, and a rougher, fast fracture region

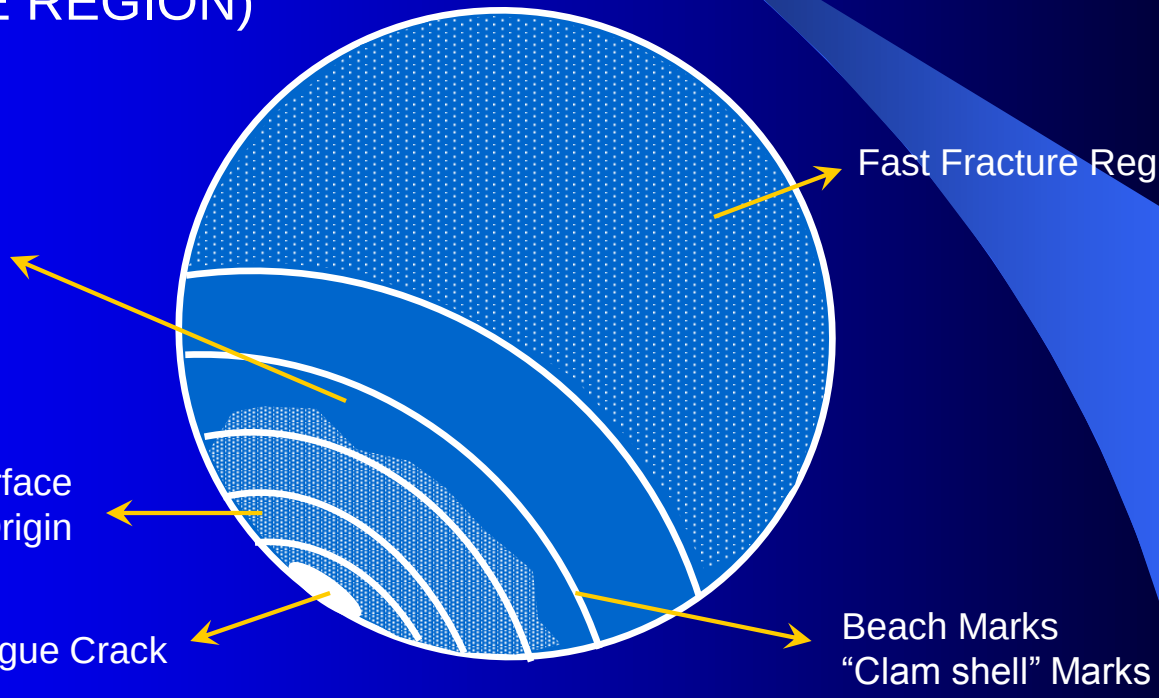
Microscopic Appearance :

⇒ Ductile in appearance (no cleavage) but not suficient to create dimples as in ductile failure



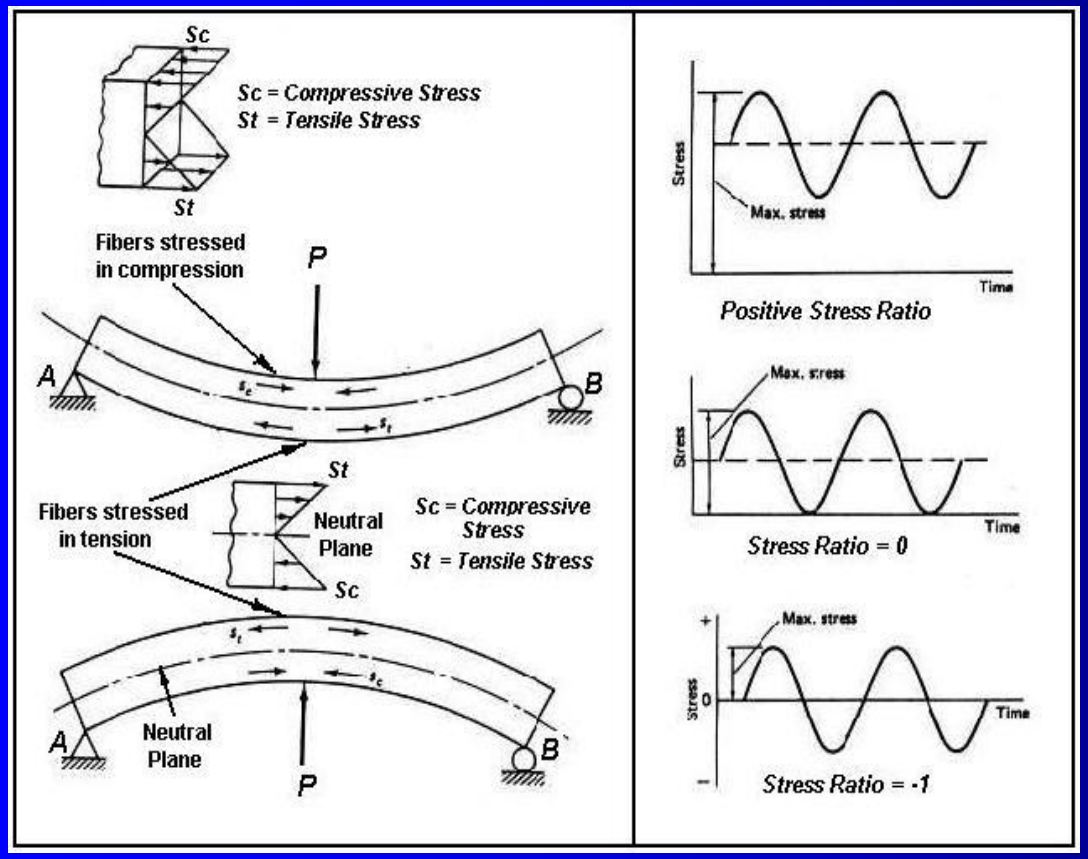
Fatigue Failure

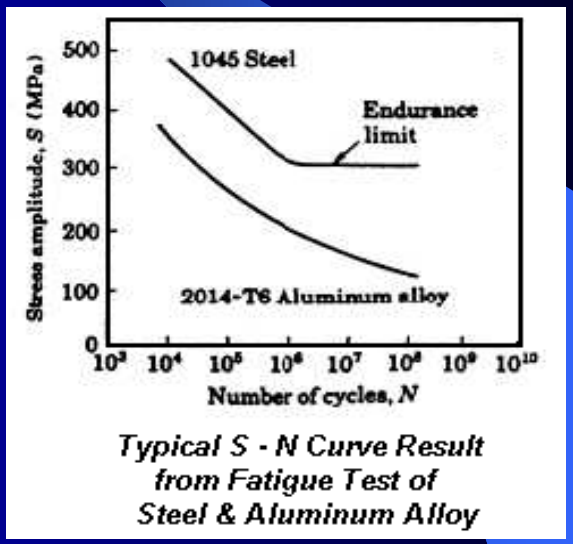
(FRACTURE REGION)



AGING AIRCRAFT

FATIGUE MECHANISM





Typical S - N Curve Result from Fatigue Test of Steel & Aluminum Alloy

FATIGUE DIAGRAM

WIDE SPREAD FATIGUE DAMAGE (WFD)

⇒ Fatigue damage is the gradual deterioration of a material subjected to repeated loads. Airplane structure experiences fatigue damage because it is subjected to repeated loads, such as the pressurization and depressurization of an airplane that occurs with each flight.

⇒ The fatigue damage could result in cracks occurring in structure over time, the mechanism of failure is the initiation and propagation of cracks

⇒ When structure experienced repeated loads in long time (high cycle), there will appear many small cracks simultaneously at multiple structure locations

⇒ These edge of cracks will join and interact one and another to be of sufficient size and density such that the structure will no longer meet the residual strength requirements of section 25.571(b)

⇒ This phenomena is widely known as ***Widespread Fatigue Damage (WFD)***

⇒ Two types of WFD :

1). Multiple Site Damage (MSD)
2). Multiple Element Damage (MED)

AGING AIRCRAFT

DESCRIPTION

FATIGUE

AAWG Aging Aircraft Program Development - Widespread Fatigue Damage Prevention

Widespread Fatigue Damage (WFD) Terminology

- Widespread fatigue damage in a structure is characterized by the simultaneous presence of (small) cracks in multiple details that are of sufficient size size and density whereby the structure will no longer meet damage tolerance requirements, i.e. to maintain regulatory residual strength after partial structural failure
- Multiple Site Damage (MSD) is a source of widespread fatigue damage characterized by the simultaneous presence of (small) fatigue cracks in the same structural element
- Multiple Element Damage (MED) is a source of widespread fatigue damage characterized by the simultaneous presence of (small) fatigue cracks in similar adjacent structural elements

What is WFD?

