



REDUCED VERTICAL SEPARATION MINIMUM (RVSM)

SKIN WAVINESS INSPECTION PROCEDURES

FOR THE

CESSNA MODEL 500/501 AND 550/551

CITATION AIRCRAFT

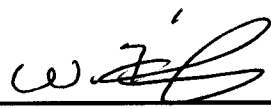
FAA STC Number ST2642AT

Prepared By: 
G. Fischer

Date: 9/16/03

Checked By: 
E. Weaver

Date: 16 Sept. 2003

Approved By: 
W. Fink

Date: 9/16/03

PROPRIETARY NOTICE

This document and the information herein are proprietary data to Star Aviation Inc. Neither this document nor the information contained herein shall be used, reproduced or disclosed to others without the written authorization of Star Aviation Inc.

Record Of Revisions

Rev	Date	Pages Affected	Description Of Revision	Approvals
IR	8/07/03	All	New Document	Prepared By: L. Kline (KSR) Checked By: T. Marshall (KSR) Approved By: W. Fink for B. Culberson
A	8/12/03	2,5,11	Sheet 2: Reformatted Record of Revision Table. Sheet 5 and 11: Updated tool P/N from KSR TOL 723F to KSR TOL 723.	Prepared By: G. Fischer Checked By: E. Weaver Approved By: W. Fink
B		11 13 16 19 20	Moved Section 5.2 to page 12. Added Section 5.4 Slope Calculation. Edit to Figure 5.2. Appendix A Figure A.1 refined wording. Appendix A added Figure A.2 Skin Waviness and Skin Overlay Slope Calculation Worksheet .	Prepared By: See front sheet Checked By: See front sheet Approved By: See front sheet

PLACEMENT OF INITIAL ISSUES AND REVISIONS

Revisions of documents are distributed to the same personnel and locations as the original issues. Every copy of a revised document is distributed with a coversheet or rev block that contains a brief description of what has been changed and what is new. The cover sheet also contains a note instructing the recipient to remove and destroy the old, superseded version of the document. Maintaining unauthorized files with superseded revisions of controlled documents is prohibited.

Table Of Contents

<u>Section</u>	<u>Page</u>
Record Of Revisions.....	2
Table Of Contents	3
List Of Tables	3
List Of Figures	3
1. Introduction.....	4
2. Equipment Identification	5
3. Pre Test Preparation.....	6
3.1. Static Port Condition	6
3.2. Paint Removal.....	6
3.3. Paint Stripes.....	6
4. Reference Grid	8
5. Measurement Procedures	11
5.1. Depth Gauge Setup	11
5.2. Reference Bar	12
5.3. Skin Map Measurement.....	12
5.4. Slope Calculation.....	13
5.5. Skin Overlay.....	15
6. Technical References.....	17
A APPENDIX A SKIN WAVINESS INSPECTION WORKSHEETS	18
B APPENDIX B STATIC PORT SKIN PREPARATION	21
B.1 Overview	22
B.2 Materials.....	22
B.3 Procedure	22

List Of Tables

<u>Table</u>	<u>Page</u>
2.1 Test Equipment.....	5

List Of Figures

<u>Figure</u>	<u>Page</u>
3.1 Paint Stripe Limitations.....	7
4.1 Reference Grid - L/H Side.....	10
5.1 Skin Map Measurement Setup	14
5.2 Skin Overlay Inspection - L/H Side	16
A.1 Skin Waviness and Skin Overlay Inspection Worksheet.....	19
A.2 Skin Waviness and Skin Overlay Slope Calculation Worksheet.....	20
B.1 Static Port Skin Preparation.....	23

1. Introduction

Future proposed reductions in the vertical space separating aircraft traveling within the airspace contained between 29,000 and 41,000 ft will require increased accuracy for aircraft altitude sensing equipment. Since the performance of the altitude sensing system can be greatly influenced by variations in the skin of the aircraft and the condition of the elements of the pitot-static system, it is important to establish inspection methods that allow variations in the skin of a given aircraft to be measured accurately and in a repeatable manner.

This document serves to outline the technical procedures needed to quantify the skin contours of a given aircraft to support Reduced Vertical Separation Minimum (RVSM) operation. The procedures contained in this document are specific to the Cessna Model 500/501 and 550/551 aircraft group which consists of the Citation, Citation I and Citation II airplanes (note: in this report, the Model 500 designation includes the Model 501, and the Model 550 designation includes the Model 551). These data are not valid for the Cessna Model 550 Bravo airplanes. A serialization of all aircraft applicable to this report is given in references 1 and 2.

This document gives a description of the inspection equipment, the inspection preparation and data acquisition process that has been developed by Kohlman Systems Research, Inc. for the Cessna Model 500 and 550 RVSM group. The procedures in this document define the acceptance criteria for RVSM qualification of aircraft to be included in the group certification. These procedures must be performed only by individuals trained and approved by Star Aviation, Inc.

