PART 4 - ULTRASONIC

FRONT SPAR EXTERNAL SURFACE ES 139.258 TO ES 212.702 (SKIN-TO-CORE)

1. **Purpose**
   A. To detect skin-to-core disbonds in the exterior skin of the front spar adjacent to actuator and hinge fittings between ES 139.258 and ES 212.702.
   B. Maintenance Planning Document (D622T001) Reference:
      (1) 5520-337-04E (Structures MRB number before April 2004); 55-484-00 (Structures MRB number after April 2004)
      (2) 5520-347-04E (Structures MRB number before April 2004); 55-538-00 (Structures MRB number after April 2004)
2. **Equipment**
   A. Any test equipment capable of detecting skin-to-core disbonds as described in this procedure may be used. The following equipment was used during the development of this procedure and found acceptable.
      (1) Instrument
         (a) Sondicator S-2B with standard probe, Automation Industries.
         (b) S5 Sondicator Bond Tester with SP3L probe, Zetec, Inc.
      (2) Honeycomb Calibration Guide ST8870-4 - see Part 1, 51-04-00, Fig. 6.
      (3) Actuator Lock Tool A27111-11 - see Aircraft Maintenance Manual (AMM) 27-31-05.
3. **Preparation for Inspection**
   A. Remove access panel numbers 335DB, 345DB, 335EB, 345EB, 335GB, 345GB, 335HB and 345HB.
   B. Remove horizontal stabilizer-to-elevator fairing seals from horizontal stabilizer lower trailing edge beam assembly, as necessary.
   C. Move elevator to up position sufficient to align forward opening in elevator with aft opening in horizontal stabilizer and gain access to inspection area.
   D. Install Actuator Lock Tool A27111-11 to prevent movement of the elevator as specified in AMM 27-31-05.
   E. Remove loose paint and wipe inspection surface clean.
4. **Instrument Calibration**

   NOTE: Other calibration procedures can be used if they get the necessary sensitivity given in this procedure.

   A. Calibration with the S-2B and the S5 Sondicator Bond Testers
      (1) Initial Instrument Calibration
         (a) Turn the amplitude and the phase dial controls fully counterclockwise to zero.
         (b) Put the probe on the bag side of the reference standard at the 6-ply thickness and near the center of the reference standard.

            NOTE: Calibration is done on the bag side of the reference standard. The inspection will be done on the tool side of the front spar.

         (c) Turn the amplitude dial control clockwise until the dial reads 2.0.
         (d) Slowly turn the phase control clockwise until the needle of the phase meter moves fully upscale and then goes back to zero. Continue to turn the phase control clockwise until the needle reaches full scale and again goes back to zero a second time.

(e) Move the probe across the disbonded area (defect area C) and monitor the phase meter. The needle will move quickly upscale when the probe is moved above the unbonded area.

NOTE: Monitor only the phase meter to find the unbonded area.

NOTE: The quantity of pressure applied to the probe can have a large effect on the signal. Keep equal pressure on the probe at all times.

(f) Do a check for noise as follows:

1) Quickly move the probe across the bonded area of the reference standard. If the needle movement is more than one on the meter scale while you move the probe, turn the phase control clockwise until the phase meter needle moves left to the zero position.

2) Quickly move the probe across the bonded area of the reference standard again and make sure that the phase meter needle stays below one on the meter scale.

3) Move the probe across the C disbond area and monitor the signal to make sure you get a quick, upscale, phase meter change.

(2) Final Calibration

(a) Put the probe on one of the areas to be examined.

1) If the needle position on the phase meter is more than 1.0, turn the phase dial control clockwise until the meter needle returns to zero.

(b) Put the probe on at least one other location in the inspection area.

1) Do a check of the needle position to make sure the instrument was adjusted on a bonded area in Paragraph 4.A.(2)(a).

(c) No more calibration adjustments are necessary.

5. Inspection Procedure

A. Identify the inspection locations. See Figure 1.

B. Calibrate the instrument. Refer to Paragraph 4.

C. Put the probe on the forward surface of the front spar and make a scan of all inspection areas. Look for a meter signal that compares to the meter signal from the disbond area used for calibration in Paragraph 4.

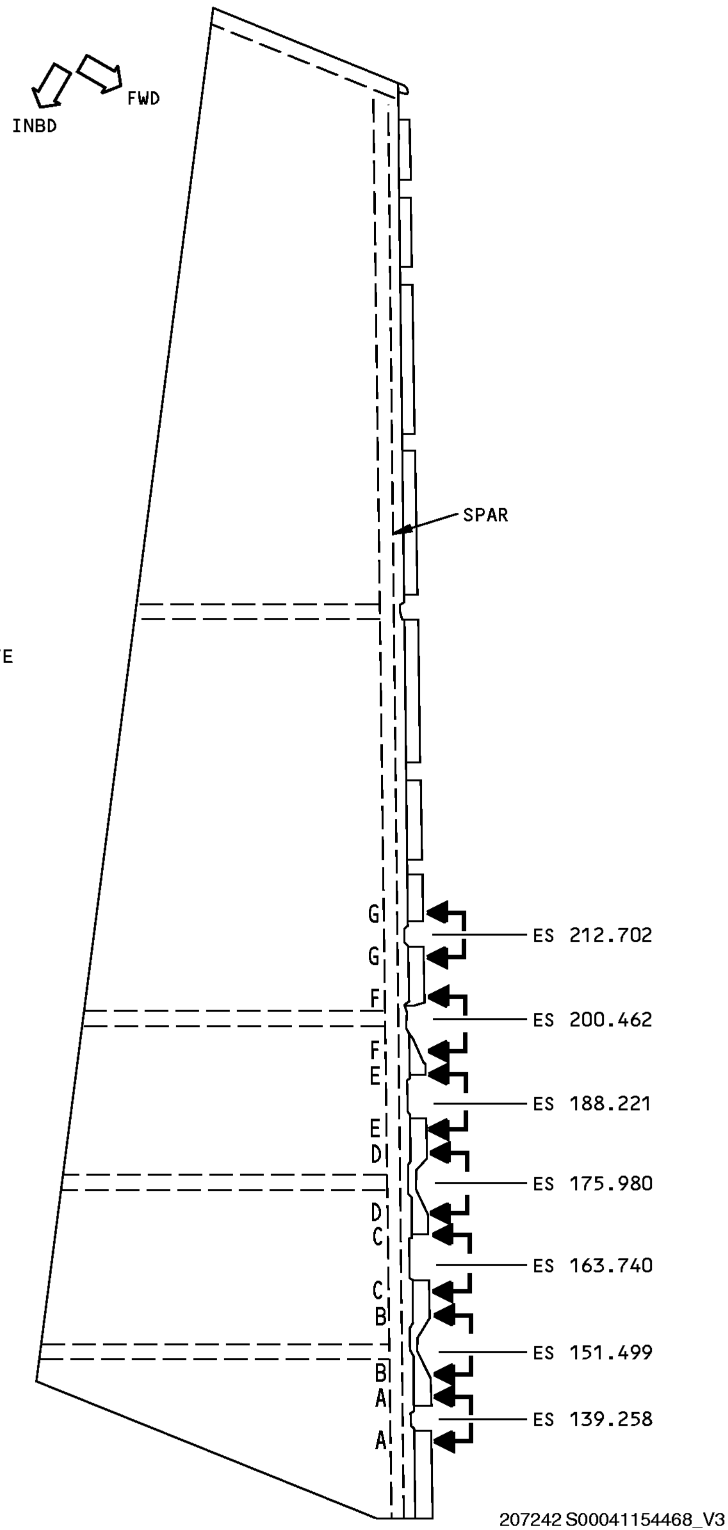
NOTE: The instrument must be calibrated each time it is used to examine a different ply thickness.

NOTE: It can be difficult to examine the laminate areas in the area of the tapered core because you can get meter signals caused by the tapered core. To examine along a tapered core area, move the probe parallel to the core edge. Compare all signals to the signal you get from an equivalent area on the reference standard.

D. Remove Actuator Lock Tool A27111-11 when the inspection is done. Refer to AMM 27-31-05.

6. Inspection Results

A. Meter signals that are almost the same as the disbond signals you get from the reference standard are indications of possible disbonds. Make a comparison of all meter signals that you are not sure of with the disbond areas in the reference standard. When you make the comparison, make sure the ply thickness you use on the reference standard is the same as the inspection area.



NOTES

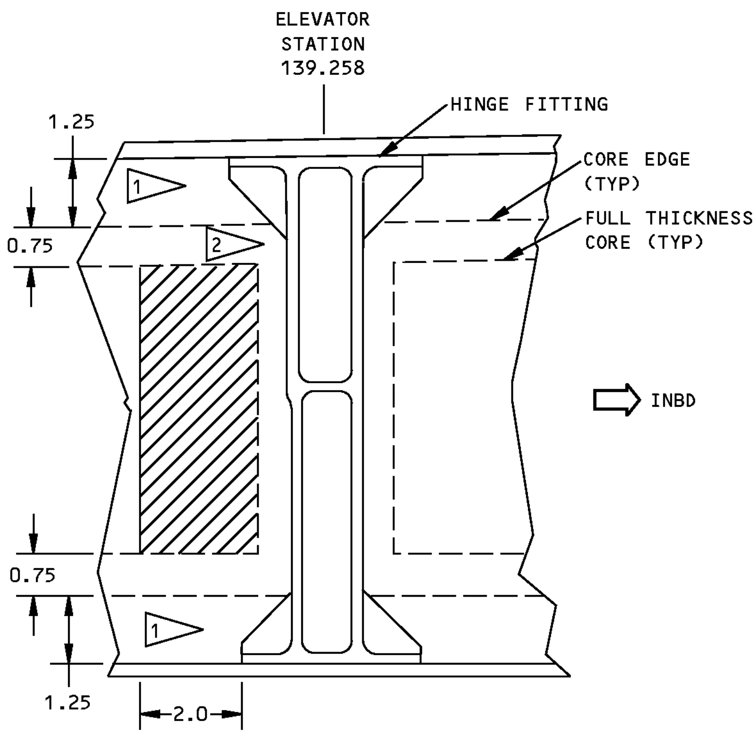
- VIEW AS YOU LOOK UP
- RIGHT ELEVATOR SHOWN, LEFT ELEVATOR OPPOSITE
- ALL DIMENSIONS ARE IN INCHES
- THE LIMIT OF EACH IDENTIFIED THICKNESS AREA CAN BE DIFFERENT FOR DIFFERENT EFFECTIVITIES. IF AN INSPECTION SHOWS THE LIMITS TO BE DIFFERENT, GET THE NECESSARY ENGINEERING DRAWINGS TO MAKE SURE THE RESULTS ARE CORRECT.
- RIB LOCATIONS NOT SHOWN

1 LAMINATE ONLY

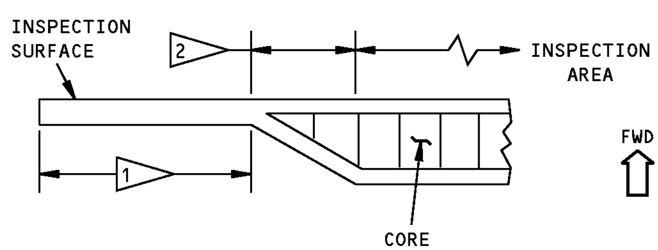
2 SIGNAL CHANGE DUE TO THICKNESS CHANGE

(hatched) INSPECTION AREA - MAKE A SCAN OF THE AREAS YOU CAN ACCESS THAT ARE WITHIN 2.0 INCHES (50.8 mm) OF EACH SIDE OF ALL HINGE AND ACTUATOR FITTINGS OF THE FRONT SPAR.

Elevator Assembly
Figure 1 (Sheet 1 of 5)

