



# Systems Operation Troubleshooting Testing and Adjusting

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## **MSS3s** **Machine Security System**

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## Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

**Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.**

**Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.**

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.



The meaning of this safety alert symbol is as follows:

**Attention! Become Alert! Your Safety is Involved.**

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

**Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.**

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.



**When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.**

**Failure to follow this warning may lead to premature failures, product damage, personal injury or death.**

**In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.**

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# Systems Operation Section

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## General Information

**SMCS Code:** 7631

The Cat<sup>®</sup> Machine Security System (MSS) discourages unwanted operation of a machine. The MSS uses the new Cat<sup>®</sup> electronic key. The Cat<sup>®</sup> electronic key contains an electronic chip. The electronic chip has a unique identification number (ID). An exciter coil is mounted around the key start switch. The exciter coil reads the ID of the key.

The electronic control module (ECM) of the MSS is set up with the ID of the keys of the intended users. When the MSS is armed, the ECM validates the ID of the key in the keyswitch. If that ID is in the list of authorized keys in the ECM and the key is valid, the machine will operate normally. If that ID is not in the list of authorized keys or the key is not valid, the MSS will keep the machine functions disabled.

### Components

The MSS consists of the following components:

- ECM (MSS3s)
- Cat<sup>®</sup> electronic key
- Exciter coil
- Status indicator
- Relays

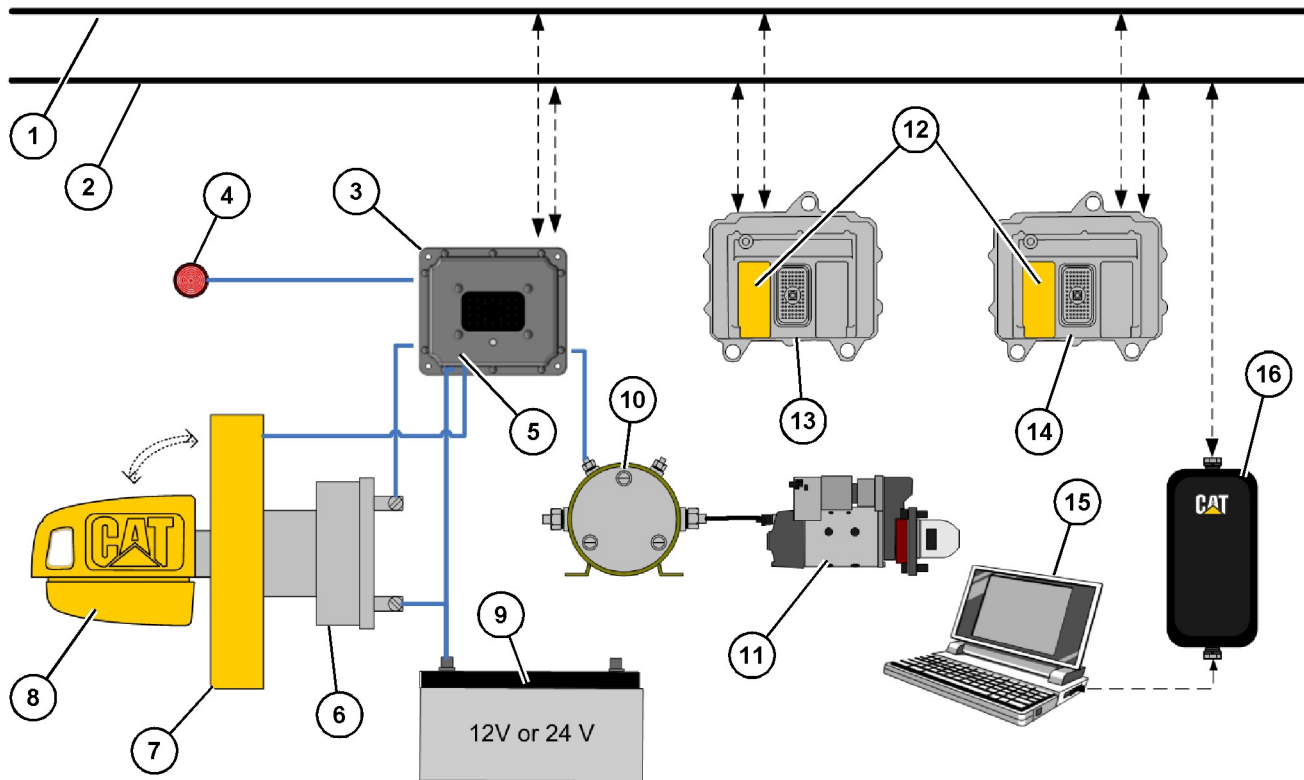


Illustration 1

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Machine security system (MSS3s)

- |  |                        |   |
|--|------------------------|---|
| (1) SAE J1939                                      | (6) Keyswitch          | (12) Immobilizer Software                     |
| (2) Caterpillar Data Link                          | (7) Exciter Coil       | (13) Critical System (Transmission ECM)       |
| (3) Machine Security System Standalone ECM (MSS3s) | (8) MSS Electronic Key | (14) Critical System (Engine ECM)             |
| (4) MSS Status Indicator                           | (9) Battery 12V or 24V | (15) Communications Adapter                   |
| (5) MSS Software                                   | (10) Relay             | (16) PC Caterpillar Service Tool (ET or PSPS) |
|  | (11) Starter           |   |

The MSS3s ECM for the machine security system is a hardened computer that is designed specifically for the MSS.

The Cat<sup>®</sup> electronic key for the MSS contains an electronic chip that is embedded in the head of the key. This chip in the head of the key contains a unique identification number. The Cat<sup>®</sup> electronic key uses the same key cut as the standard Cat<sup>®</sup> key. The electronic key can be used to operate any machine that uses the current Cat<sup>®</sup> keyswitch. The Cat<sup>®</sup> electronic key comes in a gray color or a yellow color. Cat<sup>®</sup> electronic keys are not configurable.

