



Use of X-Ray for 717 Wing XRS 164, Lower AFT Skin Cracks

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717 XRS 164, Lower AFT Skin Cracks

Background

This presentation summarizes the development effort between Boeing and Delta the use of x-ray inspection for cracks found at Wing Station 164 on the 717. The B717 fleet has seen an increase in cracking along the wing rear spar, in multiple locations (skin, doubler, ribs, spar cap). Not only was this a structural concern, but fuel leaks also often resulted.

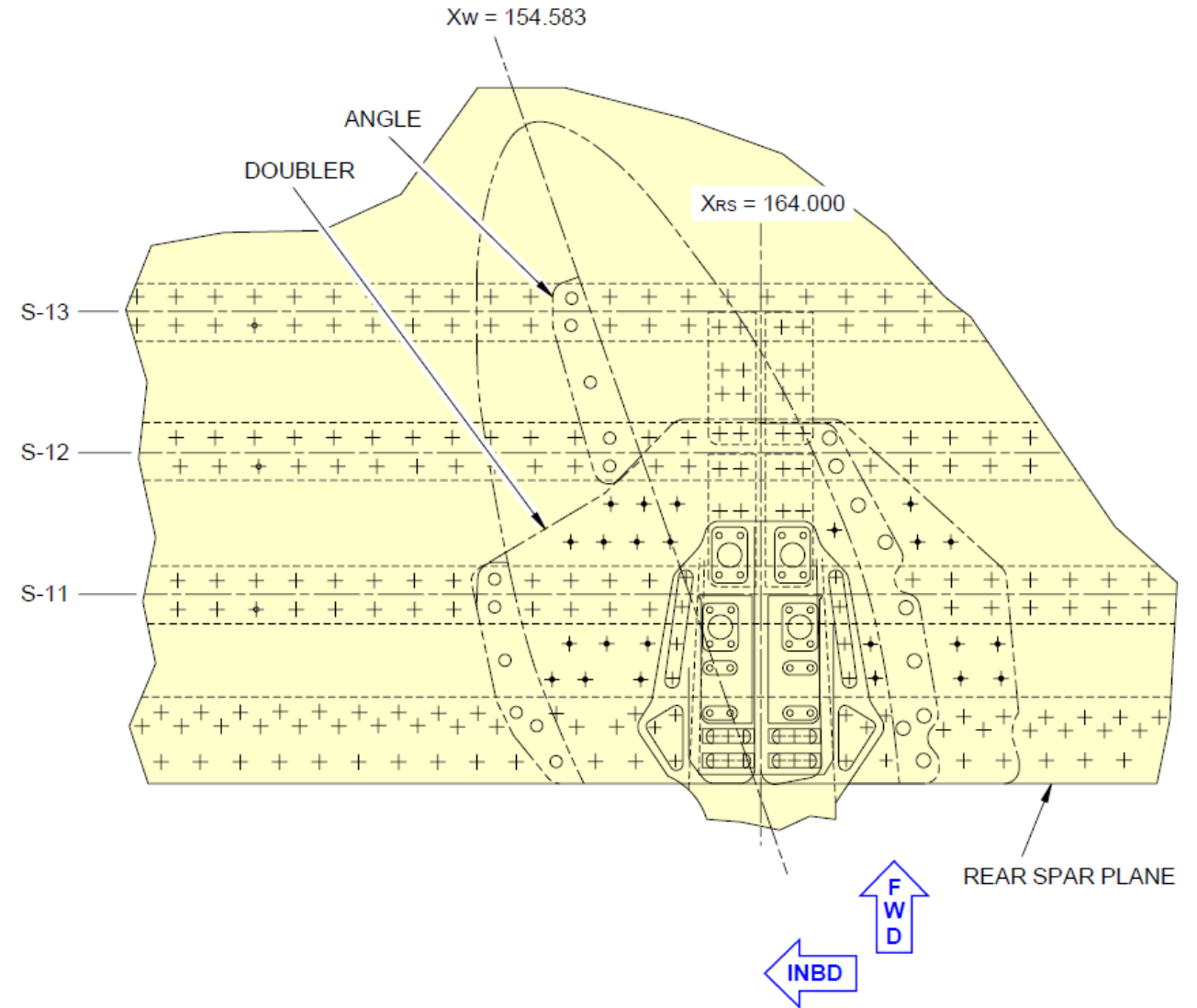
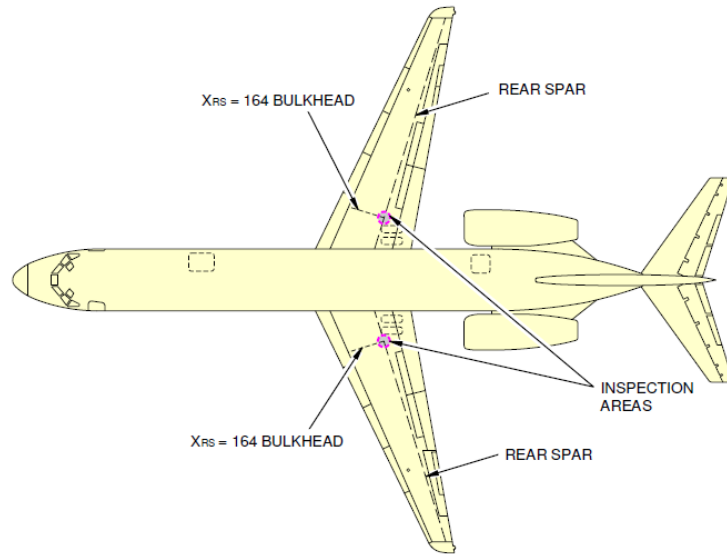
The cracking is common to the rear spar joint area, between the Lower Skin and Production Doubler from XRS -154 to -164. DVI and HFEC inspections are performed on the external surface. However, internal inspections are required with disassembly of the rear spar required for eddy current examination. The minimum detectable crack size was established at about 0.25 inches

Delta and Boeing worked together to develop and perfect x-ray inspection which could be conducted on-wing. The inspection involved several layers of inspection, and a difficult geometry. This on-wing inspection allowed for the discovery of the full extent of cracking, allowing repairs to be conducted. This in turn allowed the B717 to confidently resume service as airworthiness was assured.

Next steps include finalizing the compliance recommendation and drafting a service bulletin

717 XRS 164, Lower AFT Skin Cracks

Design Overview



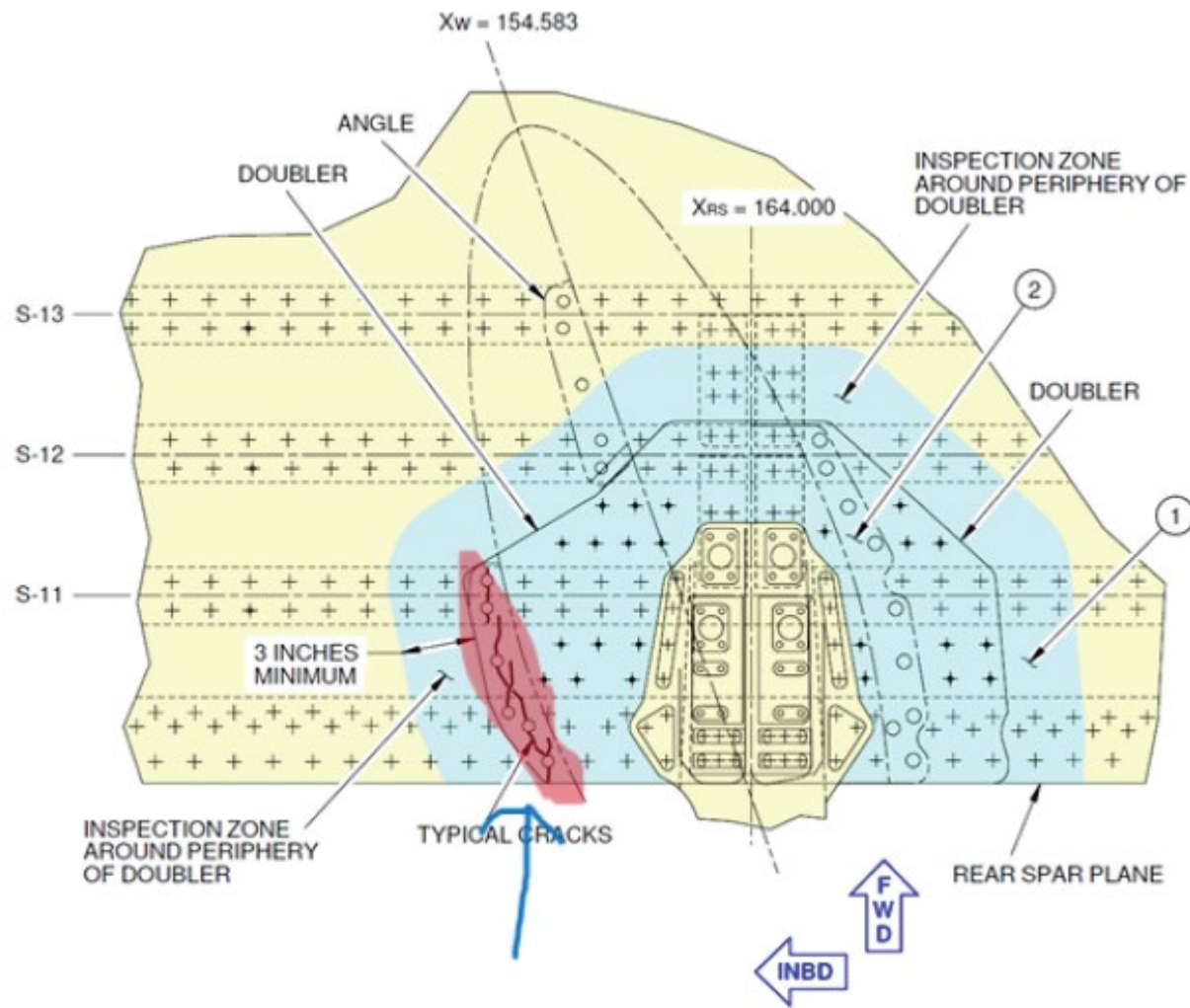
(VIEW IN THE UP DIRECTION AT LOWER WING SKIN)
(LEFT SIDE IS SHOWN, RIGHT SIDE IS OPPOSITE)

