

FAIRCHILD AIRCRAFT

SA226/227 SERIES FIELD MAINTENANCE PROCEDURES

FMP-57-011

EDDY-CURRENT INSPECTION PROCEDURES. B.L. 9

Effectivity: SA226 - T(B)303E, T(B)394-417, TC398-419, AT070; SA227 - ALL

Airframe Airworthiness Limitations Manuals ST-UN-M001, M002, and M003 require Eddy-Current inspections of the wing. Following are procedures from SWRI Final Report, Project 15-5741.

NOTE: The first time a new instrument or new probe is used, the Initial Instrument Setup Procedure must be accomplished. Once this has been completed, only Aircraft Wing Spar Inspection need be accomplished for each aircraft inspection.

1. Procedure

A. Materials and Equipment Required

- (1) NORTEC NDT-3 Eddy-Current Tester with 500 kHz frequency module (or equivalent)
- (2) NORTEC BP-16 Shielded Bolt Hole Probe (or equivalent)
- (3) NORTEC BP-16 Non-Shielded Bolt Hole Probe (or equivalent)
- (4) Set of Eddy-Current standards as shown in Figure 1
- (5) Set of spacers as shown in Figure 2

NOTE: In this section, optimum settings of the instrument controls will first be determined on the set of standard specimens. The objective in optimizing the instrument settings is to obtain a maximum meter deflection from a crack and a minimum meter deflection from probe lift-off encountered when the probe is not in good contact with the surface. These conditions are determined by first adjusting the X and R Balance Controls to obtain a minimum lift-off response and by adjusting the Gain Controls to obtain the proper meter deflection from a slot in the standard. Although these settings have already been established, they may vary somewhat for different instruments and probes, therefore when a new instrument or probe is used, new settings must be established.

B. Initial Instrument Setup

- (1) Permanently label the BP-16 Shielded Probe as Probe A, and the BP-16 Non-Shielded Probe as Probe B
- (2) Set the probe Depth Collar on Probe A so that its large flat surface is precisely 0.160 inch from the center of the probe active element as shown in Figure 3.

NOTE: It is very important that this measurement be precise or erroneous readings could result.

Tighten the Depth Collar set screw and recheck the measurement. Once the probe depth is set, a drop of cement may be placed between the probe collar and the probe housing (the opposite end from the collar large flat surface) to prevent further movement. This probe will be used for inspection of the first countersunk aluminum layer only so no further adjustment of the collar is necessary.

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- (3) Insert the probe into the hole in the standard from the side with the thin wing skin layer and check for a light snug fit between the hole and the probe as the probe is rotated. If the probe is loose in the hole, place a thin piece of compliant material (i.e. a small piece of rubber band) between the split layers of the probe housing until a light snug fit is obtained.
- (4) On probe B mark a series of scribe lines on the probe housing as shown in Figure 3 with distances from the center of the probe active element measuring 0.250, 0.375, 0.500, 0.625, 0.750, and 0.875 inch

NOTE: It is very important that these measurements be precise and that the scribe lines be very narrow.

- (5) Set the probe depth collar on the 0.625 inch scribe line and adjust the probe fit in the standard same as step B.(3).
- (6) Connect Probe A to the instrument, press Battery Test Button #1, and note the meter reading. Release Button #1, press Battery Test Button #2 and note the meter reading. A meter reading of 60 or greater indicates the batteries are in good condition. For readings below 60, replace batteries.
- (7) Set the instrument controls to the values shown in Table 1 for the first layer of the structure (countersunk aluminum).
- (8) Insert the probe into the hole in the standard from the side with the thin wing skin layer. Place the probe active element 90° from the Mylar tape layer and then adjust the instrument Level Control to bring the meter to approximately a mid-scale value. (The only function of the Level Control is to position the meter on the scale). Alternately rotate the probe so that it is positioned first 90° away from the tape and then precisely over the tape and note the fluctuation in the meter reading. Repeat this procedure, adjust the X Balance Control each time, until a minimum meter deflection is obtained. If the meter goes off scale, position it back on scale with the Level Control. Record the X Balance Control reading in the blank space in Table 2 for use in later inspections.
- (9) Position the probe active element 45° away from the slot and adjust the Level Control until the meter is positioned to a reading of approximately 90 and note the reading.
- (10) Slowly rotate the probe until it is over the slot and a minimum meter reading is obtained. Subtract this reading from that 45° away to obtain the meter deflection from the slot. Rotate the probe back and forth very slowly between the position where maximum downscale deflection is obtained and a position 45° away and adjust the Fine Gain Control each time so that the meter deflection shown in Table 1 is obtained from the slot. Adjust the Level Control as needed to keep the meter on scale. Record the final Fine Gain Control setting in Table 2.
- (11) Connect Probe B to the instrument and set the flat portion of the probe Depth Collar precisely even with the 0.250 scribe line. Tighten the set screw making sure that the collar position does not change as the screw is tightened. This will position the probe in the center of the second aluminum layer of the structure.
- (12) Set the controls on the instrument to the values shown for the second aluminum layer in Table 1.
- (13) Repeat steps B.(8) through (10) and record the final instrument settings in Table 2 for use in later inspections.