The exciter coil of the MSS is a ring shaped device. The exciter coil is mounted around the existing Cat<sup>®</sup> keyswitch. The exciter coil is used to read the ID that is contained in the Cat<sup>®</sup> electronic key.

**Note: Ensure that you have only one electronic key near the exciter coil when the MSS reads the key. If more than one electronic key is near the exciter coil, the MSS3s ECM will not read the key and the machine will not start.**

The status indicator for the MSS is mounted in the dash of the machine near the keyswitch. The status indicator will give basic information about the MSS to the operator of the machine. The status indicator has two colors: red and green.

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## System Overview

### SMCS Code: 7631

The machine security system (MSS) is designed to restrict operation of a machine. A list of the authorized electronic keys for a machine is contained in the electronic control module (ECM) for the MSS. Only a Cat<sup>®</sup> electronic key that is authorized can disarm the MSS. Disarming is accomplished by assigning the ID of an electronic key to the ECM for the MSS. The Cat<sup>®</sup> Electronic Technician (Cat<sup>®</sup> ET) service tool must be used to program the ECM with the authorized keys.

When the exciter coil is used with MSS, the electronic key is placed in the keyswitch of the machine and turned to the ON position. The ECM will read the unique ID that is stored in the key. The ECM will then compare this ID to the list of authorized keys.

If the ID of the key that is read matches an authorized key, the following actions will occur:

- The status indicator will turn a green color.
- The MSS will disarm allowing the machine to operate.

If the ID of the key that is read does not match the list in the ECM, the following actions will occur:

- The status indicator will become a red color.
- The MSS remains in the armed state.
- The machine will remain disabled.

**Note: Ensure that you have only one electronic key near the exciter coil when the MSS reads the key. If more than one electronic key is near the exciter coil, the MSS3s ECM will not read the key and the machine will not start.**

The machine security system can be installed in a combination of ways:

#### 1. Electronic Control

The MSS disables the machine by controlling up to two devices (relays) that are used to power a critical machine system.

#### 2. Immobilizer

The MSS disables the machine by communicating with other electronic control modules across the J1939 CAN Data-Link and Cat<sup>®</sup> Data-Link (CDL) by disabling critical machine functions.

To change the list of authorized keys or configuration parameters, the user must have one of the following items:

- Cat<sup>®</sup> Electronic Technician (Cat<sup>®</sup> ET) service tool and a key with master access level for that specific machine security system
- Cat<sup>®</sup> ET and a factory password

When a key with the master access level is not available, a factory password is required to change certain parameters in the configuration.

Refer to Testing and Adjusting, "Factory Password - Obtain" for additional information on factory passwords.

The Cat<sup>®</sup> ET screen for the factory level security password will display the following parameters:

- ECM serial number
- Product ID (Serial number of the machine)
- Serial number of the service tool
- Reason code
- Total tattletale number

To obtain the proper passwords, the information must be given to an authorized Cat<sup>®</sup> dealer.

If a key with the master access level for the machine is not available, a factory password must be entered before changes can be made. The following information is needed before you call for a factory password:

Table 1

Information That is Needed for the Factory Password	
Product Identification	
Software Part Number from MSS3s ECM	
Serial Number from ET	
Tattletale	
Reason Code	99 or 4

**Note: The password may only be used for one programming session. A different password will be required after you exit the Cat® ET screen.**

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## Normal Operation

**SMCS Code:** 7631

### Reading the ID of a Key

Before you can operate the machine, the MSS must identify a valid electronic key ID. The MSS identifies a valid electronic key ID via the exciter coil.

#### Exciter Coil

When the key is turned to the ON position, the MSS enters the read mode. The MSS then checks for a valid electronic key ID. If the electronic key ID matches one stored in the MSS3s ECM, then power is supplied to the output drivers of the MSS3s ECM. An “enable” message is also sent via the CAT data link to the other electronic control modules that are on the machine. The machine will operate normally.

**Note: Ensure that you have only one electronic key near the exciter coil when the MSS reads the key. If more than one electronic key is near the exciter coil, the MSS3s ECM will not be able to read the key. If the MSS3s ECM cannot read the key, the machine will not start.**

**Note:** If the MSS3s ECM has failed or been removed, the other critical machine operations controlled by the other electronic control modules will not operate.

### Timeouts

After a machine has been started successfully, the operator will have 30 seconds after the machine is turned off before the MSS is automatically armed. The operator is not required to arm the system manually.

If the MSS is unable to read an electronic key ID, the system will remain armed.

When the MSS identifies a key with an invalid electronic key ID, the system will remain armed.

### Armed

When the MSS is armed, the output drivers are open. The output drivers being open, disables the power that is supplied to each component that is powered by the output drivers. The machine will not be able to operate normally. When the system has been armed, the red LED of the status indicator will illuminate.

There are two states of operation within the “armed” mode.

#### 1. “MSS Armed”

When no power is applied to the MSS, the MSS will default to “armed” state. When power is applied to the MSS, and all timeouts have expired, the MSS will return to the “MSS Armed”.

#### 2. “MSS Read”

##### Exciter Coil

When the keyswitch is first moved to the ON position, the MSS tries to read the electronic key ID. The ECM will continue reading attempts until an ID is read or the read timeout expires. If an ID is read, the MSS changes to the “MSS read” state. If the read timeout expires, the MSS will turn on the red LED of the status indicator and the MSS will remain armed.

**Note: Ensure that you have only one electronic key near the exciter coil when the MSS reads the key. If more than one electronic key is near the exciter coil, the MSS3s ECM will not be able to read the key. If the MSS3s ECM cannot read the key, the machine will not start.**

### Disarm

When the MSS is disarmed, the machine can be operated. The MSS has enabled the starter and main circuits on the machine. A message is sent to the other machine ECMs over the J1939 and Cat data links. The machine will be able to start. The green LED of the status indicator will illuminate.

There are two ways to disarm the machine:

- Use a valid electronic key for this machine.
- Use the Cat Electronic Technician with a “Master Access Level” key or a factory password to modify the configuration of the system.

