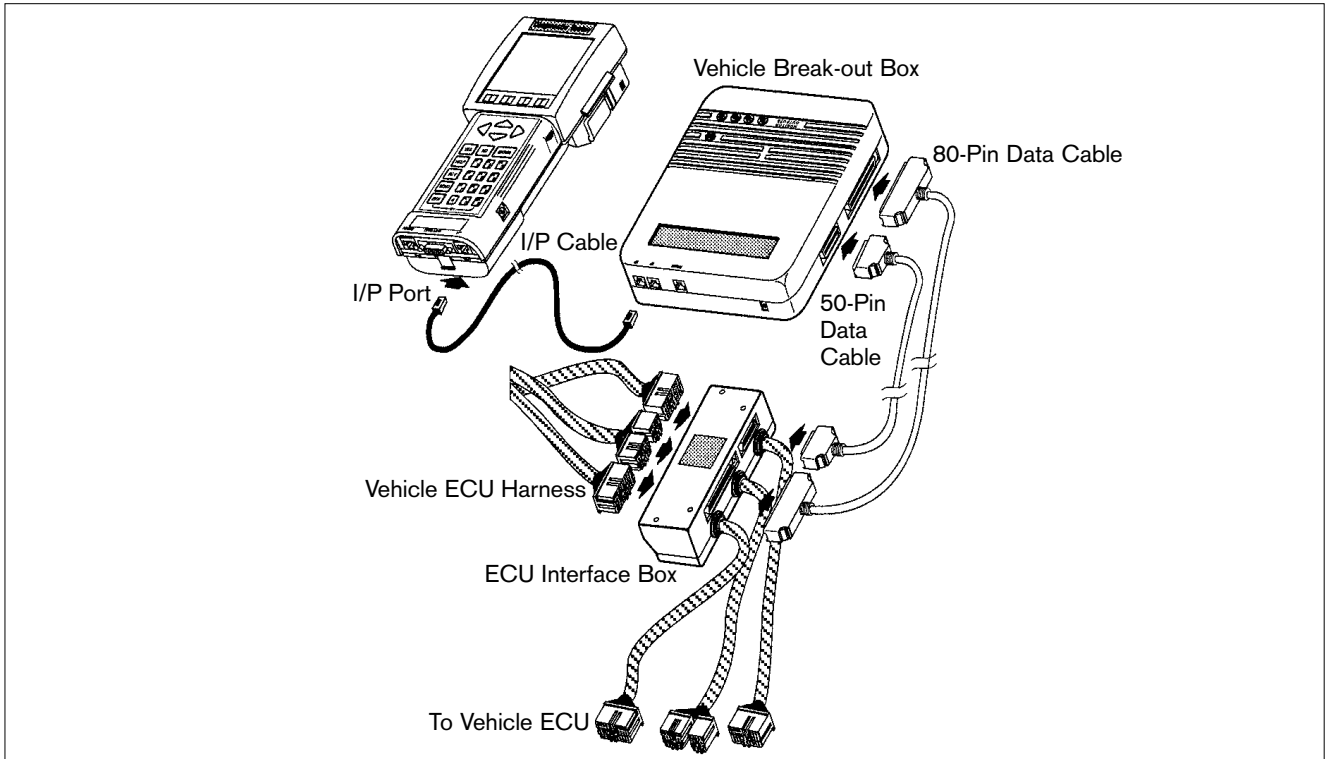


## Section 1

# Introduction to Engine Control System Processes and Diagnostic Tools

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### Learning Objectives:

1. Perform a general diagnostic process regardless of the type of customer concern on ECU controlled systems.
2. Utilize advanced diagnostic tools for greater accuracy and speed.
3. Lay out the troubleshooting steps and resources you will need to follow when diagnosing customer concerns.

# Introduction to Engine Control System Processes and Diagnostic Tools

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**Overview** The purpose of this section is to:

- help you understand the general diagnostic process that you will follow regardless of the type of customer concern you are troubleshooting.
- features of diagnostic tools that will help you with greater accuracy and speed.
- lay out the troubleshooting steps and resources you will need to follow when diagnosing customer concerns.

## Diagnostic Tools and Resources

There are many troubleshooting “tools” that can be used to accurately identify and troubleshoot driveability problems. These include:

- Previous Troubleshooting Experience
- Use of the OBD self-diagnostic system
- Service Literature – Technical Information System (TIS), Repair Manuals, Electrical Wiring Diagrams, and Technical Service Bulletins
- Diagnostic Toolset
- TechView

There are also other resources at your disposal for those extraordinary situations where your best attempts fail to resolve the customer concerns:

- Technical Assistance hotline
- Area office assistance; STSs, FTSs, and FPEs

With these resources available to you, even the most difficult customer concerns can be resolved while maintaining high standards for customer satisfaction.

## Previous Troubleshooting Experience

Your experience is one of the best resources you have. Depending on the symptom or customer description of the driveability concern, you can often eliminate many sub-systems from your diagnostic investigations. It is important to note, however, this does not mean that troubleshooting is performed in a random manner. In fact, you will always fix the car faster and with more accuracy when you follow a systematic diagnostic approach.

**Use of the On-Board (Self) Diagnostic System** All ECMs are equipped with an on-board self-diagnostic system (OBD). This system is capable of detecting shorts and opens in most sensor electrical circuits and in some actuator circuits. Later models equipped with the OBD II system can also detect component and system performance.

These OBD systems are an integral part of your troubleshooting process and will weigh heavily in your diagnostic outcome.

