Section 2

NVH DIAGNOSTIC PROCEDURES

Introduction

An organized, systematic procedure is important in any type of diagnosis.

It is the most efficient/cost effective way to resolve complaints the first time. NVH complaints are sensed by feeling or hearing and are therefore, very subjective in nature.

A good **systematic diagnostic procedure** is critical to deal with these types of complaints because the symptoms may not clearly point to the condition. Systematic diagnostic procedures will help you successfully resolve NVH conditions as they do with difficult computer and electrical problems.

Elements incorporated in a systematic diagnostic procedure are:

- An organized **process of elimination** which prioritizes activities to quickly isolate the condition
- A thorough **visual inspection** for obvious conditions or clues to help diagnose the condition

NOTE

In order to apply these elements to NVH troubleshooting, a solid understanding of the NVH theory in Section 1 is important. Diagnosis applies the theory to isolate the condition. An incorrect diagnosis usually results from a poor diagnostic procedure, a lack of understanding on how the system works or both.

This section of the course will address in detail the first three items of the NVH diagnostic procedure:

- Verify the complaint
- Classify the complaint
- Road test with NVH analyzer

Practice implementing the NVH diagnostic procedure will be accomplished by following **two customer complaint scenarios or case studies**.

- The first scenario is incorporated in this section of the technician handbook.
- The second is part of the worksheet activities.

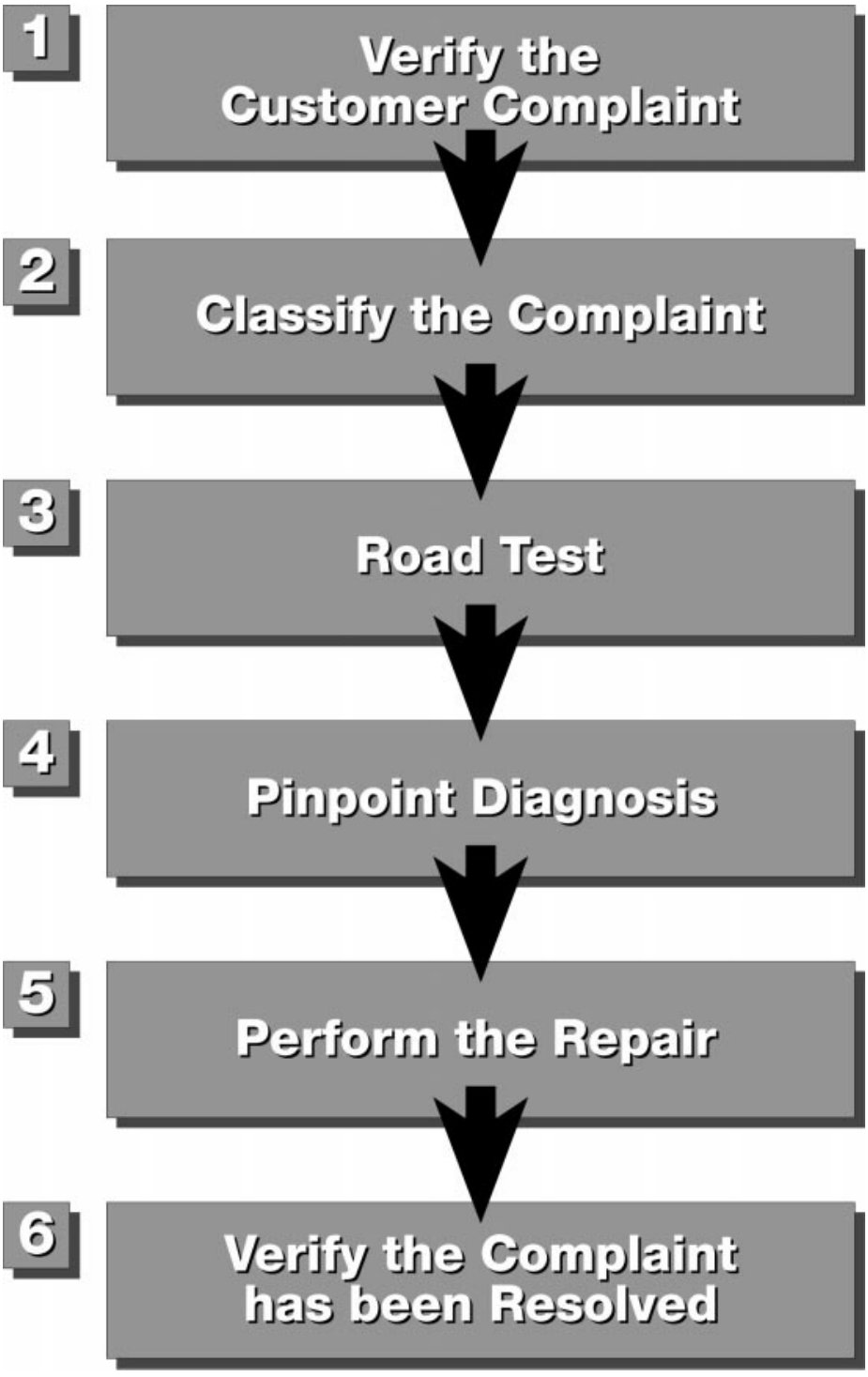


Fig. 2-1

Case Study: Background

In order to help illustrate the concept of NVH diagnosis we will apply the principles outlined above to a customer complaint involving a 4Runner. Each topic in this section will be applied to the scenario and at the end of the section the condition will be resolved.

The details of the diagnostic scenario are contained in the following repair order. They are also included in each procedure and illustration as it applies.

Repair Order for 4Runner

Fig. 2-2

TOYOTA MOTOR SALES U.S.A.
VEHICLE SERVICE CENTER
19001 S. WESTERN AVENUE
TORRANCE, CALIFORNIA 90509

SERVICE WORK ORDER

PAGE 1 OF 1 ANYBODY , JOHN DATE 7/26/93 TIME 14:35 RO# 1018938

*** SERVICE HISTORY ***

???	DATE	MILES	PRIME ITEM	MENU ITEMS
???	04/28/93	022549		

MENU/OP PRIME ITEM

INSTRUCTIONS/NOTES
VIBRATIONS AND NOISE BETWEEN
40-60MPH FROM STEERING WHEEL
AND SEAT
-
NOISE COMES FROM REAR
-
CUST STATES IT NEEDS ALIGNMENT

CONDITION 01 - CUSTOMER PAY

QTS.OIL
LBS.GREASE
GAL. GAS
QTS. TRANS.
ESTIMATE $
ADDITIONAL $
TOTAL $

SERVICE ADV. 500
SAVE PARTS (Y)
PHONE READY (Y)
PROM. TIME PM
DATE 7/26/93
TIME PM
AUTH. DATE
OK'D

SA: 5110 8952000- ALL LEASE VEH

DISCLAIMER OF WARRANTIES

TERMS
CASH
CREDIT CARD
CHARGE

I hereby authorize the repair hereinafter set forth to be done along with the necessary material and agree that you are not responsible for loss or damage to vehicle or articles left in vehicle in case of fire, theft or any other cause beyond your control or for any delays caused by unavailability of parts or delays in parts shipments by the supplier or transporter. I hereby grant you and/or your employees permission to operate the vehicle herein described on streets, highways or elsewhere for the purpose of testing and/or inspection. An express mechanic's lien is hereby acknowledged on above vehicle to secure the amount of repairs thereto.

NOTICE TO CONSUMER: PLEASE READ IMPORTANT INFORMATION ON REVERSE SIDE

CUSTOMER SIGNATURE X

VIN J T 3 V N 3 9 W 9 P 0 0 9 5 2 1 9
YEAR 93 MAKE TOYOTA COLOR DARK GREEN MODEL 4 RUNNER
MILES LICENSE PROD. DOFU
NAME JOHN ANYBODY
ADDRESS 19001 S WESTERN AVENUE
CITY TORRANCE STATE CA ZIP CODE 90009
HOME PHONE (310) 555-1111 BUS PHONE (310) 777-2222 357 EXT.

Case Study: Background
Continued

*Each area of this section includes a worksheet which is **based on a customer complaint scenario**. Your instructor has created a similar problem in a shop vehicle for you to troubleshoot.*

*Detailed information and instructions for the worksheets will be provided by your instructor. Upon **completion** of each worksheet, the complaint should be **resolved** on the shop vehicles.*

Verify the Customer Complaint

Verification of the customer complaint is a **key starting point** in an NVH diagnostic procedure for two reasons:

- If the complaint can't be verified, a plan can be implemented that involves satisfying the customer through education or returning the vehicle for service when the complaint can be duplicated.
- It is important that the technician experiences **exactly** what the customer is complaining about and knows what is involved to satisfy the customer.

There are **three courses of action** to successfully resolve an NVH complaint:

1. Customer consultation
2. Technician diagnosis and repair
3. Technical assistance for non-serviceable conditions

Starting a diagnostic procedure **implies** that there is a problem with the vehicle. The service department is then **committed to the second or third course of action**. If it is discovered **after the diagnosis begins** that the complaint was not verified, then it is difficult to step back to the first course of action and customer satisfaction is very difficult.

The **earlier** the appropriate course of action is chosen the more likely a **positive service experience** will occur.

Notes

Customer Interview Sheet

The **Interview sheet** is a **tool** designed to solve one of the largest problems identified in NVH service, poor **communication**. Proper communication helps you educate the customer and ensures an appropriate course of action can be taken.

Research involving unresolved NVH complaints indicates that technicians often start a diagnosis without knowing the **exact details** of the complaint. This results from a lack of communication with the customer which wastes time or causes a missed diagnosis.

Good communication skills include:

- **Description or terminology** that mean the same thing to all parties involved.
- **Time** to help the customer **clarify the complaint**. (The customer is not expected to know the technical terms of the automotive industry).
- **Information** collected in an **organized manner**.

A customer, when properly interviewed, can provide a wealth of information to start the diagnosis and process of elimination.

It is important to determine if the person bringing the vehicle in for service is the **primary operator** of the vehicle. Often, vehicles are brought in for service by someone who has no knowledge of the complaint.

The **interview process** is designed to help the customer focus on details of the NVH complaint and vehicle conditions when the complaint occurs.

The **interview sheet** provides a format to communicate these conditions using **standard NVH terminology**.

Verification of the complaint is also a critical area of diagnosis, when the condition is **intermittent or only occurs under specific conditions**.

For example:

> Noises from suspension components may be much more pronounced at ambient temperatures below 40°F. If these temperature conditions are not present at the time of diagnosis, the technician may not experience the complaint to the same degree as the customer.

The technician needs to **experience the condition** and be able to duplicate it in order to accurately diagnose it. The more details that are available, the more likely the condition can be found quickly.

An additional benefit of the interview sheet is the documentation of the communication with the customer. It provides **a history of the service experience**. In the event the complaint can't be verified, this documentation will provide valuable information in the event of subsequent service visit.

Customer Interview Sheet
Continued

The customer interview sheet is designed to be as **short and concise** as possible. The information collected is divided into the following areas.

- Customer data
- Vehicle data
- NVH data

Interview Sheet for 4Runner

Fig. 2-3

CUSTOMER INTERVIEW SHEET

INSTRUCTIONS
The interview should be conducted and the sheet filled out by personnel trained in NVH diagnosis.
Please fill in or check all areas with the appropriate response, enter N/A if it does not apply.
The details collected during the interview are critical in successfully resolving the concern.

