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## NONDESTRUCTIVE TEST MANUAL

### PART 10 - VISUAL/OPTICAL

#### FUSELAGE SKIN AND BUTT JOINT SCRIBE INSPECTION AND DEPTH MEASUREMENT

##### **1. Purpose**

- A. Use this procedure to find scribe lines and measure scribe line depths in the fuselage skin and butt joint splice plates.
- B. The maximum width of the inspection area is 0.39 inches (9.9 mm).
- C. The maximum depth of the scribe line that can be measured is 0.250 inches (6.35 mm).

##### **2. Equipment**

- A. The equipment that follows has been approved for use:
  - (1) Surface Deformation Measurement System (SDMS) part number RVS-SDMS-001 with software version 7-02-10 or later and the applicable inspection plates; Remote Vision Solutions.

NOTE: The SDMS includes the Image Manager SDMS-VM-004 and the Laser Measurement Module SDMS-PM-001. Software versions higher than 7-02-10 can have different software commands than specified in this procedure but are satisfactory to use.

##### **3. Preparation for Inspection**

- A. Remove paint, sealant, dirt and other unwanted material from the surface as specified in the Airplane Maintenance Manual (AMM).

- (1) Use approved scrapers to remove paint and sealant.

NOTE: Remove paint and sealant from the inspection surface so as not to damage the part. Do not use abrasives such as abrasive paper or Scotch Brite pads. The use of abrasives can cause the scribe line inspection or depth measurement to be incorrect. See Figure 1 for an example of the effects that can occur when abrasive pads are used on a scribed surface.

- (a) A rag, wet with solvent, that is put on an approved scraper, works good to remove small quantities of paint and sealant.

- B. Clean the inspection surface with a rag that is wet with solvent. Refer to SOPM 20-30-80 for more data about approved solvents.

##### **4. Instrument Calibration**

NOTE: Each inspector must calibrate the instrument each day before it can be used.

NOTE: Also, if you think the instrument was dropped or damaged you must calibrate the instrument again.

NOTE: The reference standard that is supplied with the Surface Deformation Measurement System (SDMS) instrument is measured to do the instrument calibration.

- A. Connect the cord from the Image Manager (IM) to the Laser Measurement Modula (LMM), and apply power to the SDMS instrument.

NOTE: After "boot up", the help pages are shown on the IM.

- B. Press the "Live" key on the IM keyboard.
- C. Clean the reference standard that is supplied with the SDMS instrument as specified in Paragraph 3.
- D. Put the reference standard on the calibration plate so that:
  - (1) The reference standard number is on top.
  - (2) The reference standard number can be read by the inspector.

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- (3) The lower edge of the reference standard is against the bottom edge of the calibration plate.
- (4) The reference standard step is in the forward to aft direction.
- E. Adjust the LMM optical lens to 0.7.
- F. Adjust the "left-to-right" adjustment knob so that the reference standard step or rod is at the center of the screen.
- G. Adjust the LMM optical lens to 4.5 zoom.
- H. Adjust the laser intensity and white light intensity with the knobs on the aft side of the LMM. Refer to Figure 2 for the correct intensity.
- I. Press the "TAB" key on the IM until the screen displays a 4.5 and a grid pattern.
- J. Adjust the laser line location (with the most forward knob of the LMM) so that it is at the center (approximately) of the video screen and is in focus.

NOTE: The laser line must be parallel to the horizontal grid line on the IM display.

- K. Put the video camera image into focus with the "focus" adjustment knob that is near the back of the camera.
- L. Adjust the laser focus knob with the second knob from the front of the LMM and do Paragraph 4.K. again.
- M. Measure the height of the reference standard step or rod as follows:

NOTE: To measure the height of the reference standard step or rod, the image must be stored in the IM memory and then recalled from memory.

- (1) Prepare the selected ID for storage of files as follows:
  - (a) Press the menu function on the IM keyboard.
  - (b) Select the "Set ID" option with the up/down arrow of the menu key on the IM keyboard and push enter.
  - (c) Select an ID with the up/down arrow of the menu key on the IM keyboard and push enter.
  - (d) Press the menu function to exit the ID selection.
  - (e) Make sure the IM is in the Live mode.
  - (f) Press the "Store" function on the IM keyboard to store the image.

NOTE: All files will now be stored into the selected ID.

- (g) Press the "Recall" function on the IM keyboard to recall the image.

- (2) Press the mouse wheel to go into the measurement mode.

NOTE: The stored image of the reference standard is now shown on the IM with measurement functions shown on the left and right sides of the screen display.

- (3) Put the cursor at the bottom of the laser line that falls on the toe area (see Figure 16) of the reference standard so that there is no red in the cross hairs of the cursor.
- (4) Move the cursor position up until there is red in the center of the cross hairs of the cursor.
- (5) Press the "3" key on the keyboard and then press the "W" key on the keyboard.
- (6) Move the cursor to the side of the screen above the reference standard step or rod to be measured.
- (7) Press the "4" key on the keyboard.

NOTE: This step will draw a horizontal line from the "3" key data point.

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- (8) Do a check to make sure that a horizontal line has been drawn at the bottom of the continuous red laser line and not at the bottom of a high intensity location or at a lower than normal intensity location of the laser line.
- (9) Do not move the mouse and press the right button of the mouse to set the horizontal measurement number. Then press the backspace key on the keyboard to delete the horizontal measurement number.

NOTE: The mouse can be moved after this step is done.

- (10) Press the "J" key on the keyboard for the join function.
- (11) Put the cursor below the laser line at the step down location so that there is no red in the cross hairs of the cursor.
- (12) Move the cursor position up with the mouse until there is red in the center of the cross hairs of the cursor.
- (13) Press the "4" key on the keyboard.
- (14) Do a check to make sure that a vertical line is drawn from the bottom of the laser line of the step down and up to the horizontal baseline.

NOTE: The step height is now displayed.

- (15) Press the right mouse button to set the height measurement.
- N. Do Paragraph 4.M.(3) thru Paragraph 4.M.(15) two or more times, as necessary, one after the other.
- (1) Continue to do Paragraph 4.M.(3) thru Paragraph 4.M.(15) until the last three height measurements are within plus or minus 3 percent of the reference standard height.
- O. If you cannot get three height measurements within the range specified in Paragraph 4.N., contact Boeing Service Engineering, Nondestructive Testing or the instrument manufacturer.

**5. Inspection Procedure**

NOTE: Operate the instrument as specified in the manufacturer's instructions.

- A. Install the correct inspection plate.
- B. Calibrate the instrument as specified in Paragraph 4.
- C. Wipe the inspection plate with a clean rag to remove unwanted material.
- D. Adjust the white background light and the red laser light to the correct intensities as shown in Figure 2. Adjust the background light intensity so that the part looks grey in color. Adjust the red laser line intensity so that the laser is red in color.

NOTE: Tell Boeing if you want color copies of the Figures to be sent to you.

- (1) Figure 3 shows the white background light and red laser light intensities that are not correct. Figure 3 shows the part mostly white in color; that occurs when the background light is set at an intensity that is too high. Figure 3 also shows the laser line that is white and orange; that occurs when the laser is set at an intensity that is too high.
- E. Examine the area for scribe lines as follows:
- (1) Set the zoom to 0.7.
  - (2) Adjust the laser light and the focal zone so that they are in the center of the screen display.
  - (3) Move the instrument along the inspection area and monitor the screen display for scribe line indications. Do the steps that follow, as necessary, during the inspection:

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- (a) Clean the part as specified in Paragraph 3. when dirt or other unwanted materials are found. Figure 4 shows dirt and other unwanted material in the inspection area. Dirt and unwanted material can collect on the inspection plate and, as the instrument is moved, damage to the part can occur.
- (b) Frequently clean the inspection plate with a rag, wet with solvent, to remove unwanted material.
- (c) Remove sealant and paint to get a satisfactory inspection. Figure 5 shows sealant and paint at the edge of the lap.
- (d) When lap joints or repaired structure are examined, follow the manufacturer's instructions and adjust the inspection plate to the left or to the right with the adjustment screw so that the edge of the structure is displayed on about 10 percent of the screen display width.
- (e) When butt joints are examined, follow the manufacturer's instructions and adjust the inspection plate to the left or to the right with the adjustment screw so that the butt joint gap is displayed in the center of the screen display.
- (f) When areas that are not at an edge of a structure are examined, center the instrument in the inspection area.
- (g) Examples of scribe line indications are as follows:

**NOTE:** Most scribe lines will be seen on the screen display for a distance of 2 inches (51 mm) or more as the instrument is moved along the inspection area. Some scribe lines can be less than 2 inches (51 mm) long.