AGING AIRCRAFT

DESCRIPTION

FATIGUE

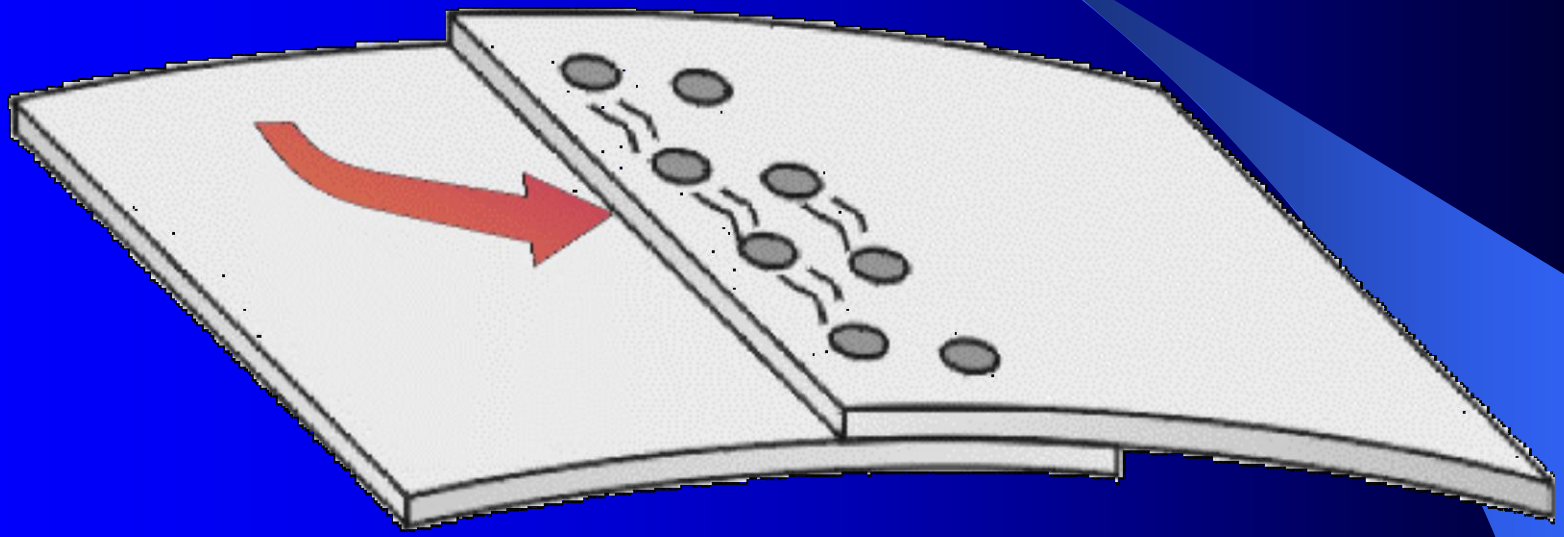


Illustration of WFD

AGING AIRCRAFT

DESCRIPTION

FATIGUE

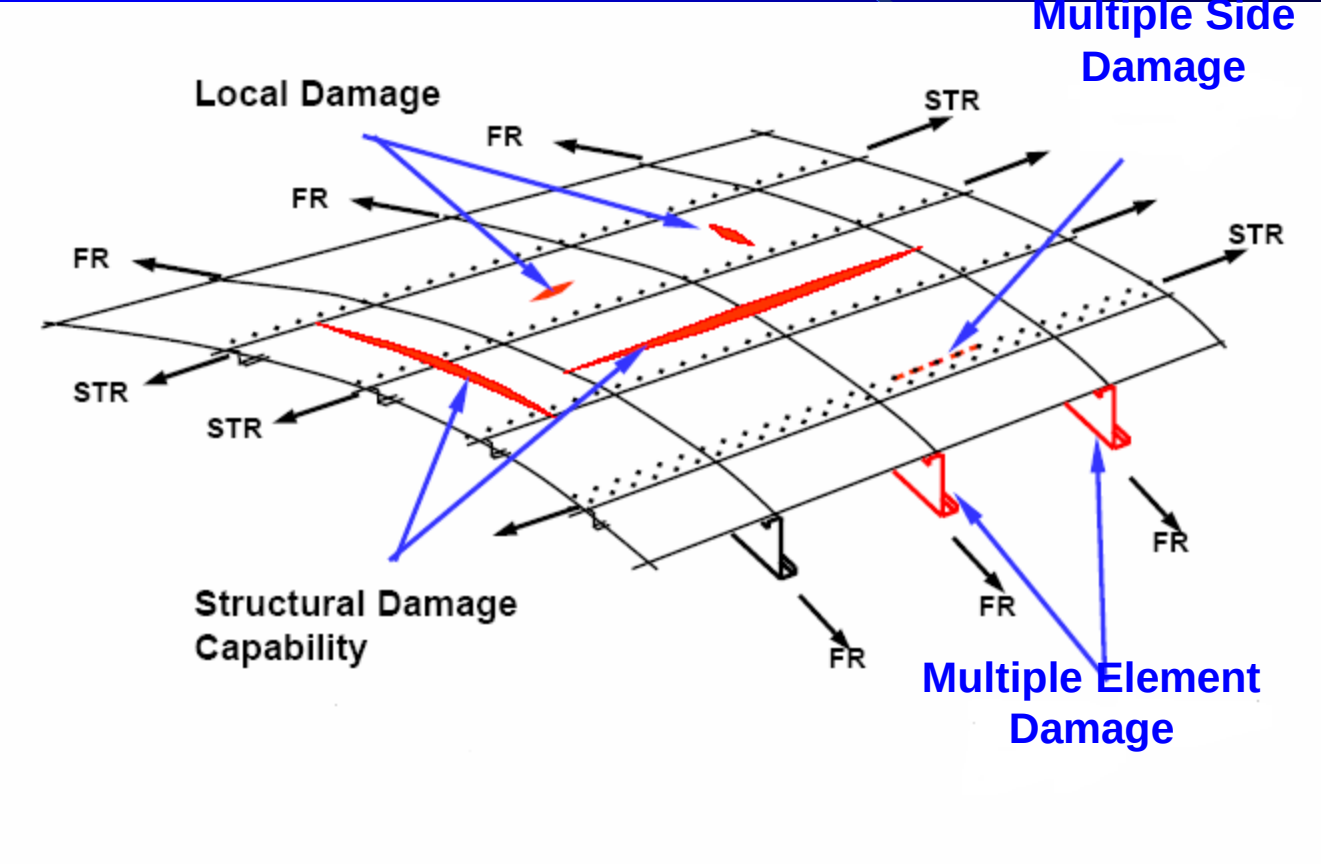


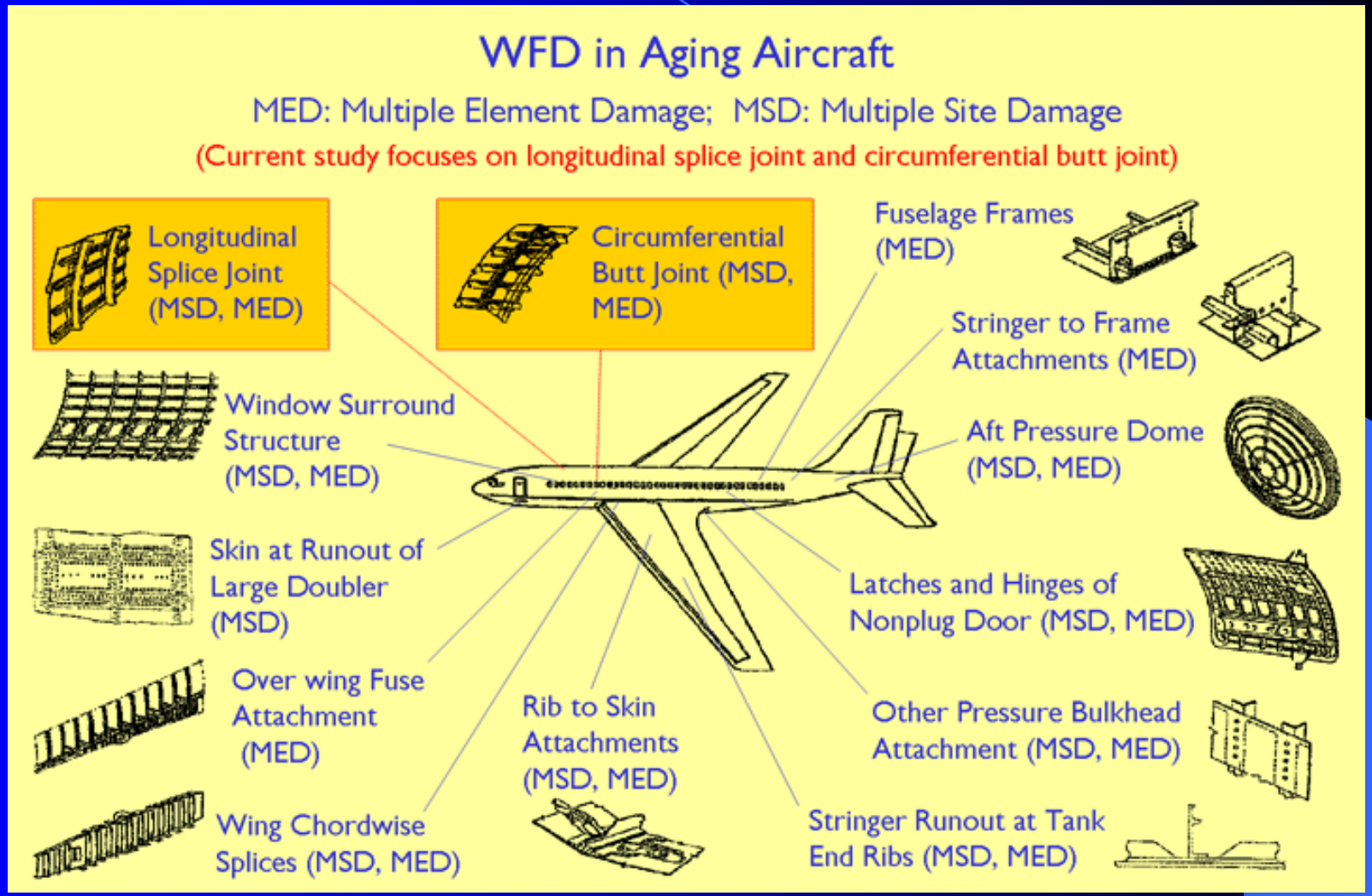
Illustration of WFD

AGING AIRCRAFT

DESCRIPTION

FATIGUE

Example of WFD Area (MSD/MED)



AGING AIRCRAFT

DESCRIPTION

CORROSION

CORROSION FAILURE

Definition :

⇒ Destructive attack of metals by reaction with the environment
⇒ Need condition which allow electron to flow
⇒ Moist or electrolyte must be present

Two Fundamental Types :

⇒ General/Uniform Corrosion
⇒ Localized Corrosion,
- Galvanic Corrosion
- Crevice Corrosion
- Pitting Corrosion
- Intergranular Corrosion
- Stress Corrosion
- Exfoliation
- Corrosion Fatigue