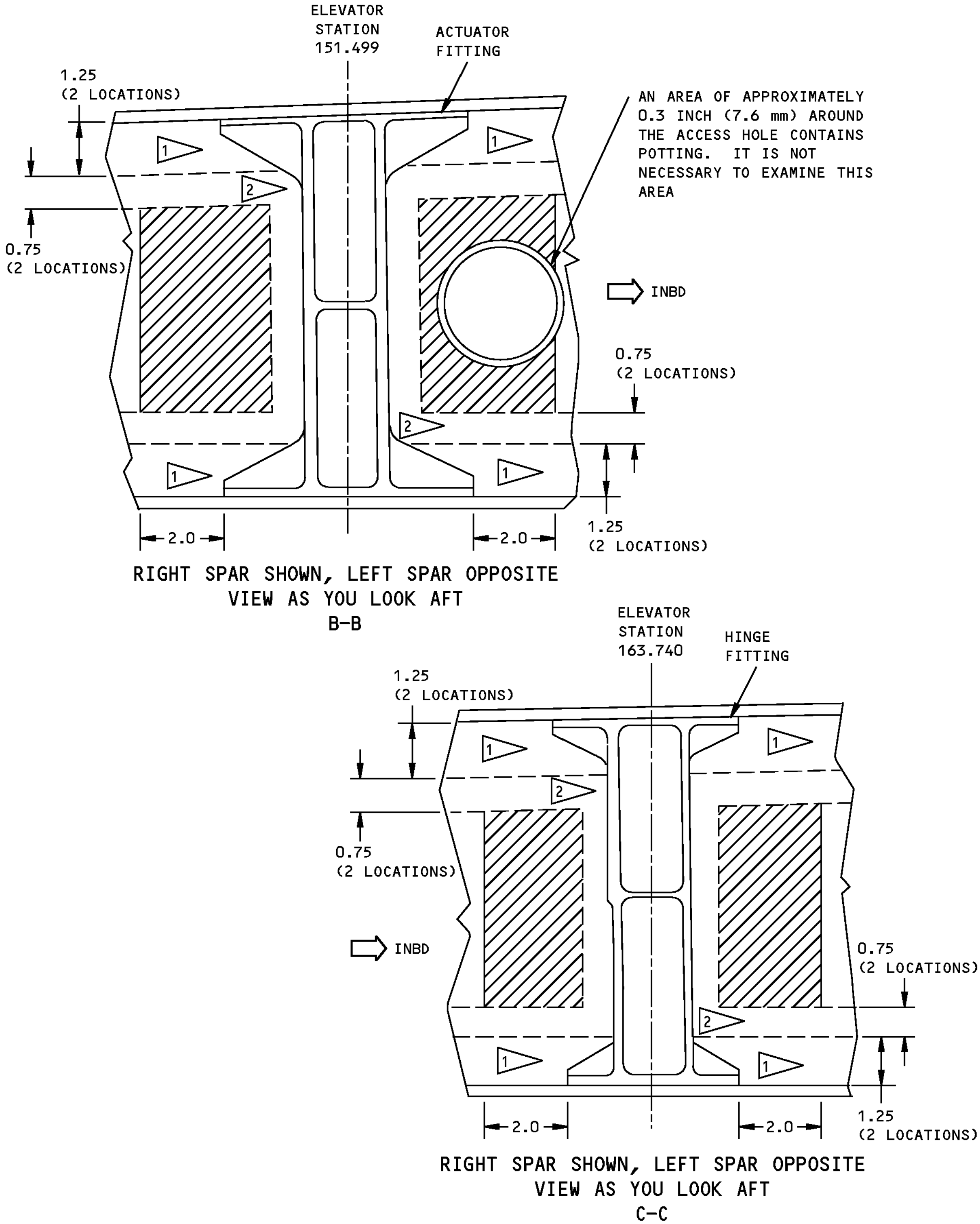


RIGHT SPAR SHOWN, LEFT SPAR OPPOSITE
VIEW LOOKING AFT
SECTION A-A

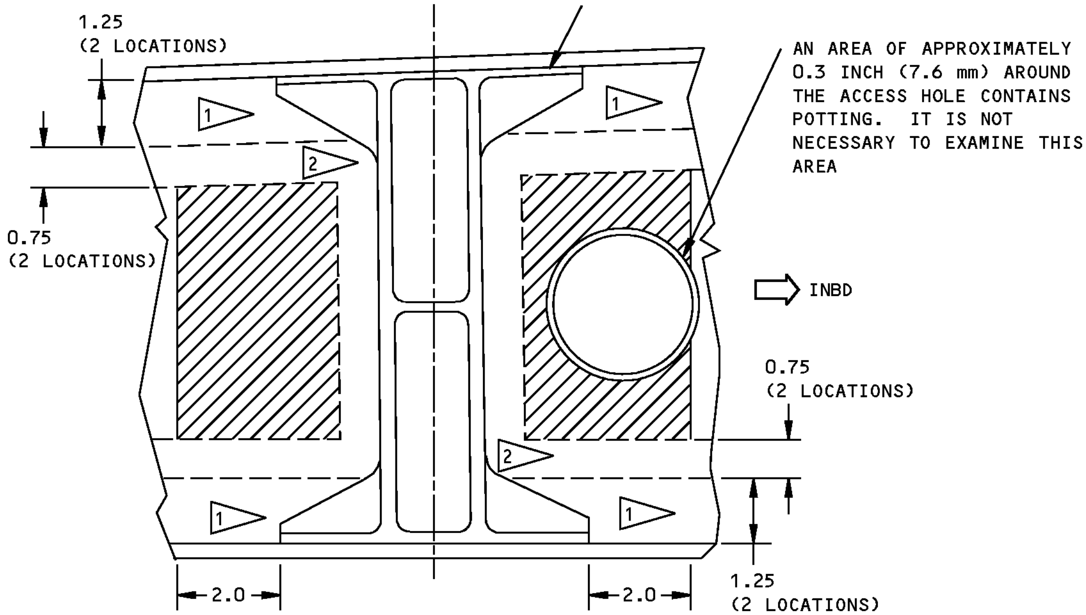


TYPICAL EDGE VIEW

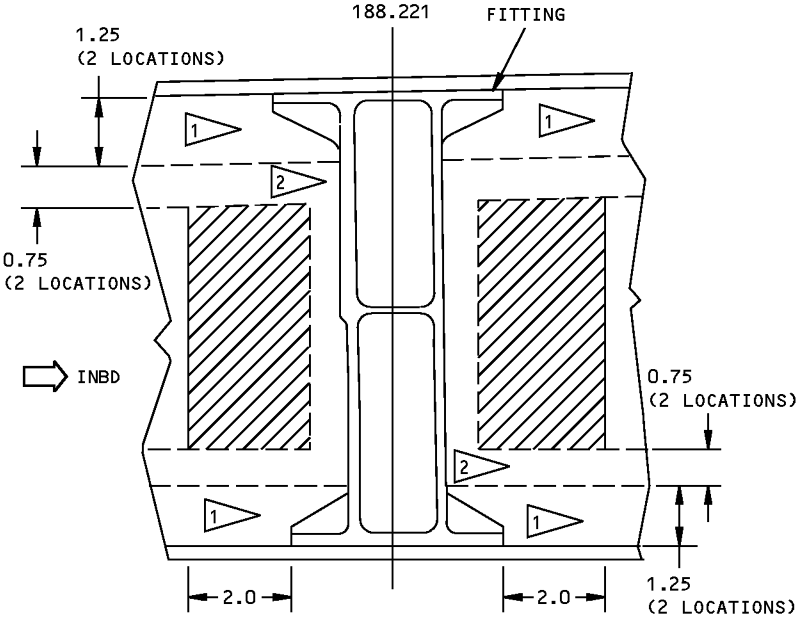
Elevator Assembly
Figure 1 (Sheet 2 of 5)



Elevator Assembly
Figure 1 (Sheet 3 of 5)

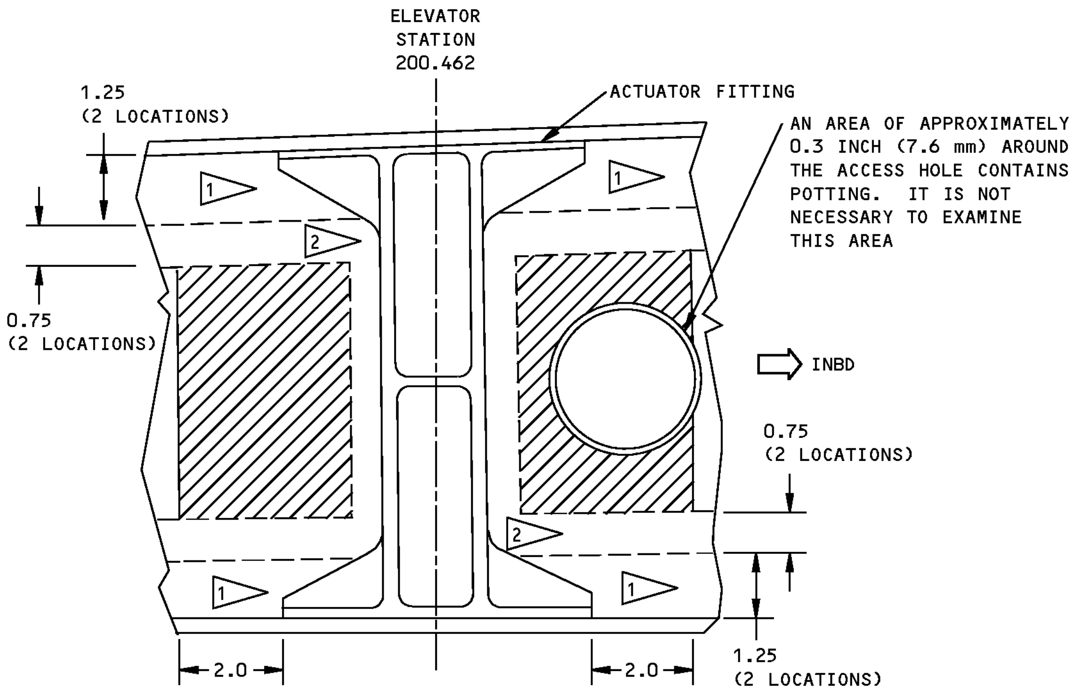


RIGHT SPAR SHOWN, LEFT SPAR OPPOSITE
VIEW AS YOU LOOK AFT
D-D

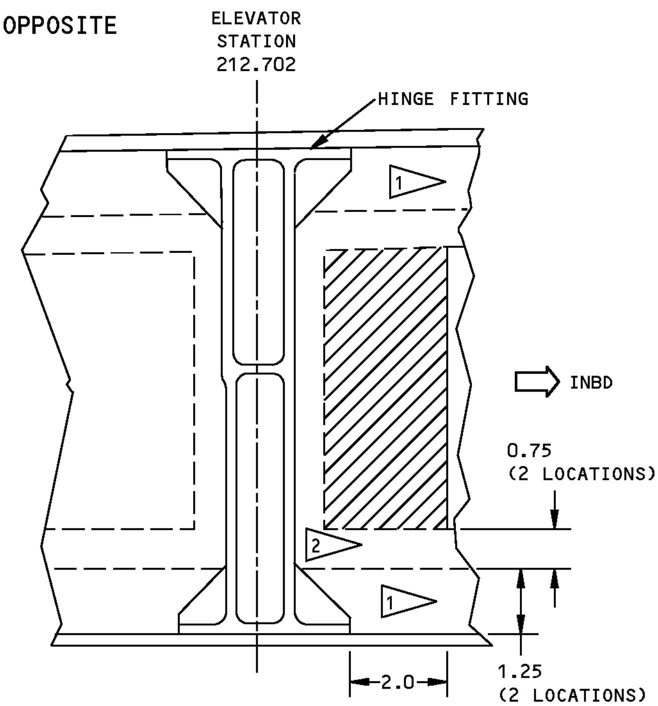


RIGHT SPAR SHOWN, LEFT SPAR OPPOSITE
VIEW AS YOU LOOK AFT
E-E

Elevator Assembly
Figure 1 (Sheet 4 of 5)



RIGHT SPAR SHOWN, LEFT SPAR OPPOSITE
VIEW AS YOU LOOK AFT
F-F



RIGHT SPAR SHOWN, LEFT SPAR OPPOSITE
VIEW AS YOU LOOK AFT
G-G

Elevator Assembly
Figure 1 (Sheet 5 of 5)

PART 4 - ULTRASONIC

FRONT SPAR EXTERNAL SURFACE ES 139.258 TO ES 212.702 (INTERPLY)

1. **Purpose**

   A. To detect interply disbonds in the exterior skins laminate structure to the front spar adjacent to actuator and hinge fittings, between ES 139.258 and ES 212.702. Refer to Figure 1, Sheet 1.

   B. Maintenance Planning Document (D622T001) Reference:

      (1) 5520-337-04E (Structures MRB number before April 2004); 55-484-00 (Structures MRB number after April 2004)

      (2) 5520-347-04E (Structures MRB number before April 2004); 55-538-00 (Structures MRB number after April 2004)

2. **Equipment**

   A. Any ultrasonic equipment that satisfies the instrument resolution check of Part 4, 51-00-02 and the performance requirements of this procedure is suitable. The following equipment was used during the development of this procedure and found acceptable.

      (1) Instrument - USL 38, Krautkramer-Branson.

      NOTE: A Bondascope 2100 (NDT Instruments Inc.) and a Bondmaster (Staveley Instruments) were used for the inspection of high attenuation material. Refer to Paragraph 6.D.(4).

      (2) Transducer - 10 MHz Alpha, 0.25-inch diameter with delay line, KB Aerotech.

      (3) Laminate Calibration Guides ST8870-7 and ST8870-8 - see Part 1, 51-04-00, Fig. 6.

      (4) Couplant - Any couplant compatible with the airplane composite structure.

      NOTE: Do not use grease, oil, glycerin or silicon based couplant on unpainted or damaged composite structures.

   B. Actuator Lock Tool A27111-11 - see Aircraft Maintenance Manual (AMM) 27-31-05

3. **Preparation for Inspection**

   A. Remove access panels numbered 335DB, 345DB, 335EB, 345EB, 335GB, 345GB, 335HB and 345HB.

   B. Remove horizontal stabilizers-to-elevator fairing seals from horizontal stabilizer lower trailing edge beam assembly, as necessary.

   C. Move elevators to up position sufficient to align forward opening in elevator with aft opening in horizontal stabilizer and gain access to the inspection area.

   D. Install Actuator Lock Tool A27111-11 to prevent movement of the elevator as specified in AMM 27-31-05.

   E. Remove loose paint and wipe inspection surface clean.

4. **Instrument Calibration**

   A. Apply a thin film of couplant to surface of calibration guides.

   B. Perform preliminary instrument adjustments per owner's operating manual.

   NOTE: Reject or signal suppressor is not to be used in calibration or inspection.

   C. Place transducer on portion of the calibration guide closest to the maximum indicated skin thickness of the inspection area (see Figure 1 for laminate thickness values).

D. Use the delay and range controls to position the front surface reflection at the left edge of screen and the back surface reflection at approximately 80 percent of screen width.

NOTE: The ability of an ultrasonic instrument to position the back surface reflection towards the far right edge of the screen is different for each manufacturer. Position the signal as far right as possible to obtain maximum ply separation.

E. Adjust back surface signal level to 50 percent full screen height (see Figure 2, Detail I).

F. Place transducer on the single ply portion of the calibration guide and fine tune the instrument adjustments to obtain optimum back surface resolution. Instrument/transducer resolution must be such that an easily definable back surface reflection is obtained (see Figure 2, Detail II).

G. Position transducer along calibration guide from the step equal to the maximum thickness to be inspected, through all intermediate steps in the inspection. At each transducer position, note location and check signal resolution along scope baseline (Figure 2, Detail III).

5. Inspection Procedure

A. Identify inspection locations and determine laminate thickness per Figure 1.

B. Calibrate instrument per Paragraph 4.

NOTE: Reject or signal suppresser is not to be used in calibration or inspection.

C. Apply couplant to the inspection surface.

D. Place transducer on the thickest part of inspection area and adjust back surface reflection to approximately 50 percent of full screen height.

NOTE: Adjust instrument sensitivity, as necessary, to maintain an approximate 50 percent back surface signal height when a change in the laminate thickness causes the signal to fall below 30 percent or increase greater than 80 percent of full screen height.

E. Scan in noted inspection areas (Figure 1). Note locations of a shift to the left of the screen in the back surface signal position along scope baseline indicating an unexpected thinning of laminate and/or a loss of signal height.

NOTE: Signal shift, as a result of laminate thickness change, should approximate equivalent thickness change on the calibration guide. Do not confuse laminate thickness changes with disbond indications. Anticipate laminate thickness variations by referring to Figure 1.

NOTE: The actual skin thickness can be different from the Figure 1 specified thickness because of the permitted ply tolerance. In an area without specified thickness changes, the actual thickness should stay constant. Signal changes will occur on the screen at locations where the thickness changes. The ply changes shown in Figure 1 can be different for different airplanes. If the inspection shows structure or thickness differences, get the necessary engineering drawings to make sure the results are correct.

NOTE: No significant signal shift should be expected when moving from an unpainted calibration guide to a painted inspection surface.

NOTE: Sound attenuation and interference signals are inherent due to the nature of graphite composites. The appearance of significant interference signals accompanied by loss of back reflection is evidence of a potential defect condition and should be noted.

F. Remove Actuator Lock Tool A27111-11 when the inspection is done. Refer to AMM 27-31-05.

6. Inspection Results

A. Signals caused from various construction or material conditions can be erroneously interpreted as defect conditions. Use Table 1 for signal identification.

Table 1 Signal Response Identification

SIGNAL SCREEN RESPONSE	FIGURE NUMBER	REFERENCE PARAGRAPH
One hundred (100) percent loss of back reflection at expected screen position with appearance of a new signal to the right of expected back reflection position.	Figure 3	Paragraph 6.B.
One hundred (100) percent loss of back reflection at expected screen position with appearance of a new signal(s) to the left of expected back reflection position.	Figure 4	Paragraph 6.C.
Eighty (80) percent to 100 percent loss of back reflection amplitude with/or without similar drop in all signals.	Figure 5	Paragraph 6.D.

B. A signal response to the right of the expected signal indicates an increase in laminate thickness and is not considered a defect condition (Figure 3, Details I and II).

(1) Check reference drawings for a ply buildup.

(2) Ply overlaps can be defined by a one-ply thickness increase not exceeding 1 inch in width and extending in a straight line.

(3) Previously repaired areas may be defined by visual evidence of a round or rectangular patch on the skin surface or by moving probe from good area into suspect area and observing a one-ply change around the edge of a round or rectangular patch.

C. A signal response to the left of the expected signal, indicating a decrease in the laminate thickness not noted in Figure 1, is a defect condition. See Figure 4, Details I, II, and III.

(1) At the same gain level as the inspection, map the extent of the discrepant area where 100 percent loss of back reflection occurs.

(2) Define the type of discrepancy by moving the transducer throughout the defect area. Reduce or increase the gain as needed to obtain signal(s) at 50 percent screen height.

(a) A single signal to the left of the expected signal location indicates a delamination. Note depth by comparison with calibration guide response obtained at the same horizontal position along scope baseline. See Figure 4, Detail II.

(b) Multiple signals on the CRT screen indicate a fracture in the laminate. See Figure 4, Detail III.

D. A signal response where back reflection drops below 20 percent of full screen height indicates a potential defect condition (Figure 5, Details I and II) which may be confirmed by the following:

(1) Increase gain to obtain a back surface reflection of 50 percent full screen height.

(2) If a definable back surface reflection is obtained:

(a) Check reference drawing for faying surface sealant. Recognition of faying surface sealant is characterized by a definable back surface reflection at a higher gain level (usually 12 to 15 dB). Signal amplitude will vary as transducer is scanned over inspection area.

(b) Check for noticeable increase in paint thickness or the addition of mylar decals on the skin surface. Recognition of excess paint or a mylar decal is characterized by a definable back surface reflection at a higher gain level with an apparent signal shift to the right.

NOTE: Paint or decal disbonds can cause erroneous defect interpretations. If necessary, remove paint or decal in suspect area.

(c) Continue inspection at increased gain level per Paragraph 5.E. as long as a definable back surface reflection is obtained.

(3) If you do not get a good back surface reflection in the area where the 0.045 inch (1.14 mm) skin thickness is adjacent to the 0.118 inch skin thickness (flagnotes 2 and 4 of Figure 1), it can be because there is too much adhesive at the edge of the core. (Figure 1, Sheet 1, flagnote 6 and the cross-section drawing of the front spar on Figure 1, Sheet 2.) Examine these areas as follows:

(a) Adjust the instrument gain so it is set to the value you got during the performance of Paragraph 5.D.

(b) Find an adjacent 0.045 inch (1.14 mm) skin thickness where you can get a good back surface reflection.

(c) Mark the location of the back surface signal on the screen of the ultrasonic instrument (use a temporary marker).

(d) Make a scan of the problem area and reject all full screen height indications that are between the front surface signal and the temporary mark.

