X-RAY INSPECTION FOR WATER IN HONEYCOMB STRUCTURE

1. Purpose

A. To detect water in honeycombed structures using radiography.

NOTE: This procedure will detect the presence of water in honeycombed structures fabricated with any combination of metallic and/or nonmetallic honeycomb cores and skins.

B. Part 9, 51-00-01 and Part 9, 51-00-02 can be used as alternative procedures on nonmetallic 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 - An X-ray generator capable of operating in the range from 30 to 100 KV may be used.

B. Film - Any wide-range radiographic film is acceptable. ASTM Class II radiographic film was used to develop this procedure.

C. Processor - Manual or automatic processor may be used.

3. Preparation for Inspection

A. Extend control surface or remove honeycombed panel if necessary to provide unobstructed access for radiographic exposure. See Figure 1.

4. Inspection Procedure

A. Position X-ray generator perpendicular to the surface of the honeycombed panel at the area being inspected. Expose from lower side for control surfaces and flaps. See Figure 1 for typical orientation of X-ray tube head and inspection member.

B. Place film on upper side of control surface, or side of part opposite X-ray tube head, covering area suspected of containing water. See Figure 1, flagnotes 3 and 4.

NOTE: Approximately 70 inches (177 cm) can be inspected per exposure at a source-to-film distance (SFD) of 120 inches (305 cm).

C. Set X-ray generator controls using Table 1 as a guide. Expose film to obtain a cell density of 2.0 to 3.0.

D. Repeat above procedure as required for all suspected water-contaminated honeycomb areas.

5. Inspection Results

A. Interpretations of radiographs of water-contaminated honeycomb is dependent upon: the number of cells containing water; the volume of water per cell; the thickness of the honeycomb core; and the orientation of the X-ray beam to the honeycomb cell walls. Water is detectable when honeycomb core cell walls are aligned within 45 degrees of being parallel to the impinging radiation.

B. Honeycombed structures may contain areas of uneven adhesive accumulation as a by-product of the manufacturing process. The appearance of adhesive accumulations on radiographs is not cause for rejection. Radiographic images of adhesive accumulations can be misinterpreted as water when the honeycomb cell wall orientation with respect to the X-ray beam prevents individual cells from being recognized (Figure 2). Discrimination of water in honeycomb from adhesive accumulations is best accomplished when the cell walls are aligned parallel to the radiation beam. Water images usually have a constant film density in any particular cell when radiographed in this manner. Adhesive images can vary in film density within a cell and show indications of porosity. See Figure 3.

NOTE: Three to five times magnification will aid identification of adhesive porosity.

C. Water contamination usually involves several adjacent cells, whereas evidence of adhesive accumulations gives the appearance of significant amounts of water scattered randomly. Also, the appearance of adhesive images on radiographs does not vary significantly between radiographs with different X-ray beam-to-cell wall orientations. The presence of such accumulations is confirmed when no change in the appearance of the suspect images occurs on repeat inspections with different X-ray beam-to-cell wall orientations.

D. Small amounts of water may be difficult to detect. Baseline radiographs should be established for comparison when performing repeat inspections for small amounts of water in honeycomb.

E. Closely interpret radiographs for water at all areas with visible damage.

Table 1 X-Ray Generator and Film Parameters

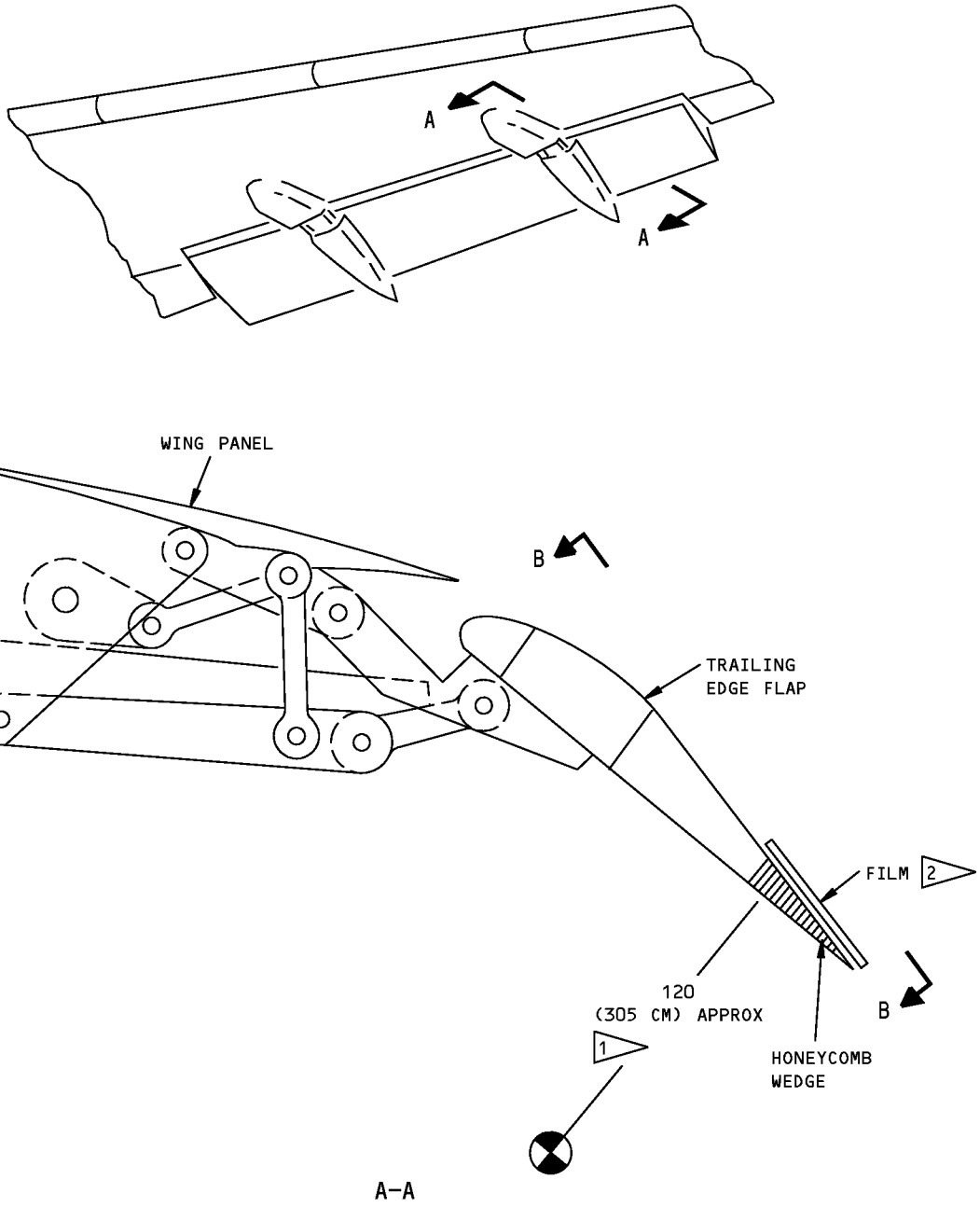
X-RAY PARAMETER						
	FILM				GENERATOR SETTINGS	
EXPOSURE NUMBER	POSITION	ASTM CLASS	SIZE	SFD	KV	MAS
*[1]	*[2]	II *[3]	14 X 17	120 (305 CM)	30-100	*[4]

*[1] USE AS MANY EXPOSURES AS NECESSARY TO INSPECT THE AREA OF INTEREST. SEE Figure 1 FOR TYPICAL X-RAY GENERATOR POSITION

*[2] AS MANY AS FIVE FILMS OF THE SIZE SPECIFIED MAY BE USED WHEN USING THE TYPICAL X-RAY SETUP SHOWN IN Figure 1

*[3] THIS FILM WAS USED TO DEVELOP THIS PROCEDURE. A WIDE RANGE OF FILM TYPES ARE ACCEPTABLE FOR RADIOGRAPHIC DETECTION OF WATER IN HONEYCOMB