**Diagnostic Toolset** The Diagnostic Toolset consists of the Diagnostic Tester and the Vehicle Break-out Box (V-BoB). Depending on the vehicle you are working on and the nature of the customer concern, both of these tools are extremely valuable for gathering large quantities of diagnostic data in a relatively short period of time. For troubleshooting engine control system concerns, the Diagnostic Toolset allows you to quickly perform the following functions:

- Read and define Diagnostic Trouble Codes (DTCs)
- Display serial data stream containing sensor, actuator, and diagnostic information
- Display signal voltages on a fully adjustable laboratory oscilloscope
- Store and playback snapshot data.
- Test sensors and actuators dynamically using Active Tests
- All CARB OBD II functions

### *Diagnostic Toolset with TIS*

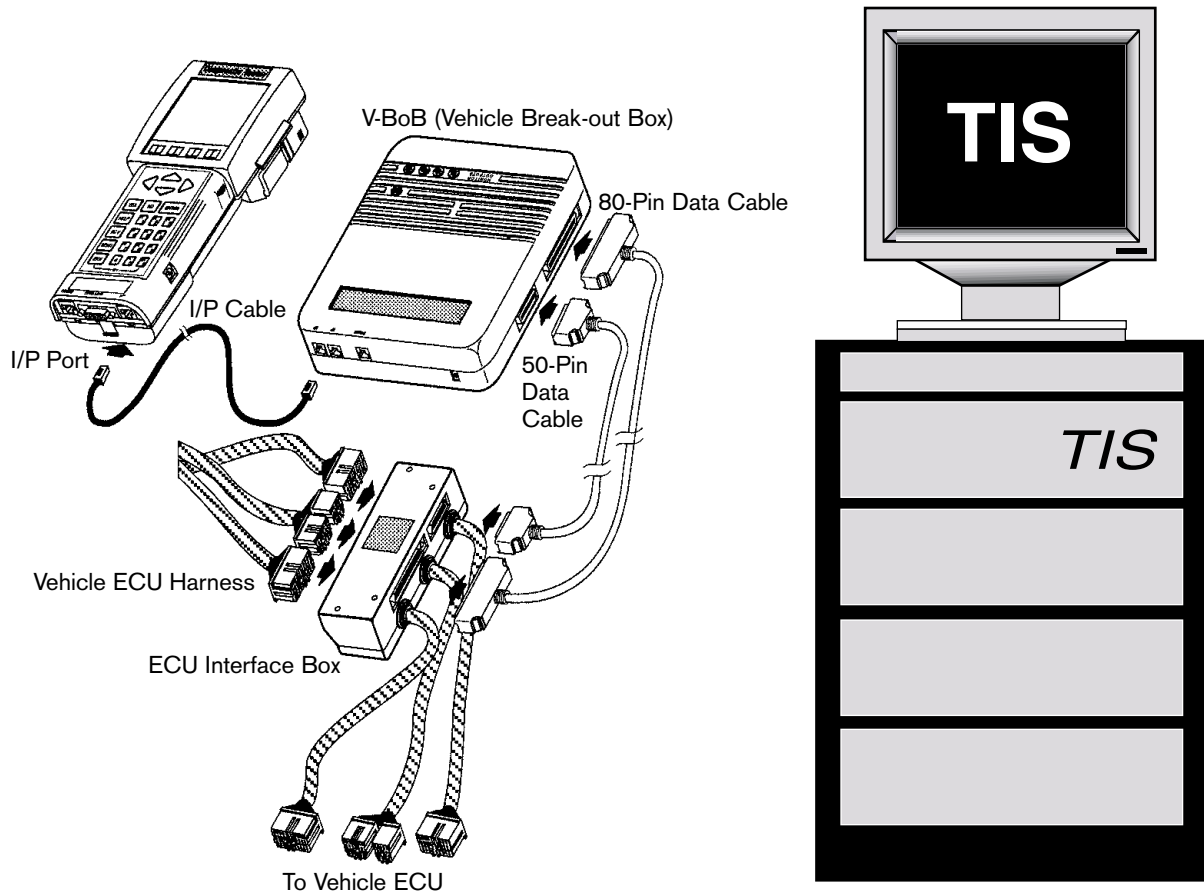


Fig. 1-1

TL874f101

**TechView** TechView is a computer-based program that works hand in hand with the Diagnostic Tester. This tool aids in collecting live data from the vehicle where the technician can view the data in a variety of formats (graphs, charts, lists) and store files for later viewing. Some of the TechView features include:

- Real Time Data List
- Tester Snapshot Data
- DTC Information
- OBD System Monitors
- Freeze Frame Data
- File Information

Each technician creates a user name where all of the vehicle information is stored and can be used again for future reference.

Before using the Diagnostic Tester, the Diagnostic Toolset Manual should be read thoroughly.

**General OBD II  
Scan Tool or  
Diagnostic  
(Hand-held)  
Tester  
Procedure**

If the Diagnostic Tester cannot communicate with ECU controlled systems when connected to DLC3, the ignition switch is ON, and the Diagnostic Tester is on, there is a problem on the vehicle side or tool side.

(1) If communication is normal when the Diagnostic Tester is connected to another vehicle, inspect the diagnosis data link line (Bus line) or ECM (ECU) power circuit of the vehicle.

(2) If communication is still not possible when the Diagnostic Tester is connected to another vehicle, the problem is probably in the Diagnostic Tester itself, so perform the Self Test procedures outline in the Diagnostic Toolset Operator's Manual.