CUSTOMER DATA

Name: Anybody, John Date: 7/26/94
Telephone #: (310) 555-1001 RO #: 22467

VEHICLE DATA

Model/Year: LS400 Mileage: 25318
VIN #: JT8UF11E0P0149811
Is the customer the primary operator of the vehicle? ✔ Yes ○ No

NVH DATA

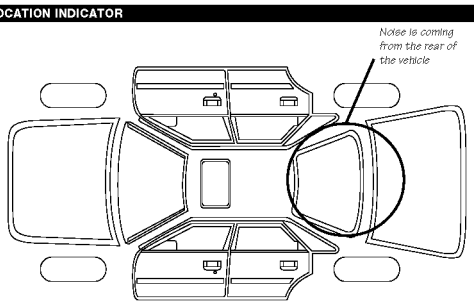
What type of condition is the customer experiencing? ✔ Noise ✔ Vibration ○ Harshness (ride quality)
Is the condition constant? ✔ Constant ○ Intermittent
When did it start? ✔ While in Service ○ Since New ✔ Gradually ○ Suddenly
○ Other

NOISE
Describe the Noise: ○ Squeak ○ Rattle ○ Wind Noise ✔ Other
When does the noise seem to be the loudest or most frequent?
At Highway Speed
Note here and mark the location of the noise on the illustration (reverse side of this form).
From the rear

VIBRATION
Where is it felt:
✔ Steering Wheel ○ Floor ○ Seat ○ Instrument Panel
○ Brake Pedal ○ Console ○ Accelerator Pedal
○ Shifter ○ Body ○ Mirrors ○ Clutch Pedal
Describe the vibration:
○ Vertical ○ Horizontal ✔ Rotational
○ Other:

HARSHNESS (Ride Quality)
Where do you experience it? N/A
When do you experience it? N/A
Has the vehicle ever been damaged? ○ Yes ✔ No If so, please indicate where on the illustration.
Is there any relevent service history? ○ Yes ✔ No If so, please describe:
Has there been any accessory installation ? ○ Yes ✔ No
Is the vehicle used for towing or to carry any cargo or equipment? ○ Yes ✔ No

LOCATION INDICATOR



OPERATING CONDITION

When does the condition occur? ○ Starting ○ Idling ✔ Cruise ✔ Coasting ○ Other
Vehicle Speed (MPH): 40-60 mph Engine Speed (RPM): N/A
○ Cornering Left ○ Cornering Right ○ Acceleration ○ Deceleration
○ Braking ○ Clutch Engagement ○ Other N/A
Accessories: ○ HVAC ○ 4WD ○ Audio ○ Other N/A
Engine Temperature: ○ Cold ✔ Normal ○ Hot
Road Conditions: ○ Highway ○ Suburb ○ City
Road Surface: ○ Asphalt ○ Dirt/Off Road ○ Concrete with Expansion Joints
○ Undulating ○ Other Irregularities
Explain: N/A

WEATHER CONDITIONS

Temperature: N/A °F ○ Clear ○ Rain ○ Ice/Snow ○ Wind
○ Other

ADDITIONAL INFORMATION

Customer Interview Sheet
Continued

Customer and vehicle data are for obvious logistical and administrative purposes. The value of this data becomes clear if future tracking of the customer, the vehicle or an NVH condition is required.

Customer and Vehicle Data

Fig. 2-4

CUSTOMER INTERVIEW SHEET TOYOTA

INSTRUCTIONS

The interview should be conducted and the sheet filled out by personnel trained in NVH diagnosis.
Please fill in or check all areas with the appropriate response, enter N/A if it does not apply.
The details collected during the interview are critical in successfully resolving the concern.

CUSTOMER DATA

Name: Anybody, John Date: 7/26/94

Telephone #: (310) 555-1001 RO #: 22467

VEHICLE DATA

Model/Year: LS400 Mileage: 25318

VIN #: JT8UF11E0P0149811

Is the customer the primary operator of the vehicle? ✔ Yes ○ No

The **NVH data** is organized to provide the **details of the complaint** and data on **conditions present** when the complaint occurs.

Communication is the key objective of the interview sheet and should be done by **trained service personnel** to provide assistance and clarification. Technician involvement in the interview may be required to allow **direct communication** and minimize problems created by passing information through a third person.

Begin the interview by asking the customer to **classify the concern** by selecting one or more of the following:

- Noise
- Vibration
- Harshness

The next question determines whether the condition is **constant or intermittent**.

The customer should also be asked if the complaint has developed while operating the vehicle or whether it has been present since the vehicle was new. This information will be useful to the technician in determining which **course of action** to select, either technician diagnosis or technical assistance.

Customer Interview Sheet
Continued

The customer is provided with a list of possible locations with a few details specific to each location.

For example:

If the steering wheel is the location then there are three possible types of steering wheel vibrations:

- Vertical
- Horizontal
- Rotational

Using this information, in conjunction with the **classification flow chart** (discussed later), will considerably reduce the large list of possible causes of the condition.

NVH Data

Fig. 2-5

NVH DATA

What type of condition is the customer experiencing? ✔ Noise ✔ Vibration ❍ Harshness (ride quality)
Is the condition constant? ✔ Constant ❍ Intermittent
When did it start? ✔ While in Service ❍ Since New ✔ Gradually ❍ Suddenly
❍ Other _____

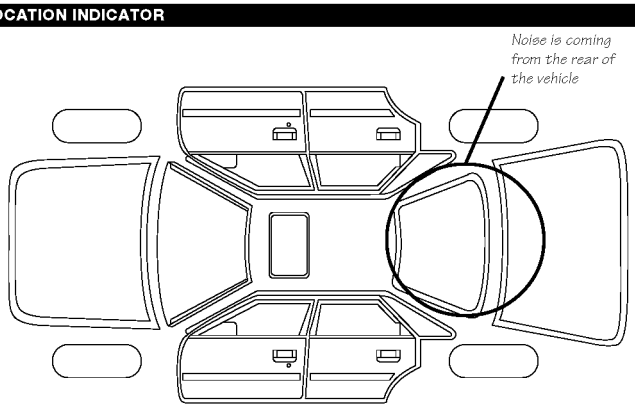
NOISE Describe the Noise: ❍ Squeak ❍ Rattle ❍ Wind Noise ✔ Other _____
When does the noise seem to be the loudest or most frequent?
At Highway Speed
Note here and mark the location of the noise on the illustration (reverse side of this form).
From the rear

VIBRATION
Where is it felt:
✔ Steering Wheel ❍ Floor ❍ Seat ❍ Instrument Panel
❍ Brake Pedal ❍ Console ❍ Accelerator Pedal
❍ Shifter ❍ Body ❍ Mirrors ❍ Clutch Pedal
Describe the vibration:
❍ Vertical ❍ Horizontal ✔ Rotational
❍ Other: _____

HARSHNESS (Ride Quality)
Where do you experience it? *N/A*
When do you experience it? *N/A*

Has the vehicle ever been damaged? ❍ Yes ✔ No If so, please indicate where on the illustration.
Is there any relevent service history? ❍ Yes ✔ No If so, please describe: _____
Has there been any accessory installation ? ❍ Yes ✔ No _____
Is the vehicle used for towing or to carry any cargo or equipment? ❍ Yes ✔ No _____

LOCATION INDICATOR



Customer Interview Sheet
Continued

The **conditions section** of the interview sheet is designed to collect data for the following subjects:

- Operating conditions
- Vehicle conditions
- Road conditions
- Weather conditions

Each of these areas have specific conditions to select, which will provide the technician with the details necessary to **duplicate the complaint**.

Each area has space provided to record information on unique complaints or conditions that fall outside the parameters outlined in the interview sheet.

The interviewer should cover **all areas** that apply to the complaint. **N/A** should be entered in areas that do **not** apply, indicating to the technician that the customer considered the subject and did not over look it.

The customers should be aware of the **key role they play in resolving the complaint**.

Vehicle and Operating Conditions

Fig. 2-6

OPERATING CONDITION

When does the condition occur? ❍ Starting ❍ Idling ✔Cruise ✔Coasting ❍ Other _____

Vehicle Speed (MPH): 40-60 mph Engine Speed (RPM): N/A

❍ Cornering Left ❍ Cornering Right ❍ Acceleration ❍ Deceleration

❍ Braking ❍ Clutch Engagement ❍ Other N/A

Accessories: ❍ HVAC ❍ 4WD ❍ Audio ❍ Other N/A

Engine Temperature: ❍ Cold ✔Normal ❍ Hot

Road Conditions: ❍ Highway ❍ Suburb ❍ City

Road Surface: ❍ Asphalt ❍ Dirt/Off Road ❍ Concrete with Expansion Joints

❍ Undulating ❍ Other Irregularities

Explain: N/A

WEATHER CONDITIONS

Temperature: N/A °F ❍ Clear ❍ Rain ❍ Ice/Snow ❍ Wind

❍ Other _____

ADDITIONAL INFORMATION

_____

_____

_____

_____

Summary

At this point in the diagnosis the technician has:

- A completed repair order
- A completed interview sheet
- Verified the complaint
- Chosen one of three course of actions

The technician can now proceed with a plan for customer consultation or NVH diagnosis equipped with a **strong background** of the complaint.

Case study: Part I

In the 4Runner scenario the customer has filled in the customer and vehicle data sections. This has to be reviewed to make sure that it is completely filled out.

*The customer has indicated to the interviewer that he is the **primary driver** and has experienced the complaint.*

The NVH data indicates the following areas have been selected during the interview:

Classify

- *Noise other than squeak, rattle or wind noise*
- *Vibration*

*They are both **constant and started gradually**. The vibration is felt in the **steering wheel** and is **rotational**. The sound is heard in the **rear of the vehicle**.*

Operating conditions

- *40 - 60 MPH*
- *Cruise*
- *Coasting*

*It is also important to note that the following data has **not** been selected:*

- *Since new*
- *Vehicle condition section*
- *Road condition section*
- *Engine RPM*
- *Weather condition section*

*The fact that these areas were marked **N/A** indicates that the condition has developed **while in service**, **engine speed does not** effect it and that **it is always there** once the vehicle speed range is reached.*

*For the purposes of this scenario the technician has gone for a short ride with the customer and **has verified** that the complaint **does exist** as described.*

*The technician has also chosen the **second option, technician diagnosis and repair**, based on the information and verification available. The technician agrees that an unacceptable condition does*

exist. The customer has indicated that the vehicle has recently developed the condition.

Notes

WORKSHEET #1
Verification of the Customer complaint

Vehicle	Year/Prod. Date	Engine	Transmission

Diagnostic Description: Verify the Complaint

It is critical for the technician to **experience** the complaint for it to be successfully resolved. The Customer Interview Sheet is a **tool**, used by trained NVH service personnel, to collect the details associated with the customer complaint. With the information from the interview the technician can easily **duplicate** the symptom and gain valuable insight for diagnosis.

Your instructor has created **typical NVH conditions** in the shop vehicles. The completion of worksheets 1, 2, 4A and 4B will provide **practice** using the **NVH diagnostic procedures** and **resolve** the conditions on these vehicles. Worksheets 3A, 3B and 3C will provide **experience** using the **NVH Analyzer**.

NOTE Your instructor will also act as the customer providing the information necessary to complete the first step, the customer interview (Copy Attached).

Customer Interview Sheet

Fig. 2-7

CUSTOMER INTERVIEW SHEET TOYOTA

INSTRUCTIONS
The interview should be conducted and the sheet filled out by personnel trained in NVH diagnosis.
Please fill in or check all areas with the appropriate response, enter N/A if it does not apply.
The details collected during the interview are critical in successfully resolving the concern.

CUSTOMER DATA
Name: _____ Date: _____
Telephone #: _____ RO #: _____

VEHICLE DATA
Model/Year: _____ Mileage: _____
VIN #: _____
Is the customer the primary operator of the vehicle? ○ Yes ○ No

NVH DATA
What type of condition is the customer experiencing? ○ Noise ○ Vibration ○ Harshness (ride quality)
Is the condition constant? ○ Constant ○ Intermittent
When did it start? ○ While in Service ○ Since New ○ Gradually ○ Suddenly
○ Other _____

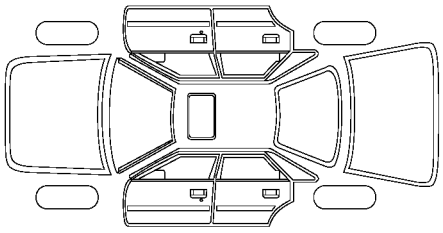
NOISE Describe the Noise: ○ Squeak ○ Rattle ○ Wind Noise
When does the noise seem to be the loudest or most frequent? _____
Mark the location of the noise on the illustration (reverse side of this form).

VIBRATION
Where is it felt:
○ Steering Wheel ○ Floor ○ Seat ○ Instrument Panel
○ Brake Pedal ○ Console ○ Accelerator Pedal
○ Shifter ○ Body ○ Mirrors ○ Clutch Pedal
Describe the vibration:
○ Vertical ○ Horizontal ○ Rotational
○ Other: _____

HARSHNESS (Ride Quality)
Where do you experience it? _____
When do you experience it? _____

Has the vehicle ever been damaged? ○ Yes ○ No If so, please indicate where on the illustration.
Is there any relevent service history? ○ Yes ○ No If so, please describe: _____
Has there been any accessory installation ? ○ Yes ○ No _____
Is the vehicle used for towing or to carry any cargo or equipment? ○ Yes ○ No _____

LOCATION INDICATOR



OPERATING CONDITION
When does the condition occur? ○ Starting ○ Idling ○ Cruise ○ Coasting ○ Other _____
Vehicle Speed (MPH): _____ Engine Speed (RPM): _____
○ Cornering Left ○ Cornering Right ○ Acceleration ○ Deceleration
○ Braking ○ Clutch Engagement ○ Other _____
Accessories: ○ HVAC ○ 4WD ○ Audio ○ Other _____
Engine Temperature: ○ Cold ○ Normal ○ Hot
Road Conditions: ○ Highway ○ Suburb ○ City
Road Surface: ○ Asphalt ○ Dirt/Off Road ○ Concrete with Expansion Joints
○ Undulating ○ Other Irregularities
Explain: _____

WEATHER CONDITIONS
Temperature: _____ °F ○ Clear ○ Rain ○ Ice/Snow ○ Wind
○ Other _____

ADDITIONAL INFORMATION
_____
_____
_____
_____

Instructions

1. **Conduct** the customer interview with the customer/instructor by asking **all** the questions on the attached sheet.