- 1) A "V" shape or a sine wave shape of the laser line as shown in Figure 2.
  - 2) A break in the laser line as shown in Figure 6 and Figure 7.
  - 3) A high intensity laser line as shown in Figure 7.
  - 4) Continuous marks as shown in Figure 8 are not signs of scribe line damage.
- (h) Monitor the screen display to find the area of the scribe line that has the most depth. Do Paragraph 5.F. to measure the scribe line that has the most depth.
- F. Do the steps that follow to measure the depth of a scribe line:
- (1) Put the inspection plate at the edge of the structure and adjust the inspection plate so that the scribe line is at the center of the screen display.
    - (a) To measure the depth of a scribe line that is not at an edge of a structure, move the instrument so that the scribe line is at the center of the screen display.
  - (2) Set the zoom to 4.5. The zoom adjustment will make the center of the screen display larger. If the scribe line is not at the center of the screen display, it is possible that the scribe line will not be displayed. Move the inspection plate or instrument as necessary to put the scribe line in the center of the screen display.
  - (3) Adjust the white background light and the red laser light intensities to be as shown in Figure 9.
  - (4) Store and recall the scribe line.
  - (5) Draw a base line as shown in Figure 9 as follows:
    - (a) Use the "B" function and put the cursor on the left side of the scribe line on the surface of the part that is not damaged and do function "3".
    - (b) Then put the cursor on the right side of the scribe line on the surface of the part that is not damaged and do function "4" to draw a base line as shown in Figure 9.
  - (6) Measure the depth of the scribe line as follows:
    - (a) Do a "D" or depth function,



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- (b) Put the cursor on the base line and do a "3" function.
- (c) Put the cursor on the lowest part of the continuous laser line at the scribe line and do a "4" function to measure the depth of the scribe line.

### 6. Inspection Results

- A. If scribe lines in the laps or butts have been measured and found to be less than 0.001 inches (0.025 mm) in depth for the full length, do Paragraph 6.A.(1) thru Paragraph 6.A.(3) to make sure that an accurate measurement was made.
  - (1) The bottom of the scribe line in Figure 9 is black in color and is a sign that the scribe line is not clean. The bottom of the scribe line shown in Figure 11 has white lines and is a sign that the scribe line is clean. See Figure 12 for examples of a clean scribe line and a scribe line that is not clean. An accurate measurement of the scribe line depth can only be made when the bottom of the scribe line is clean. If white lines cannot be seen in the scribe line, use a 10 power magnification lens to see if the bottom of the scribe line is clean.
  - (2) If the scribe line is not clean, do Paragraph 3. again and also apply solvent to the scribe line. With the scribe line wet with solvent, blow the scribe line clean with dry shop air or air from an aerosol can.
  - (3) Measure the scribe depth again as specified in Paragraph 5.F.
- B. A laser line that is not continuous is shown in Figure 13 and is a sign that the measurement is not correct. Do not measure scribe lines at locations that are not continuous as shown in Figure 13.
- C. A scribe line that is not fully closed can have a laser line as shown in Figure 14. This type of a laser line is a sign that the measurement is not correct. Do not measure scribe lines at locations as shown in Figure 14.
- D. A laser line that is not continuous is shown in Figure 15 and is from a scribe line that has a vertical left side and the right side is not as vertical, or the scribe line is not fully closed. For a laser line as shown in Figure 15, it can help to make a continuous laser line if the scribe line is moved to the left side of the screen display.
- E. If a measurement cannot be made because of the laser signal shown in Paragraph 6.B., Paragraph 6.C. or Paragraph 6.D., the scribe depth is deeper than 0.001 inch (0.025 mm).

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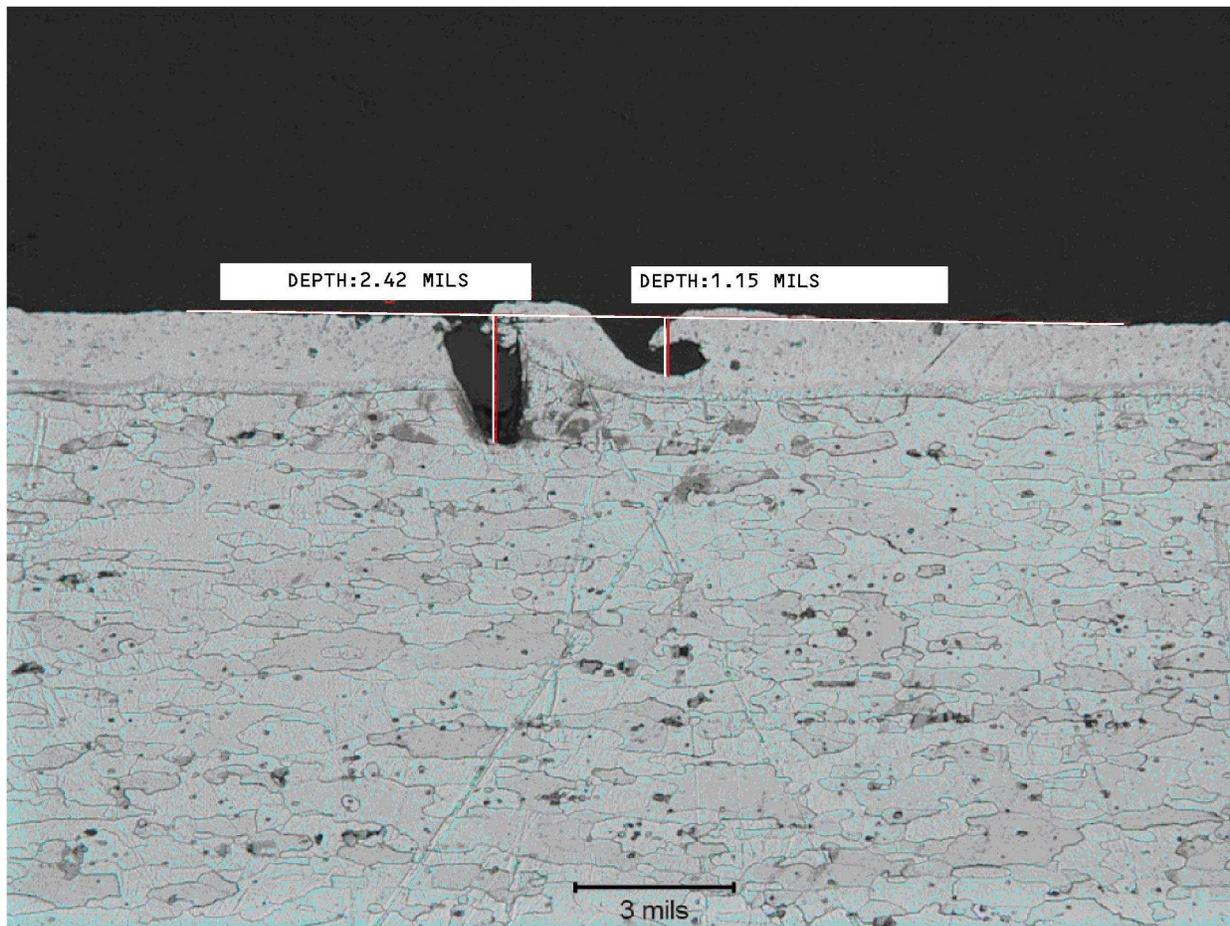
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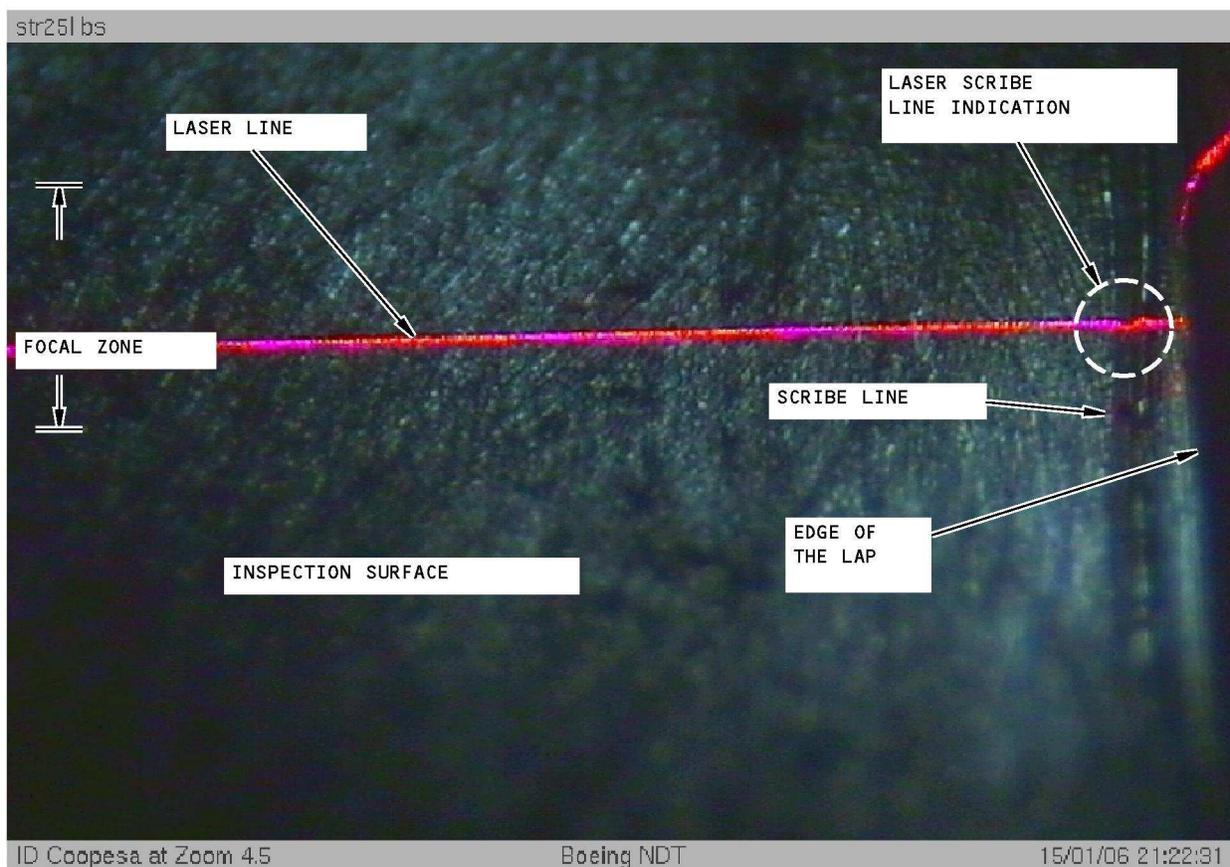
THIS CROSS SECTION SHOWS THE EFFECT THAT FIVE WIPES WITH AN ABRASIVE PAD CAN HAVE ON AN INSPECTION SURFACE. THE TWO SCRIBE LINES ARE ALMOST CLOSED.

