



767

NONDESTRUCTIVE TEST MANUAL

PART 1 - GENERAL

COMPARATIVE VACUUM MONITORING (CVM) SYSTEM ALUMINUM PART SURFACE INSPECTION

1. Purpose

- A. This procedure uses the Comparative Vacuum Monitoring (CVM) System to examine aluminum parts for surface cracks. The CVM system uses adhesive sensors that stay attached to the part to be examined.
- B. This procedure uses linear and curved-linear type sensors. It will be necessary to use a different procedure for other sensor types. For each use of CVM, a sensor or sensors must be specially made.
- C. This procedure can be used to examine internal aircraft structure that is free from the effects of external environmental conditions. The inspection surface can only have primer on it to use this procedure; this procedure cannot be used if the inspection surface has an enamel top coat.
- D. Use this procedure to find surface cracks in aluminum parts that are 0.09 inch (2.29 mm) thick or less.

2. Equipment

- A. General
 - (1) It is necessary to use a periodic monitoring inspection instrument that can be calibrated to measure vacuum differential.
- B. Instrument
 - (1) Use a CVM instrument that:
 - (a) Has applicable firmware version installed
 - (b) Operates with an impedance of 2 T PASM (Terra Pa.second/meter²)
 - (c) Has the recommended equipment for the inspection
 - (d) Has the CVM instrument Operations Manual
 - (e) Has the correct Test Point Plug (TPP)
 - (2) The instrument that follows was used to help prepare this procedure.
 - (a) PM200; Structural Monitoring Systems (see Figure 1)
- C. Sensors (see Figure 2)
 - (1) Use a CVM sensor that:
 - (a) Has been laser ablated (tape) or cast (silicone).

NOTE: Laser ablated sensors must use silicone terminals to connect to the CVM tubes.
 - (2) The sensors that follow were used to help prepare this procedure.
 - (a) A0354; a cast linear sensor for use between rivet holes and part edges (see Figure 2)
 - (b) SMS/S/0060, a cast curved-linear sensor for use at fastener hole locations
 - (3) Test Point Socket (TPS) (see Figure 3)
- D. Special Tools
 - (1) Consumables kit that comes with the CVM sensors.

3. Preparation for Inspection

- A. Install a CVM sensor as follows:
 - (1) Get access to the inspection area.



PART 1 51-11-01

Page 1
Aug 15/2008

D634T301

NONDESTRUCTIVE TEST MANUAL

- (2) Refer to the control documents to identify the area for sensor installation. If more than one sensor is necessary in the inspection area, refer to the equipment manufacturer's instructions to connect sensors together.

NOTE: Sensor position is very important for correct operation of the CVM system.

- (3) Use approved procedures to remove dirt and sealant from the inspection area.
- (4) Do an inspection of the sensor installation area as follows:
- (a) Do a surface eddy current inspection of the inspection area as specified in the applicable NDT manual.
 - (b) If a crack is found during the inspection, repair the crack as specified in the applicable maintenance document and contact Boeing for CVM installation instructions.
- (5) Prepare the surface for CVM sensor installation as specified in the equipment manufacturer's instructions and the steps that follow:

WARNING: IT IS VERY IMPORTANT TO PREPARE THE INSPECTION AREA CORRECTLY TO HAVE A GOOD BOND BETWEEN THE SENSOR AND THE INSPECTION AREA. CONTAMINATION AT THE INSPECTION AREA WILL CAUSE THE CVM SENSOR TO DISBOND FROM THE STRUCTURE.

- (a) Use approved procedures to make the surface smooth. It is necessary to have a surface finish of 63 microinches (Ra) or better for an acceptable bond of the sensor.
- (b) Clean and dry the surface as specified in the equipment manufacturer's instructions and the instructions that follow:

NOTE: It is permitted to use de-ionized water as an alternative for distilled water.

- 1) Do a visual inspection of the surface for damage that will prevent a good bond of the sensor. Some damage examples are:
 - a) Scratches
 - b) Corrosion
 - c) Loose paint
 - 2) Use approved procedures to remove all damage from the inspection area.
- (6) Install the CVM sensors as follows:
- (a) Attach the sensor to the inspection surface as specified in the equipment manufacturer's instructions and the steps that follow:

NOTE: Sensor position is very important for correct operation of the CVM system. The length of crack that can be found with the CVM system is directly related to the sensor position. Refer to Figure 5 for sensor position instructions.