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- (14) Set the probe Depth Collar to the 0.500 scribe line. This will position the probe in the center of the fourth layer which is made of titanium. Setup is not required in the third layer because it is also made of titanium and the same readings should result.
- (15) Set the instrument to the values shown for the titanium layer in Table 1 and repeat steps B.(8) through (10) and record the final instrument settings in Table 2 for both titanium layers for use in later inspections.
- (16) Set the probe Depth Collar to the 0.875 scribe line. This will position the probe in the center of the seventh layer which is made of steel. Setup is not required in the fifth and sixth layers because they are also made of steel and the same readings should result.
- (17) Set the instrument to the values shown for the steel layer in Table 1, repeat steps B.(8) through (10), and record the instrument settings in Table 2 for all three steel layers.

Layer	Material	Probe	Probe Depth	Coarse Gain	Fine Gain	X Balance	R Balance	Meter Deflection From Standard
1	Aluminum	B	0.160	3	210	572	818	50
2	Aluminum	B	0.250	3	220	340	879	80
4	Titanium	B	0.500	3	30	591	726	60
7	Steel	B	0.875	2	350	790	166	80

APPROXIMATE SETTINGS FOR INITIAL INSTRUMENT SETUP

TABLE 1

Layer	Material	Probe	Coarse Gain	Fine Gain	X Ball	R Ball	Meter Deflection From Standard	Meter Deflection Indicating Crack
1	Aluminum	A	3	—	—	818	50	50
2	Aluminum	B	3	—	—	879	80	50
3	Titanium	B	3	—	—	726	60	50
4	Titanium	B	3	—	—	726	60	50
5	Steel	B	2	—	—	166	80	50
6	Steel	B	2	—	—	166	80	50
7	Steel	B	2	—	—	166	80	50

EXACT SETTINGS FOR EDDY-CURRENT INSPECTION

TABLE 2

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(C) Aircraft Wing Spar Inspection

Inspection of First Aluminum Layer with Countersink

- (1) Remove screws from the Forward Wing Spar forward and aft flanges three screws inboard and three outboard of LH and RH B.L. 9. Total 12 screws LH and RH, or 24 per aircraft. Screws may be removed one at a time or all at the same time.
- (2) Visually inspect screws and holes for corrosion. Clean holes per SRM 51-30-01. Discard corroded screws.
- (3) Connect Probe A to the instrument.
- (4) Press Battery Test Button #1, then #2. A meter reading of 60 or greater indicates the batteries are in good condition. For readings below 60, replace batteries.
- (5) Adjust the instrument controls according to Table 2 for the first aluminum layer.
- (6) Place the probe in the standard from the side with the thin wing skin at a position 45° away from the slot. Position the meter to a value of approximately 90 using the Level Control and note the reading.
- (7) Slowly rotate the probe until it is over the slot and a minimum reading is obtained. Subtract this reading from that 45° away to obtain the meter deflection from the slot. Adjust the Fine Gain Control if necessary to obtain a deflection of 50 as shown in Table 2.
- (8) Position the probe 90° away from the tape layer and note the meter reading.
- (9) Rotate the probe until it is directly over the tape. The deflection from the tape (reading at 90° minus reading over tape) should be less than approximately 1/2 of that from the slot. If it is greater than 3/4 that from the slot, repeat steps B.(7) through (10) to optimize the instrument setup and then repeat steps C.(5) through (9).
- (10) Insert the probe in the hole to be inspected with the active element facing the outboard side of the hole.
- (11) Rotate the probe very slowly clockwise around the hole keeping uniform pressure against the probe Depth Collar. If the meter rapidly deflects downscale then rapidly upscale similar to the indication from the slot in the standard, then slowly rotate the probe counterclockwise and clockwise until a minimum reading is obtained. Record the amount of deflection (reading before downscale deflection minus minimum reading). Note that slow variations in meter deflection as the probe is rotated are not due to a crack, but to other variables such as probe lift-off.
- (12) Repeat step C.(11) rotating the probe counterclockwise in the hole. If in either step the deflection is greater than 50 the indication should be considered a suspected crack.