General/Uniform Corrosion

Corrosion Fatigue

AGING AIRCRAFT

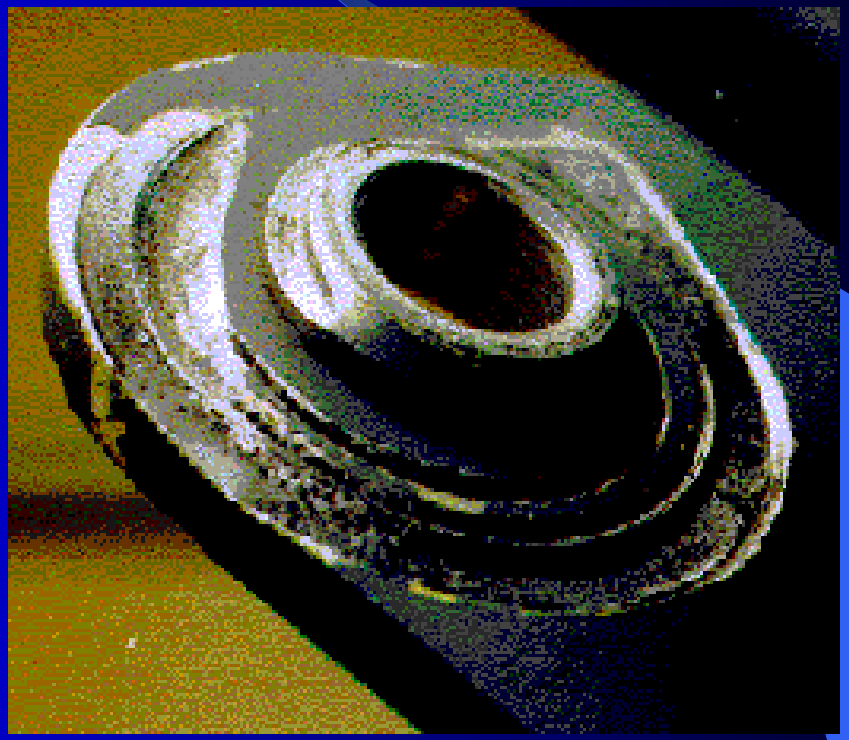
DESCRIPTION

WEAR

Wear Failure

Causes loss material from the surface as a result of rubbing contact with another surface

⇒ May cause direct failure, or
⇒ Contribute to other type of failure such as fatigue



AGING AIRCRAFT

DESCRIPTION

DETERIORATION

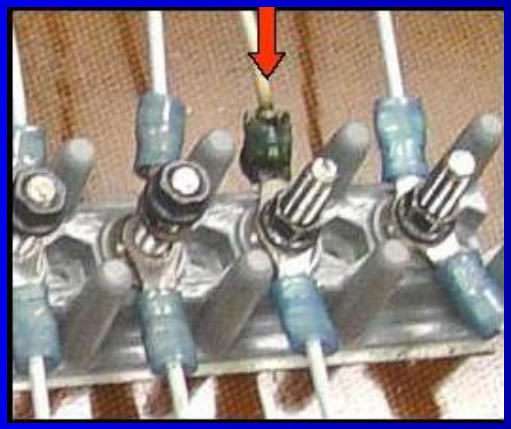
WIRE AGING

Affected Factors :

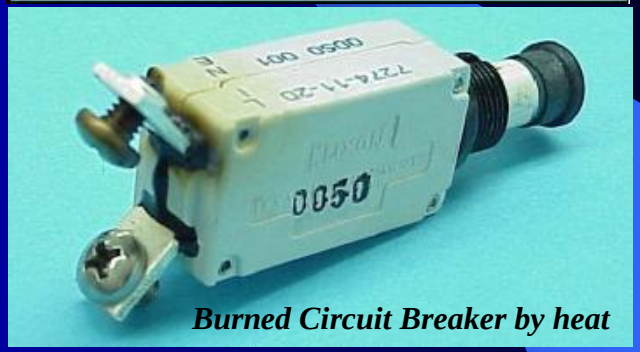
- ✓ Time
- ✓ Thermal
- ✓ Electrical
- ✓ Mechanical
  - Bend
  - Abrasion
  - Thermal
- ✓ Chemical
  - Aircraft Fluids
  - Humidity
  - Oxidizers
- ✓ Radiation
  - Heat
  - Ultraviolet
- ✓ Biological organism

Damaged Wire exposed to heat

Loose Terminal arcing



Wire Bundle damaged by wet arc



Burned Circuit Breaker by heat

Damaged Wires prior to arcing

AGING AIRCRAFT

Aging Aircraft Activity

AGING AIRCRAFT

PROGRAM

ACTIVITY

- ***GENERAL ACTIVITIES FOR AGING AIRCRAFT PROGRAM***
  - **Review all related Service Bulletin (SB) and Airworthiness Directive (AD) requiring structural inspection of specific areas at certain intervals for mandatory modification**
  - **Review and update Supplemental Structural Inspection Documents (SSID)**
  - **Review existing corrosion prevention program and develop a baseline Corrosion Prevention and Control Program (CPCP) to maintain corrosion to an acceptable level**
  - **Develop Repair Assessment Program (RAP) to assess the damage tolerance of existing Structural Repair Manual, which may have been designed without using damage tolerance criteria**
  - **Develop Aging Aircraft Repair and Modification Program**

AGING AIRCRAFT

- ***GENERAL TOOLS FOR AGING AIRCRAFT ACTIVITY***
  - **Service Bulletin (SB) and Airworthiness Directives (AD)**
  - **Supplemental Inspection Document (SID)**
  - **Supplemental Inspection Procedure (SIP)**
  - **Corrosion Prevention and Control Program (CPCP)**
  - **Aging Aircraft non-structural Inspection Procedure**

"SERVICE BULLETIN" (SB)

- Service Bulletin is document prepared by the Manufacturer of the product or appliance to provide technical information on changes to the type design to the product or appliance.
- Service Bulletin will make available to all Operators of the product or appliance.
- A Service Bulletin is used to transmit action, which required a record of accomplishment.
- The classification of service bulletin is proposed by the manufacturer to Authority, who may accept the classification or if necessary require a change to the classification
- SB can classified into : 'mandatory', 'recommended' and 'optional'

AGING AIRCRAFT

"AIRWORTHINESS DIRECTIVES" (AD)

- **Legally rules that apply to the products (aircrafts, aircraft engines, propellers and appliances) that experience an unsafe condition.**
- **If the State of Design has not issued mandatory correction information, an AD will be issued to correct that unsafe condition.**

AGING AIRCRAFT

- ***SUPPLEMENTAL STRUCTURAL INSPECTION DOCUMENTS (SSID)***
  - **Documents that contains the recommendation for the inspection procedures and replacement or modification of parts or components necessary for continued safe operation of the airplane (ref. AC 91-56)**

Detail Information on SSID

- Parts or components description and any relevant adjacent structure including means of access to the part
- The type of damage which is being considered
- Relevant service experience
- Likely site(s) of damage
- Recommended inspection method and procedure and alternatives
- Minimum size of damage considered detectable by methods of inspection
- Service Bulletins revised or issued as a result of in-service finding resulting from implementation of SID
- Guidance to the operator on which inspection findings should be reported to the manufacturer
- Recommended initial inspection threshold
- Recommended repeat inspection interval
- Reference to any optional modification or replacement of part or component as terminating action to inspection
- Reference to the mandatory modification or replacement of the part or component at given life
- Information related to any variation found necessary to ‘safe lives’ already declared

"CORROSION PREVENTION AND CONTROL PROGRAM" (CPCP)

- *The* ***CPCP*** is a systematic **approach** to controlling and preventing corrosion in order to avoid expensive repairs and maintains structural integrity by control corrosion to level 1 or better in all listed areas, where :
  - corrosion program inspection intervals is based on *the passage of time*.
  - stresses structurally significant zones and recognizes the relationship between corrosion damage and duration of exposure to the environment

AGING AIRCRAFT

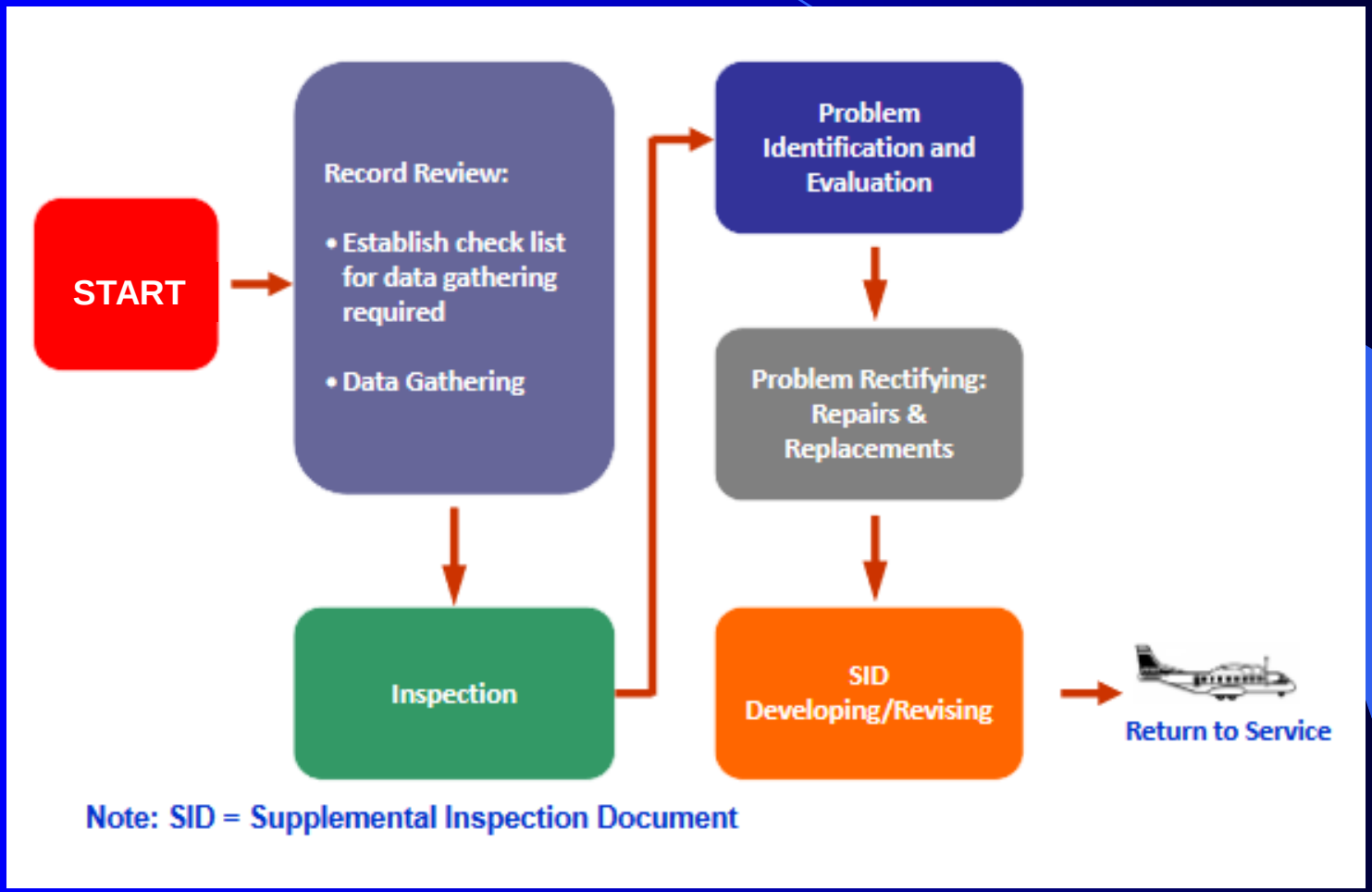
"REPAIR ASSESSMENT PROGRAM" (RAP)