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## Operation of Status Indicator

**SMCS Code:** 7631

The Machine Security System uses a status indicator that is mounted in the cab near the key start switch. The status indicator provides a visible alert of the presence of the security system. When the MSS is armed and the “key start switch” is first turned to ON or START, the status indicator momentarily displays a red light. This light provides a warning that the machine is armed with a security system.

## Status Indicator

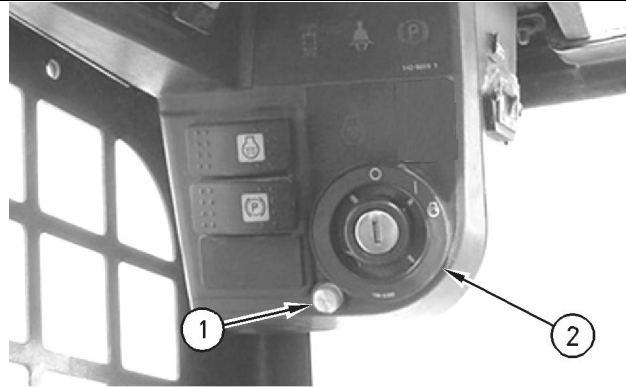


Illustration 2

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### Typical installation of the Status Indicator

- (1) Status Indicator (2) Keyswitch with Exciter Coil

The state of the MSS is displayed by the status indicator in accordance with Table 2 . The operator can use the status indicator to determine the status of the system or for troubleshooting.

Table 2

Status Indicator	Description
Continuously Red	The MSS is armed. <sup>(1)</sup>
Continuously Green	The MSS is disarmed. The green LED will remain ON 30 seconds after powerdown. After the 30 seconds have passed, the MSS automatically returns to the "armed" mode.
Continuously Orange <sup>(2)</sup>	<b>The red LED and the green LED of the status indicator are tested momentarily by the MSS3s ECM at powerup. The status indicator will remain on if No "application" software is detected in the electronic control module (ECM).</b>

<sup>(1)</sup> The red LED will remain ON while the key is in the ON position or until a valid key is read. The red LED will turn OFF approximately 3 seconds after the key is turned to the OFF position.

<sup>(2)</sup> The red LED and the green LED are continuously ON.

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## Key Information

### SMCS Code: 7631

You may configure the machine security system to recognize 255 authorized keys. This list contains those keys that will disarm the machine security system. The user adds keys to this list.

The ECM can store five configuration parameters that identify each electronic key. These parameters are listed below:

- Description
- Access level
- Expiration date
- ID1

- ID2
- Key Type

The parameters are not stored in the electronic key. A complete list of the configuration parameters that are available in the Cat<sup>®</sup> Electronic Technician (Cat<sup>®</sup> ET) are listed below:

1. Add an electronic key.
2. Change the following information that is related to the electronic key.
  - a. Access level
  - b. Expiration date
  - c. Description
3. Delete an electronic key.
4. Security bypass times



5. Set the internal clock.

6. Fleet configuration

**Note:** Refer to the Testing and Adjusting, “Key - Program” section for additional information on items 2.a, 2.b,2.c,3, 5, and 6. Refer to the Systems Operation, “System Disarm Feature” section for additional information on item 4.

**Note:** A single electronic key can be used on as many machines with an MSS as desired. A separate key for every machine is not necessary. Key strategies will vary depending on machine fleet usage. The following parameters can be different on each machine: Description, Access Level and Expiration Date. The ID will be the same on all the machines.

**Note:** The features of the MSS are supported in version 2015B or later of the Cat® ET service tool.

Table 3

Security Type	Description	Access Level	Expiration	Security ID
Key	Operator 1	Master	" _ _ _ _ "	0:183243096
Key	Operator 2	Standard	" _ _ _ _ "	0:110105956

## Security Type

The security type identifies the type of security access that is being utilized. There are currently two types of security identification.

- Key

## Security ID

The ID that is stored in the electronic key is a 16-digit number that is displayed as two 8-digit numbers in the Cat ET service tool. This field is known as “Security ID” . When the numbers are combined, the complete ID number is formed. The ECM uses this ID to associate a key to the set of parameters in the list of keys. Entries in the list may have the same information for Description, Access Level, and Expiration Date. You may choose a description of 11 characters or less for each key in the list of keys. There can be multiple entries in the list with the same description. Create a description so that the key describes either the owner of the key or the function of the user.

**Note:** Do not make duplicate descriptions for the electronic keys.

## Access Level

You may assign one of two access levels to a key in the list of keys. The levels are either “Standard” or “Master” . Both access levels allow the key to disarm the system for operation. The master access level also gives the user the ability to modify the settings of the MSS with the Cat ® ET service tool.

The standard access level is for normal operation of the machine. The master access level should be restricted to those persons that need to modify the settings of the machine security system.

## Expiration Date

An expiration date may be assigned to any key in the list of keys. This expiration date is defined in 6 hour intervals on a given date. The third entry in Table 3 contains an expiration date. For all of the other keys in Table 3 , the column with the expiration date is filled with “Dashed lines” . “Dashed lines” indicate that those entries do not have an expiration date. The machine security system has an internal clock. Once the internal clock has passed the expiration date for a key, that key will no longer disarm the system. However, the entry will not be deleted from the list of keys. A new expiration date can be set, or the feature can be disabled. A possible use for the expiration date is used with a rental contract.

**Note:** If the machine is running when the expiration date and time are reached, the machine will continue to run. When the machine is shut down and the 30 second grace period has timed out, the machine will not be allowed to restart.

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## Scheduled Access ( “Security System Bypass Times” )

**SMCS Code:** 7631

The Machine Security System can be programmed to disarm temporarily for a time period. The MSS can be set to disarm for different time periods on each day. Within these periods of time, any Caterpillar key (a standard key or an electronic key) will operate the machine.