## Customer Problem Analysis

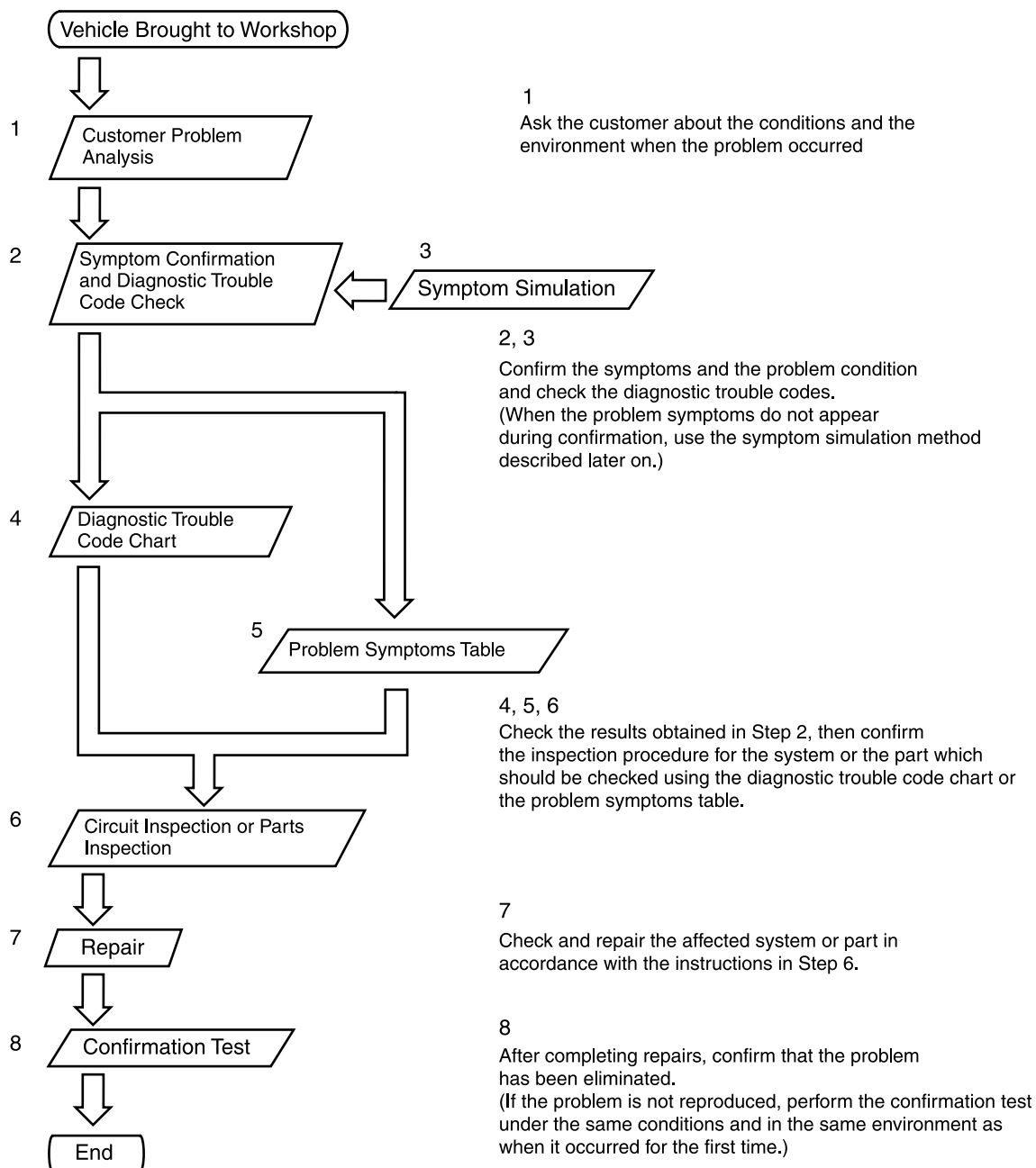


Fig. 1-2

TL874f102

**Customer Problem Analysis (1)** In troubleshooting, the problem symptoms must be confirmed accurately and all preconceptions must be cleared away to give an accurate judgment. To ascertain just what the problem symptoms are, it is extremely important to ask the customer about the problem and the conditions at the time it occurred.

**Important Point in the Problem Analysis** The following five items are important points in the problem analysis. Past problems which are thought to be unrelated and the repair history, etc., may also help in some cases, so as much information as possible should be gathered and its relationship with the problem symptoms should be correctly ascertained for reference in troubleshooting. A customer problem analysis table is provided in the Diagnostics section for each system for your use.

### The Five Major Questions

#### Important Points in the Customer Problem Analysis

- What?... Vehicle model, system name
- When?... Date, time, occurrence frequency
- Where?... Road conditions
- Under what conditions?... Running conditions, driving conditions, weather conditions
- How did it happen?... Problem symptoms

Fig. 1-3

TL874f103

### Customer Problem Analysis Check Sheet

CUSTOMER PROBLEM ANALYSIS CHECK			
ENGINE CONTROL SYSTEM Check Sheet		Inspector's Name _____	
Customer's Name	_____	Model and Model Year	_____
Driver's Name	_____	Frame No.	_____
Data Vehicle Brought in	_____	Engine Model	_____
License No.	_____	Odometer Reading	_____ km miles
Problem Symptoms	<input type="checkbox"/> Engine does not Start <input type="checkbox"/> Engine does not crank <input type="checkbox"/> No initial combustion <input type="checkbox"/> No complete combustion		
	<input type="checkbox"/> Difficult to Start <input type="checkbox"/> Engine cranks slowly <input type="checkbox"/> Other _____		
	<input type="checkbox"/> Poor Idling <input type="checkbox"/> Incorrect first idle <input type="checkbox"/> Idling rpm is abnormal <input type="checkbox"/> High (    rpm) <input type="checkbox"/> Low (    rpm)		
	<input type="checkbox"/> Poor Drive ability <input type="checkbox"/> Rough idling <input type="checkbox"/> Other _____		
	<input type="checkbox"/> Hesitation <input type="checkbox"/> Back fire <input type="checkbox"/> Muffler explosion (after-fire) <input type="checkbox"/> Surging		
	<input type="checkbox"/> Knocking <input type="checkbox"/> Other _____		
Engine Stall	<input type="checkbox"/> Soon after starting <input type="checkbox"/> After accelerator pedal depressed		
	<input type="checkbox"/> After accelerator pedal released <input type="checkbox"/> During A/C operation		
<input type="checkbox"/> Shifting from N to D <input type="checkbox"/> Other _____			
<input type="checkbox"/> Others _____			

\_\_\_\_\_ constant    ☐ Sometimes (    times per    day/month)

Fig. 1-4

TL874f104



**Symptom Confirmation and Diagnostic Trouble Code Check (2)** The diagnostic system fulfills various functions. The first function is the Diagnostic Trouble Code Check. A malfunction in the signal circuits to the ECM is stored in code in the ECM's memory at the time of occurrence. This DTC is retrieved by the technician during troubleshooting.