2. Your instructor will act like a customer and may not understand the question or the terminology used. Be sure to provide **clarification and explanations** as necessary.

   NOTE

   You may need to ask probing questions to determine if the customer understands the questions. They may not easily indicate that they don't understand.

   The questions asked during this process may prompt the customer to provide additional, valuable information that they may not normally think of as important. You are the NVH expert, not the customer.

   It is important that the interview be conducted and the sheet filled out by personnel trained in NVH service. The customers should **not** be left to fill out the sheet on their own. Trained personnel can provide assistance, as necessary, to ensure high quality information about the complaint.

3. When the interview is complete, **review** all the data collected and **answer** the following questions. If the review or the following questions identify a lack of information, conduct that portion of the interview again.

4. Take a quick **test drive** with the customer to experience the complaint and determine what needs to be done to satisfy the customer.

5. Refer to the **Technician Handbook** for additional information to answer the following questions.

Questions

1. What is the difference between a **test drive** with the customer and a **road test** performed during diagnosis?

2. What is the reason for knowing who is the **primary operator** of the vehicle?

Questions (continued)

3. If the person who brings the vehicle in for service is **not** the primary operator, what is your **plan of action**?

4. What value is it to have **precise vehicle data** when conducting a **road test**? (i.e. year, trans, axle, tire size)

5. What is the **value** of knowing:
   - Service History
   - Damage History
   - Accessory installation

6. If the customer indicates that there **has** been one of the above situations with the vehicle (question #5), what would your **next questions include**? Please list and explain.

   Where would you **record** this information?

Questions (continued)

7. What is the **pitfall** associated with **assuming** the customer **understands the meaning** of NVH terms, such as “harshness”.

8. **When** should the **operating conditions** be determined to maximize a **positive** service experience and why?

9. What information is provided when the interviewer enters **N/A** as an answer?

10. What is the **advantage** to filling in the final details the customer could not answer, during the test drive?

11. What is the **value** of having the interviewer and customer **review and sign** the interview sheet?

Conclusions

1. **List** the information from the interview sheet that is relevant to **resolving** the complaint. Briefly explain each.

2. From the information gathered at this point, what **test drive techniques** are necessary to **duplicate** the symptoms? Explain.

3. Based on the information collected from the interview sheet and the test drive, which of the following **course of actions** would you choose and why?

   - Customer Consultation
   - Technician Diagnosis and Repair
   - Technical Assistance for non-serviceable conditions

4. If **customer consultation** is chosen, what is your **plan of action**? Explain.

5. What is the **pitfall** associated with **starting** a diagnosis **before** the verification process is complete?

Notes

CUSTOMER INTERVIEW SHEET

TOYOTA

INSTRUCTIONS

The interview should be conducted and the sheet filled out by personnel trained in NVH diagnosis.
Please fill in or check all areas with the appropriate response, enter N/A if it does not apply.
The details collected during the interview are critical in successfully resolving the complaint.

CUSTOMER DATA

Name: _____ Date: _____

Telephone #: _____ RO #: _____

VEHICLE DATA

Model/Year: _____ Mileage: _____

VIN #: _____

Is the customer the primary operator of the vehicle? ❍ Yes ❍ No

NVH DATA

What type of condition is the customer experiencing? ❍ Noise ❍ Vibration ❍ Harshness (ride quality)

Is the condition constant? ❍ Constant ❍ Intermittent

When did it start? ❍ While in Service ❍ Since New ❍ Gradually ❍ Suddenly

❍ Other _____

NOISE

Describe the Noise: ❍ Squeak ❍ Rattle ❍ Wind Noise ❍ Other _____

When does the noise seem to be the loudest or most frequent?

_____

Note here and mark the location of the noise on the illustration (reverse side of this form).

_____

VIBRATION

Where is it felt:

❍ Steering Wheel ❍ Floor ❍ Seat ❍ Instrument Panel
❍ Brake Pedal ❍ Console ❍ Accelerator Pedal
❍ Shifter ❍ Body ❍ Mirrors ❍ Clutch Pedal

Describe the vibration:

❍ Vertical ❍ Horizontal ❍ Rotational
❍ Other: _____

HARSHNESS (Ride Quality)

Where do you experience it? _____

When do you experience it? _____

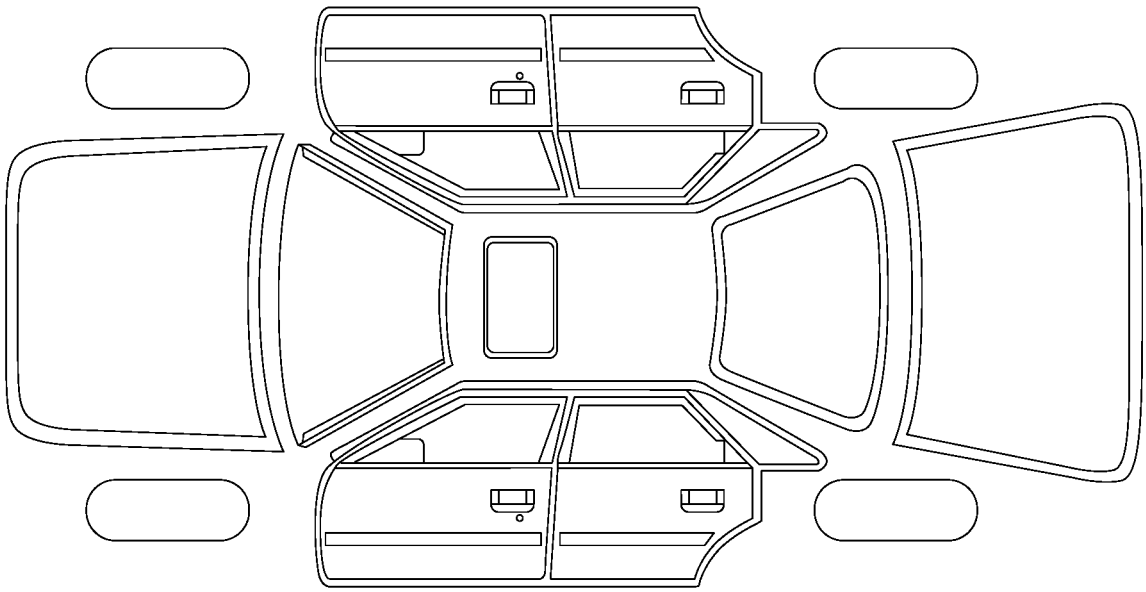
Has the vehicle ever been damaged? ❍ Yes ❍ No If so, please indicate where on the illustration.

Is there any relevent service history? ❍ Yes ❍ No If so, please describe: _____

Has there been any accessory installation ? ❍ Yes ❍ No _____

Is the vehicle used for towing or to carry any cargo or equipment? ❍ Yes ❍ No _____

LOCATION INDICATOR



OPERATING CONDITION

When does the condition occur? ❍ Starting ❍ Idling ❍ Cruise ❍ Coasting ❍ Other _____

Vehicle Speed (MPH): _____ Engine Speed (RPM): _____

❍ Cornering Left ❍ Cornering Right ❍ Acceleration ❍ Deceleration

❍ Braking ❍ Clutch Engagement ❍ Other _____

Accessories: ❍ HVAC ❍ 4WD ❍ Audio ❍ Other _____

Engine Temperature: ❍ Cold ❍ Normal ❍ Hot

Road Conditions: ❍ Highway ❍ Suburb ❍ City

Road Surface: ❍ Asphalt ❍ Dirt/Off Road ❍ Concrete with Expansion Joints

❍ Undulating ❍ Other Irregularities

Explain: _____

WEATHER CONDITIONS

Temperature: _____ °F ❍ Clear ❍ Rain ❍ Ice/Snow ❍ Wind

❍ Other _____

ADDITIONAL INFORMATION

_____

_____

_____

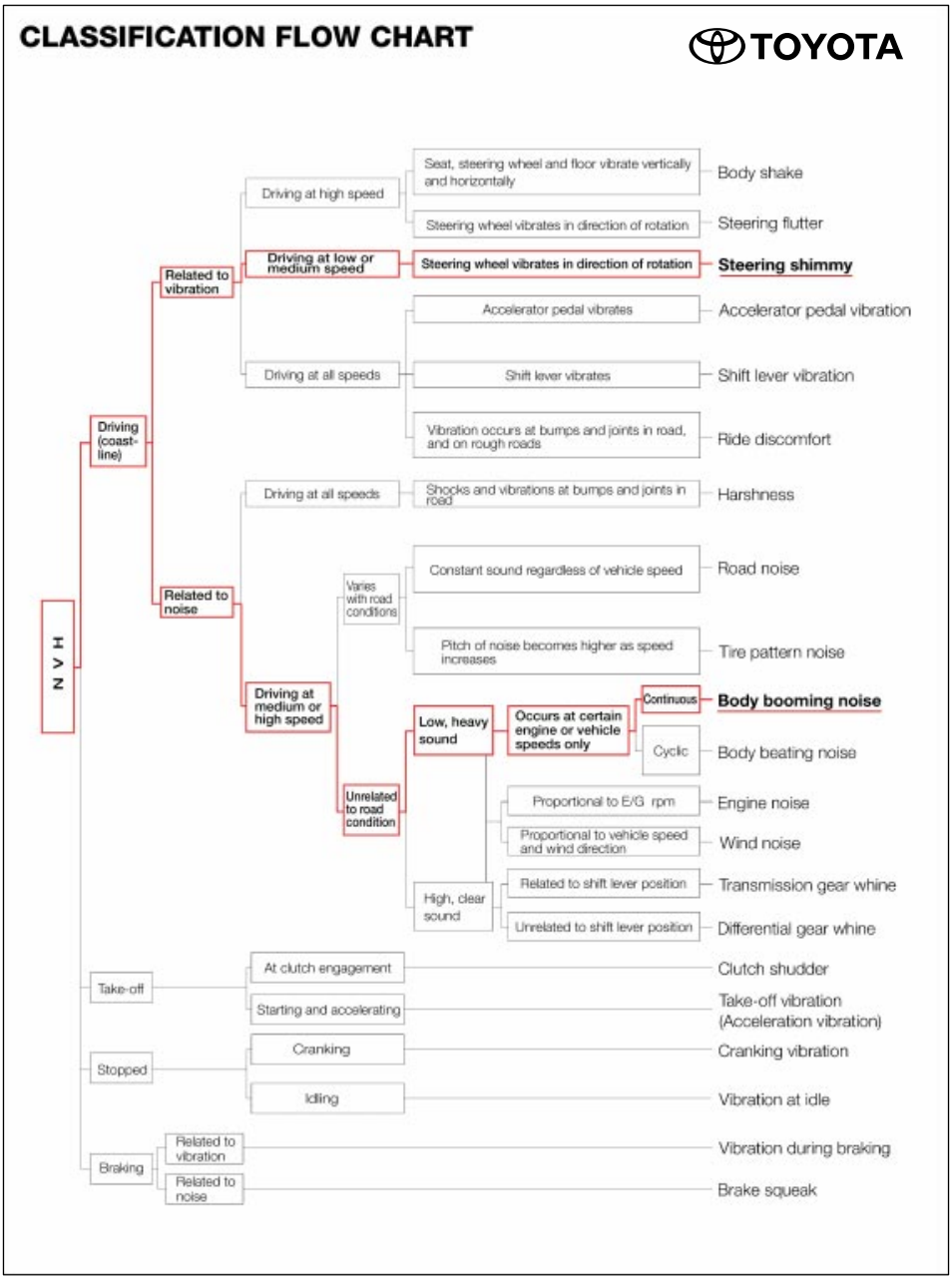
_____

Classify the Complaint

During diagnosis a technician has to take a **large list** of possible NVH conditions and, through a **process of elimination**, find the one that applies to the situation.

Symptoms Classification Flow Chart

Fig. 2-8



Classify the Complaint
Continued

Once the complaint has been classified, a specific diagnostic approach can be applied which will identify the source. This **eliminates random diagnosis** resulting in wasted time, confusion and frustration.

A further advantage of this organized style of diagnosis is that it allows the technician to **trace the steps**. The point where a decision was made, which led to a wrong, diagnosis can be identified. **Only the necessary procedures** need to be repeated to successfully find the condition.

Classification is done by collecting information about the complaint that is **unique to the condition**. Each step in the process **eliminates possibilities** until there is only one left.

Efficient diagnosis **prioritizes** the procedures that eliminates the largest number of possibilities first. This process will **minimize the number of tests** required and will be less likely to send the technician looking in the wrong direction.

