PART 2 - X-RAY

WATER DETECTION IN HONEYCOMB STRUCTURE

1. Purpose

   A. Use this radiography procedure to do an inspection for water in honeycomb structures.

      NOTE: This procedure will find water in honeycomb structures that are assembled with metallic and/or non-metallic honeycomb cores or skins.

   B. Part 9, 51-00-01 and 51-00-02 can be used as alternative procedures on non-metallic honeycomb parts. Before you use an alternative procedure, make sure there is sufficient sensitivity for the number of plies to be examined.

2. Equipment

   A. X-ray Generator -- Use an X-ray generator that operates in the range from 30 to 100 kilovolts (kV).

   B. Film -- Use a radiographic film that has a wide range. ASTM Class II radiographic film was used to make this procedure.

   C. Processor -- Use a manual or an automatic film processor.

3. Preparation for Inspection

   A. Get access to the inspection area.

   B. Extend the control surface or remove the honeycomb panel, if necessary, to give clear access for the radiographic exposure. See Fig. 2.

   C. Remove loose paint, dirt and sealant from the surface of the inspection area.

4. Inspection Procedure

   A. Position the head of the X-ray tube perpendicular to the inspection area of the honeycomb panel. See Fig. 2 for an example of the relation between the head of an X-ray tube and the inspection part.

   B. Place the film on the upper side of the inspection part or the side of the part that is opposite the head of the X-ray tube. Make sure you examine the area thought to contain water. See Fig. 2, flagnotes 3 and 4.

      NOTE: Approximately 70 inches (1770 mm) of inspection area can be examined during each exposure if you have a source-to-film distance (SFD) of 120 inches (3050 mm).

C. Use Figure 1 as an aid to help set the X-ray generator controls.

D. Expose the film to get a cell density of 2.0 to 3.0.

E. Do steps 4.A thru 4.D again, if necessary, to examine all areas thought to contain water.

5. Inspection Results

A. The radiographs of honeycomb parts that have water contamination are effected by:

(1) The number of cells that contain water.

(2) The volume of water in each cell.

(3) The thickness of the honeycomb core.

(4) The orientation of the X-ray beam to the cell walls.

Water can be found in honeycomb structures when the honeycomb core cells are aligned parallel to the radiation within 45 degrees.

B. Make sure you do not incorrectly reject a part because you think the image on a radiograph is from water when it is from adhesive.

(1) When a honeycomb part is made, different quantities of adhesive can collect in the honeycomb cells. The density of the images caused by the adhesive on the radiograph usually change within a cell and show indications of porosity. Figures 3 and 4 show the effect adhesive can have on the radiograph.

NOTE: Three to five times magnification (of the radiograph) will aid identification of adhesive porosity.

(2) When the honeycomb cell walls are oriented to the X-ray beam such that individual cells cannot be seen on the radiograph, the adhesive images on the radiograph can be incorrectly identified as water (see Figure 3).

(3) When the honeycomb cell walls are aligned parallel to the radiation beam (see Figure 4), the image on the radiograph will be the best to identify the difference between water and adhesive. Water images usually have a constant film density in a cell when the radiograph is done this way.

C. Water contamination usually occurs in several adjacent cells. Adhesive (as shown in radiographs) looks as if it is a large quantity of water that has been separated throughout adjacent cells. To help you identify if the image is caused by water or adhesive you can do additional radiographs of the area at different X-ray beam-to-cell wall orientations. Images caused by adhesive will not change very much for radiographs that have different X-ray beam-to-cell wall orientations.

D. Small quantities of water are not easy to find. Initial radiographs must be made so they can be compared with radiographs in subsequent inspections to identify small quantities of water in honeycomb.

E. Examine all radiographs for water very carefully in areas that have visible damage.

X-RAY DATA						
EXPOSURE NUMBER	FILM			SFD	GENERATOR SETTINGS	
	POSITION	ASTM CLASS	SIZE		KV	MAS
*[1]	*[2]	II *[3]	14 X 17	120 (3050)	30-100	*[4]

NOTES

ALL DIMENSIONS ARE IN INCHES (MILLIMETERS ARE IN PARENTHESES)

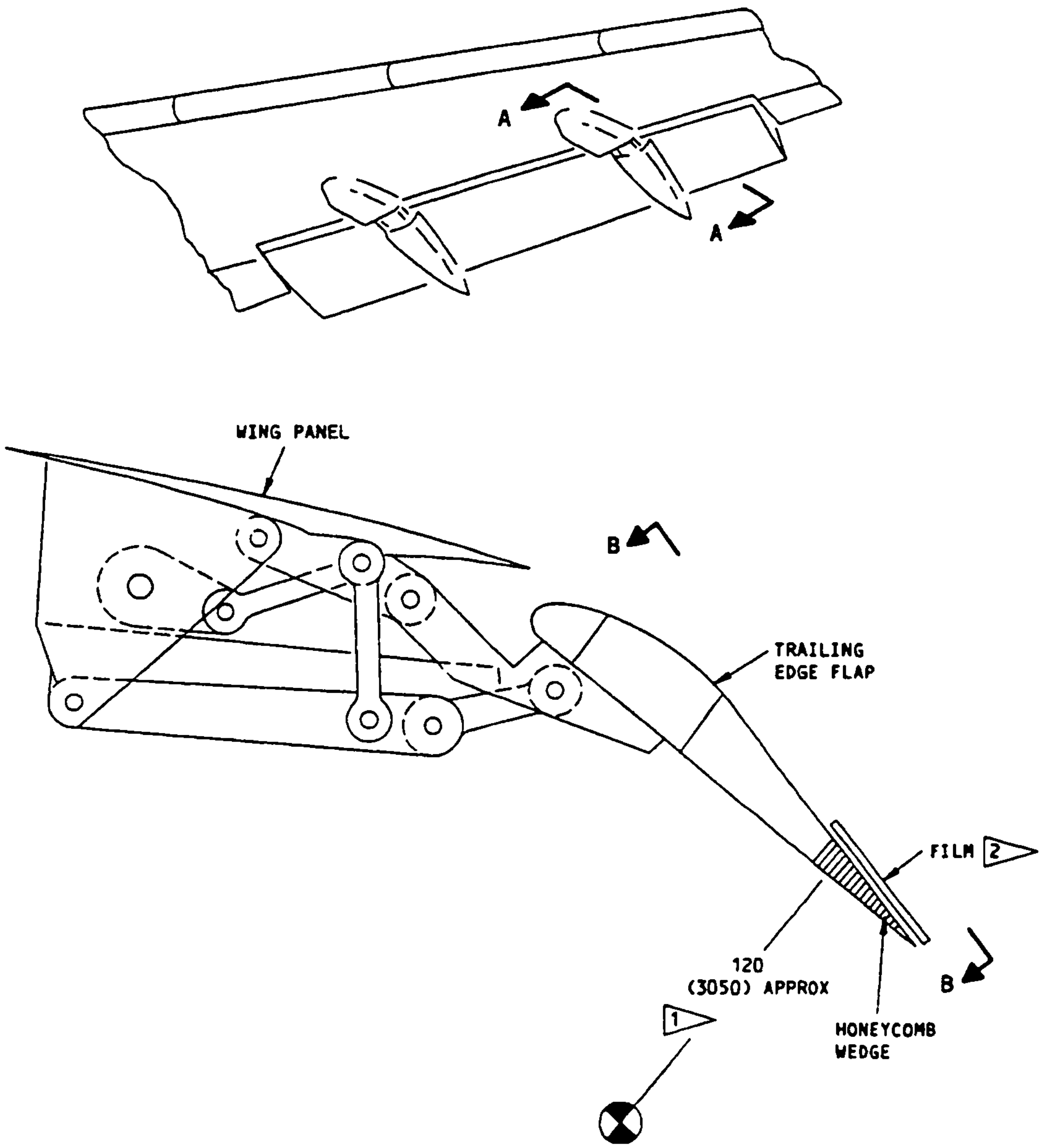
*[1] DO AS MANY X-RAY EXPOSURES AS NECESSARY TO EXAMINE THE INSPECTION AREA. SEE FIG. 2 FOR A TYPICAL X-RAY GENERATOR POSITION

*[2] AS MANY AS FIVE FILMS OF THE SIZE SPECIFIED CAN BE USED WITH A SOURCE TO FILM DISTANCE (SFD) OF 120 INCHES (3050 MM) AS SHOWN IN FIG. 2

*[3] THIS FILM WAS USED TO PREPARE THIS PROCEDURE. A WIDE RANGE OF FILM TYPES ARE PERMITTED FOR RADIOGRAPHIC INSPECTION FOR WATER IN HONEYCOMB