(4) If you do not get a good back surface reflection in all areas other than the area identified in Paragraph 6.D.(3), it can be caused by high signal attenuation. Graphite/epoxy laminates with high attenuation can cause too many interference signals as shown in Figure 5, Detail III so that it is not easy to see the back surface reflection. Do the steps that follow, as necessary, if you do not get a good back surface reflection:

(a) Calibrate the instrument again with a 5 MHz transducer and examine the area again.

(b) If you cannot get a back wall signal that is 50 percent of full screen height at 5 MHz, calibrate the instrument again with a 2.25 MHz (or lower) frequency transducer or a larger diameter transducer (such as 0.5 inch) and do the inspection again.

(c) If you cannot get a 50 percent back surface reflection at the lower frequency or with a larger diameter transducer, do a careful visual inspection and an inspection with a bondtest instrument. The frequency range for the bondtest instrument must be between 100 KHz and 400 KHz. Refer to the NOTE inParagraph 2.A. The paragraphs that follow identify the different visual indications of defects.

NOTE: In areas where access to the two surfaces is available, you can do a TTU (thru-transmission ultrasonic) inspection.

NOTE: Aids to visual inspection include a 10X magnifying glass, an extending mirror, a flashlight and a borescope.

1) Impact Damage - Indications of impact damage include:

a) Cracked, crazed, or chipped paint.

b) Indentations on structure surface.

c) Cracked or fractured plies, partial loss of ply buildup and/or total ply loss showing internal damage to honeycomb structure.

2) Lightning Strike - Indications of lightning strike include:

a) Blistered, scorched, chipped and/or discolored paint.

b) Frayed fibers.

c) Partial loss of ply buildup.

d) Delamination.

e) Total ply loss.

f) Evidence of stress around fasteners.

3) Erosion - Indications of erosion include:

a) Chipped and/or missing paint.

b) Worn and/or frayed plies.

c) Missing plies.

4) Stress - Indications of stress damage include:

a) Fastener hole damage such as:

<1> chipped, loose, or raised paint

<2> fastener pull-through

5) Cracks - Indications of crack damage include:

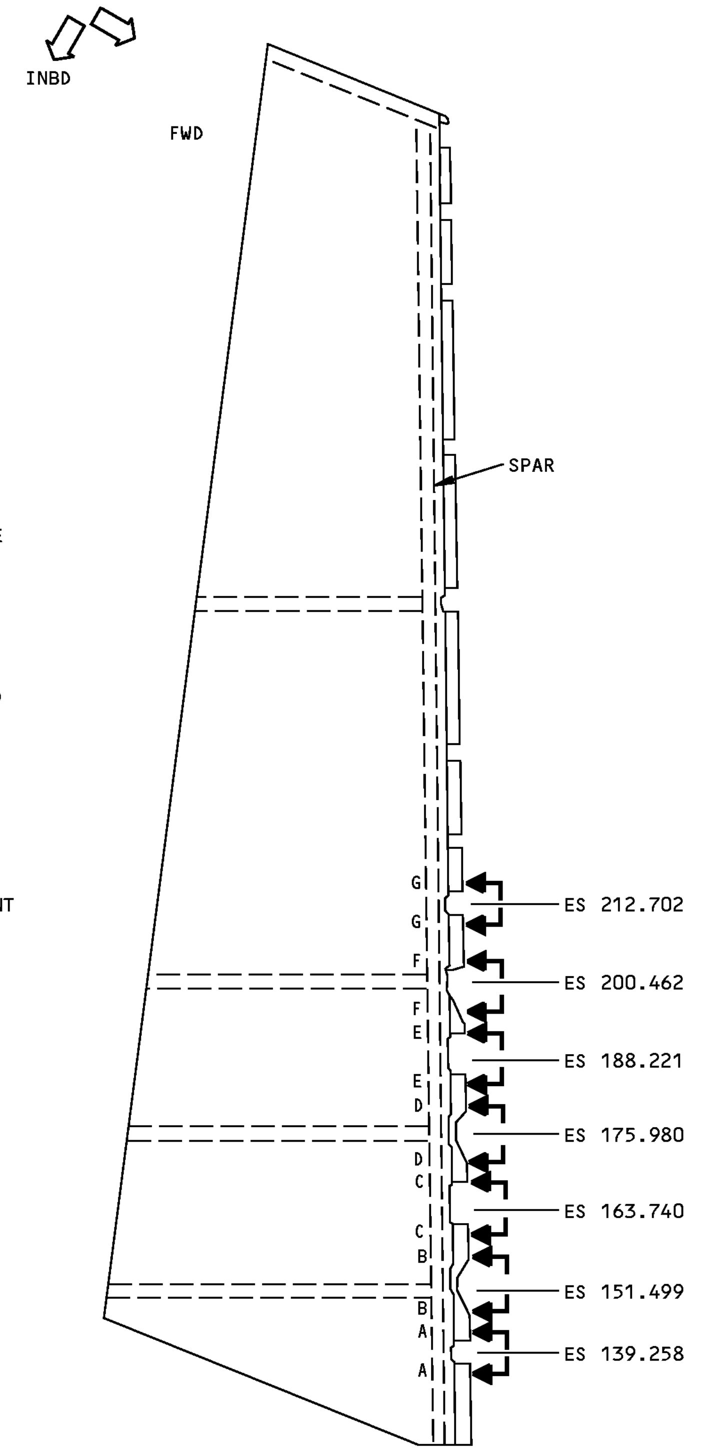
a) Fractured plies evidenced by linear cracking of paint.

b) Member displacement.

6) Burn or Overheating - Indications of burn or overheating include:

a) Blistered and/or discolored paint.

(d) Accept the parts if no indications are found by the visual or bondtest inspections.



NOTES

- VIEW AS YOU LOOK UP
- RIGHT ELEVATOR SHOWN, LEFT ELEVATOR OPPOSITE
- ALL DIMENSIONS ARE IN INCHES, MILLIMETERS ARE IN (PARENTHESES).
- RIB LOCATIONS NOT SHOWN
- IT IS ACCEPTABLE FOR THE SKIN THICKNESS TO BE DIFFERENT FROM THE THICKNESSES IDENTIFIED IN FLAGNOTES 1,2,3,4, AND 5 BECAUSE OF THE PERMITTED PLY THICKNESS TOLERANCE. BUT, IN EACH AREA IDENTIFIED, THE THICKNESS MUST STAY CONSTANT.

  WHERE SKIN THICKNESS CHANGES ARE SHOWN IN THE FIGURES, A CHANGE IN THE SIGNAL MUST OCCUR. THE LIMIT OF EACH IDENTIFIED SKIN THICKNESS AREA CAN BE DIFFERENT FOR DIFFERENT EFFECTIVITIES. IF AN INSPECTION SHOWS A STRUCTURE OR THICKNESS DIFFERENCE, GET THE NECESSARY ENGINEERING DRAWINGS TO MAKE SURE THE RESULTS ARE CORRECT.

1. PLY THICKNESS - 0.088 (2.2 mm)
2. PLY THICKNESS - 0.118 (3.0 mm)
3. PLY THICKNESS - 0.053 (1.4 mm)
4. PLY THICKNESS - 0.045 (1.1 mm)
5. PLY THICKNESS - 0.037 (0.9 mm)
6. IT CAN BE DIFFICULT TO GET A BACKWALL SIGNAL IN THE AREA WHERE THE NEAR SIDE AND FAR SIDE SKINS MEET AT THE CORE EDGE. THIS IS CAUSED BY THE ADHESIVE THAT FILLS IN THE SMALL SPACE BETWEEN THE CORE EDGE AND THE LAMINATED SKINS.
7. MAKE A SCAN OF ALL ACCESSIBLE AREAS OF THE FRONT SPAR WITHIN AN AREA 2.0 INCHES (50.8 mm) EACH SIDE OF ALL HINGE AND ACTUATOR FITTINGS.

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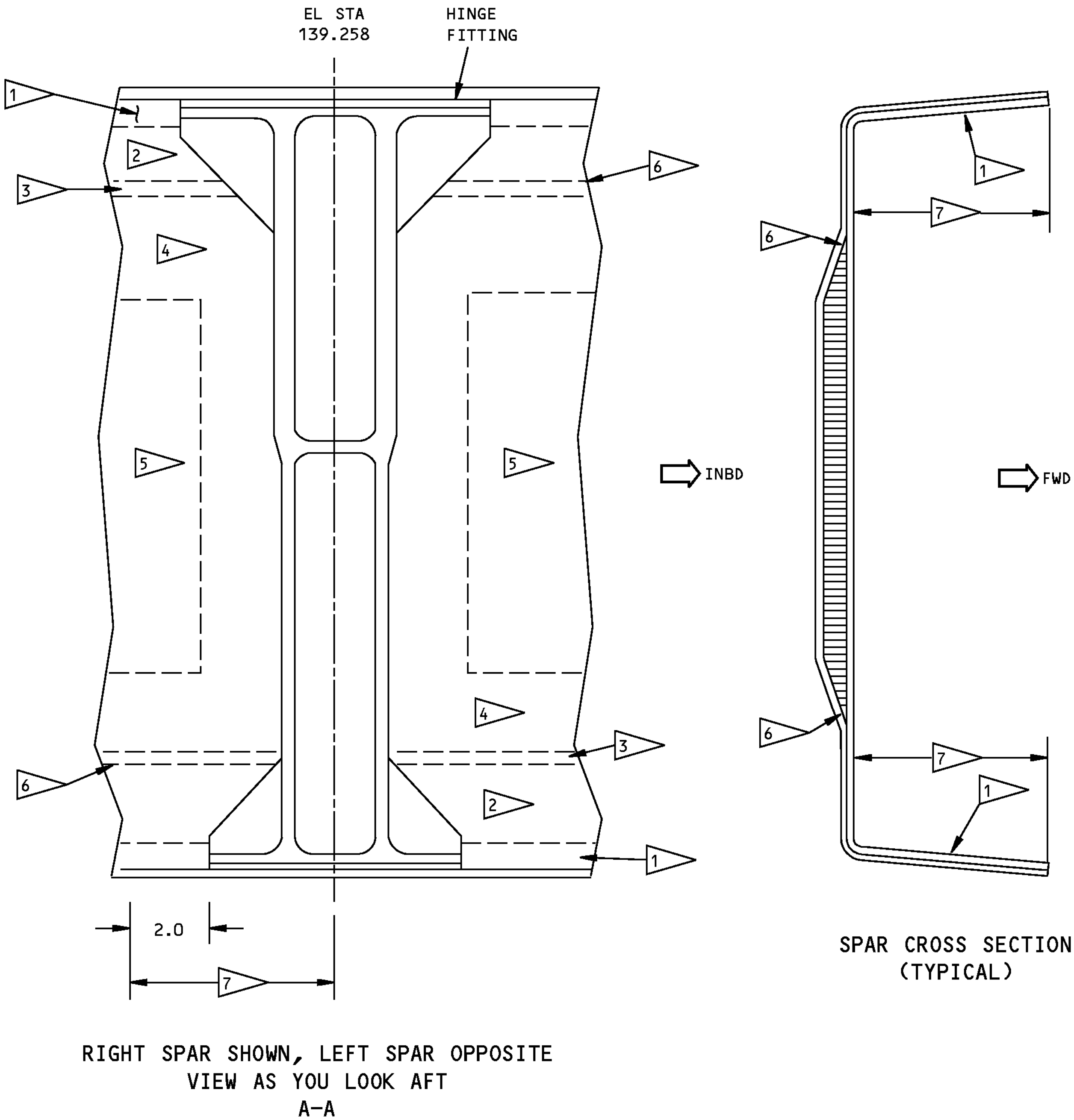
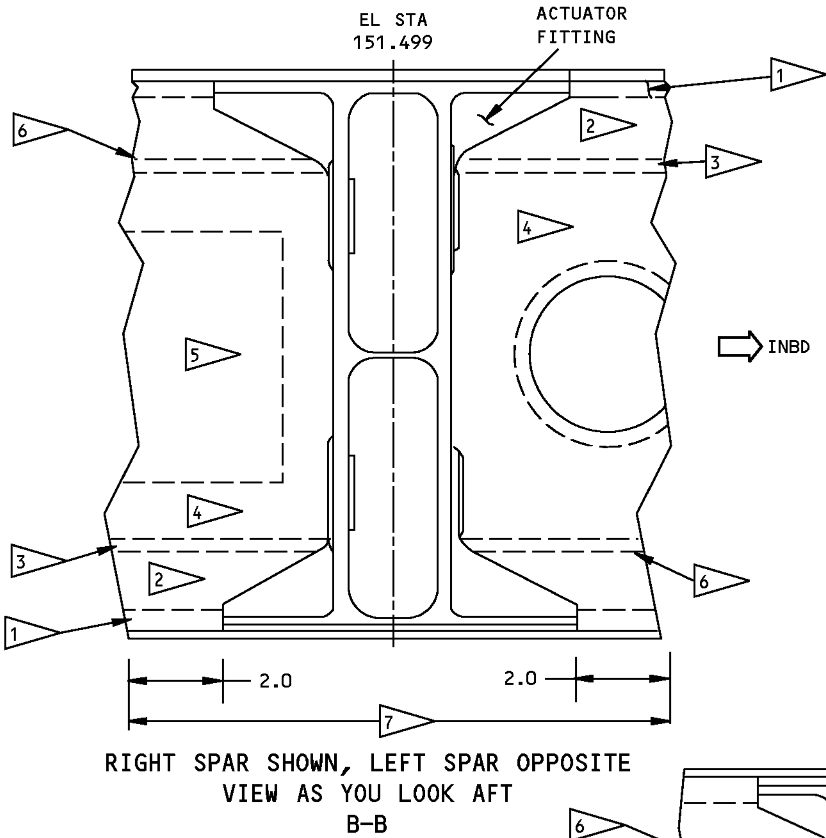
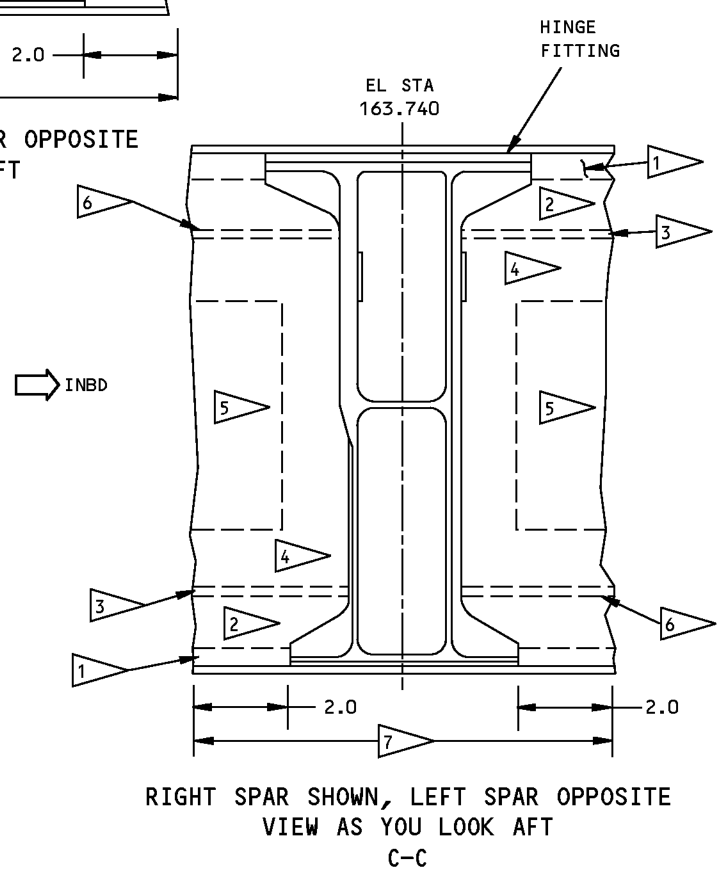
Elevator Assembly
Figure 1 (Sheet 1 of 5)