- **Guideline to establish a damage- tolerance based supplement inspection program for repairs to detect damage, which may develop in a repaired area, before that damage degrades the load carrying capability of the structure below the levels required by the applicable airworthiness**

AGING AIRCRAFT

PROGRAM

ACTIVITY



AGING AIRCRAFT

The required data of aircraft for the records reviews:

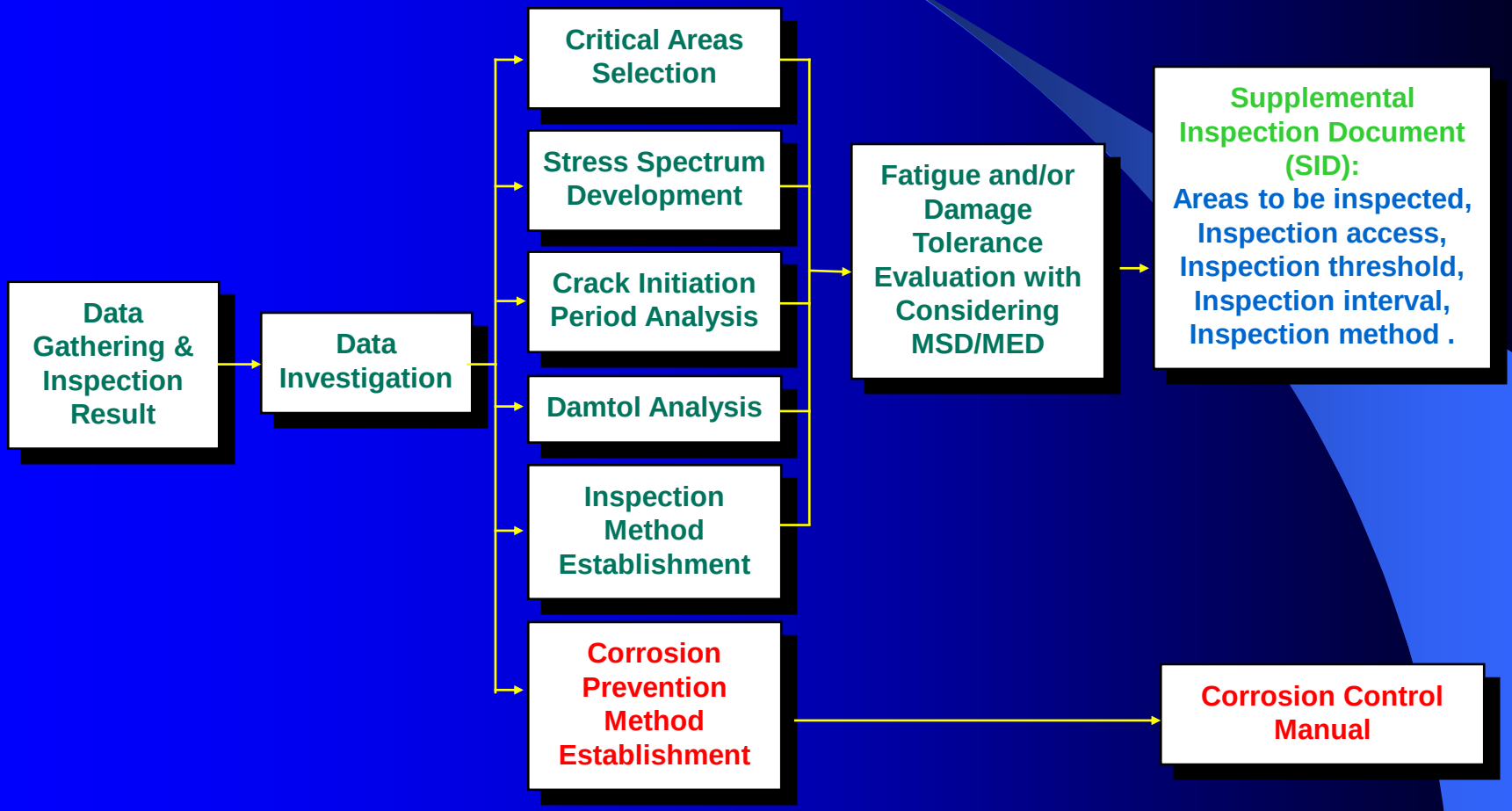
1. *Total time in service*
2. *Total flight cycles/flight hours*
3. *Mandatory Service Bulletin (SB) Implementation*
4. *Current status of the life-limited parts*
5. *Current inspection status*
6. *List of major repair, replacement, alterations/modifications*

AGING AIRCRAFT

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

PROGRAM

ACTIVITY



AGING AIRCRAFT

Aging Aircraft Inspection :

1) *Heavy Maintenance Check ("C" check or segment thereof), ref. FAA AC 120-84 (Aging Aircraft Inspection and Record Review)*
2) *Principal Structure Elements (PSE's).*
3) *Corrosion Prevention and Control Program (CPCP) Areas*
4) *Structure areas possible to experience Multiple Site Damage (MSD) or Multiple Element Damage (MED).*
5) *Electrical Wiring Interconnection System*

AGING AIRCRAFT

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

PROGRAM

ACTIVITY

PRODUCT UNDER LICENSE

PTDI PRODUCT

OWN PRODUCT

- **NC 212 A4/AB4/CC4**
- **BO 105 CB**
- **SA 330**
- **NAS 332**
- **NBELL 412**

CN235/-100/-110/-220

PTDI AGING PROGRAM

INCORPORATED WITH LICENSOR [TC HOLDER]

DEVELOP ASSOCIATED DOCUMENTS RELATED TO AGING AIRCRAFT

LICENSOR HAS BEEN DEVELOPED AGING PROGRAM ASSOCIATED WITH THE AIRWORTHINESS AUTHORITY AND THEIR OPERATORS

AGING AIRCRAFT

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

PROGRAM

ACTIVITY

General Tools For CN235 Aging Activity

- **Currents Service Bulletin (SB) and Airworthiness Directives (AD)**
  - ✈ ***AVAILABLE***
  - → ***Shall be evaluated***
- **Supplemental Inspection Document (SID) & Supplemental Inspection Procedure (SIP)**
  - ✈ ***NOT AVAILABLE***
  - → ***Shall be initiated to develop SID & SIP***
- **Corrosion Prevention and Control Program (CPCP)**
  - ✈ ***AVAILABLE***
  - → ***Shall be evaluated***
- **Repair Assessment Program (RAP)**
  - ✈ ***NOT AVAILABLE***
  - → ***Shall be developed***
- **Aging Aircraft non-structural Inspection Procedure**
  - ✈ ***NOT AVAILABLE***
  - → ***Shall be developed***

Task to be taken

- Review all related Airworthiness Directives [AD] & Service Bulletin (SB) requiring structural inspection of specific areas at certain intervals for mandatory modification
- Review Supplemental Structural Inspection Documents (SSID)
- Review existing corrosion prevention program and develop a baseline Corrosion Prevention and Control Program (CPCP) to maintain corrosion to an acceptable level
- Customer Visit
  - Establish check list for data gathering required
  - Customer visit plan
- Review and analysis data gathering result
- Develop Repair Assessment Program to assess the damage tolerance of existing Structural Repair Manual, which may have been designed without using damage tolerance criteria
- Develop Aging Aircraft Repair and Modification Program
- Develop Aging Aircraft Non-Structural Inspection Procedure
- Coordination with DGCA

Aging Aircraft
Lesson Learn

AGING AIRCRAFT

LESSON LEARN

CASE EXAMPLES

CN235 Aging Aircraft Program had been done by PTDI

2019 - 2021	
Customer	: **United Arab Emirates (UAE) Air Force/Air Defence (AFAD)**
Program	: SLEP 6 units of CN235-100 (TN811 – TN816)
Partnership	: GAL/AMMROC
Scope of Work	: Sustain Inspection Program (SIP) – Wiring, Principal Structure Element, Widespread Fatigue Damage, Corrosion Prevention Control Program

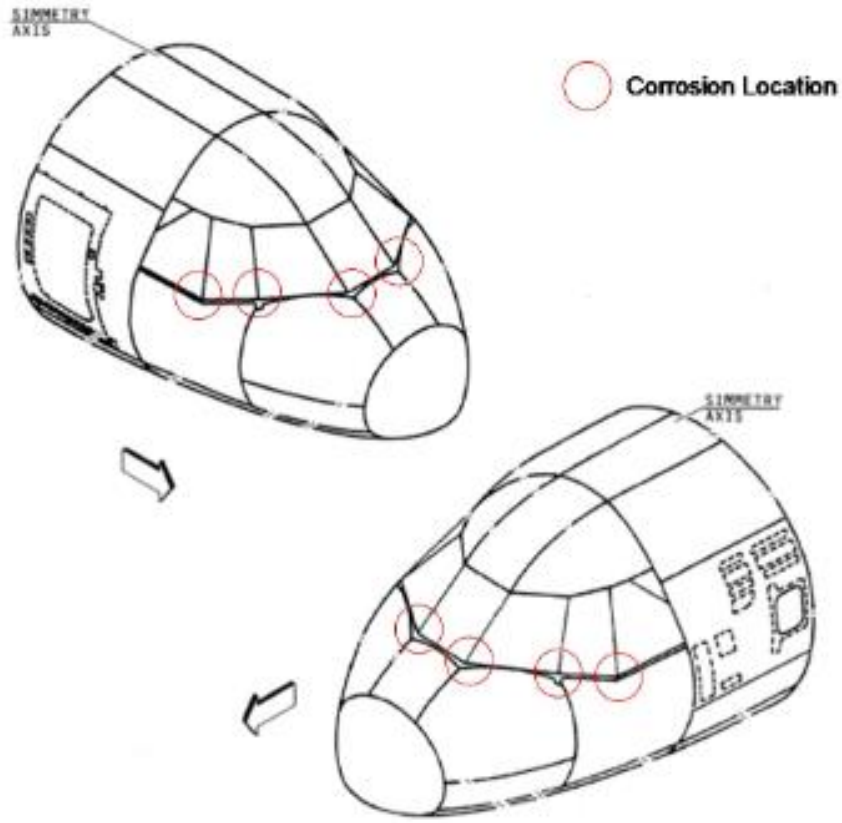
2020 - 2024	
Customer	: **Royal Malaysian Air Force (RMAF)**
Program	: SLEP 4 units of CN235-220M (M44-02, M44-03 , M44-04, M44-06)
Partnership	: -
Scope of Work	: Sustain Inspection Program (SIP) – Wiring, Principal Structure Element, Widespread Fatigue Damage, Corrosion Prevention Control Program