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Inspection of Second Aluminum Layer

NOTE: For inspection of the remaining layers of the wing spar it is necessary to find the center of each layer using the Eddy-Current probe. The probe cannot be positioned accurately by simply setting the probe depth according to the nominal layer thicknesses since the stack up of manufacturing tolerances on layer thicknesses can be too large. Inaccuracy of probe positioning will result in reduced sensitivity to corner (approximately triangular shaped) cracks. The center of the layers are found by locating the interfaces between layers with the probe and adding or removing spacers from the probe Depth Collar to position the probe in the center of each layer. It was not necessary to follow this procedure when setting up the instrument on the standard since the standard slots have the same depth through the layer thickness.

- (13) Connect Probe B to the instrument and use this probe for inspection of remaining layers.
- (14) Set the instrument controls according to Table 2 for the second aluminum layer.
- (15) Place the 0.063 inch spacer on the probe in contact with the probe Depth Collar per Figure 3.
- (16) Adjust the Depth Collar so that the edge of the spacer (away from the collar) is aligned with the 0.250 scribe line.
- (17) Place the probe in the standard from the side with the thin wing skin at a position 45° away from the slot. Position the meter to a value of approximately 90 using the Level Control and note the reading.
- (18) Slowly rotate the probe until it is over the slot and a minimum reading is obtained. Subtract this reading from that 45° away to obtain the meter deflection from the slot. Adjust the Fine Gain Control if necessary to obtain a deflection of 80 as shown in Table 2.
- (19) Position the probe 90° away from the tape layer and note the meter reading.
- (20) Rotate the probe until it is directly over the tape. The deflection from the tape (reading at 90° minus reading over tape) should be less than approximately 1/4 of that from the slot. If it is greater than 1/2 that from the slot, repeat steps B.(12) and (13) to optimize the instrument setup and then repeat steps C.(14) through (20).
- (21) Insert the probe in the hole to be inspected with the active element facing the outboard side of the hole.
- (22) Loosen the Depth Collar set screw, and while holding the collar against the wing skin, very slowly withdraw the probe body until the meter indicates a minimum. Adjust the Level Control as necessary to keep the meter on scale. When the meter indicates a minimum reading the probe is positioned at interface A shown in Figure 4. Tighten the set screw at this point.
- (23) Remove the 0.063 spacer and reinsert the probe into the hole being inspected. The active element is now positioned in the center of the second layer.
- (24) Rotate the probe very slowly clockwise around the hole keeping uniform pressure against the probe Depth Collar. If the meter rapidly deflects downscale then rapidly upscale similar to the indication from the slot in the standard, then slowly rotate the probe counterclockwise and clockwise until a minimum reading is obtained. Record the amount of deflection (reading before downscale deflection minus minimum reading). Note that slow variations in meter deflection as the probe is rotated are not due to a crack, but to other variables such as probe lift-off.

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- (25) Repeat step C.(24) rotating the probe counterclockwise in the hole. If in either step the deflection is greater than 50 the indication should be considered a suspected crack.

Inspection of Third and Fourth Titanium Layers

- (26) Set the instrument controls according to Table 2 for the third and fourth Titanium layers.
- (27) Place the 0.063 inch spacer on the probe in contact with the probe Depth Collar per Figure 3.
- (28) Adjust the Depth Collar so that the edge of the spacer (away from the collar) is aligned with the 0.500 scribe line.
- (29) Place the probe in the standard from the side with the thin wing skin at a position 45° away from the slot. Position the meter to a value of approximately 90 using the Level Control and note the reading.
- (30) Slowly rotate the probe until it is over the slot and a minimum reading is obtained. Subtract this reading from that 45° away to obtain the meter deflection from the slot. Adjust the Fine Gain Control if necessary to obtain a deflection of 50 as shown in Table 2. Record this Fine Gain Control setting for use in step C.(37).
- (31) Position the probe 90° away from the tape layer and note the meter reading.
- (32) Rotate the probe until it is directly over the tape. The deflection from the tape (reading at 90° minus reading over tape) should be less than approximately 1/3 of that from the slot. If it is greater than 2/3 that from the slot, repeat steps B.(14) and (15) to optimize the instrument setup and then repeat steps C.(26) through (32).
- (33) To locate the interface between the two Titanium layers, settings different from those for crack detection must be used. Set the instrument controls to: X=500, R=400, Coarse Gain=3, Fine Gain=100.
- (34) Insert the probe in the hole to be inspected with the active element facing the outboard side of the hole.
- (35) Adjust the Level Control to bring the meter on scale. Loosen the Depth Collar set screw, and while holding the collar against the wing skin, very slowly withdraw the probe body until the meter indicates a minimum. Adjust the Level Control as necessary to keep the meter on scale. When the meter indicates a minimum reading the probe is positioned at interface C shown in Figure 4. Tighten the set screw at this point.
- (36) Remove the 0.063 spacer and reinsert the probe into the hole being inspected. The active element is now positioned in the center of the fourth layer.
- (37) Set the instrument controls according to Table 2 for the fourth Titanium layer and set the Fine Gain Control to the value recorded in step C.(30).
- (38) Rotate the probe very slowly clockwise around the hole keeping uniform pressure against the probe Depth Collar. If the meter rapidly deflects downscale then rapidly upscale similar to the indication from the slot in the standard, then slowly rotate the probe counterclockwise and clockwise until a minimum reading is obtained. Record the amount of deflection (reading before downscale deflection minus minimum reading). Note that slow variations in meter deflection as the probe is rotated are not due to a crack, but to other variables such as probe lift-off.