2. Equipment Identification

The Cessna Citation Model 500 and 550 airframes are assembled in a like manner using similar parts and are intended to be identical, taking into consideration manufacturing tolerances. The static port regions are illustrated in Figure 4.1. Airframe to airframe variability that occurs around the static ports from manufacturing and paint condition can influence the accuracy of altitude sensing equipment due to slight skin variations around the static ports and differences between the Pilot and Copilot side of the airframe.

In addition to the paint condition, other airframe variables that can potentially influence the accuracy of the altitude sensing equipment include skin surface variations and the static port flushness. A quantitative assessment of each of these potential influences is required to establish RVSM airworthiness.

The precision equipment, identified in Table 2.1 is required to accurately measure the skin waviness and skin lap heights for the Cessna Model 500 and 550 aircraft. It consists of a 16 inch steel reference bar with a base that is used in conjunction with a dial-indicator depth gauge to measure the skin contour. The reference bar consists of a rectangular bar attached to a three-point base. The equipment is meant to provide the necessary level of accuracy while being portable and easy to use.

Table 2.1 Test Equipment

Component	Part Number
Skin Map Reference Bar – With Base	KSR TOL 723
Dial Indicator Depth Gauge	Mitutoyo 547-217
24 in. Flexible Steel Ruler	Various
Grease Pencil or Dry Erase Marker	Various

3. Pre Test Preparation

In order to ensure repeatable and accurate results the condition of all items in the area surrounding the static ports shall be checked. This includes the condition of the static ports, the fasteners used to mount the static ports, the paint condition and the skin waviness.

3.1. Static Port Condition

Check each of the static port for damage in accordance with appropriate Cessna Maintenance Manual. Make sure the area around the static port, 6 inches aft, 24 inches forward, 12 inches above and below is clean and has no visible damage.

Any static ports and static port areas that do not meet the requirements noted above must be replaced or repaired to bring them into compliance.

3.2. Paint Removal

To reduce the influence of the paint thickness and condition on the measured pressures, the static port area on the Cessna Model 500 and 550 airframes is to be stripped of paint within approximately a 1.25 inch radius of the center of the static ports prior to RVSM certification. Appendix B describes in detail on how the static port area must be prepared before the skin contour measurements can be taken.

3.3. Paint Stripes

Excessive ridges in the paint caused by stripes or similar color scheme changes need to be eliminated.

In an area 3 feet forward of the static ports and 1 foot above and below the static ports, any transitions in the paint scheme must be smooth. Reference Figure 3.1 for acceptable paint stripe configurations.