717 XRS 164, Lower AFT Skin Cracks

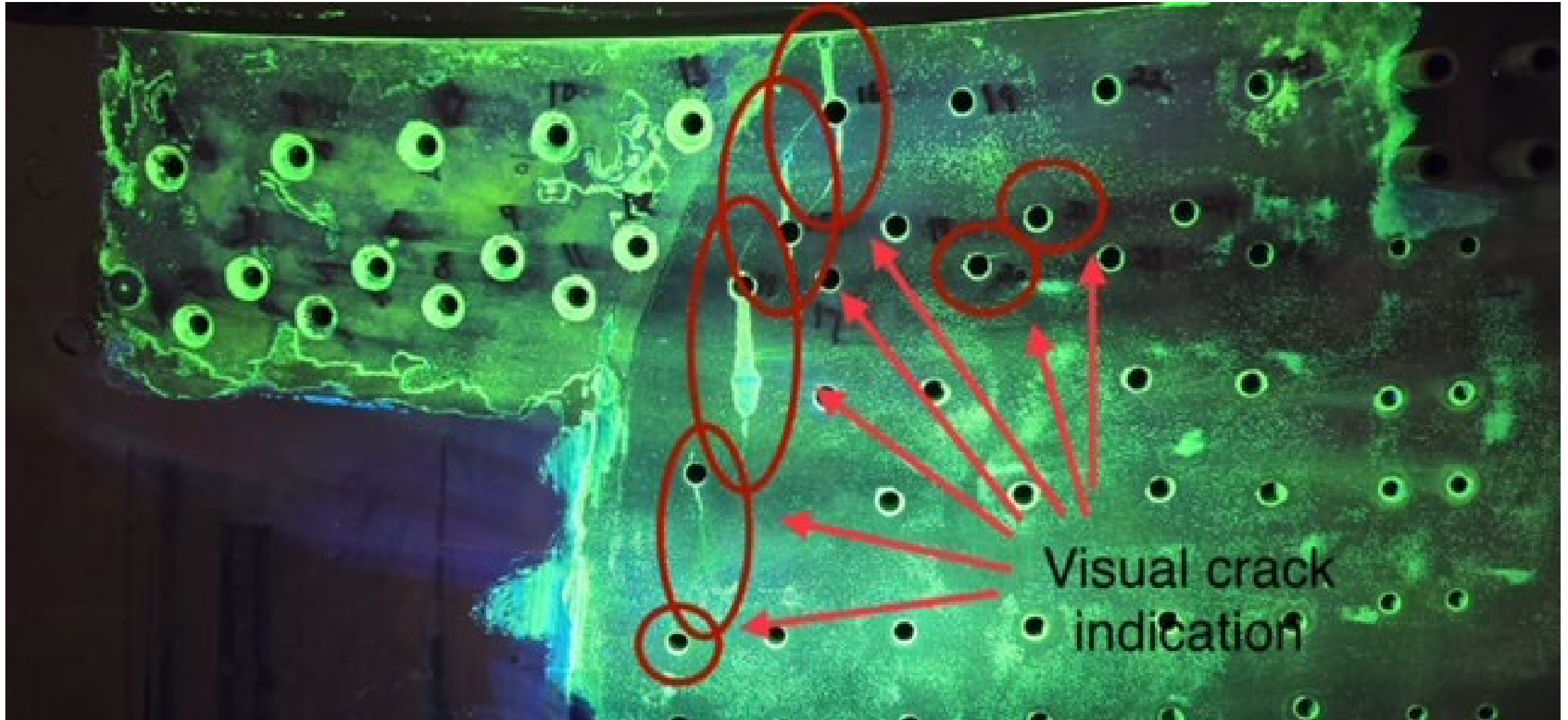
Design Overview



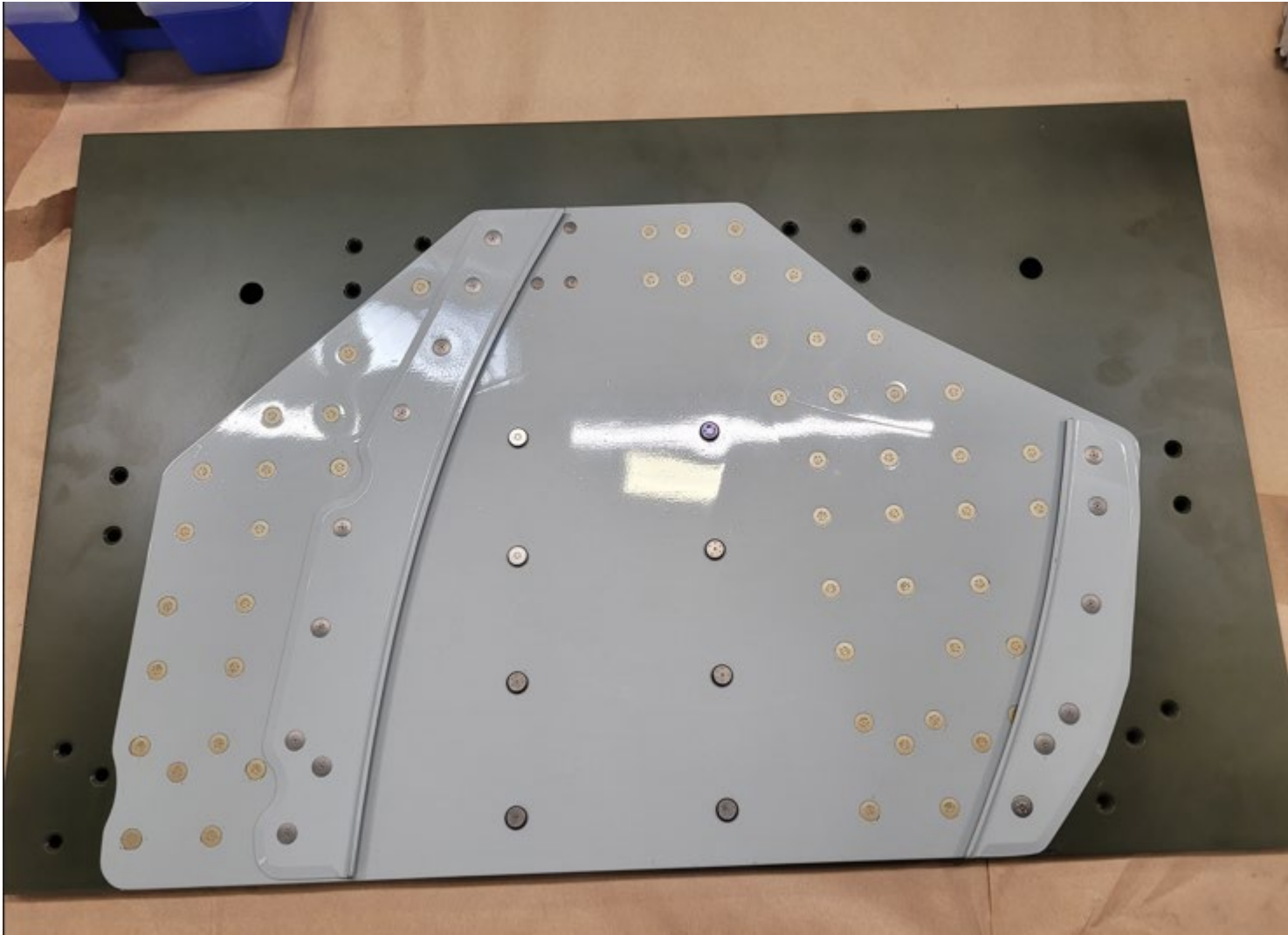
717 XRS 164, Lower AFT Skin Cracks - Inspection



717 XRS 164, Lower AFT Skin Cracks – FPI Inspection

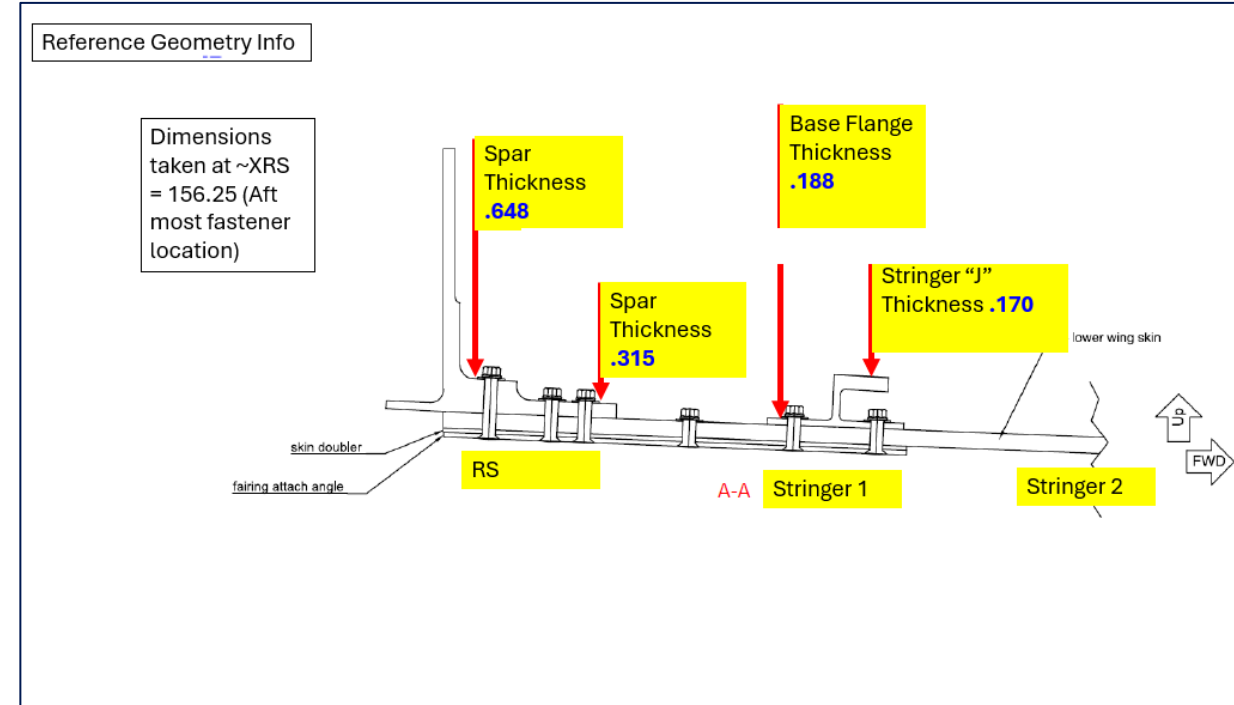
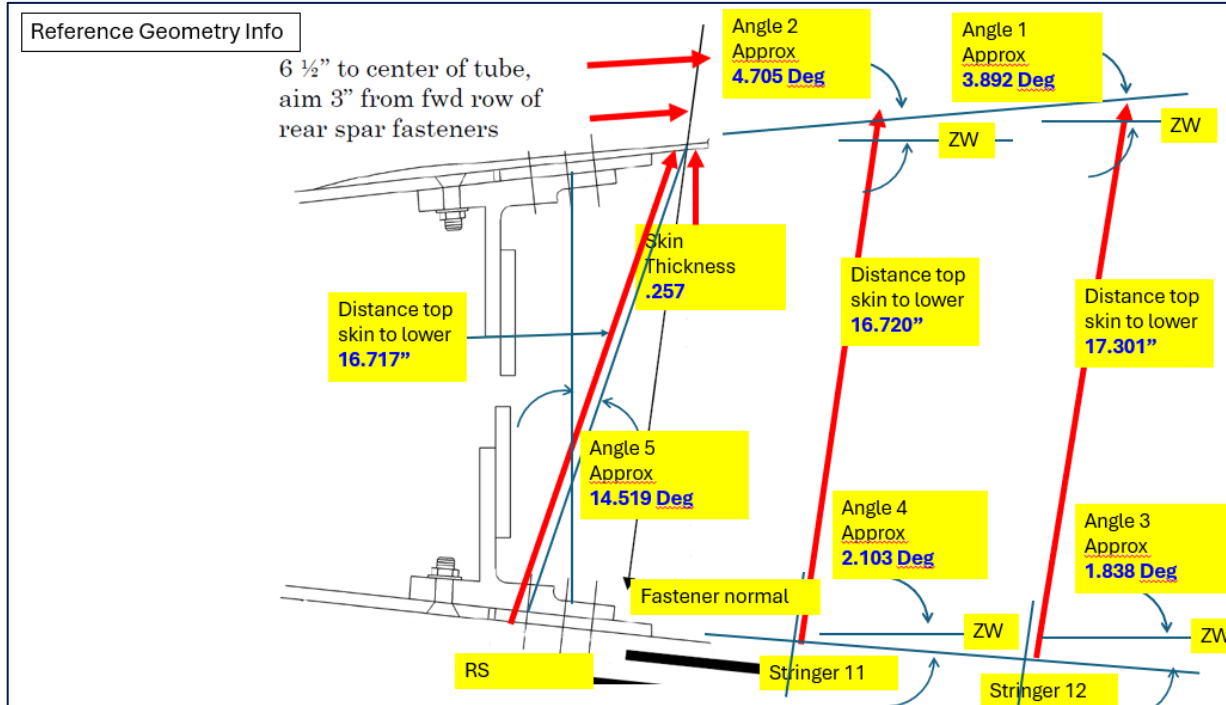