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- (39) Repeat step C.(38) rotating the probe counterclockwise in the hole. If in either step the deflection is greater than 50 the indication should be considered a suspected crack.
- (40) Place the 0.125 inch spacer on the probe and reinsert the probe into the hole. This will position the probe in the center of the third Titanium layer.
- (41) Repeat steps C.(38) and (39) to inspect the third layer.

Inspection of Fifth through Seventh Steel Layers

- (42) Set the instrument controls according to Table 2 for the fifth through seventh Steel layers.
- (43) Place the 0.063 inch spacer on the probe in contact with the probe Depth Collar per Figure 3.
- (44) Adjust the Depth Collar so that the edge of the spacer (away from the collar) is aligned with the 0.875 scribe line.
- (45) Place the probe in the standard from the side with the thin wing skin at a position 45° away from the slot. Position the meter to a value of approximately 90 using the Level Control and note the reading.
- (46) Slowly rotate the probe until it is over the slot and a minimum reading is obtained. Subtract this reading from that 45° away to obtain the meter deflection from the slot. Adjust the Fine Gain Control if necessary to obtain a deflection of 80 as shown in Table 2.
- (47) Position the probe 90° away from the tape layer and note the meter reading.
- (48) Rotate the probe until it is directly over the tape. The deflection from the tape (reading at 90° minus reading over tape) should be less than approximately 1/4 of that from the slot. If it is greater than 1/2 that from the slot, repeat steps B.(16) and (17) to optimize the instrument setup and then repeat steps C.(43) through (48).
- (49) Insert the probe in the hole to be inspected with the active element facing the outboard side of the hole.
- (50) Loosen the Depth Collar set screw, and while holding the collar against the wing skin, very slowly withdraw the probe body until the meter indicates a minimum. Adjust the Level Control as necessary to keep the meter on scale. When the meter indicates a minimum reading the probe is positioned at interface F shown in Figure 4. Tighten the set screw at this point.
- (51) Remove the 0.063 spacer and reinsert the probe into the hole being inspected. The active element is now positioned in the center of the seventh layer.
- (52) Rotate the probe very slowly clockwise around the hole keeping uniform pressure against the probe Depth Collar. If the meter rapidly deflects downscale then rapidly upscale similar to the indication from the slot in the standard, then slowly rotate the probe counterclockwise and clockwise until a minimum reading is obtained. Record the amount of deflection (reading before downscale deflection minus minimum reading). Note that slow variations in meter deflection as the probe is rotated are not due to a crack, but to other variables such as probe lift-off.
- (53) Repeat step C. (52) rotating the probe counterclockwise in the hole. If in either step the deflection is greater than 50 the indication should be considered a suspected crack.
- (54) Place the 0.125 inch spacer on the probe and reinsert the probe into the hole. This will

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position the probe in the center of the sixth Steel layer.

- (55) Repeat steps C. (52) and (53) to inspect the sixth layer.
- (56) Replace the 0.125 inch spacer on the probe with the 0.250 inch spacer and reinsert the probe into the hole. This will position the probe in the center of the fifth Steel layer.
- (57) Repeat steps C. (52) and (53) to inspect the fifth layer.
- (58) Should crack indications be found in any layer, it is recommended that they be verified through use of other inspection techniques such as a penetrant inspection and borescope.
- (59) Install screws. If screw cad plating is scratched, prime screw or install a new one.
- (60) Report results of all inspections to Fairchild Field Support Engineering whether cracks are indicated or not.

2. Reference:

SECP A-195, B-206, C-199, 27-31251 EO F-3A, SWRI Final Report, Project 15-5741.

NOTE: Eddy-Current testers other than the Nortec instrument listed above may provide satisfactory results, however Fairchild Aircraft has determined that a 500 kHz frequency is optimum and the Nortec instrument was the best choice. A Halec MK-II instrument was also tried with unsatisfactory results.