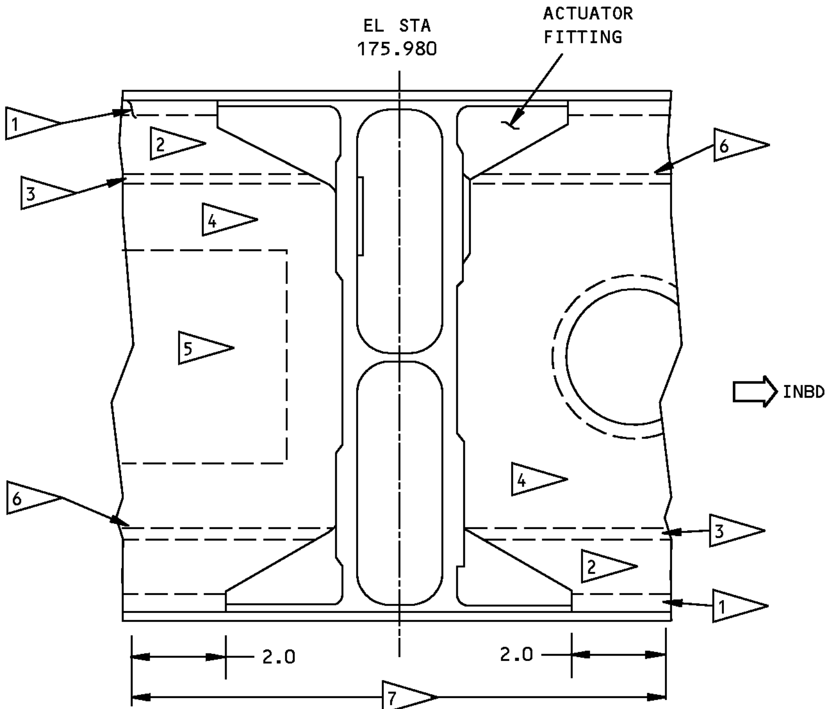


Elevator Assembly
Figure 1 (Sheet 2 of 5)

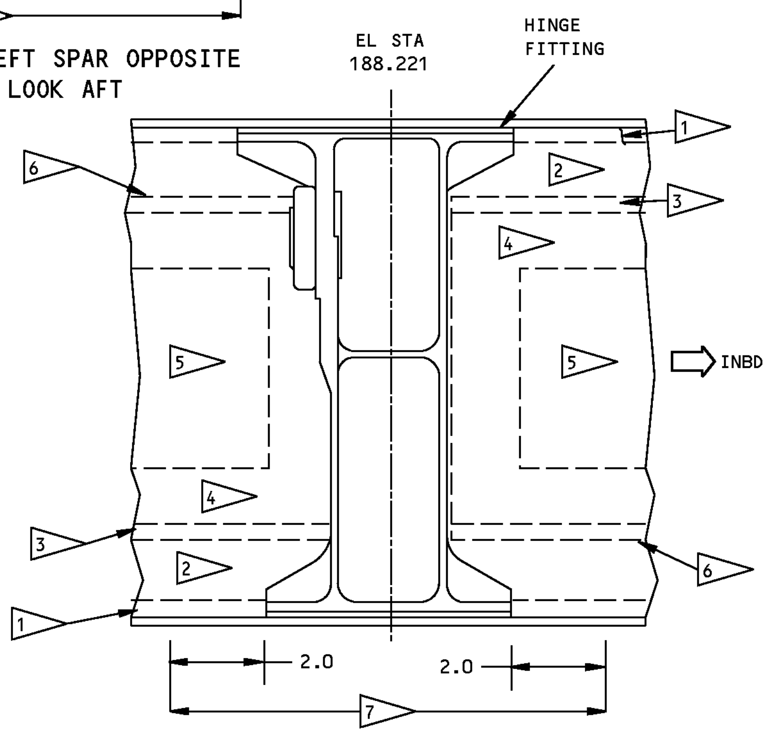




Elevator Assembly
Figure 1 (Sheet 3 of 5)

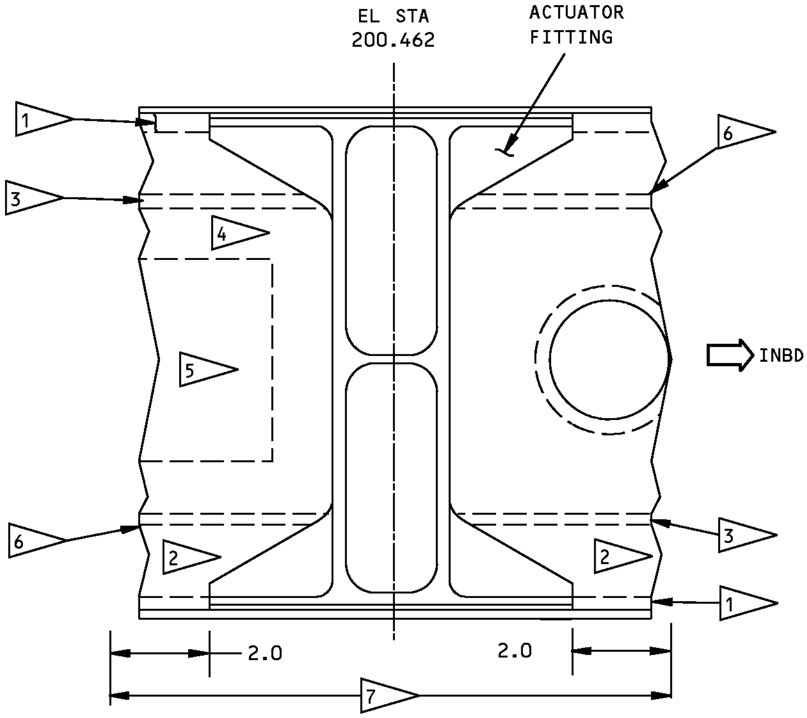


RIGHT SPAR SHOWN, LEFT SPAR OPPOSITE
VIEW AS YOU LOOK AFT
D-D

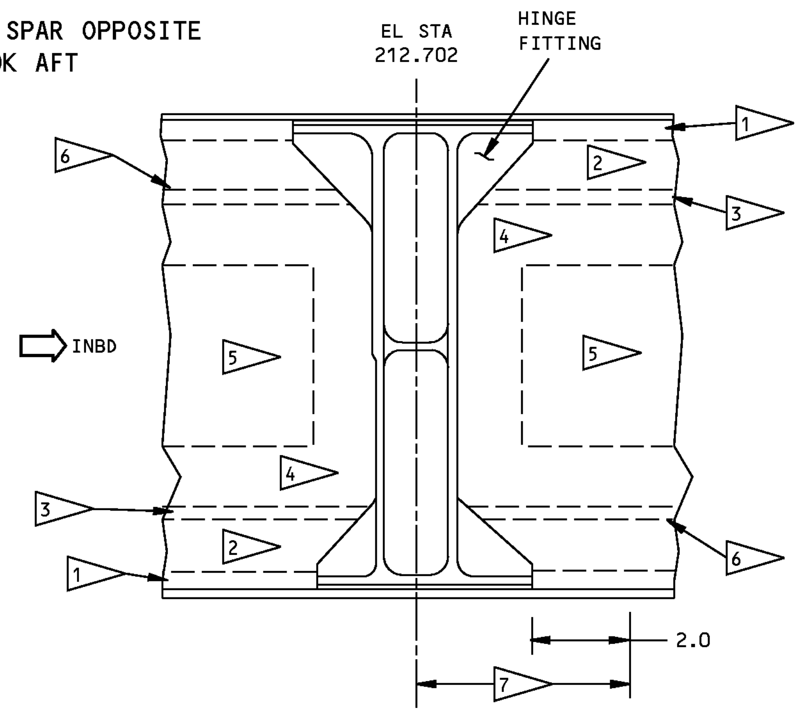


RIGHT SPAR SHOWN, LEFT SPAR OPPOSITE
VIEW AS YOU LOOK AFT
E-E

Elevator Assembly
Figure 1 (Sheet 4 of 5)

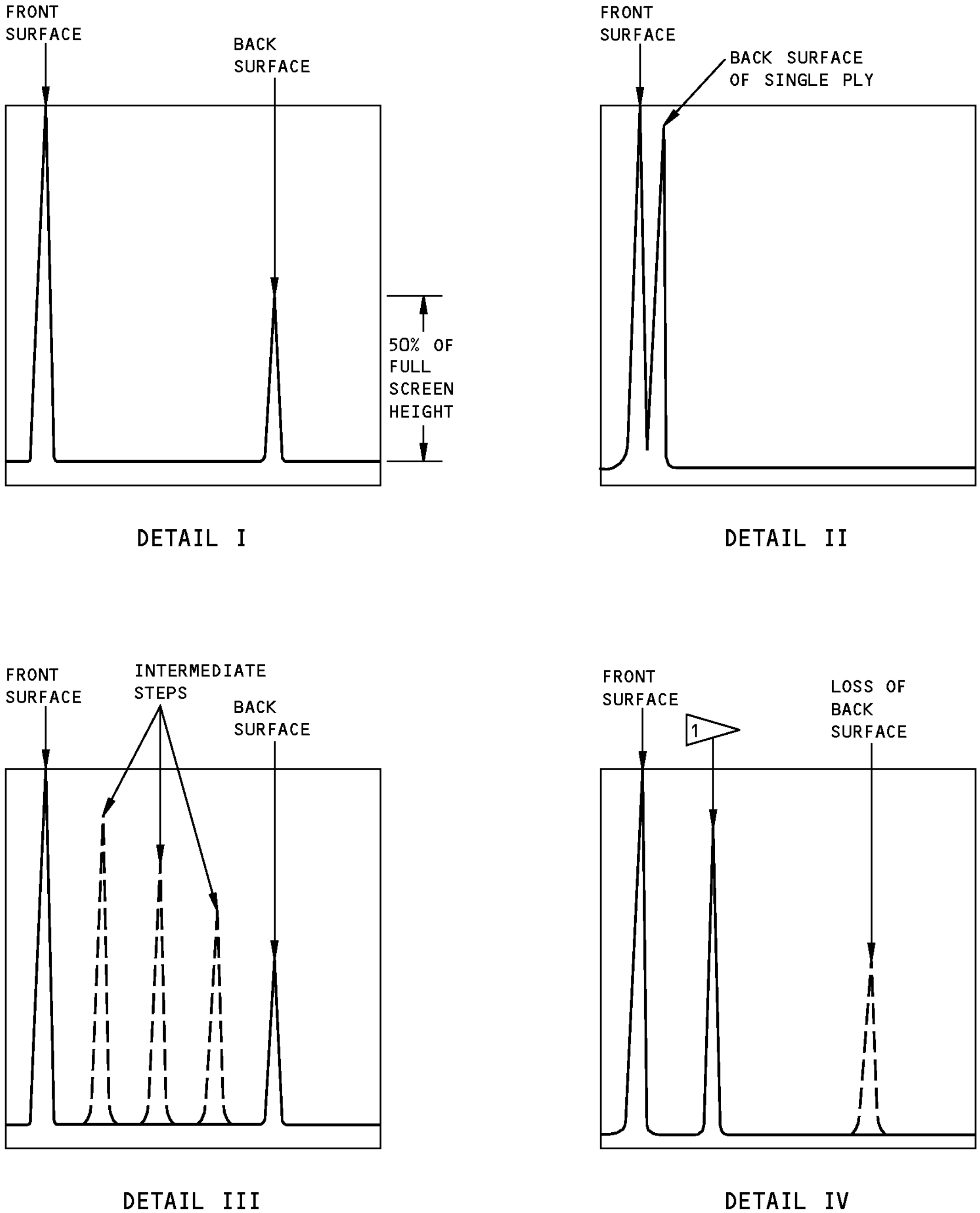


RIGHT SPAR SHOWN, LEFT SPAR OPPOSITE
VIEW AS YOU LOOK AFT
F-F



RIGHT SPAR SHOWN, LEFT SPAR OPPOSITE
VIEW AS YOU LOOK AFT
G-G

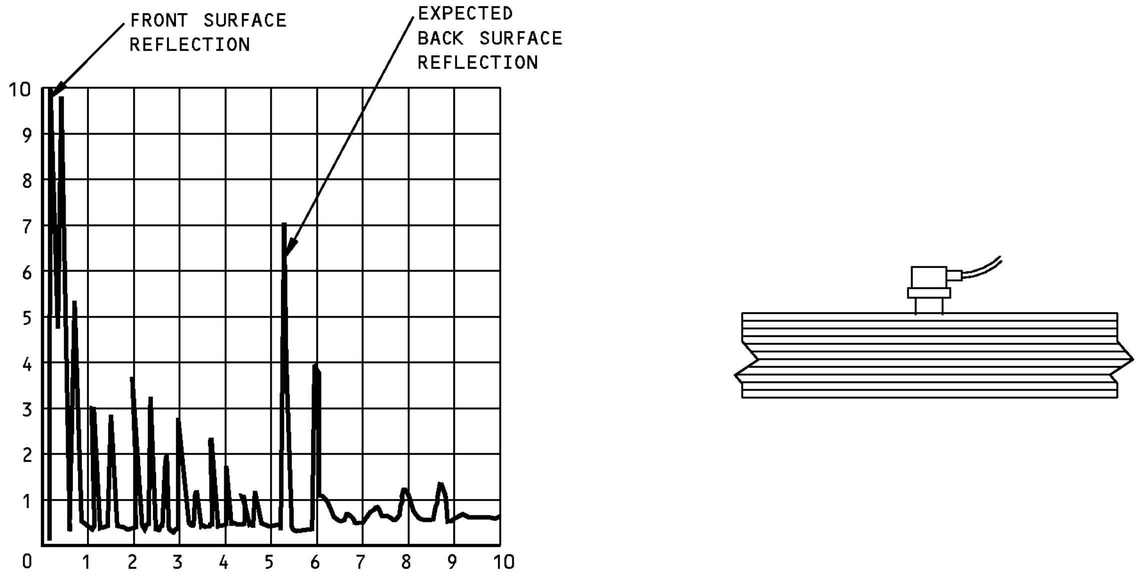
Elevator Assembly
Figure 1 (Sheet 5 of 5)