*[4] MAS IS SELECTED TO OBTAIN A FILM DENSITY OF FROM 2.0 TO 3.0 AS MEASURED WITHIN A CELL



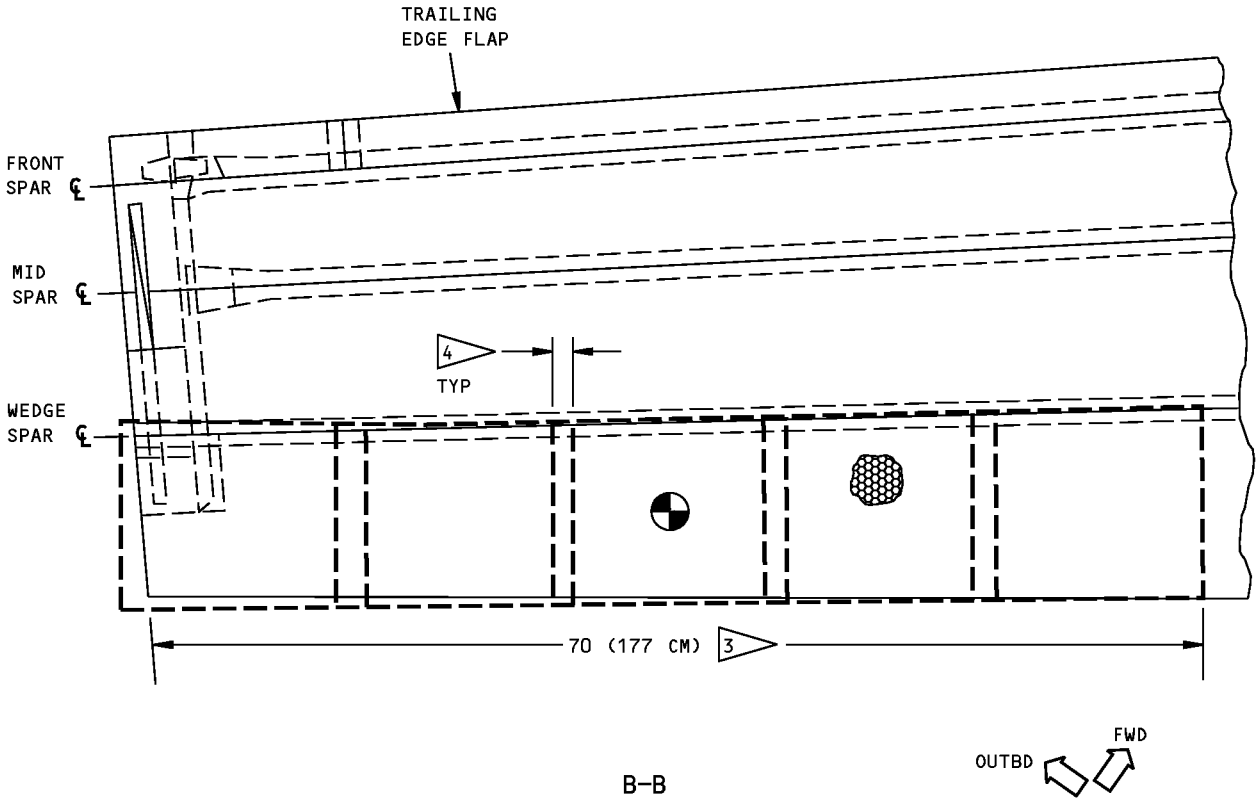
NOTES

- ALL DIMENSIONS ARE IN INCHES (CENTIMETERS IN PARENTHESES)

1 ALIGN X-RAY TUBE HEAD SO THAT RADIATION BEAM IS PERPENDICULAR TO FLAP LOWER SURFACE AT APPOX 120 (305 CM) SFD

2 PLACE FILM ON FLAP UPPER SURFACE COVERING FLAP TRAILING EDGE WEDGE HONEYCOMB STRUCTURE

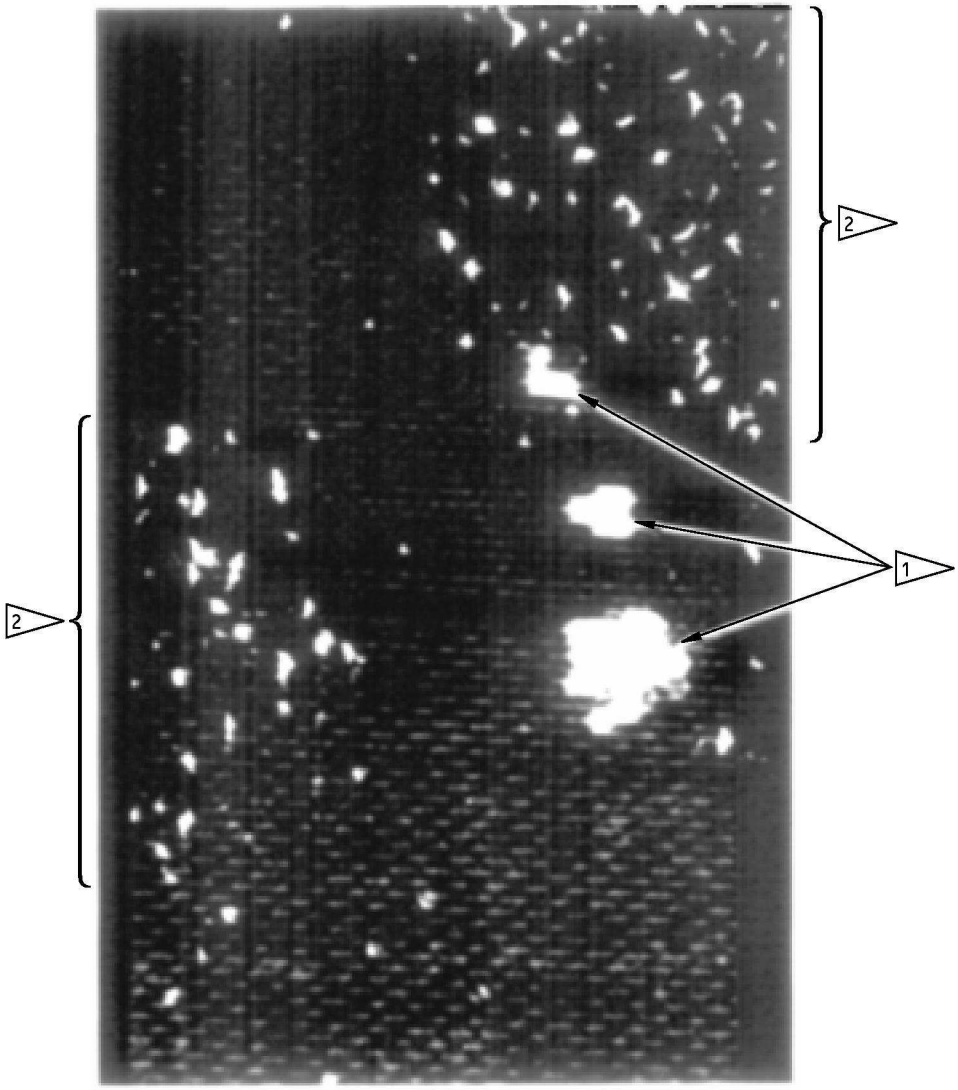
Typical X-Ray Setup to Detect Water in Honeycomb Structure
Figure 1 (Sheet 1 of 2)



NOTES

- ALL DIMENSIONS ARE IN INCHES (CENTIMETERS IN PARENTHESES)
- AIM X-RAY GENERATOR AT CENTER OF FILM COVERAGE
- 3 APPROX 70 (177 CM) OF FLAP TRAILING EDGE WEDGE COVERAGE PER EXPOSURE
- 4 OVERLAP FILM 2.0 (5.0 CM) TO ENSURE COVERAGE IN EXPOSURE AREA

Typical X-Ray Setup to Detect Water in Honeycomb Structure
Figure 1 (Sheet 2 of 2)