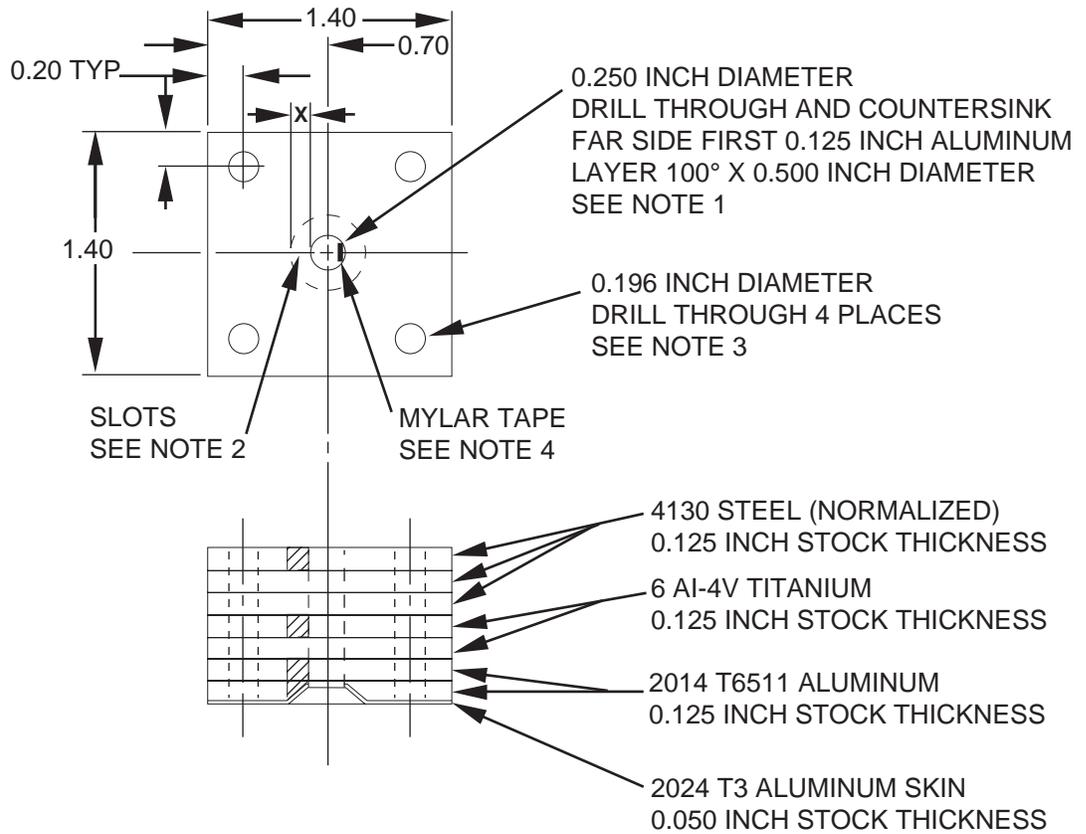
3. Material List:

Parts may be locally manufactured or purchased.

<u>PART NUMBER</u>	<u>NOMENCLATURE</u>	<u>QUANTITY</u>
FMP57011-KIT	Kit, Eddy-Current Standard Kit consists of:	1
FMP57011-001	Eddy-Current Standard (Fig.1)	1
FMP57011-002	Spacer, 0.063 (Fig.2)	1
FMP57011-003	Spacer, 0.125 (Fig.2)	1
FMP57011-004	Spacer, 0.250 (Fig.2)	1

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NOTE 1: MACHINE ALL PARTS TO SIZE, THEN STACK AND DRILL 0.250 INCH DIAMETER HOLE THROUGH ALL LAYERS IN ONE SETUP USING 0.250 INCH DIAMETER COBALT BIT GROUND TO 68° ANGLE, DRILL SPEED 400-500 RPM, FEED 0.002 INCH/REVOLUTION. COUNTERSINK FIRST ALUMINUM LAYER. DIMPLE SKIN TO FIT COUNTERSINK.

NOTE 2: SLOT DIMENSIONS

LAYER	DEPTH OF X (INCH)
STEEL	0.012 + 0.000 - 0.001
TITANIUM	0.034 + 0.000 - 0.002
ALUMINUM	0.013 + 0.000 - 0.001
ALUMINUM	0.027 + 0.000 - 0.001
COUNTERSUNK	

CUT SLOTS PREFERABLY USING ELECTRONIC DISCHARGE MACHINING (EDM). OPTIONAL USE 0.006 INCH WIDE JEWELER'S SAW BLADE. SLOT MAXIMUM WIDTH 0.0085 INCH.