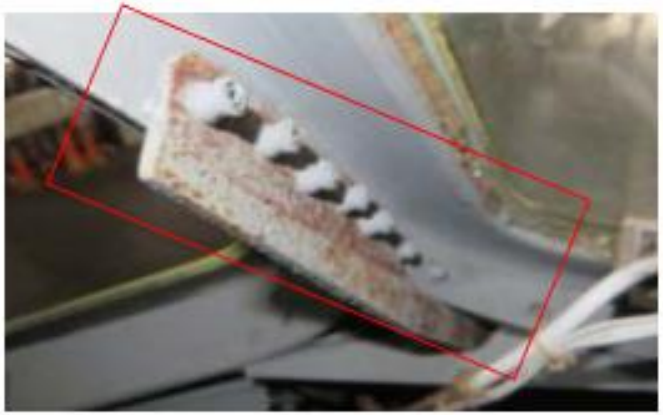
AGING AIRCRAFT

LESSON LEARN

CASE EXAMPLES

Windshield Area - Corrosion



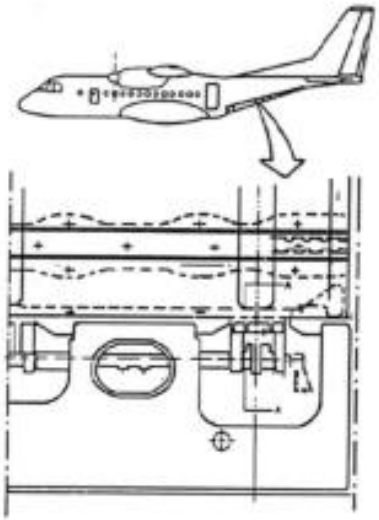


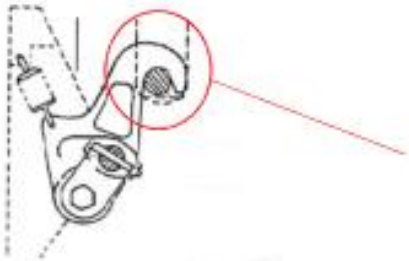
AGING AIRCRAFT

LESSON LEARN

CASE EXAMPLES

Ramp/Port Door Area - Corrosion



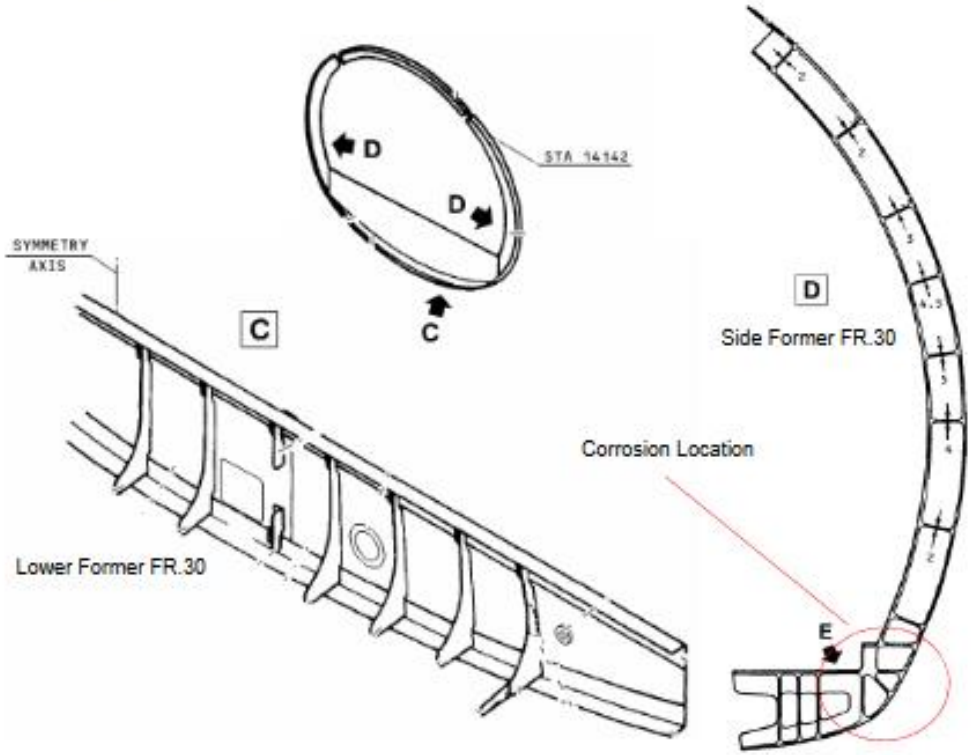


AGING AIRCRAFT

LESSON LEARN

CASE EXAMPLES

Fuselage Side Former FR 30 - Corrosion

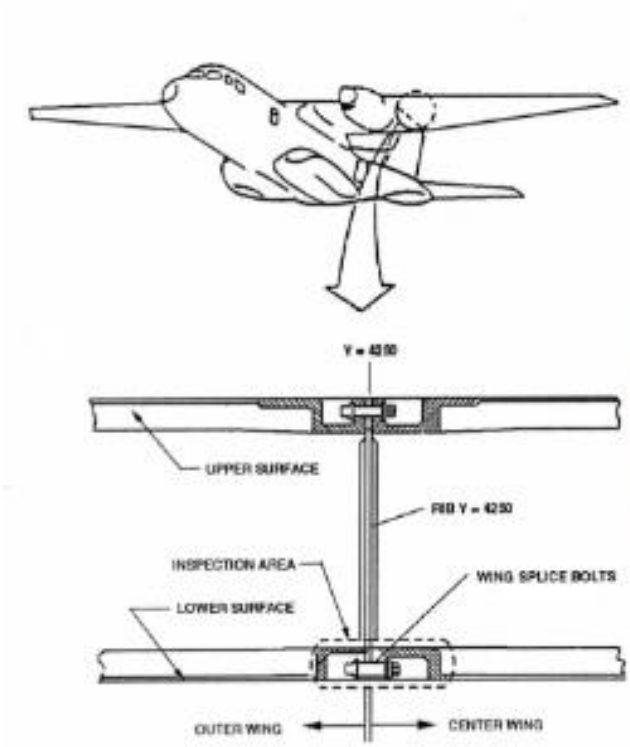


AGING AIRCRAFT

LESSON LEARN

CASE EXAMPLES

Center to Outer Wing, Splice Bolts - Broken and Corrosion



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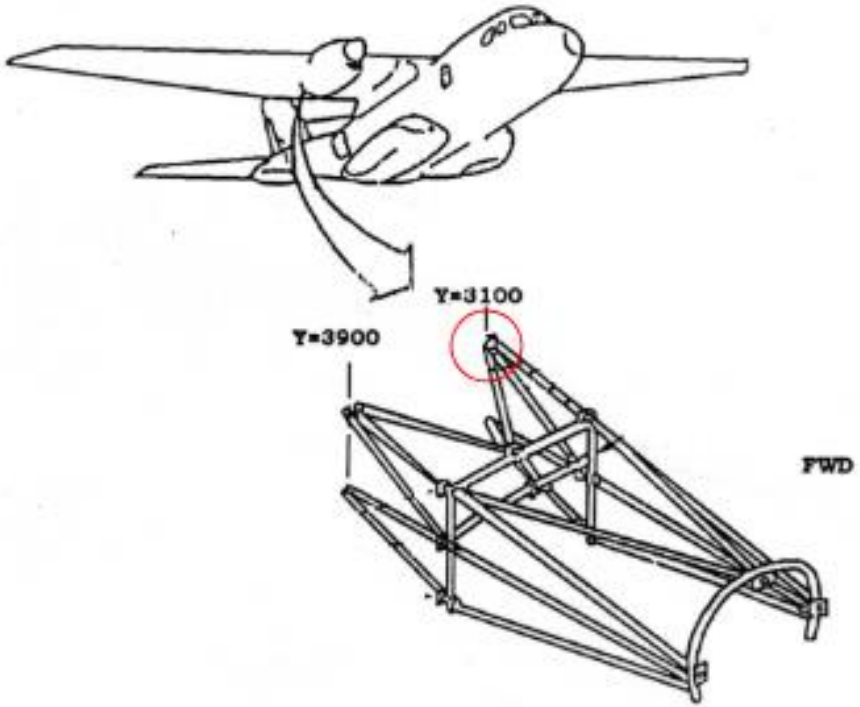
LESSON LEARN

CASE EXAMPLES

Engine Mount - Corrosion



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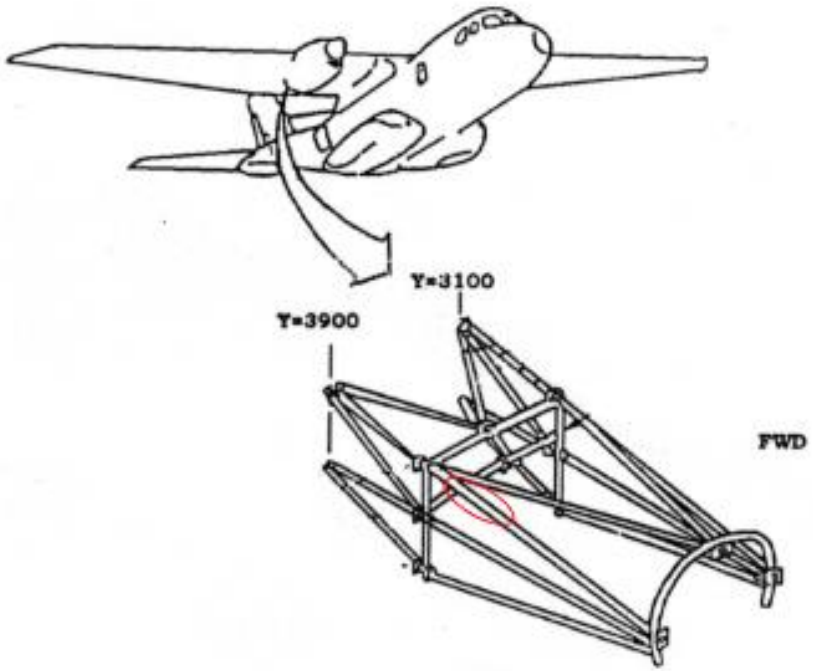
LESSON LEARN