**Effect of Five Wipes with an Abrasive Pad on the Inspection Surface  
Figure 1**

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THIS SDMS PHOTOGRAPH SHOWS THE CORRECT BACKGROUND AND LASER LIGHT INTENSITIES.

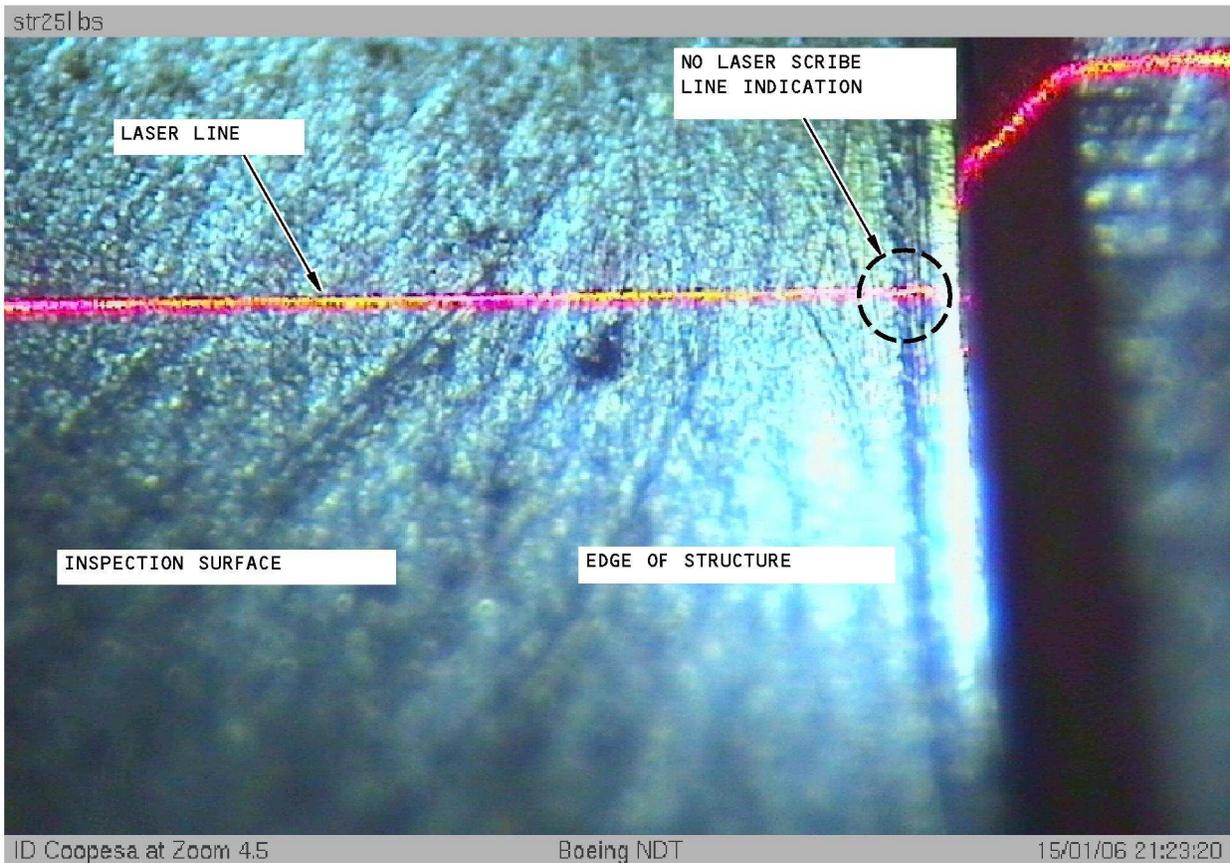
**Correct Background and Laser Light Intensities  
Figure 2**

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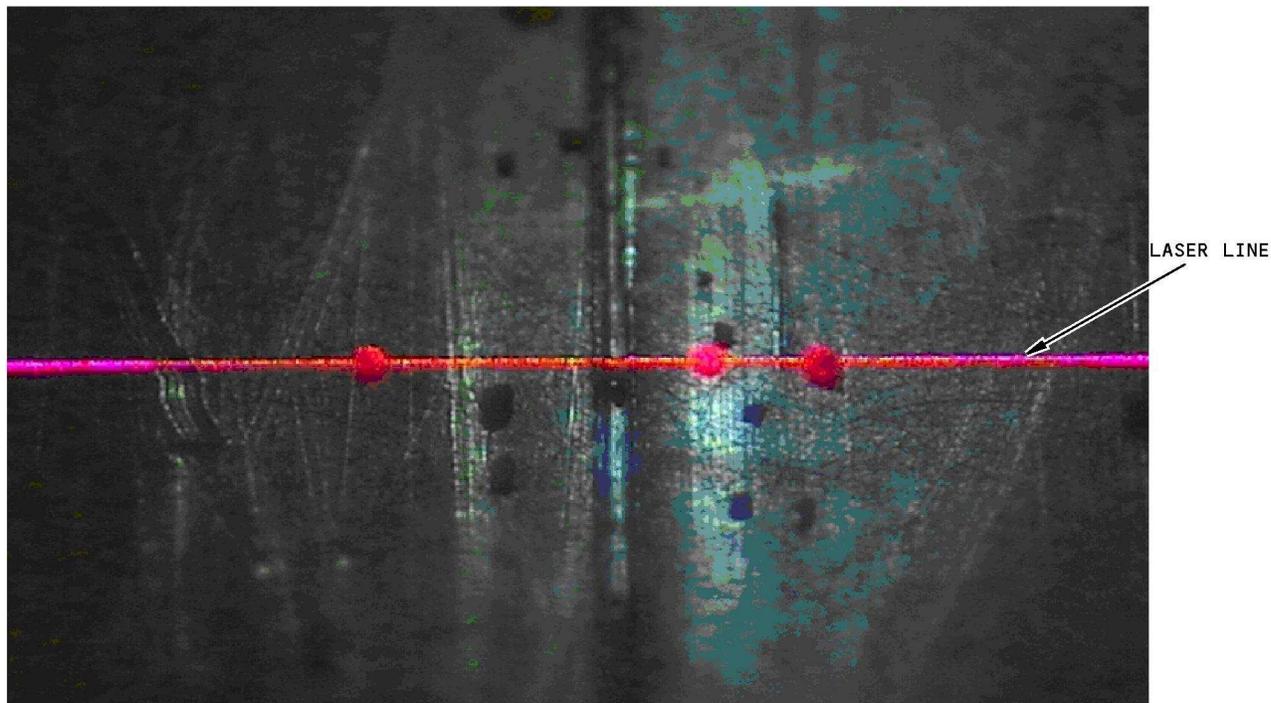


THIS SDMS PHOTOGRAPH SHOWS THE INCORRECT BACKGROUND AND LASER LIGHT INTENSITIES.