The **four tools** available in the classification process are:

- Customer interview sheet
- Flow chart for classification
- Road test
- NVH Analyzer

With the data collected from the complaint verification and interview sheet, the technician can follow a path through the flow chart by making **yes or no decisions** at each level of the chart.

If a decision **can't** be clearly made at a specific point in the chart, then a point has been identified where **more information is needed**, and exactly what that information has to include.

Successful completion of the flow chart will provide the technician with a classification for the symptoms which can be associated with **specific characteristics.** These specific characteristics can only be caused by one area on a vehicle and **pinpoint diagnosis** can be focused on that area for the cause and repair (See Section 1 for the specific characteristics).

WORKSHEET #2
Classify the complaint

Vehicle	Year/Prod. Date	Engine	Transmission

Diagnostic Description: Symptoms Classification Flow Chart

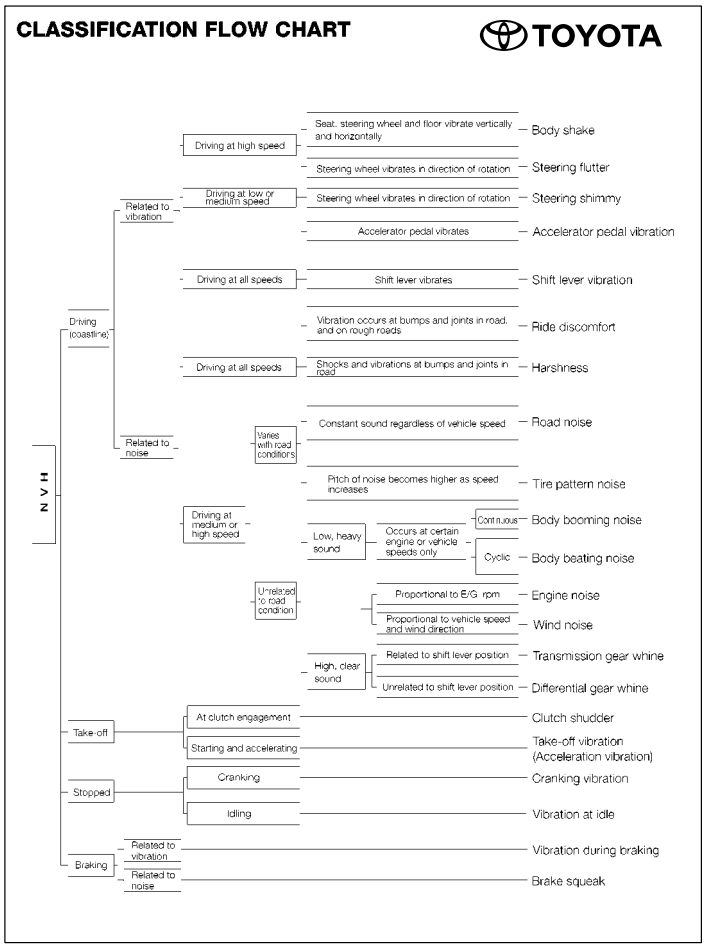
The recent emphasis placed on NVH in automobiles has brought with it a **new vocabulary**. In addition, **quality communication** from the customer to the technician, has been identified as one of the major areas of concern for successful NVH service.

Standardized NVH terminology is very important to ensure that everyone understands the conditions in the same way. The flow chart is a **tool** used by the technician to identify the symptom from the data collected during the interview and the test drive.

When the proper symptom is selected from the list, there are **specific characteristics** associated with the term which are helpful in diagnosis. For example, the **frequency** of the symptom.

Classification Flow Chart

Fig. 2-9



Instructions

As indicated in worksheet #1, this worksheet is the **second** worksheet designed to:

- provide an opportunity to **practice** the NVH diagnostic procedure
- **resolve** the condition placed in the shop vehicles.

1. Use the information collected on the customer interview sheet and the test drive (worksheet #1) to answer the questions at each branch of the flow chart. (attached)

2. If you cannot clearly answer the questions on the sheet then you have identified an area that requires more information. Determine if it has to be collected from the customer/instructor or another test drive.

3. Review the characteristics of each symptom on the symptom chart (Section 1 of the student handbook) and answer the following questions.

Questions

1. **How many** symptoms were identified?

2. **List** the symptom/s below.

3. Is the symptom/s noise, vibration, harshness or a combination?

4. What are the **frequencies** associated with the symptom/s?

5. Why will **knowing** the frequency be helpful during **diagnosis**?

6. What other things are you familiar with in your daily life which operate at the same frequency? Why is this **helpful** in diagnosis?

7. Are the symptoms **engine speed** related, **vehicle speed** related or both?

Questions (continued)

8. What **conditions**, listed on the symptom chart (Section 1) are the **same** as gathered during the interview sheet and the test drive?

   What **conditions** are **different**?

9. **List** the possible **causes** from the symptom chart (Section 1) that are most likely in this case. Explain.

10. What is the **vibrating system** related to the symptom?

    - Vibrating force: _____
    - Resonance system: _____
    - Transmission system: _____
    - Vibrating body: _____

11. Does the vibrating system from the symptoms chart (Section 1) and the one associated with this case **match**?

12. Remember, not all cases follow a text book situation exactly, the chart serves as a **guide** for most cases.

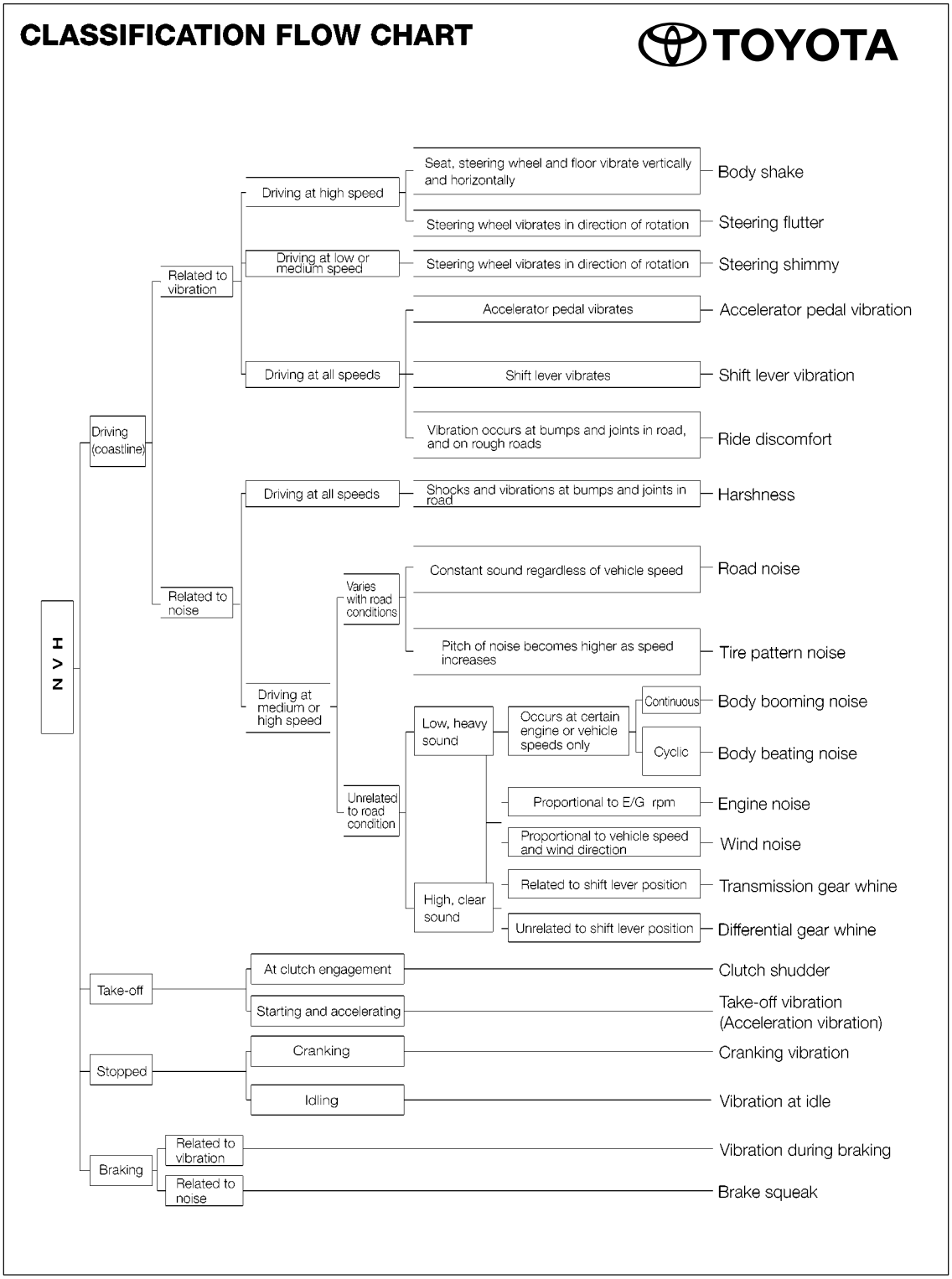
    What is your **plan of action** in the event that the case being diagnosed is **not** exactly the same as the symptoms outlined in the chart?

Conclusions

The information generated with this flow chart will be used with the customer interview sheet, the NVH analyzer, and the road test to classify the complaint and identify the possible source of the vibration or sound. (engine, driveline or wheels)

A successful pinpoint diagnosis can be done with solid background information on the complaint.

Notes



Case study: Part II

After the technician has verified the complaint, the classification flow chart is used to establish that there are two areas or classifications, for the symptoms.

- *Steering shimmy*
- *Body booming*

In the first level of the flow chart there are four choices:

- *Driving (coasting)*
- *Take-off*
- *Standing*
- *Braking*

***Driving** was selected because the symptoms occur between 40 - 60 MPH.*

*The second level asks if the symptoms are related to vibration or noise. In this case both areas need to be considered because there is a **vibration** in the steering wheel and a **noise** from the rear of the 4Runner.*

*The next level under vibration asks for the speed. The vibration is noticed first at about 40 MPH which is considered to be **medium speed.***

*The chart next asks if the steering wheel vibrates in the direction of rotation. The term to describe this symptom is **steering shimmy**.*

*The next level after noise asks for speed. In this case the noise is most noticeable at speeds **above 50 MPH**. Driving at medium or high speed is the choice that best fits the noise symptom.*

*Next, you are asked if the noise varies or is unrelated to road condition. **Unrelated** best fits in this case. The customer noted, and the verification indicated, that the noise is always there once the proper speed is reached.*

*The sound is best described as a **low and heavy sound** as opposed to high clear sound and is related to vehicle speed.*

*The final question relating to noise asks if it is continuous or cyclic. The noise in the 4Runner scenario is described as being **continuous** which points to a **body booming** classification for the noise.*

This may seem to be a complex way to arrive at a description of a symptom. But using this process and the flow chart insures that the proper terms are being used and mean the same thing to everyone involved.

In addition, there are very specific causes associated with each of these classifications which help the technician narrow down the list of possibilities. If the wrong term is used it could lead to a pinpoint diagnosis in the wrong area, wasting time.

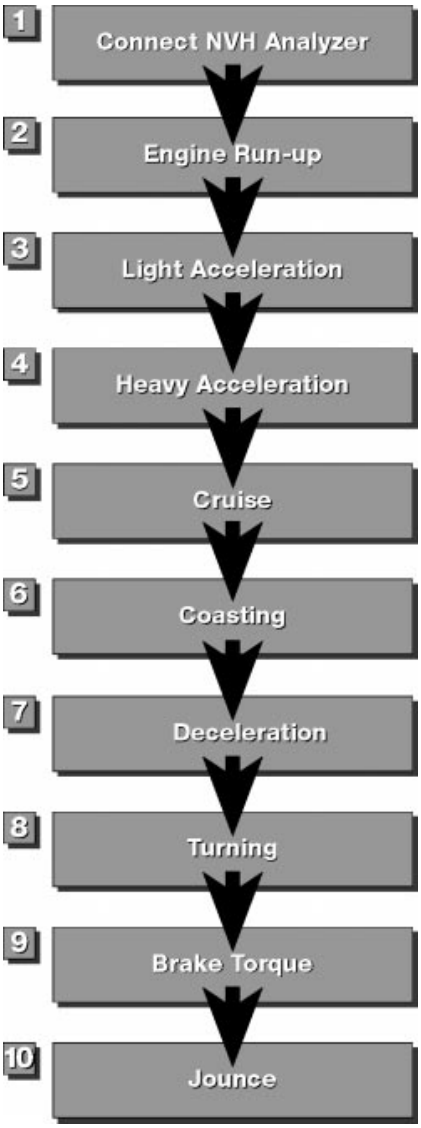
Road Test

Diagnostic road testing is done **after** the complaint has been verified. Customers are helpful in verifying the complaint but do **not** need to be part of the complete diagnostic process. Unfortunately, some diagnostic procedures do not separate the verification of the complaint from the road test. The road test is designed to help **isolate the condition** after it has been verified. Data collected from a customer and data collected from a road test are different and **serve two different functions**.