*[4] SET THE MAS (MILLIAMP SECONDS) TO GET A FILM DENSITY THAT IS FROM 2.0 TO 3.0 AS MEASURED IN A CELL

X-Ray Generator and Film Data
Figure 1



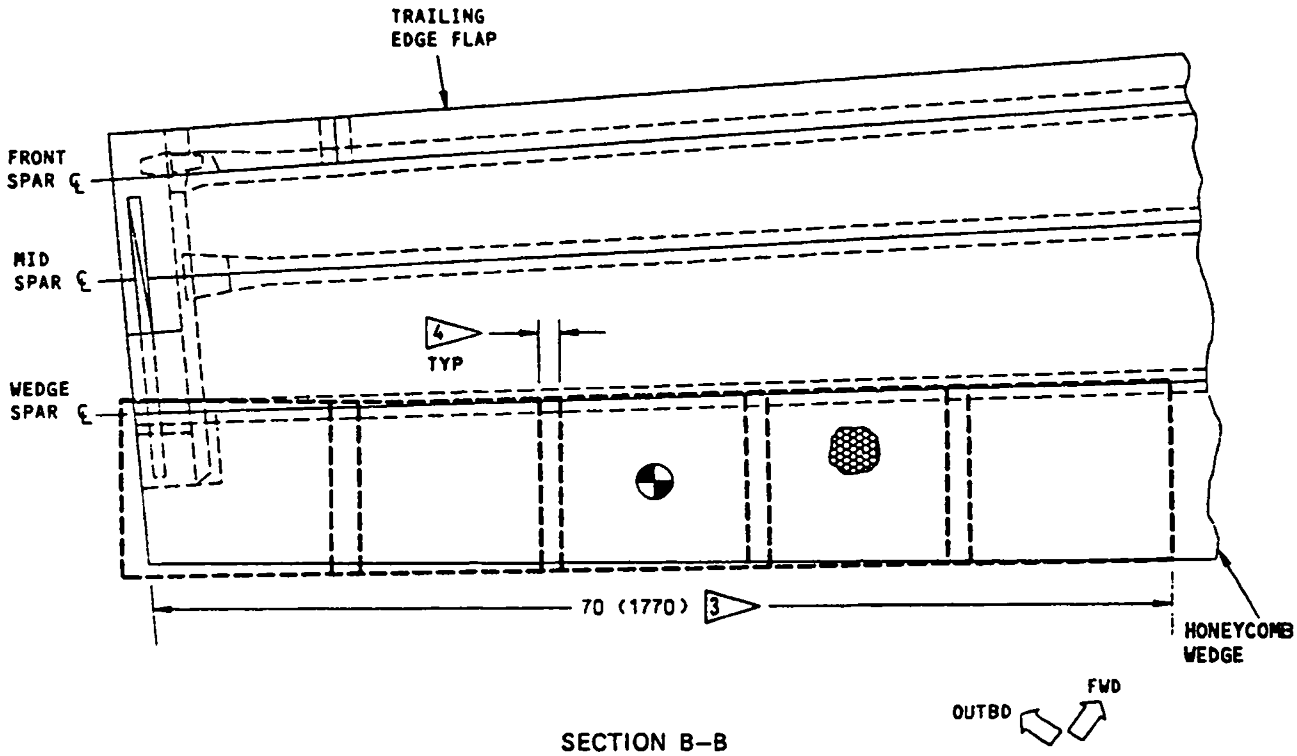
NOTES

- ALL DIMENSIONS ARE IN INCHES (MILLIMETERS ARE IN PARENTHESES)

1 ALIGN THE HEAD OF THE X-RAY SO THAT THE RADIATION BEAM IS PERPENDICULAR TO THE LOWER SURFACE OF THE FLAP AND THE SOURCE TO FILM DISTANCE (SFD) IS APPROXIMATELY 120 INCHES (3050 MM).

2 PUT THE FILM ON THE UPPER SURFACE OF THE FLAP ABOVE THE HONEYCOMB WEDGE

Example of an X-Ray Inspection to Find Water in Honeycomb Structure
Figure 2 (Sheet 1)



SECTION B-B

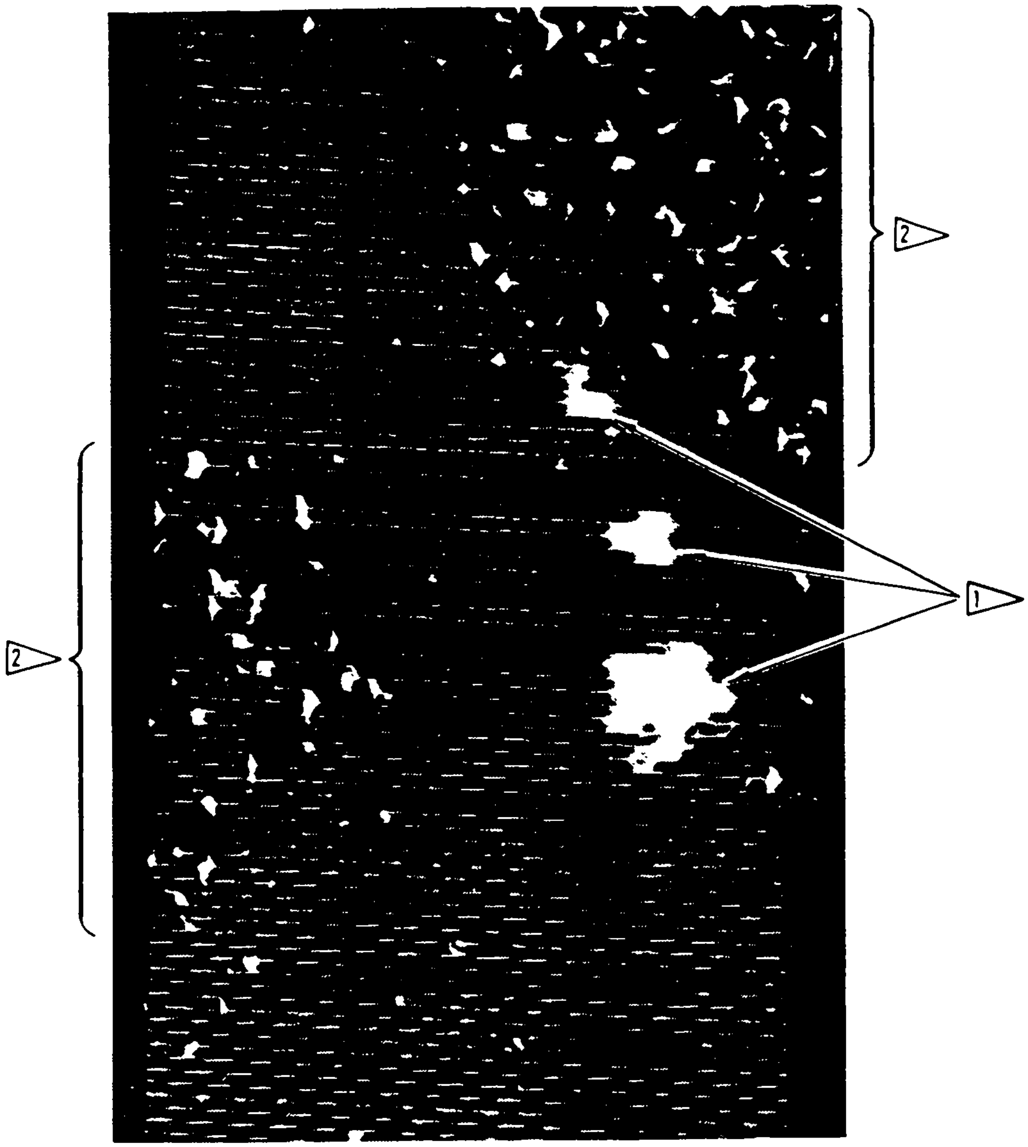
NOTES

- ALL DIMENSIONS ARE IN INCHES (MILLIMETERS ARE IN PARENTHESES)
- AIM THE X-RAY GENERATOR AT THE CENTER OF THE FILM

3 AS MUCH AS 70 INCHES (1770 MM) OF THE HONEYCOMB WEDGE CAN BE EXAMINED FOR EACH EXPOSURE.

4 MAKE SURE THE FILM IS OVERLAPPED 2 INCHES (50 MM) TO COMPLETELY EXAMINE THE INSPECTION AREA.

Example of an X-Ray Inspection to Find Water in Honeycomb Structure
Figure 2 (Sheet 2)