**Note: It is not possible to configure the “bypass times” for an individual electronic key. The “bypass times” are not associated to an individual electronic key.**

“Security System Bypass Times” are time periods that can be set to disarm the Machine Security System automatically. An electronic key is not required during these periods. This feature can be used for the normal work shift of the machine. Outside the normal work shift, the Machine Security System would be armed. When the MSS is armed, an electronic key is required to start the machine. This feature would minimize the number of electronic keys that are needed.

Table 4

“Sunday Security System Bypass Start Time”	00:00
“Sunday Security System Bypass Stop Time”	00:00
“Monday Security System Bypass Start Time”	6:00
“Monday Security System Bypass Stop Time”	18:00
“Tuesday Security System Bypass Start Time”	6:00
“Tuesday Security System Bypass Stop Time”	18:00
“Wednesday Security System Bypass Start Time”	6:00
“Wednesday Security System Bypass Stop Time”	18:00
“Thursday Security System Bypass Start Time”	6:00
“Thursday Security System Bypass Stop Time”	18:00
“Friday Security System Bypass Start Time”	6:00
“Friday Security System Bypass Stop Time”	12:00
“Saturday Security System Bypass Start Time”	12:00
“Saturday Security System Bypass Stop Time”	12:00

Table 4 shows an example of “Security System Bypass” . The “Start Time” is the time when the Machine Security System will disarm. The Machine Security System will return to the “armed” state at the “Stop Time” . Between these two periods of time, any Caterpillar key will operate the machine. Thus, the MSS is disarmed during this time period.

All times are based on a 24 hour clock. For example, 6:00 am is 06:00 and 3:00 pm is 15:00. The Machine Security System will be disarmed during the times that are listed below: Monday through Thursday from 06:00 to 18:00

On Friday, the MSS is disarmed for only half of the workday. After 12:00 on Friday, the Machine Security System will be armed automatically. Operation will be restricted to operators with electronic keys that are authorized in the MSS3s ECM on that machine. Refer to Table 4 .

The Machine Security System is “armed” on the weekend. Because the “Start Time” and the “Stop Time” are set for the same time, the Machine Security System will be armed throughout the day.

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## Diagnostic Operation

**SMCS Code:** 7631

A diagnostic code indicates that the ECM has detected one or more of the following conditions:

- an invalid signal from an input
- an improper feedback from an output
- an internal error

One method of displaying diagnostic information is provided:

- Diagnostic codes with descriptive text can be viewed with the Caterpillar Electronic Technician (ET).

### Display the diagnostic code with the Caterpillar Electronic Technician.

This method of displaying the diagnostic codes uses the service tool to display the codes. The Component Identifier (CID) identifies the specific component for a specific diagnostic. The Failure Mode Identifier (FMI) identifies the type of diagnostic that was detected. The diagnostic codes allow consistent identification of the problem. The service tool is used to display the CID-FMI with descriptive text for each combination. The descriptive text will help to avoid mistakes in interpreting the codes.

## Active Diagnostics

Active diagnostics indicate the presence of active diagnostic codes in the MSS. A diagnostic code informs the operator that a problem exists with the MSS.

If the Cat service tool is available, the service tool can be used to display all active diagnostic codes. The service tool will also display codes that have been logged.

## Logged Diagnostics

A logged diagnostic will record problems that are intermittent in the Machine Security System. Logged diagnostics eliminate the need to duplicate problems that are intermittent. Logged diagnostics will increase the accuracy of diagnosis. The time that is required to troubleshoot a problem is reduced with the use of Diagnostics. Logged diagnostics eliminate the need for trip recorders that are used to capture intermittent diagnostic information.

The memory of the control module is used to store diagnostic information. When a diagnostic code is detected, the following information is logged:

- The CID will identify the component that has failed.
- The FMI will describe the problem.
- Number of occurrences of the diagnostic code
- The time of the first occurrence that the diagnostic was detected.
- Last occurrence time, when the diagnostic was last detected (stored with both machine hours and RTC stamp)

The problems which can be logged are listed in Troubleshooting, "Diagnostic Code Procedures".

The MSS logs the number of times that the machine is started with the methods that are listed below:

- Starting using an unauthorized method

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## Events

**SMCS Code:** 7631

An event indicates that the MSS is not operating correctly. An event does not indicate that there is a failure with the system.

The MSS records data for the events that are listed in Table 5 .

## Cat<sup>®</sup> Electronic Technician (Cat ET)

When an abnormal operating condition occurs, the status screen on Cat Electronic Technician (Cat ET) indicates that there is an active event.

Event codes are displayed on Cat ET in the following format:

EXXXX Description of the code

The "E" means that the code is an event code. The "XXXX" is a numeric identifier. The numeric identifier is followed by a description of the code.

Active event codes are listed in ascending numerical order. The code with the lowest number is listed first. The active event code is removed from the list when the condition is no longer present.

## Logged Event Codes

Some event codes are logged in the ECM memory. Some event codes are active only. The logged event codes are listed in chronological order. The most recent code is listed first.

A logged code is cleared from memory when one of the following conditions occur:

- The service technician manually clears the code.
- The code does not reoccur for 1000 hours.
- A new code is logged and there are already ten logged codes in memory. In this case, the oldest logged code is cleared.

**Note:** Always clear logged event codes after investigating and correcting the problem which generated the code.

Table 5

<b>Events that are logged by the Machine Security System</b>		
<b>EID</b>	<b>Description</b>	<b>Possible Cause/Recommended Response</b>
E273	"Machine operation attempted using an invalid key"	<b>Probable Cause:</b> An unrecognized key has been used to start the machine. <b>Recommended Action:</b> Ensure that key list is up to date with all required keys.
E252	"Loss of Key Table Information"	<b>Probable Cause:</b> Possible loss of key table. <b>Recommended Action:</b> Check key table to ensure that it is correct. Possibly caused by improper machine shutdown.