**Incorrect Background and Laser Light Intensities  
Figure 3**

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THIS PHOTOGRAPH SHOWS THE EFFECT ON THE LASER LINE  
FROM DIRT AND OTHER UNWANTED MATERIAL

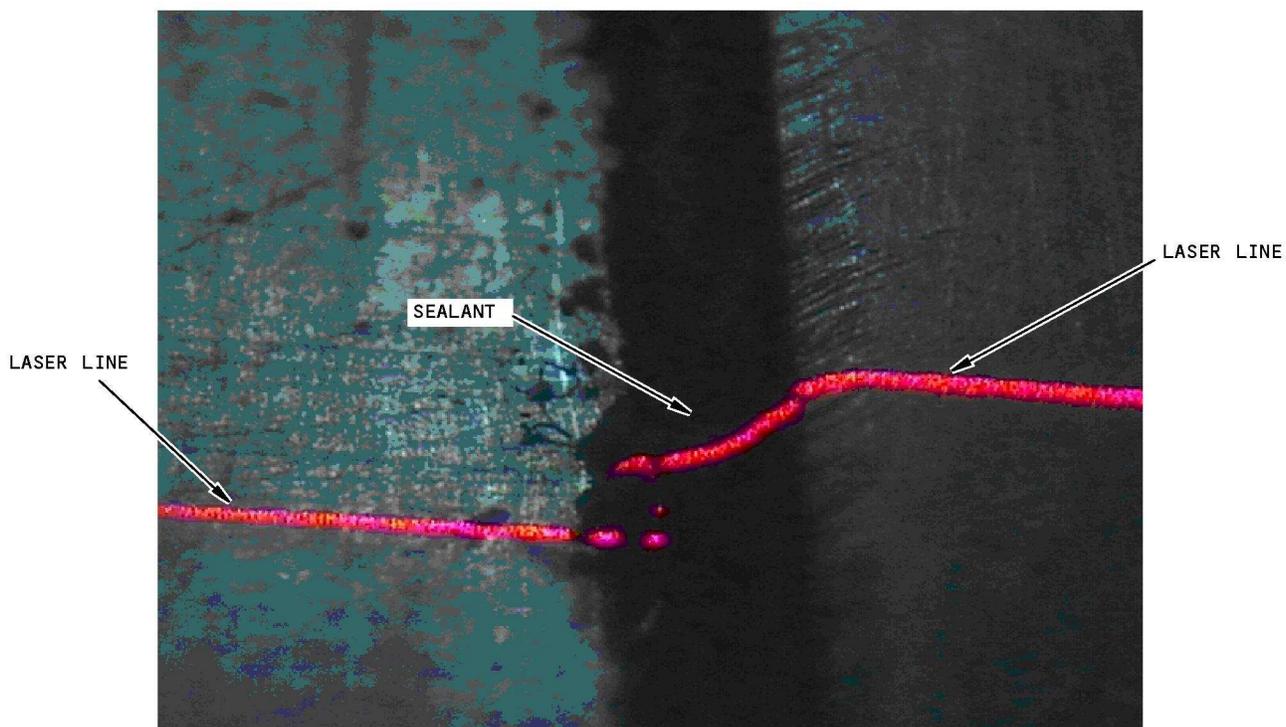
**Effect on the Laser Line from Dirt and Other Unwanted Material  
Figure 4**

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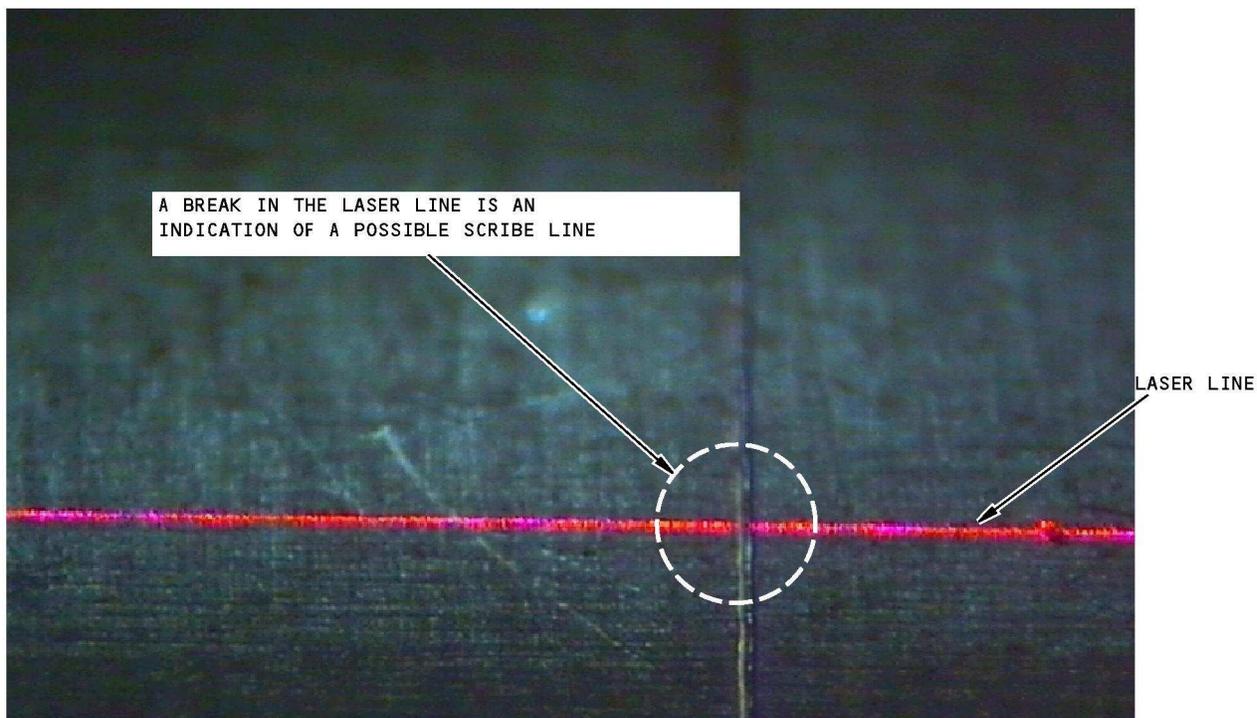


THIS PHOTOGRAPH SHOWS THE EFFECT ON THE LASER LINE FROM SEALANT AT THE EDGE OF THE LAP.

**Effect on the Laser Line from Sealant at the Edge of the Lap**  
**Figure 5**

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A BREAK IN THE LASER LINE IS A SIGN OF A SCRIBE LINE.

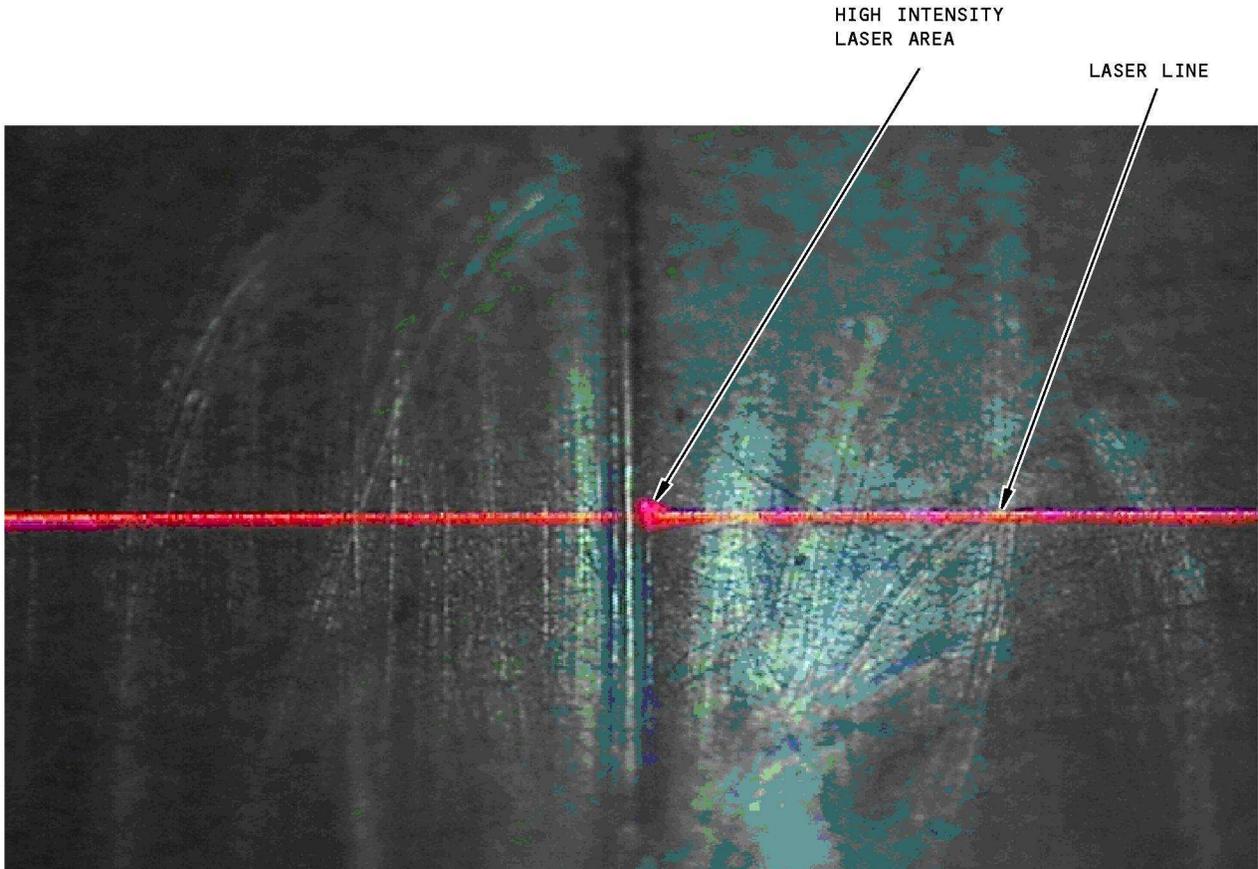
**Scribe Line Indication  
Figure 6**

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THIS PHOTOGRAPH SHOWS A HIGH INTENSITY RED LASER AREA FROM A SCRIBE LINE AND A BREAK IN THE LASER LINE FROM THE SCRIBE LINE.