ACTUAL RADIOGRAPH

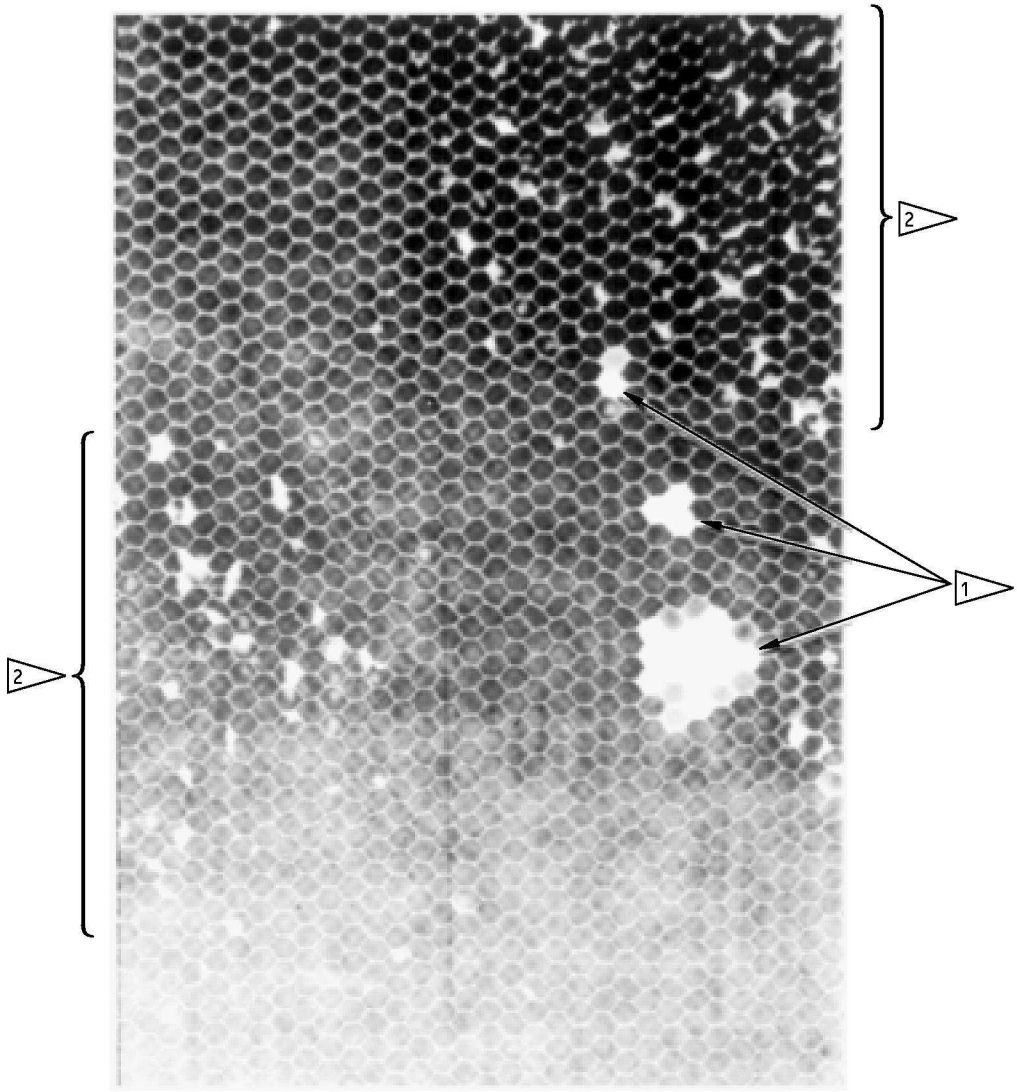
NOTES

- TYPICAL RADIOGRAPH INTERPRETATION FOR WATER CONTAMINATION WHEN RADIATION BEAM IS NOT PARALLEL TO HONEYCOMB CELL WALLS

1 HONEYCOMB CELLS CONTAINING VARIOUS AMOUNTS OF WATER

2 AREAS SHOWING UNEVEN ADHESIVE ACCUMULATION

Radiographic Identification of Water and Adhesive in Honeycomb Structure
Figure 2



ACTUAL RADIOGRAPH

NOTES

- TYPICAL RADIOGRAPH INTERPRETATION FOR WATER CONTAMINATION WHEN RADIATION BEAM IS PARALLEL TO HONEYCOMB CELL WALLS

1 HONEYCOMB CELLS CONTAINING VARIOUS AMOUNTS OF WATER

2 AREAS SHOWING UNEVEN ADHESIVE ACCUMULATION

Radiographic Identification of Water and Adhesive in Honeycomb Structure
Figure 3

SUBSURFACE FRACTURE IN COMPOSITE STRUCTURE

1. Purpose

A. To detect broken structure or large subsurface fractures when there is some displacement of members in graphite-epoxy composite structures using radiographic inspection.

NOTE: Extensive fractures in which member displacement has not occurred might not be detectable.

2. Equipment

A. Generator - Any X-ray generator capable of operating at a minimum of 20 kilovolt (kv) and 3 milliamp (ma).

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

C. Processor - Manual or automatic.

3. Preparation

A. Identify inspection area and wipe surface clean.

4. Inspection Procedure

A. Place film on side of part nearest flange of structural member being inspected (Figure 1).

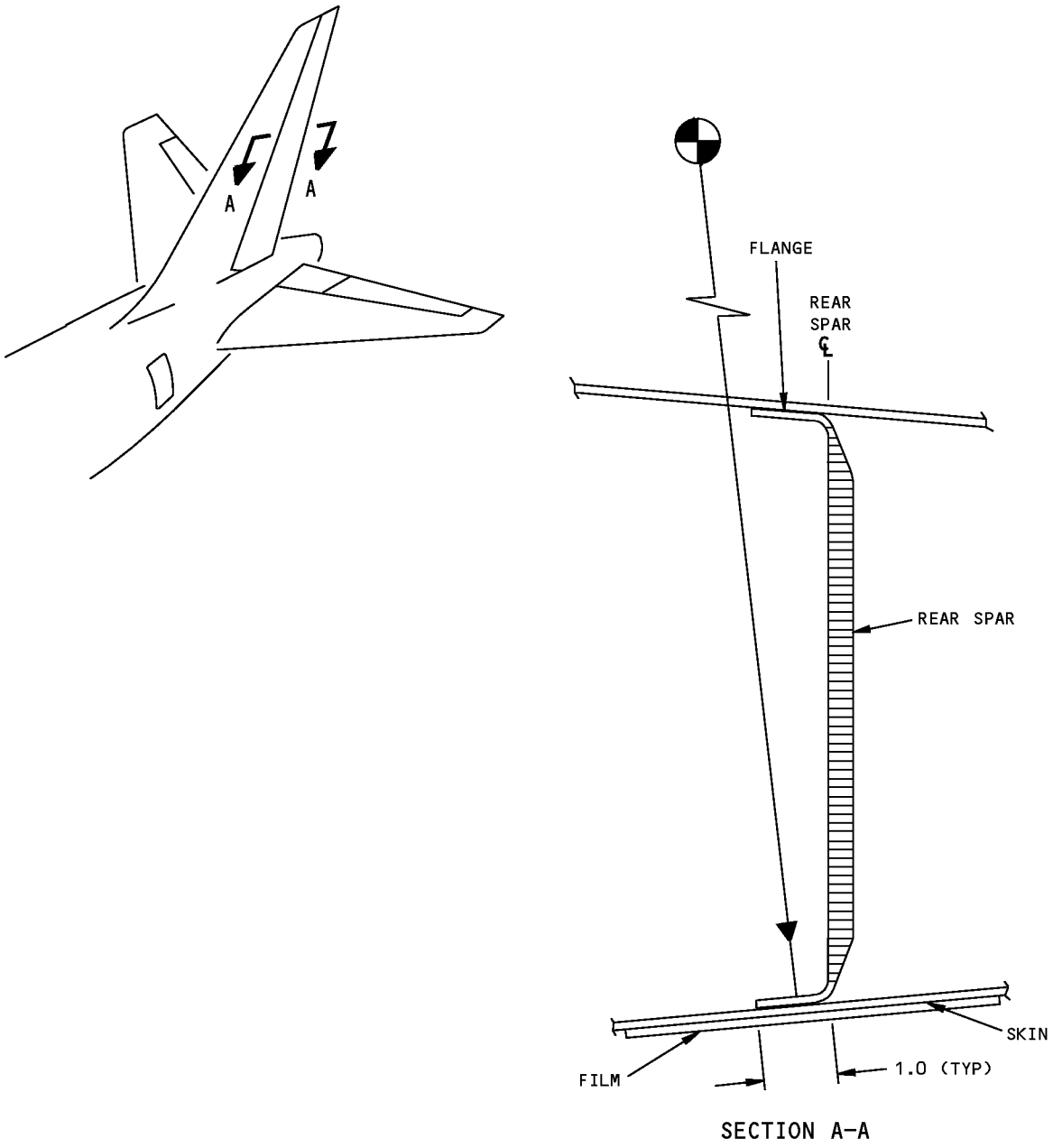
B. Position X-ray generator focal spot on opposite side of part and offset from any centerlines of structural member suspected of being fractured (Figure 1).

C. Set X-ray generator controls and make exposure to obtain a density of 1.8-2.5. Use technique chart to obtain initial X-ray generator control setting.

NOTE: Construct a technique chart for each unit showing exposure time required for various thicknesses to obtain maximum results with the least amount of lost time.

5. Inspection Results

A. Interpretation of radiographs for broken members or large subsurface fractures in graphite-epoxy composite structure is similar to crack detection in metallic structures (Figure 2, Figure 3, and Figure 4).



