EFFECTIVITY
MODEL: ALL
STRUCTURAL REPAIR
MANUAL REFERENCE:
707, 720 51-11-1
727, 737, 51-40-9
747 51-40-09

PART 6 - EDDY CURRENT

MEASUREMENT OF RADOME THICKNESS

1. Purpose

   A. The electrical properties of radomes are dependent upon accurate control of radome thickness. This technique provides a method of measuring radomes to ensure that the thickness after repair is within tolerance. This is done by observing the changes in the meter response when probe spacing from a conductor is increased or decreased. The conductor is shaped to provide flush contact with the inner curvature of the radome. By calibrating the eddy current instrument on a non-conductive reference standard, a meter response range can be obtained to represent the expected radome wall thickness. Careful calibration and measurement should give radome thickness measurements within ± 0.005 inch.

   B. Two methods are provided in this procedure. Method I (par. 2 thru 6) uses the NDT-3 eddy current instrument and the F80124 probe, which are no longer manufactured. Method II (par. 7 thru 11) is an updated procedure using currently manufactured instruments and probes.

2. Equipment (Method I)

   A. Any eddy current instrument and probe combination which will satisfy the performance requirements of this procedure is acceptable. The following instruments and probes were utilized in the development of this procedure:

      (1) Instrument -- NDT-3, Nortec

      (2) Eddy Current Probe -- F80124 (replaced by commercial equipment for future procurement. See par. 7) P/N F80124, Nortec Inc.

B. Standard

(1) Thickness standard of nonconducting material, see Details IV and V.

(2) Reflector

(a) Aluminum section, see Detail VI.

3. Preparation for Inspection (Method I)

A. It is assumed that the area of radome to be measured is a repaired area of fiberglass without an erosion shoe covering it.

B. Ensure that the inner and outer surfaces are clean to permit good contact of the probe and reflector disk.

4. Instrument Calibration (Method I)

A. Preliminary Procedure

(1) Install 100 kHz frequency module per manufacturer's instructions.

(2) Connect probe to instrument.

B. Procedure to determine X-R Operating Point.

(1) Turn instrument power on to coarse sensitivity, Position No. 1.

(2) Turn X and R control until both read 500 and fine sensitivity to zero.

(3) Place the probe on a 0.250 $\pm$0.005 inch thickness standard and locate the maximum or minimum reading to line up the center of the probe with respect to the reflector. Now turn the X or R control alternately for a minimum null point. If the meter needle is off scale turn the level control as necessary for an on-scale reading. After the null point is obtained the coarse sensitivity control is then increased to position No. 2. Repeat the nulling procedure until the null is obtained in position No. 4. The X-R dial reading is the operating point for the specific probe and instrument.

C. Procedure to Calibrate Instrument for Thickness Measurement of X-Band and C-Band Radomes.

(1) Turn the X and R control to the dial values previously determined in par. 4.B. Lock the X and R control by pressing the locking arm clockwise.

(2) Set the coarse sensitivity to position No. 3 and fine sensitivity to zero.

(3) Select either the X-band or C-band thickness standard for the range of thickness to be measured and place on the reflector.

(4) Place the probe on the thinnest standard for the thickness range to be measured. Adjust level control for on-scale meter reading. Center probe for minimum reading. Adjust level control to the meter reading for the thickness given on the appropriate (X- or C-band) calibration curve as shown in Details I or II. Now place the probe on the thickest standard. Center probe for minimum reading. Adjust the fine sensitivity control to the meter reading to that thickness given on the calibration curve. If the sensitivity is inadequate, increase the coarse sensitivity to the next higher position, adjust the fine control to zero and repeat the above procedure. Place probe on thinnest standard and adjust level control until no further adjustment of either control is required. Check the calibration at an intermediate point and compare the meter reading obtained with the calibration curve meter reading. If the meter reading varies more that 1/2 division adjust the level control and recheck the instrument calibration. Remember to adjust the level control for the thinnest standard and the fine sensitivity control for the thickest standard.

(5) If the radome wall thickness is greater than 0.66 inch thick, establish a new calibration curve by changing the meter zero point to a thicker value. For example, if the thickness to be measured is 0.665 inch, use a 0.590-inch thick standard as the meter zero point instead of 0.580 inch as shown in Detail I, plus a 0.670-inch thick standard as the upper end point corresponding to a meter reading of 100 microamps.