PROOF

## Logged Events



Illustration 3

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“Logged Event Codes” screen from the Caterpillar® Electronic Technician for the Machine Security System

Logged events provide a secure list of events that are critical to the security of the machine. The ECM for the MSS is used to store information about events. When an event is detected, the following information is logged:

- EID for the event
- Number of occurrences
- Time of the first occurrence of the event
- Time of the last occurrence of the event

**Note:** The ECM will record a maximum of 127 occurrences of the events. The newest event replaces the oldest event after 127 events have been stored in the memory of the ECM.

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## Protected Functions

**SMCS Code:** 7631

There are two levels of protection:

- An electronic key with standard access level and a non-electronic key
- An electronic key with master access level (factory password)

The requirements for each level are explained below:

### An Electronic Key with Standard Access Level and a Non-electronic Key

- The table of the MSS keys can be viewed but the table cannot be modified.
- The configuration settings of the MSS can be viewed but the settings cannot be modified.

### Electronic Key with Master Access Level

A factory password or a master access level is needed to modify any settings through the service tool.

- The settings for the MSS can be modified.
- The list of valid key IDs can be modified.
- The logged events can be cleared.

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## Service Operation Using Machine Security System

**SMCS Code:** 7631

The onboard interface has several purposes. The interface can provide the following information to the operator: diagnostic feedback and event feedback. The system can also be programmed through the onboard interface.

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## Service Operation Using Service Tool

**SMCS Code:** 0785-UE; 7631

The service tool is used to communicate with the ECM for the following information:

- display and control of code
- programming
- management
- diagnostics
- events

To protect the machine properly, the service tool requires a factory password or a key with the master access level. This password or key is required before any modifications can be made to the MSS.

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## Electronic Control Module (ECM)

**SMCS Code:** 7610-MCH

### FCC NOTICE

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

### Industry Canada Notice to Users

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :  
 (1) l'appareil ne doit pas produire de brouillage, et  
 (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement



Illustration 4

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## ECM Inputs

### Keyswitch

The key start switch is also used as an input signal to the MSS. The input from the key switch is used to determine when the machine is on. Battery voltage is connected to this input through the ON and START positions of the keyswitch. When the machine is operating and the alternator is charging, the voltage on this input will be:

- 14.1 - 15.1V for a 12V system
- 27.6 - 29.6V for a 24V system

When the machine is not running, the voltage on this input will be approximately 12V for a 12V system and 24V for a 24V system.

### Neutral Start Input

When activated, the NEUTRAL START input supplies power to the neutral start ON/OFF driver 5 (STARTER solenoid driver) using +BATT.

### Switch to ground

These inputs allow the ECM to detect closure of switches to the ECM ground (- BATTERY input).

## ECM Outputs

### Status Indicator

The status indicator displays status of the system. The status indicator has three connections. One of the three connections is for a ground. Another connection is for the red LED. The third connection is for the green LED.

### Output Drivers

Two output drivers are available to control relays or solenoids on the machine. Unless a valid "key ID" has been identified by the system, the drivers will remain without power. The drivers are rated at 2A.

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## System Components

SMCS Code: 7631

### Cat® Electronic Key

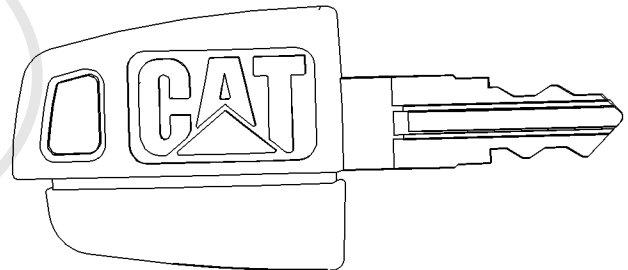


Illustration 5

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The Cat® electronic key

The Cat® key is the universal key for all Caterpillar machines. The electronic key has an electronic chip that is embedded inside the head of the key. The electronic keys are gray or yellow.

### Exciter Coil

The exciter coil provides communication between the electronic key and the control module.

The exciter coil is mounted around the keyswitch. This position allows the exciter coil to communicate with the electronic key. Any ferrous metal between the coil and the electronic key will interfere with the communications. Mounting the coil in the same plane as the top of the keyswitch will minimize the interference.

**Note: Ensure that you have only one electronic key near the exciter coil when the machine security system (MSS) reads the key. If more than one electronic key near the exciter coil, the MSS3s ECM will not read the key and the machine will not start.**

The exciter coil is connected to the harness via a 2-pin connector and a length of wire.

## Status Indicator

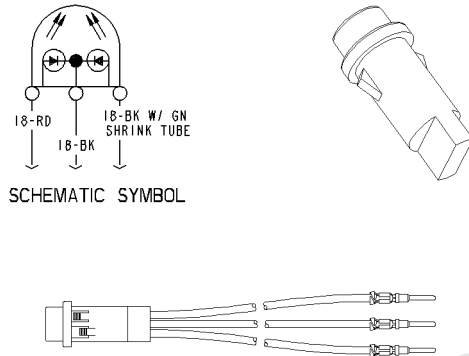


Illustration 6

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The state of the MSS is displayed by the status indicator. The green LED of the status indicator turns on when the system is disarmed. The machine should start. The red LED of the status indicator turns on when the system is armed and an invalid electronic key has been read by the MSS. The machine should not start. Both LEDs will turn on, producing an orange light if the application software of the MSS has not been programmed into the ECM.

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## Data Links

**SMCS Code:** 7631

The J1939 and Cat Data Link can connect the ECM for the MSS to the following items:

- Service tools
- Onboard controls
- Monitoring systems

The service tool can send information to the MSS through the J1939 and Cat Data Link. The MSS can provide information over the J1939 and Cat Data Link to transmission control, engine control, and service tool. The information can be for diagnostics, or the information can be used to control other systems on the machine.



# Troubleshooting Section

## Introduction

During troubleshooting, inspect all connections before any component is replaced. If the connections are not clean and tight, permanent electrical problems or intermittent electrical problems can result. Check that the wires are pushed into the connectors completely. Make sure that the connections are tight before other tests are made.