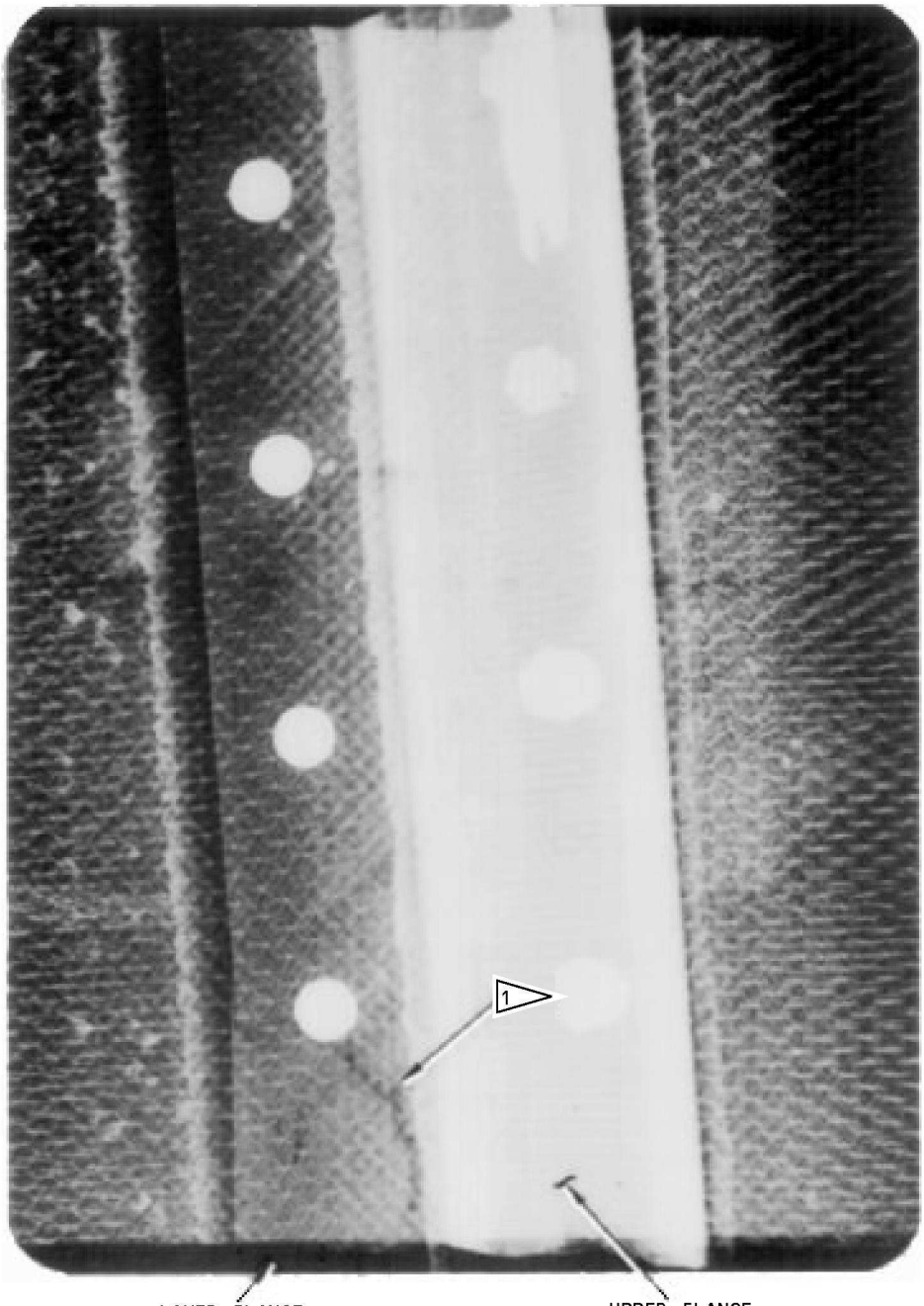
GRAPHITE/EPOXY RUDDER REAR SPAR

NOTES

- ALL DIMENSIONS ARE IN INCHES

X-RAY GENERATOR POSITION - POSITION FOCAL SPOT OFFSET FROM SPAR CENTERLINE TO PREVENT SUPERIMPOSING SPAR FLANGES ON RADIOGRAPH

