

AGENDA:

- **Types of damage.**
- **NDI inspection types.**
 - **NDT manual presentation.**
 - **Visual inspection.**
 - **Tap test.**
- **Water break test**
- **Water, moisture removal.**
- **Paint removal.**
- **Environmental condition:**
 - **Workshop**
 - **Workshop build up**
 - **in situ condition.**
- **Material handling and storage.**
- **Tool, cutting drilling, Etc.**

SKILLMAN DAY 3

- **Why Composites Inspection?**
 - Much larger percentage of Composites in the world today
 - Need to detect discontinuities that may lead to premature failure

Boeing 787 fuselage section



Damage

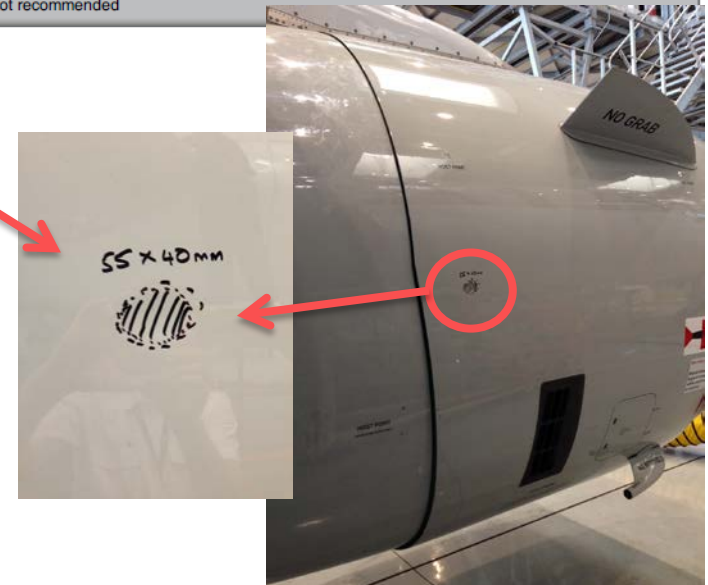


VISUEL INSPEKTION

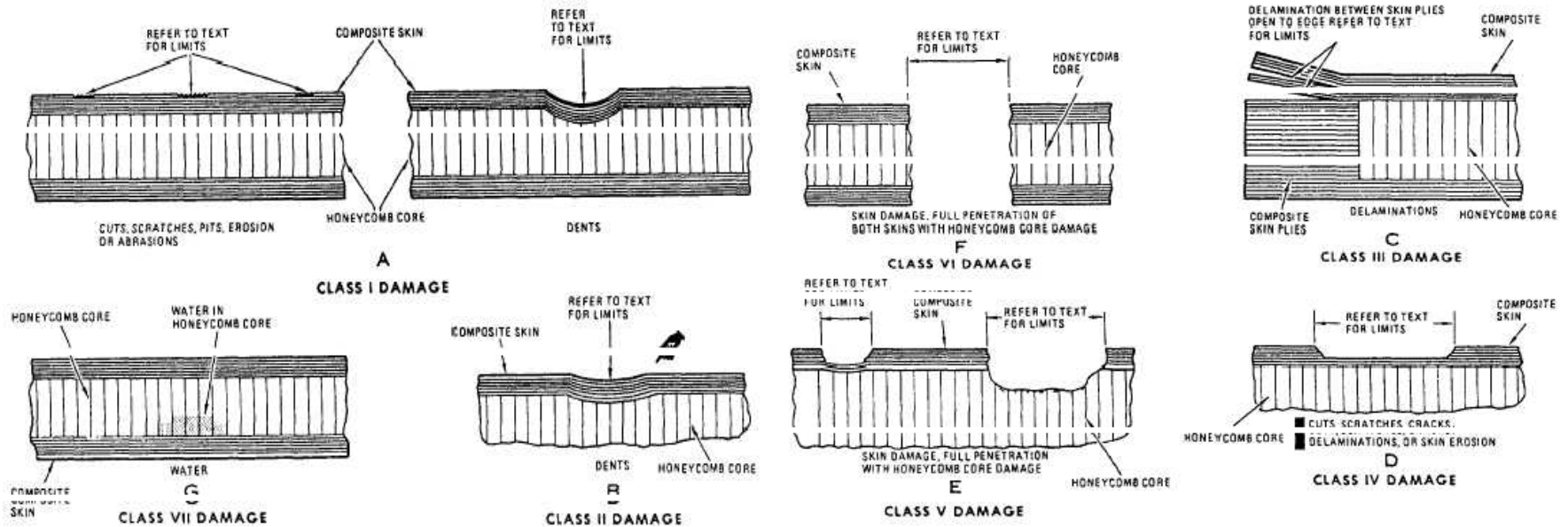
- Abrasion
- Scratches, Gouges and Nicks.
- Dents
- DE-bonding and Delamination
- Perforation and puncture damage.
- Erosion and corrosion.
- Contamination
- Heat Damage and Lightning strike.

Method of Inspection	Type of Defect							
	Disbond	Delamination	Dent	Crack	Hole	Water Ingestion	Overheat and Burns	Lightning Strike
Visual	X (1)	X (1)	X	X	X		X	X
X-Ray	X (1)	X (1)		X (1)		X		
Ultrasonic TTU	X	X						
Ultrasonic pulse echo		X				X		
Ultrasonic bondtester	X	X						
Tap test	X (2)	X (2)						
Infrared thermography	X (3)	X (3)				X		
Dye penetrant				X (4)				
Eddy current				X (4)				
Shearography	X (3)	X (3)						

Notes: (1) For defects that open to the surface
(2) For thin structure (3 plies or less)
(3) The procedures for this type of inspection are being developed
(4) This procedure is not recommended



VISUEL INSPEKTION





Visible impact Damage

Visual

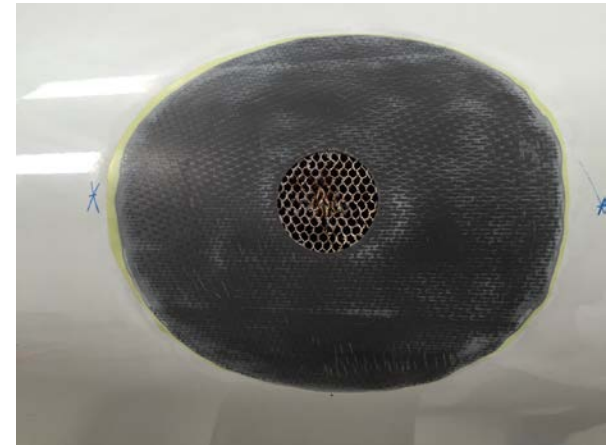
- **Simplest nondestructive technique for inspecting laminates**
 - **Identifies surface imperfections:**
 - Impact damage (scuffing, chipping, surface cracking, or crazing)
 - Near-surface delaminations (appear as bulges)
 - Severe disbonding (damage appears white)
 - With access to back side, illumination will make internal defects such as delaminations visible as dark or grey areas
 - **Main tool for visual inspections:**
 - **Good light source**
 - » Low incident-angle illumination

Visual Guidelines:

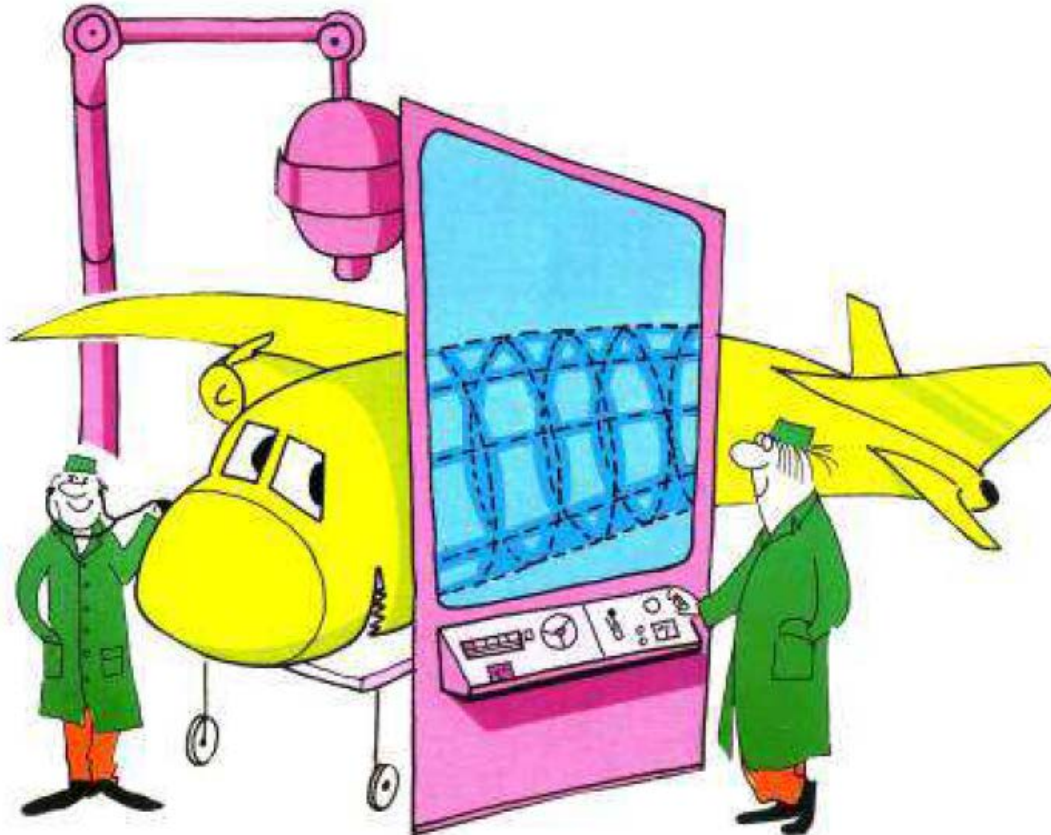
1. Become familiarized by examining the applicable diagram/drawing.
 2. If necessary, remove surface coat around damaged area.
 3. Examine tactily by running hands over surface of suspect damage area to feel for surface imperfections and anomalies.
 4. Dimple and dent damage is similar in appearance to hail damage on a metal surface.
 5. Delamination and disbonding are more difficult to detect:
 - Sometimes it is possible to feel this type of damage by pressing on the area.
 - May feel soft and movement between the separated layers may be detected.
 6. Use a back light to reveal internal defects and delaminations. Examine exposed laminate for stress whitening.
 7. If possible, the backside of the suspected area should be examined.
 8. A borescope can be a helpful tool for examining interior areas. Interior surfaces are usually not painted and damage to glass-fabric structures will show up as a white area.
 9. Use a Sharpie to mark suspect areas to facilitate a coin tap test.
- Note: Paint will generally crack before damage occurs in a laminate, therefore cracked paint does not indicate the extent of the damage, only that damage may have occurred.

Klassificering af skader / Damage Evaluation.

- SRM ATA Chapters 51 to 57
- Aircraft Registration and type.
- Location, Length, Width and Depth.
- Within or not within allowable damage.
 - Repairable.
 - Require manufacture's instructions.
 - Repair Category A, B or C.
- Describe damage on repair Card.
 - Abrasion.
 - Scratches, Gouges or Nicks.
 - Dent.
 - Debonding.
 - Delamination.
 - Perforating damage, puncture.
 - Contamination.
 - Heat Damage.
 - Erosion, Corrosion.



NDT/NDI, NTM



NDE PRACTICES FOR COMPOSITES

Ultrasonic

Acoustic Emission

Tap Test

Resonance

X-ray

Visual

Optical

Thermal...

Emerging Technologies:

In-process monitoring

In-Situ Sensors

Remote Sensors

Embedded Sensors

Advanced Techniques:

X-ray Tomography

Laser Ultrasonic

Holography

Laser-optical

Vibro-thermography

Acousto-ultrasonic

D-sight

Neutron radiography

Microwaves...

Thermal (Time resolved...)

TECHNOLOGIES:

Health monitoring

Prognostics

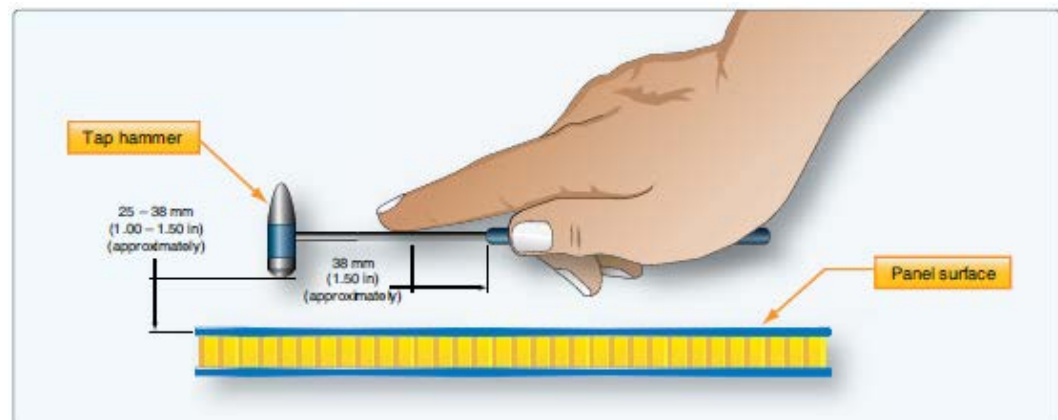
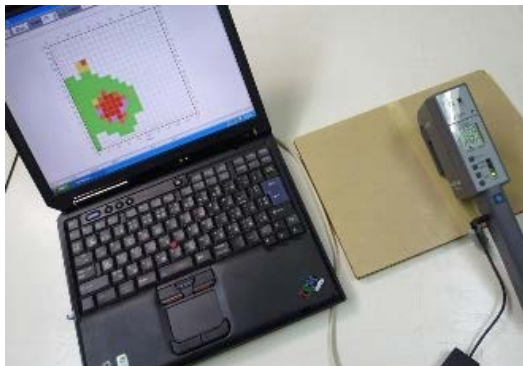
NONDESTRUCTIVE TESTING MANUAL