ACTUAL RADIOGRAPH

NOTES

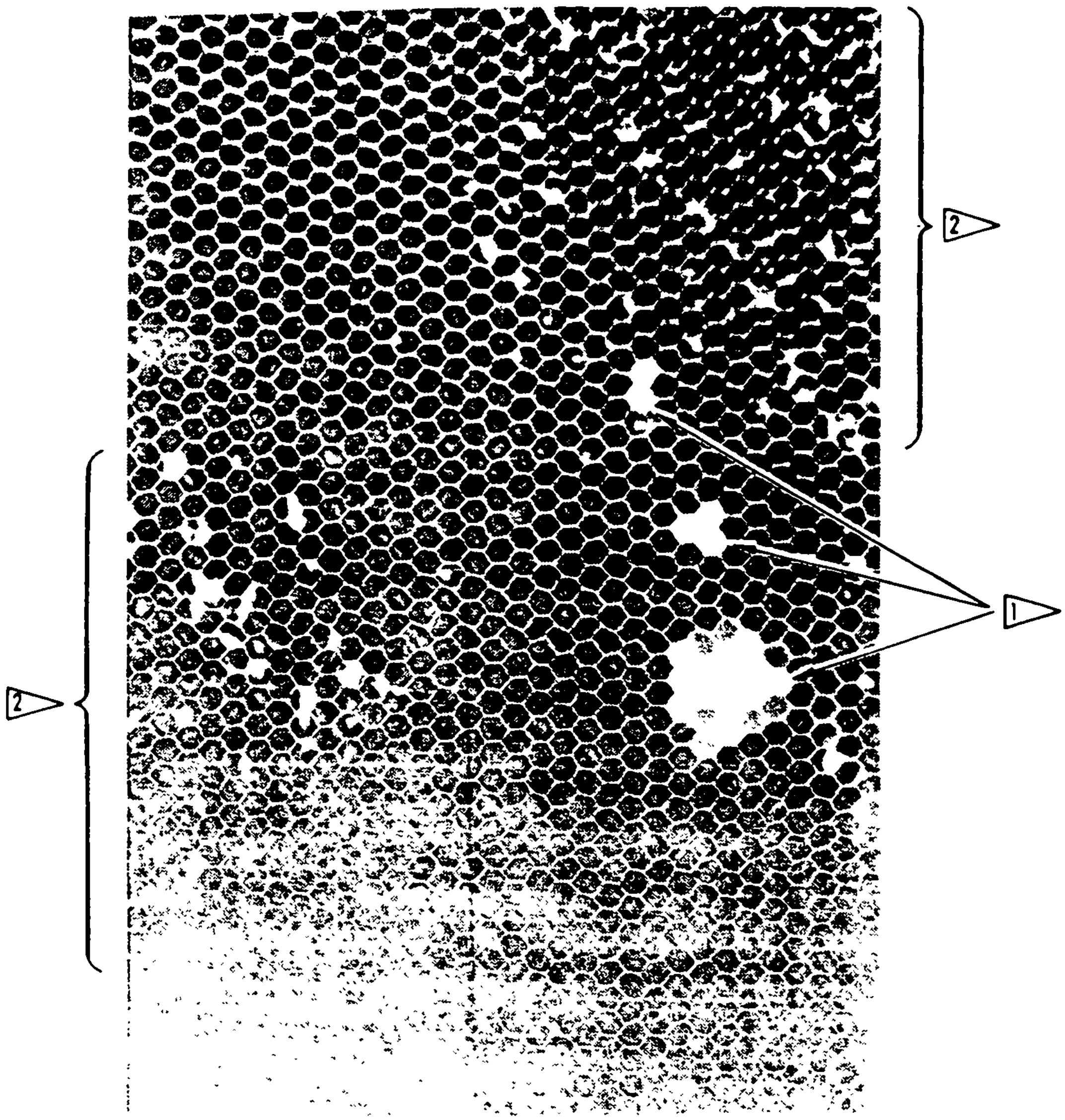
- EXAMPLE OF A RADIOGRAPH THAT SHOWS WATER AND ADHESIVE CONTAMINATION WHEN THE RADIATION BEAM IS NOT PARALLEL TO THE HONEYCOMB CELL WALLS

[1] HONEYCOMB CELLS THAT CONTAIN DIFFERENT AMOUNTS OF WATER

[2] AREAS THAT CONTAIN DIFFERENT QUANTITIES OF ADHESIVE

E58969

Radiographic Identification of Water and Adhesive in Honeycomb Structure
Figure 3



ACTUAL RADIOGRAPH

NOTES

- EXAMPLE OF A RADIOGRAPH THAT SHOWS WATER AND ADHESIVE CONTAMINATION WHEN THE RADIATION BEAM IS PARALLEL TO THE HONEYCOMB CELL WALLS

1 HONEYCOMB CELLS THAT CONTAIN DIFFERENT AMOUNTS OF WATER

2 AREAS THAT CONTAIN DIFFERENT QUANTITIES OF ADHESIVE

E58967

Radiographic Identification of Water and Adhesive in Honeycomb Structure
Figure 4

PART 2 - X-RAY

SUBSURFACE FRACTURE IN COMPOSITE STRUCTURE

1. Purpose

   A. Use this radiography procedure to do an inspection of graphite-epoxy composite structures for fractures or large subsurface fractures when there is a visible indication of subsurface damage.

      NOTE: It is possible that some subsurface fractures will not be identified if there are no visible defect indications on the surface of the part.

2. Equipment

   A. X-ray Generator - Use an X-ray generator that operates at a minimum of 20 kv and 3 ma.

   B. Film - Use ASTM Class I or II radiographic film.

   C. Processor - Use a manual or an automatic processor.

3. Preparation for Inspection

   A. Get access to the inspection area.

   B. Remove loose paint, dirt and sealant from the surface of the inspection area.

4. Inspection Procedure

   A. Put the film on the side of the part that is on the opposite side of the X-ray generator. See Fig. 1.

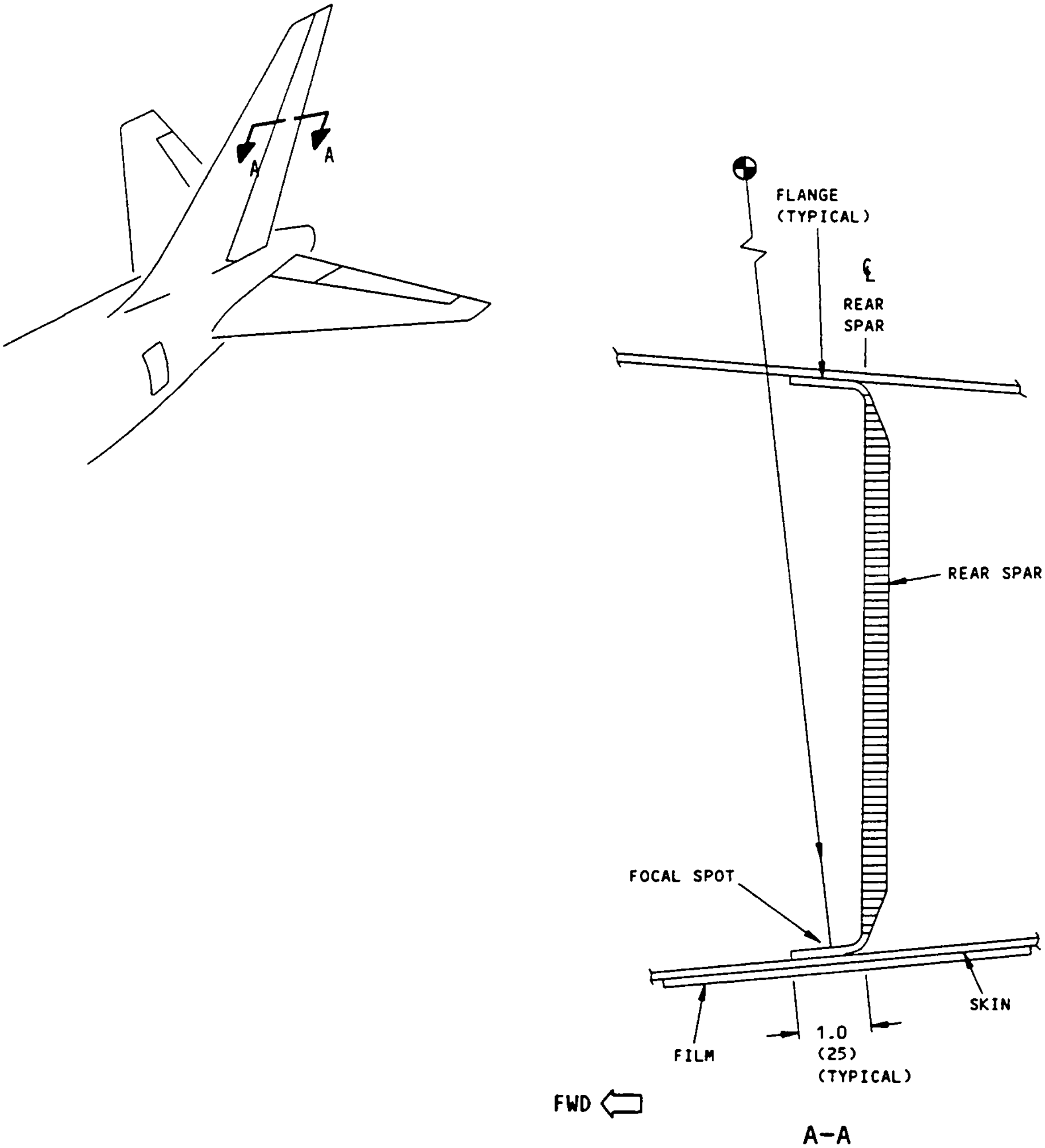
   B. Put the X-ray focal spot on the side of the part nearest the film and away from centerlines of the part thought to be fractured. See Fig. 1.