Another function is the Input Signal Check, which checks if the signals from various switches are sent to the ECM correctly. By using these check functions, the problem areas can be narrowed down quickly and troubleshooting can be performed effectively.

In diagnostic trouble code check, it is very important to determine if the problem indicated by the diagnostic trouble code is present or occurred in the past and returned to normal.

In addition, it must be checked in the problem symptom check whether the malfunction indicated by the diagnostic trouble code is directly related to the problem symptom or not. For these reasons, the diagnostic trouble codes should be checked before and after the symptom confirmation to determine the current conditions, as shown in the following figure.

If this is not done, it may, depending on the case, result in unnecessary troubleshooting for normally operating systems, thus making it more difficult to locate the problem, or in repairs not pertinent to the problem. Therefore, always follow the procedure in correct order and perform the diagnostic trouble code check.

### ***DTC Check Procedure***

#### **DIAGNOSTIC TROUBLE CODE CHECK PROCEDURE**



<b>Diagnostic Trouble Code Check (Make a note of and then clear)</b>	<b>Confirmation of Symptoms</b>	<b>Diagnostic Trouble Code Check</b>	<b>Problem Condition</b>
Diagnostic Trouble Code Display	Problem symptoms exist	Same diagnostic trouble code is displayed	Problem is still occurring in the diagnostic circuit
	  No problem symptoms exist	Normal code is displayed	The problem is still occurring in a place other than in the diagnostic circuit (The diagnostic trouble code displayed first is either for a past problem or it is a secondary problem)
			The problem occurred in the diagnostic circuit in the past
Normal Code Display	Problem symptoms exist	Normal code is displayed	The problem is still occurring in a place other than in the diagnostic circuit
	No problem symptoms exist	Normal code is displayed	The problem occurred in a place other than in the diagnostic circuit in the past

Fig. 1-5  
TL874f105

### **DTC Check Procedure**

Taking into account the points on the previous page, a flow chart showing how to proceed with troubleshooting using the diagnostic trouble code check is shown here. This flow chart shows how to utilize the diagnostic trouble code check effectively, then by carefully checking the results, indicates how to proceed either to diagnostic trouble code troubleshooting or to troubleshooting of problem symptoms table.

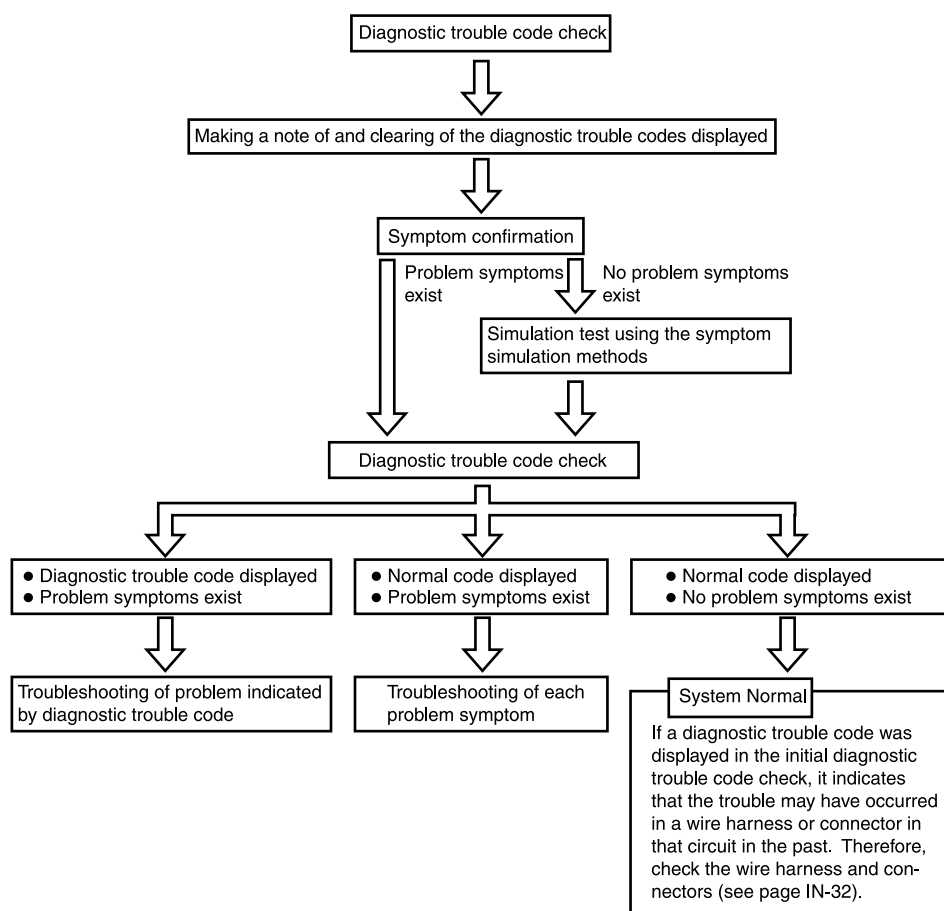


Fig. 1-6

TL8741106

**Symptom Simulation (3)** The most difficult cases to diagnose is when no problem symptoms are occurring. In such cases, a thorough customer problem analysis must be carried out, then simulate the same or similar conditions and environment in which the problem occurred in the customer's vehicle.

No matter how much experience or how skilled the technician is, to proceed to troubleshoot without confirming the problem symptoms will often result in wasted time and failure to resolve the customer concerns. For example, for a problem which only occurs when the engine is cold, the problem can never be determined so long as the symptoms are confirmed when the engine is hot.