During the road test, the technician **duplicates** the complaint under several specific operating conditions. This is done to **identify unique characteristics** which will help classify the complaint. In addition to duplicating the complaint, the technician should try to **change or eliminate** the symptom using techniques such as different speeds, RPM, load or other operating conditions.

Road Test Procedures

Fig. 2-10



Road Test
Continued

The road test is designed to get the **most** information in the **shortest** amount of time. It is also part of a process of elimination reducing a large list of possibilities to the one causing the complaint.

The **condition of the vehicle must not be modified** prior to the road test. A thorough visual inspection may find conditions such as low tire inflation. Properly inflating the tires prior to the road test may modify the vehicle to the point that the symptoms may be effected.

Once the complaint has been verified the road test can be **modified specifically to the complaint**. Only conditions that apply to the complaint need to be duplicated.

For example:

> If the condition occurs at a specific speed then road test parameters that do not apply to that condition do not need to be performed, like engine idle in Neutral or Park.

Collecting, Reading and Analyzing NVH Data

During the road test, the ability to **quantify the frequency and the level** of the vibration or sound is very useful for diagnosis. It also provides an **objective basis for comparison**.

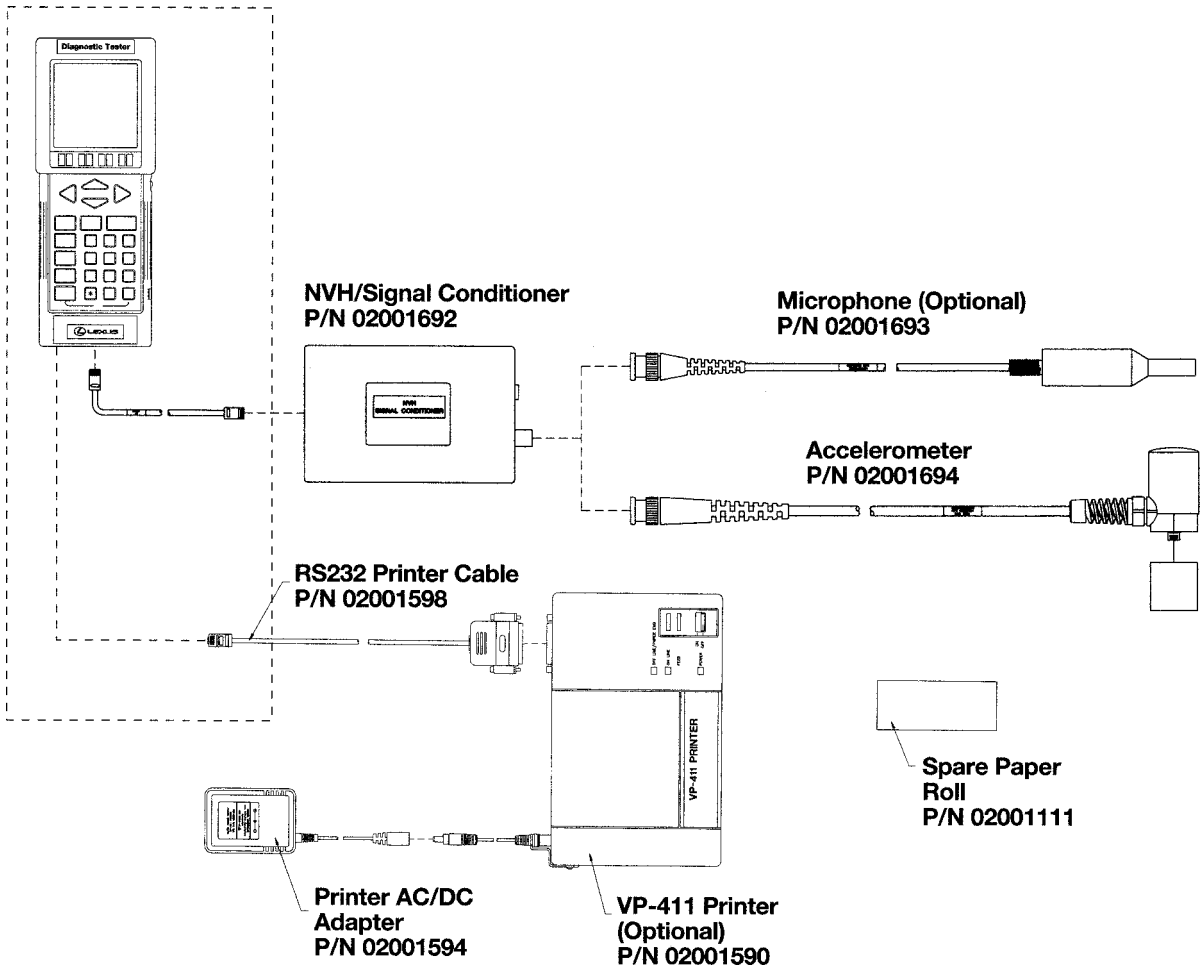
Knowing the **frequency** of the condition will help classify the symptom. The large list of possibilities can be reduced considerably due to the fact that only specific components operate at specific frequencies.

A vibration analyzer, such as the **Toyota NVH Analyzer,** can measure the level of a specific frequency vibration or sound. This level can be recorded and compared to known good vehicles as well as the complaint vehicle, after the repair has been performed.

If a frequency analyzer is not available, experience with **known vibrations** is helpful in diagnosis. This approach, however, is very subjective when comparing levels of noise or vibration (See Section 1 for details).

NVH Analyzer

Fig. 2-11



Collecting, Reading and Analyzing NVH Data
Continued

The Diagnostic tool set includes an extensive **Operator's Manual** with **operating instructions** for each program card. These references provide an excellent resource for the following information:

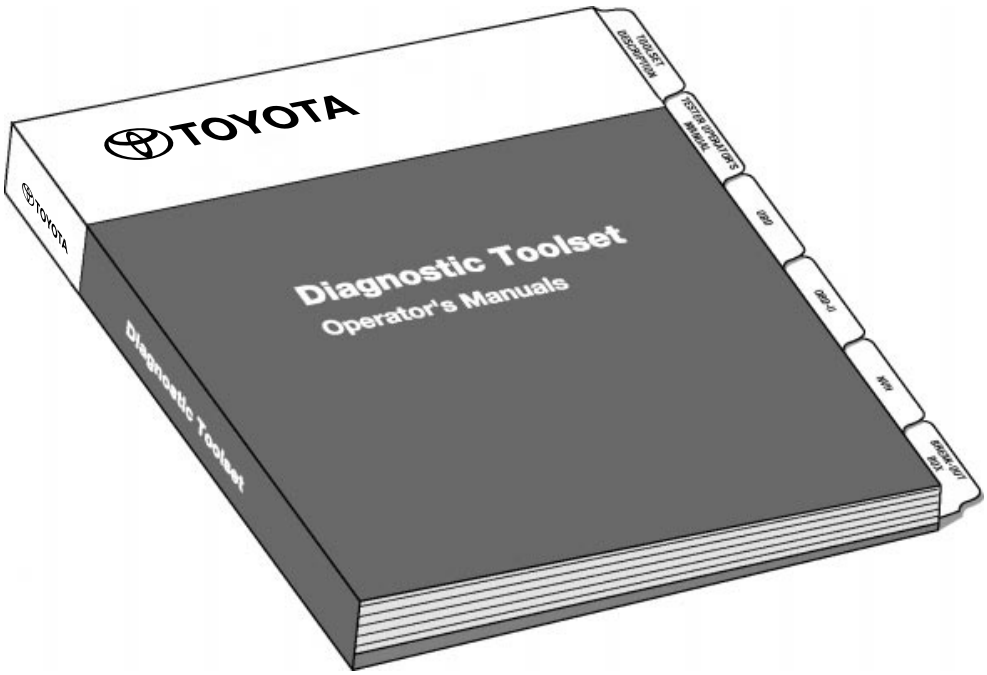
- Hardware
- Features
- Operating precautions
- Getting started
- Using the RS232 and instrumentation ports

The appendices provide valuable additional information to help the operator get the most out of the Diagnostic Tool Set (See operator's manual table of contents).

The operating instructions provide details on the NVH Analyzer functionality. When one of the program cards is selected, the instructions will walk the operator through the menu selections and key strokes until the appropriate data is displayed. It will also explain how to move through the different displays, modify the displays and how to pause or snapshot the data. **Interpreting the data is left to the technician**.

Toyota Diagnostic Tool Set Manual

Fig. 2-11b



WORKSHEET #3A
Getting Started with the NVH Analyzer

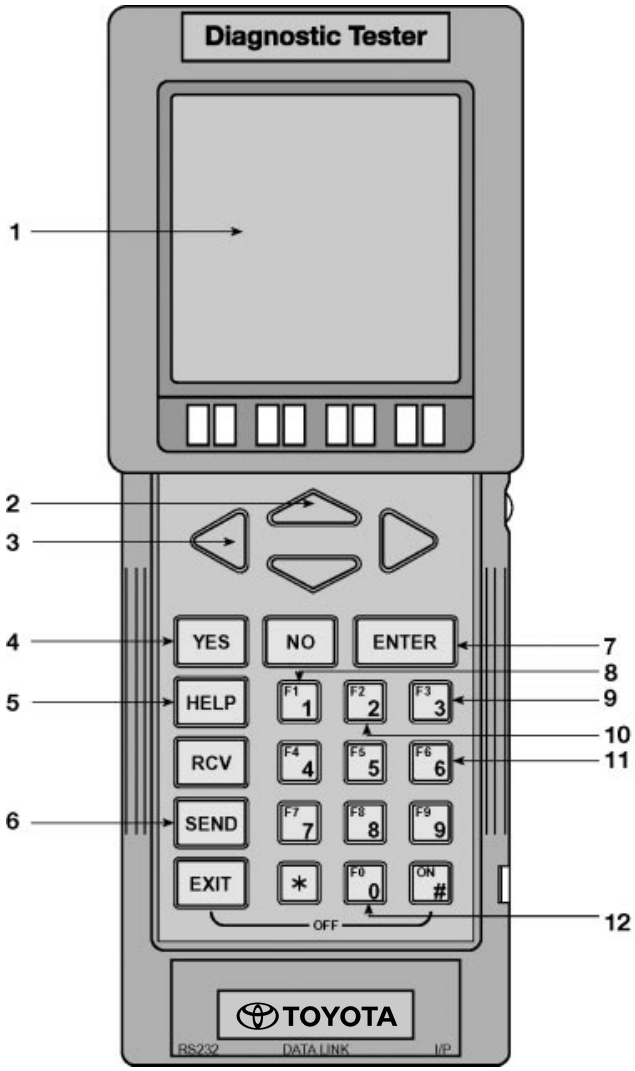
Description: **The NVH Analyzer Set-up**

The NVH Analyzer is designed to be very **user friendly**, with the **minimal** menu selections required to select the vehicle and access the data displays.

This worksheet is designed to orient you to the **NVH menus** and the **active keys** on the analyzer.

Toyota Diagnostic Tester

Fig. 2-12



1. Display
2. ⌃ and ⌄ arrows move the cursor on the menu screens or changes amplitude on the display screens
3. ◁ and ▷ arrow move the cursor on all screens and displays
4. YES key changes the company on the program ID screen
5. HELP displays a summary of active keys
6. SEND with ON # will print the screen
7. ENTER moves forward through the menu
8. F1 1 key changes NVH displays
9. F3 3 key changes the source indicators
10. F2 2 key changes frequency band width
11. F6 6 key saves a paused screen
12. F0 0 key pauses the display

Instructions

1. **Install** the NVH Training Software card.

2. Refer to the NVH section of the Diagnostic Tool Set **Operator's Manual** (Sections 1.0 - 3.0) and follow the procedures outlined to familiarize yourself with the operators manual, menu structure, active keys, and functions.

   - 1.0 Getting Ready
   - 2.0 Vehicle and System Selection
   - 3.0 NVH Main Menu

3. Press the HELP key frequently to familiarize yourself with the **help information** available in the software. Use the EXIT key to return to the menu or data displays.

4. Perform the **selection procedures** on the following vehicles and note the different selections required to access the NVH data displays.

   - 93 4Runner, 3VZ-E-4WD, AXLE G254, MT 10.5R15
   - 93 Supra
   - 93 Tercel, 4speed MT and AT

5. **Repeat** a vehicle selection from above using the "LAST VEHICLE" selection. **Note** the menus eliminated using this selection compared to the "NEW VEHICLE" selection.