717 XRS 164, Lower AFT Skin Cracks – X-Ray Development



Reference Standard

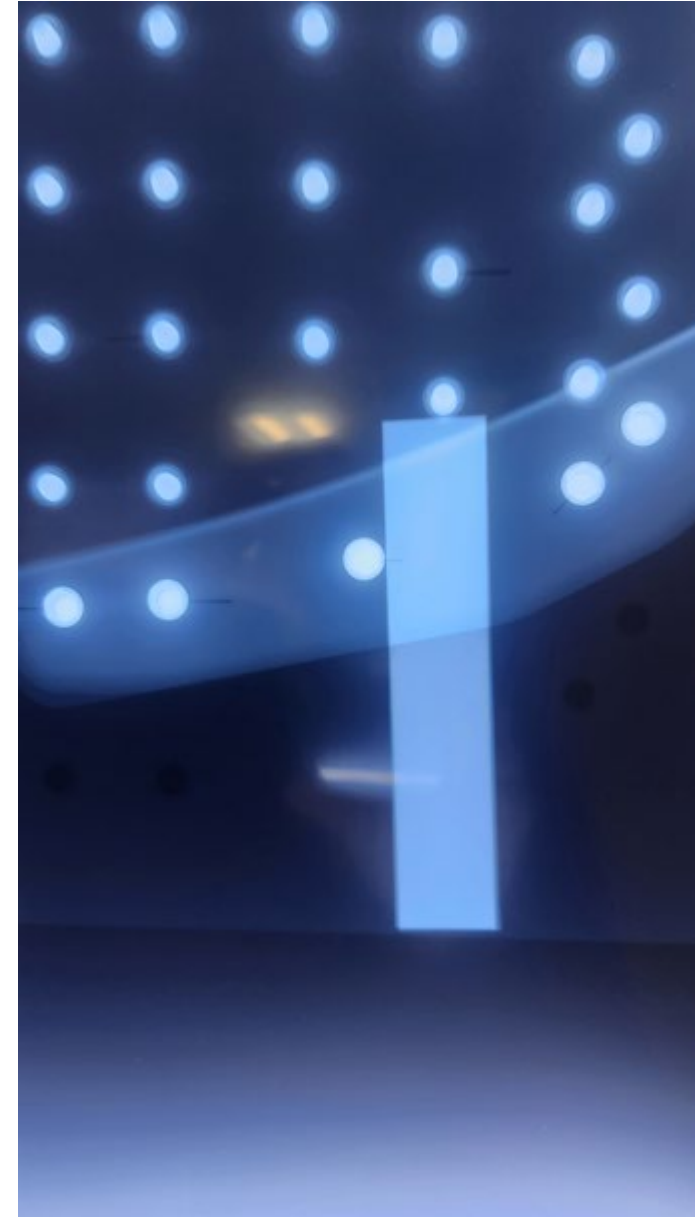
717 XRS 164, Lower AFT Skin Cracks – X-Ray Development



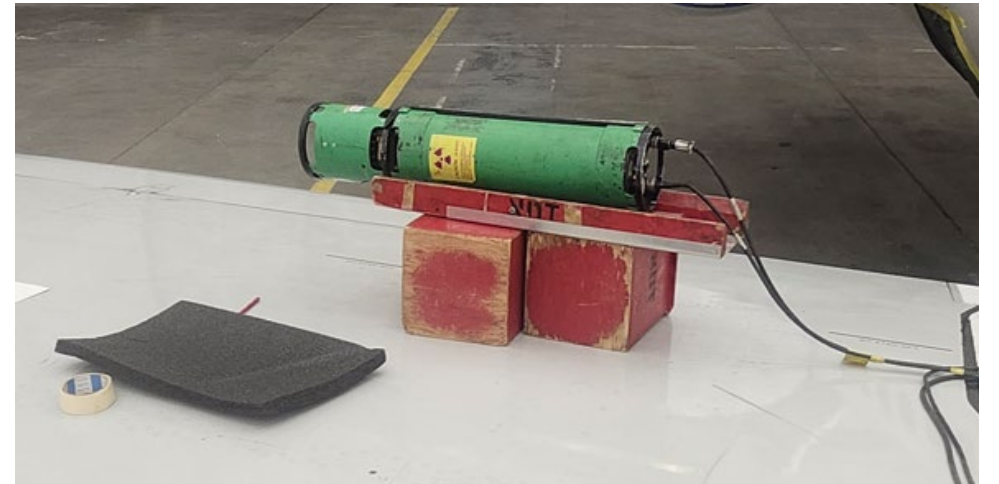
717 XRS 164, Lower AFT Skin Cracks – X-Ray Development



717 XRS 164, Lower AFT Skin Cracks – X-Ray Development



717 XRS 164, Lower AFT Skin Cracks – Airplane



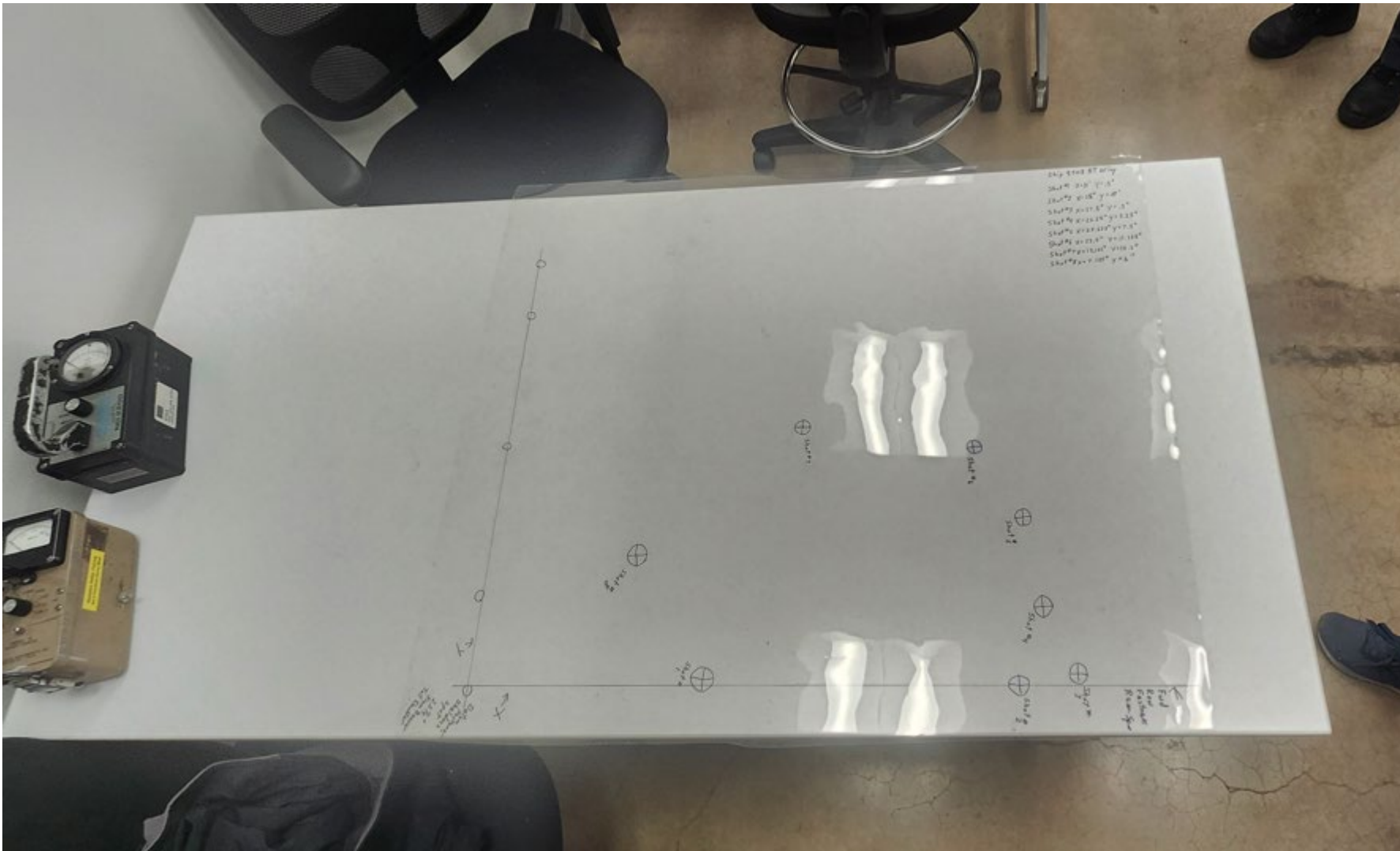
717 XRS 164, Lower AFT Skin Cracks – Airplane