**Examples of a High Intensity Red Laser Area and a Break in the Laser Line Caused by a Scribe Line**  
**Figure 7**

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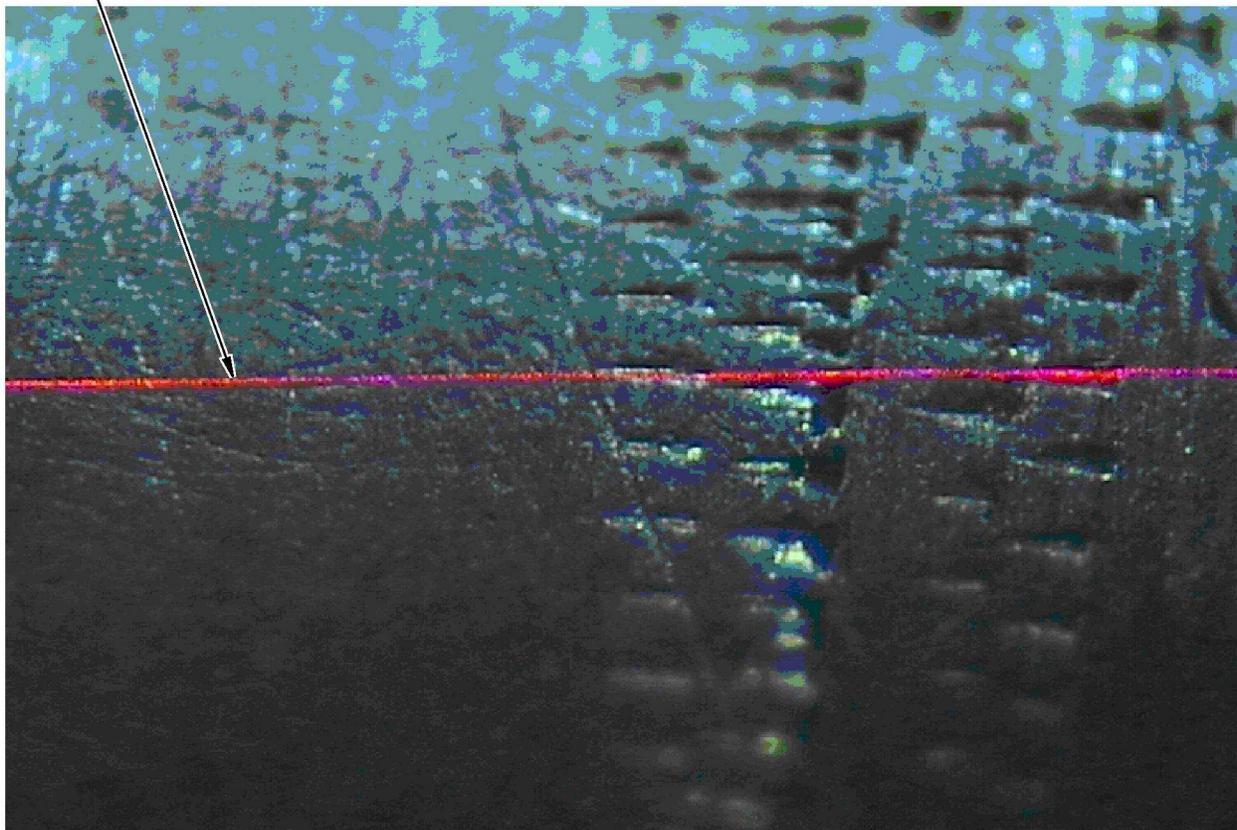
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LASER LINE



THIS PHOTOGRAPH SHOWS CONTINUOUS MARKS IN THE FUSELAGE SKIN  
AND IS NOT A SIGN OF SCRIBE LINE DAMAGE.

**Example of Continuous Marks in the Fuselage Skin**  
**Figure 8**

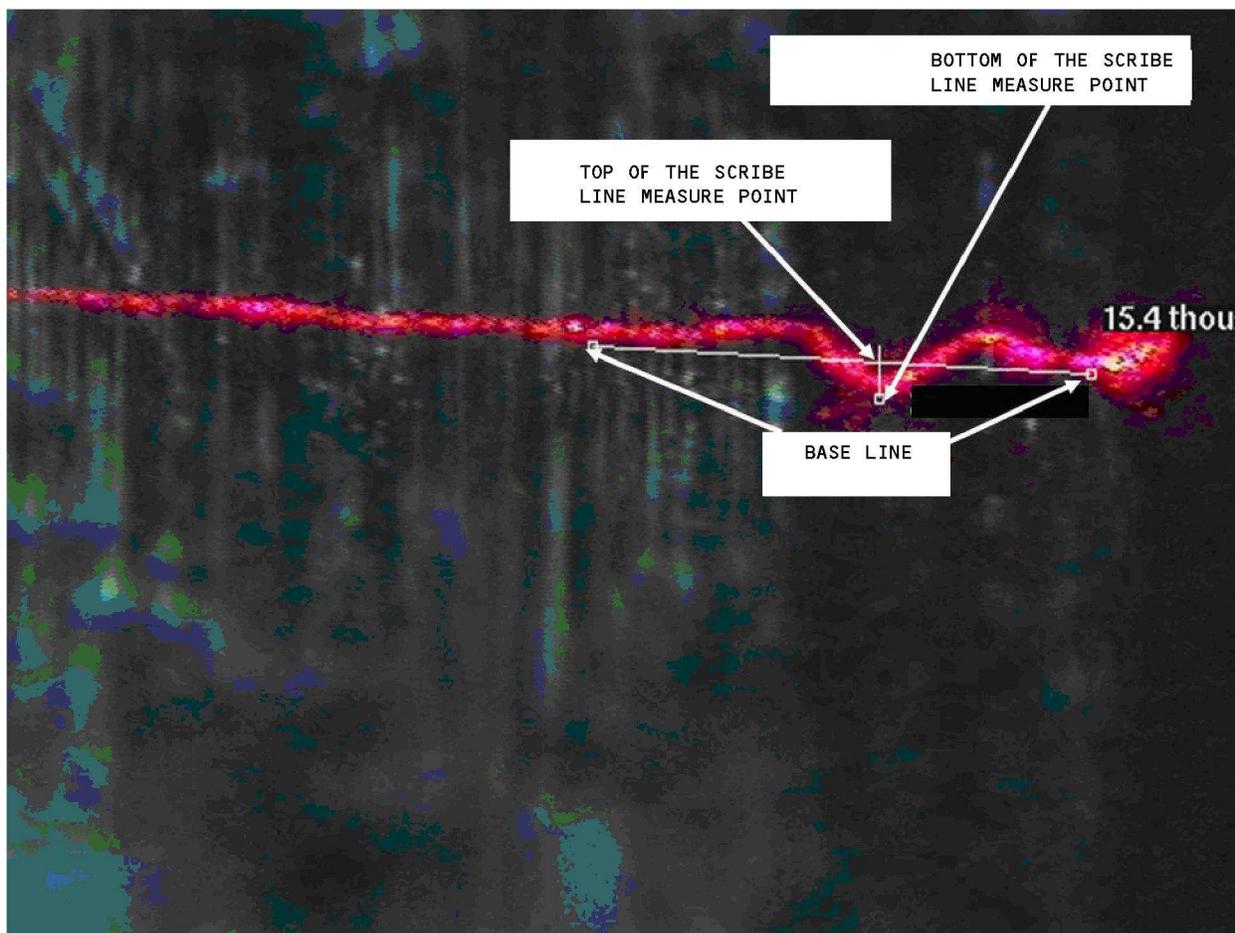
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THIS PHOTOGRAPH SHOWS THE BASE LINE USED TO MEASURE THE DEPTH OF A SCRIBE LINE.