Typical Inspection of Internal Structure
Figure 1



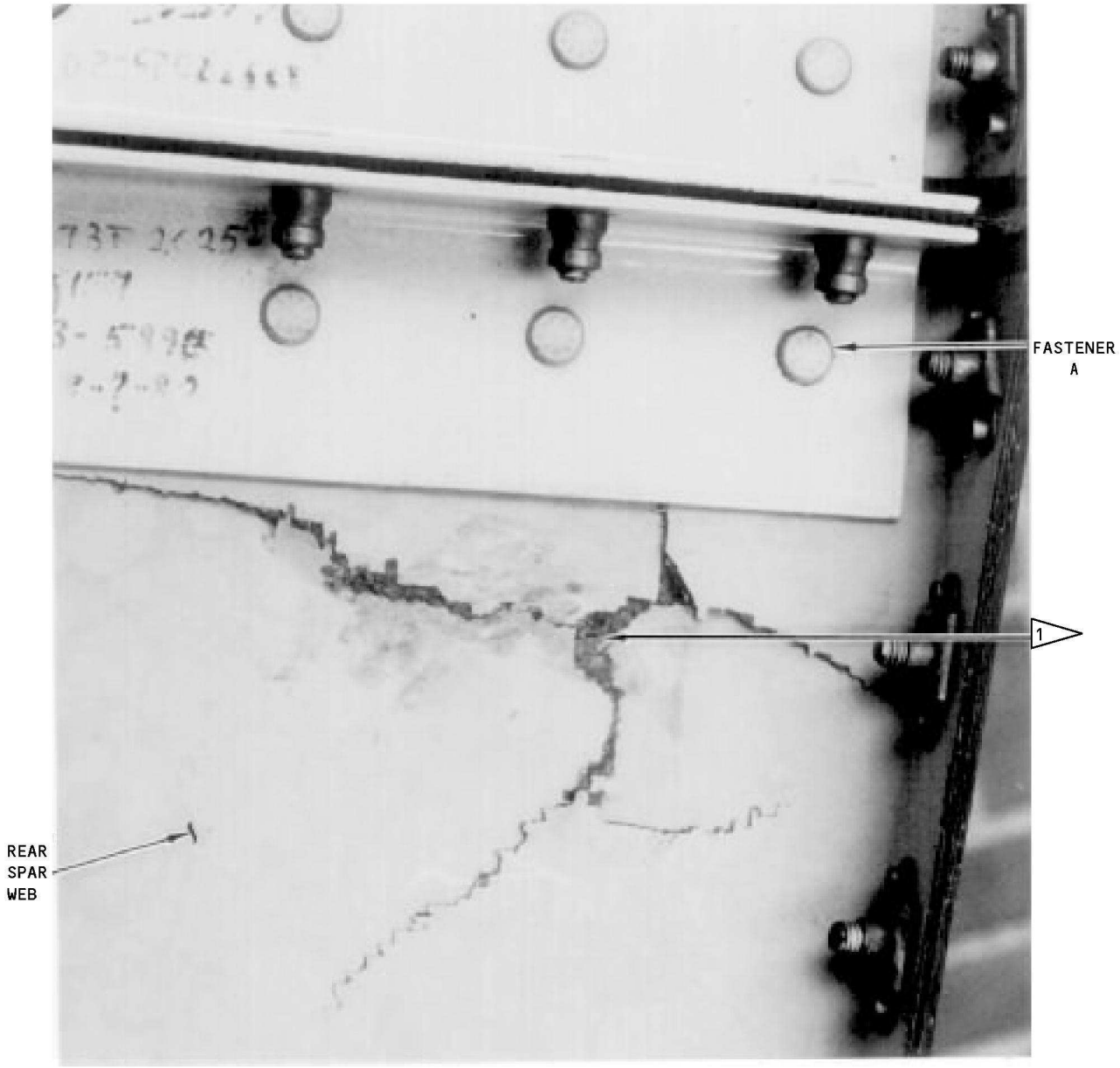
ACTUAL RADIOGRAPH

NOTES

- TYPICAL RADIOGRAPH INTERPRETATION FOR BROKEN MEMBERS OR LARGE SUBSURFACE FRACTURES

1 LARGE SURFACE FRACTURE WITH SOME FLANGE DISPLACEMENT

Radiograph Interpretation
Figure 2

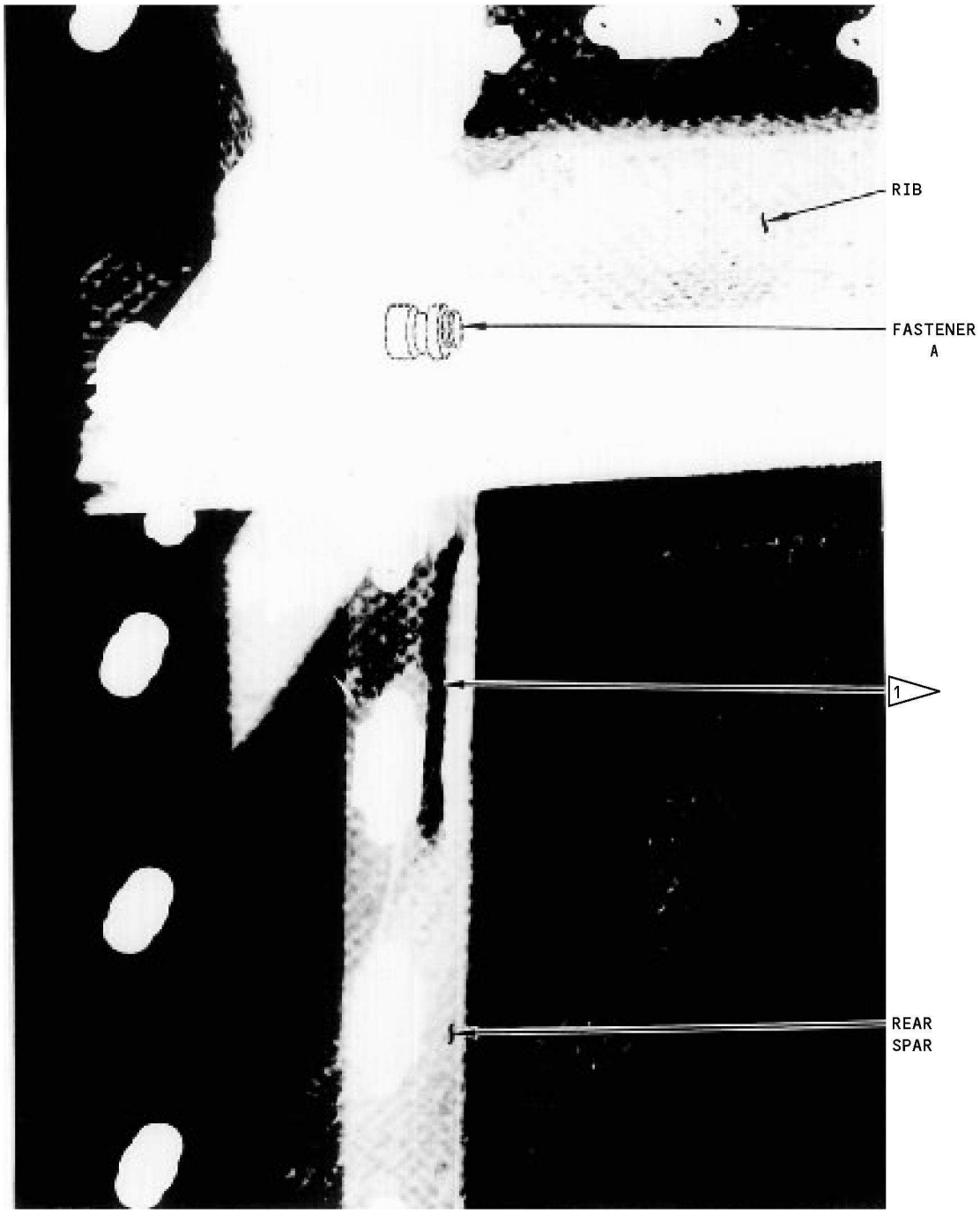


PHOTOGRAPH OF INTERNAL DAMAGE TO RUDDER REAR SPAR

NOTE

1 LARGE SKIN/CORE FRACTURE WITH MEMBER DISPLACEMENT

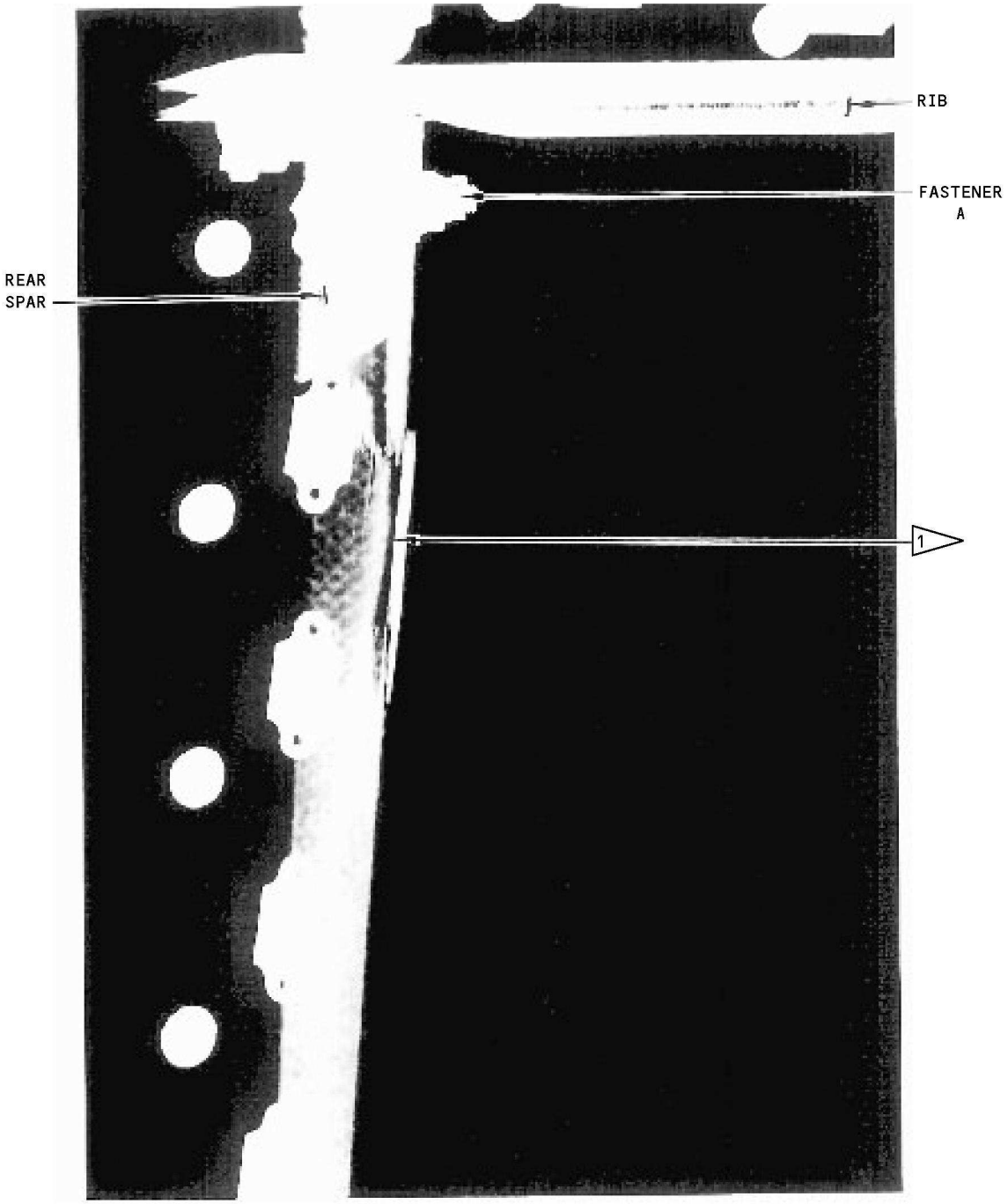
Radiographic Interpretation
Figure 3 (Sheet 1 of 3)