   C. Set the X-ray generator controls and make an exposure to get a density of 1.8 to 2.5. Use a technique chart to help make the initial X-ray generator control adjustments.

      NOTE: A technique chart is necessary for each X-ray generator. Show the exposure time necessary for different thicknesses to get the maximum results in the least time.

5. Inspection Results

A. Radiograph examples are shown in Fig. 2 thru 4. Analysis of radiographs for broken parts or large subsurface fractures in graphite-epoxy composite structure is equivalent to crack detection in metallic structures.

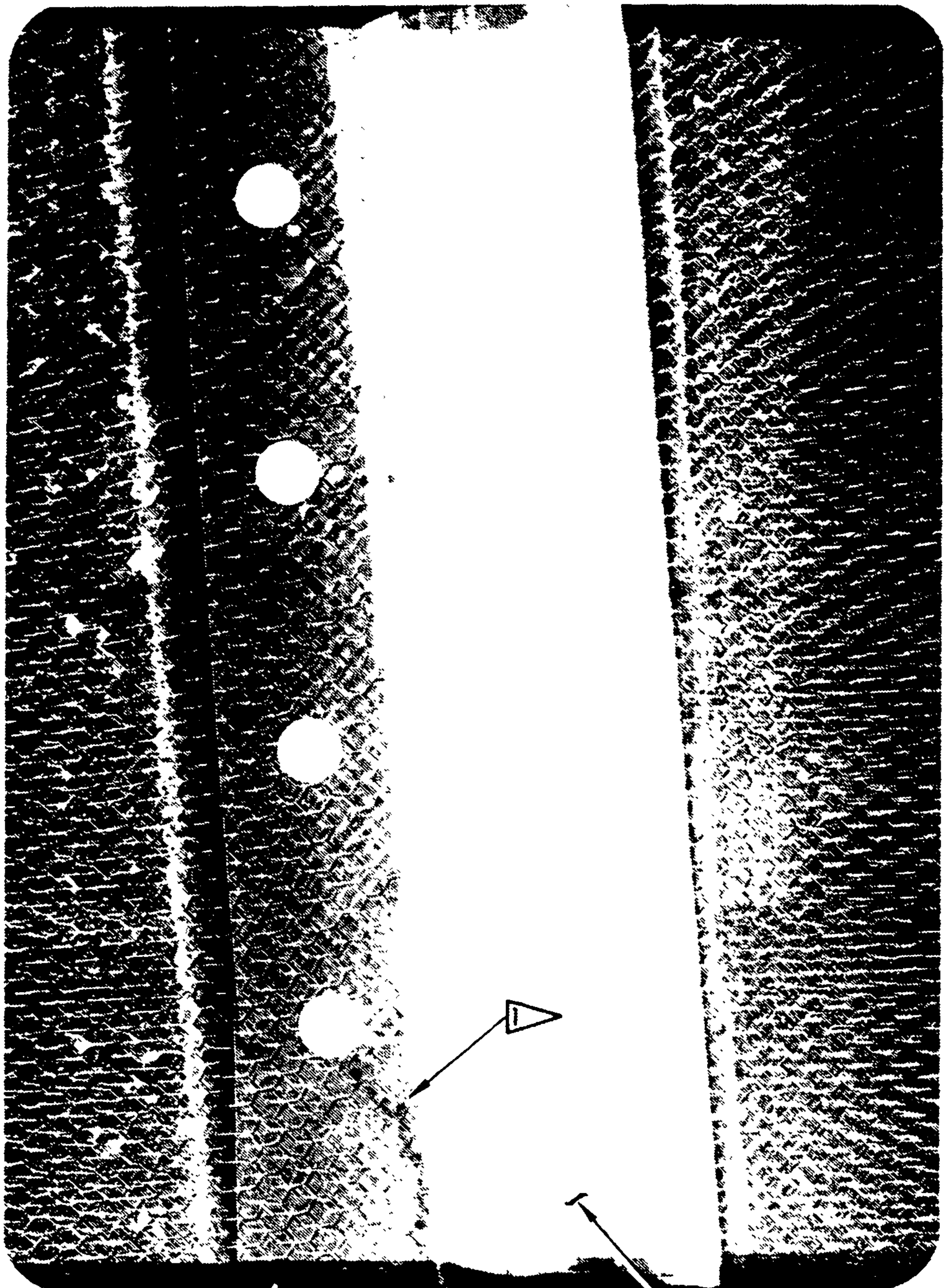


GRAPHITE/EPOXY RUDDER REAR SPAR

NOTES

- ALL DIMENSIONS ARE IN INCHES (MILLIMETERS ARE IN PARENTHESES).
- X-RAY GENERATOR POSITION TO EXAMINE THE REAR SPAR FLANGE - POSITION THE FOCAL SPOT AWAY FROM THE SPAR CENTERLINE TO PREVENT AN OVERLAP OF THE SPAR FLANGES ON THE RADIOGRAPH.

Example Inspection of Internal Structure
Figure 1

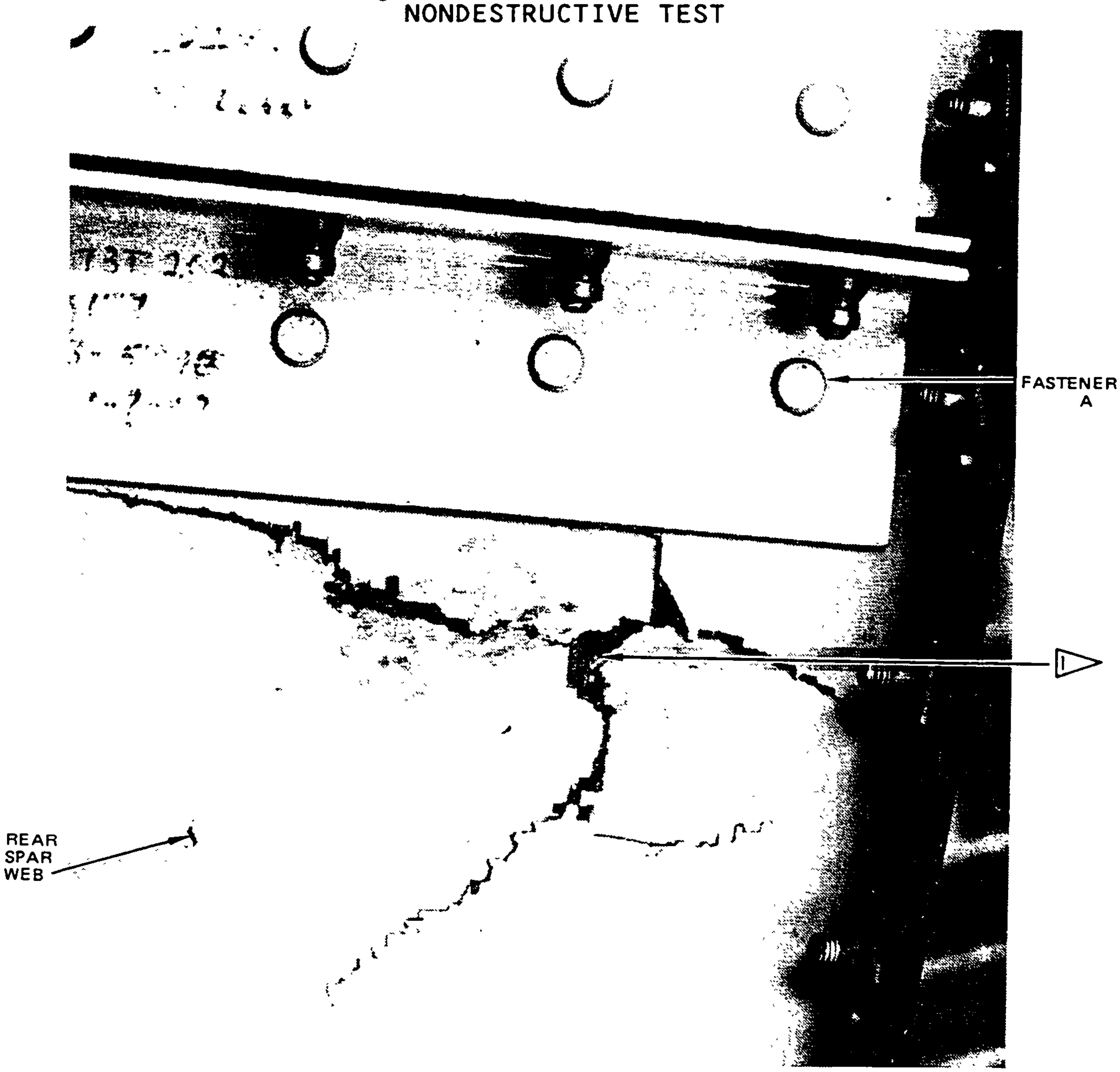


ACTUAL RADIOGRAPH

NOTES

1 EXAMPLE OF A RADIOGRAPH WHICH IDENTIFIES A LARGE SURFACE FRACTURE WITH SOME SEPARATION IN THE REAR SPAR FLANGE. THE REAR SPAR FLANGE IS AN INTERNAL PART OF THE RUDDER.