**Example of a Base Line Used to Measure the Depth of a Scribe Line  
Figure 9**

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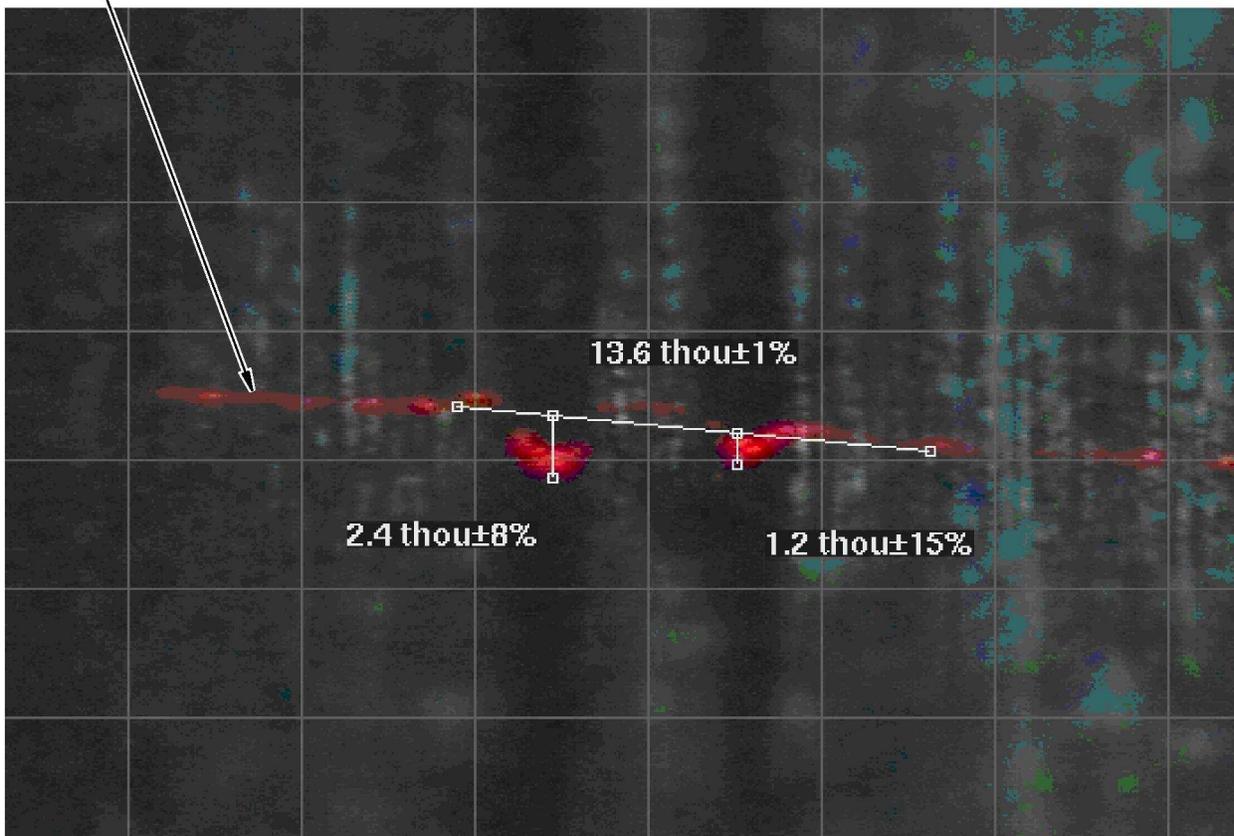
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LASER LINE

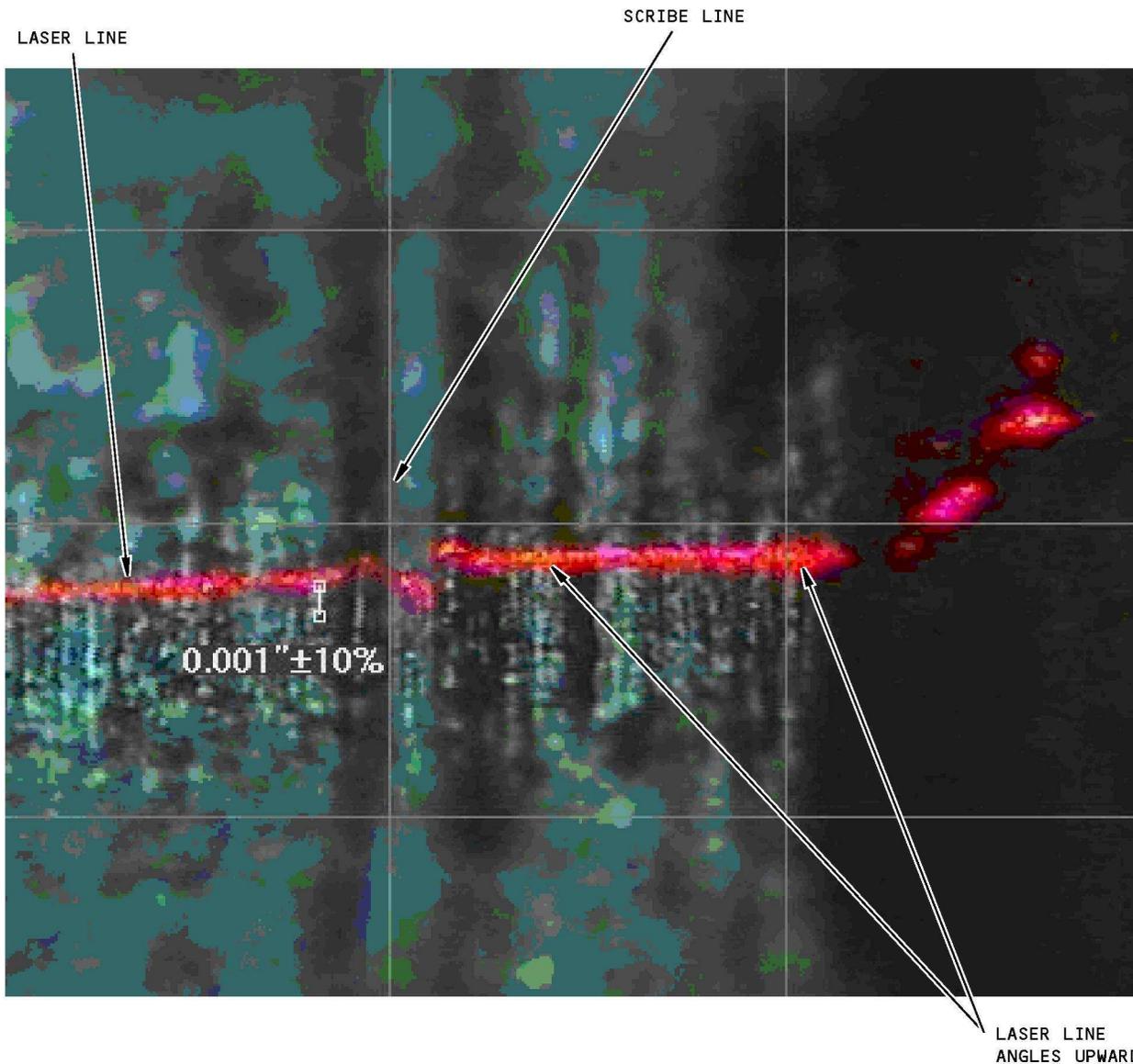


THIS PHOTOGRAPH SHOWS THE BASE LINE USED TO MEASURE  
THE DEPTH OF A SCRIBE LINE.