ACTUAL RADIOGRAPH

TYPICAL RADIOGRAPH INTERPRETATION FOR BROKEN MEMBERS
WHEN RADIATION BEAM IS NOT PARALLEL TO MEMBER

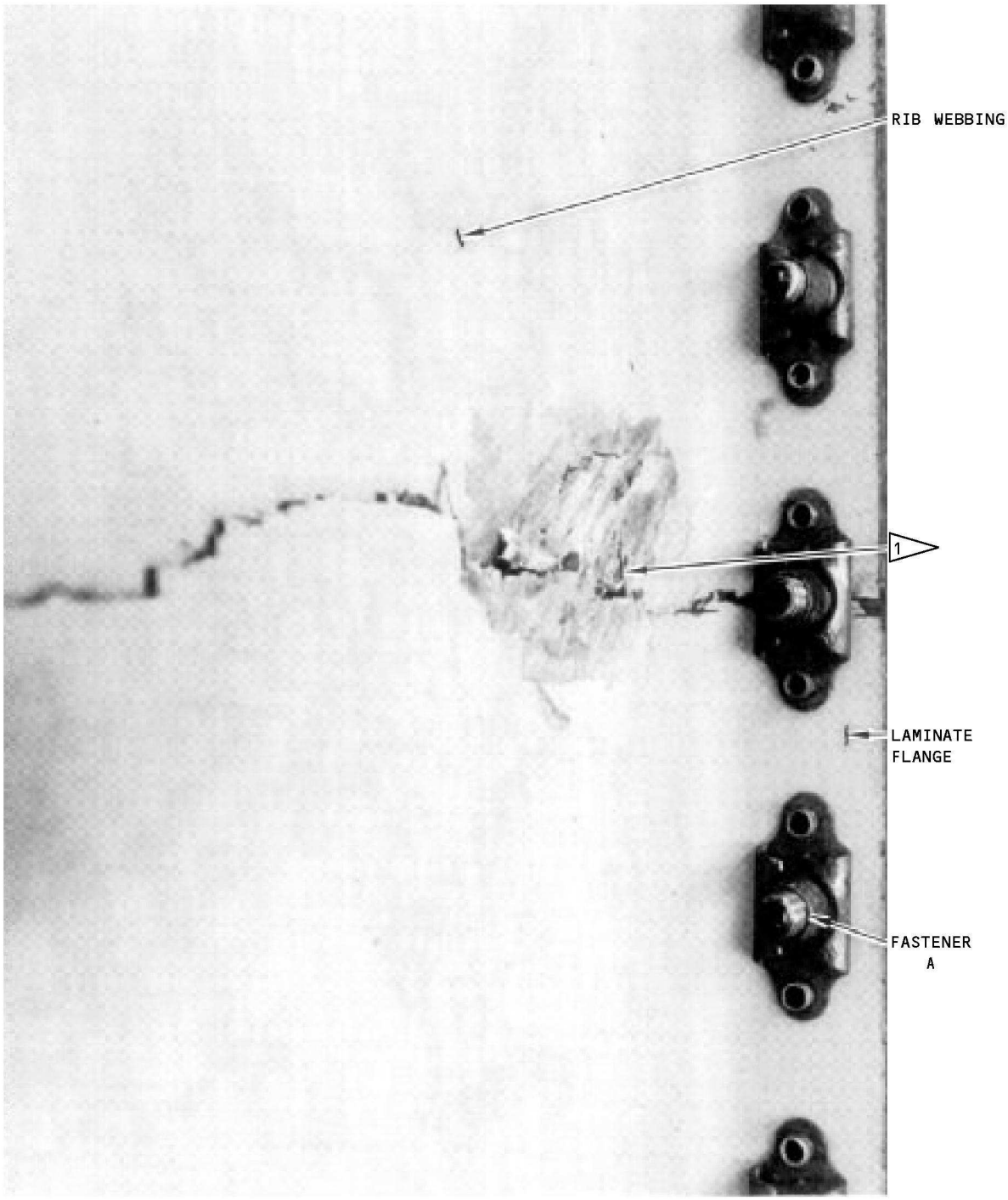
Radiographic Interpretation
Figure 3 (Sheet 2 of 3)



ACTUAL RADIOGRAPH

TYPICAL RADIOGRAPH INTERPRETATION FOR BROKEN MEMBERS
WHEN RADIATION BEAM IS NOT PARALLEL TO MEMBER

Radiographic Interpretation
Figure 3 (Sheet 3 of 3)