717 XRS 164, Lower AFT Skin Cracks – Airplane

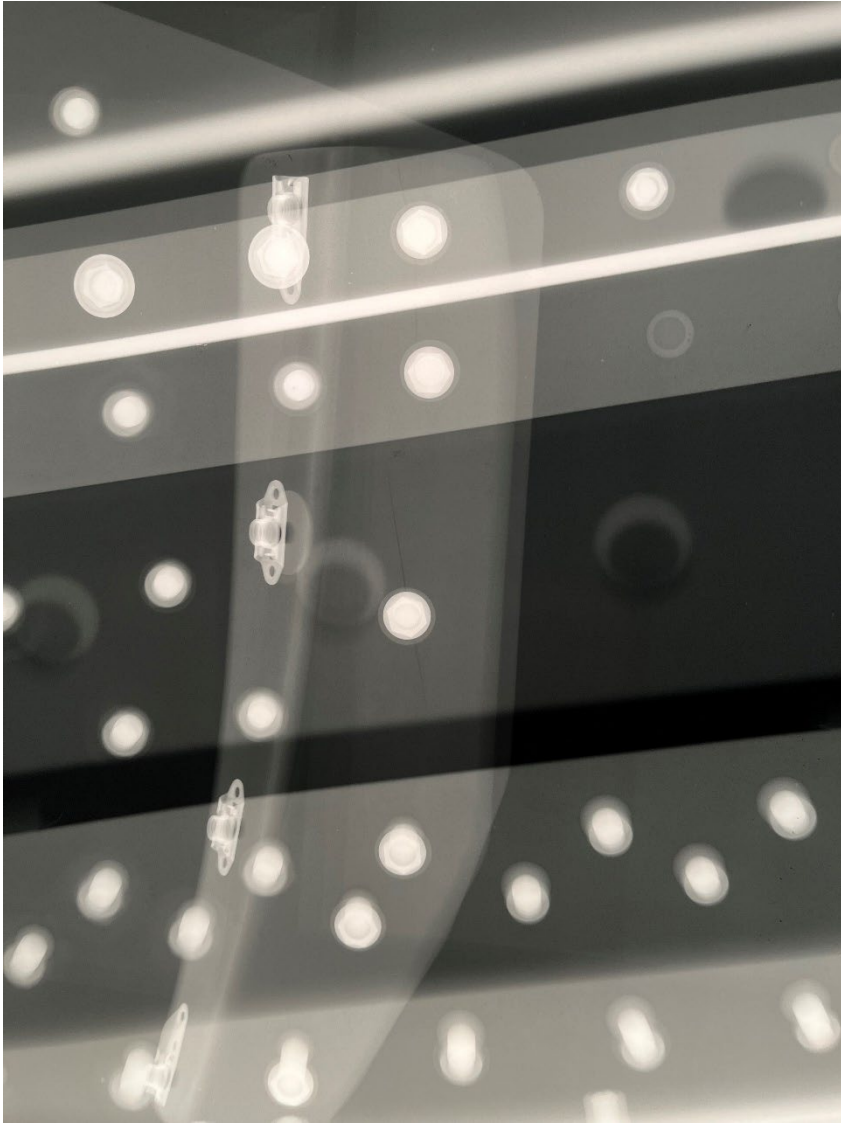


717 XRS 164, Lower AFT Skin Cracks – Airplane

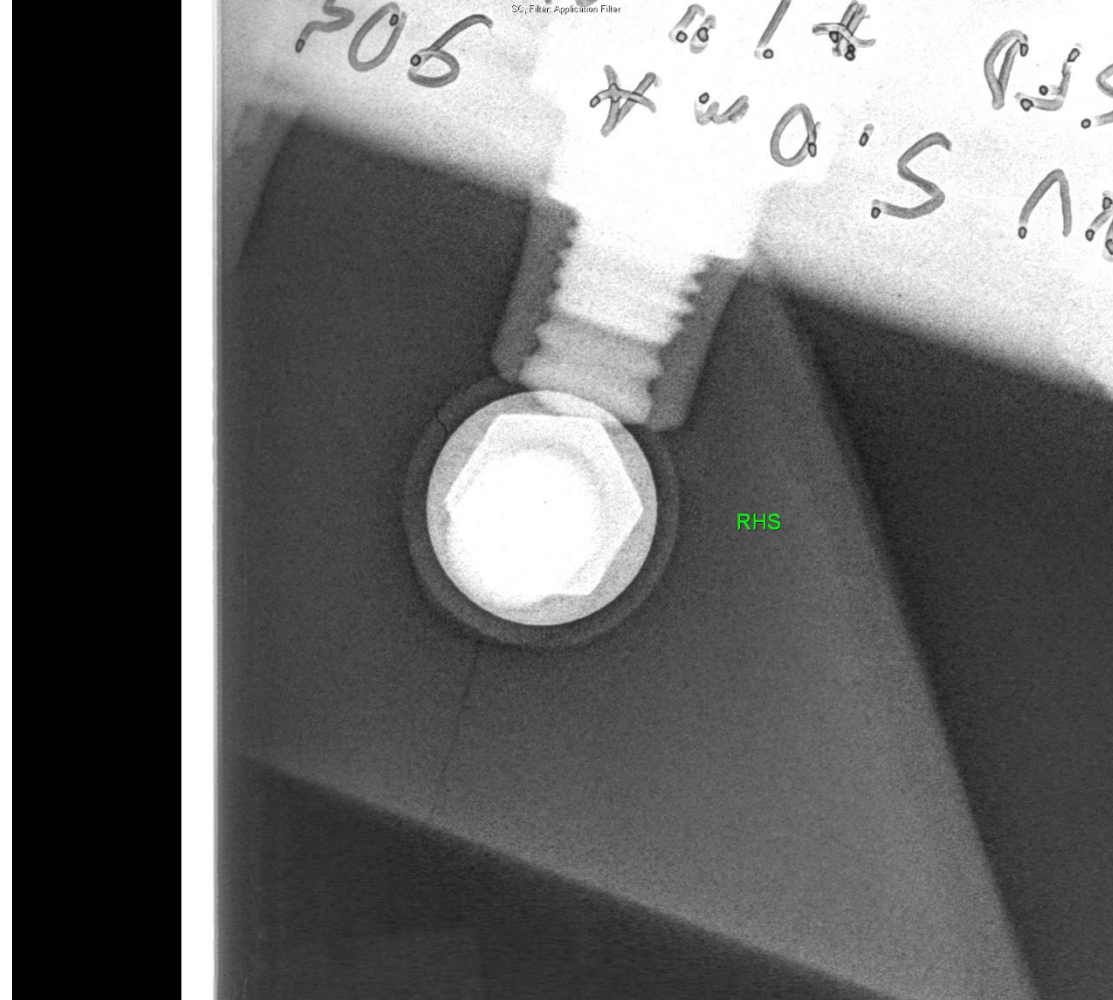


Shot #1	X=11"	Y=.5"
Shot #2	X=25"	Y=0"
Shot #3	X=27.5"	Y=.5"
Shot #4	X=26.25"	Y=3.25"
Shot #5	X=25.625"	Y=7.5"
Shot #6	X=23.5"	Y=11.125"
Shot #7	X=15.125"	Y=12.5"
Shot #8	X=7.125"	Y=6"