Radiograph Analysis
Figure 2

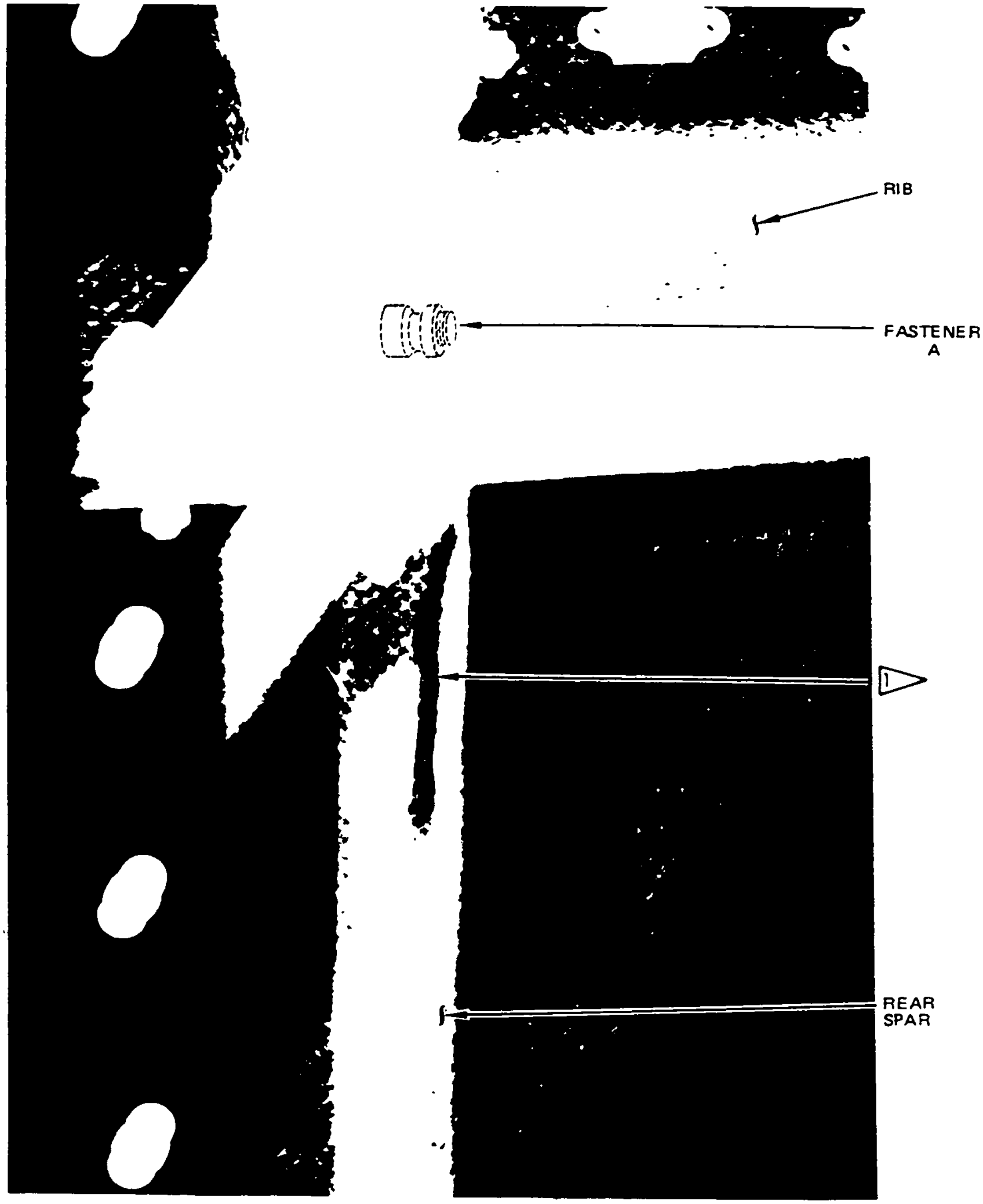


PHOTOGRAPH OF INTERNAL DAMAGE TO THE REAR SPAR OF THE RUDDER

NOTES

1 LARGE SKIN/CORE FRACTURE WITH PART SEPARATION.

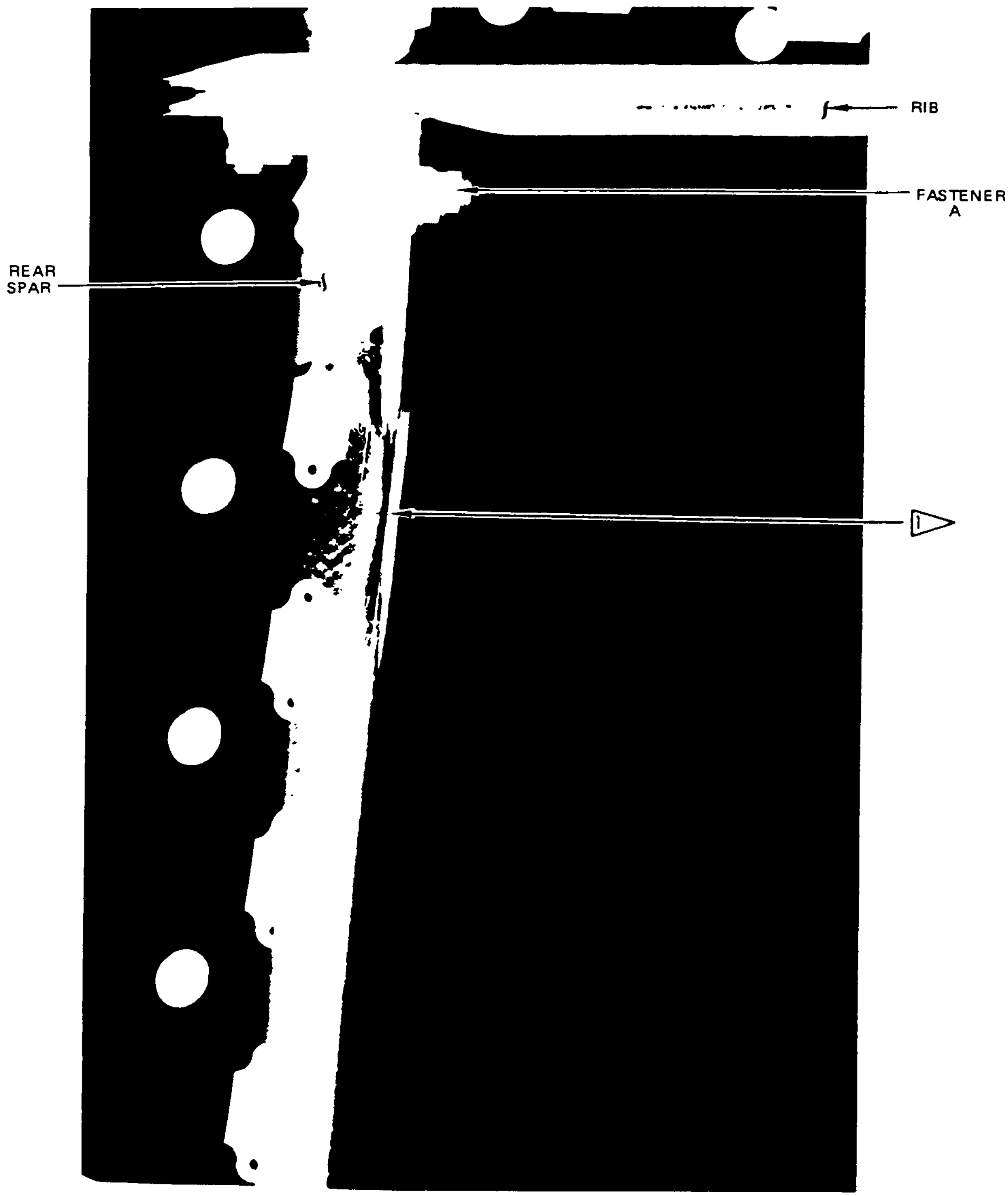
Radiographic Analysis
Figure 3 (Sheet 1)



ACTUAL RADIOGRAPH

(EXAMPLE OF A RADIOGRAPH THAT IDENTIFIES FRACTURED PARTS WHEN THE RADIATION BEAM IS NOT PARALLEL TO THE PART)