NOTE An auxiliary power source is recommended during this worksheet to avoid interruptions from a dead battery. (Refer to the operators manual section, "Powering the Diagnostic Tester")

Questions

1. Which key moves **forward** through the menu structure?

   _____

2. Which key moves **back** through the menu structure?

   _____

3. What are the **two ways** to select "NVH" on the Function Select Menu?

   _____

4. What is the **purpose** of selecting the vehicle **specific** year, engine, transmission, etc.?

   _____

5. What effect will the **wrong** vehicle or vehicle parameters selection have on **diagnosis**? How will you know?

   _____

   _____

6. What is the **advantage** to using the "LAST VEHICLE" selection when possible?

   _____

Questions (continued)

7. List the resources available to **verify** the vehicle axle ratio.

8. Under what conditions would the axle ratio need to be **changed**? Be specific.

9. List **three** useful pieces of information available on the vehicles parameters screen. Explain.

10. Does the tool tell you where to connect the **data link cable** on the vehicle selected?

    If so, which screen?

11. What is your **plan of action** if you get the “NVH Signal Conditioner Failure” screen? Explain.

12. What is the printer “Baud Rate” **default** value? _____

    Where did you find the answer?

13. How many **unit conversions** can be modified?

    List the ones applicable to NVH.

14. What **type** of information is available through “help”?

Notes

WORKSHEET #3B
Getting Started with the NVH Analyzer

Description: **The NVH Analyzer Data Displays**

The NVH software provides **three data displays** for NVH diagnosis.

- 2d (2 dimensional)
- Barchart
- 3d (3 dimensional)

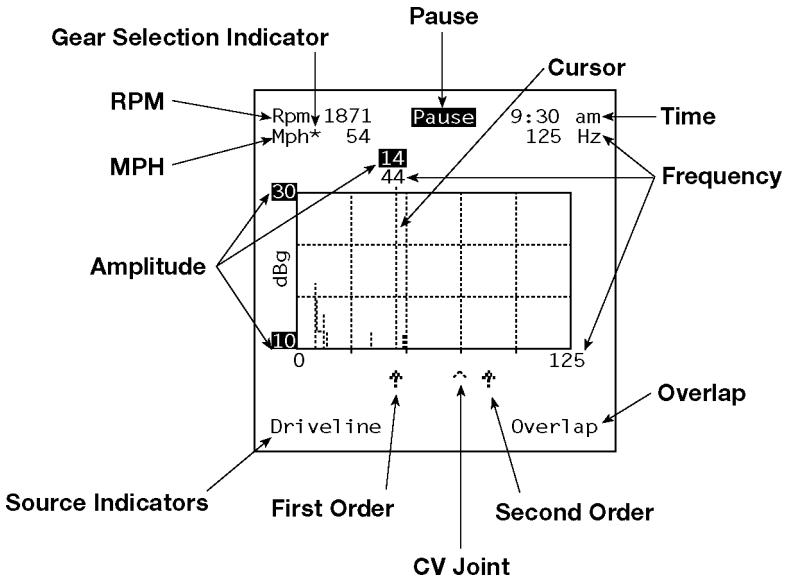
These displays are available to **analyze** the vibrations and noise in a vehicle. They are accessed after the vehicle and function selections are made. (worksheet #3A) In addition to the vehicle vibrations, each display provides information including:

- Vibration indicator arrows
- MPH & RPM
- Time
- Frequency and amplitude

This worksheet is designed to review each of the displays in detail for the **information available** and the **key strokes** necessary to **manipulate** the information.

2d Display

Fig. 2-13



Instructions

1. Install the NVH training software card.
2. Perform the **set-up procedures** outlined in the NVH section of the operator's manual (Sections 1.0 - 3.0).
   - 93 Previa, 4wd AT
   - 93 Celica, 5S-FE, convertible
   - 93 Corolla, 4A-FE, DLX
3. Refer to **Sections 4.0 - 6.0** for details relating to each of the displays and functions.
   - 4.0 NVH Displays
   - 5.0 Pause Mode
   - 6.0 Data Record
4. **Practice manipulating** the displays with the active keys to learn the range and function of the data available for diagnosis.

Questions

1. What do the two axises represent on the 2d display?
   - Vertical
   - Horizontal

   ---

2. What are the **active keys** on the 2d display that change the:
   - amplitude
   - frequency (for each direction)
   - source indicator (engine, driveline and wheel)
   - cursor

   ---

3. **How many** ranges or bands are available for:
   - Amplitude
   - Frequency

   ---

4. If the time is **not** correct how is it **changed**?

   ---

5. What is the value of the **time indicator** on the display or a screen print?

Questions (continued)

6. If the “no data” indicator is displayed adjacent to the MPH and RPM indicators, what is your **plan of action**? Explain.

7. If the vehicle requires a manual gear selection, how is it **indicated** on the display?

8. What is the key to enter the **gear selection** display?

9. What is the key required to **change** the vibration source indicators (selected component)?

10. **Why** do some vehicles require gear selection while others do **not**?

11. What is the **default** gear selection if none is selected?

12. What **effect** will using the default gear position have in diagnosis?

13. Which active key **changes** the three NVH Data displays?

14. **How many events** are displayed on the barchart and 3d display?

15. Which line is the **most recent event** on both the:
    - barchart
    - 3d display

Questions (continued)

16. On the **barchart** display, is the total dBg displayed:

    A. the sum of the engine, driveline, and wheel dBs

    B. or the greatest level of total vibration felt in the vehicle (engine, driveline, and wheel levels are compared to the total)

---

17. How do you change the **amplitude scale factor** on the barchart display?

    What is the range?

---

18. What is the function of the **RCV** key?

WORKSHEET #3C
Getting Started with the NVH Analyzer

Description: **NVH Data Analysis**

NVH data analysis is the **key** to using the NVH Analyzer in the diagnostic process. The ability to **accurately identify** the “spikes” associated with the vibration, causing the customer complaint, will contribute to your success and customer satisfaction.

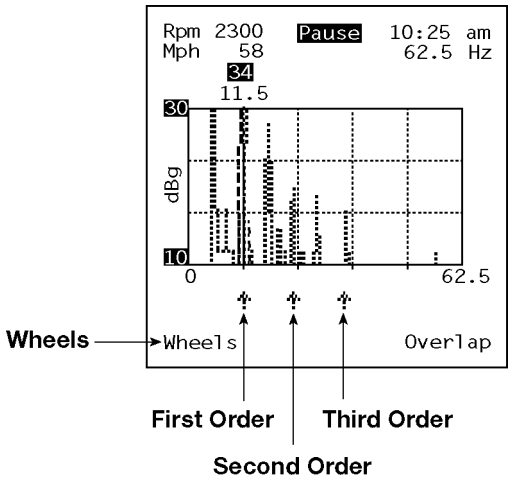
The NVH training simulation software contains pre-recorded vehicles with **typical vibration characteristics** and **customer complaint vibrations**. Specific scenarios are selected by choosing one of the following vehicles on the vehicle select screen.

- 93 Truck 3VZ-E 4WD G254 AT STREAM 31
- 93 Truck 3VZ-E 4WD G254 AT STREAM 73
- 93 Truck 3VZ-E 4WD G254 AT STREAM 76
- 93 Camry 5S-FE AT STREAM 35
- 93 Camry 5S-FE AT STREAM 72
- 93 Landcruiser STREAM 30

The NVH data analysis worksheet is designed to utilize the NVH training software to provide **practice analyzing vibrations**. The software allows this activity to take place in the classroom where everyone can benefit from the same scenarios, discussions and direction from the instructor.

2d Display

Fig. 2-14



Instructions

1. **Install** the NVH training simulation software and go through the function and **vehicle selection menus**. Use the skills developed in worksheet #3A.

NOTE

Follow the directions from your instructor in selecting the vehicles. The directions will include details from the **customer interview sheet** and the **symptoms classification flow chart**.

2. **Observe** the data displayed on each of the three displays. Use the skills developed in worksheet #3B to **manipulate** the screens to observe the **clearest view** of the data.

For example:

Changing the amplitude to a higher scale may eliminate vibrations that are normal. Changing the frequency range may make low frequency wheel vibrations easier to read.

NOTE

The scenarios were recorded for the length of time required to capture a **representative sample**. The software will display the data in a **continuous loop**. **Watch** the RPM and MPH indicators to determine the beginning of the loop.

3. Select each of the three source indicators and **identify the spikes** above each arrow on the 2d and 3d displays.

4. **Compare** what is indicated on the 2d and 3d displays to the data indicated on the barchart display.

5. When you have **identified** the spike that is associated with the symptom perform a **save and screen print** of all the displays. Attach to the sheet provided.

6. **Formulate a plan** for a thorough **road test** that you would perform to determine if your conclusions are correct. Base the plan on the information from:

   - the customer interview sheet
   - the symptoms classification flow chart
   - the data viewed in the scenario

   Place your answer in the space provided on the attached sheet.

NOTE

The ability to **anticipate** what spikes you should find is very helpful in diagnosis. It makes it easier and more efficient to plan the display manipulations and the road test.

7. Answer the questions as you review the scenarios and place your answers for 1-10 on the **chart** (attached).

Questions

1. Based on the information from the customer interview and the symptom classification, indicate what **type of vibration** you **expect** to see on the display prior to reviewing the NVH data.

• engine	1st order	2nd order	3rd order	4th order
• driveline	1st order	2nd order	3rd order	4th order
• wheels	1st order	2nd order	3rd order	4th order

Questions (continued)

2. Observing the spikes in question, what **frequency range** would best display the spikes? Explain.

3. While viewing data on the 2d display, are there any spikes shown at frequencies **greater** then 125 Hz?

4. What **amplitude range** will clearly display the larger spikes and eliminate the normal vibrations?

5. Which scenarios indicate an **overlap** condition?

6. Which **indicators** are overlapping?

7. What would your **plan of action** be for a road test to determine which **source** was causing the spike? Be specific.

8. Which source shows the greatest level of **energy** on the **barchart** display?

9. **After reviewing** the displays which are the vibrations of **concern**?

10. What are your **conclusions** and **plan of action** from the symptom information and NVH data on this vehicle?

Conclusion

1. Why were the three sources of vibration (engine, driveline and wheel) **selected** for indication by the NVH Analyzer?

2. When is a **comparison of amplitude level** from vehicle to vehicle of little value?

3. What is the value of **recording** the amplitude level of the vibration causing the complaint **before** the repair?

4. How do you **obtain** the **exact** frequency and amplitude of any spike displayed?

5. What is your **plan** if you find a significantly large spike that is **not** over an arrow?

6. What type of vibrations and sounds are the technician **expected** to repair? Give examples.

   Explain.

7. What type of vibrations and sounds are **beyond the scope** of the technician? Give examples.

   Explain.

Questions (continued)

8. What is the value of the **diagnostic procedures** and the **NVH Analyzer** when dealing with vibrations that require assistance?

9. **List** the information necessary prior to calling for assistance.

10. On the Stored Data Blocks screen which is the **most current** stored data and where is the **default** position of the cursor?

11. **How many** data blocks can be stored?

    What are the **active keys** required to store data?

12. What happens if you hit ENTER to save **paused** data and the all the **blocks are full**?

13. **When** do you get the “Review Old Data” screen?

    Under what **conditions** does it appear?

14. What are the **two ways** to delete data saved?

15. What is missing when analyzing data on the training software compared to analyzing data during the Road Test?

QUESTION / VEHICLE	1. ANTICIPATED VIBRATION SOURCE/ORDER	2. BEST FREQUENCY RANGE	3. "SPIKES" ABOVE 125 Hz YES/NO	4. BEST AMPLITUDE RANGE
LANDCRUISER (30)	/	Hz	Hz YES/NO	dBg
TRUCK A (33)	/	Hz	Hz YES/NO	dBg
TRUCK B (73)	/	Hz	Hz YES/NO	dBg
TRUCK C (76)	/	Hz	Hz YES/NO	dBg
CAMRY A (35)	/	Hz	Hz YES/NO	dBg
CAMRY B (72)	/	Hz	Hz YES/NO	dBg

	SYMPTOM 1
LANDCRUISER (30)	
TRUCK A (33)	
TRUCK B (73)	
TRUCK C (76)	
CAMRY A (35)	
CAMRY B (72)	

5. OVERLAP YES/NO 6. INDICATORS 7. PLAN OF ACTION	8. BARCHART LEVEL	9. ACTUAL VIBRATIONS SOURCE/ORDER	10. CONCLUSIONS PLAN OF ACTION
YES/NO	ENGINE DRIVELINE WHEELS		
YES/NO	ENGINE DRIVELINE WHEELS		
YES/NO	ENGINE DRIVELINE WHEELS		
YES/NO	ENGINE DRIVELINE WHEELS		
YES/NO	ENGINE DRIVELINE WHEELS		
YES/NO	ENGINE DRIVELINE WHEELS		

SYMPTOM 2

2D	BARCHART	3D
LANDCRUISER (30)		
ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE
COMMENTS		
CAMRY A (35)		
ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE
COMMENTS		
CAMRY B (72)		
ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE
COMMENTS		

2D	BARCHART	3D
TRUCK A (33)		
ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE
COMMENTS		
TRUCK B (73)		
ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE
COMMENTS		
TRUCK C (76)		
ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE
COMMENTS		

Notes

WORKSHEET #3D
Dynamic NVH Data Analysis

Diagnostic Description: Dynamic NVH Data Analysis

The NVH training software used in worksheets #3A, #3B, and #3C provide excellent classroom training to **introduce** and **develop** basic skills with the NVH Analyzer.