5. Inspection Procedure (Method I)

A. Place the reflector disk on the inside of the radome at the location to be measured, but away from metallic materials that will affect the thickness measurement.

B. With the instrument calibrated as described in par. 4., place probe on the outside of the radome and scan the area to be measured. A meter reading will be obtained as the probe approaches the reflector. Scan with the probe until a minimum reading is obtained. Take a minimum of three readings and compute the average and range of these readings. If the range is greater than one division then some or all of the readings are suspect and it may be advisable to take more readings. Then using the computed average and appropriate calibration curve determine the corresponding thickness value.

NOTE: Temperature difference can introduce significant uncertainty in the instrument readings. It is suggested that the calibration process and the actual measuring process be done under the same temperature environment. Instrument signal drift due to the effects of hand temperature on the probe may be reduced by wrapping the probe with thermal insulation.

6. Battery Replacement (Method I)

A. If the batteries test less than a meter reading of 60, they should be replaced as follows:

(1) Remove instrument from case by removing four front panel screws.

(2) Batteries are on the bottom of the chassis in spring mount connections. Push in to remove, replace with Mallory TR-135R 6.75-volt mercury batteries or equivalent.

(3) Replace instrument in case and check battery voltages.

7. Equipment (Method II)

A. Eddy current instruments -- Multi-frequency eddy current instruments with manual phase adjustment are required. The following instruments were used in the development of this procedure:

(1) MIZ-10B, Zetec.

(2) Alcoprobe-S, Inspection Instruments (NDT) Ltd.

NOTE: For other than battery powered models, a voltage regulator is required on the power source if the instrument's internal voltage regulators are not adequate to prevent signal variation.

B. Eddy current probes -- Low frequency surface or ring probes operating in the 100 Hz to 500 Hz range are recommended. Probes should not give interfering responses from normal handling pressure, manipulation, or operating pressure variations on the sensing coil. The following probes were used in the development of this procedure:

(1) Nortec SP-0.1, 100 Hz, 1.250-inch (3.175 cm) OD (used only on MIZ-10B).

(2) Nortec SPO 1274, 100 Hz, 0.8-inch (2.0 cm) ID and 1.4-inch (3.56 cm) OD (used only on MIZ-10B).

NOTE: These are standard sensitivity probes (absolute probe used in a differential system) and should adequately determine the thickness of radome structure up to 0.6 inch (1.016 cm) in thickness.

(3) Nortec ARP/13.5/29P, 100 Hz - 10 kHz, 0.54-inch (1.37 cm) ID and 1.15-inch (2.92 cm) OD.

NOTE: This is a higher sensitivity probe (driver pick-up probe used in a differential system) and may be required to determine the thickness of radome structure greater than 0.4 inch (1.016 cm) in thickness.

C. Reference Standards

(1) Radome thickness standard -- A stepwedge or block set representing the inspection thickness range constructed of any non-conductive material. Machine stepwedge or blocks to a thickness tolerance of ± 0.001 inch and include in the thickness range the required nominal radome inspection thickness and ± 0.030 inch in 0.010-inch steps. Refer to Details VII and VIII.

(2) Conductive reflector

(a) An aluminum reflector disk constructed of 2024, 7075 or equivalent. Refer to Detail VI.

NOTE: Reflector disk should have an outer radius slightly less than the inner radius of the radome inspection location to assure satisfactory contact of reflector disk with radome inner surfaces.

D. Connector -- A probe connector shall be used which will physically and electronically match the probe and the instrument to yield the sensitivity specified in par. 9.G.

8. Preparation for Inspection (Method II)

A. If necessary, remove radome erosion shoe.

B. Identify inspection locations and determine radome thickness ranges. Refer to Detail VIII or part drawing.

C. Ensure inner and outer inspection surfaces of radome are clean.

D. Locate inspection instruments a minimum of 10 feet (3 m) from any items that generate a large magnetic field, such as large motors, generators, transformers, or power lines.

9. Instrument Calibration (Method II)

A. Set the frequency to 500 Hz.

B. Place the reflector and the probe on opposite sides of the radome thickness standard at the step 0.030 inch thinner than the nominal inspection thickness. Refer to Detail VIII. Center the probe for a minimum reading from the reflector. Refer to Detail IX.