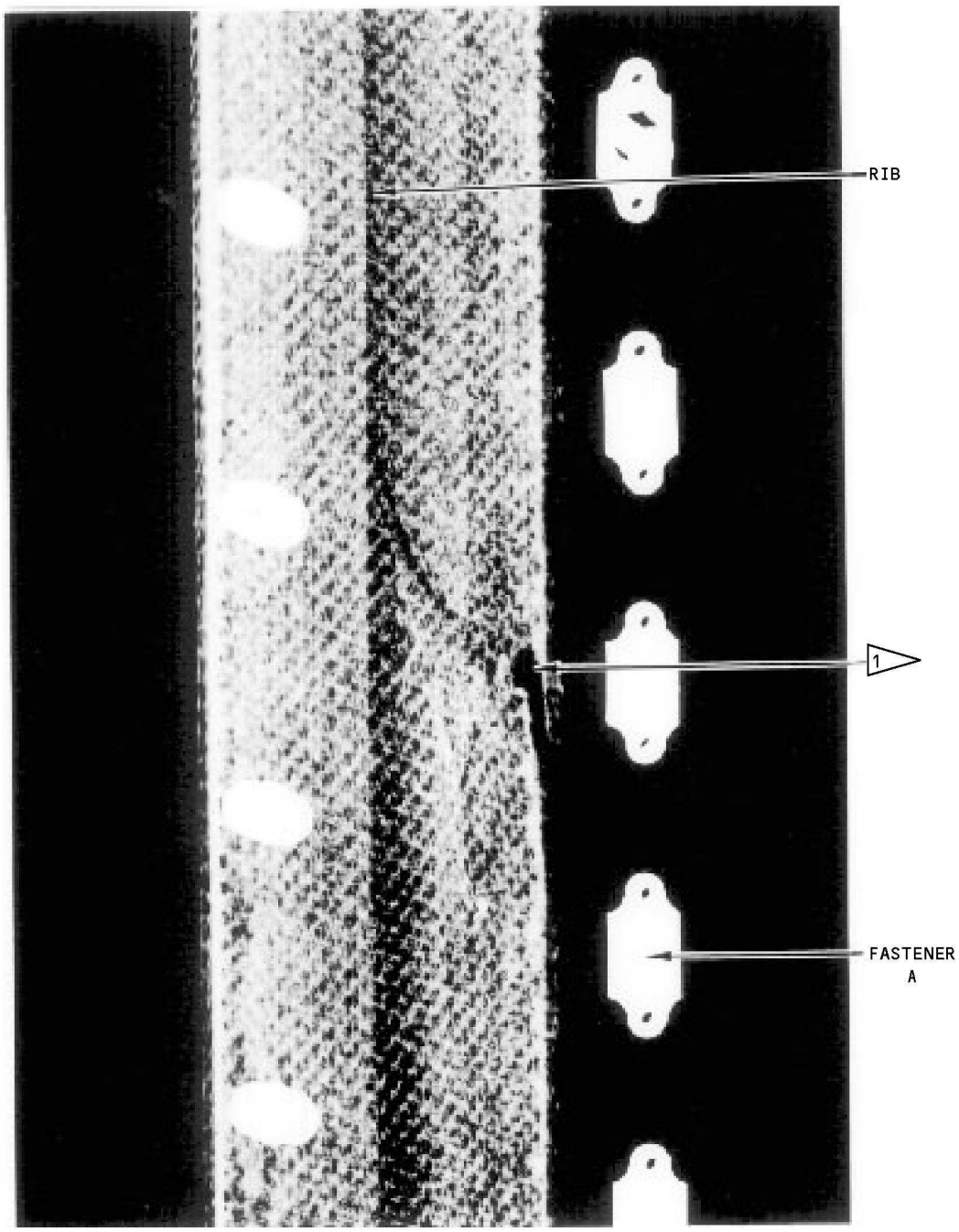


PHOTOGRAPH OF INTERNAL DAMAGE TO RUDDER RIB

NOTE

1 MEMBER DISPLACEMENT WITH SKIN/CORE FRACTURE EXTENDING THROUGH LAMINATE FLANGE

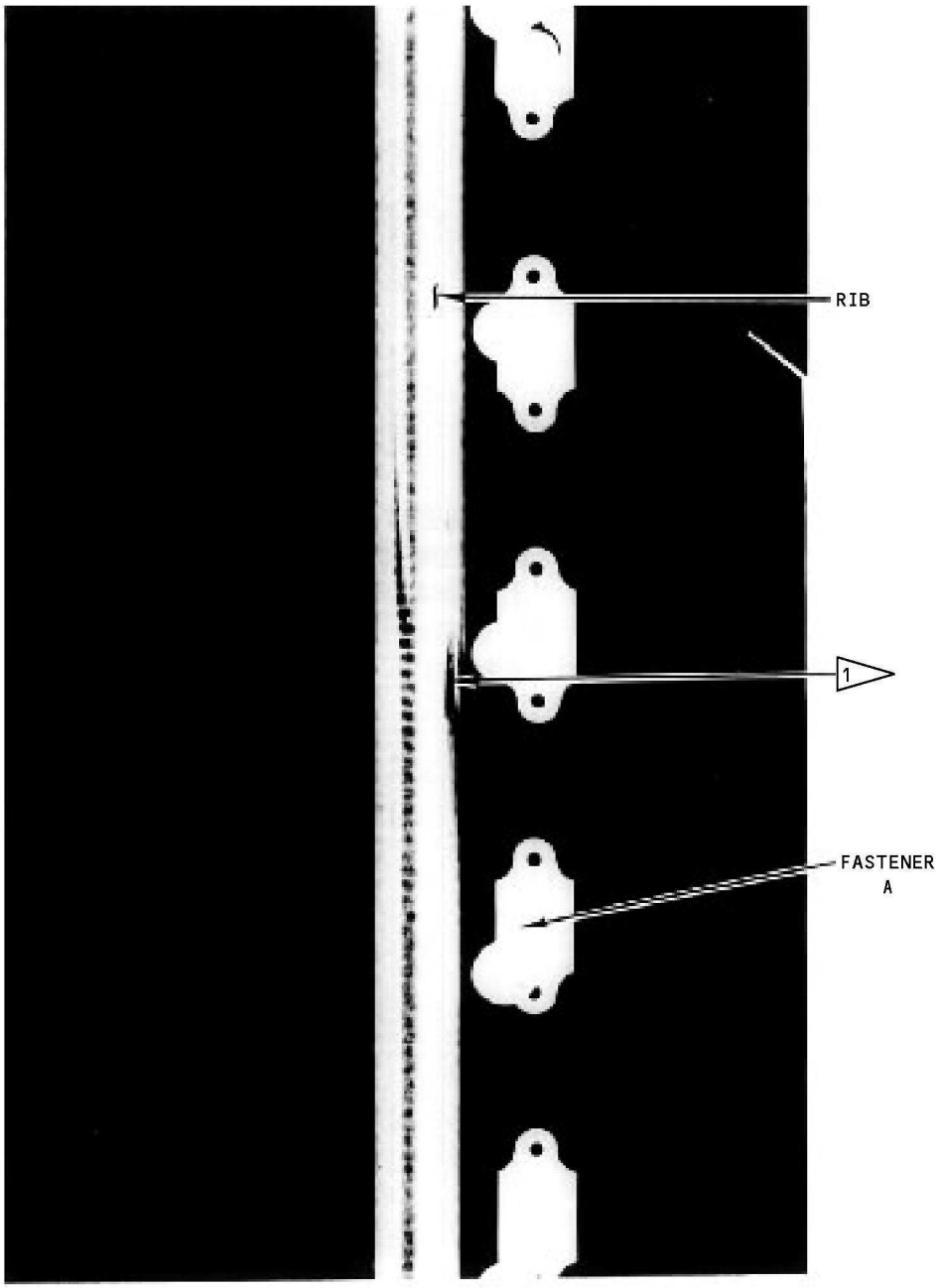
Radiographic Interpretation
Figure 4 (Sheet 1 of 3)



ACTUAL RADIOGRAPH

TYPICAL RADIOGRAPH INTERPRETATION FOR BROKEN MEMBERS
WHEN RADIATION BEAM IS NOT PARALLEL TO MEMBER

Radiographic Interpretation
Figure 4 (Sheet 2 of 3)



ACTUAL RADIOGRAPH

TYPICAL RADIOGRAPH INTERPRETATION FOR BROKEN MEMBERS
WHEN RADIATION BEAM IS NOT PARALLEL TO MEMBER

Radiographic Interpretation
Figure 4 (Sheet 3 of 3)

INSPECTION OF HONEYCOMB STRUCTURE

1. Purpose

A. To detect the following defects in nonmetallic honeycomb-sandwich structures using X-ray:

NOTE: For inspection of honeycombed structures for water contamination, refer to Part 2, 51-00-01.

(1) Damage caused by lightning strike.

(2) Crushed or distorted honeycomb caused by severe impact.

2. Equipment

A. Generator - Any X-ray generator capable of operating at 20 kilovolt (kv) and 3 milliamp (ma) minimum.

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

C. Processor - Manual or automatic.

3. Preparation

A. Remove part to be inspected from airplane if practical.

B. Identify inspection area and wipe surfaces clean.

4. Inspection Procedure

A. Position X-ray generator such that X-ray beam is aligned with honeycomb cell walls in area of interest (see Figure 1).

NOTE: Honeycomb cells are typically oriented perpendicular to an outward-facing aerodynamic surface, or perpendicular to the surface of least curvature in the case with two exposed aerodynamic surfaces.

B. Place film on side of part opposite X-ray generator (see Figure 1).

C. Set X-ray generator controls and make exposure to obtain a density of 1.8-2.5. Use technique chart for initial X-ray generator controls setting.

NOTE: Construct a technique chart for each X-ray generator showing required exposure time for various thicknesses to obtain maximum results with the least amount of lost time.

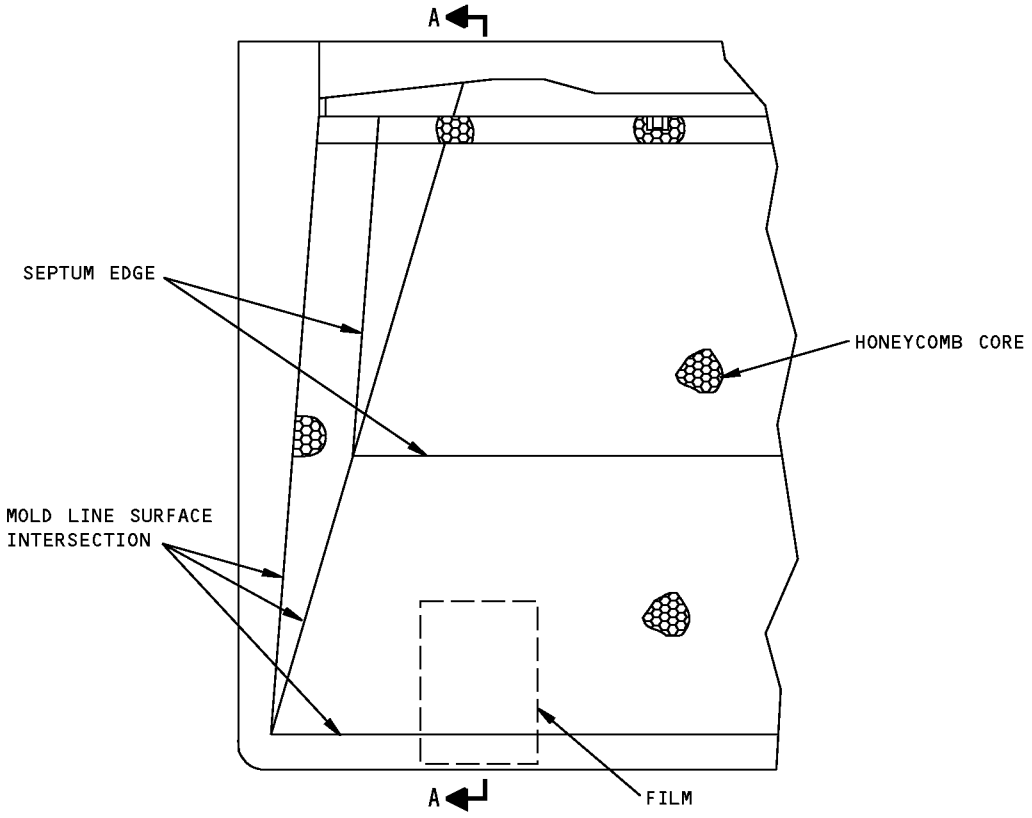
5. Inspection Results

A. Lightning Strike Damage

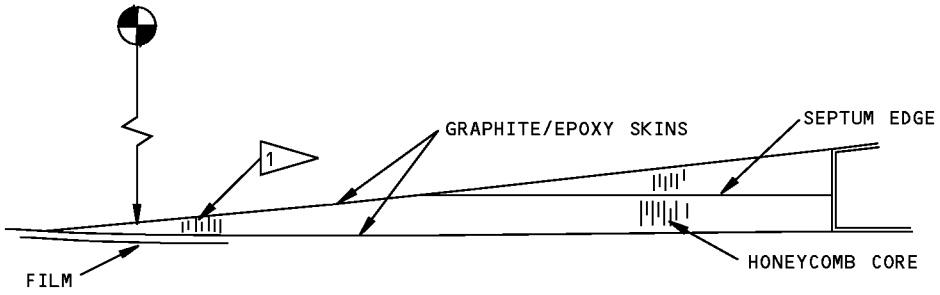
(1) Compare radiograph with damaged area to determine full extent of lightning strike damage. Inspect for crushed or distorted honeycomb core and signs of cracking in the innermost skin plies (see Figure 2).

B. Severe Impact Damage

(1) Inspect for crushed or distorted honeycomb core and signs of cracking in the innermost skin plies (see Figure 3).