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## General Information

**SMCS Code:** 7000

Failure of an electrical component can cause the failure of other components. Also, failure of an electrical component can be caused by the failure of other components. Always attempt to correct the cause of an electrical system failure before you replace a component.

**Note: If you suspect that there is a problem with the Machine Security System, ensure that the machine starting system is working properly. Use the electrical system schematic to troubleshoot the starting circuit.**

**Note: Electronic control modules seldom fail. Perform the troubleshooting procedures that are provided in the Troubleshooting, “Symptom Procedures” section of this manual, before you replace an ECM.**

Test procedures progress from the most likely points of failure to the least likely points of failure. The procedures normally proceed in the following order:

- A component is bad.
- Wiring or connectors are bad.
- An electronic module is bad.

Each procedure assumes the following data:

- No previous troubleshooting has been performed on the system.
- The system has not been altered.

Assume for repair:

- The batteries are fully charged and the charging system is operating properly.
- Caterpillar® Electronic Technician (Cat® ET) is available and the technician is trained on the operation of Cat ET. See Troubleshooting, “Service Tools”.

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## Service Tools

**SMCS Code:** 0785

Standard Caterpillar® tools should be adequate for service. The following tools are needed to troubleshoot the Machine Security System:

Table 6

Service Tools	
Part Number	Description
9U-7246	Connector Repair Kit
7X-1710	Multimeter Probe
8T-5318	Wire Removal Tool
6V-7070	Digital Multimeter
4C-4911	Battery Load Tester

In addition to the tools listed in Table 6, a laptop computer with the Cat® Electronic Technician (Cat ET) and the communication adapter are required.

The Cat ET 2015B or later is required to use the full security management potential of the Machine Security System.

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## Connector Locations

**SMCS Code:** 7553-546-WW

The locations of the components of the MSS will vary between machines. If the MSS was installed by a Caterpillar dealer, consult the installation instructions for component locations. If the MSS was an attachment that was installed at the factory, consult the electrical schematic for that machine.

For each output use a twisted wire pair, all the way between the MSS3s ECM and the load (recommended).

**Note:** There is a need to manage shared returns, connecting the returns together as close to the ECM as possible. Failure to do so may result in difficulty reading keys due to electromagnetic interference.

- The 2A drivers share a separate return.
- The 300mA drivers share a separate return.

- The 20mA LED drivers share a separate return.
- The exciter coil has a dedicated return that is not to be shared.

Use the Machine Electrical Schematic, Parts Manual, and Operation and Maintenance Manual to locate electrical components and connectors.

The following information is a guide to reading the tables on the back of the Electrical Schematic.

- The “Component Location” table uses a numeric value for each component on the machine. Cross reference the machine location number from the table to the corresponding number in the machine views graphic.
- The “Harness Connector Location” table uses a numeric value for each connector on the machine. Cross reference the connector number from the table to the corresponding number in the machine views graphic.

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## Diagnostic Capabilities

**SMCS Code:** 1400

Diagnostic information for the Machine ECM can be accessed using the Cat<sup>®</sup> Electronic Technician (Cat ET) Service Tool. Diagnostic information can also be accessed by using the Operator Monitor Display.