**Example of a Base Line Used to Measure the Depth of a Scribe Line  
Figure 10**

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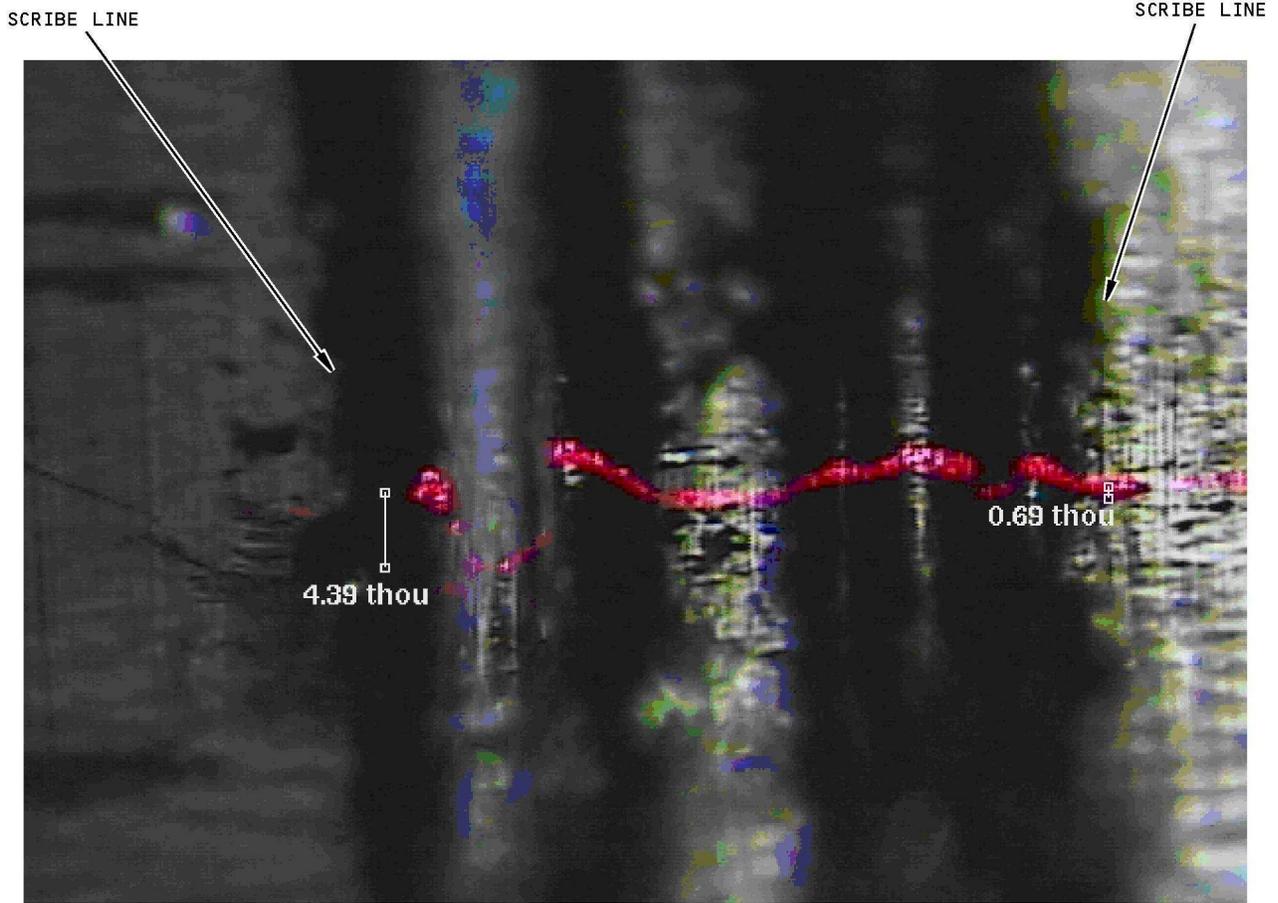
THIS PHOTOGRAPH SHOWS A CLEAN SCRIBE LINE AS SHOWN BY THE WHITE LINES AT THE BOTTOM OF THE SCRIBE LINE. THE LASER LINE ANGLES UPWARDS TO THE RIGHT AND IS AN INDICATION THAT THE PART SURFACE IS NOT FLAT. A BASE LINE MUST BE USED FOR THIS DEPTH MEASUREMENT AT THIS LOCATION.

**Scribe Line Example and an Example of a Part Surface That is Not Flat**  
**Figure 11**

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THIS PHOTOGRAPH SHOWS A CLEAN SCRIBE LINE ON THE LEFT SIDE OF THE PHOTOGRAPH AND A DIRTY SCRIBE LINE ON THE RIGHT SIDE OF THE PHOTOGRAPH. A BASE LINE MUST BE MADE TO MEASURE THE SCRIBE LINES IN THIS FIGURE.

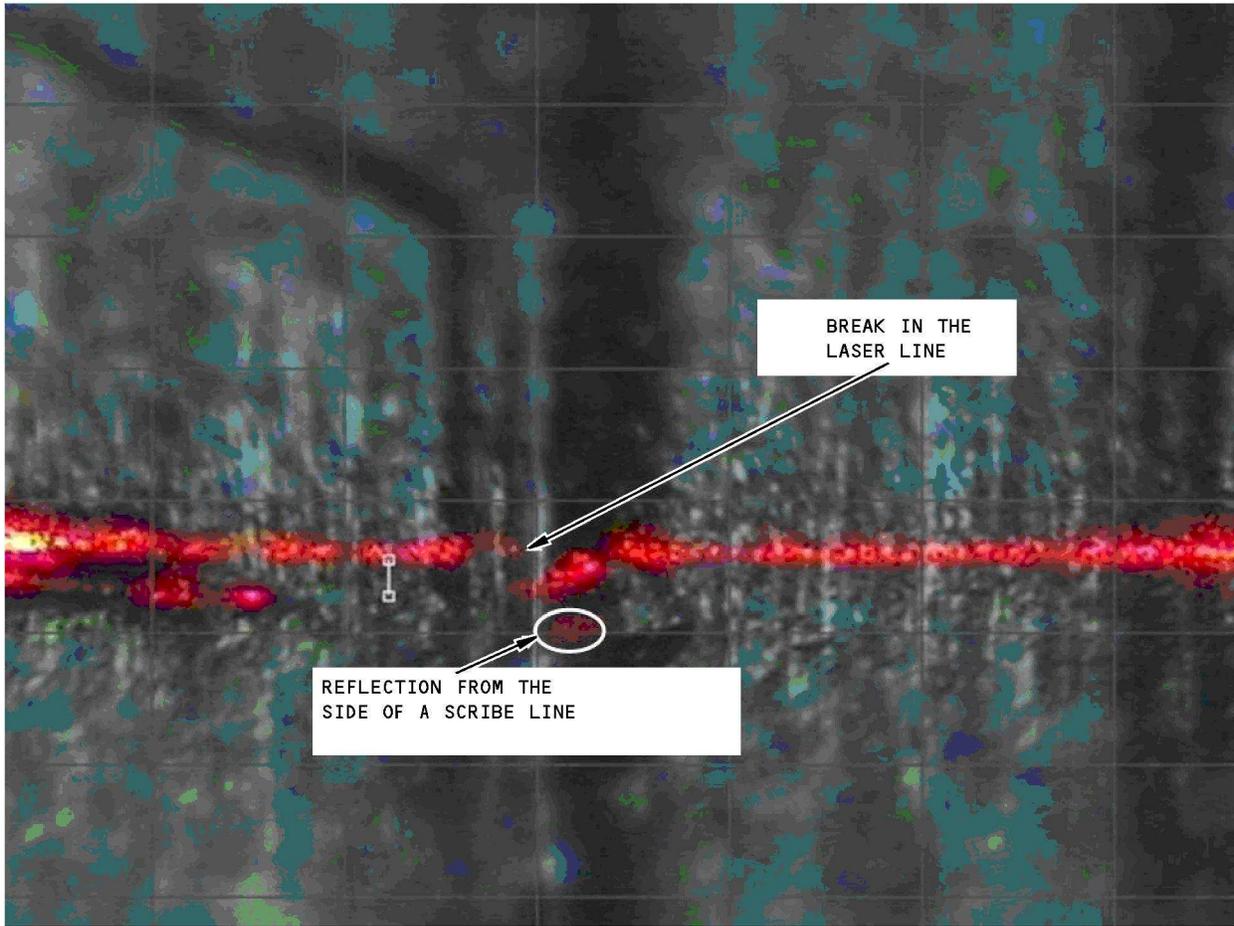
**Examples of Clean and Dirty Scribe Lines  
Figure 12**

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THIS IS A PHOTOGRAPH OF A BREAK IN THE LASER LINE AND A LASER REFLECTION AT THE BOTTOM OF THE SCRIBE LINE. SCRIBE LINES MUST NOT BE MEASURED AT A LOCATION THAT HAS A REFLECTION OR BREAK IN THE LASER LINE.

**Examples of a Break in the Laser Line and a Laser Reflection at the Bottom of the Scribe Line**  
**Figure 13**

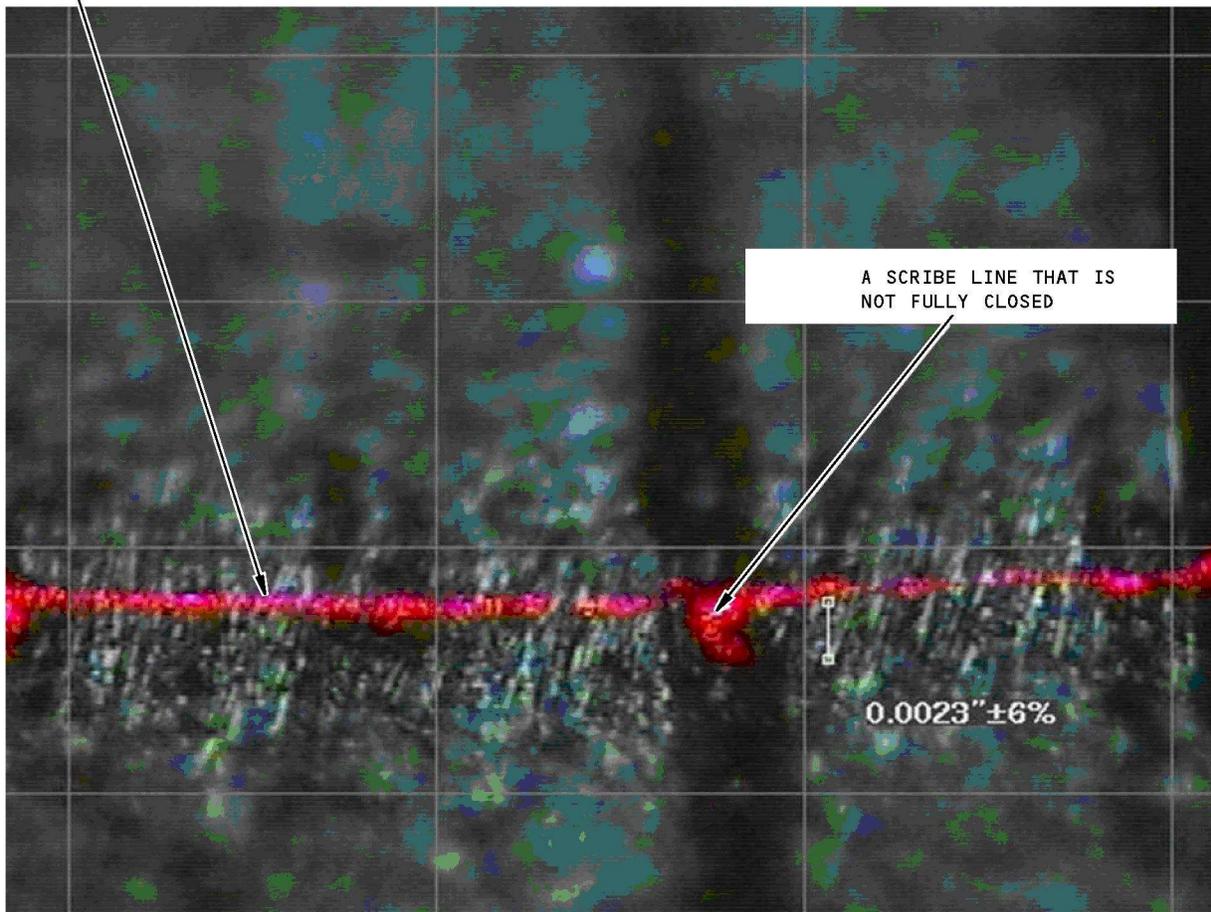
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LASER LINE