GRAPHITE/EPOXY COMPOSITE SPOILER



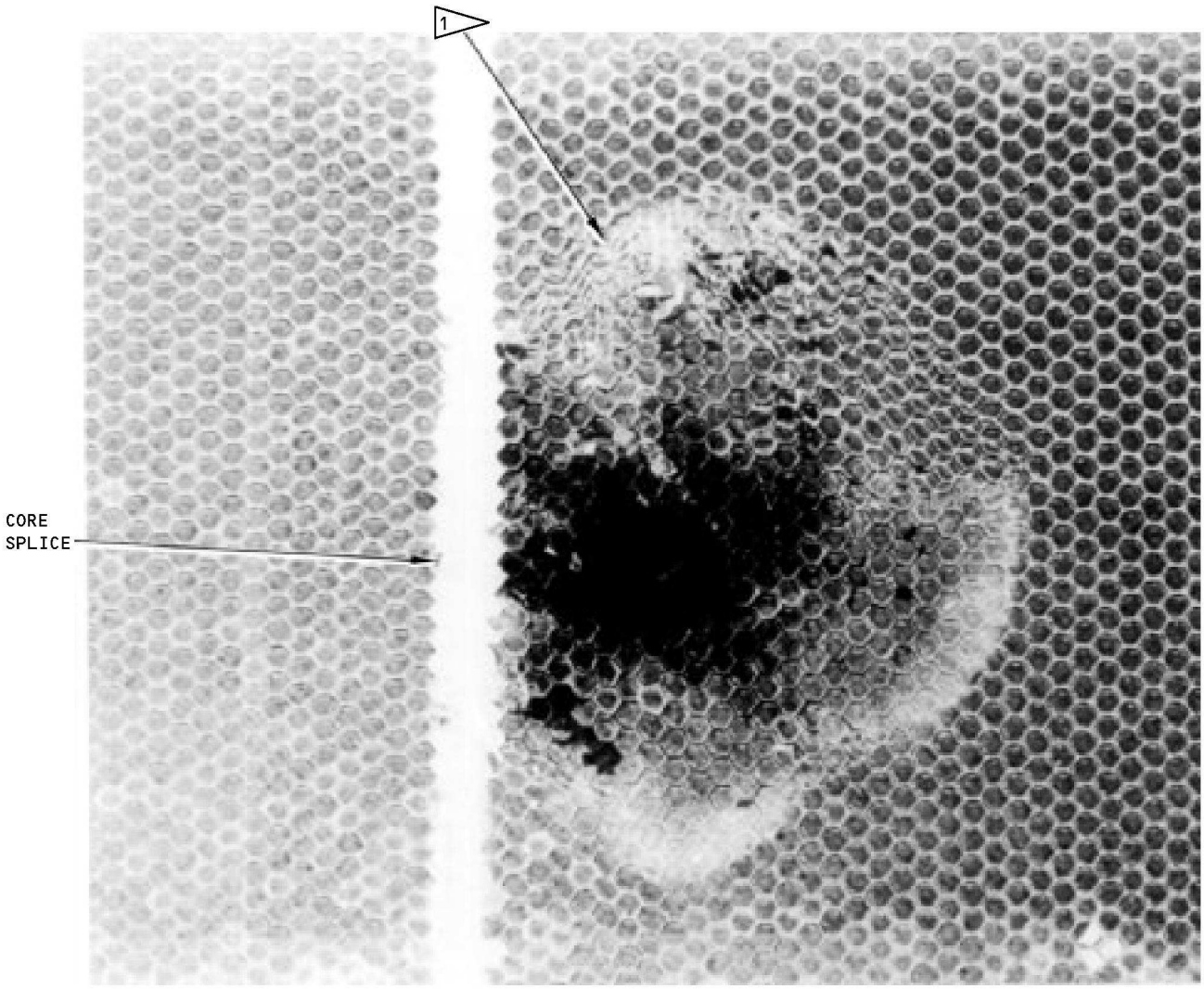
SECTION A-A
(ROTATED 90°CW)

NOTES

X-RAY GENERATOR POSITION

1 ALIGN HONEYCOMB CORE CELL WALLS PARALLEL TO RADIATION BEAM

Typical Inspection of Honeycomb Structure
Figure 1



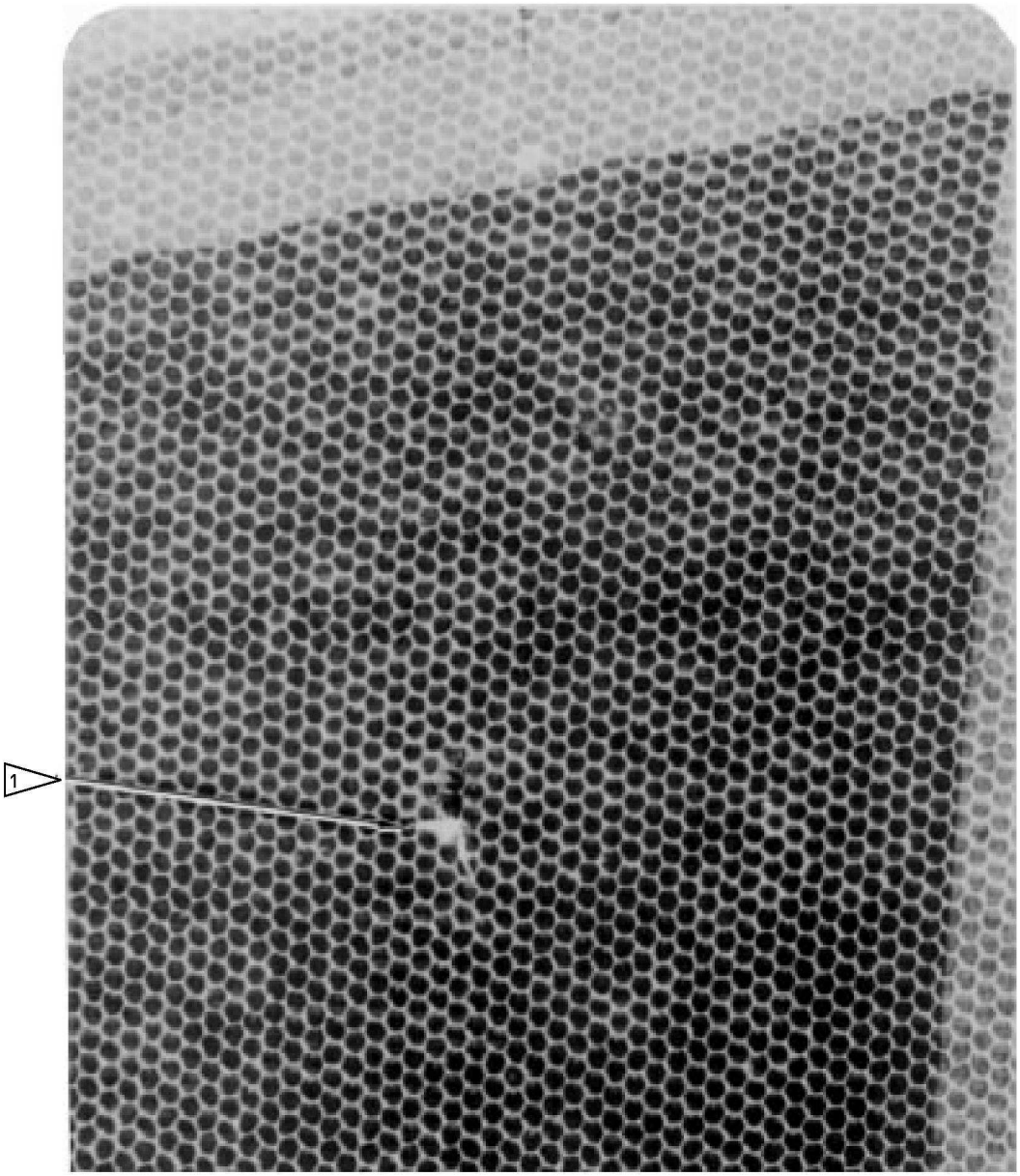
ACTUAL RADIOGRAPH

NOTES

- TYPICAL RADIOGRAPH OF HONEYCOMB PANEL WITH LIGHTNING DAMAGE

1 INSPECT FOR CRUSHED OR DISTORTED CORE AND CRACKS NOT VISIBLE IN SKIN

Lightning Strike Damage
Figure 2



ACTUAL RADIOGRAPH

NOTES

- TYPICAL RADIOGRAPH OF HONEYCOMB PANEL WITH SEVERE IMPACT DAMAGE

1 INSPECT FOR CRUSHED OR DISTORTED HONEYCOMB CORE AND CRACKS NOT VISIBLE IN SKIN

Impact Damage
Figure 3