## The Cat<sup>®</sup> Electronic Technician (Cat ET) Service Tool

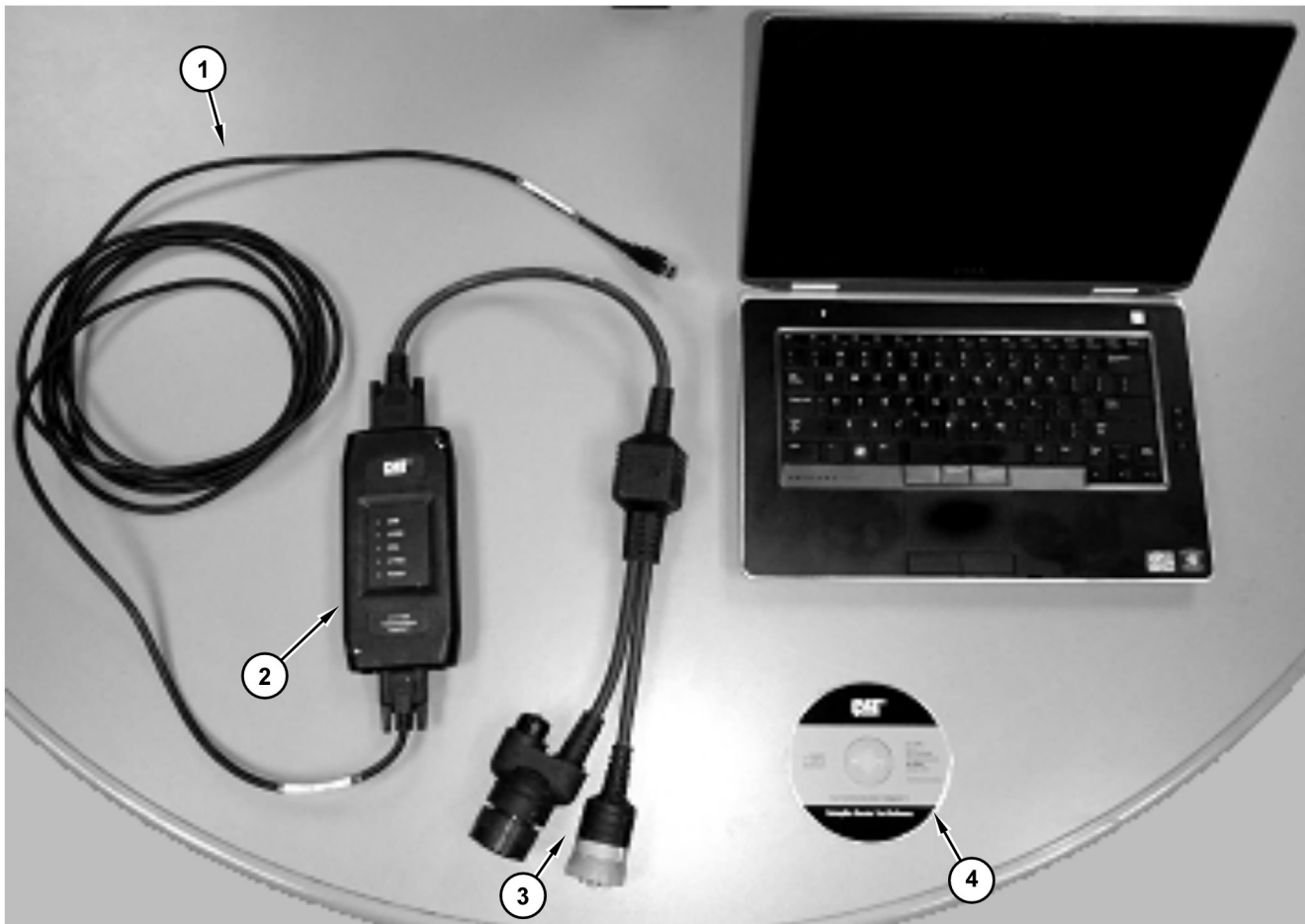


Illustration 7

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### Connections for the Communication Adapter 3 and Cat<sup>®</sup> Electronic Technician (Cat ET) Service Tool

The components that are needed to use the Communication Adapter III and Cat ET to determine diagnostic codes are listed:

- |                                       |  |
|---------------------------------------|--|
| (1) Cable                             | (4) Current version of Cat ET program software and an IBM-COMPATIBLE personal computer |
| (2) 317-7484 Communication Adapter Gp |  |
| (3) 457-6114 CA3 Ethernet FLASH Cable |  |

Cat<sup>®</sup> Electronic Technician (Cat ET) is a software program used to access, view, monitor and sometimes change data that a particular ECM uses to control a machine system. The service technician can use the Cat ET to perform maintenance on the machine. Some of the options that are available with the Cat ET are listed below:

- View the active diagnostic codes and logged diagnostic codes. See Troubleshooting, "Using the Cat<sup>®</sup> Electronic Technician (Cat ET) Service Tool to Determine Diagnostic Codes".
- Viewing the active event codes and logged event codes.

- View the status of parameters.
- Clear active diagnostic codes and clear logged diagnostic codes.
- Perform calibrations of machine systems.
- Program the ECM (Flash) with the "WINflash" program. See Troubleshooting, "Electronic Control Module (ECM) - Flash Program".
- Print reports.

The following list contains some of the diagnostic functions and programming functions that are performed by the Cat ET service tool.

- The failures of the ECM system are displayed.
- The status of most of the inputs and the outputs are displayed.
- The settings for the ECM are displayed.
- Display the status of the input and output parameters in real time.
- Display the clock hour of the internal diagnostic clock.
- The number of occurrences and the clock hour of the first occurrence and the last occurrence is displayed for each logged diagnostic code.
- The definition for each logged diagnostic code and each event is displayed.
- Load new FLASH software.
- Active diagnostic codes.
- Logged diagnostic codes.

See Troubleshooting, “Diagnostic Code List” for the list of diagnostic codes that can be activated by the Machine ECM.

## Event Codes

### Logged Event Codes

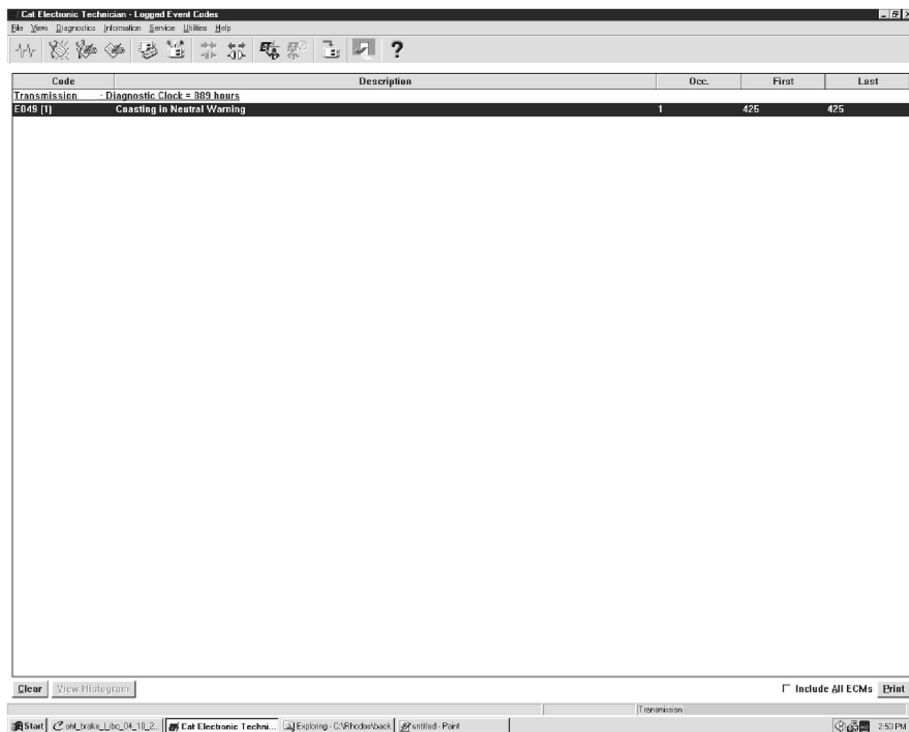


Illustration 8

Typical Cat ET screen for logged events

An indicator for logged events is provided. The indicator allows the service technician to track event codes that are intermittent. The data for the logged event will include the following information:

- An event identifier (EID).
- A text description of the problem.
- The number of occurrences of the problem.
- A time stamp will display the first occurrence of the problem.
- A time stamp will display the last occurrence of the problem.