NOTE: Figure 6 shows the installation of a silicone terminal.

- 1) Use BMS 5-95 sealant, or an equivalent sealant that is approved in Boeing documents such as the Airplane Maintenance Manual (AMM), to attach the sensor to the inspection surface.
- 2) For linear and curved-linear sensors, it is necessary to put the sensor galleries at a 90 degree angle to the direction of the possible crack. See Figure 5, Details I and II.

ALL

EFFECTIVITY

PART 1 51-11-01

D634T301

Page 2
Aug 15/2008



767

NONDESTRUCTIVE TEST MANUAL

- 3) Put the sensor as near as possible to the start point of the possible crack. The distance from the hole or edge to the nearest sensor gallery must be less than 0.024 inches (0.64 mm). See Figure 5, Detail III.

NOTE: It may be necessary to connect tubes with a DT Joiner, or equivalent (see Figure 4).

- (b) Do a quality check of the CVM sensors as specified in the equipment manufacturer's instructions.
 - (c) Install the Test Point Socket (TPS) and Sensor Lead as specified in the equipment manufacturer's instructions.
 - (d) Apply a layer of Boeing approved sealant to the sensors for protection as specified in the equipment manufacturer's instructions. See Figure 8 for an example.
- (7) If necessary, make a TPS Baseline as specified in the CVM operations manual.
 - (8) Use approved procedures to install warning and identification decals, if available.

4. Instrument Calibration

- A. Get access to the TPS.
- B. Energize the instrument.

CAUTION: CVM INSPECTION MUST NOT BE DONE IN AN AREA WHERE CORROSION INHIBITING COMPOUNDS HAVE BEEN APPLIED IN THE LAST 30 DAYS. IF YOU ARE NOT SURE, CONTACT THE EQUIPMENT MANUFACTURER FOR THIS DATA.

- C. Remove the protective cap from the TPS and the Test Point Plug (TPP).
- D. Connect the TPP to the TPS. The instrument will automatically start the test when the TPP is connected to the TPS. Monitor the instrument display to make sure that the TPP is correctly connected to the correct TPS.
- E. Monitor the continuity test data as it is shown on the instrument display. Data recorded from the test will be stored in the memory of the instrument.

5. Inspection Procedure

- A. The inspection procedure starts automatically, after the continuity check is completed.
- B. Monitor the CVM test data as it is shown on the instrument display.

CAUTION: THE TPS AND TPP CAPS MUST BE INSTALLED IMMEDIATELY AFTER THE TEST HAS BEEN COMPLETED TO KEEP THE CONNECTORS SERVICEABLE AND FREE FROM CONTAMINATION. DIRT, CHEMICALS AND AIRBORNE PARTICLES CAN BLOCK AND DAMAGE SENSITIVE INSTRUMENTATION AND EFFECT SYSTEM FUNCTION.

- C. When the test is completed, immediately install the protective caps of the TPS and TPP.
- D. If necessary, move the inspection data from the inspection instrument to a computer that has the applicable software. Refer to the equipment Operations Manual for instructions.
- E. Record the applicable data on a form (see Figure 7 for an example form) that contains the data that follows:
 - (1) Names of CVM installation personnel
 - (2) Aircraft Model and Sub-model, Tail Number and Installation Site name
 - (3) Sensor Identification number, Sensor Batch number, Sensor Lead Serial Number
 - (4) CVM Instrument Serial Number, Instrument Lead Serial Number
 - (5) Substrate Description
 - (6) List of Abrasives and Solvents with batch number and expiration date

ALL

EFFECTIVITY

PART 1 51-11-01

D634T301

Page 3
Aug 15/2008



767

NONDESTRUCTIVE TEST MANUAL

- (7) System continuity value
- (8) System CVM value

6. Inspection Results

- A. If the CVM instrument identifies a possible crack, get access to the sensor area for more examination.
 - (1) For cracks at fastener locations, do a HFEC surface eddy current inspection with the applicable procedure and report the results to Boeing.
 - (a) If the CVM crack indication does not occur during the surface eddy current inspection, do an open hole eddy current inspection with the applicable procedure and report the results to Boeing.
 - (2) For cracks at other locations, do a HFEC surface inspection with the applicable procedure and report the results to Boeing.
 - (a) If the CVM crack indication does not occur during the surface eddy current inspection, call Boeing for more instructions.
- B. If the CVM instrument shows a blocked line or a disbonded sensor, do not use the instrument for inspections until you repair the instrument, or the sensor installation.