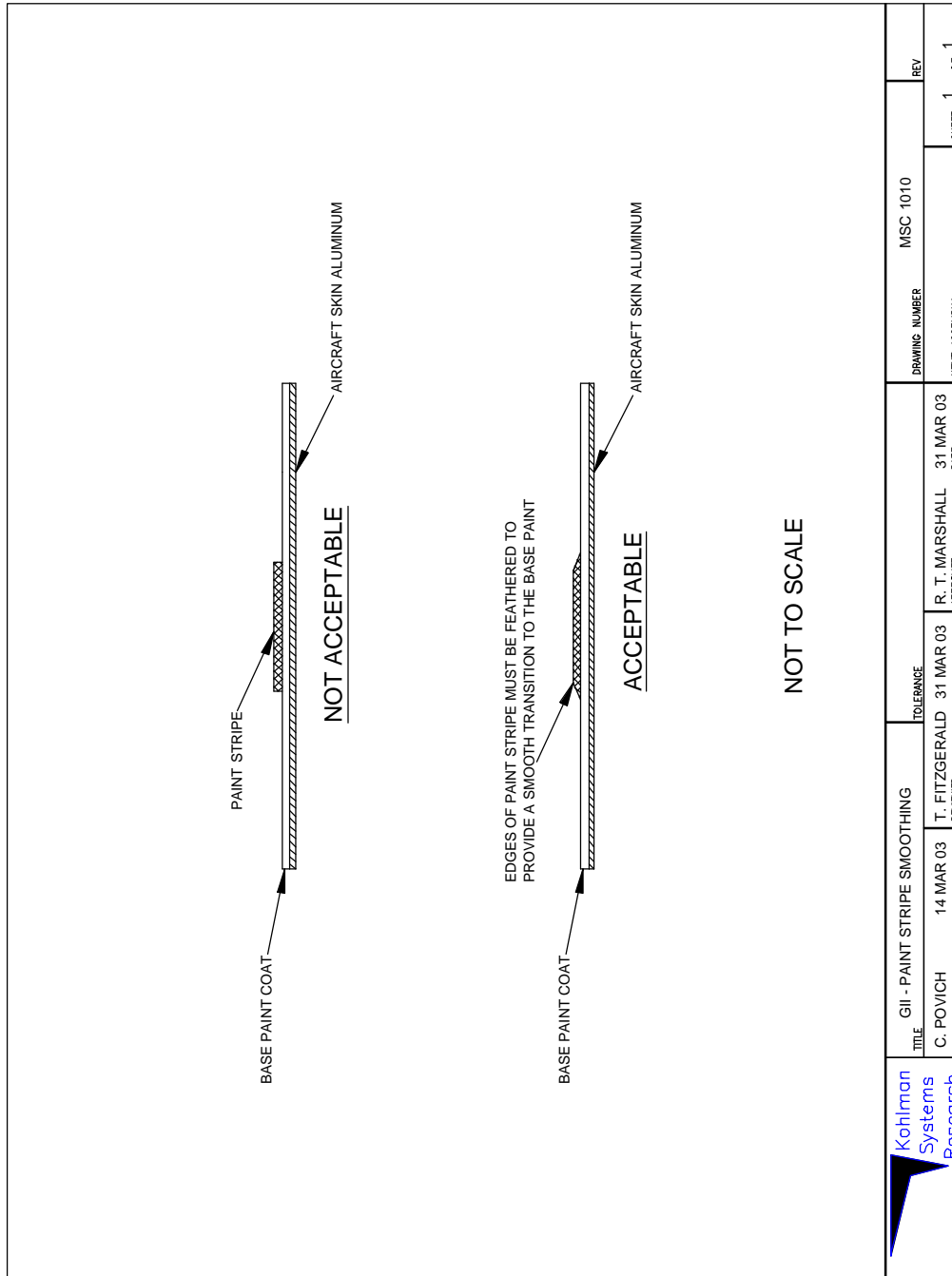


Figure 3.1 Paint Stripe Limitations

4. Reference Grid

In order to create a repeatable and accurate means to quantify the skin waviness, a reference grid must be established. This grid will be used to determine the location of each point at which the skin waviness measurements will be taken.

For the Cessna aircraft, a grid spacing of one inch is used. The waterline reference for this grid is a line that runs through the centerline of the static ports, parallel to the skin overlay, which is approximately 3.25 inches below the center of the static ports. This grid will cover an approximate area 10 inches forward and 3 inches aft of the centerline of the static ports and 6 inches above and 6 inches below the centerline of the static ports.

Figure 4.1 shows the grid as it should be marked on the aircraft.

The following steps are used to establish the grid. This should be done on both sides of the aircraft.

1. Draw a vertical line through the upper and lower static ports, at least 6 inches above and below, and locate a point midway between the upper and lower static ports.
2. Determine the distance from of the center point between the upper and lower static ports to the skin overlay below the static ports.
3. At a point about 12 inches forward of the static ports, measure up from the skin overlay this same offset.
4. Using the 24 inch straight edge and the dry erase marker, draw a horizontal line through the centerline of the static ports and the mark from step three. Extend this line at least 14 inches forward of the static point centerline and at least 4 inches aft
5. Locate the double vertical row of rivets approximately three inches aft of the static ports. Locate a point just forward of these rivets, centered between these and the rivets just forward. Measure the distance of this point from the vertical line drawn in step 1. Measure aft from the top and bottom of the vertical line from step one this same distance, and using the 24 inch straight edge and the dry erase marker, draw a vertical line through these points.
6. At a point 15 inches forward of the aft vertical line, use the straight edge and the dry erase marker to draw a vertical reference line. This vertical reference line should extend eight inches above and below the horizontal reference line.

7. For both vertical lines, at each one inch increment (up to seven inches above and below the horizontal reference line) on the forward vertical reference line, make a mark and indicate the distance from the horizontal reference (positive numbers above the horizontal reference line and negative numbers below the horizontal reference line).
8. Verify the vertical reference lines are parallel by measuring the distance between the lines at the positive and negative seven inch mark. See Figure 4.1 for reference. The distance from the aft reference line to the forward vertical reference line should be 15 inches.
9. After all skin waviness measurements are completed, remove all markings from the aircraft.