This worksheet is designed to add the dynamic element of **sensing** the vibration or noise while analyzing the NVH data. Sensing the symptom while viewing the data develops the **relationship** between the vibration or noise and the spikes. The ability to make this relationship is **key** to duplicating and manipulating the symptom which will make diagnosis **easier**.

Instructions

1. **Install** the NVH/BREAK-OUT BOX Program Card.
2. Connect the **Data Link Cable** and the **Accelerometer** to the vehicle set up in the shop, using the Operator's Manual.
3. **Review** the information from the Customer Interview Sheet and the Classification Flow Chart for the vehicle selected.
4. Use the skills gained in worksheet #3C to **anticipate** and **develop a plan** to analyze the data.
5. With the help of the instructor **confirm** the customer complaint in the vehicle set up in the shop.
6. **Analyze** the data while duplicating and manipulating the symptom, **save** and **print** a representative sample of each display. Attach to the sheet provided.
7. Based on the complaint information and the NVH data analysis, **develop a plan** for a pinpoint diagnosis.
8. **Remove** the "bug" and **retest** the vehicle to **confirm** the "repair". Attach a screen print to sheet provided.

Questions

1. What are your **conclusions** from the NVH data analysis for developing a pinpoint diagnosis plan?

_____

_____

_____

2. **List** the advantages of being able to **sense** the vibration or noise while analyzing the NVH data.

_____

_____

_____

Questions (continued)

3. How does sensing the symptoms make the diagnosis **more efficient** than simply viewing the data in worksheet #3C?

4. After the “bugs” were identified would you have come to the **same** conclusions or a pinpoint diagnostic plan in question #1? Explain.

Notes

2D	BARCHART	3D
BEFORE		
ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE
AFTER		
ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE
COMMENTS		

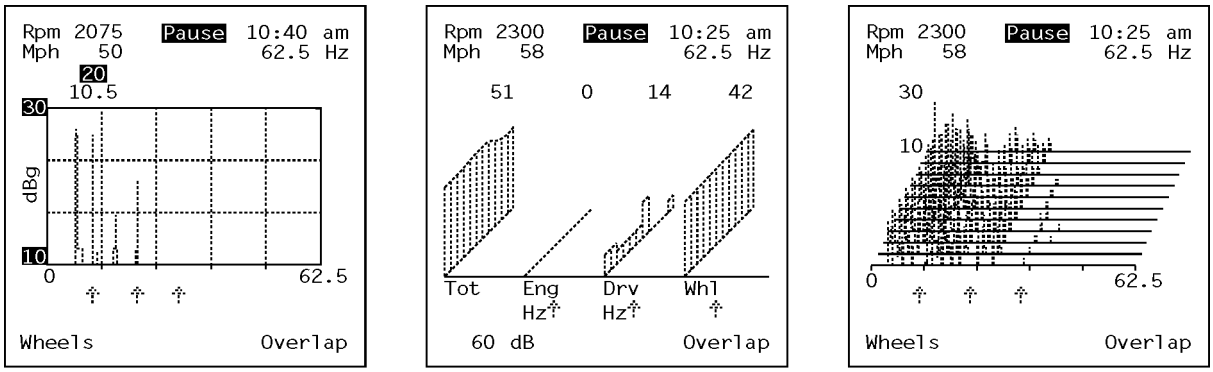
Diagnostic Display Interpretation Hints

"VIBRATION" function

Learning to associate the NVH data with vehicle vibrations takes **practice** and an **understanding** of how the different displays provide information. It is also helpful to understand how the displays can be compared to one another to isolate the data that relates to the complaint.

NVH Analyzer Displays

Fig. 2-15



2d **BARCHART** **3d**

"VIBRATION" function
Continued

The **road test techniques** are also valuable when using an NVH analyzer while trying to isolate a complaint. Duplicating and controlling the symptoms during a road test can help identify specific data that responds in the same way as the symptom.

For safety reasons, the **pause and save** (F0 0 F6 6) features are helpful to store and review the data after the road test. It is very difficult to safely operate the vehicle and analyze data at the same time. A second person to operate the vehicle is also useful during a road test, especially if the vibration is intermittent.

For example:

> The **2d display** (which is a **two dimensional display** that plots the vibrations according to frequency and amplitude) is useful during the test drive of an engine vibration. The driver can shift the vehicle into neutral and coast while the technician watches or records the vibrations. The spikes on the display that are related to the engine should go away while the spikes that are related to the driveline or wheels should remain.

The **barchart display** is a three dimensional display that shows eleven samples of data, plotting the amount of energy of the vibrations in the three source groups:

- Engine
- Driveline
- Wheels and tires

The barchart display makes an excellent **starting point** for diagnosis. It is very helpful to determine where the most amount of energy is generated or how the energy is distributed.

A technician can decide which of the above areas to focus on when moving to the 2d or the 3d displays for more specific analysis of the vibrations.

For example:

While test driving a vehicle, the barchart display may show the majority of the energy in the area of the driveline. The technician can now switch to the 2d display (F1 1), select the driveline indicators (F3 3), and look for large spikes that fall above the driveline arrows. Large spikes would indicate vibrations that would generate the high energy levels on the bar chart display.

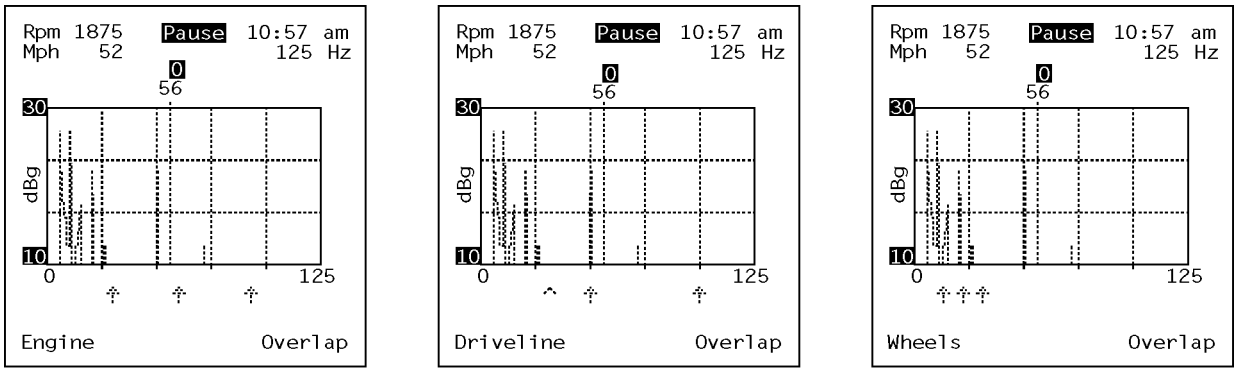
"VIBRATION" function
Continued

A large spike above a **driveline arrow** would confirm a driveline condition. The amplitude level can be **documented** for future reference. A technician can now focus the diagnosis in the driveline area.

The NVH Analyzer is designed to do the math required to associate a specific frequency vibration with one of the three groups listed above. It displays this by providing the terms "engine", "driveline" or "wheels" on the display and arrows for various order vibrations. These arrows are placed below the display pointing to the associated frequencies. A "^" is used to depict the CV joint frequency when checking driveline vibrations.

2d Display Indicators

Fig. 2-16



ENGINE **DRIVELINE** **WHEELS**

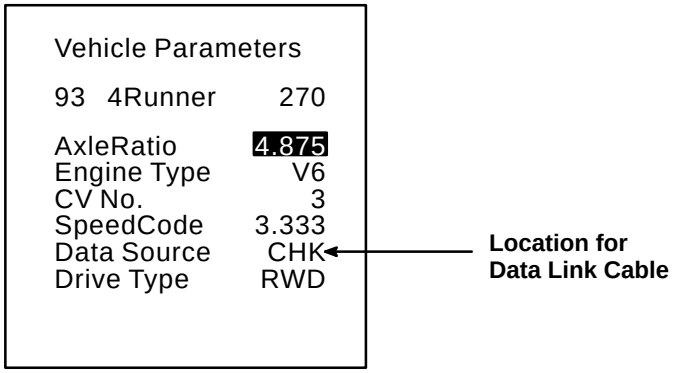
"VIBRATION" function
Continued

NOTE

When using the NVH Analyzer it is very important that the **vehicle parameters be verified** for the vehicle being tested. Every effort has been made to provide an accurate data base but there are many variables and combinations involved with our vehicles.

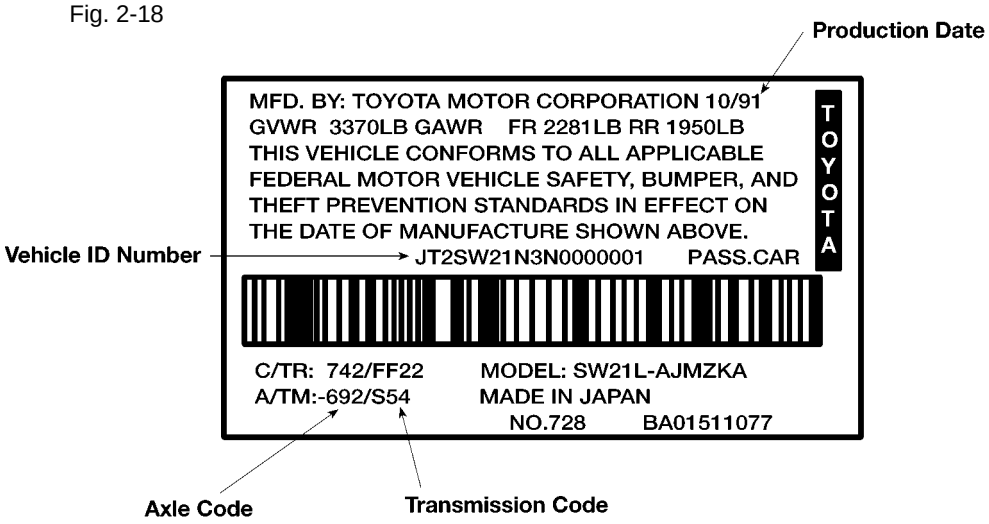
Vehicle Parameters Menu

Fig. 2-17



Sticker on "B" Pillar

Fig. 2-18



"VIBRATION" function
Continued

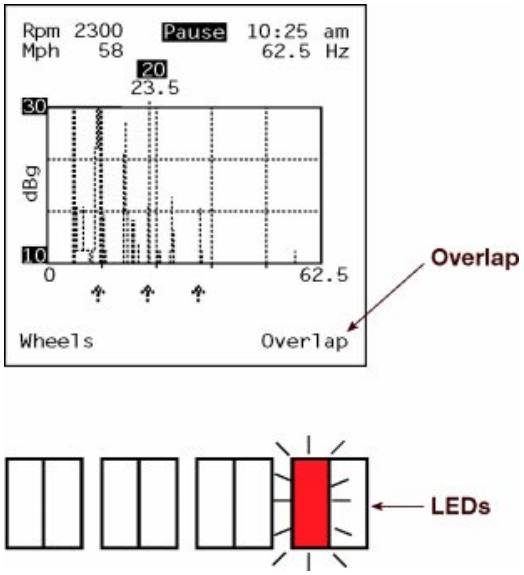
It is possible to have a unique situation that requires research in the Repair Manuals, parts fiche, TSBs and NCFs to collect the specifications necessary to modify the data base.

When the data base is accurate, the arrows will properly line up with engine, driveline and wheel vibrations.

An **LED will light** and **"overlap"** will flash when there is a possible overlap situation. This indicates that **more then one source** needs to be considered for a vibration displayed on the screen. The arrow will also flash indicating which spike could be caused by more than one source.

Overlap/LEDs Indicators

Fig. 2-19



For example:

When a vehicle is operating in fourth gear on a manual transmission it is possible for the gear ratio to be 1:1. The engine speed and the driveline speed are the same in this case, therefore an overlap could occur with a vibration generated by either area.

In this case an LED will light warning the technician of the overlap condition. The technician would view the other two groups (F3 3) to identify the overlap. This is done by finding the spike that has an arrow pointing to it in more than one area (engine, driveline, wheels).

In this example, the technician could select a different gear or step on the clutch to make the engine and driveline RPM different. This would isolate the vibration to a specific source.