ALL

EFFECTIVITY

PART 1 51-11-01

D634T301

Page 4
Aug 15/2008



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**PM200 Periodic Monitoring System Shown with a Test Point Plug (TPP)
Figure 1**



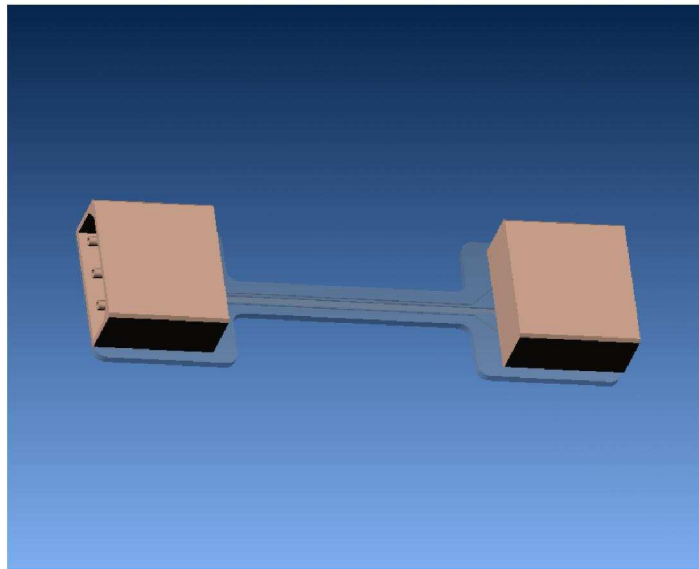
PART 1 51-11-01

Page 5
Aug 15/2008

D634T301



767
NONDESTRUCTIVE TEST MANUAL



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Example of a Linear CVM Sensor - Sensor A0354 Shown
Figure 2

	EFFECTIVITY
ALL	

PART 1 51-11-01

Page 6
Aug 15/2008

D634T301

767
NONDESTRUCTIVE TEST MANUAL



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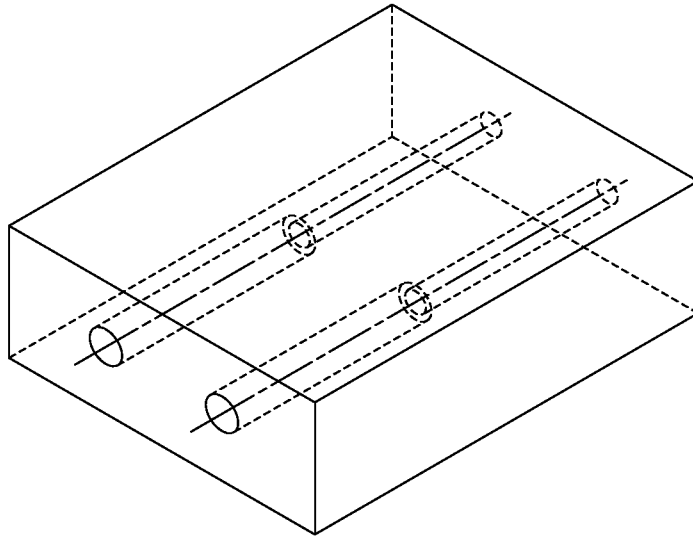
Test Point Socket (TPS)
Figure 3



PART 1 51-11-01

Page 7
Aug 15/2008

767
NONDESTRUCTIVE TEST MANUAL



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DT Joiner (S0601 Shown)
Figure 4