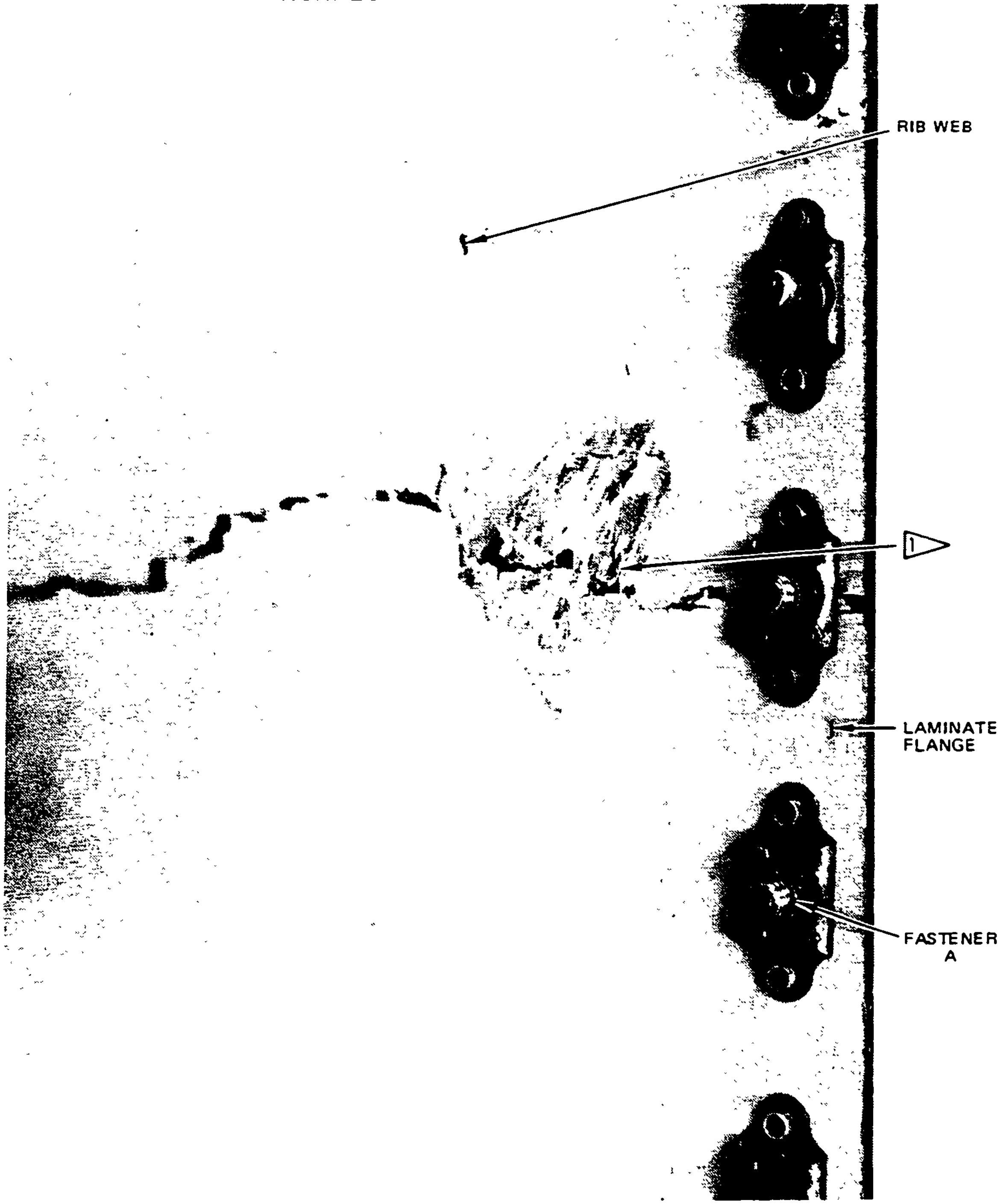
Radiographic Analysis
Figure 3 (Sheet 2)



ACTUAL RADIOGRAPH

(EXAMPLE OF A RADIOGRAPH THAT IDENTIFIES FRACTURED PARTS WHEN THE RADIATION BEAM IS PARALLEL TO THE PART)

Radiographic Analysis
Figure 3 (Sheet 3)