NOTE 3: AFTER CUTTING SLOTS, INSERT 0.2497 ± 0.0000 - 0.0002 INCH PRECISION GROUND SHAFT INTO THE 0.250 INCH DIAMETER HOLE FOR ALIGNMENT AND STACK LAYERS AS SHOWN. DRILL FOUR 0.196 INCH DIAMETER HOLES AND INSTALL #10 SCREWS AND NUTS. REMOVE SHAFT.

NOTE 4: PLACE 0.10 INCH WIDE X 0.003 INCH THICK LAYER OF MYLAR TAPE INSIDE HOLE.

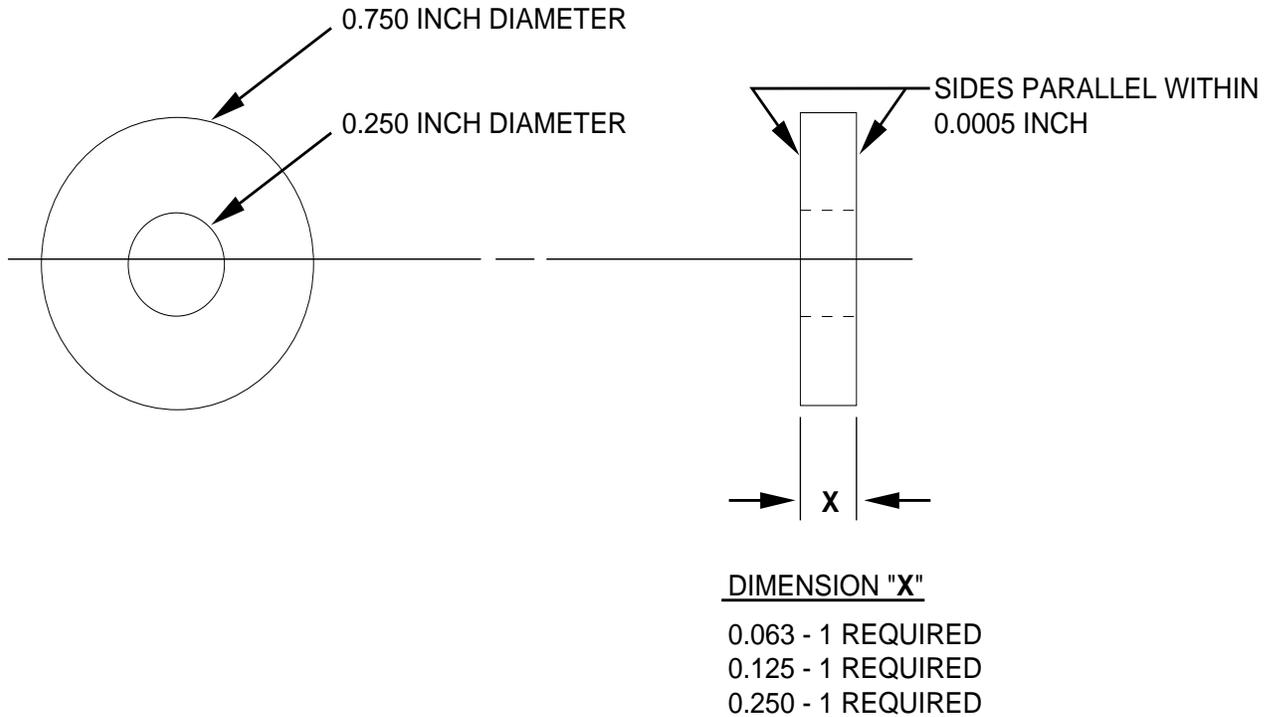
**FMP57011-001 EDDY-CURRENT STANDARD
FIGURE 1**

FMP570111

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NOTE 1: MATERIAL: DELRIN, OR EQUIVALENT. THREE SPACERS REQUIRED; ONE EACH THICKNESS SHOWN AS DIMENSION "X".