CASE EXAMPLES

Engine Mount - Corrosion



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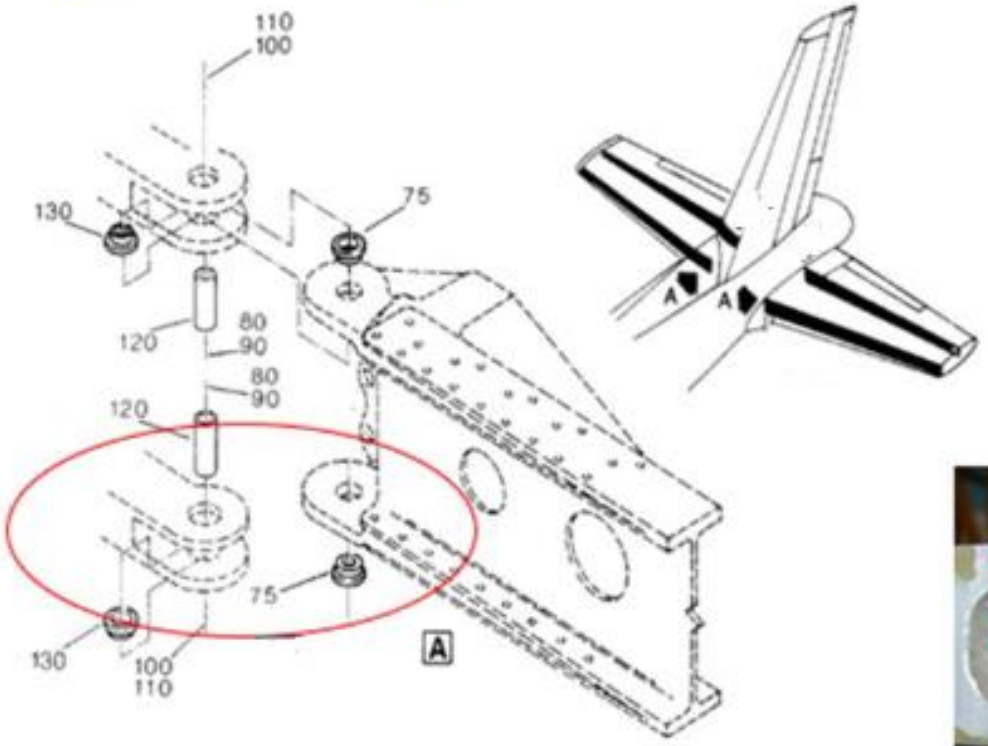
LESSON LEARN

CASE EXAMPLES

HTP Fittings to Fuselage - Corrosion

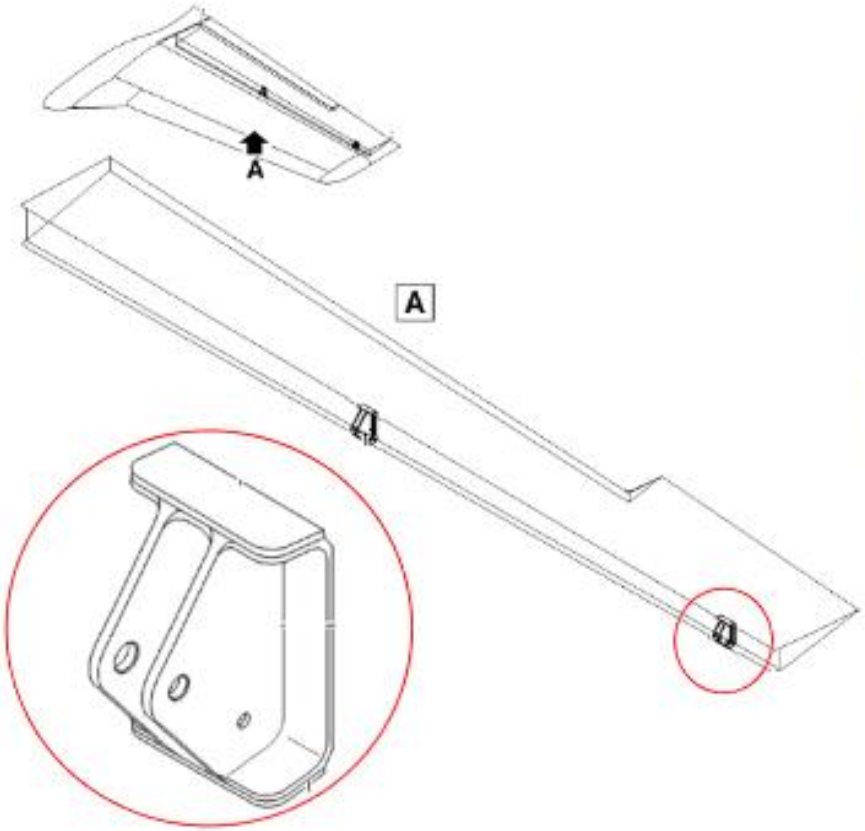


AGING AIRCRAFT

LESSON LEARN

CASE EXAMPLES

Elevator Fittings to HTP - Broken

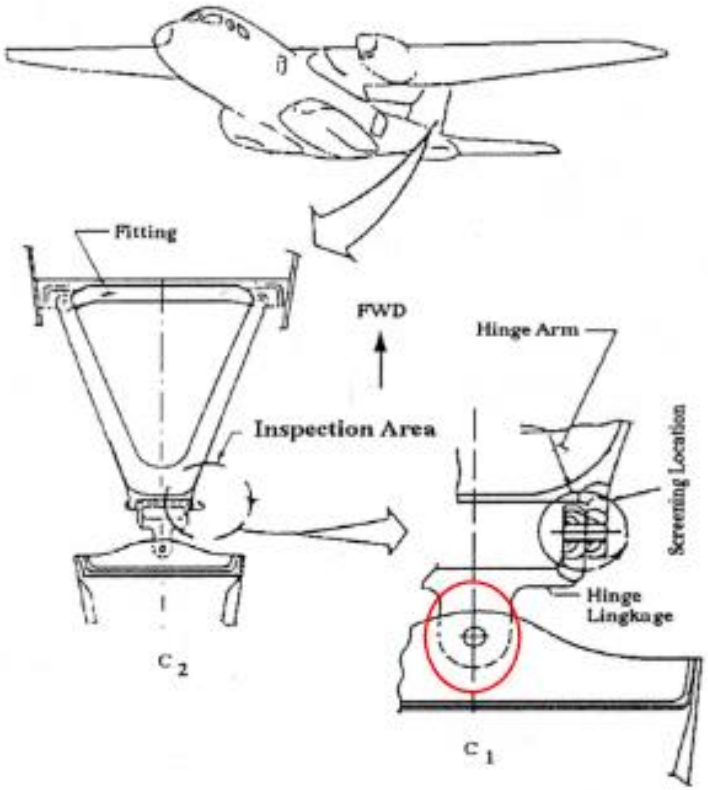


AGING AIRCRAFT

LESSON LEARN

CASE EXAMPLES

Bolt of VTP Rudder Hinge - Corrosion

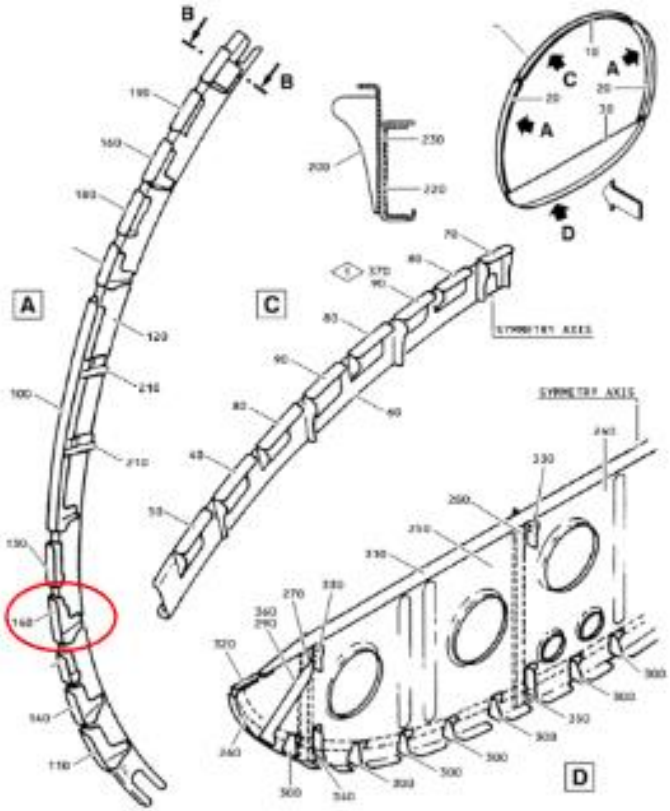


AGING AIRCRAFT

LESSON LEARN

CASE EXAMPLES

Widespread Fatigue Damage Area - Shear Clips Dent



AGING AIRCRAFT

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

LESSON LEARN

Cooperation

AIRWORTHINESS AUTHORITY [FAA]

AIRCRAFT MANUFACTURER [BOEING]

AIRCRFAT OPERATOR / OWNER

DEVELOP AND ESTABLISH AGING AIRCRAFT PROGRAM

OPERATIONAL REQUIREMENTS [FAR 91, 121, 135] & Associated Guidance Material

- **Airworthiness Directives**
- **Service Bulletin**
- **Supplements Type Certificate**

AGING AIRCRAFT

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

LESSON LEARN

Cooperation

COOPERATION & DATA GATHERING

AIRCRAFT OWNER/ OPERATOR

AIRCRAFT MANUFACTURER [TC & PC HOLDER]

COROSSION PREVENTION CONTROL PROGRAM [CPCP]