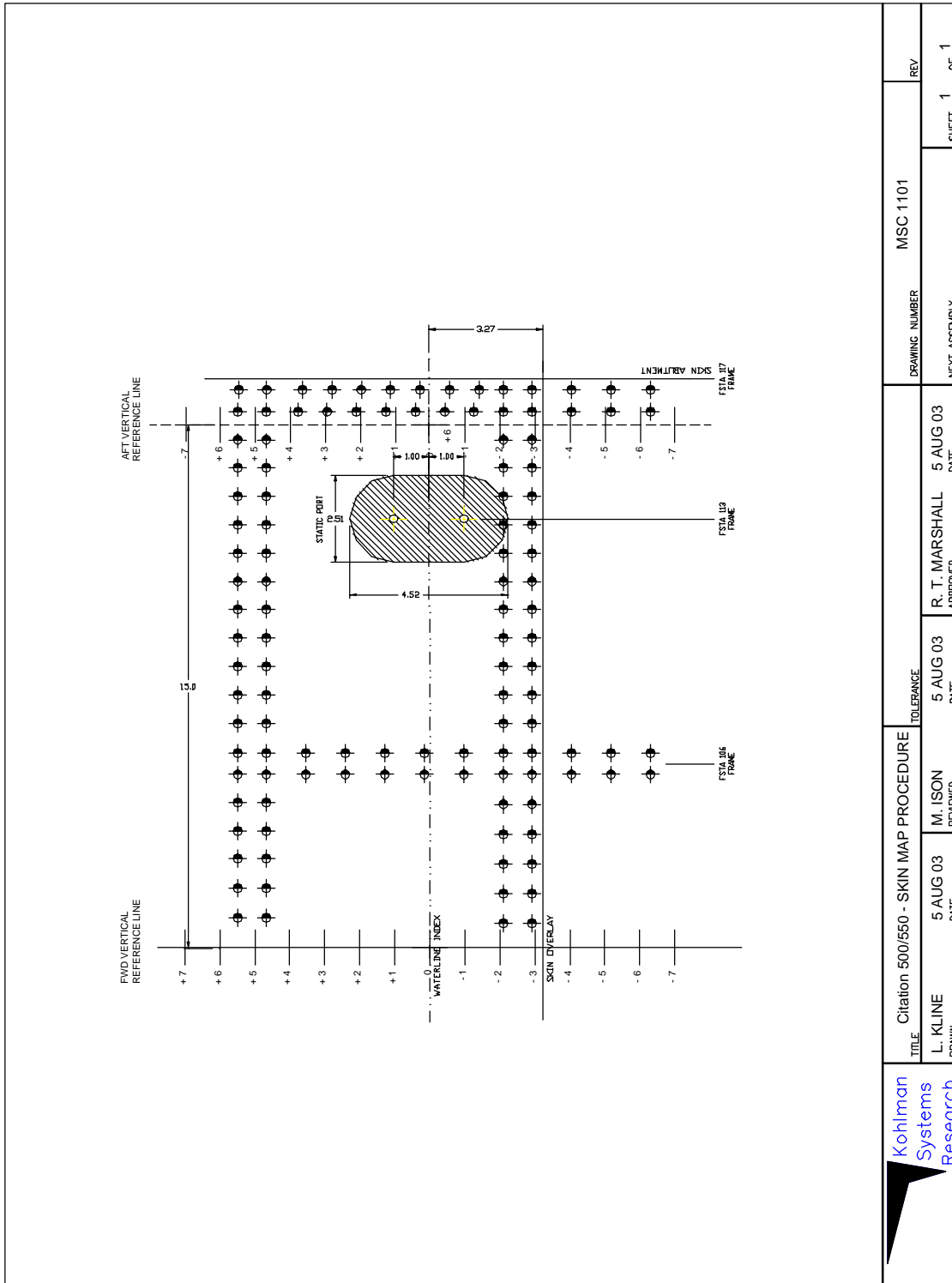


Figure 4.1 Reference Grid - L/H Side

Note: Figure 4.1 depicts the paint-free area (shaded zone).

	TITLE Citation 500/550 - SKIN MAP PROCEDURE L. KLINE DRAWN	DATE 5 AUG 03	REVIEWED M. ISON	DATE 5 AUG 03	TOLERANCE DATE 5 AUG 03	APPROVED R. T. MARSHALL	DATE 5 AUG 03	DRAWING NUMBER MSC 1101	REV 1 OF 1
				SHEET 1 OF 1					

5. Measurement Procedures

Skin waviness is measured as the dimensional variation between the airframe skin and an offset from the foot of a reference bar (KSR TOL 723). To alleviate airframe induced measurement error, the waviness reference plane is offset from the skin surface. The reference bar (KSR TOL 723), is held against the aircraft skin at the points on the reference grid. A dial depth gauge is then used to measure the distance from the reference bar to the aircraft skin. Figure 5.1 shows how the different pieces of equipment are used in the measurement.

5.1. Depth Gauge Setup

The dial depth gauge is used to determine the distance from the reference point to the aircraft skin. In order to ensure repeatable measurements the following steps should be taken:

1. Check the function of the dial depth gauge. Ensure the plunger movement is free and smooth. Clean the gauge as necessary with a clean, dry, cloth. Do not use any oil based cleaning products on the depth gauge.
2. Remove the plunger end and replace it with the 2 ½ inch extension and plunger end. Ensure that the tip of the plunger is securely in place. Adjust the depth gauge base so that the plunger end will extend and retract comparable distances below and above the bottom of the feet of the reference bar.
3. Place the reference bar on a flat smooth surface. Place the depth gauge in the reference bar track near one end of the reference bar. Zero the dial indication to read 0.000. Confirm this zero (± 0.002) at the opposite end of the reference bar.
4. Check the function of the dial depth gauge. Ensure the gauge reads a negative number when the plunger is extended and a positive number when the plunger is retracted. If not, push the +/- button on the upper right of the gauge and confirm the proper sign. Reconfirm the proper sign convention periodically throughout the measurement process.