THIS PHOTOGRAPH SHOWS A LASER LINE THAT CAN OCCUR AT A SCRIBE LINE THAT IS NOT FULLY CLOSED. SCRIBE LINES MUST NOT BE MEASURED AT LOCATIONS THAT HAVE THIS TYPE OF LASER LINE.

Example of a Scribe Line That is Not Fully Closed  
Figure 14

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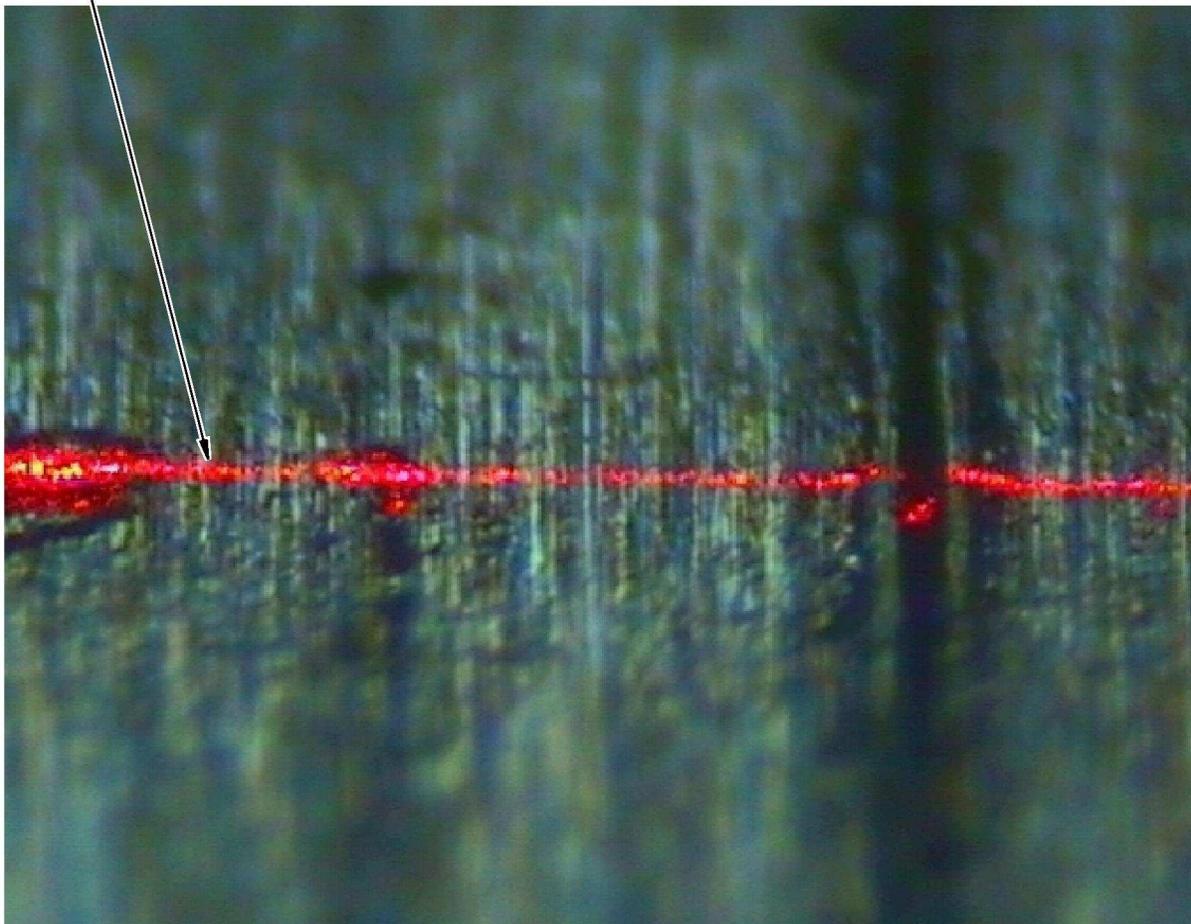
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LASER LINE



THIS IS A PHOTOGRAPH OF A LASER LINE THAT IS NOT CONTINUOUS. IT IS FROM A SCRIBE LINE THAT HAS A VERTICAL LEFT SIDE AND THE RIGHT SIDE IS NOT AS VERTICAL, OR THE SCRIBE LINE IS NOT FULLY CLOSED. FOR A LASER LINE AS SHOWN ABOVE, IT CAN HELP TO MAKE THE LASER LINE CONTINUOUS IF YOU MOVE THE SCRIBE LINE TO THE LEFT SIDE OF THE SCREEN DISPLAY.

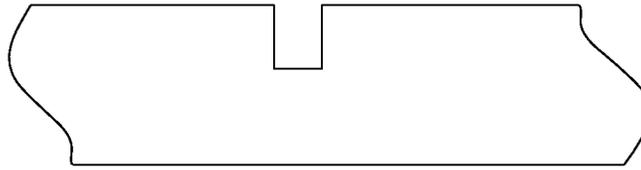
Example of a Laser Line That is Not Continuous  
Figure 15

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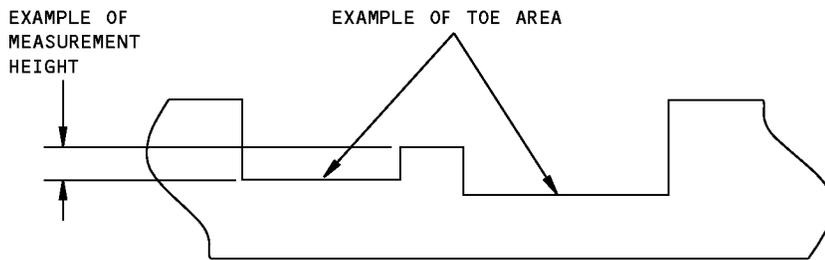
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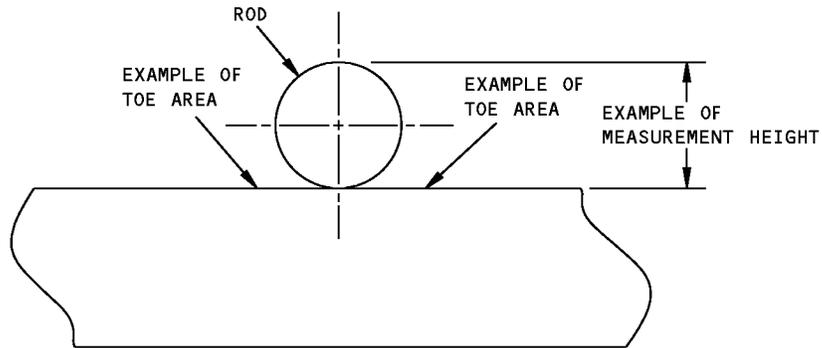
DETAIL I

EXAMPLE OF A NOTCH TYPE REFERENCE STANDARD  
(THIS NOTCH TYPE OF REFERENCE STANDARD CAN COLLECT FOREIGN MATERIAL IN THE NOTCH)



DETAIL II

EXAMPLE OF A STEP TYPE REFERENCE STANDARD



DETAIL III

ROD TYPE REFERENCE STANDARD  
(THIS IS THE RECOMMENDED TYPE OF REFERENCE STANDARD)

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Cross Sections Through Typical Reference Standards  
Figure 16

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