## Status Groups For Cat ET

The Status groups list the machine parameters. The status of the parameters is shown in real time.

The screenshot shows the Caterpillar Electronic Technician (ET) software interface. The main window displays a table of machine parameters. The table has the following columns: Description, Value, Unit, Min, Max, and ECM. The data is as follows:

Description	Value	Unit	Min	Max	ECM
Right Joystick Thumbwheel Control Mode	Auxiliary Valve #1				Machine Control M318D MH
Right Joystick Thumbwheel Position	0.00	%	0.00	0.00	Machine Control M318D MH
Left Attachment Pedal Position	Disabled or Not Installed	%			Machine Control M318D MH
One Way / Two Way Valve Solenoid Status	Data Invalid				Machine Control M318D MH
Auxiliary Valve #1 Port A Line Relief Pressure Solenoid Current Status	0.000	Amps	0.000	0.000	Machine Control M318D MH
Auxiliary Valve #1 Port A Solenoid Current Status	0.000	Amps	0.000	0.000	Machine Control M318D MH
Auxiliary Valve #1 Port B Solenoid Current Status	0.000	Amps	0.000	0.000	Machine Control M318D MH
Auxiliary Valve #1 Load Sense Solenoid Current Status	0.000	Amps	0.000	0.000	Machine Control M318D MH
Hammer Valve Solenoid Current Status	Disabled or Not Installed	Amps			Machine Control M318D MH

The interface also includes a tree view on the left with categories such as Machine Control 312 E, Membrane Keypad Switches, Hystat Inputs, Hystat Outputs, Brake System, Machine Status, Monitoring System, Engine Information, Hydraulics - Basic, Hydraulics - Pump Control, Hydraulics - Boom Functionality, Hydraulics - Auxiliary #1, Hydraulics - Auxiliary #2, Medium Pressure Hydraulic Circuit, Hydraulic Cab Riser System, Miscellaneous, Joystick Steering, Ride Control, Implement Generator, C.S. M318D (CSE0001), Core Engine, Pressures and Temperatures, General Engine & Machine, Fan Control, No Start Parameters, Security System, VIMS Main Module, Status Parameters, GPS Information, GSM Information, Digital Inputs #1 and #2, Digital Inputs #3 and #4, <TEMPORARY GROUP>, Ride Control Test, and Travel Lock. The status bar at the bottom shows 'Active Codes [0]', 'Active Events [0]', and 'Status Flags [1]'.

Illustration 9  
Typical Cat ET Status Screen

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## Machine Preparation for Troubleshooting

SMCS Code: 7000-035

### Warnings

#### WARNING

Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine.

To prevent possible injury, perform the procedure that follows before testing and adjusting the power train.

#### WARNING

Hot hydraulic oil under high pressure can remain in the components of the hydraulic system or the power train system after the engine has been stopped. The uncontrolled release of the hydraulic oil can cause sudden machine movement and can also result in the following conditions:

- Burns
- The penetration of body tissue
- Other personal injury
- Death

If hydraulic oil penetrates body tissue, the injury must be treated immediately by a doctor who is familiar with this type of injury. Use a board or a piece of cardboard to check for a hydraulic oil leak. Make sure that all of the attachments have been lowered to the ground and that all trapped pressure has been released from the hydraulic system and the power train system. Also, make sure that the hydraulic oil is cool before the removal of any components or lines. Remove the hydraulic oil filler cap only when the engine is stopped and the filler cap is cool enough to touch with your bare hand.

#### WARNING

Personal injury or death can result from not engaging the parking brake.

Transmission engagement alone will not prevent machine from rolling when the engine is stopped.

#### WARNING

Personal injury can result if the machine moves while testing.

If the machine begins to move during test, reduce the engine speed immediately and engage the parking brake.

#### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat® products.

Dispose of all fluids according to local regulations and mandates.

## General Procedure

### 1. Know the Machine

Understand the operation and the interaction of the machine systems. Know if the symptom is a characteristic of normal operation or if the symptom is a problem.

Refer to the Systems Operation in your Service Manual.

### 2. Identify the Symptom

a. Speak with the operator about the symptom.

- Ask about the performance of the machine prior to the problem.
- Determine the time that the symptom first occurred.
- Determine the operating conditions at the time of the problem.
- Ask the operator about the sequence of events prior to the failure. Determine the order of the occurrences.
- Ask the operator about the steps that have been taken to troubleshoot the machine.
- Check the history of repairs of the machine.
- Ask about the preventive maintenance of the machine.

- b. Inspect the machine. Look for problems. Notice any unusual odors in the air. Listen for unusual noises.

Complete the steps in Troubleshooting, "Visual Inspection".

If you complete the visual inspection and the problem is not identified, perform the appropriate tests and/or adjustments in Specifications, Systems Operation/Testing and Adjusting for your machine.

### 3. Troubleshoot the faults with the service codes

Determine if the ECM has detected any faults. A service code is used to specify each detected fault.

Each of the components such as switches and sensors are referenced by a unique CID (component identifier).

In order to read a diagnostic code, refer to Troubleshooting, "Diagnostic Capabilities" in this manual.

### 4. Troubleshoot using the description of the symptom

If you troubleshoot the service codes and the problem is not resolved, continue troubleshooting using the symptom. Identify the component that is the most probable cause of the symptom.

5. After the problem is resolved, prepare the machine for operation. Complete a maintenance record for the machine: problem, symptom, and repairs.

Refer to the instructions in the Operation and Maintenance Manual for your machine.

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## Visual Inspection

**SMCS Code:** 7000-035

### Check the Electrical System

1. Inspect the wires and check the electrical connectors to the component that is suspect.

#### Expected Results

- The wires and the electrical connectors are not damaged. The electrical connectors are clean.

#### Results

- OKAY: Proceed with Diagnostic Trouble Codes.

- NOT OKAY: Replace any damaged wires. Replace any damaged electrical connectors. Ensure that all the seals are properly in place. Check the machine for the original problem.