STRUCTURAL INSPECTION DOCUMENT [SID]

APPLICABLE AD & SB MANDATORY

AIRCRAFT MAINTENANCE RECORD

INSPECTION PROGRAM & REVIEW

REPAIR / MODIFICATION PROGRAM

RETURN TO SERVICES

100

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

AGING AIRCRAFT

LESSON LEARN

Cooperation

CASA 212 CB was FAA Certified at February 22, 1977 with Type Certificate Data Sheet [TCDS] A43 EU , Revision 8
CASA 212 DE is the last model was FAA Certified at October 1, 1991

CASA RESPONSE TO FAA AC 91-56

CASA SUPPLEMENTAL INSPECTION DUCUMEN [SID]
No. C-212-PV-01-SID, dated June 1, 1987
First Mandated Spanish Direccion General de Aviacion Civil [DGAC] and FAA

- **Contains inspections instruction for total of 66 PSE's**
- **Positive and negative inspection findings to be reported back to the manufacture**

FAA ISSUED AD 96-07-14, March 28, 1996

- **Mandating the incorporation of CASA SID No. C-212-PV-01-SID, Dated June 1, 1987**
- **Required replacement of certain horizontal stabilizer to fuselage attach fittings on the C-212-CB Series airplane**
- **Only applicable to the first 5 model C212 model airplane certified by FAA**

AGING AIRCRAFT

Aging Aircraft
PTDI Program

AGING AIRCRAFT

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

PROGRAM

PTDI [RODUCT AND LICENSOR

PTDI PRODUCT

PRODUCT UNDER LICENSE

- NC 212 A4/AB4/CC4
- BO 105 CB/CBS
- SA 330
- NAS 332
- NBELL 412 SP/HP

INCORPORATED WITH LICENSOR [TC HOLDER]

OWN PRODUCT

CN235/-100/-110/-220

DEVELOP ASSOCIATED DOCUMENTS RELATED TO AGING AIRCRAFT

LICENSOR HAS BEEN DEVELOPED AGING PROGRAM ASSOCIATED WITH THE AIRWORTHINESS AUTHORITY AND THEIR OPERATORS

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (IAe)

AGING AIRCRAFT

PROGRAM

AIRCRAFTS MADE BY PTDI AGE

IAe Aircraft Products Ages:

- 70 CN235 (51 aircrafts ≥ 20 years old)
- 127 NC212 (98 aircrafts ≥ 20 years old)
- 122 NBO (±100 aircrafts ≥ 20 years old)
- 25 NAS332 (21 aircrafts ≥ 20 years old)
- 11 SA330 (11 aircrafts ≥ 20 years old)
- 73 NBell 412 (31 aircrafts ≥ 20 years old)
- 3 BK 117 (2 aircrafts ≥ 20 years old)

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

AGING AIRCRAFT

PROGRAM

CN235 Structure Aging Development

AGING AIRCRAFT

AGING 'STRUCTURE' R & D

TEAR DOWN INSPECTION

Tear Down Inspection Activity at Fuselage of CN235 Full Scale Fatigue Test after loaded at 120,000 flight cycle

CN235 Tear Down Activity

AGING AIRCRAFT

DIRGANTARA INDONESIA
INDONESIAN AEROSPACE (Ae)

AGING 'STRUCTURE' R & D

TEAR DOWN INSPECTION

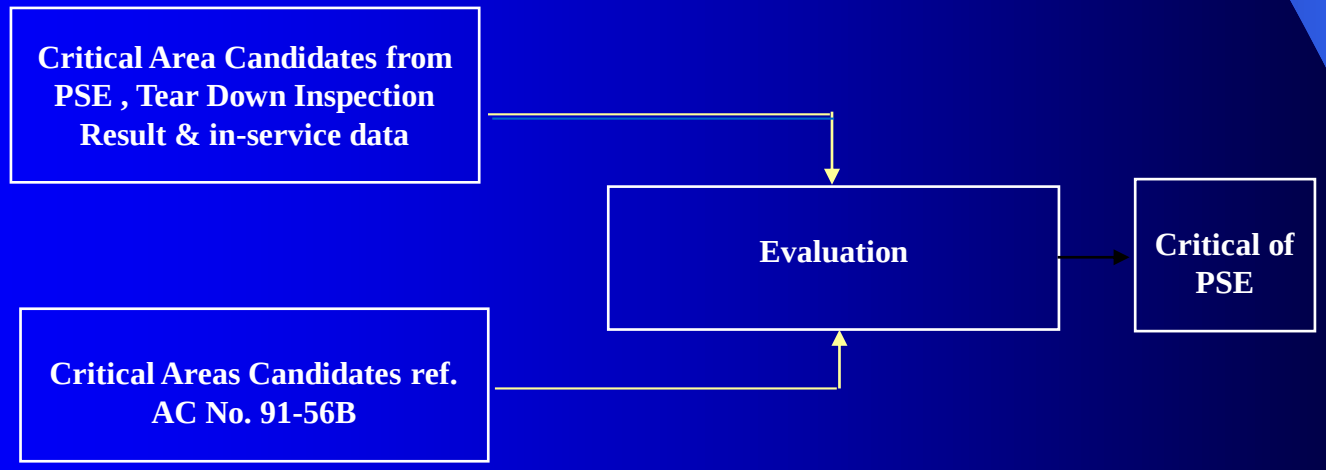
Tear Down Inspection Activity at Wing of CN235 Full Scale Fatigue Test after loaded at 120,000 flight cycle

CN235 Tear Down Activity

AGING AIRCRAFT

CRITICAL AREA SELECTION

- ***Critical area will be selected based on investigation of Principal Structural Element (PSE), Tear Down Inspection Result, in-service data and combined with AC 91-56B (Continuing Structural Integrity Program for Large Transport Category Airplanes)***



AGING AIRCRAFT

AGING 'STRUCTURE' R & D

CRITICAL AREA SELECTION

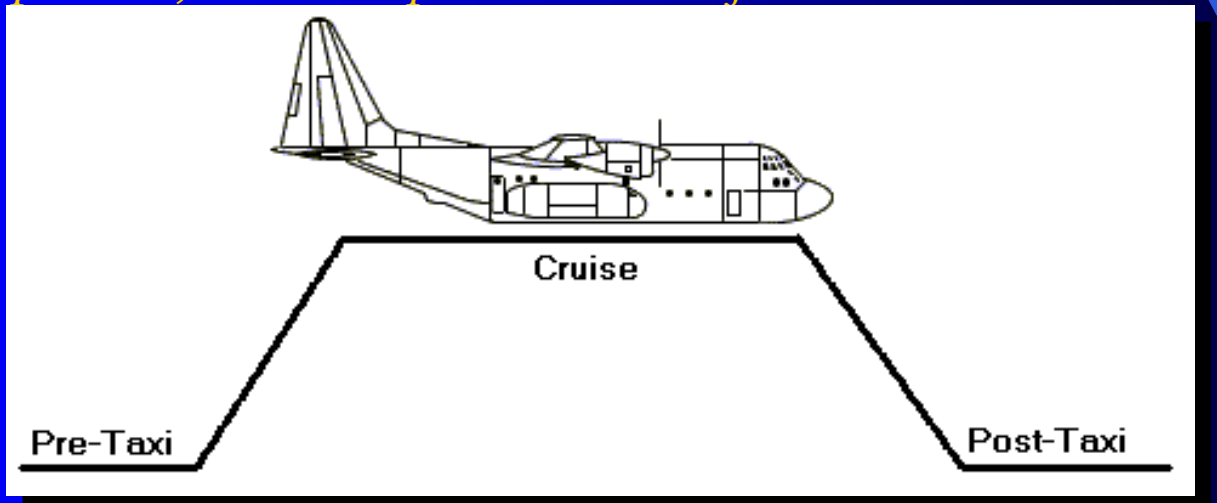
Refer to AC. No. 91-56B, structure area possible to experience Multiple Site Damage (MSD) or Multiple Element Damage (MED) :

1. *Fuselage*
   a. *Longitudinal skin joints, frames, and tear straps (MSD, MED)*
   b. *Circumferential joints and stringers (MSD, MED)*
   c. *Fuselage frames (MED)*
   d. *Aft pressure dome outer ring and dome web splices (MSD, MED)*
   e. *Other pressure bulkhead attachment to skin and web attachment to stiffener and pressure decks (MSD, MED)*
   f. *Stringer to frame attachment (MED)*
   g. *Window surround structure (MSD, MED)*
   h. *Over-wing fuselage attachment (MED)*
   i. *Latches and hinges of non-plug doors (MSD, MED)*
   j. *Skin at run-out of large doubter (MSD)*
2. *Wing and Empennage*
   a. *Skin at run-out of large doubter (MSD)*
   b. *Chord wise splices (MSD, MED)*
   c. *Rib to skin attachments (MSD, MED)*
   d. *Stringer run-out (MSD, MED)*

AGING AIRCRAFT

LOAD SPECTRUM DEVELOPMENT

- *The main purpose is to develop/create the actual stress spectrum operated at each critical area (PSE) to be used for calculating fatigue and crack propagation*
- *The first step to develop stress/load spectrum is to conduct survey of flight mission for each aircraft to the operator, with the parameter as follows :*