717 XRS 164, Lower AFT Skin Cracks – X-Ray Film

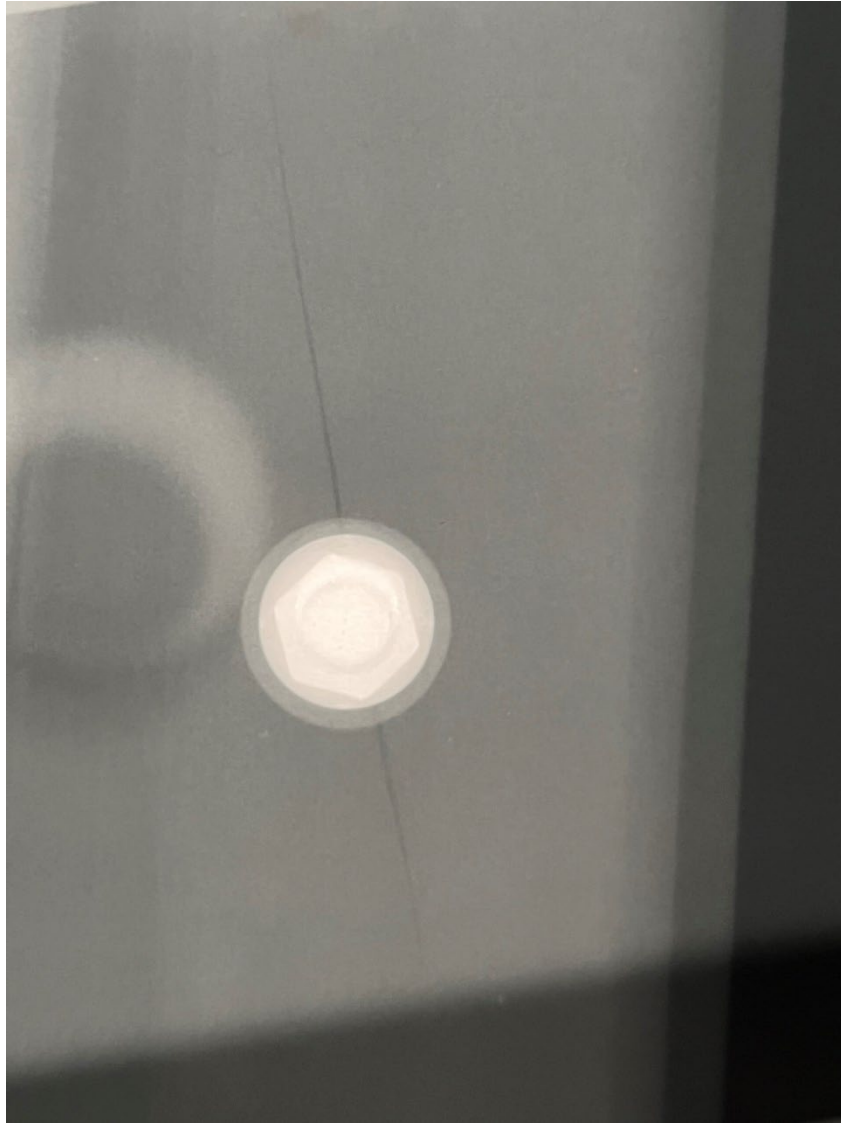


Radiograph Overview IB

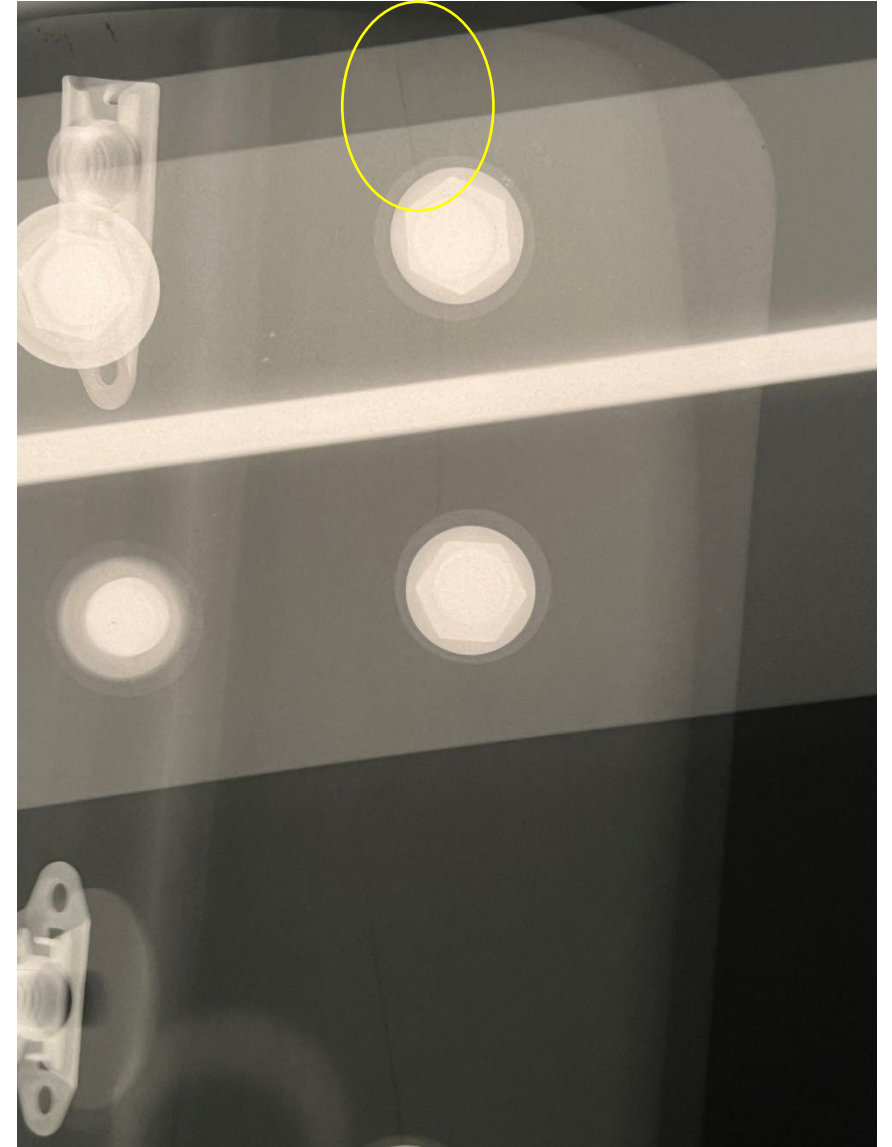


Rear Spar Crack Digitized

717 XRS 164, Lower AFT Skin Cracks – X-Ray Film



Skin Crack Radiograph



Stringer Crack

717 XRS 164, Lower AFT Skin Cracks – Procedure

This inspection is a set of double-wall exposures with single-wall evaluation of the lower wing skin through the upper wing structure.

This procedure is intended to find 0.25 inch and larger thru-thickness cracks in the lower wing skin that originate at the fasteners of interest.

Equipment: Lorad LPX160 source

A larger diameter source tube can be used if the radiographic sensitivity of 2-2T can be achieved.

Use ASTM E1815 Type I film (ultra fine grain, high contrast), such as Agfa D4 (lead-pack). An equivalent or finer grain film may be used if the required radiographic sensitivity can be achieved

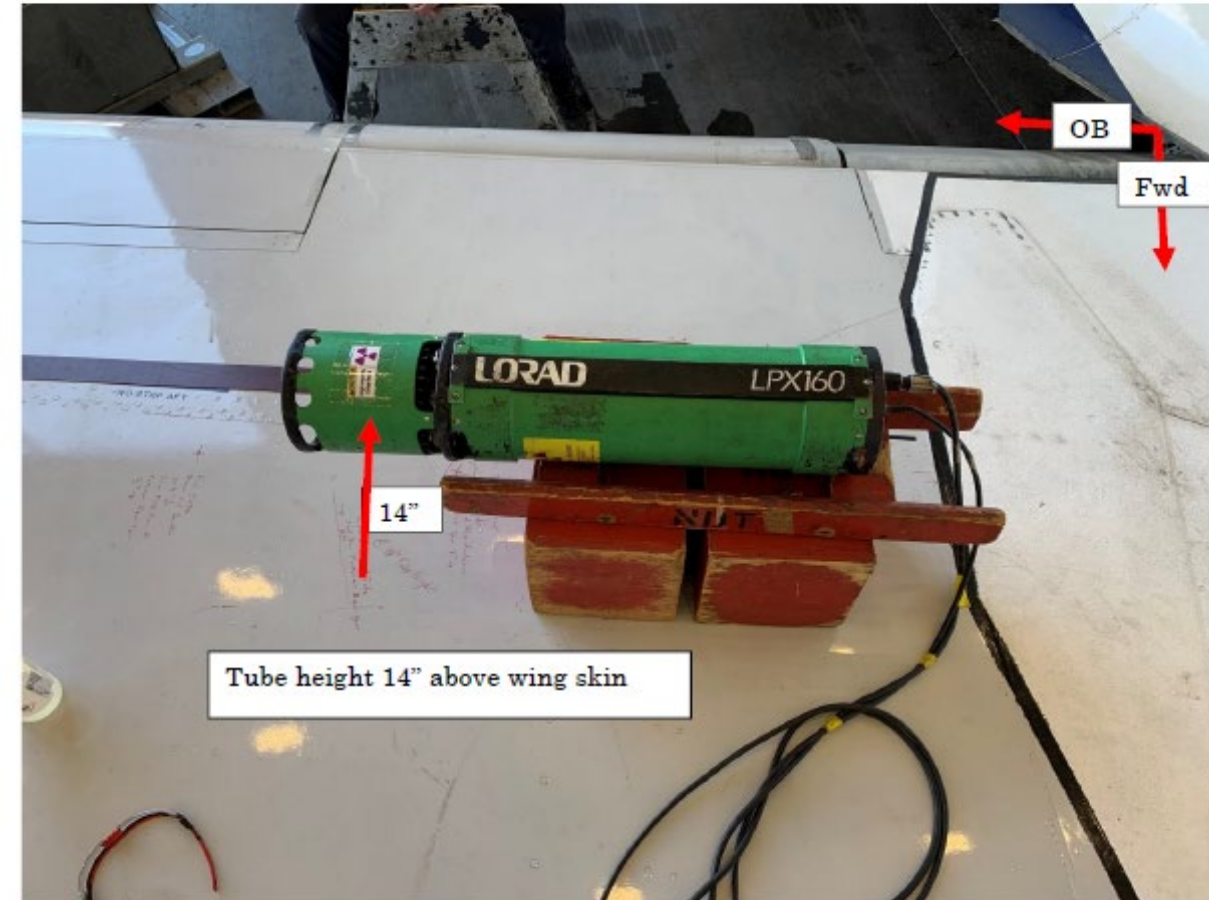
A minimum of 16 sheets of film are necessary to do this inspection. Sheets of film must be a minimum of 2.75 inches (70 mm) wide and 8.0 inches (203 mm) long. Larger films may be used as needed to ensure coverage of the inspection area.

Manual processing may be used

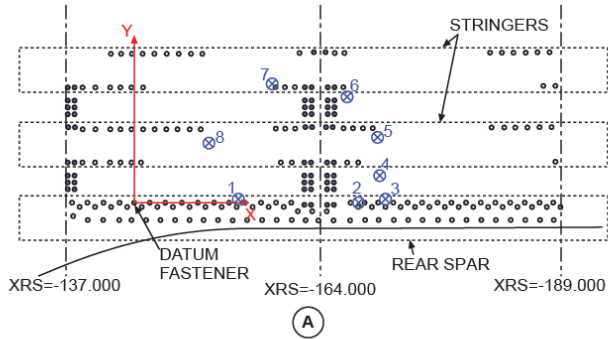
Automatic Processing - A leader film is required at the start of the shift to prevent damage to inspection films. Two films exposed were processed using a run time of 9 minutes at 29°C.

Image Quality Indicators (IQI's) - the aluminum material in the lower wing inspection area is approximately 0.38 inch (9.7 mm) to 1.118 inch (28.4 mm) thick. Use the designated aluminum plaque type penetrameters to get 2-2T radiographic sensitivity.