C. Balance the instrument according to the manufacturer's instructions.

D. Adjust lift-off to obtain maximum upscale needle movement when probe is moved from the thickness standard to air.

E. Reposition the probe on the thickness standard as in par. 9.B and adjust the meter position control to obtain a meter reading of 10 percent of full scale.

F. Place the reflector and the probe on opposite sides of the radome thickness standard at the step 0.030 inch greater than the nominal inspection thickness. Center the probe for a minimum reading from the reflector.

G. Adjust the sensitivity to obtain a meter reading of 80 percent full scale between probe positions from par. 9.B and par. 9.F.

H. Place the reflector against the probe on the step representing the nominal inspection thickness and note the meter response. Place the reflector and probe on steps indicating the minimum and maximum inspection thickness range and note the meter response. Refer to Detail VIII.

I. With the above setting, average at least three readings from each standard step and plot the points. Draw a "best-fit" line through these points to obtain a calibration curve similar to Detail III.

10. Inspection Procedure (Method II)

A. Prepare for inspection per par. 8.

B. Perform instrument calibration per par. 9.

C. Place the curved surface of the reflector against the inside of the radome at the location to be measured, but away from any conductive materials which will affect the inspection results.

D. Place the probe on the outside of the radome opposite the reflector. Scan the area over the reflector with the probe until a minimum meter reading is obtained.

NOTE: Some radomes, due to size and configuration, may require a second person to hold the conductor on the inner surface of the radome while the inspector manipulates the probe on the outer surface.

E. Periodically check the instrument/probe calibration response. If the response is found to be unsatisfactory, reinspect all areas inspected since last calibration check.

F. Note any areas outside the minimum and maximum thickness allowances.

11. Inspection Results (Method II)

A. A thickness measurement outside the minimum or maximum thickness allowances is an unacceptable condition.

(1) Note thickness measurement in affected area.

(2) Note size of area affected.

B. Several conditions may give erroneous inspection results.

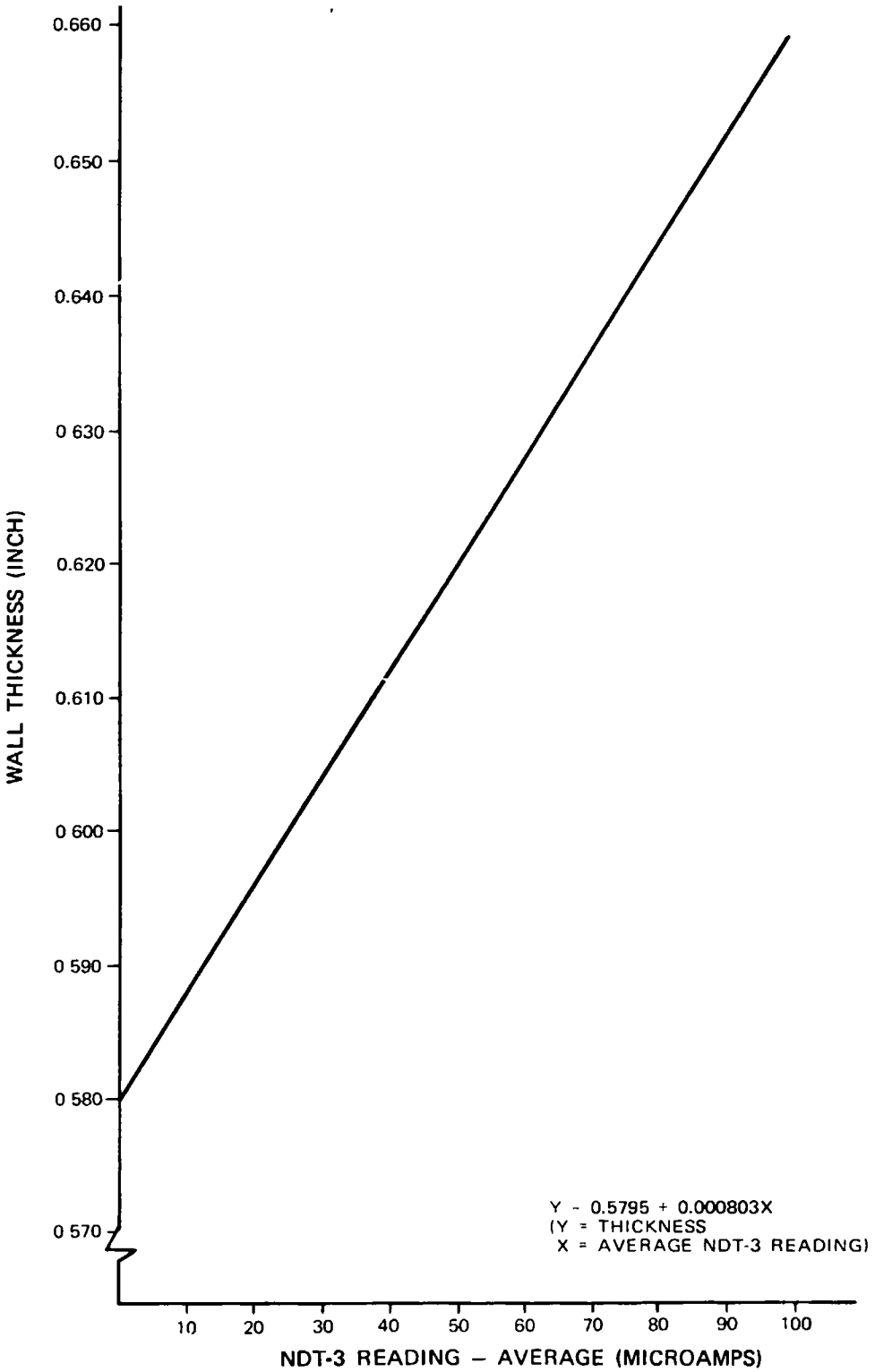
(1) Reflector does not fit tightly against the radome - position reflector to conform tightly to radome inner surface.