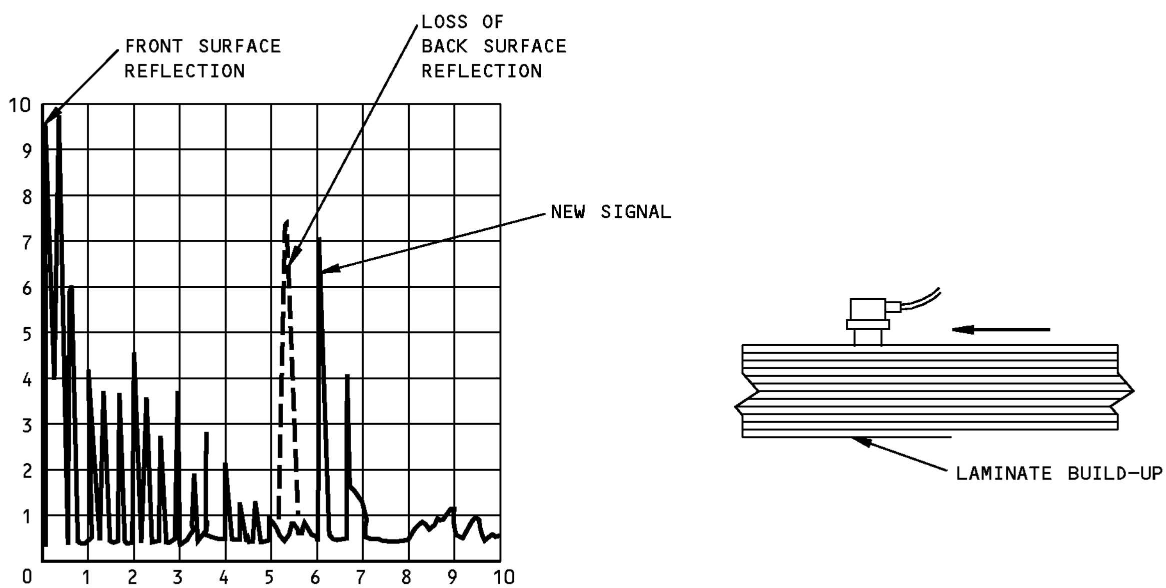
NOTE

1 SHIFTED SIGNAL POSITION REPRESENTING A TYPICAL DISBOND

Instrument Calibration
Figure 2

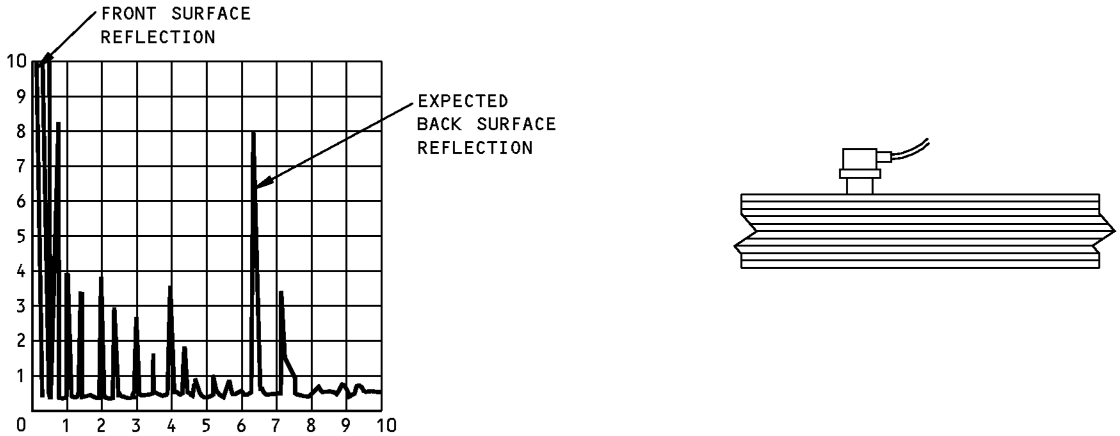


EXPECTED SCREEN RESPONSE
DETAIL I

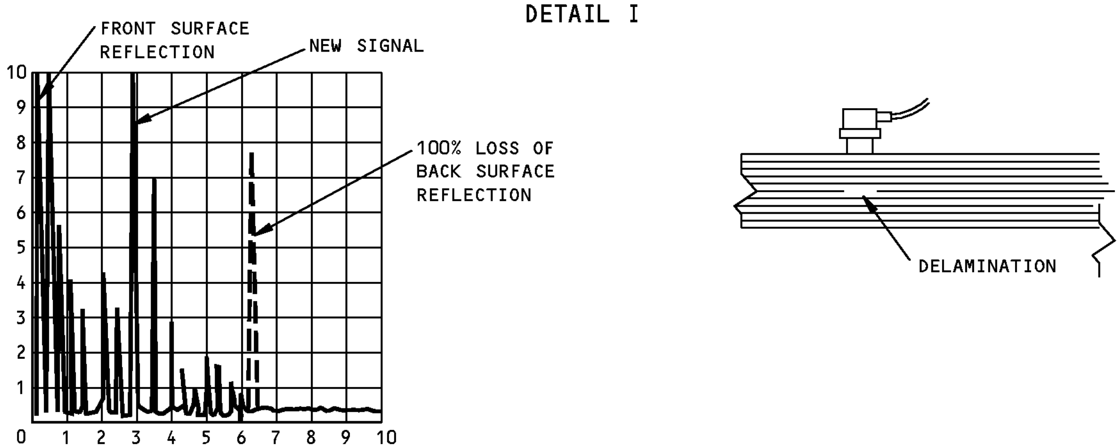


LAMINATE THICKNESS INCREASE RESPONSE
DETAIL II

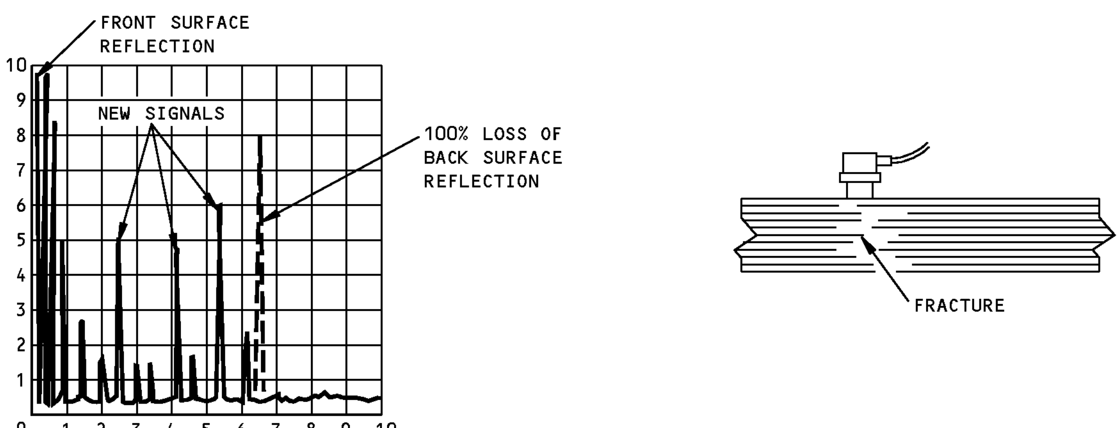
Signal Response Identification
Figure 3



EXPECTED SCREEN RESPONSE
DETAIL I

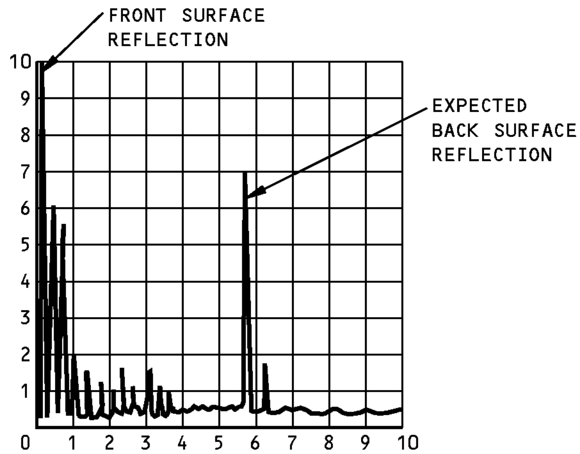


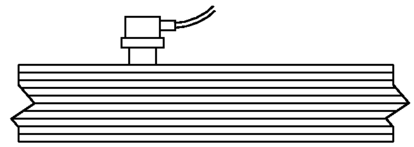
DELAMINATION RESPONSE
DETAIL II



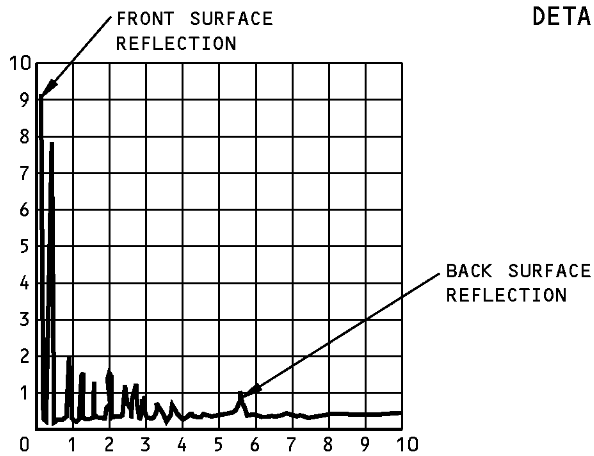
FRACTURE RESPONSE
DETAIL III

Signal Response Identification
Figure 4





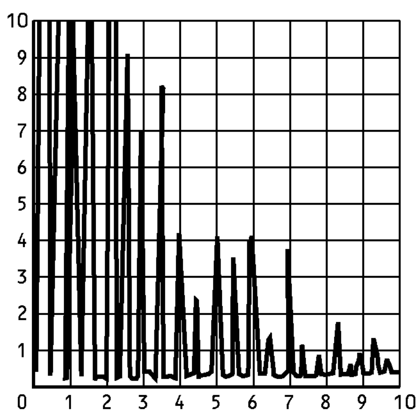
EXPECTED SCREEN RESPONSE
DETAIL I



NOTES

- 80-100 PERCENT LOSS OF BACK SURFACE REFLECTION AMPLITUDE
- ACCOMPANYING SIGNALS MAY ALSO DECREASE

LOSS OF BACK SURFACE REFLECTION
DETAIL II



NOTES

- NO IDENTIFIABLE BACK SURFACE REFLECTION WITH INCREASED INSTRUMENT GAIN

EXCESSIVE INTERFERENCE SIGNALS - "HASH"
DETAIL III

Signal Response Identification
Figure 5

PART 4 - ULTRASONIC

SKIN PANEL EXTERNAL SURFACE ES 139.258 TO ES 212.702

1. **Purpose**

   A. To detect interply disbonds in the laminate structure of the skin panel between ES 139.258 and ES 212.702 from the front spar to the trailing edge. Refer to Figure 1, Sheet 1.

   B. Maintenance Planning Document (D622T001) Reference:

      (1) 5520-337-04E

      (2) 5520-347-04E

2. **Equipment**

   NOTE: Any ultrasonic equipment capable of meeting the performance requirements of this procedure may be used. See Part 1, 51-01-00 for a list of equipment manufacturers.

   A. Instrument - Any ultrasonic instrument capable of operating between 1 MHz and 12 MHz that satisfied the instrument resolution check of Part 4, 51-00-02 may be used. The following instrument was used in developing this procedure.

      (1) USL 38 manufactured by Krautkramer-Branson.

      NOTE: A Bondascope 2100 (NDT Instruments Inc.), Bondmaster (Staveley Instruments), or an S-9R (Zetec) instrument can be used for the inspection of high attenuation material. Refer to Paragraph 6.A.(1)(c)3).

   B. Transducers

      (1) Pulse echo

         (a) For the initial inspection, use a highly damped 5.0 MHz, 0.50 inch (13 mm) diameter, delay line transducer. The transducer that follows was used to help prepare this procedure:

            1) Aerotech Alpha delay line transducer, part number 389-024-410; made by Krautkramer Branson.

            NOTE: You can use smaller transducers, as specified in the first revisions of this procedure, but scans will take longer. Also, it will be more difficult to find and monitor the back surface signal on structure with high attenuation.

         (b) To examine delamination indications, use a highly damped 10 MHz, 0.250 inch (6.4 mm) diameter, delay line transducer. The transducer and instrument, used together, must have one ply resolution as specified in Part 4, 51-00-02. The transducer that follows was used to help prepare this procedure:

            1) Aerotech Alpha delay line transducer, part number 126-660; made by Krautkramer Branson.

      (2) Through-transmission - Two 2.25 to 5.0 MHz delay line transducers are required. Transducer diameters of 0.25 to 0.50-inch are required. The following transducers were used to develop this procedure:

         (a) 2.25 MHz, Alpha, with removable Lucite tips manufactured by KB Aerotech.

         (b) 5.0 MHz, Alpha, with removable Lucite tips manufactured by KB Aerotech.

   C. Laminate Calibration Guides ST8870-7 and ST8870-8 - see Part 1, 51-04-00, Fig. 8.

   D. Couplant - Any couplant compatible with airplane composite structure.

      NOTE: Do not use grease, glycerin, or silicon-based couplant on unpainted or damaged composite structures.

E. Actuator Lock Tool A27111-11 - see AMM 27-31-05.

3. **Preparation for Inspection**

A. Remove access panels numbered 335DB, 345DB, 335EB, 345EB, 335GB, 345GB, 335HB and 345HB.

B. Remove horizontal stabilizer-to-elevator fairing seals (both upper and lower) from horizontal stabilizer trailing edge beam assembly, as necessary.

C. Alternate elevator between full up, neutral, and full down positions to facilitate 100 percent coverage of the noted upper and lower skins inspection area.

D. Install Actuator Lock Tool A27111-11 to prevent movement of the elevator as specified in Maintenance Manual 27-31-05.

E. Remove loose paint and wipe inspection surface clean.

4. **Instrument Calibration**

A. Pulse-Echo Calibration

(1) Apply a thin film of couplant to surface of calibration guides.

(2) Connect single transducer (Paragraph 2.B.(1)) and perform preliminary instrument adjustments for pulse-echo testing per owner operating manual.

NOTE: Reject or signal suppressor is not to be used in calibration or inspection.

(3) Place transducer on portion of the calibration guide closest to the maximum indicated skin thickness (see Figure 1 for laminate thickness values) of the inspection area.

(4) Use the delay and range controls to position the front surface reflection at the left edge of screen and the back surface reflection at approximately 70 percent of screen width (Figure 2, Detail I).

NOTE: The ability of an ultrasonic instrument to position the back surface reflection towards the far right edge of the screen is different for each manufacturer. Position the signal as far right as possible to obtain maximum ply separation.

(5) Adjust back surface signal level to 80 percent of full screen height (Figure 2, Detail I).

(6) Place transducer on the ply step of the calibration guide that is as near as possible to the minimum skin thickness to be examined. Fine tune the instrument adjustments to obtain optimum back surface resolution. Instrument/transducer resolution must be such that an easily definable back surface reflection is obtained (Figure 2, Detail II).

(7) Position transducer along calibration guide from the step equal to the maximum thickness to be inspected, through all intermediate steps in the inspection. Make a note of the signal change that occurs when you move the transducer across a ply step.

B. Through-Transmission Calibration

(1) Connect two transducers and perform preliminary instrument adjustments for through-transmission inspection per owners operating manual.

NOTE: Reject or signal suppressor is not to be used in calibration or inspection.

(2) Put couplant on the end of one of the delay tips and place tips together making sure good contact is made.

(3) Adjust instrument controls to get the initial pulse signal on the left edge of the screen and the through-transmission signal at approximately mid screen (Figure 3).

(4) Apply a thin film of couplant to both surfaces of step 8 of Calibration Guide ST8870-7.

(5) Line up transducers on step 8 of the calibration guide.

NOTE: The use of one 0.25-inch delay line transducer and one 0.50-inch transducer increases the ease of inspection.

(6) Adjust through-transmission signal level to 100 percent of full screen height.

5. **Inspection Procedure**

A. Pulse-echo Inspection

(1) Identify inspection locations and determine laminate thickness per Figure 1.

(2) Calibrate instrument per Paragraph 4.A.

NOTE: Reject or signal suppresser is not to be used in calibration or inspection.

(3) Apply couplant to inspection surface.

(4) Place transducer on thickest part of inspection area and adjust back surface reflection to approximately 80 percent of full screen height.

NOTE: Adjust instrument gain, as necessary, to maintain an approximate 80 percent back surface signal height when a change in the laminate thickness or contour causes the signal to fall below 50 percent or increase greater than 100 percent of full screen height [adjust per Paragraph 4.A. and Paragraph 5.A.(4)].

(5) Scan in noted inspection areas on both upper and lower surfaces (Figure 1). Note location of a shift to the left of the screen in back surface signal position along scope baseline indicating an unexpected thinning of laminate, and/or a loss of signal height.

NOTE: Signal shift, as a result of laminate thickness change, should approximate equivalent thickness change on the calibration guide. Do not confuse laminate thickness changes with disbond indications. Anticipate laminate thickness variations by referring to Figure 1.

NOTE: The actual skin thickness can be different from the Figure 1 specified thickness because of the permitted ply tolerance. In an area without specified thickness changes, the actual thickness should stay constant. Signal changes will occur on the screen at locations where the thickness changes. The ply changes shown in Figure 1 can be different for different airplanes. If the inspection shows structure or thickness difference, get the necessary engineering drawings to make sure the results are correct.

NOTE: No significant signal shift should be expected when moving from an unpainted calibration guide to a painted inspection surface.

NOTE: Sound attenuation and interference signals are inherent due to the nature of graphite composites. The appearance of significant interference signals accompanied by loss of back reflection not identified with faying surface is evidence of a potential defect condition and should be noted.

B. Through-Transmission Inspection

(1) Identify inspection locations with faying surface sealant and determine laminate thickness per Figure 1.

(2) Calibrate instrument per Paragraph 4.B.

(3) Apply couplant to both sides of inspection surfaces.

(4) Line up transducers on a good section of inspection area and adjust through-transmission signal to 100 percent of full screen height (maximum 20 dB increase above calibration settings).

(5) Scan between fasteners in inspection areas with faying surface sealant (Figure 1). Note locations where there is a 90 percent or greater loss of the signal.

C. Remove Actuator Lock Tool A27111-11 when the inspection is done. Refer to Maintenance Manual 27-31-05.

6. **Inspection Results**

A. Pulse-Echo Results

(1) Signals caused from various construction or material conditions can be erroneously interpreted as defect conditions. Use Table 1 for signal identification.

Table 1 Signal Response Identification

SIGNAL SCREEN RESPONSE	FIGURE NUMBER	REFERENCE PARAGRAPH
One hundred (100) percent loss of back reflection at expected screen position with appearance of a new signal to the right of expected back reflection position.	Figure 4	Paragraph 6.A.(1)(a)
One hundred (100) percent loss of back reflection at expected screen position with appearance of a new signal(s) to the left of expected back reflection position.	Figure 5	Paragraph 6.A.(1)(b)
Eighty (80) percent to 100 percent loss of back reflection amplitude with/or without similar drop in all signals.	Figure 6	Paragraph 6.A.(1)(c)

(a) A signal response to the right of the expected signal indicates an increase in laminate thickness and is not considered a defect condition (Figure 4).