FMP57011-001, -002, -003 PROBE DEPTH SPACERS
FIGURE 2

FMP570112

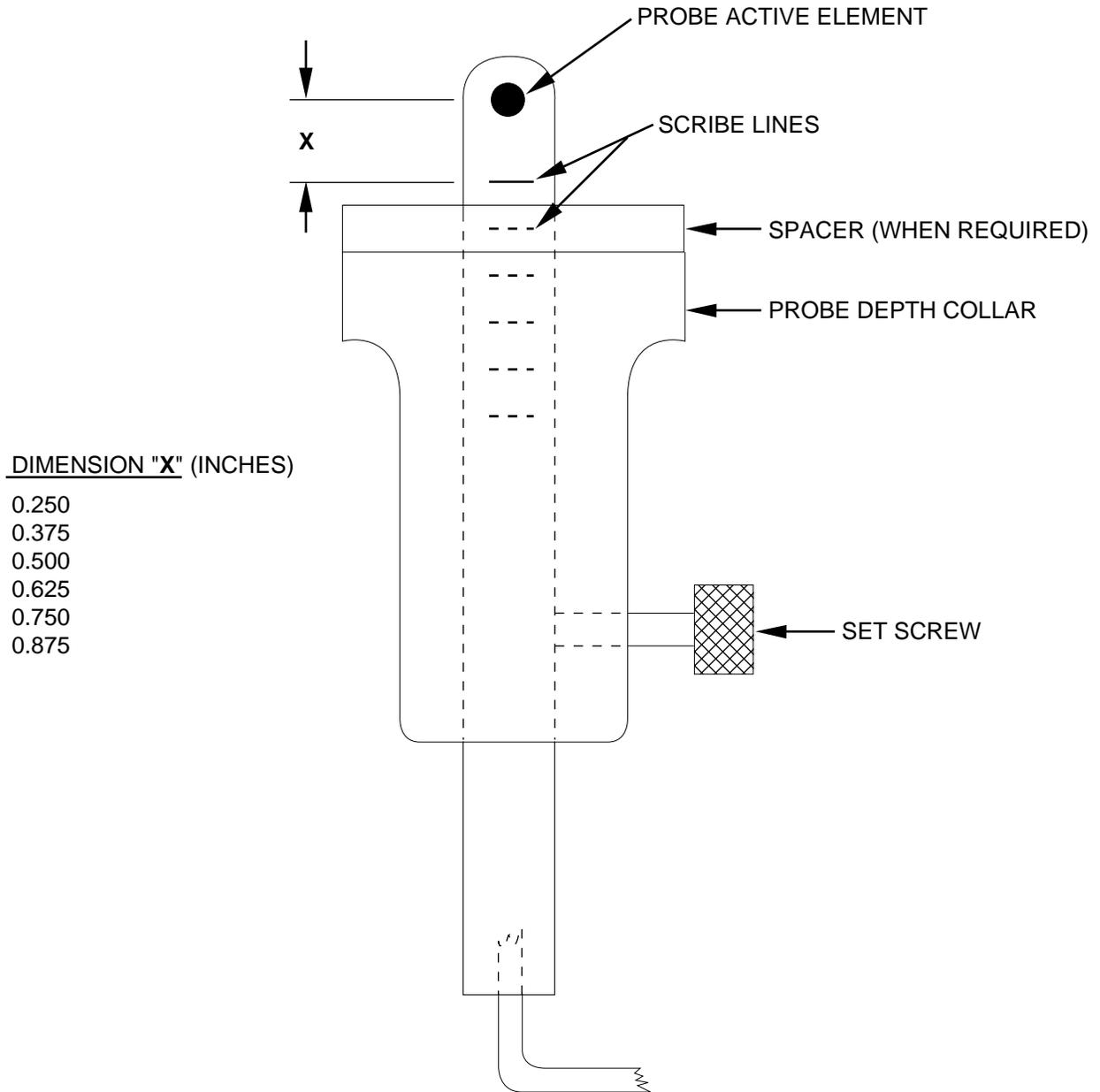
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EDDY-CURRENT PROBE
FIGURE 3