(2) Flat surface probe does not fit tightly against the radome - substitute ring probe for flat surface probe in inspection.

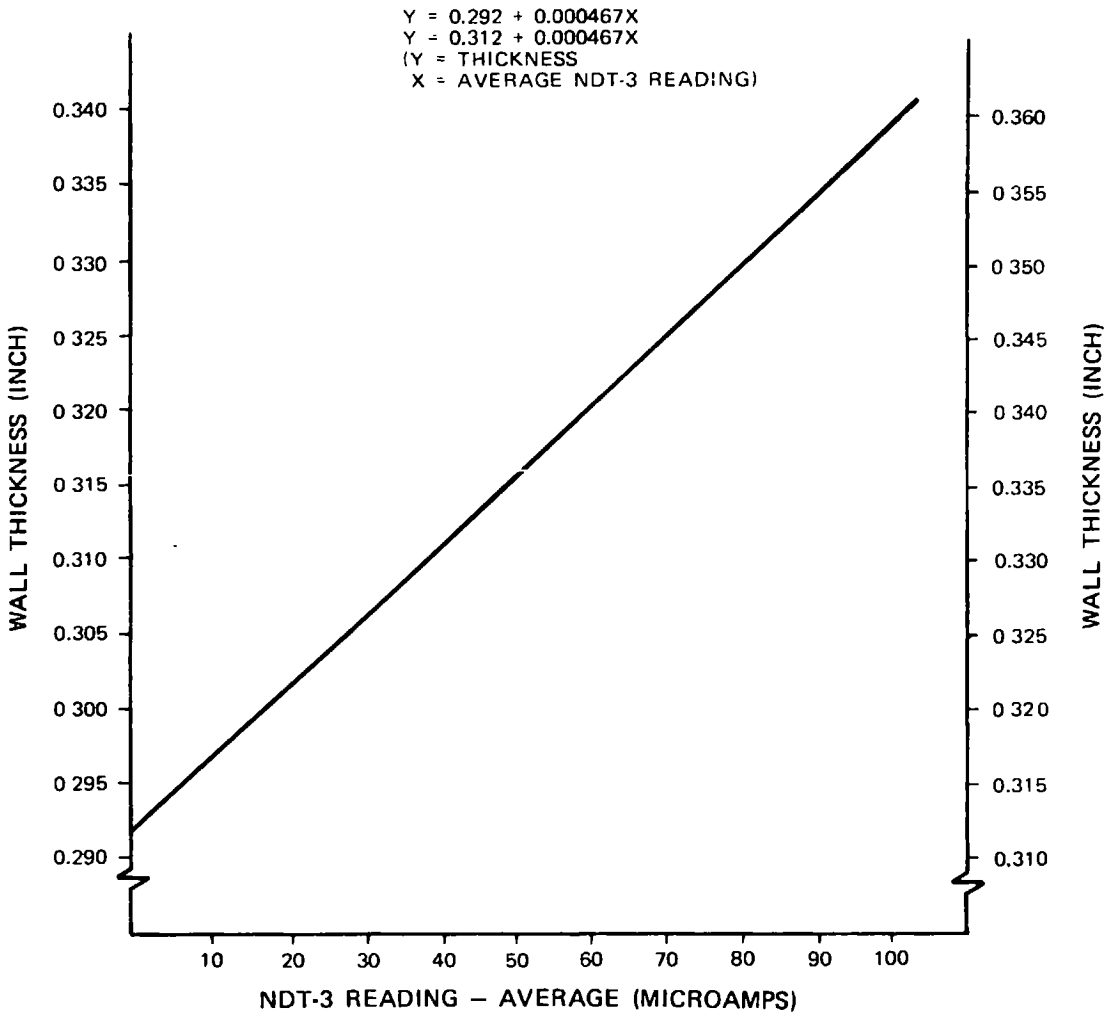
(3) Standard sensitivity probe [par. 7.B.(1) or (2)] does not penetrate thickness adequately - switch to higher sensitivity probe [par. 7.B.(3)] and recalibrate.