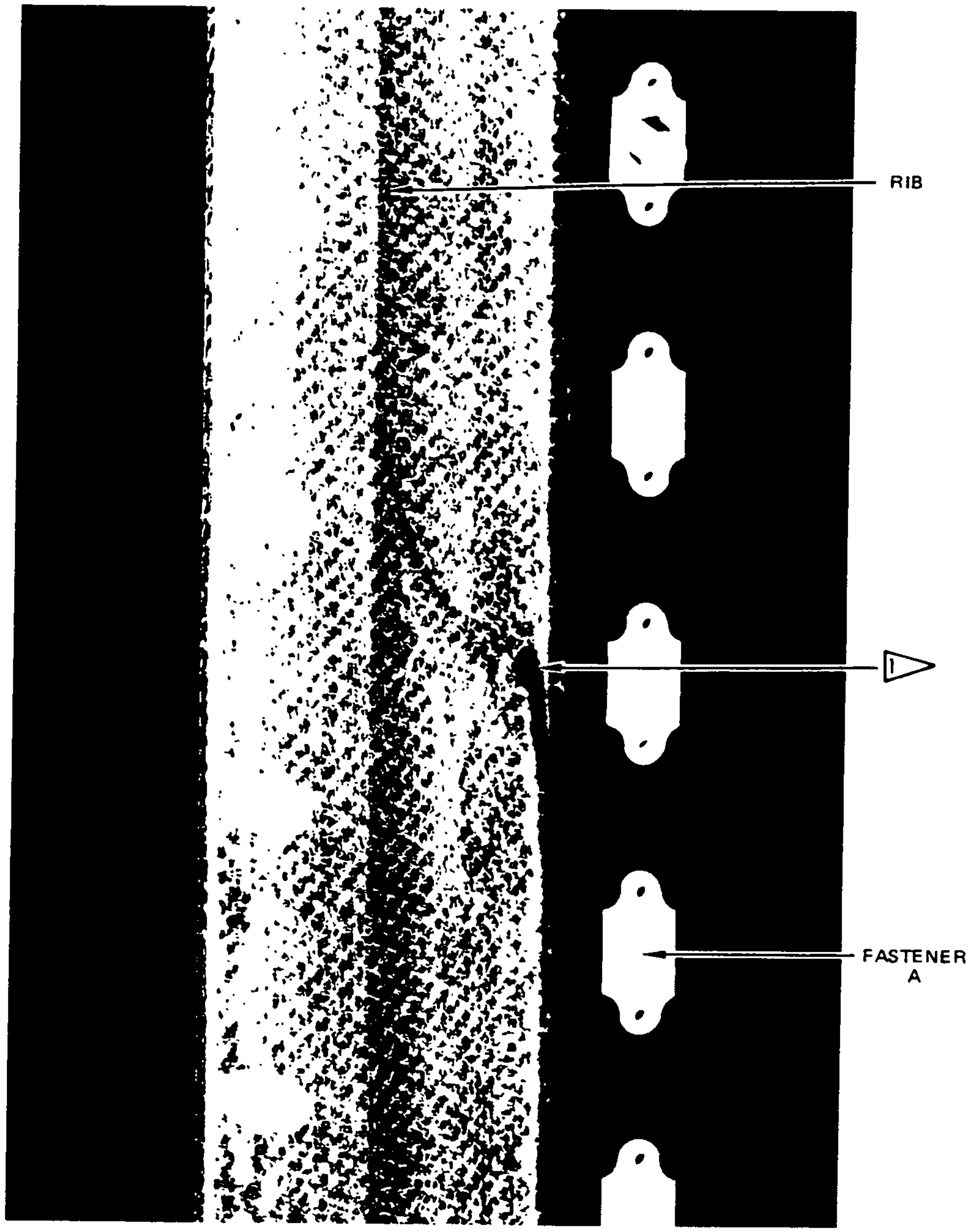


PHOTOGRAPH OF INTERNAL DAMAGE TO THE RUDDER RIB

NOTES

1 PART SEPARATION WITH A SKIN/CORE FRACTURE THAT EXTENDS THROUGH THE LAMINATE FLANGE.

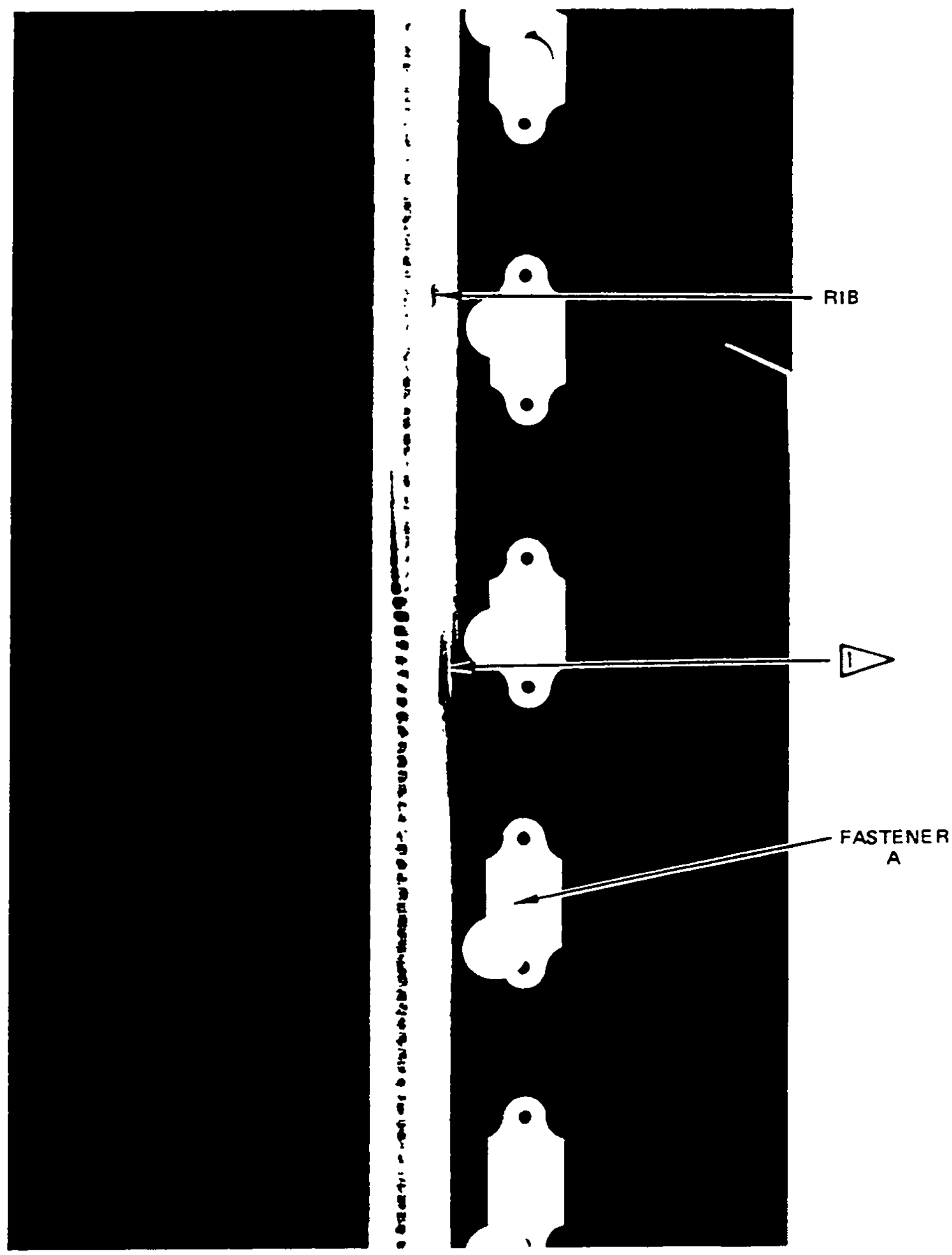
Radiographic Analysis
Figure 4 (Sheet 1)



ACTUAL RADIOGRAPH

(EXAMPLE OF A RADIOGRAPH THAT IDENTIFIES FRACTURED PARTS
WHEN THE RADIATION BEAM IS NOT PARALLEL TO THE PART)

Radiographic Analysis
Figure 4 (Sheet 2)



ACTUAL RADIOGRAPH

(EXAMPLE OF A RADIOGRAPH THAT IDENTIFIES FRACTURED PARTS
WHEN THE RADIATION BEAM IS PARALLEL TO THE PART)

Radiographic Analysis
Figure 4 (Sheet 3)

PART 2 - X-RAY

INSPECTION OF HONEYCOMB STRUCTURE

1. Purpose

   A. Use this radiography procedure to examine nonmetallic honeycomb-sandwich structures for the defects identified below:

      (1) Damage caused by lightning strike

      (2) Crushed or damaged honeycomb caused by a large impact.

   B. To examine honeycomb structures for water contamination, refer to Part 2, 51-00-01.

2. Equipment

   A. X-ray Generator - Use an X-ray generator that operates at a minimum of 20 kv and 3 ma.

   B. Film - Use ASTM Class I or II radiographic film

   C. Processor - Use a manual or an automatic processor.

3. Preparation for Inspection

   A. Get access to the inspection area.

   B. Remove the part to be examined from the airplane, if possible.

   C. Remove loose paint, dirt and sealant from the surface of the inspection area.

4. Inspection Procedure

   A. Position the X-ray generator to align the X-ray beam with the honeycomb cell walls in the inspection area.

      NOTE: Honeycomb cells are usually perpendicular to the aerodynamic surface. If there are two aerodynamic surfaces, the honeycomb cells are usually perpendicular to the surface with the largest radius.

   B. Put the film on the side of the part opposite the X-ray generator as shown in Fig. 1.

C. Set the X-ray generator controls and make an exposure to get a density of 1.8 to 2.5. Use a technique chart to help make the initial X-ray generator control adjustments.

NOTE: A technique chart is necessary for each X-ray generator. Show the exposure time necessary for different thicknesses to get the maximum results in the least time.

5. Inspection Results

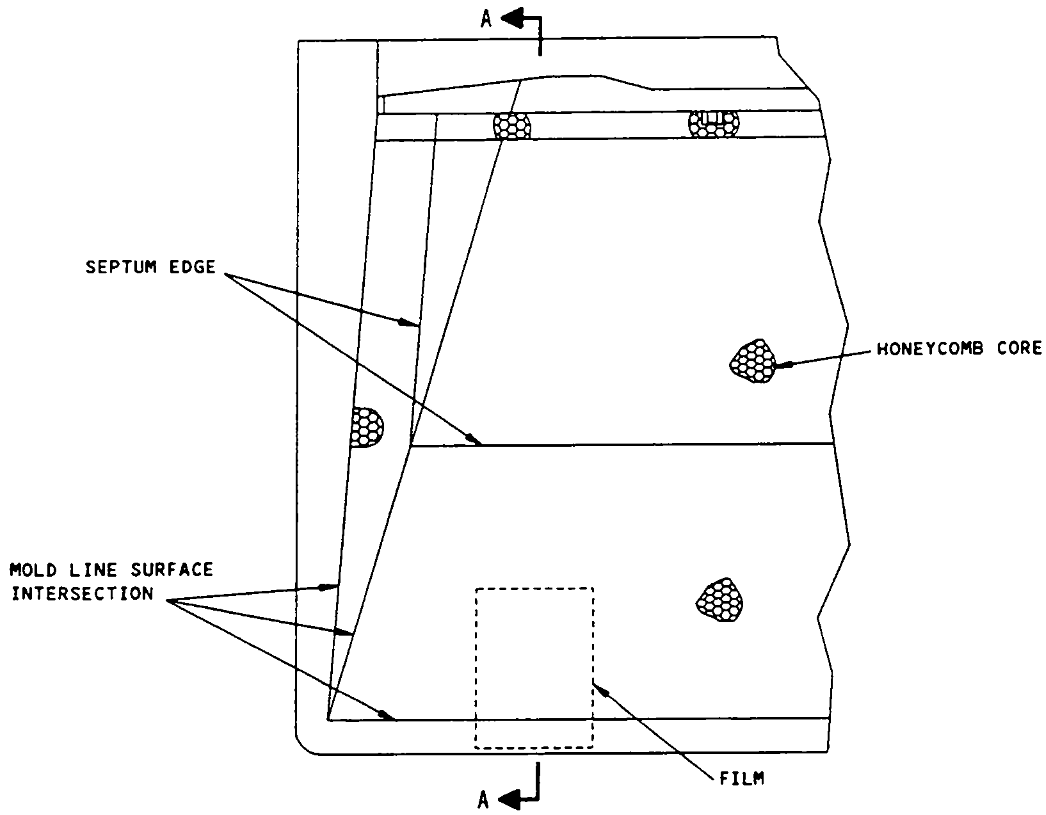
A. Lightning Strike Damage:

(1) Compare the radiograph with the damaged area to find the full quantity of lightning strike damage. See Fig. 2 for a radiograph example of an area damaged by lightning.

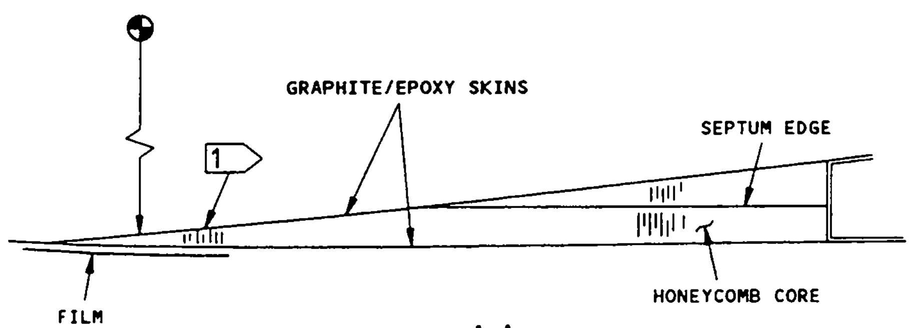
(2) Make an inspection for crushed or damaged honeycomb core and signs of cracks in the inner skin plies.