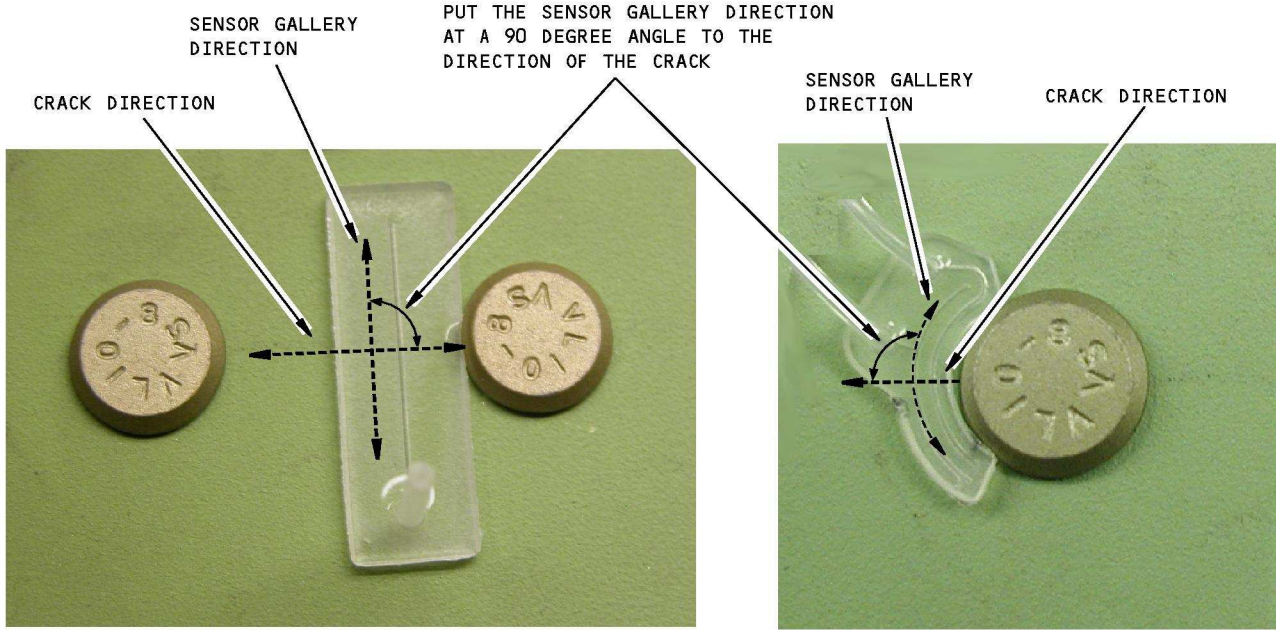
	EFFECTIVITY
ALL	

PART 1 51-11-01

Page 8
Aug 15/2008

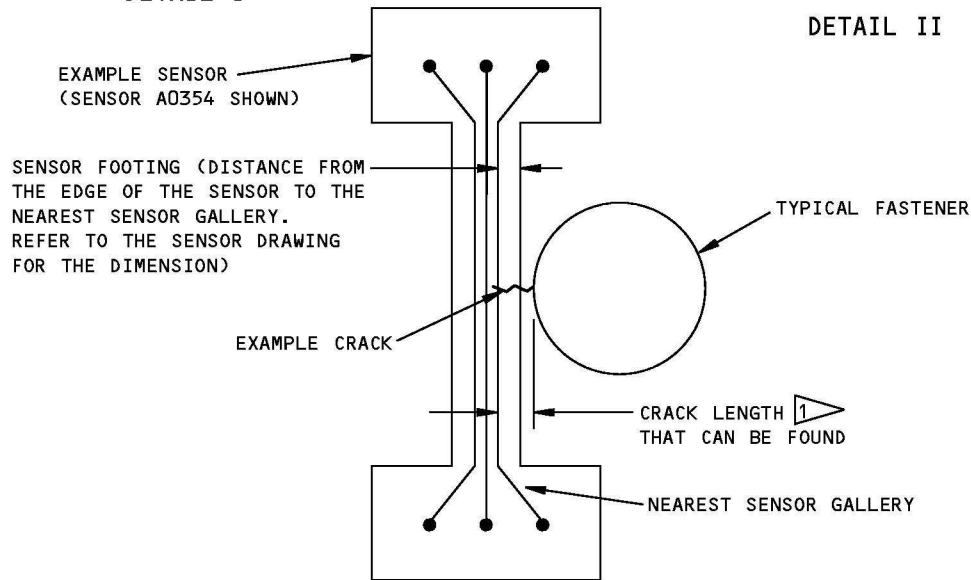
D634T301

NONDESTRUCTIVE TEST MANUAL



**HOW TO POSITION A LINEAR CVM SENSOR
DETAIL I**

**HOW TO POSITION A
CURVED-LINEAR CVM SENSOR
DETAIL II**



**DIMENSIONS THAT HAVE AN EFFECT ON
THE POSITION OF CVM SENSORS
DETAIL III**

NOTES:

- 1 PUT THE SENSOR AS NEAR AS POSSIBLE TO THE START POINT OF THE POSSIBLE CRACK. THE DISTANCE FROM THE HOLE OR EDGE TO THE NEAREST SENSOR GALLERY MUST BE LESS THAN 0.024 INCHES (0.64 mm).