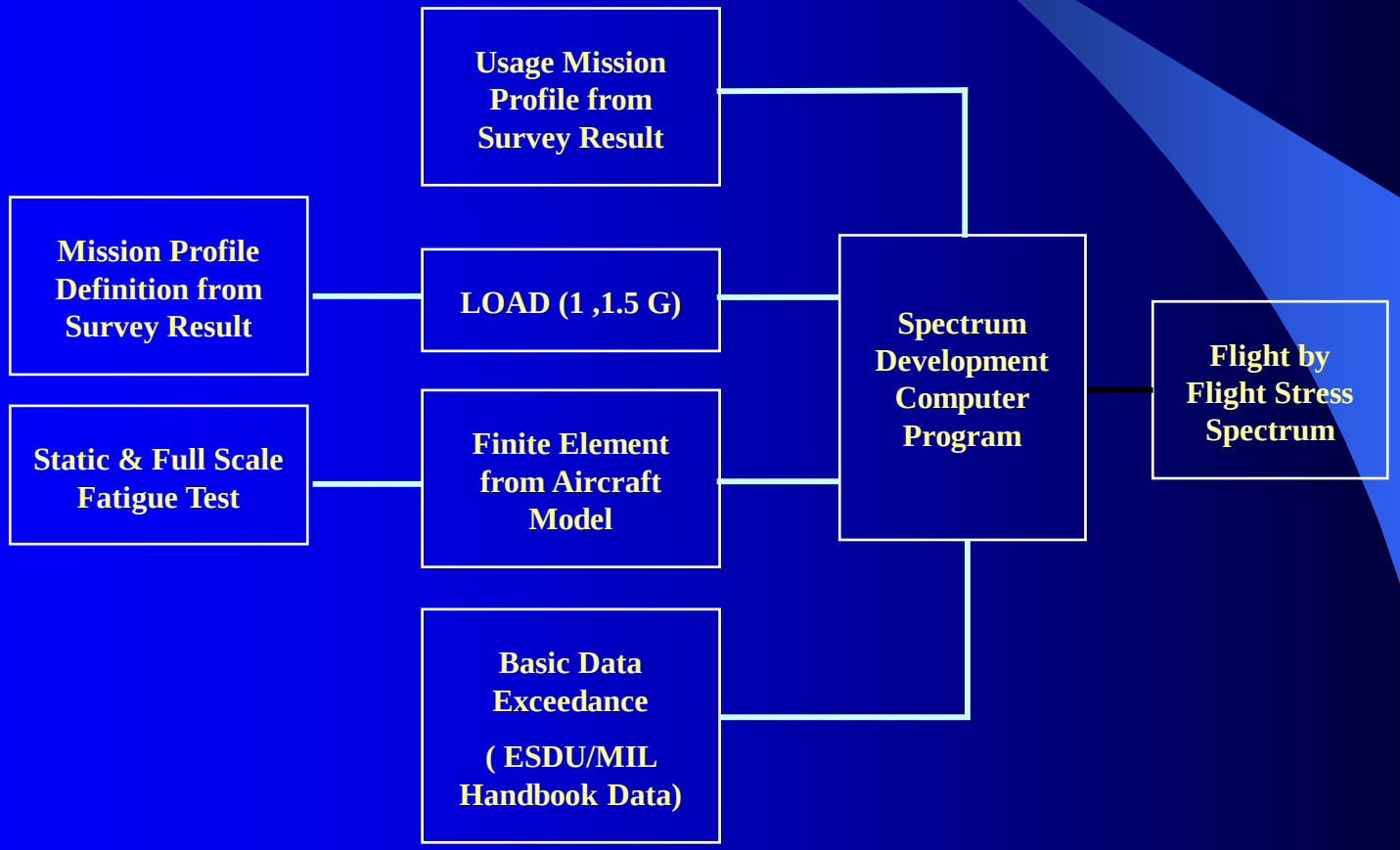


AGING AIRCRAFT

AGING 'STRUCTURE' R & D

LOAD SPECTRUM

LOAD SPECTRUM DEVELOPMENT



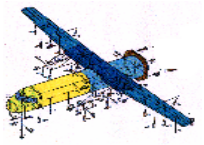
AGING AIRCRAFT

AGING 'STRUCTURE' R & D

LOAD SPECTRUM

LOAD SPECTRUM DEVELOPMENT

GROUND TEST STRAIN SURVEY



OR

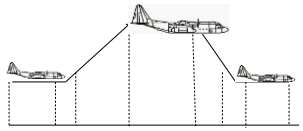
FLIGHT TEST STRAIN SURVEY

FLIGHT / GROUND LOADS

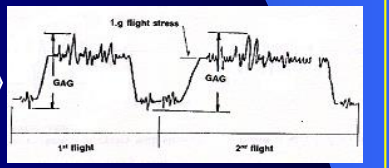
DEVELOP STESS COEFFISIENT

USAGE SURVEY

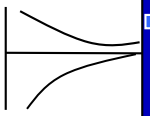
FLIGHT PROFILE REPRESENTATIVE



DEVELOP STRESS SPECTRUM



BASIC DATA
ESDU
MILL-HB
NACA ETC



FLIGHT BY FLIGHT SPECTRUM WILL BE USED IN DAMAGRE TOLERANCEA ANALYSIS

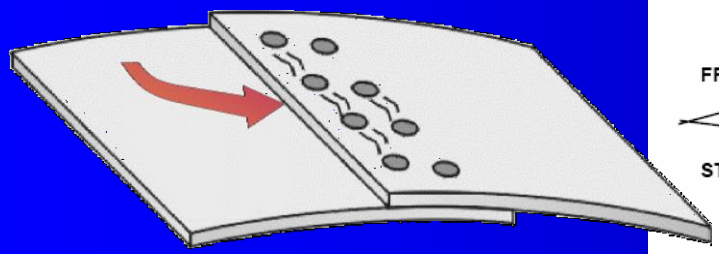
AGING AIRCRAFT

AGING 'STRUCTURE' R & D

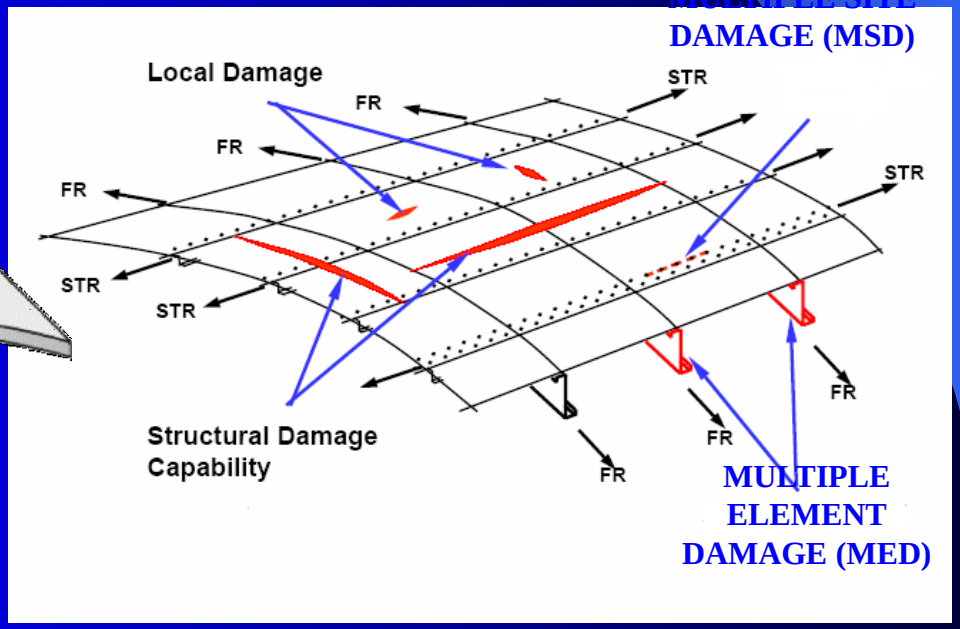
DAMTOL ANALYSIS

CRACK INITIATION PERIOD & DAMTOL ANALYSIS

- *Fracture mechanic concept is used to analyze crack initiation and damage tolerance, while crack growth analysis using Widespread Fatigue Damage (WFD), Multiple Side Damage (MSD) and Multiple Element Damage (MED) scenario*



WFD PHENOMENA



AGING AIRCRAFT

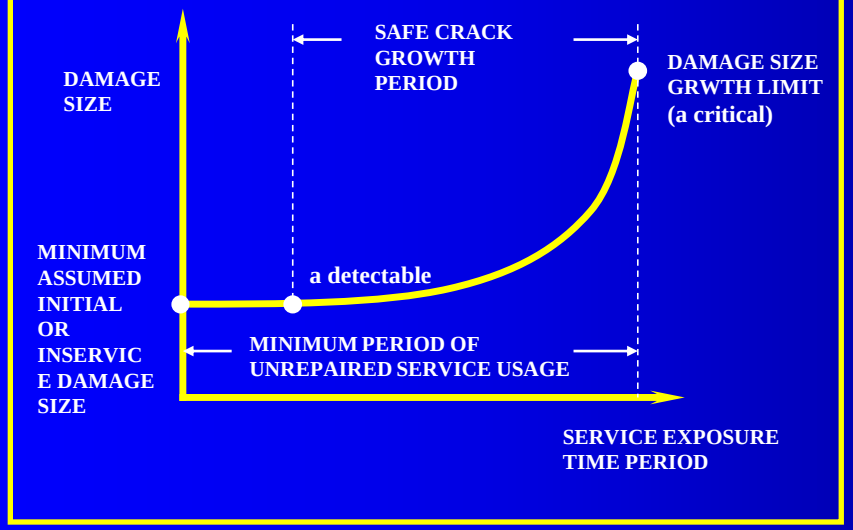
AGING 'STRUCTURE' R & D

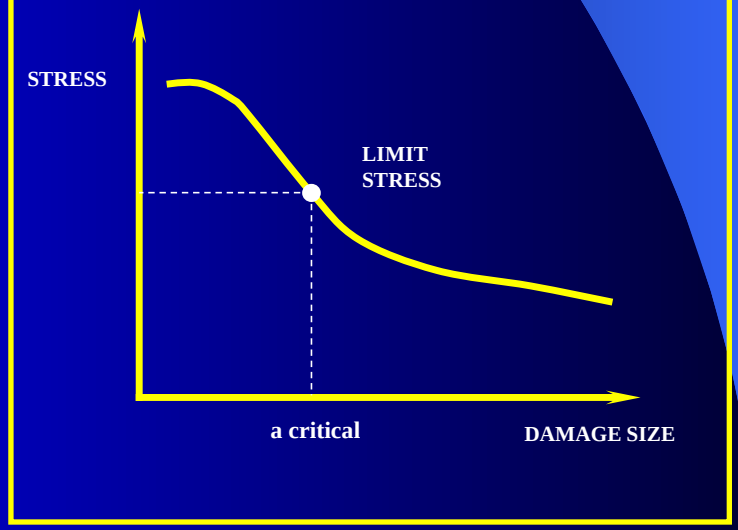
DAMTOL ANALYSIS

CRACK INITIATION PERIOD & DAMTOL ANALYSIS

$$\text{Threshold Inspection} = \left\{ \frac{\text{Minimum Period of Unrepaired Service Usage}}{\text{Factor}} \right\}$$

$$\text{Interval Inspection} = \left\{ \frac{\text{Safe Crack Growth Period}}{\text{Factor}} \right\}$$






Thanks For
Your Kind Attention
Good Luck,
All The Best…!