- Manual Front Matter
- 51 - STANDARD PRACTICES AND STRUCTURES ** ON A/C ALL
 - 51-00 - STANDARD PRACTICES AND STRUCTURES - GENERAL ** ON A/C ALL
 - 51-10 - GENERAL PROCEDURES ** ON A/C ALL
 - 51-10-00 - COATING THICKNESS MEASUREMENT - GENERAL ** ON A/C ALL
 - 51-10-01 - ROTATING PROBE TESTING - GENERAL ** ON A/C ALL
 - 51-10-02 - INSPECTION TO VERIFY THE REMOVAL OF CORROSION ** ON A/C ALL
 - 51-10-03 - INSPECTION OF CFRP AND GFRP COMPOSITE COMPONENTS - HONEYCOMB SANDWICH PARTS - GENERAL ** ON A/C ALL
 - 51-10-04 - MEASUREMENT OF REMAINING STRUCTURE THICKNESS - GENERAL ** ON A/C ALL
 - 51-10-06 - ACCIDENTAL DAMAGE - GENERAL NDT PROCEDURE FOR THE INSPECTION OF CARBON FIBER MONOLITHIC STRUCTURE ** ON A/C ALL
 - 51-10-07 - EVALUATION OF CRACK LENGTH ** ON A/C ALL
 - 51-10-08 - HFEC INSPECTION FOR SURFACE BREAKING CRACKS IN ALUMINUM OR TITANIUM ALLOY MATERIALS ** ON A/C ALL
 - 51-10-09 - GENERAL PROCEDURE FOR DETAILED VISUAL INSPECTION FOR CARBON FIBRE ** ON A/C ALL
 - 51-10-10 - X-RAY INSPECTION TO DETECT WATER IN HONEYCOMB SANDWICH PARTS ** ON A/C ALL
 - 51-10-11 - INSPECTION FOR CRACKS IN MULTI-LAYERED JOINT AL-ALLOY STRUCTURES ** ON A/C ALL
 - 51-10-12 - GENERAL PROCEDURE FOR THE DETECTION OF HEAT DAMAGE USING EDDY CURRENT CONDUCTIVITY MEASUREMENT ON AL ** ON A/C ALL
 - 51-10-13 - INSPECTION FOR CRACKS IN MULTI-LAYERED JOINT STRUCTURES ** ON A/C ALL
 - 51-10-14 - INSPECTION OF AIRCRAFT STRUCTURE MADE OF NON-POROUS MATERIALS ** ON A/C ALL
 - 51-10-15 - INSPECTION FOR SHALLOW CRACKS IN MULTI-LAYERED JOINT STRUCTURES ** ON A/C ALL
 - 51-10-16 - INSPECTION FOR SUB-SURFACE CRACKS IN AL-ALLOY STRUCTURE ** ON A/C ALL
 - 51-10-17 - GENERAL PROCEDURE FOR THE ASSESMENT OF HEAT TREATMENT USING EDDY CURRENT CONDUCTIVITY MEASUREMENT ON ** ON A/C ALL
 - 51-10-18 - ROTATING PROBE TESTING OF FLAT BOTTOM HOLES IN ALUMINUM ALLOYS MATERIALS ** ON A/C ALL
 - 51-10-19 - INSPECTION OF FRP COMPOSITE COMPONENTS HONEYCOMB SANDWICH PARTSWITH THE WOODPECKER WP632 ** ON A/C ALL
 - 51-10-20 - HFEC INSPECTION FOR SURFACE BREAKING CRACKS IN NON PLATED FERROMAGNETIC STEEL ALLOY MATERIALS ** ON A/C ALL
 - 51-10-21 - HFEC INSPECTION FOR SURFACE BREAKING CRACKS IN CADMIUM PLATED FERROMAGNETIC STEEL ALLOY MATERIALS ** ON A/C ALL
 - 51-10-24 - ULTRASONIC INSPECTION OF HONEYCOMB STRUCTURES WITH PARALLEL FRP SURFACES ** ON A/C ALL
 - 51-10-25 - THERMOGRAPHY INSPECTION TO DETECT TRAPPED WATER IN HONEYCOMB STRUCTURES MOUNTED VERTICALLY ** ON A/C ALL
 - 51-10-26 - INSPECTION OF HONEYCOMB STRUCTURES (MOSTLY WITH PARALLEL SKINS OF LIMITED THICKNESS) WITH ELCH ** ON A/C ALL
 - 51-10-27 - VISUAL ENDOSCOPE INSPECTION FOR INTERNAL HONEYCOMB CORE SANDWICH STRUCTURES ** ON A/C ALL
 - 51-10-28 - GENERAL PROCEDURE TO DETECT DAMAGE IN HONEYCOMB CORE SANDWICH STRUCTURES BY APPLYING VACUUM ** ON A/C ALL
 - 51-10-90 - THERMOGRAPHY - GENERAL ** ON A/C ALL
 - 51-20 - X-RAY RADIOGRAPHY - GENERAL ** ON A/C ALL
 - 51-21 - X-RAY EQUIPMENT SPECIFICATIONS ** ON A/C ALL
 - 51-40 - ULTRASONIC TESTING - GENERAL ** ON A/C ALL

HØRBAR TESTNING/TAP TEST.

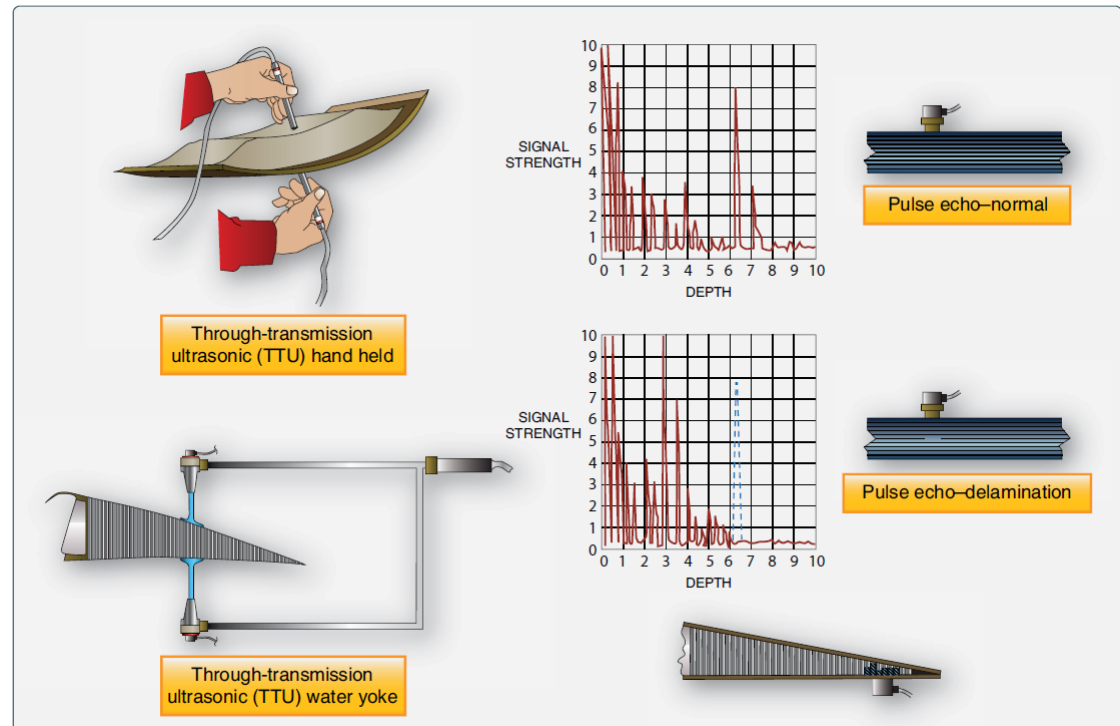
- Audio, sonic and coin tap test. (coin test)
- Not reliable for structure above 4 plies.
- Computer Aided Tap test.

Removes
Human
Safety
Issue



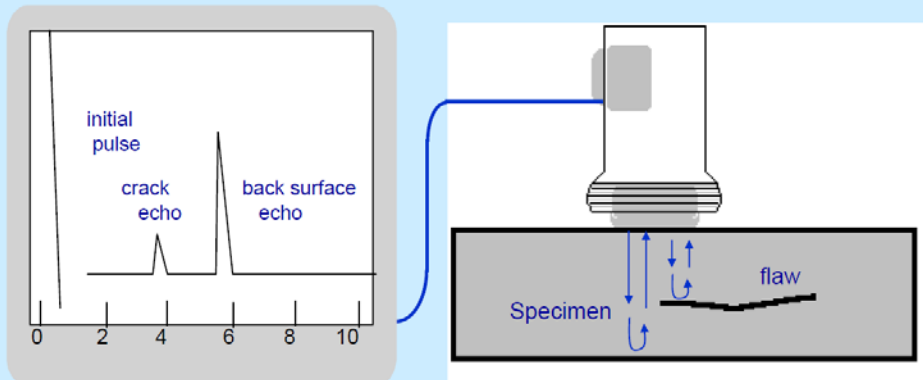
ULTRALYD INSPEKTION OG RADIOGRAFI

- Pulse echo Ultrasonic inspection.
- Radiografi (X-Ray).
- Moisture Monitor



Pulse-Echo

• Reflected sound energy is displayed versus time, and the inspector can visualize a cross section of the specimen showing the depth of features that reflect sound.



Oscilloscope, or flaw detector screen

• Advantages:

- Can be performed with access to one side only
- Can detect disbonds and delaminations deeper inside structure than tap testing
- Can give information about defect depth, down to which ply in many cases

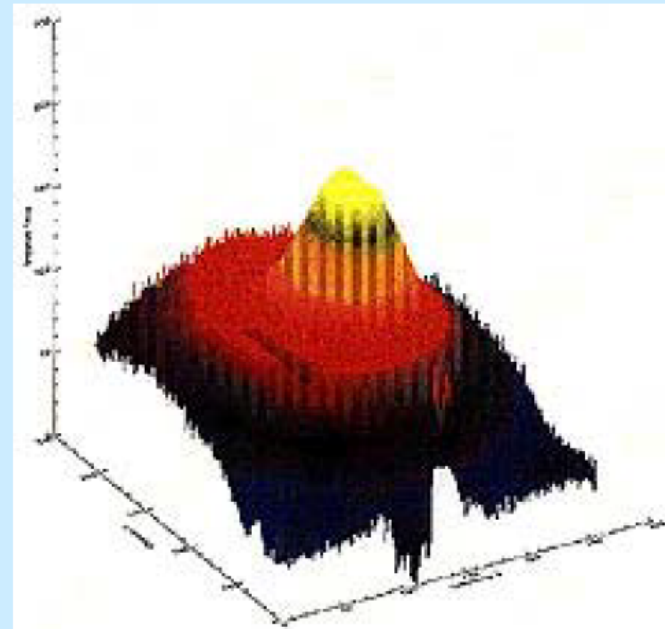
• Limitations:

- Requires rather expensive portable equipment and a well-trained operator
- Difficult to cover large areas in a reasonable time
 - More suitable for small areas
- Does not work well with core materials

Thermography

- **Nondestructive inspection technique using infrared light and an infrared camera to detect discontinuities**
 - Video image is taken as parts are heated and cooled
 - Uses thermal differences to gather information about the part
 - Core to laminate bonds
 - Ply delamination

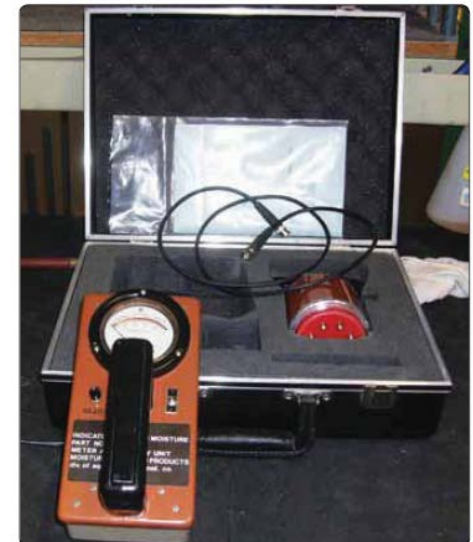
3-Dimensional Temperature Profile of an Impact Damage Zone on a Composite Pressure Vessel as Viewed by Infrared (IR) Thermography.



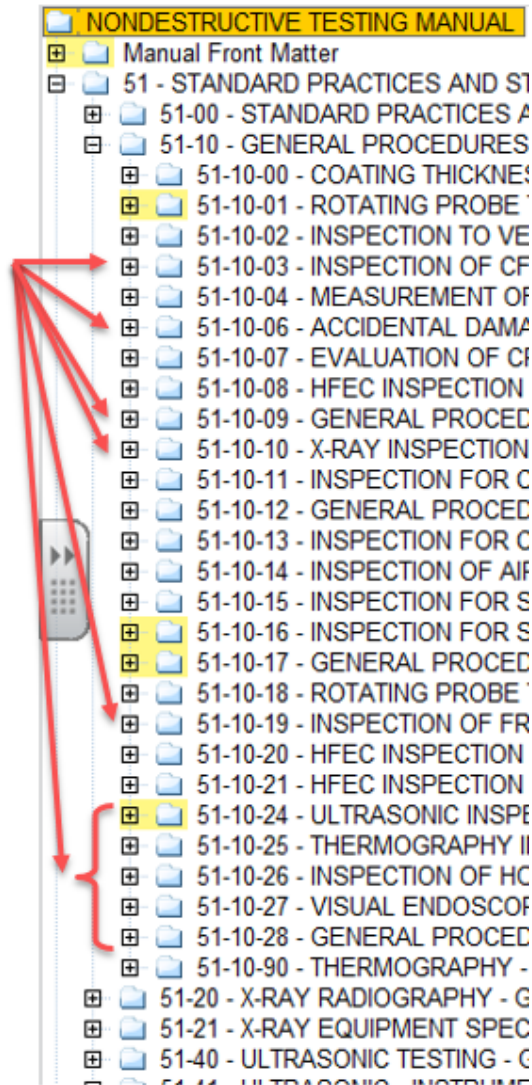
FUGT og SKIDT DETEKTION

Moisture detector:

- Water
 - Skydrol
 - Oil
-
- As general hand roll water and contamination removal required.
 - Monolithic Structure, 12 to 24 hours.
 - Sandwich Structure, 12 hours.



Post Inspection



4. Repair Procedures That Are Common to the Different Repairs (Continued)

R. Do the post-repair requirements.

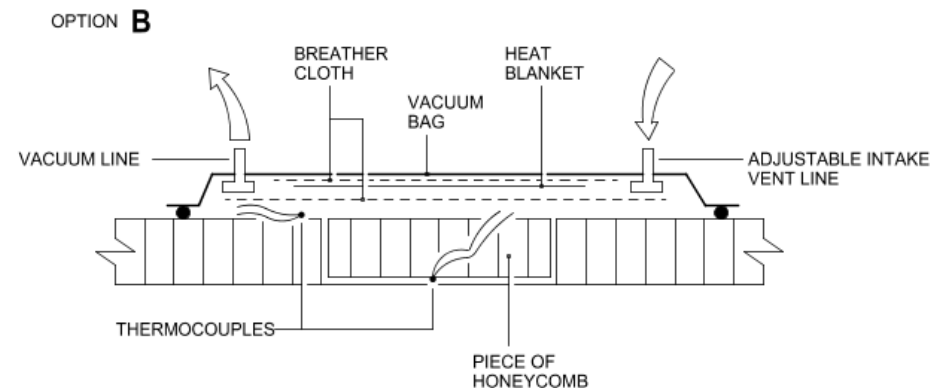
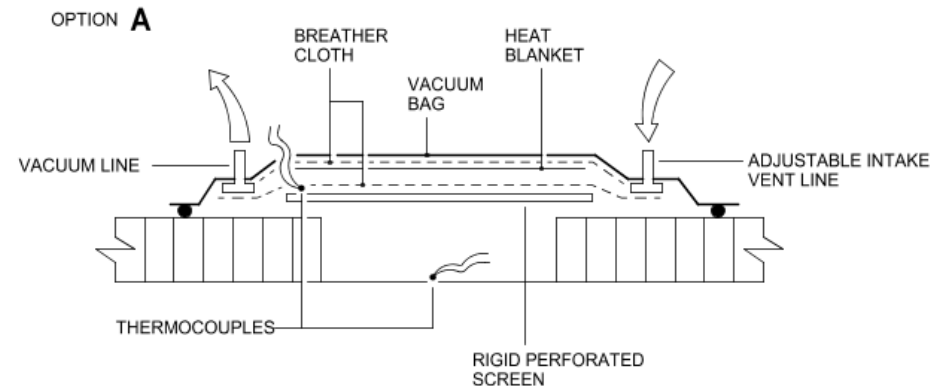
- (1) Do an inspection of the repair area to make sure that the repair is satisfactory. Refer to NDT Part 1, 51-01-01.

NOTE: In the honeycomb areas with four repair plies or less, you can use the tap test inspection procedure as given in NDT Part 1, 51-05-01 as an option.

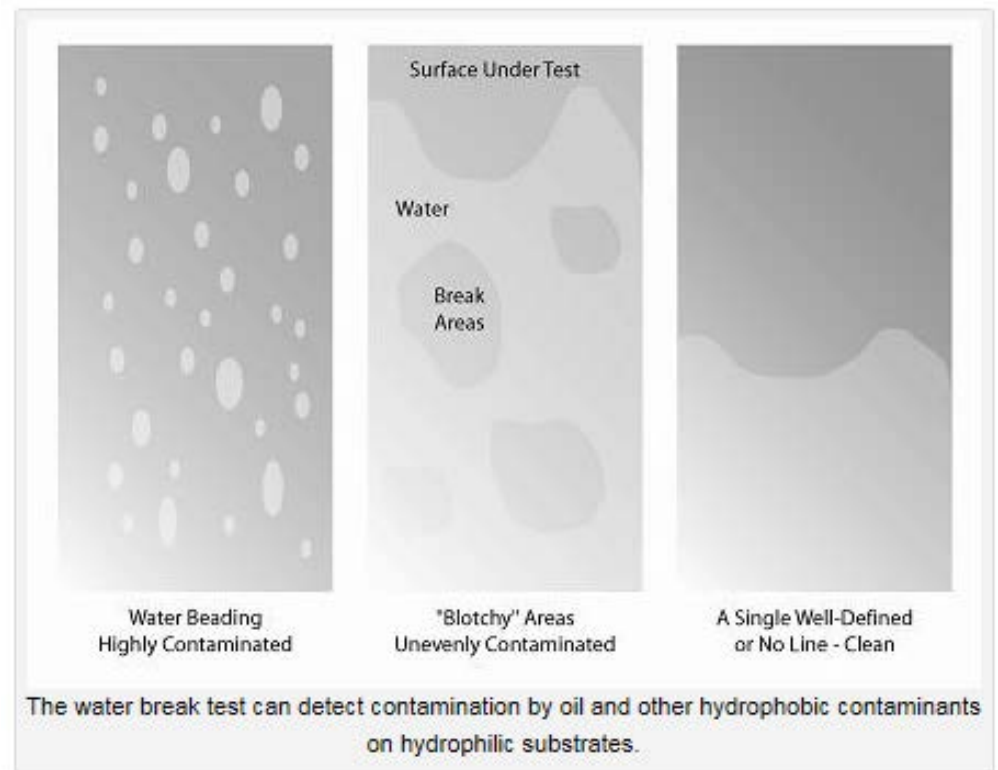
- (a) The inspection should include the areas where heat was applied plus a minimum width of 2 inches more around the heated area.
- (b) If the inspection gives an unsatisfactory result, remove and install the repair again.