5.2. Reference Bar

The rigid reference bar is used as a baseline to determine the waviness of the aircraft skin around the static ports. The feet at the end of the reference bar allow the bar to stand off from the aircraft and avoid the influence of any of the local skin waviness. The procedure for placing the reference bar on the aircraft skin is:

1. Check the reference bar for any damage or missing components. Clean the bar as necessary with a clean, dry, cloth. Do not use any oil based cleaning products.
2. Align the top of the feet of the reference bar with the tick marks on the vertical reference lines. This is shown in Figure 5.1
3. The reference bar should be held firmly against the aircraft skin at the ends. Do not push in the middle of the reference bar.

5.3. Skin Map Measurement

Using the procedures detailed in the previous sections, the entire skin map can be performed.

1. Align the reference bar, as detailed in section 5.1, with the +5 inch mark on the vertical reference lines.
2. With the reference bar in place against the aircraft, stick the plunger of the dial depth gauge through the space in the reference bar. Aligned the dial depth gauge at the number 1, one inch increment.
3. Bring the base of the dial depth gauge up against the reference bar. Gently but firmly hold the dial depth gauge against the reference bar. Figure 5.1 shows the placement of the dial depth gauge.
4. Read the indications on the dial depth gauge.
5. Record the resulting measurements in Table A1.
6. Move the dial depth gauge to each remaining one inch increment (2 thru 13) on the reference bar and repeat steps 3 thru 5.
7. Move the reference bar to the remaining points on the vertical reference lines. Repeat steps 1 thru 5 at each of the remaining points on the vertical reference lines.

5.4. Slope Calculation

Using the measurements recorded in the previous section, the slope can be calculated as follows.

1. Starting at Horizontal Grid Reference 5.0 and Reference Bar Graduation 12.0, note the recorded measurement.
2. Subtract this recorded measurement from the recorded measurement to the immediate left, in this case, Horizontal Grid Reference 5.0 and Reference Bar Graduation 13.0.
3. Enter the result in corresponding location in Table A2, in this case, Horizontal Grid Reference 5.0 and Reference Bar Graduation 12.0.
4. Repeat steps 1-3 for the remaining Reference Bar Graduations aft.
5. Repeat steps 1.4 for the remaining Horizontal Grid Reference rows down.