Since vibration, heat or water penetration (moisture) are likely causes for problems that are difficult to reproduce, the symptom simulation tests introduced here are effective measures to apply to the vehicle.

#### Important Points in the Symptom Simulation Test:

In the symptom simulation test, the problem symptoms should of course be confirmed, but the problem area or parts must also be found out. To do this, narrow down the possible problem circuits according to the symptoms before starting this test and connect a tester beforehand. After that, carry out the symptom simulation test, judging whether the circuit being tested is defective or normal and also, confirming the problem symptoms at the same time.

Refer to the problem symptoms table for each system to narrow down the possible causes of the symptom.

#### ***Vibration Method***

*Do not do this until you have confirmed that the recorded DTC is not present.*

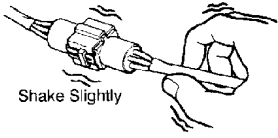
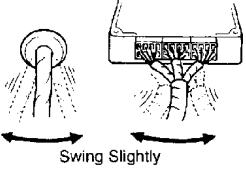
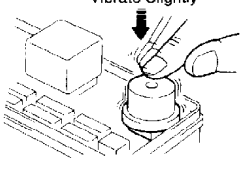
1	VIBRATION METHOD: When vibration seems to be the major cause.	
	<p><b>CONNECTORS</b> Slightly shake the connector vertically and horizontally.</p> <p><b>WIRE HARNESS</b> Slightly shake the wire harness vertically and horizontally. The connector joint, fulcrum of the vibration, and body through portion are the major areas to be checked thoroughly.</p>	 
	<p><b>PARTS AND SENSOR</b> Apply slight vibration with a finger to the part of the sensor considered to be the problem cause and check that the malfunction occurs. <b>HINT:</b> Applying strong vibration to relays may result in open relays.</p>	

Fig. 1-7  
TL874f107

### Other Methods for Simulating Conditions

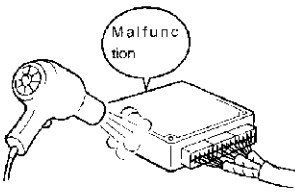

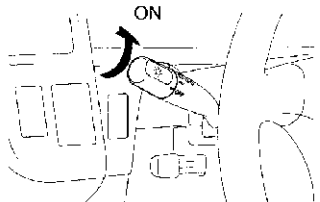
2	<b>HEAT METHOD:</b> When the problem seems to occur when the suspect area is heated.
Heat the component that is the likely cause of the malfunction with a hair dryer or similar object. Check to see if the malfunction occurs.  <b>NOTICE:</b> (1) Do not heat to more than 60 °C (140 °F). (Temperature is limited not to damage the components.) (2) Do not apply heat directly to parts in the ECU.	
 F12334	
3	<b>WATER SPRINKLING METHOD:</b> When the malfunction seems to occur on a rainy day or in a high-humidity condition.
Sprinkle water onto the vehicle and check to see if the malfunction occurs.  <b>NOTICE:</b> (1) Never sprinkle water directly into the engine compartment, but indirectly change the temperature and humidity by applying water spray onto the radiator front surface. (2) Never apply water directly onto the electronic components.  <b>HINT:</b> If a vehicle is subject to water leakage, the leaked water may contaminate the ECU. When testing a vehicle with a water leakage problem, special caution must be taken.	
 F16649	
4	<b>OTHER:</b> When a malfunction seems to occur when electrical load is excessive.
Turn on all electrical loads including the heater blower, head lights, rear window defogger, etc. and check to see if the malfunction occurs.	
 B02389	

Fig. 1-8

TL874108

**Diagnostic Troubleshooting Check (4)** The inspection procedure is shown in the following figure. This table permits efficient and accurate troubleshooting using the diagnostic trouble codes displayed in the diagnostic trouble code check. Proceed with troubleshooting in accordance with the inspection procedure given in the diagnostic chart corresponding to the diagnostic trouble codes displayed

### DTC Chart

• **DTC No.**  
Indicates the diagnostic trouble code.

• **Page or Instructions**  
Indicates the page where the inspection procedure for each circuit is to be found, or gives instructions for checking and repairs.

• **Trouble Area**  
Indicates the suspect area of the problem.

• **Detection Item**  
Indicates the system of the problem or contents of the problem.

**DTC CHART (SAE Controlled)**

**HINT:**  
Parameters listed in the chart may not be exactly the same as your reading due to the type of instrument or other factors.

If a malfunction code is displayed during the DTC check mode, check the circuit for that code listed in the table below. For details of each code, turn to the page referred to under the "See page" for the respective "DTC No." in the DTC chart.

DTC No. (See page)	Detection Item	Trouble Area	MIL*	Memory
P0100 (DI-24)	Mass Air Flow Circuit Malfunction	<ul style="list-style-type: none"> <li>• Open or short in mass air flow meter circuit</li> <li>• Mass air flow meter</li> <li>• ECM</li> </ul>	○	○
P0101 (DI-28)	Mass Air Flow Circuit Range/Performance Problem	<ul style="list-style-type: none"> <li>• Mass air flow meter</li> </ul>	○	○
P0110 (DI-29)	Intake Air Temp. Circuit Malfunction	<ul style="list-style-type: none"> <li>• Open or short in intake air temp. sensor circuit</li> <li>• Intake air temp. sensor</li> <li>• ECM</li> </ul>	○	○
P0115 (DI-33)	Engine Coolant Temp. Circuit Malfunction	<ul style="list-style-type: none"> <li>• Open or short in engine coolant temp. sensor circuit</li> <li>• Engine coolant temp. sensor</li> <li>• ECM</li> </ul>	○	○
P0116 (DI-37)	Engine Coolant Temp. Circuit Range/Performance Problem	<ul style="list-style-type: none"> <li>• Engine coolant temp. sensor</li> <li>• Cooling system</li> </ul>	○	○
	Throttle Position Sensor/Switch Malfunction	<ul style="list-style-type: none"> <li>• Open or short in throttle position sensor circuit</li> <li>• Throttle position sensor</li> <li>• ECM</li> </ul>		
	Throttle Position Sensor/Switch Range/Performance Problem	<ul style="list-style-type: none"> <li>• Throttle position sensor</li> </ul>		

Fig. 1-9

TL874/109

**Problem Symptoms Table (5)** The suspected circuits or parts for each problem symptom are shown in the table below. Use this table to troubleshoot the problem when a “Normal” code is displayed in the diagnostic trouble code check but the problem is still occurring. Numbers in the table indicate the inspection order in which the circuits or parts should be checked.