NOTE:

- Drying times will be dependent on the required curing temperature of the repair to be performed. For repairs requiring 95 °C (203 °F) maximum, dry for a period between **one to two hours**. For hot bond repairs up to 120°C (250 °F) dry for **24 hours**. The drying temperature must be controlled and maintained at 80 °C ± 5 °C (176 °F ± 9 °F). The heat up rate must be controlled at 3 °C (6 °F) per minute.



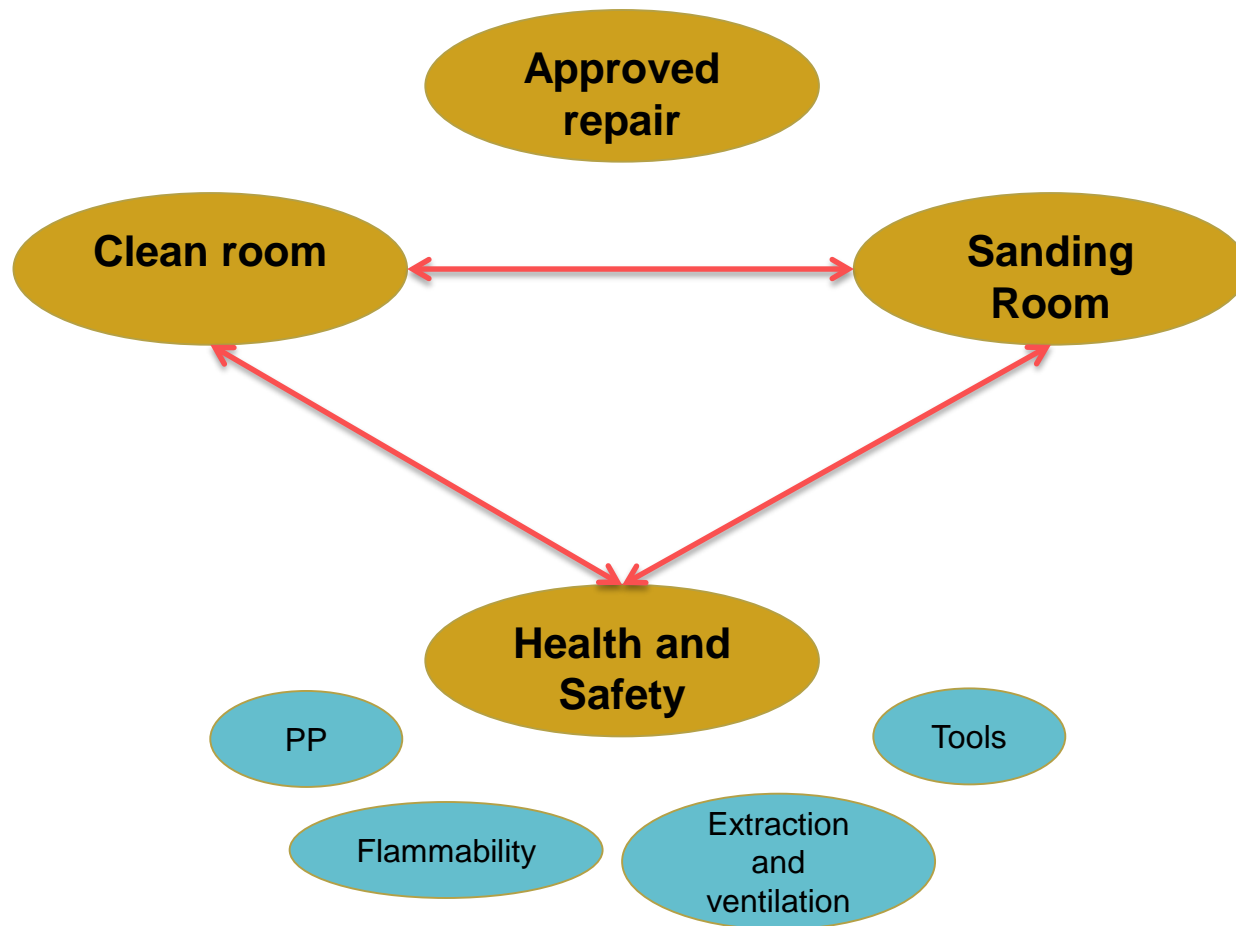
- TO DETECT REMAINING CONTAMINATION/MOISTER.
- Use Demineralised water.



MATERIALS HANDLING AND STORAGE

- **Epoxy Resin to be stored in their original Containers:**
 - **MSDS Material Safety Data Sheet.**
 - **Manufactures data sheet.**
 - **Expire date to be listed and controlled.**
 - **Store Temperature, CAT A (-18°C), B (1°C to 5°C) or C (Ambient).**
- **Prepreg and Film Adhesive to be stored in sealed bags:**
 - **MSDS**
 - **Manufactures data sheet.**
 - **Expire date to be listed and controlled.**
 - **Store in freezer with control of date and time -18°C.**
 - **Discarded every 6 to 12 months.**
- **Dry Glass, Carbon, Kevlar and Bagging material:**
 - **To be stored in clean room.**
 - **Air temperature 18 to 30°C**
 - **Relative humidity max. 65%**

FACILITIES, EQUIPMENT AND ENVIRONMENTAL CONDITIONS



ENVIRONMENTAL RESTORATION (51-80-00)

Protection from the elements is essential for the prolonged life of **bonded** composite structures.

- moisture,
- lightning,
- static,
- temperature,
- galvanic corrosion,
- rain erosion and
- ultra-violet light,

can attack the resin matrix causing **delamination**, **disbonding** and **microcracking** of the resin matrix.

ENVIRONMENTAL RESTORATION

(51-80-00)

A. Zone 1 Structure protection:

- **Lightning** will attempt to strike zone 1 areas first.
- These area are the **wing tips, radome, vertical and horizontal stablizer tips, flight control outboard surfaces and engine cowlings.**
- Zone 1 protection requires a **low resistance conductive path** to dissapate the energy quickly to the metallic airframe as follows:
 1. Copper Mesh
 2. Aluminum Flame Spray
 3. Aluminized Glass Cloth
 4. Aluminum Mesh Primed

PERSONLIG SIKKERHED VED REPARATIONER.

MSDS EA 9396

HEALTH AND SAFETY:

- Handling of Resins, cleaning and curing agency.
- MSDS - Material safety data sheet (Identification).
- Fume and dust extraction.
- Skin protection.
- Disposal of uncured resin and contaminated material and tool.
- Flammability risk.
- Glass, Carbon and aramid fibers awareness.

Punkt 8

MAL KODE



HENKEL EA 9396 Part A/B

Point 8

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Employers should complete an assessment of all workplaces to determine the need for, and selection of, proper exposure controls and protective equipment for each task performed.

Hazardous Component(s)	ACGIH TLV	OSHA PEL	AIHA WEEL	OTHER
Tetraethylene pentamine	None	None	(SKIN) Aerosol. 1 ppm (5 mg/m ³) TWA Aerosol. (Skin sensitizer)	None
N,N'-Bis(3-aminopropyl)piperazine	None	None	None	None
3,6,9,12-tetraazatetradecamethylenediamine	None	None	None	None

Engineering controls:

Provide local and general exhaust ventilation to effectively remove and prevent buildup of any vapors or mists generated from the handling of this product.

Respiratory protection:

If ventilation is not sufficient to effectively prevent buildup of aerosols, mists or vapors, appropriate NIOSH/MSHA respiratory protection must be provided.