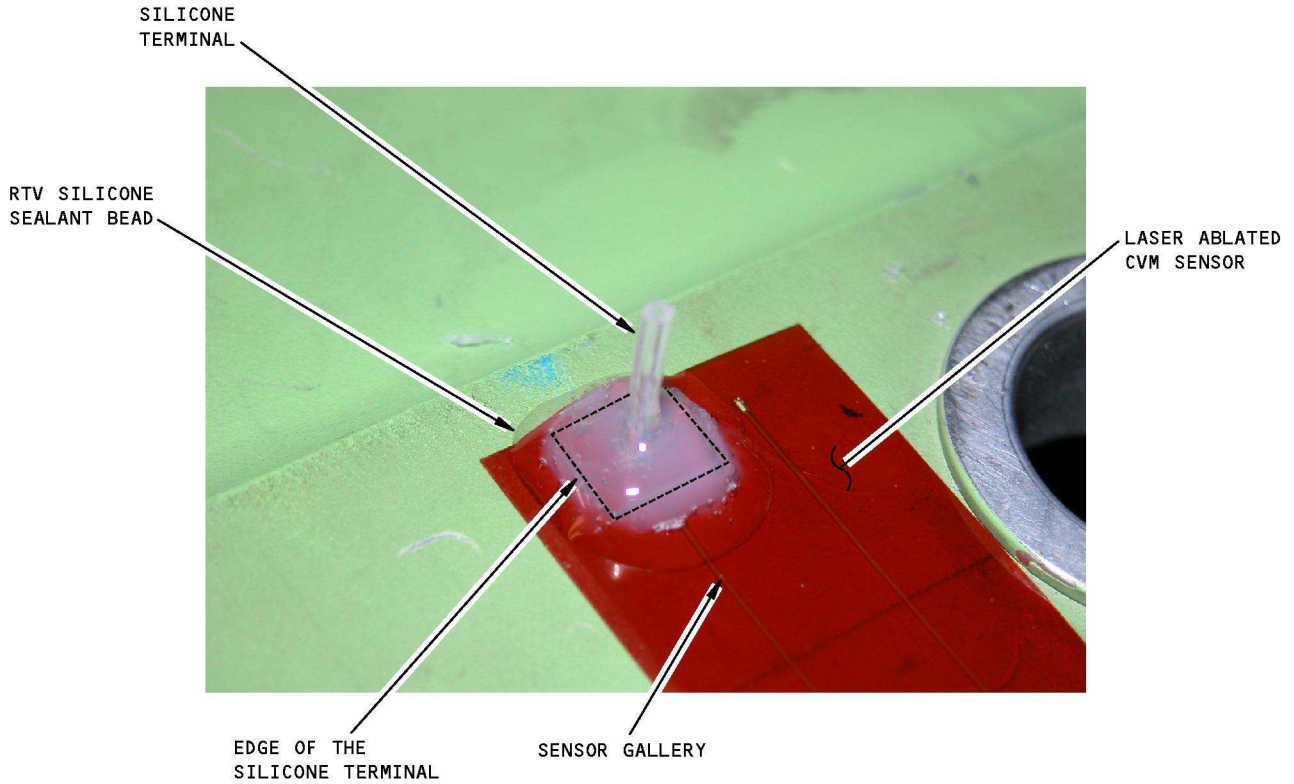
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**Position Instructions for CVM Sensors
Figure 5**