1) Check reference drawings for a ply buildup.

2) Ply overlaps can be defined by a one-ply thickness increase not exceeding 1 inch in width and extending in a straight line.

3) Previously repaired areas may be defined by visual evidence of a round or rectangular patch on the skin surface or by moving probe from good area into suspect area and observing a one-ply change around the edge of a round or rectangular patch.

(b) A signal response to the left of the expected signal, indicating a decrease in the laminate thickness not noted in Figure 1, is a defect condition. See Figure 5.

1) At the same gain level as the inspection, map the extent of the discrepant area where 100 percent loss of back reflection occurs.

2) A single signal to the left of the expected signal location indicates a delamination. Note depth by comparison with calibration guide response obtained at the same horizontal position along scope baseline. See Figure 5, Detail II.

3) An increase in width of the front surface signal, with a loss of back surface signal, is a sign of a near surface delamination. See Figure 5, Detail III.

4) Examine all indications like those in Paragraph 6.A.(1)(b)2) and Paragraph 6.A.(1)(b)3) above with a 10 MHz, 0.250-inch (6.4 mm) diameter transducer. Refer to Paragraph 2.B.(1)(b) and Part 4, 51-00-02.

(c) A signal response where back reflection drops below 20 percent of full screen height indicates a potential defect condition (Figure 6, Details I and II) which may be confirmed by the following:

1) Increase gain to obtain a clear back surface reflection.

2) If a clear back surface reflection is obtained:

a) Check reference drawing for faying surface sealant. Recognition of faying surface sealant is characterized by a clear back surface reflection at a higher gain level (usually 12 to 15 dB). Signal amplitude will vary as transducer is scanned over inspection area.

b) Check for noticeable increase in paint thickness or the addition of mylar decals on the skin surface. Recognition of excess paint or a mylar decal is characterized by a clear back surface reflection at a higher gain level with an apparent signal shift to the right.

NOTE: Paint or decal disbonds can cause erroneous defect interpretations. If necessary, remove paint or decal in suspect area.

c) Continue inspection at increased gain level per Paragraph 5.A.(5) as long as a clear back surface reflection is obtained.

3) If you do not get a clear back surface reflection, it can be because of one of the two causes that follow:

a) Fay surface sealant between the ribs and the outer panels can cause a loss of back surface reflection. This usually occurs between the fasteners that are along the length of the rib area. If a signal from the back surface can be identified on the outer edges of the rib area, no more inspection is necessary. If you do not get a back surface signal on the outer edges of the rib area, go to Paragraph 6.A.(1)(c)3)b).

b) Graphite/epoxy laminate with high attenuation properties can create too many interference signals so that it is not easy to see the back surface reflection. Refer to Figure 6, Detail III. If this occurs, calibrate the instrument again with a lower frequency transducer or a larger diameter transducer (we recommend 0.5 inch). Figure 6, Detail IV shows the effect when you use a lower frequency transducer. If you do not get a clear back surface signal at a lower frequency or with a larger diameter transducer, do a careful visual inspection and an inspection with a bondtest instrument as specified in Part 4, 51-00-01. The operating frequency range for the bondtest instrument must be between 100 KHz and 400 KHz. Refer to the NOTE in Paragraph 2.A. Accept the parts if no indications are found by the visual and bondtest inspections. The paragraphs that follow identify the different visual indications of defects. If you do not get a clear signal with a bondtest instrument, do a skin-to-core inspection of the honeycomb area adjacent to the areas that cannot be examined. The honeycomb area should be examined for approximately 3 inches on each side of the ribs and/or 3 inches aft of the forward laminate area. Refer to Part 4, 51-00-05 for the inspection procedure. Accept the parts if no indications are found with the visual or skin-to-core inspections.

NOTE: The honeycomb area adjacent to the ribs begins at approximately 1 inch on each side of the fasteners through the rib. The skin thickness in these areas is 5 plies. The honeycomb area aft of the forward laminate area begins approximately 4.5 inches aft of the actuator cutout portions of the skin. The skin thickness in these areas is six plies. In all of these areas, the skin thickness decreases to four plies to the center of the honeycomb area.

NOTE: In areas where access to the two surfaces is available, you can do a TTU (thru-transmission ultrasonic) inspection.

NOTE: Aids to visual inspection include a 10X magnifying glass, an extending mirror, a flashlight, and a borescope.

<1> Impact Damage - Indications of impact damage include:

<a> Cracked, crazed, or chipped paint.

<b> Indentations on structure surface.

<c> Cracked or fractured plies, partial loss of ply buildup and/or total ply loss showing internal damage to honeycomb structure.

<2> Lightning Strike - Indications of lightning strike include:

<a> Blistered, scorched, chipped and/or discolored paint.

<b> Frayed fibers.

<c> Partial loss of ply buildup.

<d> Delamination.

<e> Total ply loss.

<f> Evidence of stress around fasteners.

<3> Erosion - Indications of erosion include:

<a> Chipped and/or missing paint.

<b> Worn and/or frayed plies.

<c> Missing plies.

<4> Stress - Indications of stress damage include:

<a> Fastener hole damage such as: chipped, loose, or raised paint; fastener pull-through

<5> Cracks - Indications of crack damage include:

<a> Fractured plies evidenced by linear cracking of paint.

<b> Member displacement.

<6> Burn or Overheating - Indications of burn or overheating include:

<a> Blistered and/or discolored paint.

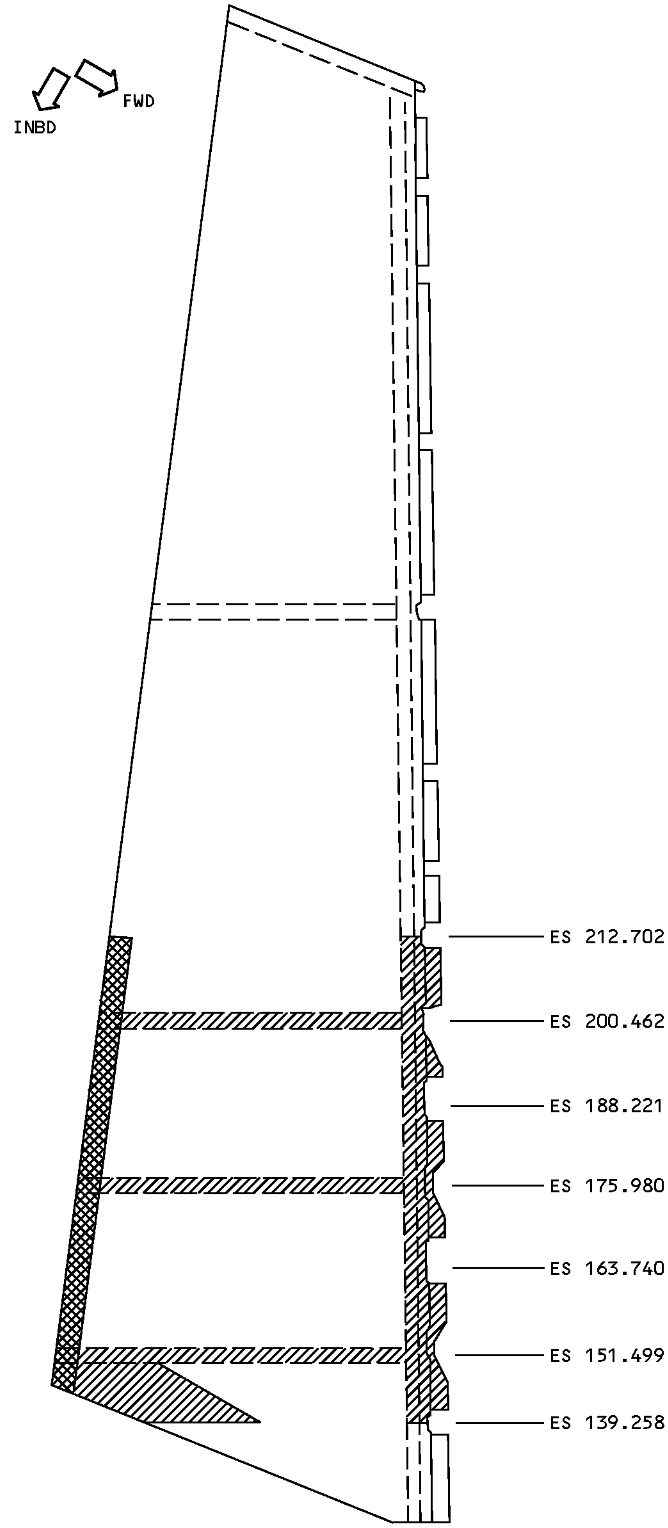
B. Through-Transmission Results

(1) Any loss of the through-transmission signal greater than 90 percent of signal height, covering an area greater than 0.5-inch by 0.5-inch, may indicate a defect condition and the following steps should be performed.

(a) Use pulse-echo technique, Paragraph 4.A. and Paragraph 5.A., to determine cause of back surface signal loss.

1) If back surface signal appears on screen at expected position for noted laminate thickness (Figure 1), there is a lack of faying surface sealant. This condition is permitted if the rivets and the laminate edges along the trailing edge flanges show no signs of damage or distress.

2) If back surface signal shifts indicating a laminate thinning not noted in Figure 1, a disbond is located at the shifted signal position depth and further investigation is required.



NOTES

- VIEW LOOKING DOWN
- LEFT ELEVATOR SHOWN, RIGHT ELEVATOR OPPOSITE
- ALL DIMENSIONS ARE IN INCHES

1 PLY THICKNESS - 0.066

2 PLY THICKNESS - 0.070

3 PLY THICKNESS - 0.073

4 PLY THICKNESS - 0.082

5 PLY THICKNESS - 0.120

6 PLY THICKNESS - 0.128

7 PLY THICKNESS - 0.137

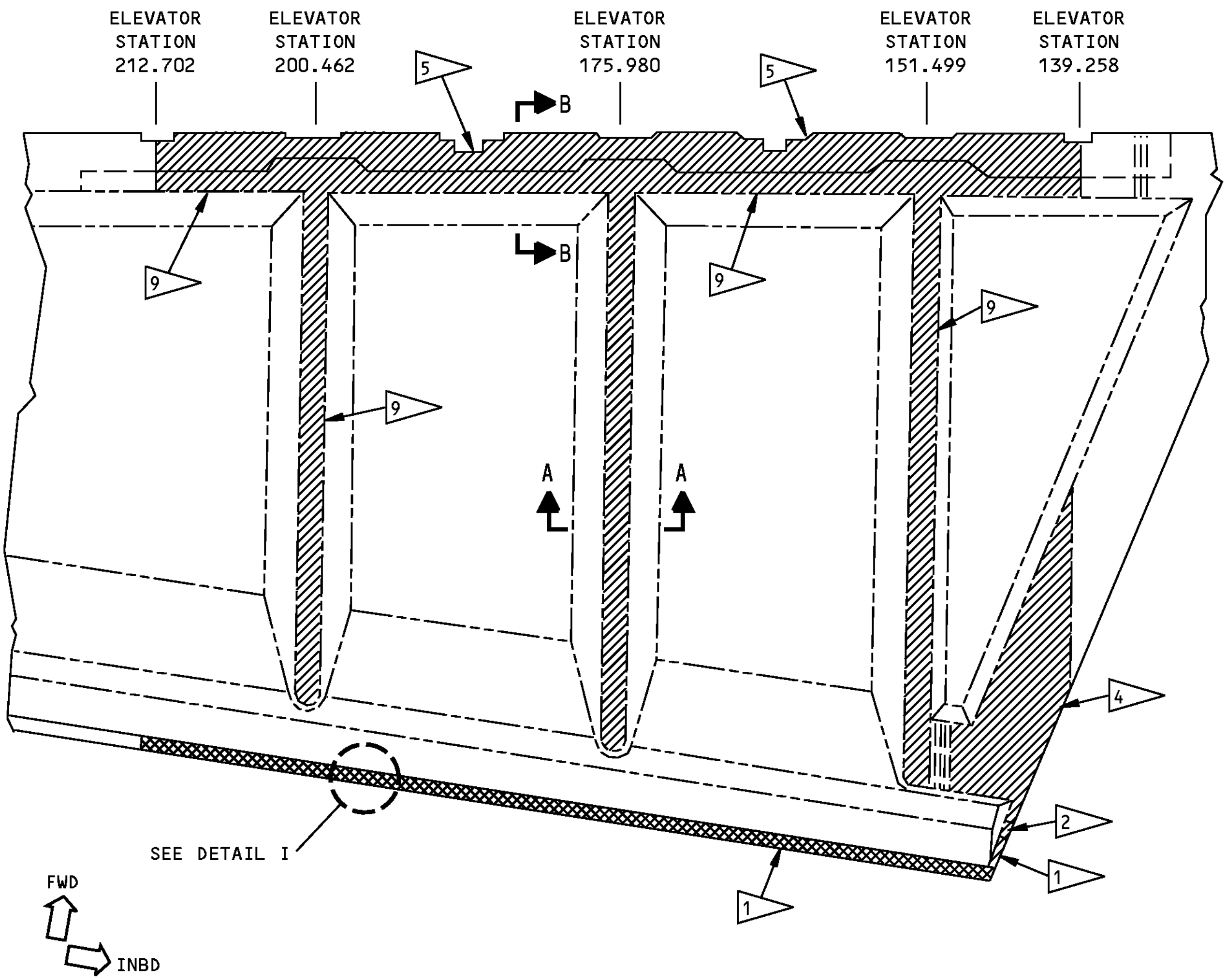
8 PLY THICKNESS - 0.154

9 PLY THICKNESS - 0.167

PLY THICKNESS INSPECTION AREA (PULSE - ECHO)

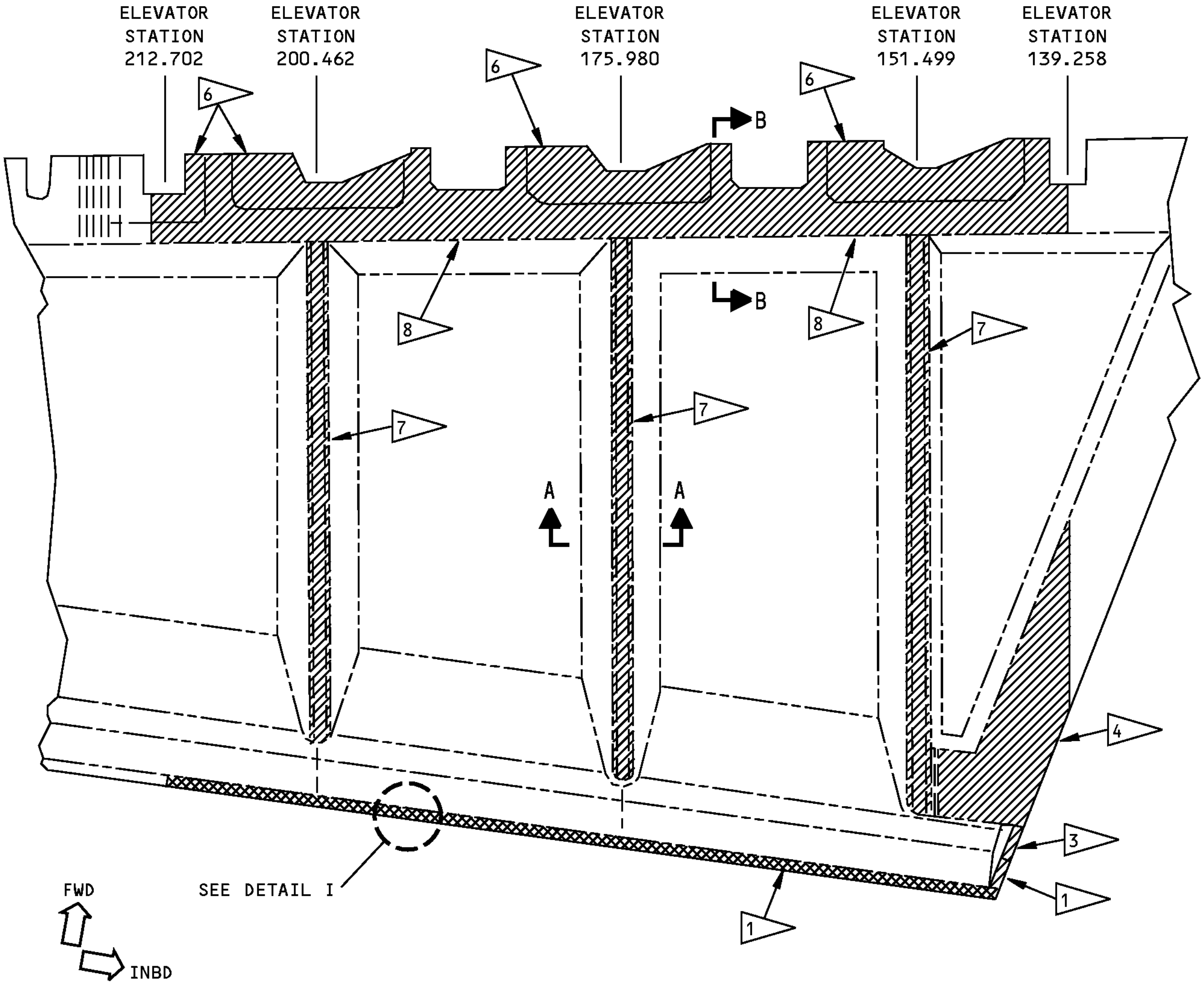
FAYING SURFACE SEALANT INSPECTION AREA (THROUGH - TRANSMISSION)