When the problem is not detected by the diagnostic system even though the problem symptom is present, it is considered that the problem is occurring outside the detection range of the diagnostic system, or that the problem is occurring in a system other than the diagnostic system.

**Problem Symptoms Table**

• **Page**  
Indicates the page where the flow chart for each circuit is located.

• **Circuit Inspection, Inspection Order**  
Indicates the circuit which needs to be checked for each problem symptom. Check in the order indicated by the numbers.

• **Problem Symptom**

• **Circuit or Part Name**  
Indicates the circuit or part which needs to be checked.

Symptom	Suspect Area	See page
Engine does not crank (Does not start)	1. Starter and starter relay	ST-2 ST-17
No initial combustion (Does not start)	1. ECM power source circuit 2. Fuel pump control circuit 3. Engine control module (ECM)	DI-147 DI-151 IN-29
No complete combustion (Does not start)	1. Fuel pump control circuit	DI-151
Engine cranks normally (Difficult to start)	1. Starter signal circuit 2. Fuel pump control circuit 3. Compression	DI-144 DI-151 EM-3
Cold engine (Difficult to start)	1. Starter signal circuit 2. Fuel pump control circuit	DI-144 DI-151
Hot engine	1. Starter signal circuit 2. Fuel pump control circuit	DI-144 DI-151
Idle speed (Poor idling)	1. A/C signal circuit (Compressor circuit) 2. ECM power source circuit	AC-88
Idle speed (High idling)	1. A/C signal circuit 2. Fuel pump control circuit	
Idle speed (Low idling)	1. Compression 2. Fuel pump control circuit	

Fig. 1-10

TL874110

**Circuit Inspection (6)** How to read and use each page is shown in the following figures. This chart provides the procedure to diagnose a circuit or system. Often, you will use the Diagnostic Tester, DVOM, or oscilloscope to diagnose faults in a circuit.