Tube Placement, Wing Upper Surface

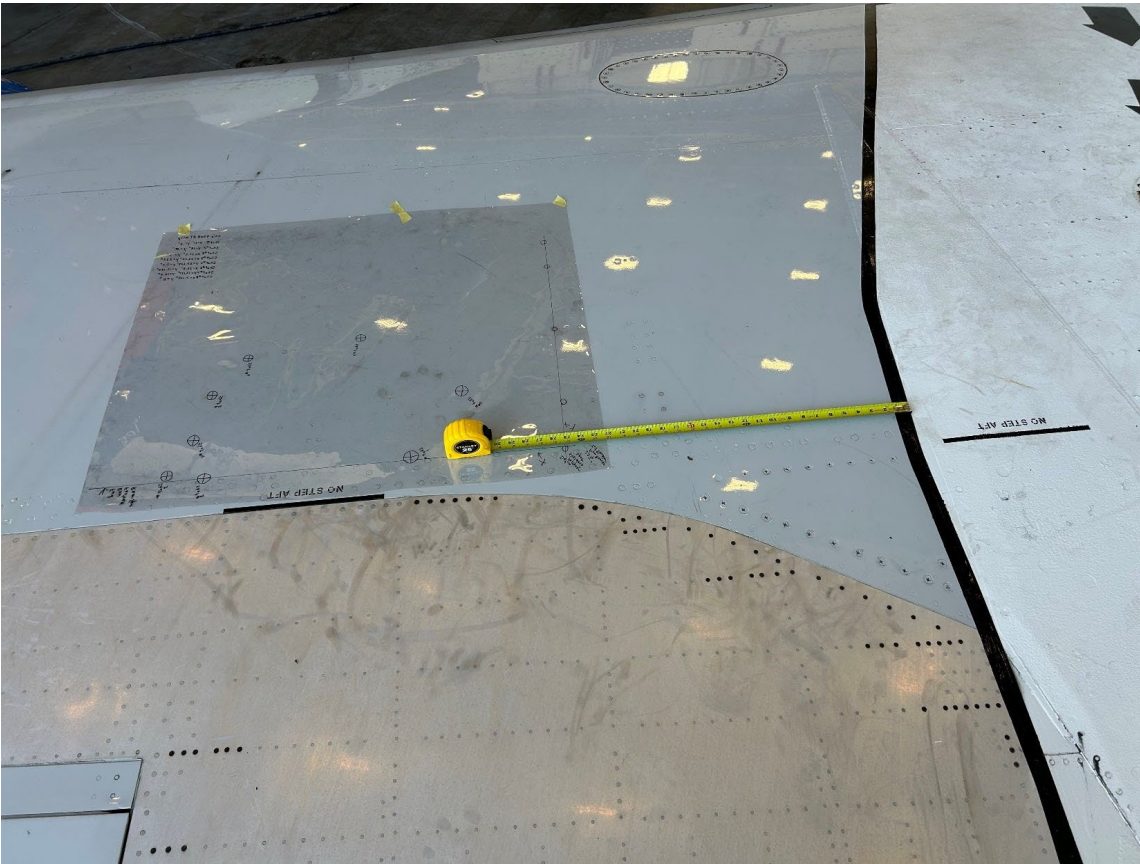
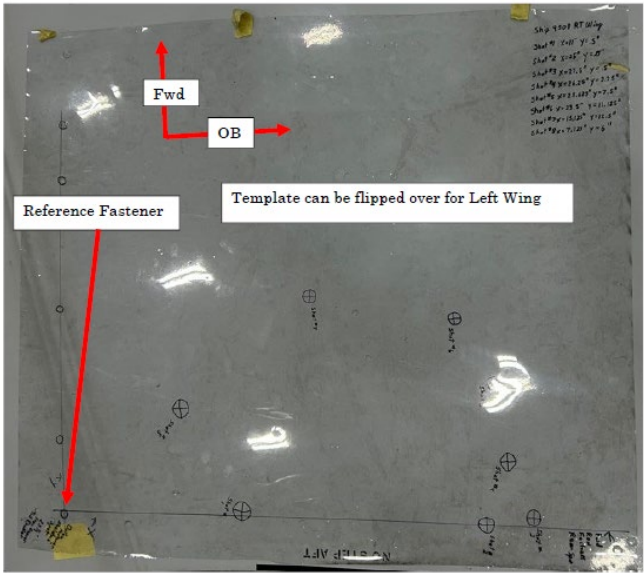


717 XRS 164, Lower AFT Skin Cracks – Procedure

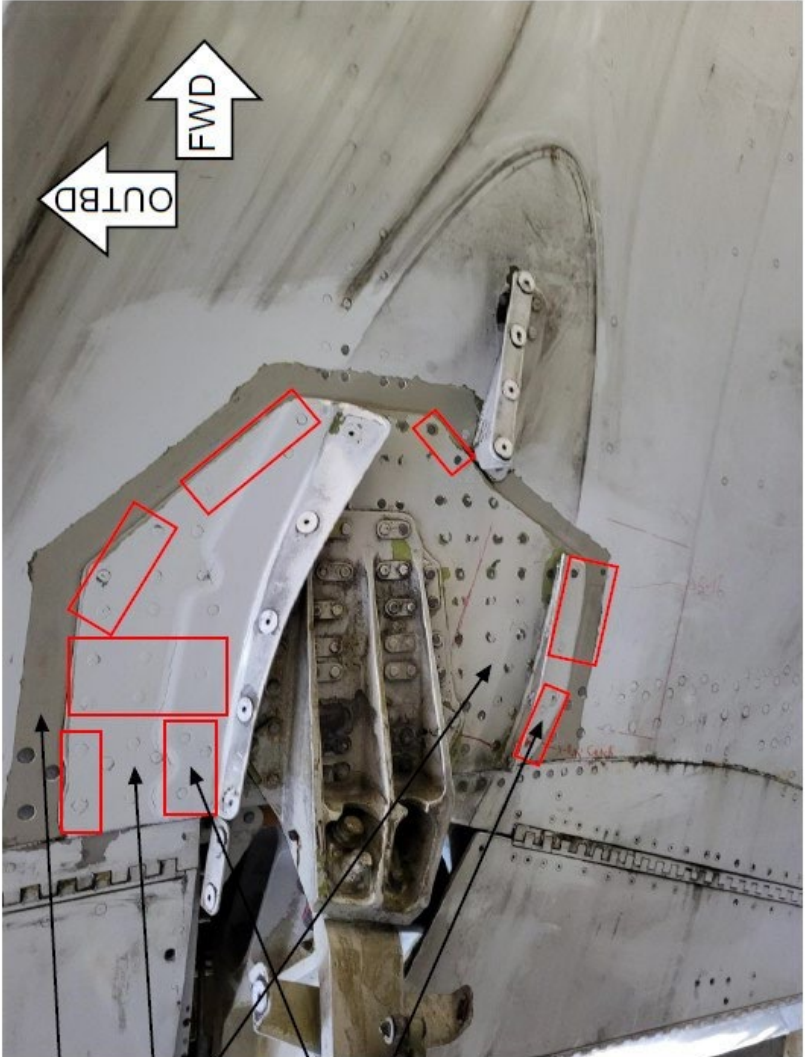


- NOTES:
- ⊗ X-RAY SOURCE APPROXIMATE POSITIONS
 - RH WING SHOWN, LH WING IS MIRRORED
 - SOURCE POSITIONS ARE APPROXIMATE; REFER TO TABLE 1 FOR EXACT POSITIONS IN X AND Y COORDINATES
 - SOME FASTENERS MAY NOT BE VISIBLE FROM THE UPPER WING SURFACE DUE TO PAINT AND OTHER CONDITIONS
- X-Ray Source Locations

Template Placement, Wing Upper Surface



717 XRS 164, Lower AFT Skin Cracks – Procedure

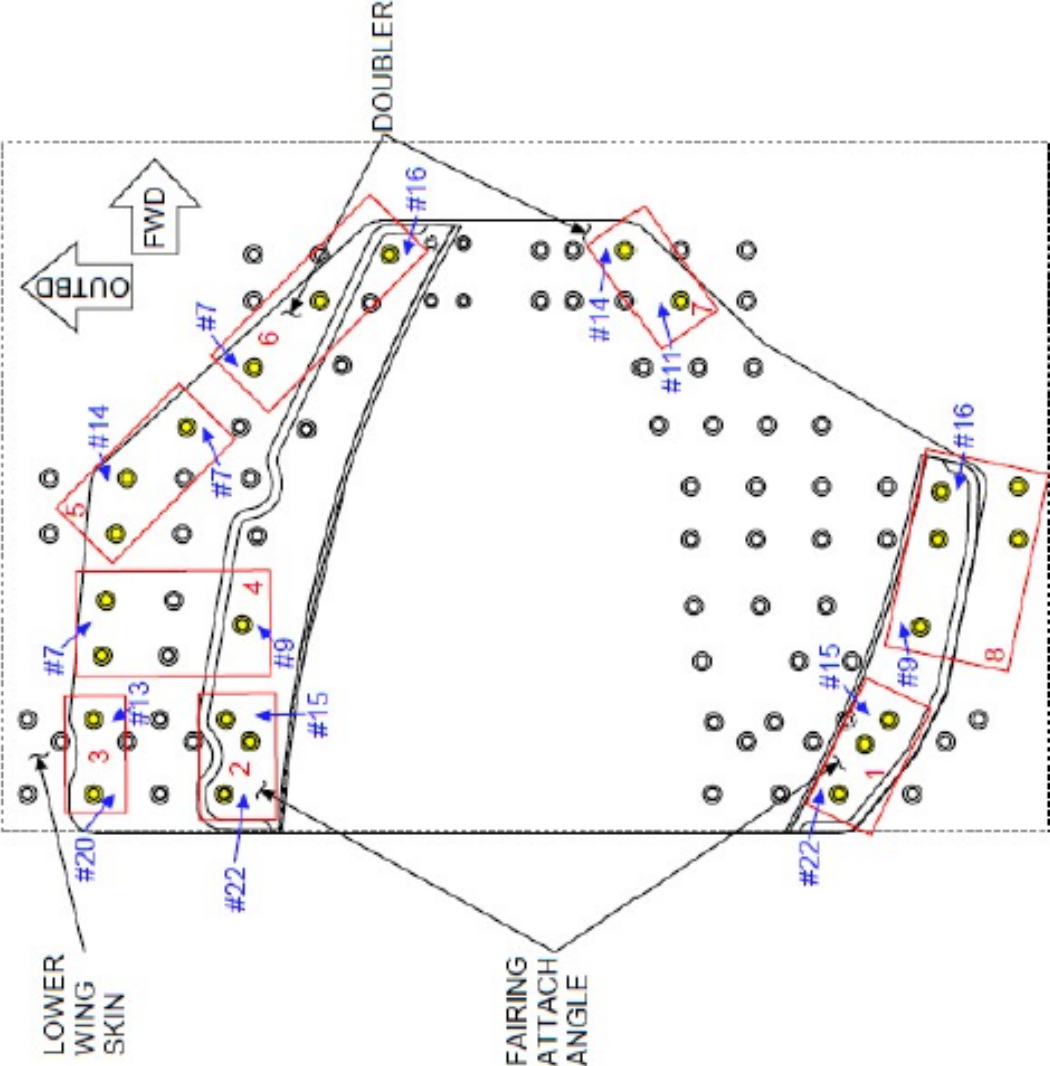


Lower Wing Skin

Doubler

Fairing Attach Angle

Film and Penetrater Placement
Wing Lower Surface



717 XRS 164, Lower AFT Skin Cracks – Technique Sheet

Radiography Technique Sheet

B717 REAR SPAR, LOWER CAP XRS 164, FUEL LEAK

A/C TYPE	B717							
MANUAL REFERENCE	MD-DC/BOEING-SPM 02-00-06							
X-RAY TUBE	LORAD							
SHOTS	#1	#2	#3	#4	#5	#6	#7	#8
KILOVOLTAGE	130	130	130	110	110	110	110	110
MILLIAMPERAGE	5	5	5	5	5	5	5	5
EXPOSURE TIME	1:00	1:00	0:50	0:35	0:55	0:40	0:46	1:00
PENETRAMETER	#15 #22	#15 #22	#13 #20	#7 #9	#7 #14	#7 #16	#11 #14	#9 #16
X,Y COORDINATES FROM REFERENCE FASTENER	11" ½"	25" 0"	27 ½" ½"	26 ¼" ¾"	25 ⅝" 7 ⅝"	23 ½" 11 ⅝"	15 ⅝" 12 ½"	7 ⅝" 6"
SOURCE TO FILM DISTANCE	SOURCE 14" ABOVE UPPER WING SKIN							
COLLIMATOR	NO							
FILTER	NONE							
FILM TYPE	D4 PB							
FILM SIZE	8"x10" (CUT TO FIT)							
SHIM, BLOCK, OR WEDGE	NONE							
COVERAGE (10° CONE)	5"							
PROCESSOR TEMPERATURE	85°							
PROCESSING TIME	9 MIN							