Elevator Assembly
Figure 1 (Sheet 1 of 4)



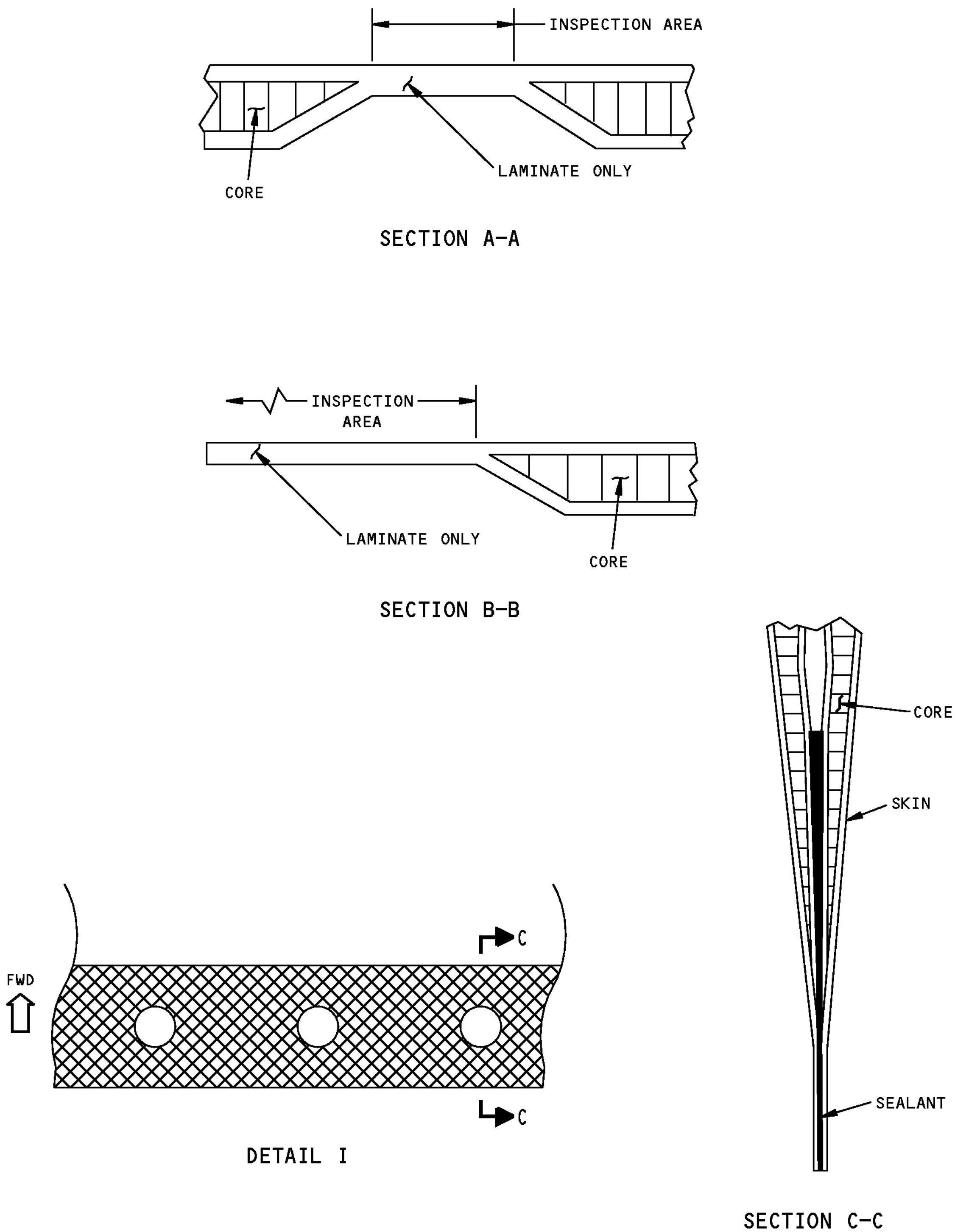
ELEVATOR UPPER PANEL
P/N 183T3002-1,-2,-23,-24
183T3072-1,-2

Elevator Assembly
Figure 1 (Sheet 2 of 4)

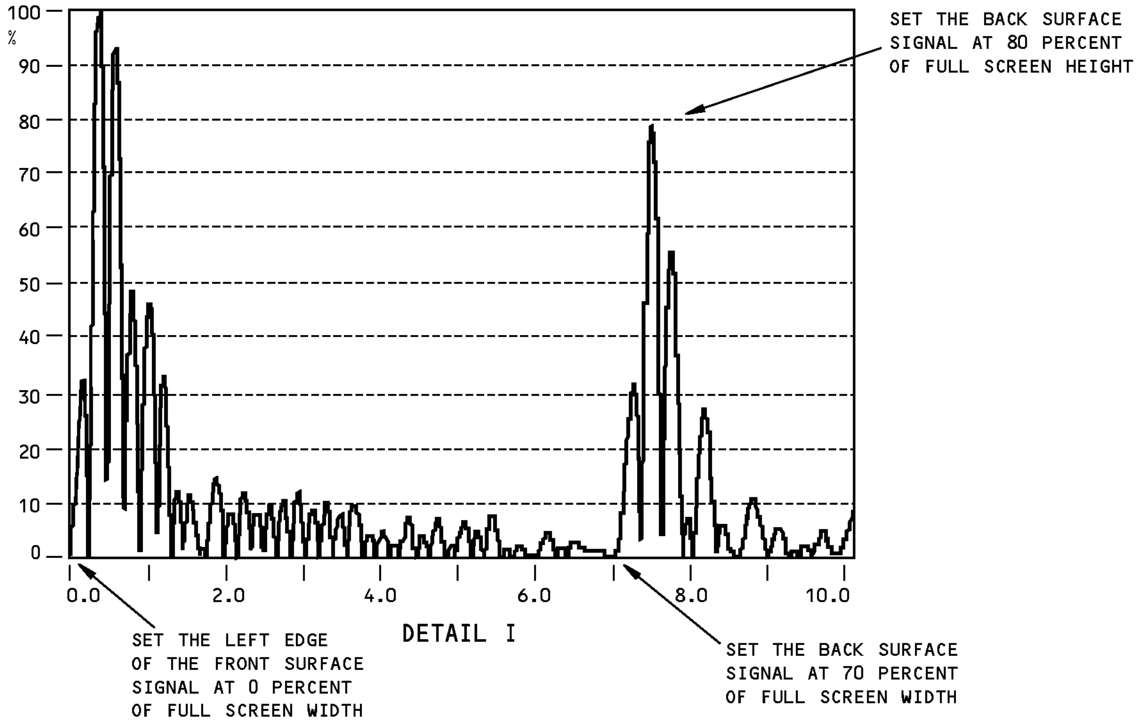


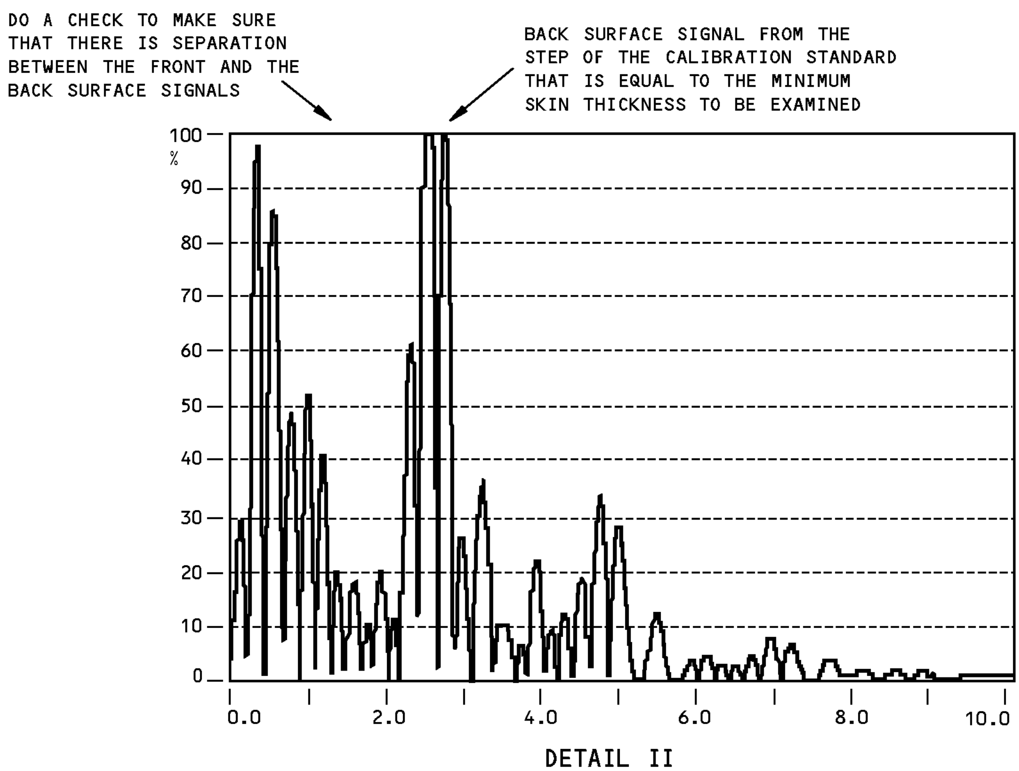
ELEVATOR LOWER PANEL
P/N 183T3003-1,-21,-22,-25,-26
183T3073-1,-2

Elevator Assembly
Figure 1 (Sheet 3 of 4)

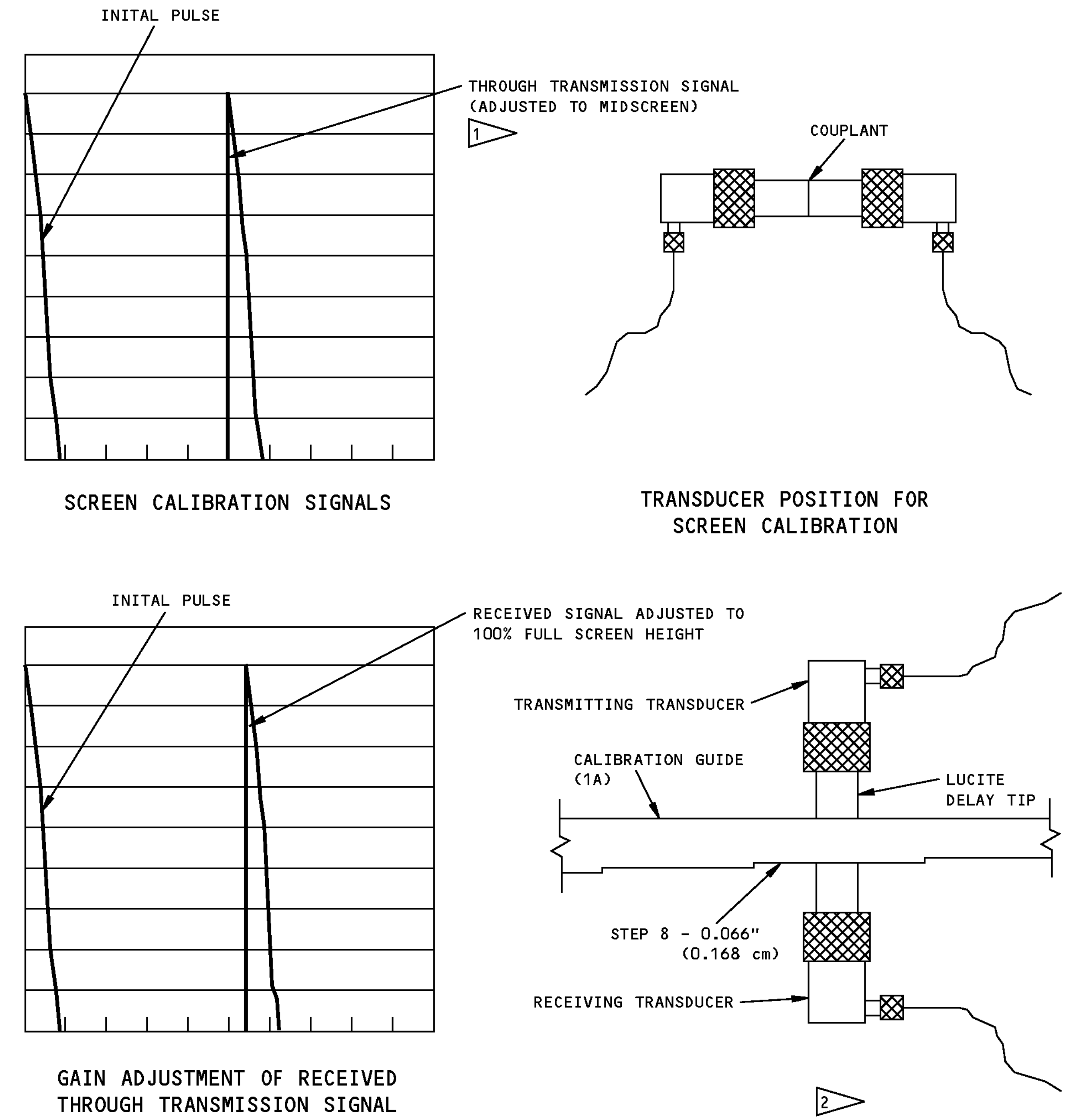


Elevator Assembly
Figure 1 (Sheet 4 of 4)





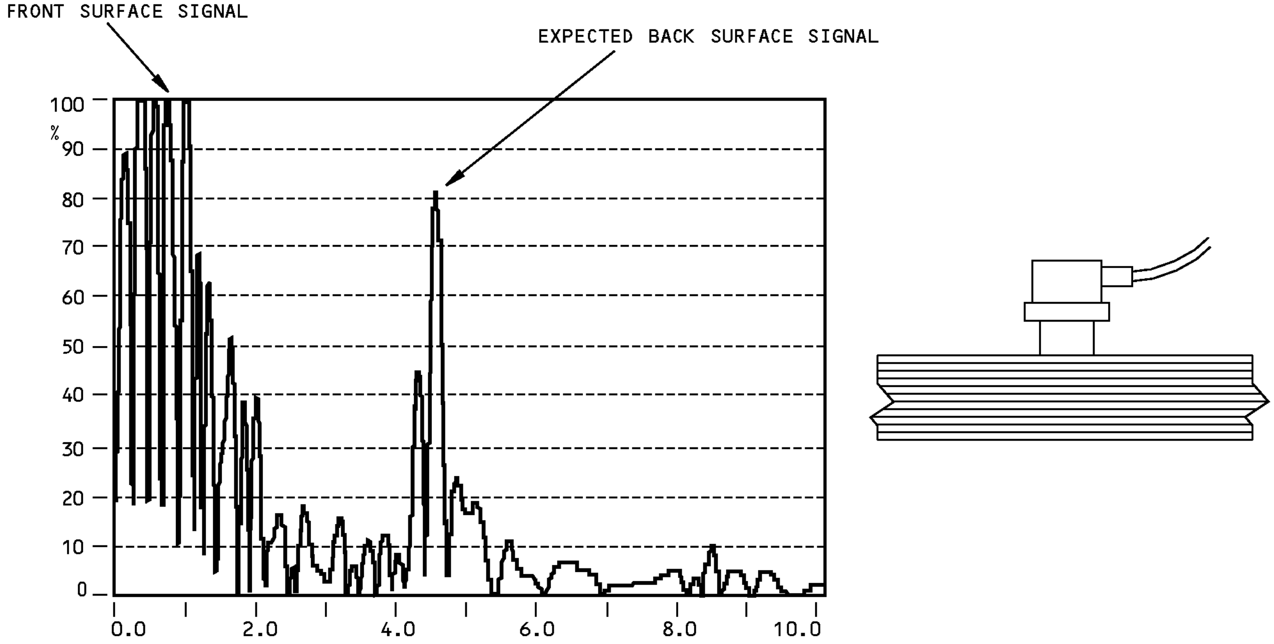
Pulse Echo Instrument Calibration
Figure 2