FMP570113

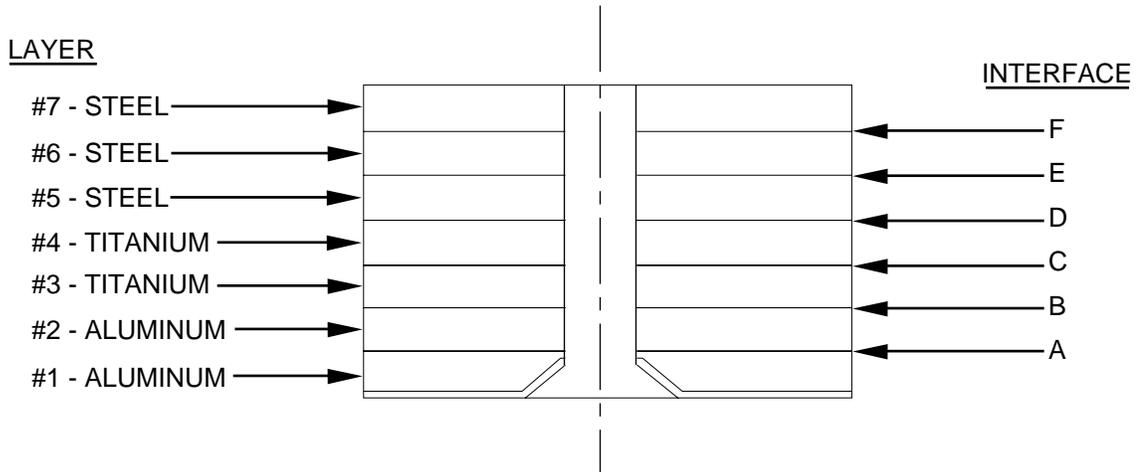
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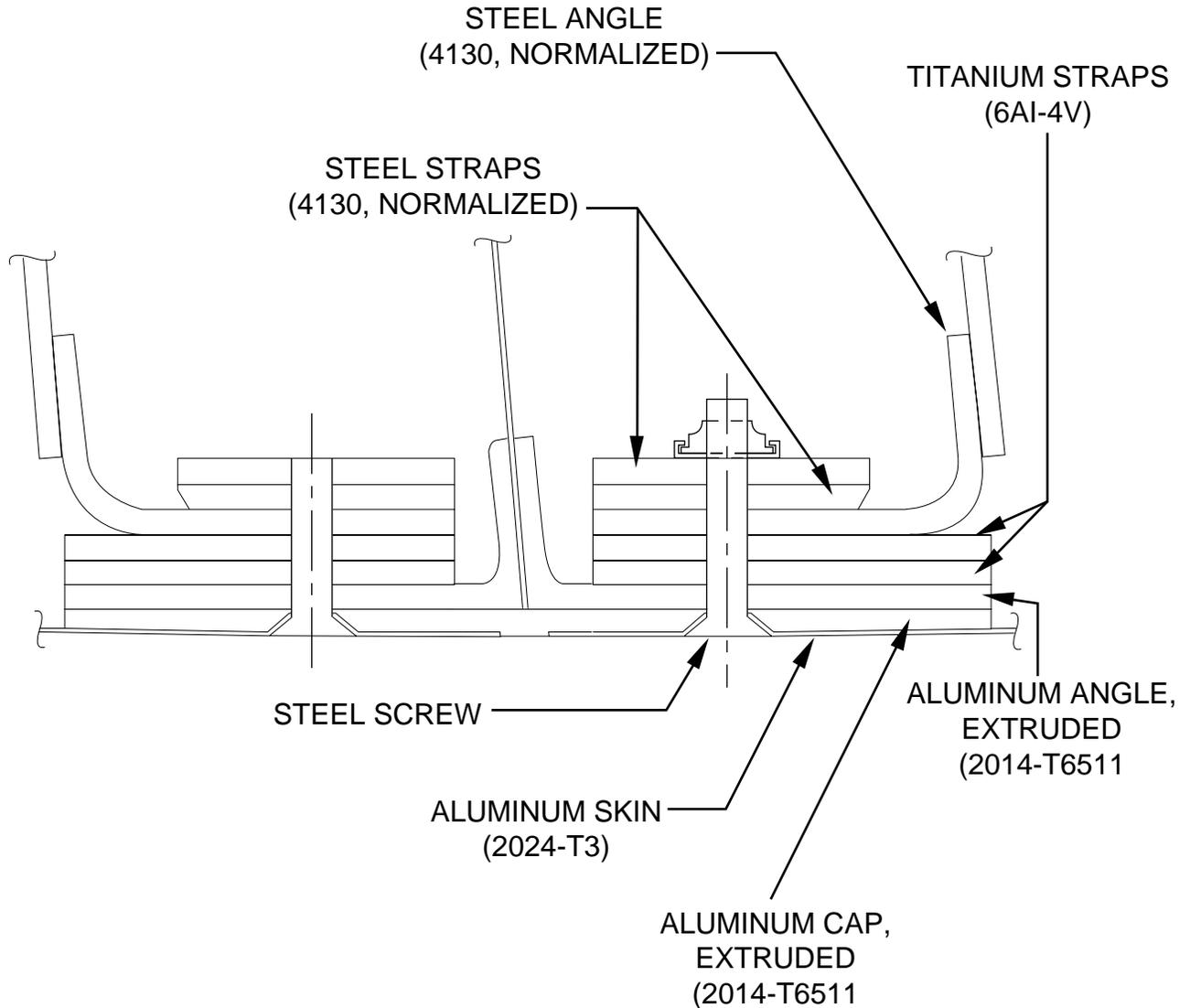
LAYER AND ITERFACE DESIGNATIONS
FIGURE 4

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CROSS SECTION OF WING SPAR AT B.L. 9
FIGURE 5

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