See Page 7 for S-11, S-12, and Rear Spar Only

INSTRUCTIONS

Wing must be defueled. 8 exposures per side are required to ensure complete coverage.
A template may be used to aid in film and tube placement. (photos on following pages).
Expose film to achieve a density of 1.5 to 4.0.
This inspection will detect cracks in the lower wing skin and structure.
Crack indications shall be reported to Liaison Engineering

REFERENCE:

MD-DC/BOEING-SPM 02-00-06, ASTM E-1742 (in the event of a conflict between ASTM E-1742 and the OEM manual, the OEM manual takes precedence)

NOTE: Parameters such as mA and time can be adjusted to meet the density requirements.

NOTE: You may use other tubes if they will produce radiographs of acceptable quality as defined by the inspection documents.

B717 REAR SPAR, LOWER CAP XRS 164, FUEL LEAK UNDER S-11, S-12, AND REAR SPAR ONLY

A/C TYPE	B717					
MANUAL REFERENCE	MD-DC/BOEING-SPM 02-00-06					
X-RAY TUBE	LORAD					
SHOTS	A	B	C	D	E	F
KILOVOLTAGE	130	130	110	110	110	110
MILLIAMPERAGE	5	5	5	5	5	5
EXPOSURE TIME	1:00	1:00	0:55	0:55	0:46	1:00
PENETRAMETER	#14 #22	#14 #22	#11 #16	#11 #16	#11 #14	#11 #16
X,Y COORDINATES FROM REFERENCE FASTENER	12½" ½"	26¼" ½"	24 ¾" 7 ½"	22 ¼" 12½"	17 ¼" 12 ½"	11 ¾" 7¼"
SOURCE TO FILM DISTANCE	SOURCE 14" ABOVE UPPER WING SKIN					
COLLIMATOR	NO					
FILTER	NONE					
FILM TYPE	D4 PB					
FILM SIZE	8"x10" (CUT TO FIT)					
SHIM, BLOCK, OR WEDGE	NONE					
COVERAGE (10° CONE)	5"					
PROCESSOR TEMPERATURE	85°					
PROCESSING TIME	9 MIN					

INSTRUCTIONS

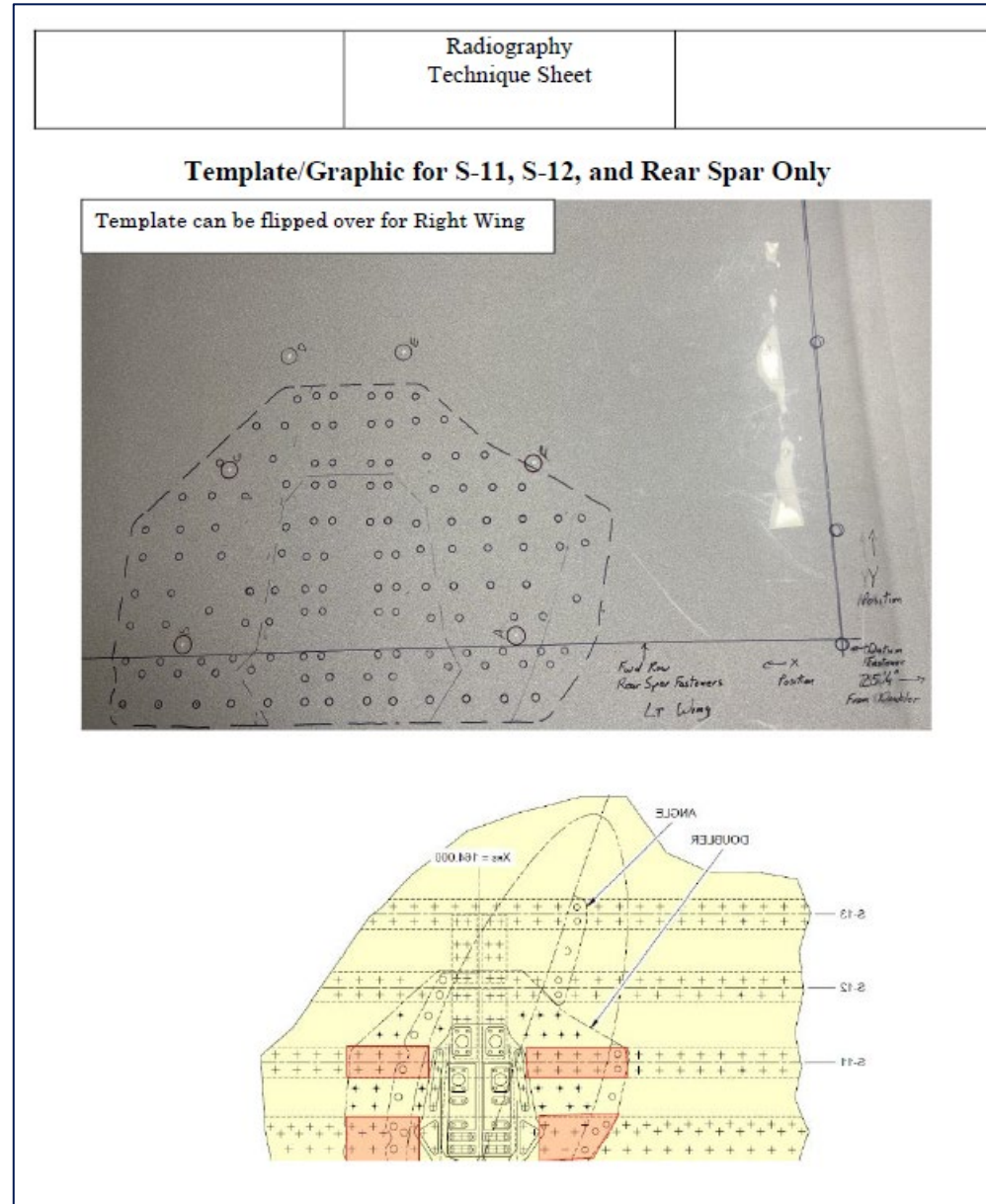
Wing must be defueled.

Adjust tube placement to ensure x-ray beam is centered on the inspection area.

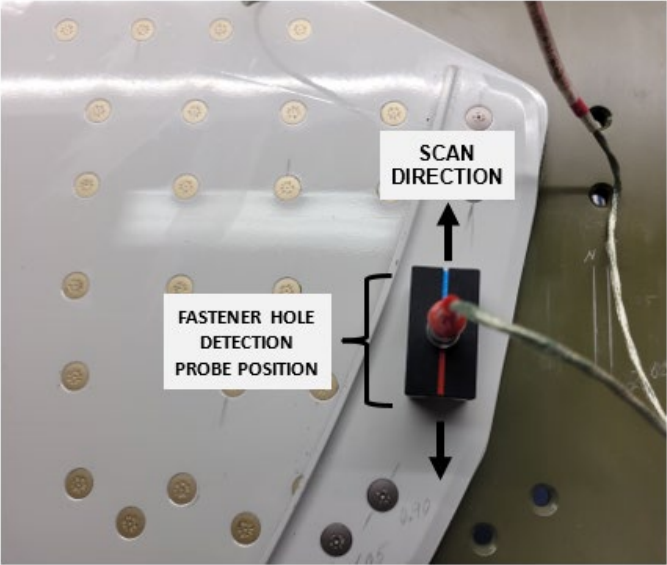
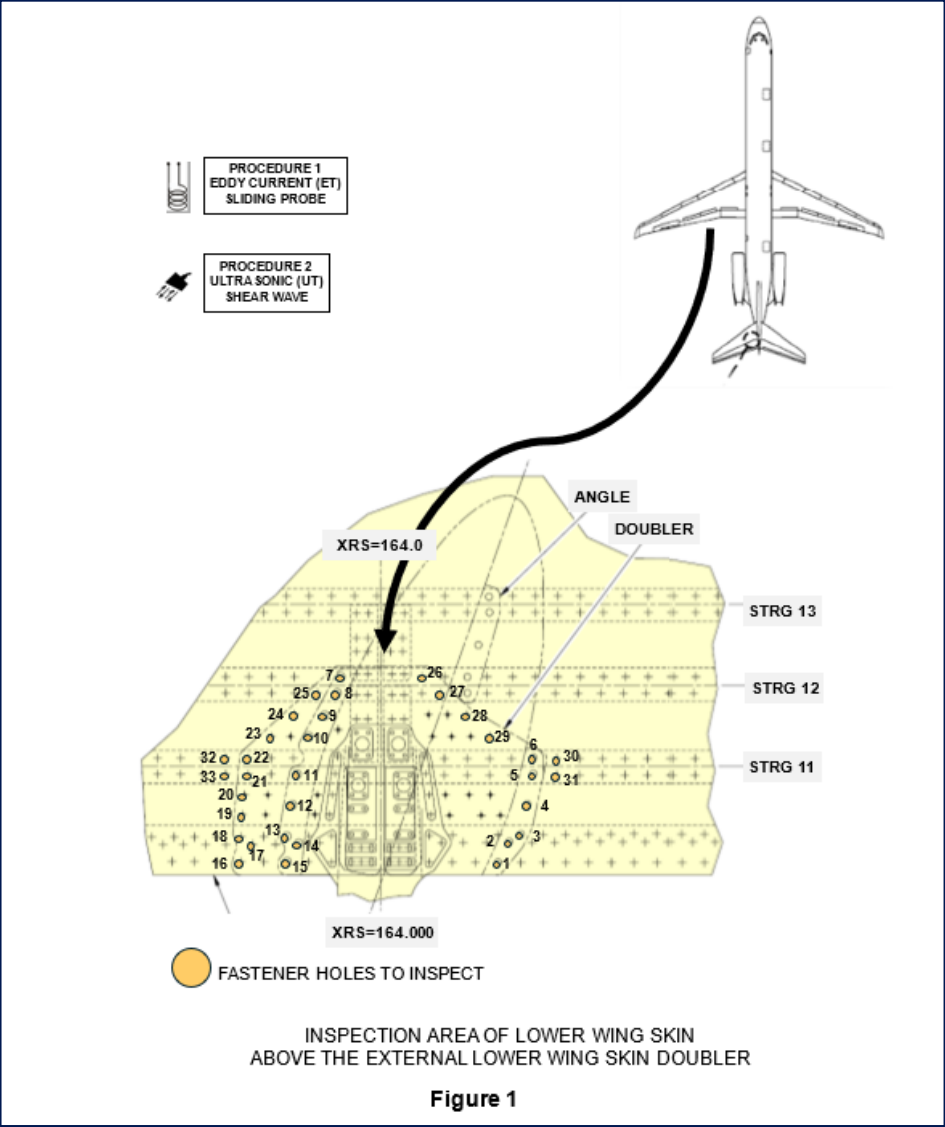
A template may be used to aid in film and tube placement. (photos on following page).