### Circuit Inspection

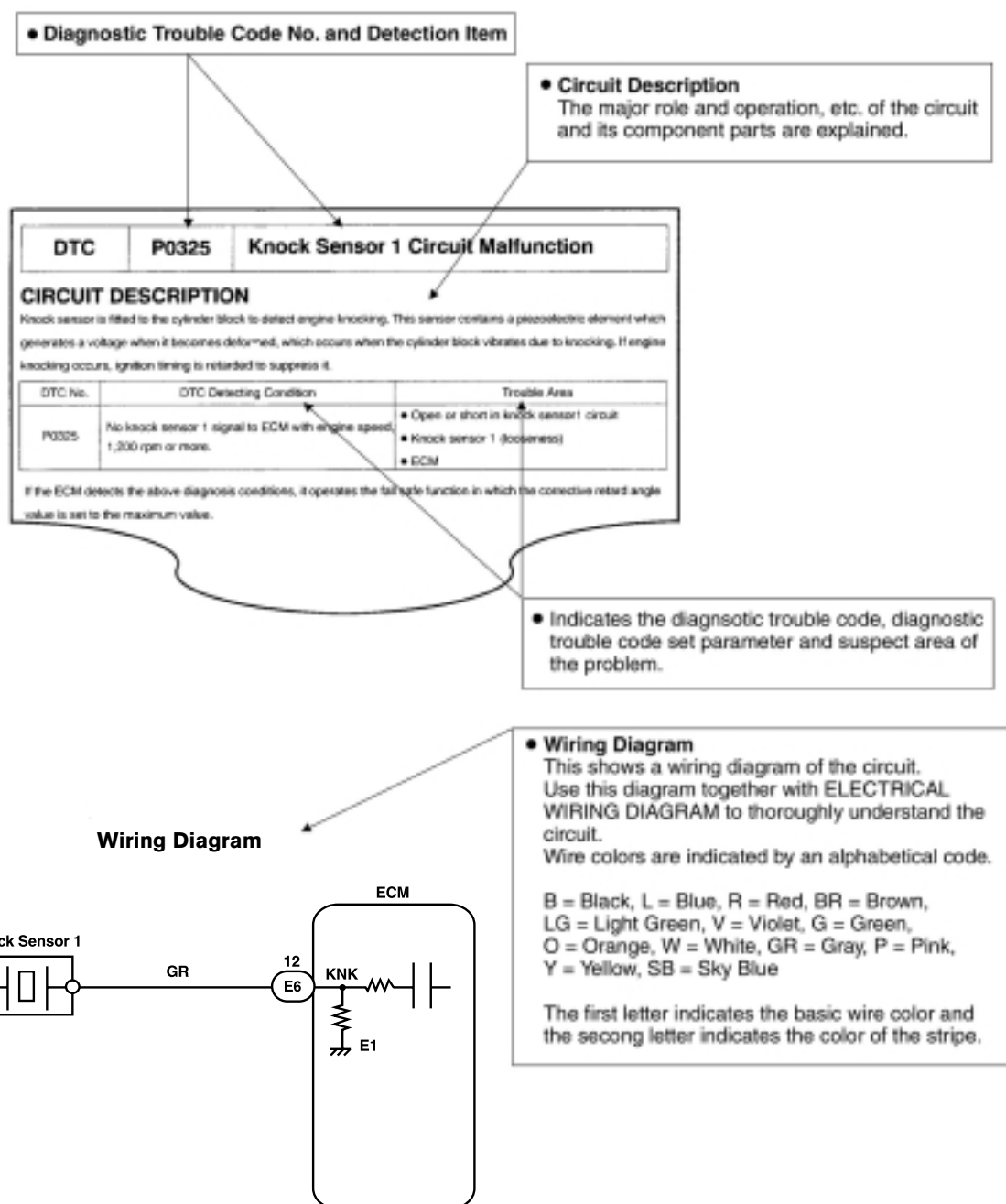


Fig. 1-11

TL874f111

## Inspection Procedure

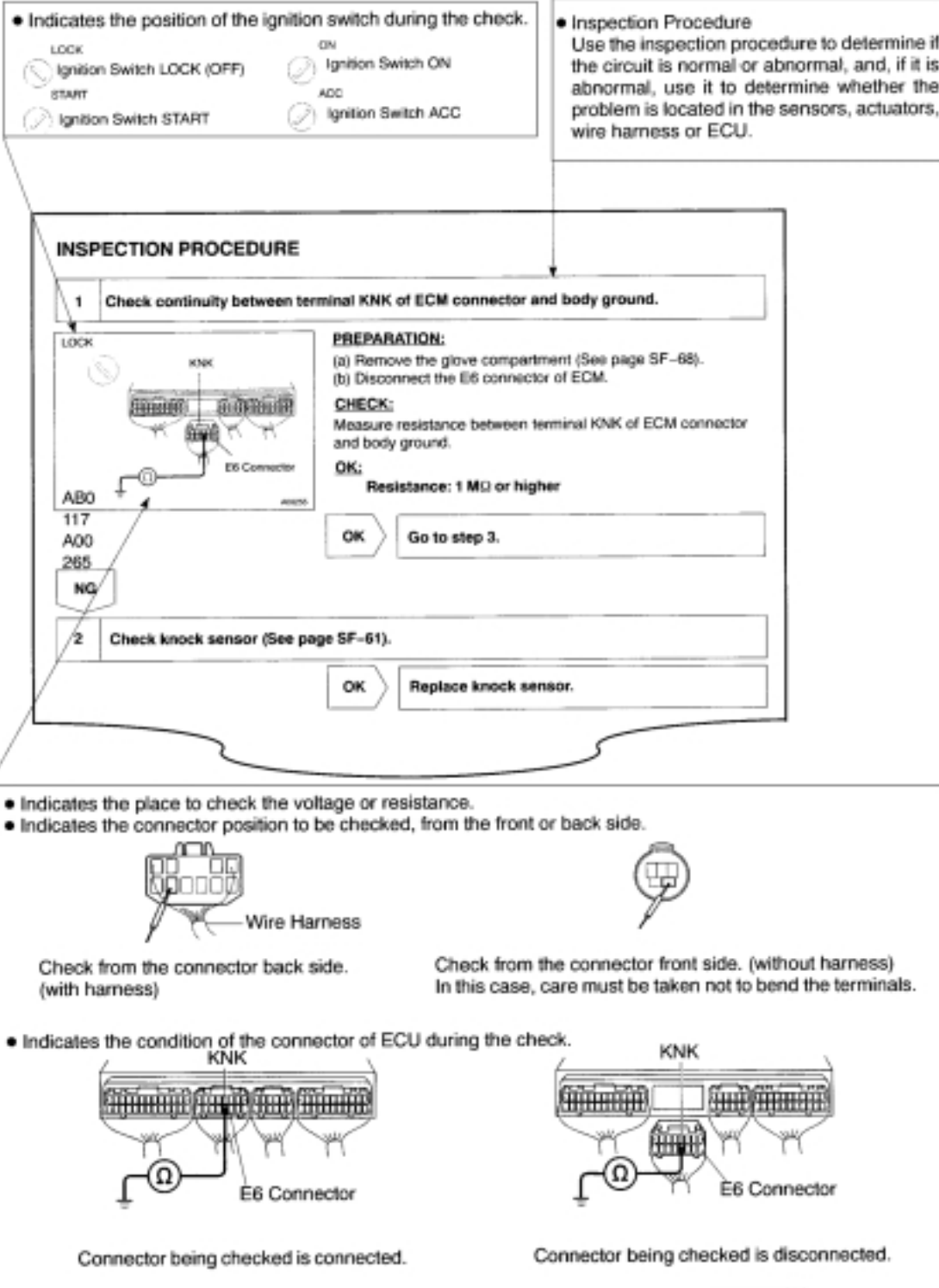


Fig. 1-12

TL874112



**Repair the Problem (7)** In electrical/electronic diagnostics, you will frequently encounter situations where diagnosis consumes 90% of the actual repair time. By using this procedure to narrow down the number of tests you perform, you can reduce diagnostic time.

After successfully locating the faulty circuit and pinpointing the fault, repair is a relatively simple matter. It is important, however, to ensure customer satisfaction after the repair by performing one last step before releasing the vehicle.

On occasion, you will have to diagnose and repair vehicles with compound problems. To ensure that the vehicle is operating normally, and that the original symptom has been remedied, a quick quality control check of the vehicle is performed. This is accomplished during the Repair Confirmation step.

**Repair Confirmation (8)** This is always the final step in diagnosis. Regardless of how you arrived at this step, there are always several items you want to confirm before releasing the vehicle to your customer. The items you will be looking for during this quality control quick check are:

- Satisfactory driveability under the problem conditions stated by the customer
- Repair Confirmation (Readiness Tests) where indicated completed
- All DTC(s) eliminated from ECM keep alive memory

These last two items can be confirmed using the Diagnostic Tester. Once confirmed, the vehicle can be returned to the customer. You can be confident that by following these procedures, in the order given, that you will repair the vehicle with a high rate of success in the shortest possible time.