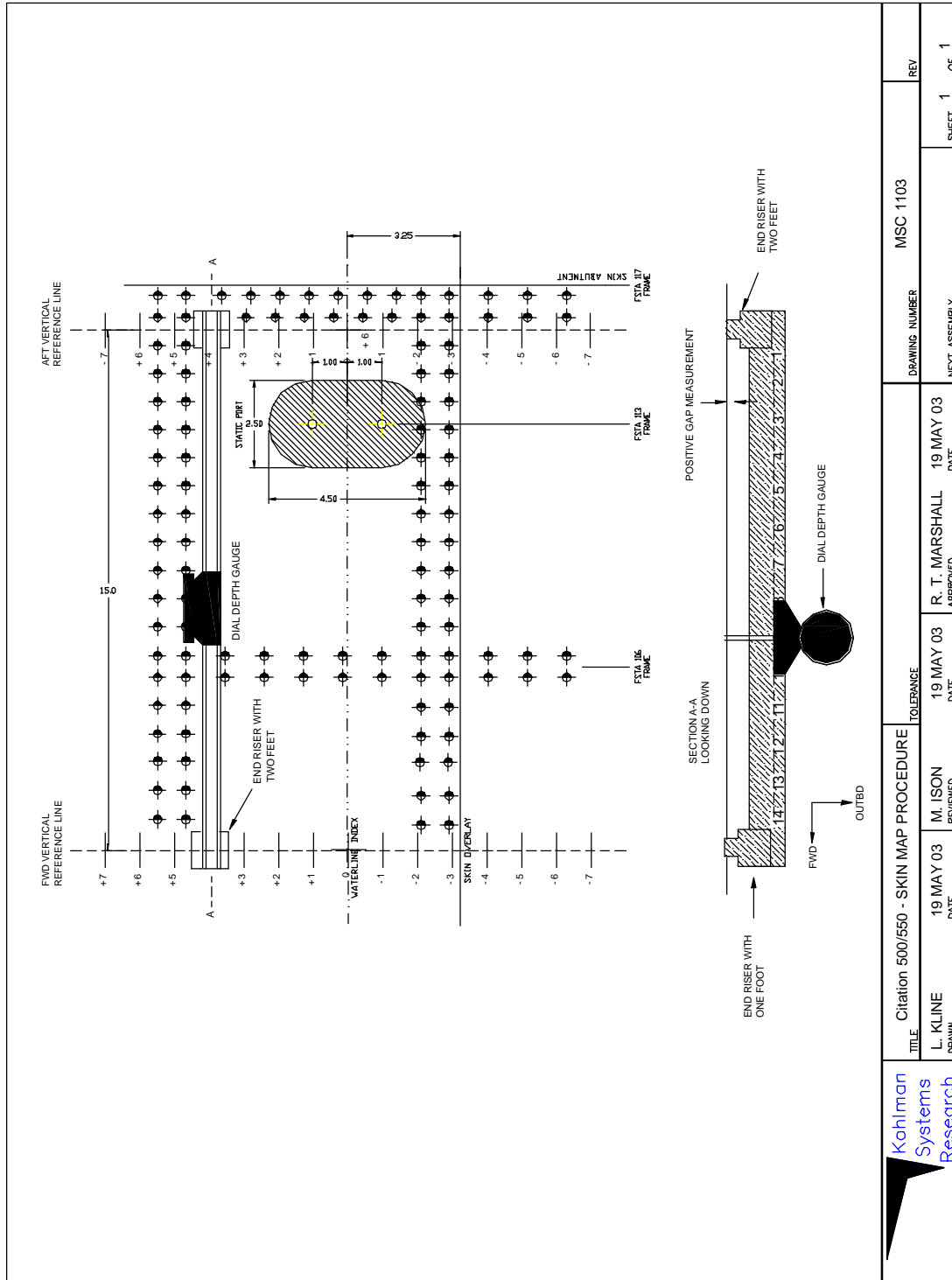



Figure 5.1 Skin Map Measurement Setup

	TITLE Citation 500/550 - SKIN MAP PROCEDURE L. KLINE DRAWN M. ISON REVIEWED 19 MAY 03 DATE		TOLERANCE 19 MAY 03 DATE R. T. MARSHALL APPROVED 19 MAY 03 DATE		DRAWING NUMBER MSC 1103 NEXT ASSEMBLY		REV SHEET 1 OF 1	

5.5. Skin Overlay

Refer to Section 4 (Reference Grid) and to Figure 5.2. For data acquisition, complete the following steps:

- Step 1.* Complete the skin waviness procedures. Before erasing the aft vertical line, use the 24 inch flexible ruler to mark 12 – one inch marks (2-13) forward of the vertical line on the skin overlay seam. Note: Do not remove these temporary index marks.
- Step 2.* Position the dial depth gauge near the skin overlay mark such that the plunger is depressed by the upper fuselage skin. Zero the dial depth gauge so it reads 0.000 while the contact is resting on the upper fuselage skin.
- Step 3.* Starting with the most forward skin overlay index mark, place dial depth gauge vertically and edgewise on the upper fuselage skin. Position the dial depth gauge vertically such that plunger is next to the skin overlay.
- Step 4.* Using the dial depth gage, measure gap between upper and lower fuselage skin. Record measurement on Figure A.1. Use unshaded and shaded boxes for the L/H and R/H sides, respectively.
- Step 5.* Repeat Step 3 for the remaining skin overlay index marks (equivalent to 12 in. steel rule indexes 12.0 through 1.0). Record data.