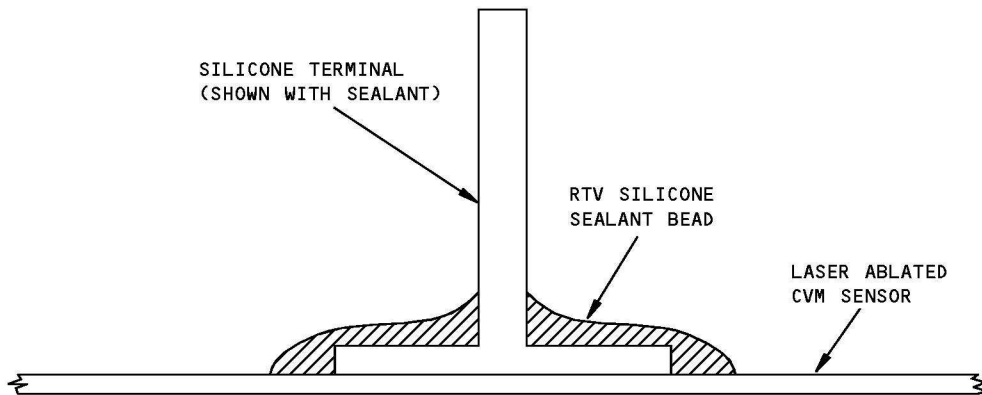
	EFFECTIVITY	
ALL		

PART 1 51-11-01

NONDESTRUCTIVE TEST MANUAL



**SILICONE TERMINAL BONDED TO A LASER ABLATED SENSOR
DETAIL I**



**SIDE VIEW OF A TYPICAL SILICONE TERMINAL INSTALLATION
DETAIL II**

1613400 S0000298565_V1

**CVM Silicone Terminal Installation
Figure 6**

EFFECTIVITY
ALL

PART 1 51-11-01



767 NONDESTRUCTIVE TEST MANUAL



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Sensor System Installation Form.

Scope:

PM-200 Rev.0 Sensor System Installation refers to the process of installing the following items, CVM sensor, Sensor Lead Rev.0, and the associated tubing run. This form is used to document this procedure and record all relevant information in regards to the installation.

Date of Installation:

Location of Installation:

Personnel involved in Installation:

Name:	Organisation:
Name:	Organisation:
Name:	Organisation:
Name:	Organisation:
Name:	Organisation:
Name:	Organisation:

Site Information:

Aircraft Type:
Tail Number:
Site Name:
General Site Description:

Equipment Used:

Sensor ID (see appendix A):	Batch Number:	
Sensor Lead SN:		
Tubing:		
PM-200 SN:		
Instrument Lead SN:		
Sensor Bead:	Batch #:	Exp. Date:
Overcoat:	Batch #:	Exp. Date:

**Example of an SMS "CVM Installation and Use Form"
Figure 7 (Sheet 1 of 3)**

EFFECTIVITY
ALL

PART 1 51-11-01



767

NONDESTRUCTIVE TEST MANUAL

Installation Checklist

Surface Preparation

Substrate Description:		
Abrasive Used:		
Solvent Used:	Batch #:	Exp. Date:
General Description:		
Name:	Sign:	Date:

Sensor Installation

General Description:		
Name:	Sign:	Date:

Sensor Lead Rev.0 Installation

General Description:		
Name:	Sign:	Date:

Tubing Run Installation

General Description:		
Name:	Sign:	Date:

Sensor Lead ID added to PM-200 Data base

Site ID:		
Tail Number:		
Site Name:		
System Continuity Value:	Tolerance:	
System CVM Value:	Tolerance:	
Name:	Sign:	Date:

Pre Over coat testing

General Description: The PM-200 was used to test obtain a continuity and CVM value for the sensor system installation prior to over coating.		
Continuity Value:	CVM Value:	
Name:	Sign:	Date:

Example of an SMS "CVM Installation and Use Form"
Figure 7 (Sheet 2 of 3)



PART 1 51-11-01



767

NONDESTRUCTIVE TEST MANUAL

Over coating

General Description:		
Name:	Sign:	Date:

Final testing for calibration and commissioning

General Description: The PM-200 was used to test obtain a continuity and CVM value for the final sensor system installation.		
Continuity 0 Value:		Approx 65 seconds
Continuity 1 Value:		Approx 65 seconds
CVM 1 Value:		Approx 245 seconds
Continuity 0 Value:		Approx 65 seconds
Continuity 2 Value:		Approx 65 seconds
CVM 2 Value:		Approx 245 seconds
Temp reading (PM200):	°C	°F
Name:	Sign:	Date:

PM-200 database updated with calibration values

System Continuity Value:	Tolerance:	
System CVM Value:	Tolerance:	
Name:	Sign:	Date:

Installation Complete, Working, and Tested

Name:
Sign:
Date:

Notes:

**Example of an SMS "CVM Installation and Use Form"
Figure 7 (Sheet 3 of 3)**

ALL	EFFECTIVITY
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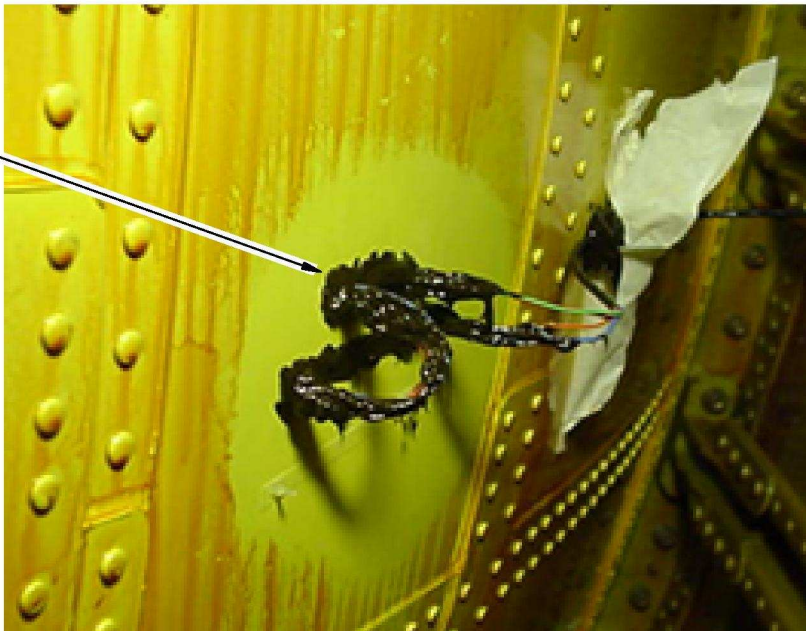
PART 1 51-11-01

Page 13
Aug 15/2008

D634T301

NONDESTRUCTIVE TEST MANUAL

CVM SENSOR
(SHOWN WITH
SEALANT)

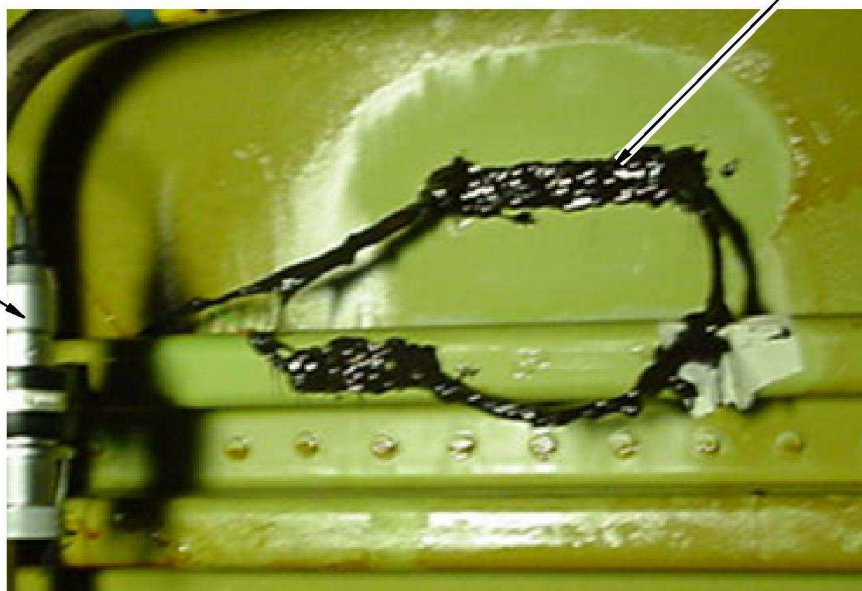


INSTALLED SENSOR WITH A LAYER OF
SEALANT FOR PROTECTION

DETAIL I

CVM SENSOR
(SHOWN WITH SEALANT)

TEST POINT
SOCKET (TPS)



INSTALLED SENSOR WITH A LAYER OF
SEALANT FOR PROTECTION AND A TPS SOCKET

DETAIL II

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**CVM Installation Examples
Figure 8**

	EFFECTIVITY
ALL	

PART 1 51-11-01