B. Large Impact Damage

(1) Make an inspection for crushed or damaged honeycomb core and signs of cracks in the inner skin plies. See Fig. 3.



GRAPHITE/EPOXY COMPOSITE SPOILER



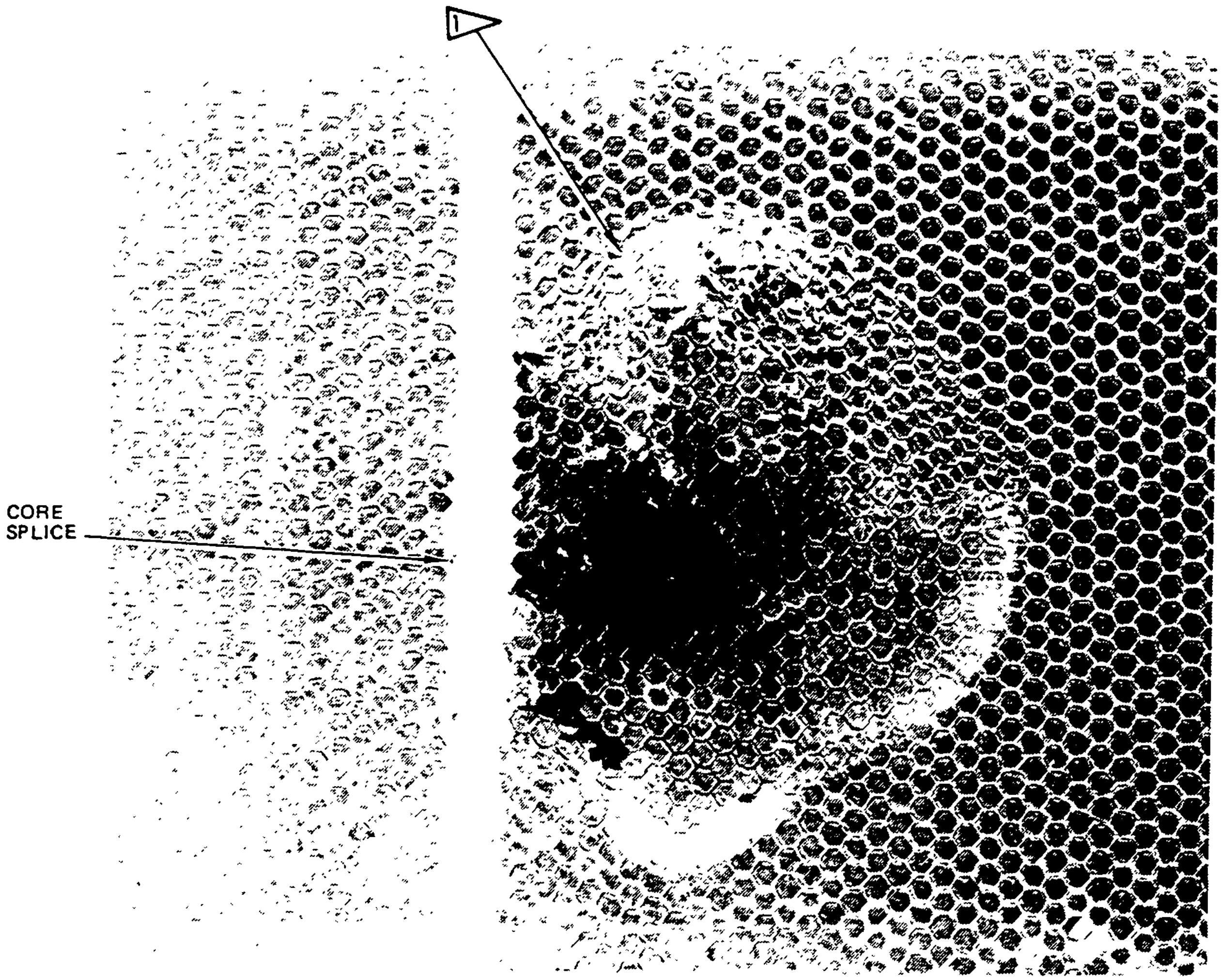
A-A
(TURNED 90°CW)

NOTES

X-RAY GENERATOR POSITION

1 ALIGN THE HONEYCOMB PART SO THAT THE CELL WALLS ARE PARALLEL TO THE RADIATION BEAM.

Typical Inspection of a Honeycomb Structure
Figure 1



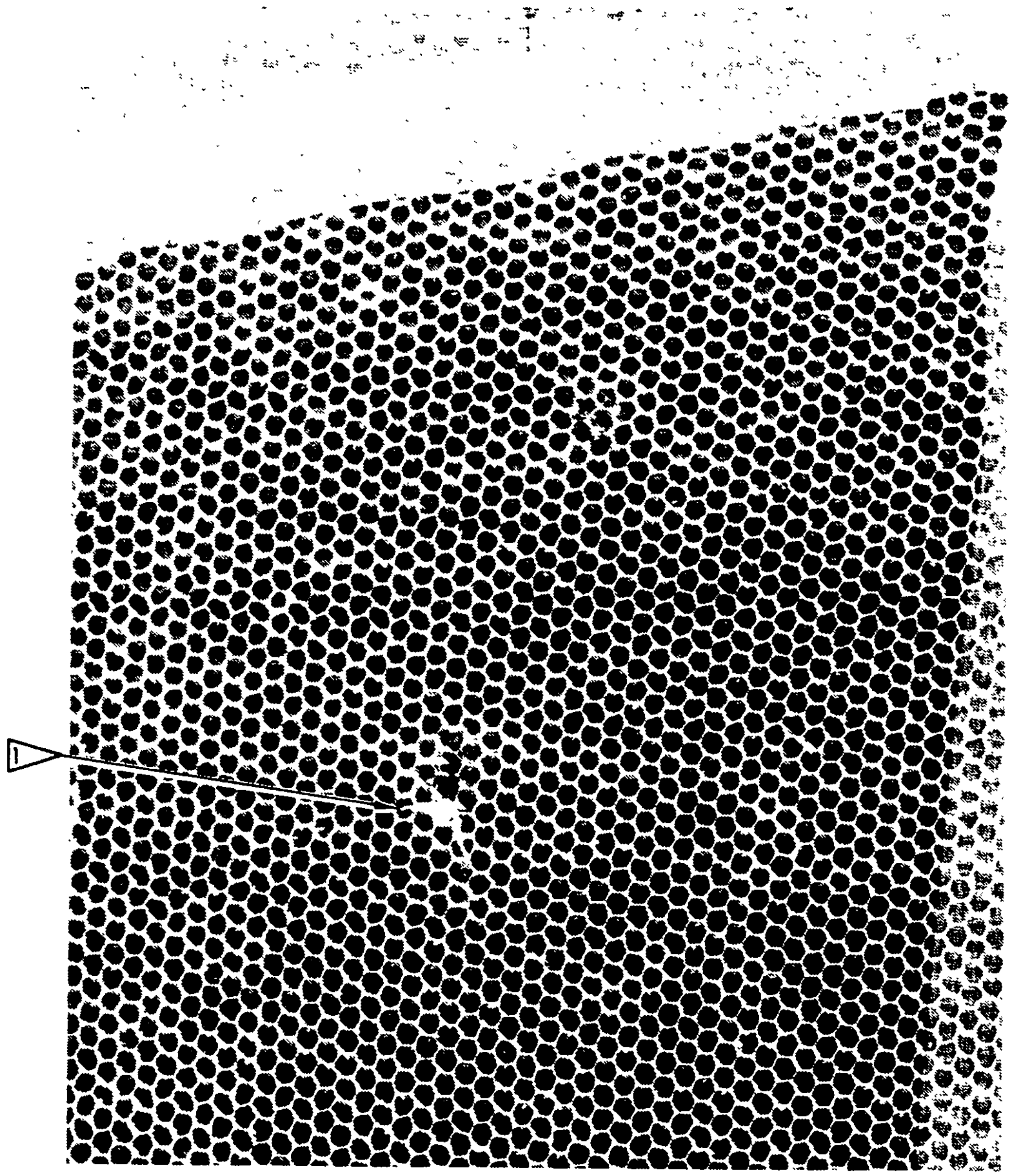
ACTUAL RADIOGRAPH

NOTES

- EXAMPLE RADIOGRAPH OF A HONEYCOMB PANEL WITH LIGHTNING DAMAGE.

1 DAMAGED HONEYCOMB CORE

Lightning Strike Damage
Figure 2



ACTUAL RADIOGRAPH

NOTES

- EXAMPLE RADIOGRAPH OF A HONEYCOMB PANEL WITH LARGE IMPACT DAMAGE.

[1] IMPACT DAMAGE

Impact Damage
Figure 3