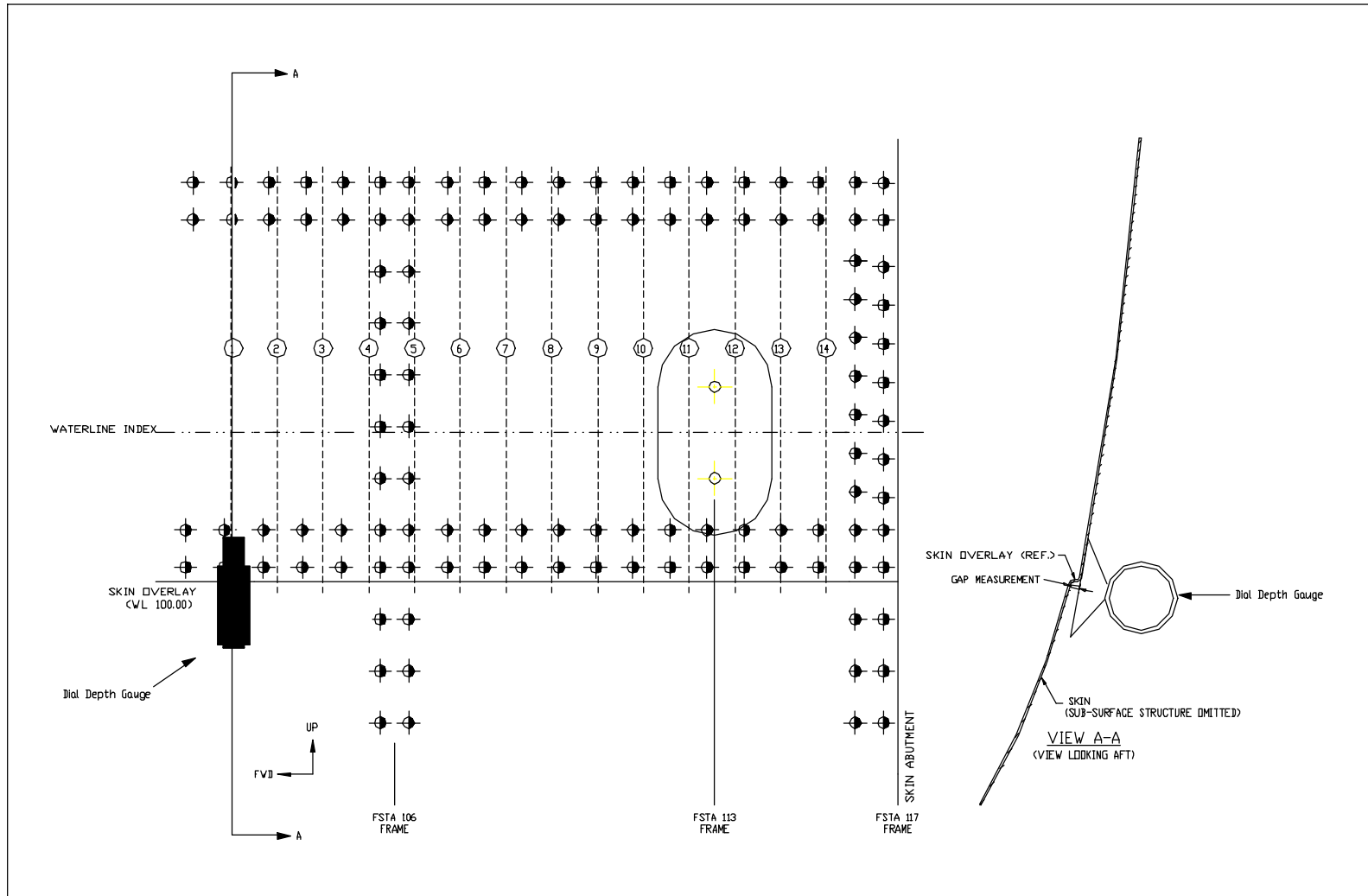


Figure 5.2 Skin Overlay Inspection - L/H Side

6. Technical References

1. Federal Aviation Administration, "Type Certificate Data Sheet No. A22CE", Revision 58, 6 March 2003.
2. Federal Aviation Administration, "Type Certificate Data Sheet No. A27CE", Revision 16, 6 March 2003.

APPENDIX A

SKIN WAVINESS INSPECTION WORKSHEETS

Cessna Model 500/550 RVSM													A/C SERIAL #:			
Skin Waviness Inspection Worksheet													A/C REG. #:			
DATE:													COMPLETED BY:			
AIRPORT:																
Horizontal Grid Reference	A/C Side	Reference Bar Graduation													Aft	Horizontal Grid Reference
		13.0	12.0	11.0	10.0	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0	1.0		
5.0 (Top)	Left															5.0 (Top)
	Right															
4.0	Left															4.0
	Right															
3.0	Left															3.0
	Right															
2.0	Left															2.0
	Right															
1.0	Left															1.0
	Right															
0.0	Left															0.0
	Right															
-1.0	Left															-1.0
	Right															
-2.0	Left															-2.0
	Right															
-3.0	Left															-3.0
	Right															
Skin Overlay	Left															Skin Overlay
	Right															
-4.0	Left															-4.0
	Right															
-5.0 (Bottom)	Left															-5.0 (Bottom)
	Right															

Figure A.1 Skin Waviness and Skin Overlay Inspection WorksheetError! Bookmark not defined.

Cessna Model 500/550 RVSM													A/C SERIAL #:			
Skin Waviness Slope Calculation Worksheet													A/C REG. #:			
DATE:													COMPLETED BY:			
AIRPORT:																
Horizontal Grid Reference	A/C Side	Reference Bar Graduation													Aft	Horizontal Grid Reference
		13.0	12.0	11.0	10.0	9.0	8.0	7.0	6.0	5.0	4.0	3.0	2.0	1.0		
5.0 (Top)	Left														5.0 (Top)	
	Right															
4.0	Left														4.0	
	Right															
3.0	Left														3.0	
	Right															
2.0	Left														2.0	
	Right															
1.0	Left														1.0	
	Right															
0.0	Left														0.0	
	Right															
-1.0	Left														-1.0	
	Right															
-2.0	Left														-2.0	
	Right															
-3.0	Left														-3.0	
	Right															
Skin Overlay	Left														Skin Overlay	
	Right															
-4.0	Left														-4.0	
	Right															
-5.0 (Bottom)	Left														-5.0 (Bottom)	
	Right															

Figure A.2 Skin Waviness and Skin Overlay Slope Calculation Worksheet

APPENDIX B

STATIC PORT SKIN PREPARATION

B.1 Overview

This procedure establishes the static port refinishing process for the Cessna Model 500/501/550/551 RVSM Group

B.2 Materials

Use standard aircraft procedure and practices for paint stripping and polishing the area defined in Figure B.1.