(4) Response interference due to conductive materials - locate and avoid conductive structures in inspection area.

(5) Signal drift due to thermal differences between probe and part - allow test equipment and radome to reach approximately the same temperature before performing calibration and inspection.

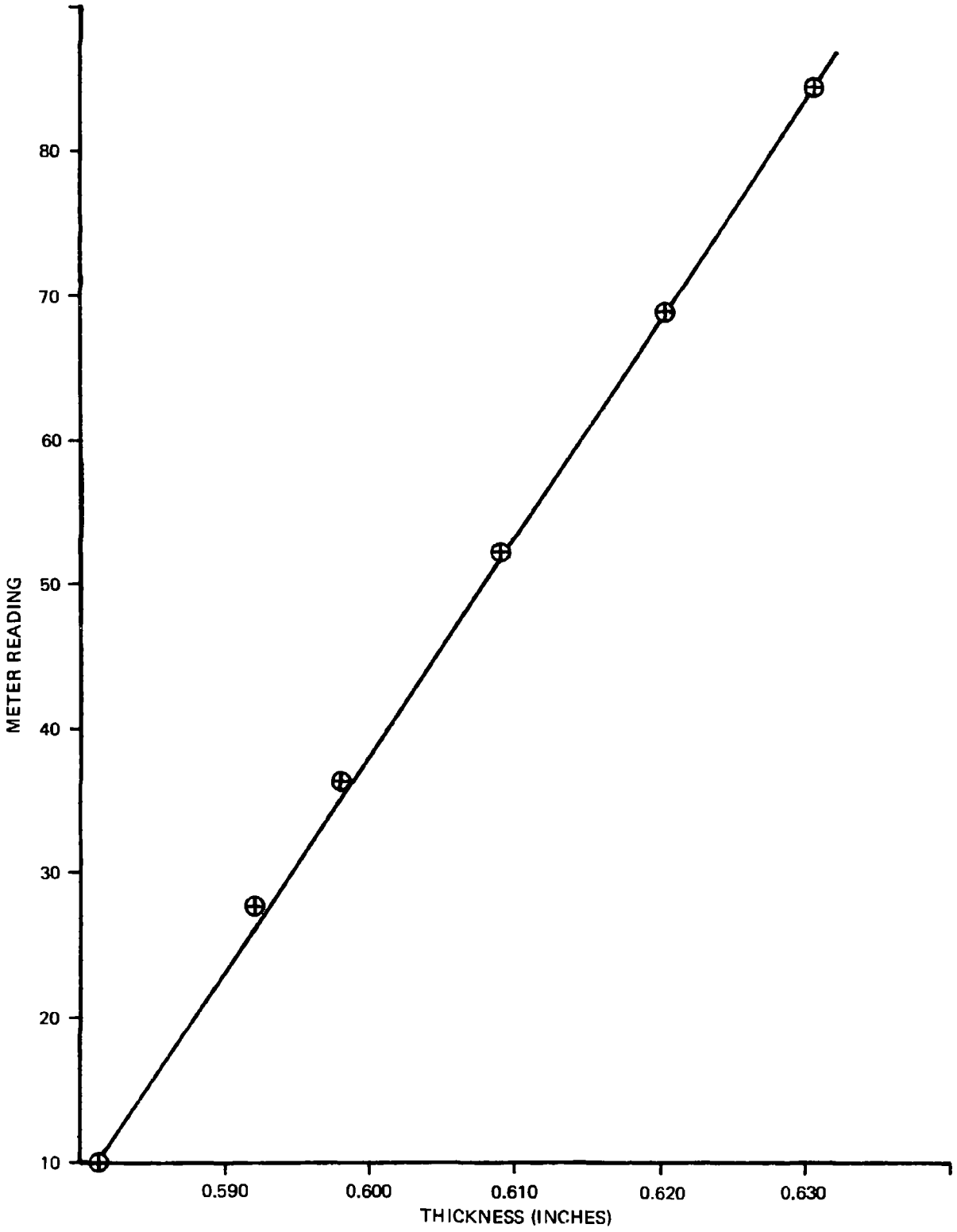


CALIBRATION CURVE FOR C–BAND RADOMES
DETAIL I



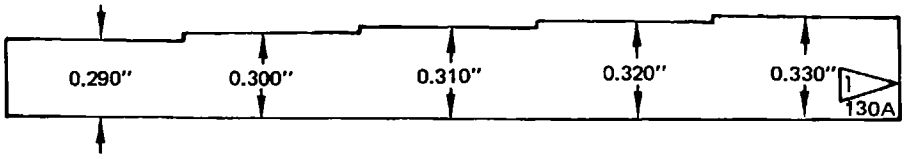
CALIBRATION CURVE FOR X–BAND RADOMES

DETAIL II

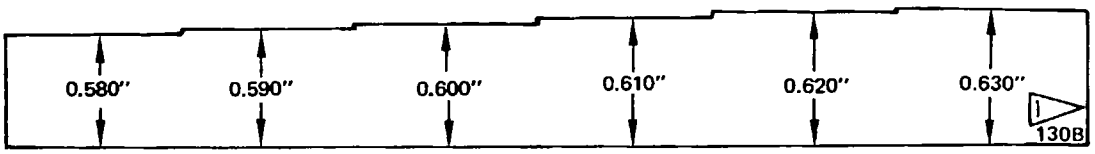


METHOD II – SAMPLE CALIBRATION CURVE