Eye/face protection:

Safety goggles or safety glasses with side shields.

Skin protection:

Wear impervious gloves for prolonged contact. Use of impervious apron and boots are recommended.

PUNKT 8: Eksponeringskontrol/personlige værnemidler**8.1. Kontrolparametre****Grænseværdier for erhvervsmæssig eksponering**

Gælder for
DK

ingen

Biologisk grænseværdi:
ingen

8.2. Eksponeringskontrol:

Åndedrætsværn:
Egnet ansigtsmaske (åndedræt) ved utilstrækkelig ventilation.
Egnet åndedrætsværn:
Filtertype: A

Håndbeskyttelse:
Kemikaliebestandige beskyttelseshandsker (EN 374)
Egnede materialer ved kort kontakt eller stænk (Anbefalet: Mindst beskyttelsesindeks 2, svarende til > 30 minutter permeationstid iht. EN 374): Nitrilgummi (NBR; $\geq 0,4$ mm lagtykkelse). Egnede materialer også ved længere, direkte kontakt (Anbefalet: Mindst beskyttelsesindeks 6, svarende til > 480 minutter permeationstid iht. EN 374): Nitrilgummi (NBR; $\geq 0,4$ mm lagtykkelse). Angivelserne baserer på litteraturangivelser og informationer fra handskeproducenter eller er afledt ved analogikonklusioner fra lignende stoffer. Man skal være opmærksom på, at en kemikaliebeskyttelseshandskes anvendelsesvarighed i praksis kan være betydeligt kortere end den permeationstid, som er beregnet iht. EN 374, på grund af de mange påvirkende faktorer (f.eks. temperatur). Ved tegn på slitage skal handskene udskiftes.

Øjenbeskyttelse:
Tætsluttende beskyttelsesbriller.
og/eller
Ansichtsbeskyttelse

Kropsbeskyttelse:
Beskyttelsesudstyr skal bæres.
Beskyttelsestøj, som dækker arme og ben.
Forklæde

Rådet for personlig beskyttelse udrustning:
Forurening af huden skal vaskes grundigt af med vand og sæbe, hudpleje.
Indånd ikke støv og dampe.

Environment

- **Working Environment:**
 - Good housekeeping directly impacts safety
 - Keep area neat & orderly
 - Properly dispose of mixing containers
 - Keep fabric remnants swept up
 - Wipe up spills, keep tools clean
 - Do not block access to safety equipment

Personal Safety

Routes of Exposure

Hazardous materials may enter the human body in four different ways:

- ☐ **Absorption**: chemicals through the skin then to blood
- ☐ **Inhalation**: breathing into lungs
- ☐ **Injection**: by piercing the skin (sharp sides of structures)
- ☐ **Ingestion**: swallowing chemicals (left on hands, clothing, contaminate food and drink)

Personal Safety

- **Personal safety while sanding or drilling:**
 - Respirators must be worn
 - Wear shop coat to minimize particles entering pores of skin
 - Use eye protection
 - Always shower at the end of the day after working with composites

PERSONAL PROTECTIVE EQUIPMENT

Equipment to protect human from four primary routes of exposure during composite repair:

- ☐ **From Absorption** - Gloves, safety glasses, ...
- ☐ **From inhalation** – Respirators
- ☐ **Limiting the risk of injection** - pay attention during work)
- ☐ **Preventing Ingestion** - washing hands before eating or smoking, and use gloves.

ENGINEERING CONTROLS

- ☐ Apparatus to remove hazardous materials in workshop: such as downdraft tables, exhaust hoods, paint booths,....

ADMINISTRATIVE CONTROLS

- ☐ Instructions to do when human is exposed to hazardous materials.

Hazards associated with matrix system and fibers

- ❑ **Chemical irritants**: From epoxy chemical components
- ❑ **Dust**: From sanding and machining of cured epoxy
- ❑ **Sensitization**: Allergic skin reaction

Shop Safety

- **Compressed air in the shop area**
 - **Moisture is your enemy!**
 - Check moisture traps often
 - **Air Tools**
 - Flexible lines can take on a life of their own if unsecured
 - Disconnect tools from air supply before changing cutters, sanding discs and drills
 - Point the exhaust away from other people
 - **Never blow surfaces with compressed air!**
 - Causes projectiles
 - Can cause delaminations
 - **Use a brush or vacuum for cleaning parts, machines, and work tables**

Tool Safety

- **Tool Safety**
 - Use Eye Protection
 - Safety glasses with side shields are a must
 - Wear dust mask when cutting, drilling, sanding
 - NIOSH-rated
 - Cutting
 - When Cutting:
 - Keep hands, fingers away from cutting surfaces
 - Razor Knives
 - Very sharp, use caution

– Drilling

- When Drilling:
 - Back up materials
 - » *Don't use your hands!*
 - » Always know what is behind
 - *Never force drills!*
 - » Will cause breakouts on other side
 - » Can disbond laminate-to-core interface
 - » Use high speed, low pressure
 - » *Let the bit do the work!*

– Sanding






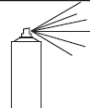
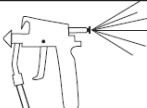






















- When Sanding:
 - Wear eye protection/dust masks
- Work in a suitable area:
 - Down-draft tables
 - Exhaust systems
- Clean up debris:
 - Clean up before tracking around
 - Wash hands before eating or using the restroom!



MAL Kode.

16

EPOXYBASEREDE CEMENT/INJEKTIONSMIDLER

Kode nr.	Arbejde:	Påføringsmidler:																
	 	     																
00-5 0-5	      											1. Ingen tilsmudsning: Handsker kan udelades						
1-5	      											2. Brug åndedrætsværn i stillestående luft						
4-5 5-5	      											3. Indeholder produktet lavt- kogende væsker: Brug altid luftforsynet åndedrætsværn						
												4. Ved arbejde med limtube: Handsker kan udelades						
												5. Brug helmaske hvis halvmaske og øjenværn ikke kan bæres samtidig						
												6. Ved risiko for tilsmudsning: Brug dragt og øjenværn						
												7. Ved arbejde på små emner: Åndedrætsværn kan udelades						

Gruppe

2

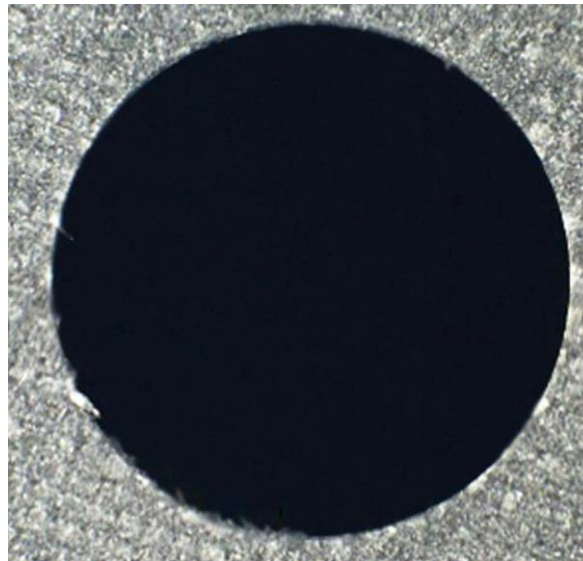
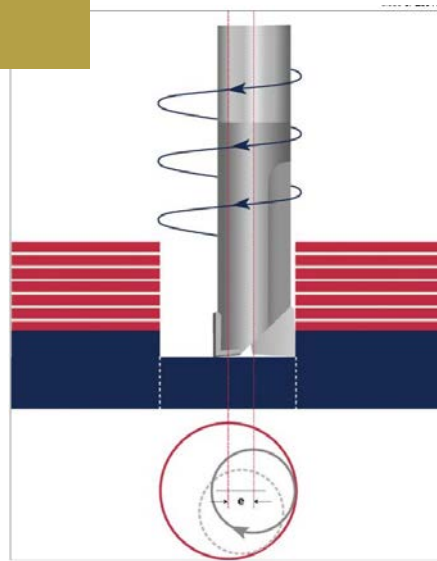
Epoxybaserede cement/injektionsmidler

Bearbejdningsprocesser og udstyr.