**Problems Which Cannot Be Duplicated** You cannot attempt to fix a problem that does not exist. Therefore, in cases where the problem cannot be duplicated, better communication with the owner, or outside assistance, may offer a solution.

Owner Perception: Sometimes an owner perceives a “normal” operating condition to be a problem. The best way to identify these cases is to accompany the owner on a “road test.” Let the customer drive and point out the problem condition during the road test.



## **WORKSHEET 1–1**

### **General Diagnostic Tester Procedure**

Vehicle	Year/Prod. Date	Engine	Transmission
---------	-----------------	--------	--------------

### **Worksheet Objectives**

When troubleshooting using the Diagnostic Tester, there are general procedures that will aid in troubleshooting the vehicle. This worksheet will familiarize you with those procedures.

### **Section 1:**

1. The primary purpose of the Customer Problem Analysis Check sheet is:

2. The DTC Check procedure is used to confirm if the problem is present or can be duplicated. What are three possible outcomes from this procedure?

3. What are the four methods for simulating conditions?

4. When is the Problem Symptoms Table used?

5. Name four items of information found in the Circuit Inspection.

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6. Name three items that are checked during the Repair Confirmation.

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## **WORKSHEET 1-2**

### **Diagnostic Tester**

Vehicle	Year/Prod. Date	Engine	Transmission
---------	-----------------	--------	--------------

### **Worksheet Objectives**

Display data using a variety of Diagnostic Tester modes that will aid in troubleshooting and interpreting the results.

### **Tools and Equipment**

- Vehicle
- Repair Manual, EWD, & NCF
- Diagnostic Tester & Manual
- Diagnostic Tester Printer
- Hand Tools, Fender Covers, Floor Mats, and Shop Towels

### **Section 1: Setup**

1. On a vehicle selected by the instructor, warm up the vehicle and connect the Diagnostic Tester to the vehicle. Refer to the Diagnostic Tester Manual for specific setup instructions if needed.

### **Section 2: Data List**

1. Select DATA LIST mode under ENHANCED OBD II.
2. Compare All DATA List to the EXTENDED DATA List. What is the major difference between these lists?

---

### **Section 3: LED/LIST Mode**

1. Select LED/LIST mode
  2. Observe DATA LIST. When would you use this mode?
- 
3. Reorder LED/LIST parameters according to instructor's directions.

### Section 4: Bar Graph Mode

1. Select BAR GRAPH mode
2. Observe Data List. When would you use this mode?  
  
\_\_\_\_\_
3. Reorder LED/LIST parameters according to instructor's directions.

### Section 5: STRIP CHART Mode

1. Select STRIP CHART mode. Select and list 5 parameters as identified by the instructor.

_____	_____
_____	_____
_____	_____

2. Observe Data List. When would you use this mode?

\_\_\_\_\_

### Section 6: CUSTOM DATA Mode

1. Select CUSTOM DATA mode. Select and list below the 6 parameters as identified by the instructor.

_____	_____
_____	_____
_____	_____

2. Observe Data List. When would you use this mode?

\_\_\_\_\_

## Section 7: SNAPSHOT Mode

1. Select SNAPSHOT mode. Select and list below the 6 parameters as identified by the instructor.

_____	_____
_____	_____
_____	_____

2. Prepare to create a fault as identified by your instructor. You will create the fault during a snapshot capture. Write below the type of fault, any terminal pin numbers used, and the intended DTC.

_____
_____
_____

3. Create a snapshot with the fault recorded. Replay the captured snapshot and repeat if the fault was not recorded. Remove the fault when done and return vehicle to original condition.

4. What DTC(s) were recorded?

_____
-------

5. Clear DTC(s)

6. When would you use SNAPSHOT mode?

_____
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7. Switch to another team's SNAPSHOT file and diagnose the cause. What was the fault?

Vehicle: _____	Fault: _____
----------------	--------------

Vehicle: _____	Fault: _____
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Vehicle: _____	Fault: _____
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**Notes**

# Diagnostic Tester

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Review this sheet as you are doing the worksheet. Check each category after completing the worksheet and instructor presentation. Ask the instructor if you have questions. The comments section is for you to write where to find the information, questions, etc.

*I have questions*

*I know I can*

**Topic**

**Comment**

Open Data List in CARB and ENHANCED OBD			
View data in LIST/LED format and describe the advantage of this mode			
View data in Strip Chart mode and describe the advantage of this mode			
Save and view a SnapShot and describe the advantage of this mode			
Interpret vehicle condition based on Data Lists			
Retrieve DTC(s), Freeze Frame and CARB Readiness data			





**Notes**



## **WORKSHEET 1-3**

### **TechView Operation**

Vehicle	Year/Prod. Date	Engine	Transmission

### **Worksheet Objectives**

In this worksheet, you will diagnose a vehicle by viewing the vehicle's Real Time Data. You will then practice saving and opening files.

### **Tools and Equipment**

- Diagnostic Tester
- TIS with Tech View
- Hand Tool Set

**NOTE: Follow the instructions and steps in the TechView Guide before proceeding.**

### **Section 1: Problem Solving using TechView**

1. Under the direction of the instructor, create a problem with the vehicle.
2. Save the DATA LIST only. Make sure the problem can be seen from the DATA LIST. Clear DTC(s) from the vehicle.
3. You will rotate through the other workstations. Write down the vehicle and the cause of the problem.

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# TechView Operation

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Review this sheet as you are doing the worksheet. Check each category after completing the worksheet and instructor presentation. Ask the instructor if you have questions. The comments section is for you to write where to find the information, questions, etc.

*I have questions*

*I know I can*

**Topic**

**Comment**

Open a new file			
Save a file			
Open and resave an existing file			
Display data in all TechView formats and describe the advantage of each mode			
Save Data Lists in TechView			
Retrieve DTC(s), Freeze Frame and CARB Readiness data			
Retrieve SnapShot data			
Interpret data from TechView to diagnose the root cause of a problem			