DETAIL III

A84812



THICKNESS STANDARD FOR X–BAND RADOMES
DETAIL IV

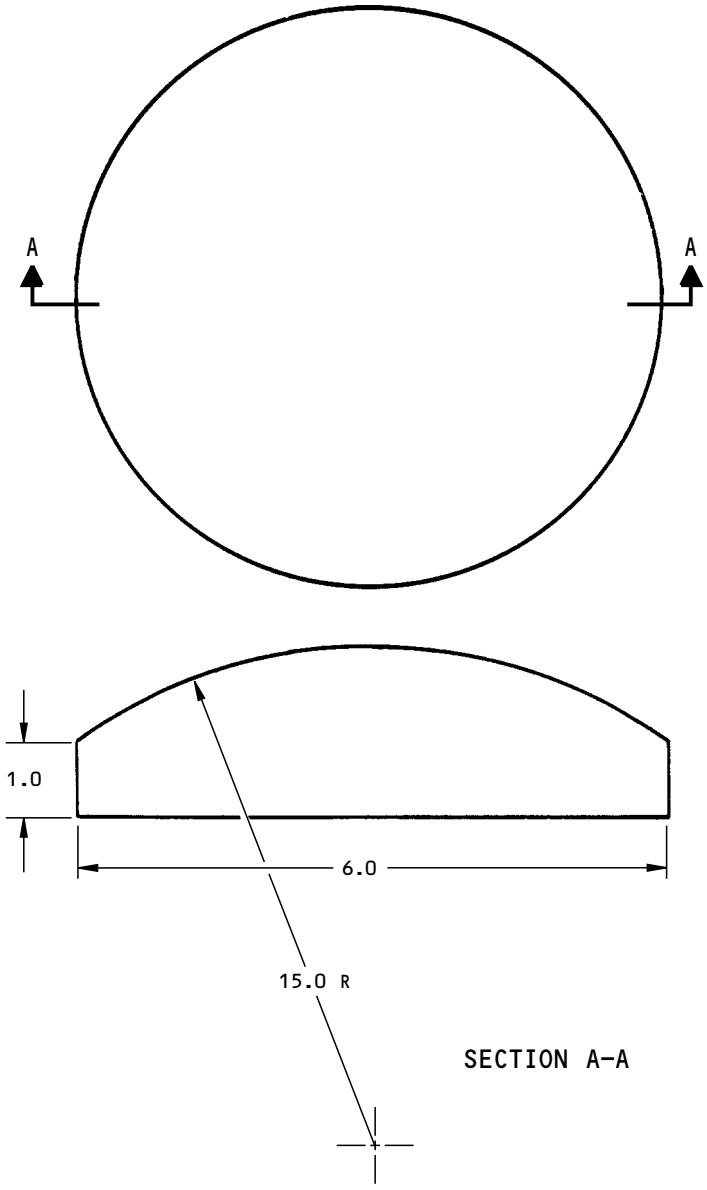


THICKNESS STANDARD FOR C–BAND RADOMES
DETAIL V

NOTES

- ALL DIMENSION ARE IN INCHES
- MATERIAL: LUCITE
- SIZE EACH STEP IS 2 INCHES LONG AND 2 INCHES WIDE WITHIN ± 0.03 INCHES, SEE DETAILS IV AND V
- THICKNESS TOLERANCE . ± 0.001 INCH

1 ETCH WITH 130A AND 130B

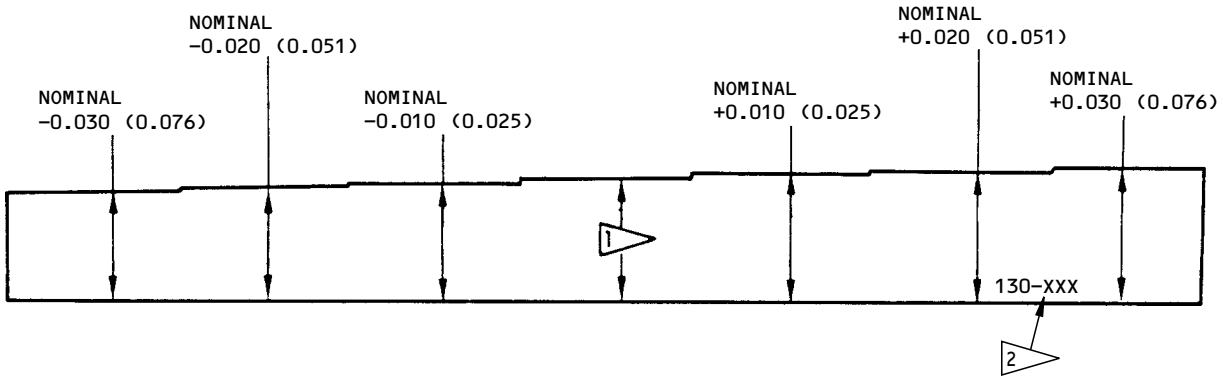


SECTION A-A

NOTES:

- ALL DIMENSIONS ARE IN INCHES
- DIMENSION TOLERANCES: ± 0.030
- MATERIAL: ALUMINUM, 2024, 7075 OR EQUIVALENT
- PART NUMBER: 130C

ALUMINUM REFLECTOR (CIRCULAR) DISK
DETAIL VI



NOTES:

- ALL DIMENSIONS ARE IN INCHES (CENTIMETERS IN PARENTHESES)
- MATERIAL: LUCITE OR ANY SUITABLE NONCONDUCTIVE MATERIAL

  SIZE: EACH STEP IS 2 INCHES (5.08) LONG AND 2 INCHES (5.08) WIDE WITHIN ± 0.03 INCHES (0.076)
- THICKNESS TOLERANCE: ± 0.001 INCH (0.003)
- ETCH STEP THICKNESS ON SIDE OF STANDARD

1 NOMINAL THICKNESS OF RADOME TO BE INSPECTED, SEE DETAIL VIII

2 ETCH OR STAMP "130-XXX" AT APPROXIMATELY THIS LOCATION (XXX IS THE NOMINAL THICKNESS OF THE RADOME. REFER TO FLAG NOTE 1.)