Expose film to achieve a density of 1.5 to 4.0.

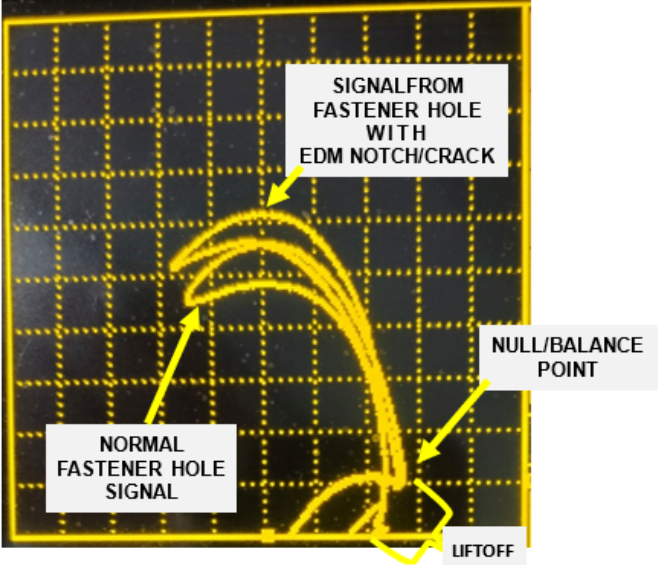
717 XRS 164, Lower AFT Skin Cracks – Technique Sheet



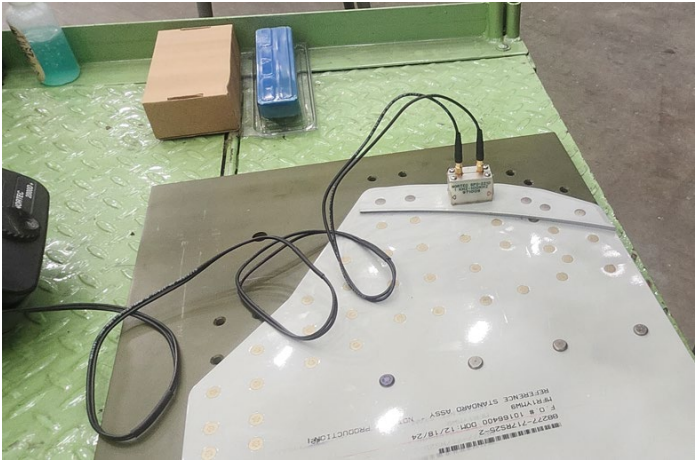
717 XRS 164, Lower AFT Skin Cracks – Additional NDT Techniques



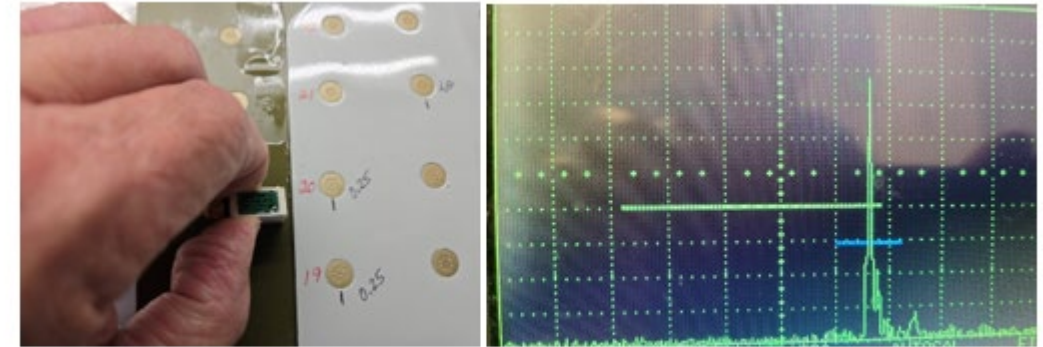
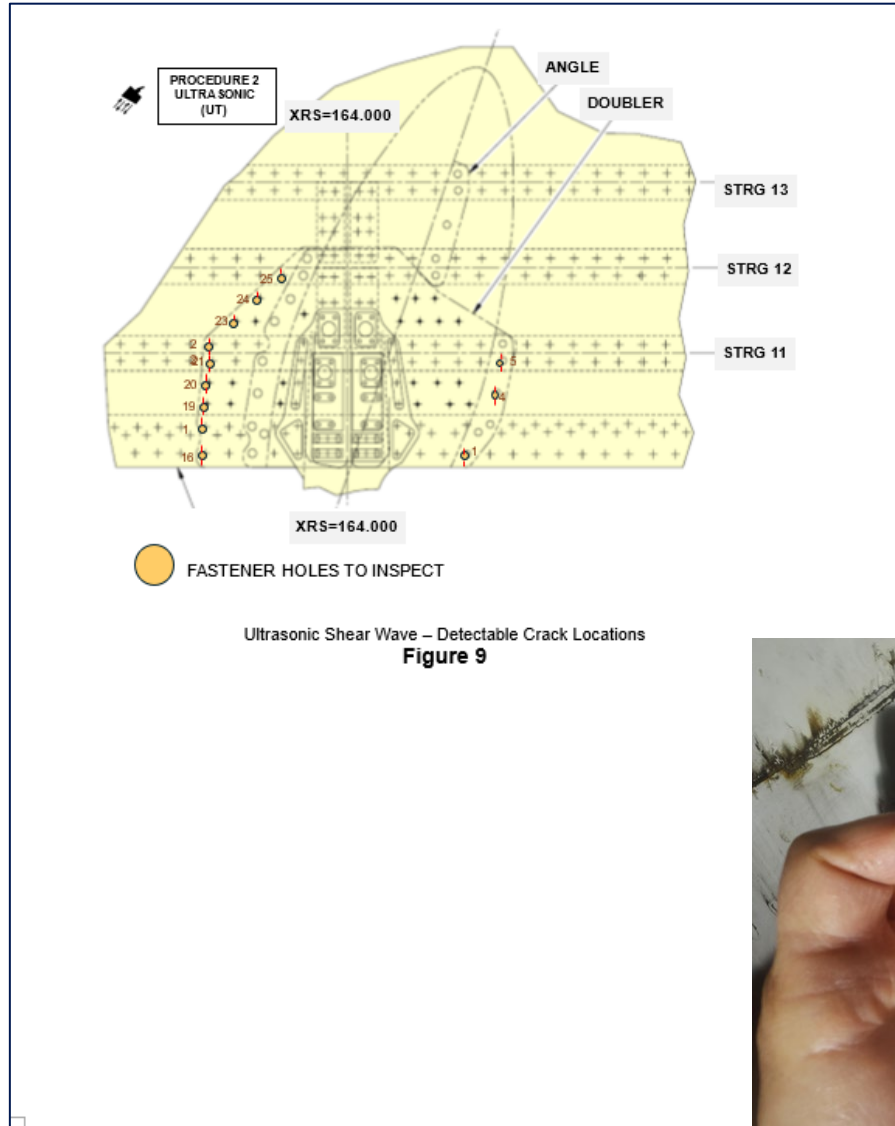
DETECTION OF NORMAL
FASTENER HOLE
ON FAIRING ATTACH ANGLE
AND DOUBLER
(TYPICAL)



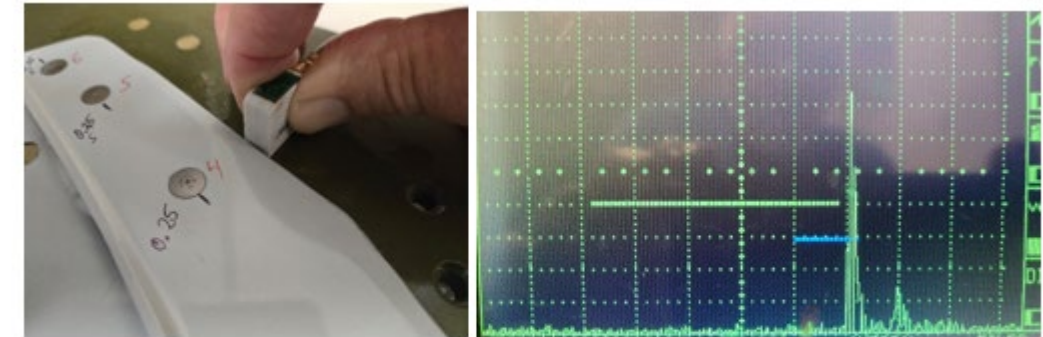
PROBE NULL/BALANCED
ON FAIRING ATTACH ANGLE
AND EDM NOTCH INDICATION
TYPICAL FOR FASTENER HOLE
NO's: 1, 3, AND 6



717 XRS 164, Lower AFT Skin Cracks – Additional NDT Techniques



POSITION 20 NOTCH. MAXIMIZED FULL SKIP NOTCH SIGNAL ON A-SCAN DISPLAY



POSITION 4 NOTCH - FULL SKIP NOTCH SIGNAL NOT ABLE TO MAXIMIZE DUE TO DOUBLER INTERFERENCE WITH FRONT EDGE OF TRANSDUCER

Questions?