B.3 Procedure

Caution: Observe Safety Precautions Listed in Cessna 500 Series Maintenance Manual, Section 20-31-00

1. Protect static ports from any residue generated by the paint removal and aluminum polishing process.
2. Remove any placards within the shaded area defined by Figure B.1 and within a zone that extends from the top to the bottom and ten (10) inches forward from the center of this area.
3. Thoroughly clean airplane surface to remove all grease and other dirt, which might keep the stripping agent from attacking paint.
4. Mask the area to be stripped to correspond to the shaded area defined by Figure B.1.
5. Strip paint from aircraft within masked area (2.50 X 4.50 +/- 0.125 in. , Ref. Figure B.1). Paint and existing primer should be removed down to bare aluminum. Clean area and allow drying.

NOTE: Ensure mechanical methods used do not scratch or in any other ways damage the surface area being stripped

6. Remove masking material.
7. "Feather" paint edge around static ports to produce a smooth transition to the area of bare aluminum surrounding the Static Ports using Fine ScotchBrite as listed.
8. Polish the bare aluminum area around the static ports using an appropriate Polishing Compound.
9. Replace any removed placards in a location that is either above or aft of the static port critical area.

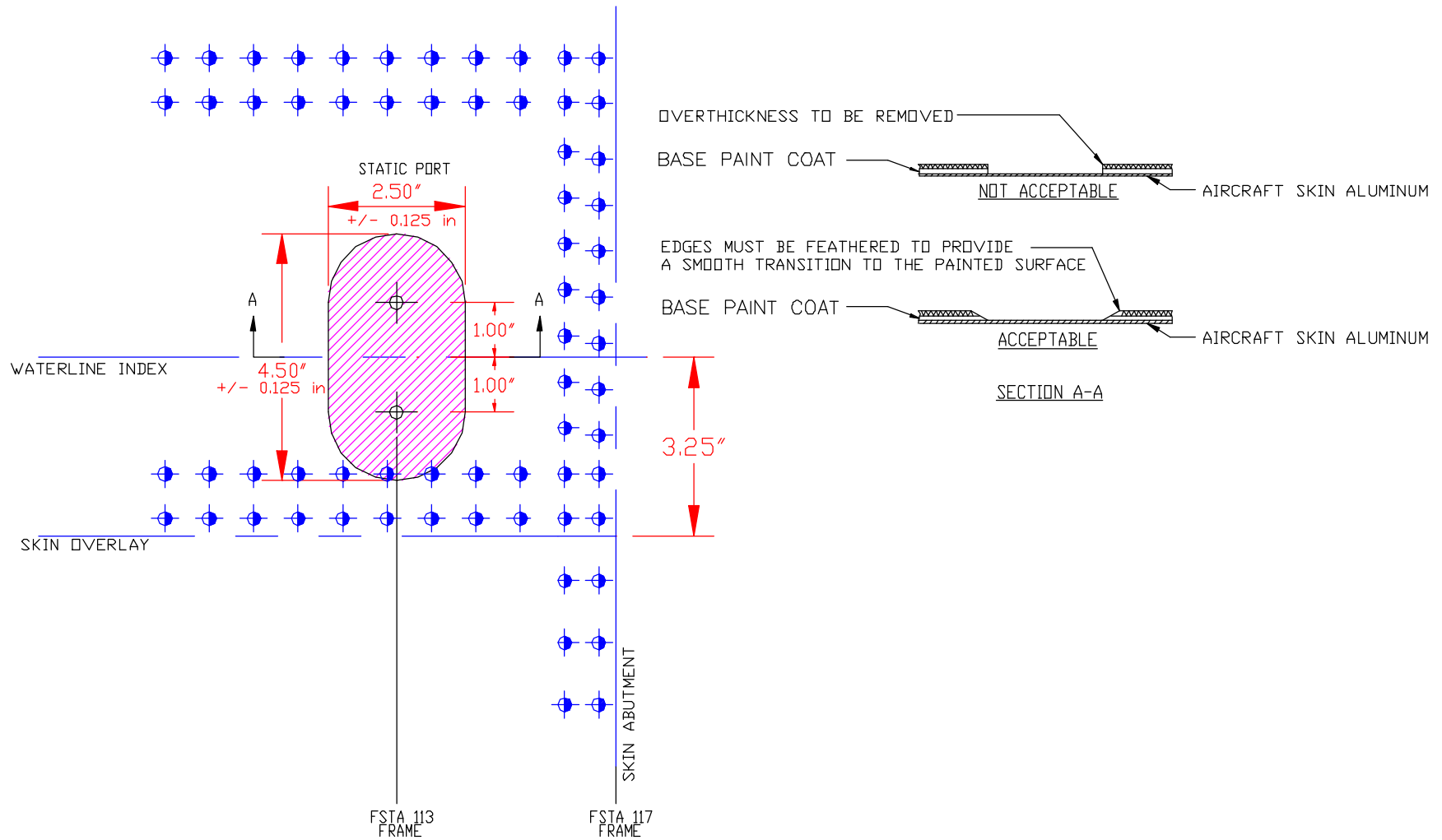


Figure B.1 Static Port Skin Preparation