THICKNESS STANDARD
DETAIL VII

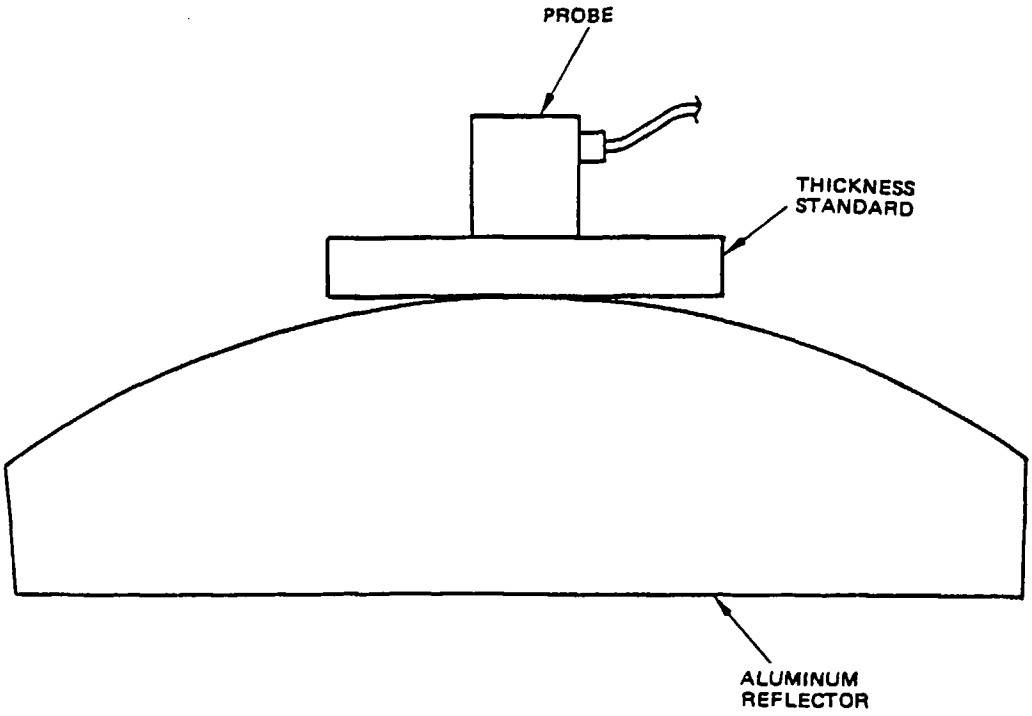
Airplane and Radome Part Number	Thickness Range of Radome Except at Overlaps *[2]	Thickness Range of Radome at Single Overlaps *[2]	Thickness Range of Radome at Double Overlaps *[2]	Thickness Range of Radome at Nose Cone
707 x-band	0.290 0.310 *[1] 0.330			
707 c-band	0.580 0.610 *[1] 0.630			
727 65-2040-6, -12, -14	0.625 0.640 *[1] 0.655	0.615 0.640 *[1] 0.655		
727/737 65-54464-1,-3 65-73295-1	0.580 0.590 *[1] 0.605	0.590 0.600 *[1] 0.615	0.600 0.610 *[1] 0.625	
727 65-2040-7,-17	0.365 0.380 *[1] 0.395	0.355 0.380 *[1] 0.405		0.315 0.330 *[1] 0.345
727/737 65-73294-1,- 2, -5, -6, -8 65-54463-1,- 3	0.304 0.312 *[1] 0.322	0.292 0.300 *[1] 0.310	0.308 0.316 *[1] 0.328	0.304 0.312 0.322
737 65-73294-7	0.39 ±0.006 *[1]	0.38 ±0.006 *[1]	0.409 ±0.006	0.39 ±0.006
737 65-73294-9	0.304 0.312 0.322	0.292 0.300 0.321	0.308 0.316 0.328	
747 65B07929-3	0.340 0.350 *[1] 0.360	0.340 0.360 *[1] 0.370		
747 65B07929-1,- 2, -4, -5	0.340 0.350 *[1] 0.360	0.323 0.335 *[1] 0.347	0.323 0.360	
757 284N1417	0.340 0.350 0.360			
767 284T0051	0.340 0.350 0.360			

NOTES

*[1] NOMINAL INSPECTION THICKNESS -- REFERENCE POINT FOR CALIBRATION AND THICKNESS STANDARD.

*[2] REFER TO RADOME DRAWINGS FOR LOCATION OF OVERLAPS.

RADOME THICKNESS RANGES
DETAIL VIII



PROBE AND ALUMINUM REFLECTOR
PLACEMENT ON THICKNESS STANDARD

DETAIL IX