- Sanding Disk.
- Drill gun.
- Drill Bit, Diamond coated or Carbide drill.
- Reamers, Carbide drill.
- Counter bore,
- Cutting tool, Diamond coated.
- Hand tool.



Special Drill for Carbon



A Lockheed Martin technician tests, via hand fastening, holes machined by an AMAMCO-customized composite drill tool. Source: AMAMCO

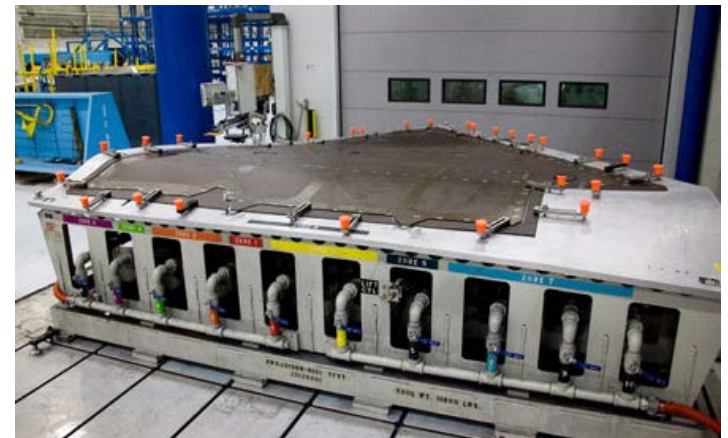




Figure 6-3-10. Abrasives such as sandpaper and Scotch-Brite™



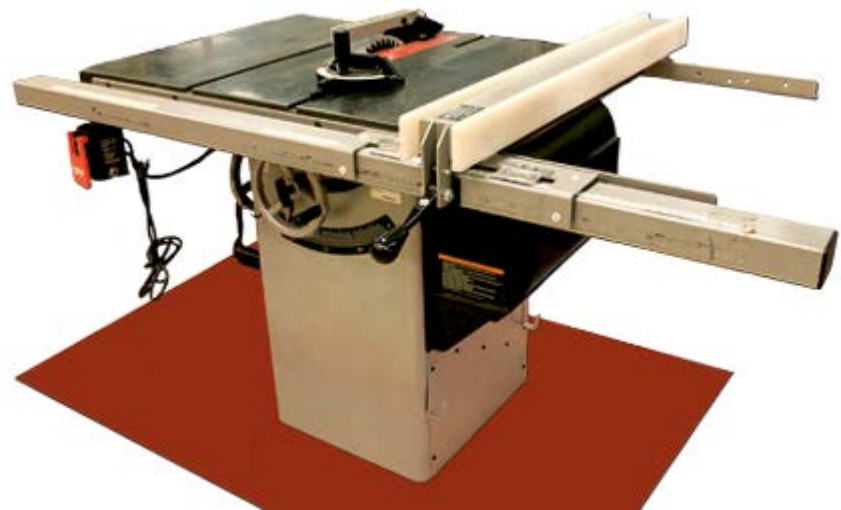
Figure 6-3-9. Electric cutters



Figure 6-2-10. Diamond coated hole saws



Figure 6-3-7. Orbital sander



Theoretical Task

51-70-05, 201

- Repair General - Repair Procedures for Preimpregnated Materials
- Repair 1 - Repair of Damage to One Skin of a Honeycomb Panel
- Repair 2 - Repair of Damage That is More Than 0.50 Inch (12.70 mm) in Diameter to
- Repair 3 - Repair of Damage to the Bagside and the Honeycomb Core
- Repair 4 - Repair of Damage to the Two Skins and the Honeycomb Core
- Repair 5 - Repair of Damage to the Two Skins and the Honeycomb Core With Access
- Repair 6 - Repair of Damage to the Edgeband of a Honeycomb Panel
- Repair 7 - Repair of Damage to the Edgeband and the Honeycomb Core
- Repair 8 - Repair of Damage to a Fastener Hole With Prepreg Materials
- Repair 9 - Repair of Damage That is 0.50 Inch (12.70 mm) or Less to Solid
- Repair 10 - Repair of Damage That is More Than 0.50 Inch (12.70 mm) in Diameter
- Repair 11 - Potted Core Repair
- Repair 12 - Repair of a Trailing Edge Panel With Full Depth Honeycomb Core

Repair 2 – Repair of Damage That is More Than 0.50 Inch (12.70 mm) in Diameter to
One Skin and the Honeycomb Core

2. General

- A. Repair 2 is a Category A damage tolerant repair. Refer to SRM 51-00-06 for the definitions of the different categories of repairs.
- B. Refer to Figure 201 for the layout of the repair parts.

3. References

- A. SRM 51-00-06, General – Structural Repair Definitions
- B. SRM 51-60-00, General – Control Surface Balancing Procedures
- C. SRM 53-00-50, Repair General – Composite Floor Panel Repairs
- D. SRM 53-10-72, Repair General – Nose Radomes

4. Repair Instructions

- A. Find the limits of the damage. Refer to Repair General, Paragraph 4.A.

4. Repair Instructions (Continued)

- D. Cut out, clean, and install the honeycomb core plug as given in Repair General, Paragraphs 4.F, 4.G, and 4.H. It is not necessary to use the vacuum bag procedure at this time.
- E. Prepare and install the repair plies to one surface of the panel as given in Repair General, Paragraph 4.N. Use a caul plate on the opposite side of the panel to hold the core plug in position.
- F. Install the vacuum bag system as given in Paragraph 4.O.
- G. Cure the repair as given in Paragraph 4.P. Make sure that the temperature is equal on the two sides of the panel.
- H. Make the core repair plug smooth with the initial core surface. Make an allowance for the slight core crush that occurs during the cure procedure.
- I. Clean the repair surface as given in Repair General, Paragraph 4.E.
- J. Prepare and install the repair plies as given in Repair General, Paragraph 4.N through 4.O.
- K. Install fabric repair plies and the vacuum bag system as given in Repair General, Paragraph 4.P.
- L. Cure the repair as given in Repair General, Paragraph 4.Q. Make sure that the temperature is equal on the two sides of the panel.
- M. Examine the completed repair as given in Repair General, Paragraph 4.R.
- N. Apply the finish to the repair area as given in Repair General, Paragraph 4.S.
- O. After repair of flight control surfaces, check to see if it must be balanced again. Refer to SRM 51-60-00 for the procedures.

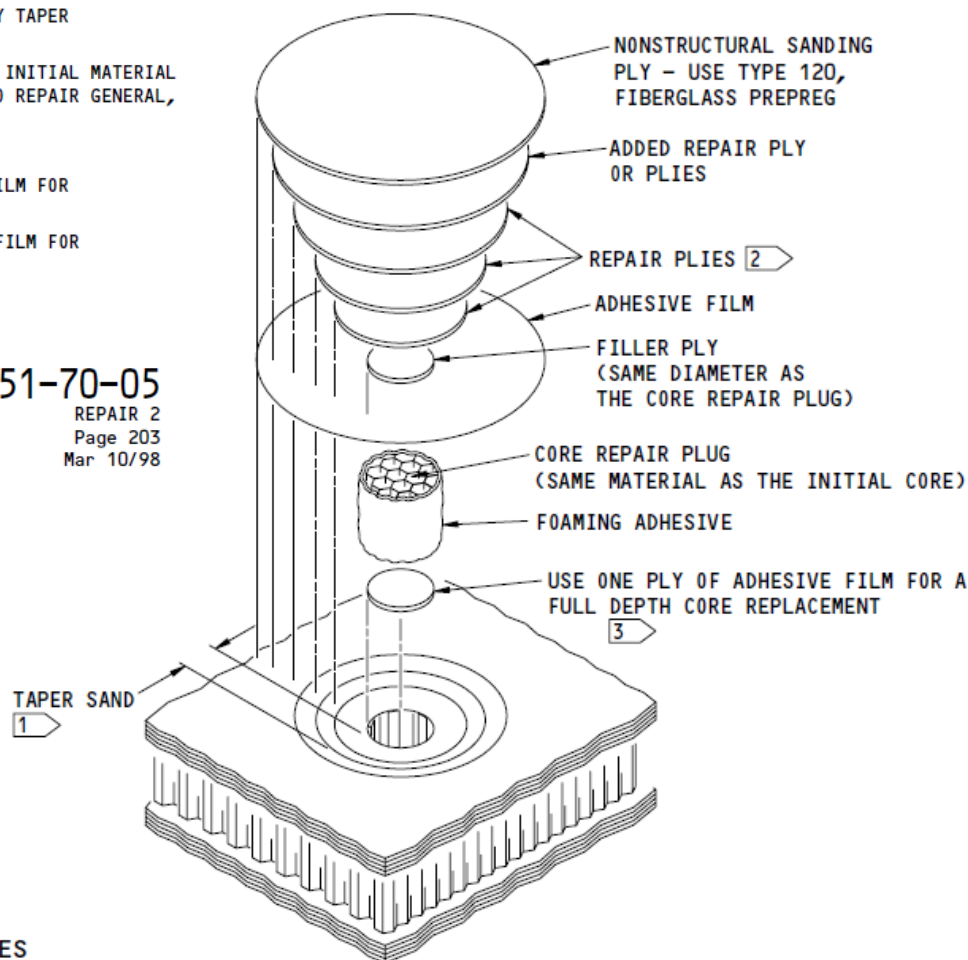
- 1 REFER TO REPAIR GENERAL, FIGURES 202 AND 203 FOR THE NECESSARY TAPER AND OVERLAP.
- 2 FIND THE NUMBER OF STRUCTURAL PLIES, PLY ORIENTATION, AND THE INITIAL MATERIAL IN THE SPECIFIED COMPONENT STRUCTURE IDENTIFICATION. REFER TO REPAIR GENERAL, TABLES 202 AND 203 FOR THE REPAIR MATERIALS.
- 3 FOR A LESS THAN FULL DEPTH CORE REPLACEMENT:
 - USE ONE PLY OF GLASS FABRIC BETWEEN TWO PLIES OF ADHESIVE FILM FOR ARAMID/NOMEX HONEYCOMB.
 - USE ONE PLY OF CARBIN FABRIC BETWEEN TWO PLIES OF ADHESIVE FILM FOR CARBON HONEYCOMB.