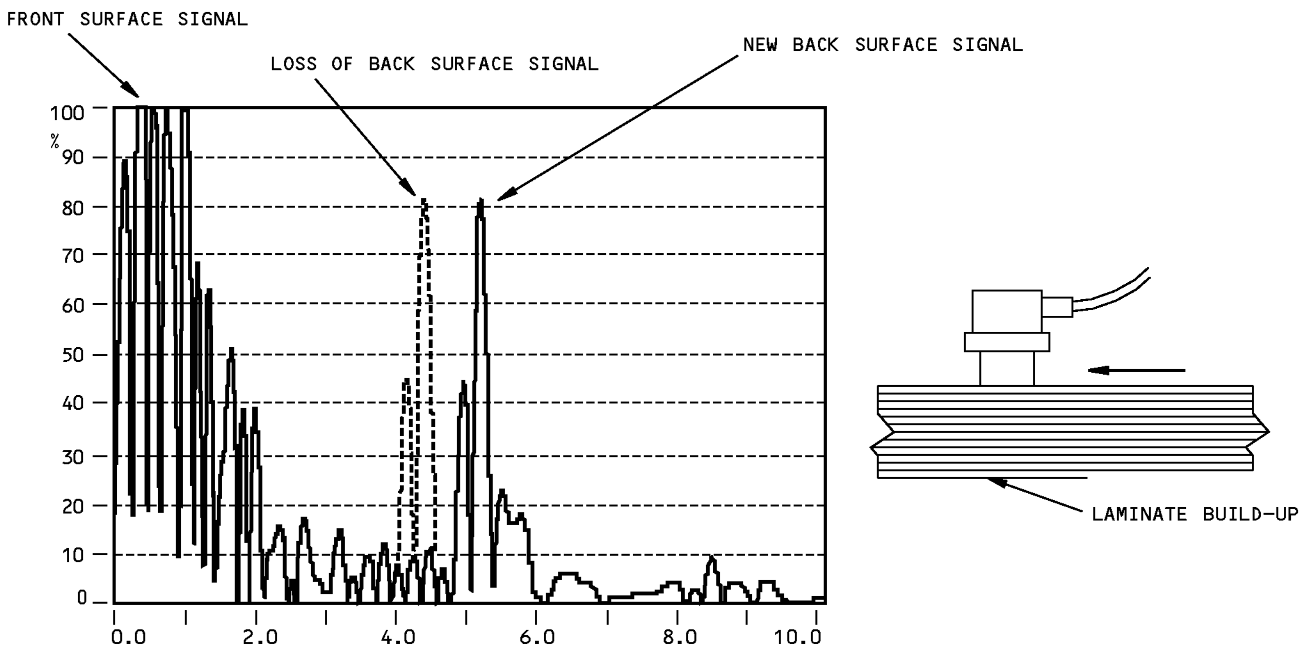
1 NOTE: THE THROUGH TRANSMISSION SIGNAL WILL MOVE TO THE RIGHT SLIGHTLY WHEN THE REQUIRED STEP OF THE CALIBRATION GUIDE IS INSERTED BETWEEN THE TRANSDUCERS TO ADJUST INSTRUMENT GAIN.

2 ALIGN TRANSDUCERS ON STEP 8 OF CALIBRATION GUIDE 1A AND ADJUST RECEIVED SIGNAL TO 100% FULL SCREEN HEIGHT

Through Transmission Screen Calibration
Figure 3

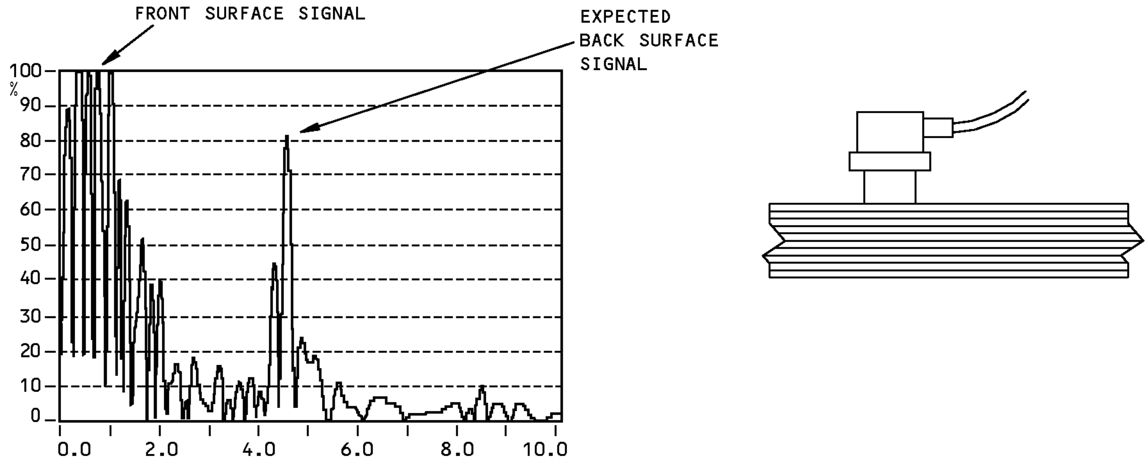


EXPECTED SCREEN RESPONSE
DETAIL I

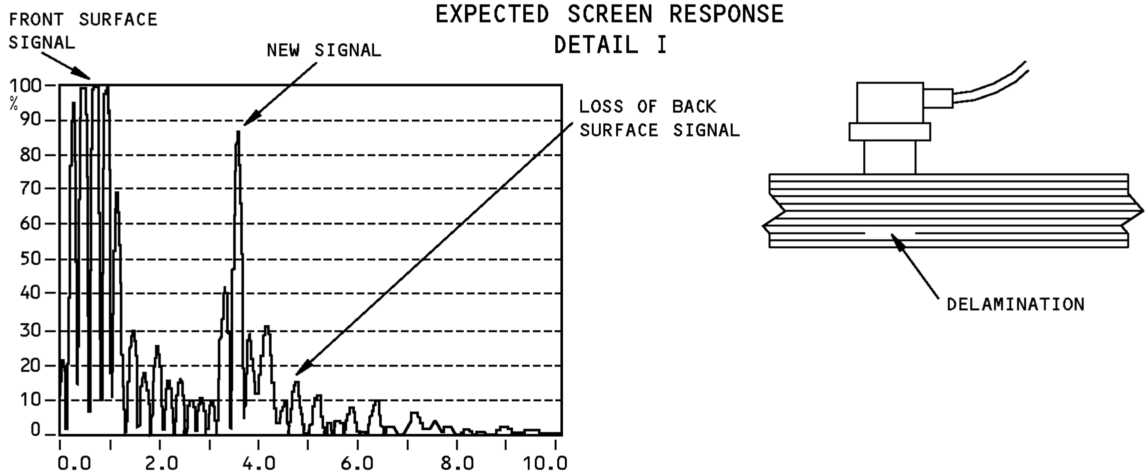


LAMINATE THICKNESS INCREASE RESPONSE
DETAIL II

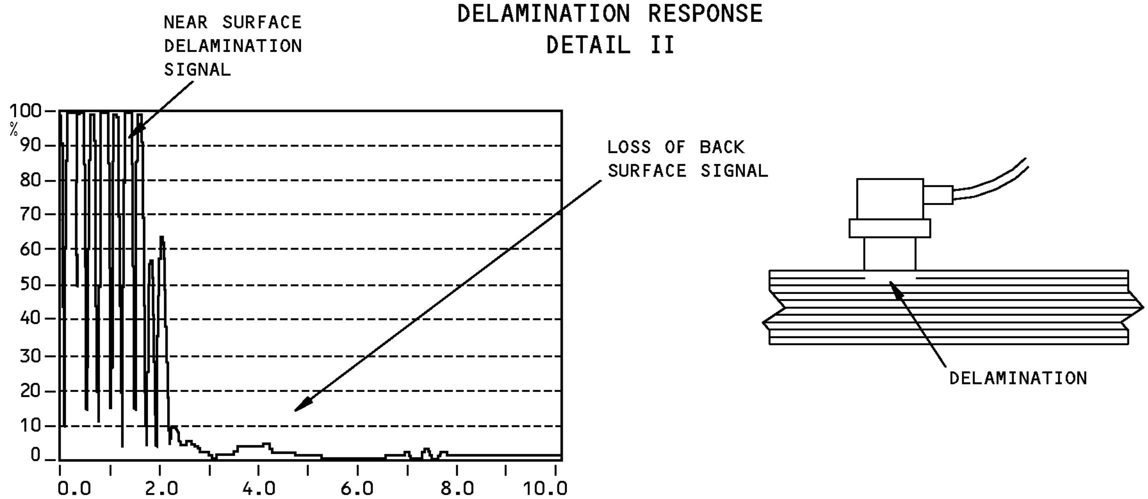
Signal Response Identification
Figure 4



EXPECTED SCREEN RESPONSE
DETAIL I

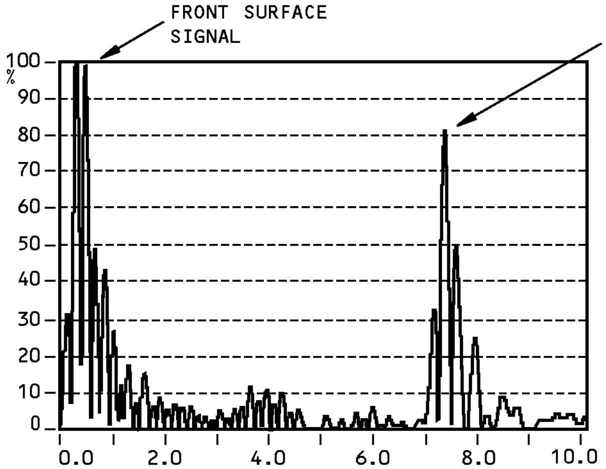


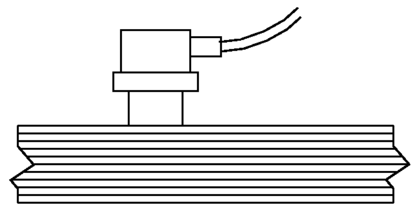
DELAMINATION RESPONSE
DETAIL II



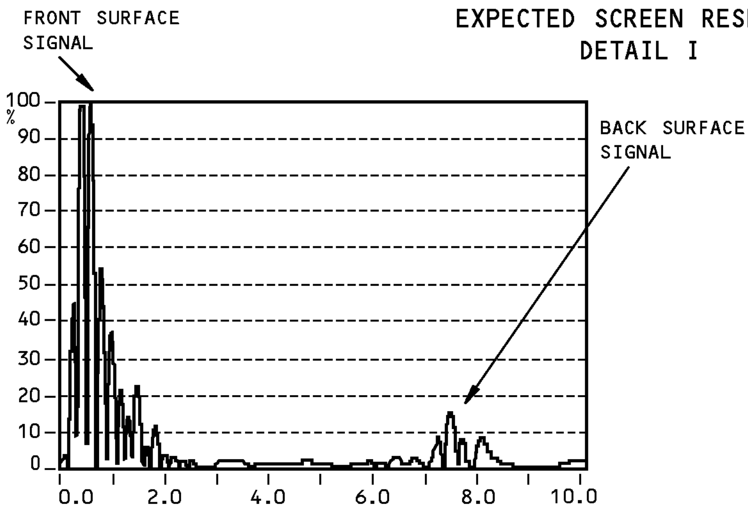
NEAR SURFACE DELAMINATION RESPONSE
DETAIL III

Signal Response Identification
Figure 5





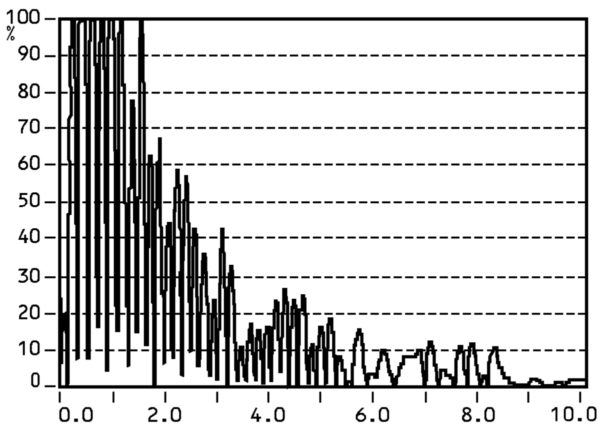
EXPECTED SCREEN RESPONSE
DETAIL I



NOTES

- 80-100 PERCENT LOSS OF BACK SURFACE REFLECTION AMPLITUDE
- ACCOMPANYING SIGNALS MAY ALSO DECREASE

LOSS OF BACK SURFACE REFLECTION
DETAIL II

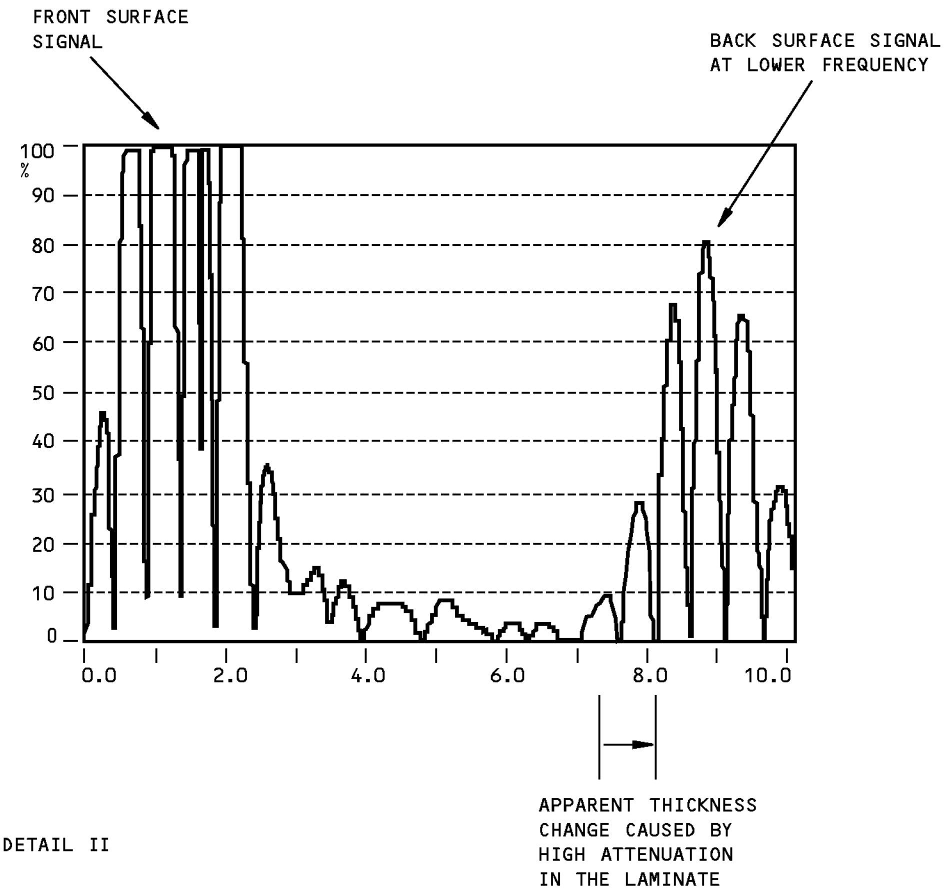


NOTES

- NO IDENTIFIABLE BACK SURFACE REFLECTION WITH INCREASED INSTRUMENT GAIN

EXCESSIVE INTERFERENCE SIGNALS - "HASH"
DETAIL III

Signal Response Identification
Figure 6 (Sheet 1 of 2)



NOTES

- COMPARE WITH DETAIL II

SIGNAL CHANGE CAUSED BY THE USE OF A LOWER FREQUENCY TRANSDUCER
DETAIL IV

Signal Response Identification
Figure 6 (Sheet 2 of 2)