Repair 2 - Layout of the Repair Parts
Figure 201 (Sheet 1)

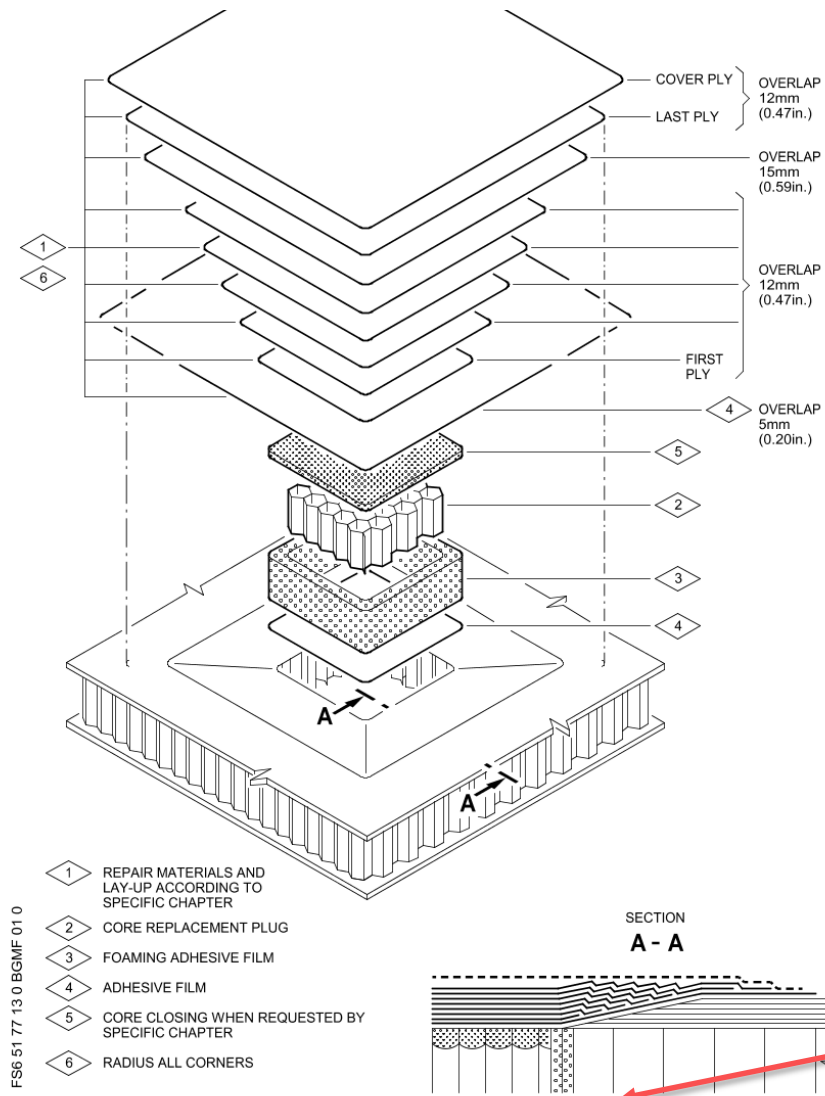
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Figure 003 (sheet 2) / 51-77-13 Hot Bond Repair with two sided access - no thickness limit Option B (applicable if skin thickness >1mm (0.04in.))

B

(3). Hot Bond Repair with two sided access - no thickness limit (Refer to Figure 003 (sheet 1 thru 4))





NOTE: This repair is applicable to curved or flat surfaces with skin and honeycomb core damage. Access must be available to both sides of the surface.

There are risks when working with composite repair materials. To reduce these risks to a minimum read and obey the warnings given in Paragraph 1.E

- (a) Prepare and dry the repair area (Refer to [Chapter 51-77-11](#), Paragraph 4.M.(2)).
- (b) Prepare and dry the honeycomb core plug (Item 4, Repair Materials List and refer to [Chapter 51-77-11](#), Paragraph 4.I.).
- (c) Install the core plug (Refer to [Chapter 51-77-11](#), Paragraph 5.G.).
- (d) Bag the repair with a vacuum bag and install heating equipment at both surfaces (Refer to [Chapter 51-77-11](#), Paragraph 5.D.) and cure at the required temperature and vacuum for the recommended time (Refer to [Chapter 51-77-11](#), Paragraphs 5.E. and 6.B.(5) and (6)).

NOTE: When required by the specific chapter, close the top surface of the honeycomb core cells in accordance with Chapter 51-77-11, Paragraph 5.H.

WARNING: BONDING AND ADHESIVE COMPOUND IS DANGEROUS.

- (e) Prepare the prepreg repair plies (Item 2 or 3, Repair Materials List and refer to [Chapter 51-77-11](#), Paragraph 4.C.) and adhesive film (Refer to [Chapter 51-77-11](#), Paragraph 6.B.(6) and 4.B.).
 - (f) Position the prepreg repair plies (and the adhesive film) in the repair area (Refer to [Chapter 51-77-11](#), Paragraph 5.B.).
 - (g) Install the vacuum bag and heating equipment (Refer to [Chapter 51-77-11](#), Paragraph 5.D.).
 - (h) Cure at the required temperature and vacuum for the recommended time (Refer to [Chapter 51-77-11](#), Paragraphs 5.E. and 6.B.(6) and (9)).
 - (i) Remove the vacuum bag and heating equipment.
 - (j) Inspect the repair (Refer to [Chapter 51-77-10](#), Paragraph 5.).
 - (k) Remove any resin remnants from the border area of the repair, use abrasive cloth. Start with 280 grade and finish with 400 grade.
 - (l) Clean the repair area with cleaning agent (Material No. [11-003](#) or [11-004](#) and refer to [Chapter 51-77-11](#), Paragraph 4.E.).
 - (m) If required, restore the surface protection (Refer to [Chapter 51-75-12](#)).
-  Figure 003 (sheet 1) / 51-77-13 Hot Bond Repair with two sided access - no thickness limit Option A (applicable if skin thickness >1mm (0.04in.))
 -  Figure 003 (sheet 2) / 51-77-13 Hot Bond Repair with two sided access - no thickness limit Option B (applicable if skin thickness >1mm (0.04in.))
 -  Figure 003 (sheet 3) / 51-77-13 Hot Bond Repair with two sided access - no thickness limit Option C (applicable if skin thickness >1mm (0.04in.))
 -  Figure 003 (sheet 4) / 51-77-13 Hot Bond Repair with two sided access - no thickness limit Option D