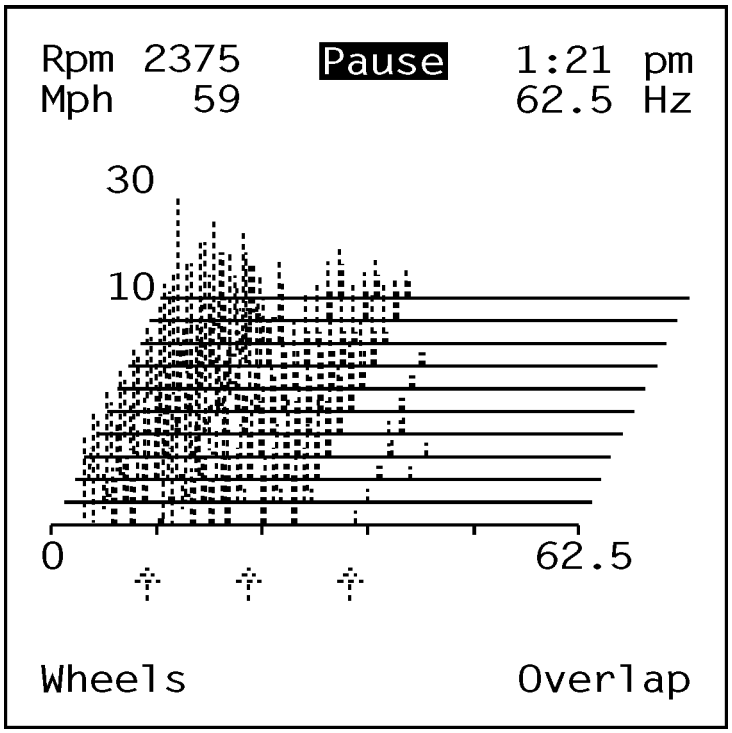
"VIBRATION" function
Continued

The **3d display** provides a three dimensional (3d) view of the vibrations in a vehicle by displaying 11 spectral lines (2d) which provides **a brief history of the vibrations**. Each of the **eleven lines** is the same as one 2d line, showing frequency and amplitude. By stacking them, a technician can easily observe **changes** in the spikes as the symptom changes.

This is helpful when road testing a vehicle with a difficult condition to diagnosis. When the technician modifies the operating conditions of the vehicle, while trying to control the symptoms, the 3d display will show changes in the spike related to the complaint. Observing which spike changes as the symptom changes can identify the area causing the condition by looking at the arrow associated with that spike.

3d Display

Fig. 2-20



"VIBRATION" function
Continued

For example:

> If you watch the normal engine firing vibrations on the 3d display, you will note a variation in the amplitude of the vibration due to power fluctuations of the engine. The power fluctuations are caused by changes in the air/fuel ratio in a normal feedback system.

Each of the displays can be changed to customize the parameters and focus in on a sample. These features allow the technician to eliminate data that is not applicable and provide a clearer view of the data that is relevant to the condition.

The parameters can be changed in the following way:

- Frequency band width (F2 2) forward & (* F2 2) backward
- Floor and ceiling level of the amplitude scale ()
- Engine, driveline and wheel indicators (F3 3)

Frequency band width is adjustable to the following four ranges using the F2 2 key:

- 0 - 500 Hz
- 0 - 250 Hz
- 0 - 125 Hz
- 0 - 62.5 Hz

The frequency band width **defaults to the 125 Hz scale** when the display is first selected from the vehicle parameters menu. Once in the display, if a different scale is selected, then it remains at that level as other displays are selected.

The scale selected is shown in **two places** on the 2d and 3d display as shown in fig. **2-21** and in the **upper right corner** of the barchart display.

The advantage of starting with the 125 Hz scale is that it gives a **clear view** of the spikes most likely generated by a vehicle. Once a spike or range has been identified, the appropriate band width can be selected using the F2 2 key. If the default is set at a smaller frequency band then a spike outside that range may be overlooked. A quick check of the 500 Hz scale will reveal any spikes that may appear above the default setting.

If there is an indicator arrow outside the frequency band selected, there will be a **flashing LED and frequency indicator** to warn the technician to check a larger frequency range for possible spikes.

"VIBRATION" function
Continued

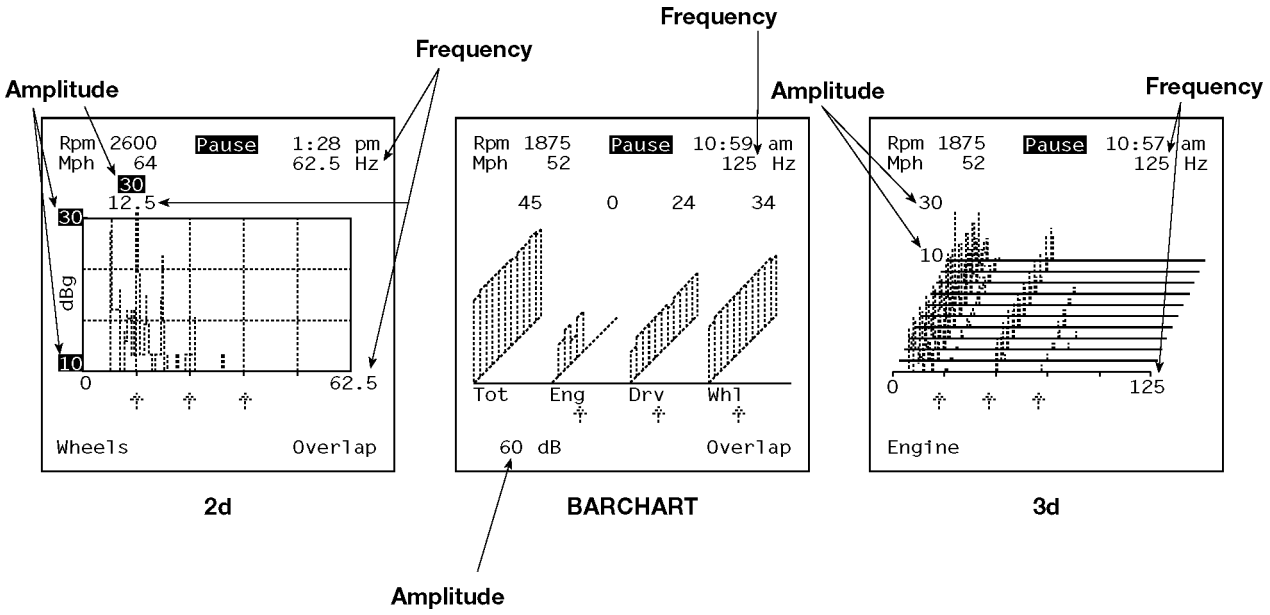
The **floor and ceiling level of the amplitude scale** is adjustable from the **default position of 10 to 30 dBg** range with the ◇ keys. The following ranges are available:

- 0 - 20 dBg
- 10 - 30 dBg
- 20 - 40 dBg
- 30 - 50 dBg
- 40 - 60 dBg

The advantage of moving the amplitude window is to **drop out of view spikes that are normal** in a particular vehicle, leaving the larger amplitude spikes for analysis. The display becomes less confusing and easier to interpret.

Default Settings for Frequency and Amplitude

Fig. 2-21



"VIBRATION" function
Continued

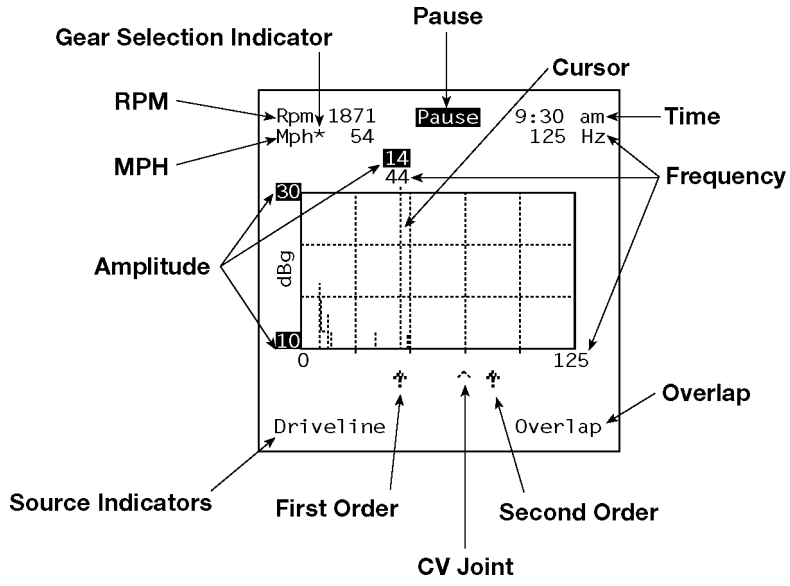
Additional display features include:

- RPM and MPH display
- Time display
- Cursor w/Hz and dBg (◁ ▷)
- "NO data" indicator for RPM/MPH

The **RPM** and **MPH** are displayed in the upper left corner of the screen. This data is collected from the **data link** connected to a **diagnostic connector** identified in the vehicle parameter screen.

Screen Indicators

Fig. 2-22



Many NVH complaints are related to **RPM or vehicle speed**. The display makes it convenient to monitor RPM and MPH from the check connector or data stream without additional test equipment.

There are two ways the tool obtains the data for RPM and MPH. The first is from the **data stream on late model vehicles** and the second is from the **IG- signal on non-data stream vehicles**. The tool is able to determine where to get the information when the vehicle is selected by the technician. The vehicles **parameters screen** has a line indicating the connector that has to be used. In addition, an **asterisk** is displayed next to the MPH indicator when gear selection is required by the user.

The tool is not able to determine the **gear selection** when using IG-. The technician needs to **press** F8 8 **and select the gear manually** for the driveline and wheel indicators to be accurate.

"VIBRATION" function
Continued

The default position for the gear selection is **the highest transmission gear available** and will be accurate when driving in that gear if a selection (F8 8) was not made.

Other differences between using the data stream and IG- include:

- The resolution of RPM on IG- is an actual reading, on the data stream it changes in 25 RPM increments.
- On IG- vehicles when the RPM is below 1600 the MPH reads 0.

RPM and MPH will be displayed if:

- The vehicle is equipped with functioning IG- in the under hood DLC1 (check connector)
- Data stream is available from the DLC1 (check connector), DLC2 (TDCL), or DLC3 (OBD2 connector)
- All connections are complete from the check connector to the NVH Analyzer
- The NVH Analyzer is functioning properly

"NO data" indicator for RPM/MPH is a feature that appears to let the technician know that there is **no communication** through the data link.

NOTE

When a vehicle has both IG- and a data stream, the data stream should be used for accuracy. Check for a DLC2 (TDCL) or DLC3 connector and use it if available.

NOTE

When using DLC2 (TDCL), the NVH Analyzer must be connected to the cigarette lighter for power. There is no B+ terminal in the DLC2 connector.

The **time** display provides the screen print with a **time stamp** which helps differentiate and sequence multiple printouts. It helps eliminate questions as to whether a printout applies to a specific vehicle or road test event.

A **cursor** is available with the use of the ◁ ▷ keys which allows the technician to find the exact frequency and amplitude of a particular spike. This is done by placing the cursor directly over the spike and reading the frequency and amplitude above the display. The indicators move with the cursor.

The cursor moves in **equal increments with each stroke** of the key or **progressively faster if the key is held**. If the end of the display is reached then the cursor automatically appears at the **opposite end** of the display.

Scale	Increment
500	4 Hz
250	2 Hz
125	1 Hz
62.5	.5 Hz

"NOISE" function (option)

The **noise selection** from the main menu will function the **same** as the vibration selection. The menus for vehicle setup are the same and the noise function uses the same diagnostic displays. The **exception** is in the parameters for amplitude.

- dB is used instead of dB**g**
- The floor and ceiling level default is **65 to 85 dB**
- The following ranges are available:

  45 - 75 dB
  65 - 85 dB
  75 - 95 dB
  85 - 105 dB
  95 - 115 dB

A **microphone** is used instead of an accelerometer as an input for sound. The microphone is **non-directional** and **cannot** be used to find the location of a noise.

Noise function operates the same as the vibration function because a **noise is also a vibration**. The same skills used to isolate a vibration are also used with noise.

It is important to understand that noise can also be generated by:

- Rattles
- Squeaks
- Wind

These are in **addition** to noises that can be generated by the three component groups indicated by the arrows on the displays:

- Engine
- Driveline
- Wheels and tires

Rattles, squeaks and wind noise will be discussed in the last part of Section 4 and in the **Wind and Interior Noise program**. The techniques used to diagnose these areas are different than noises related to the three major sources that the NVH Analyzer is able to display.

Rattles are usually **low frequency, low amplitude and intermittent** making them difficult to identify on a vibration analyzer.

Squeaks and wind noise are usually **high frequency** above the 500 Hz limit of the NVH Analyzer.

Other noises of significant amplitude, which are within the NVH Analyzer frequency limits, can be displayed on **either the vibration or the noise selection**.

"NOISE" function (option) Continued

The classification process discussed earlier is very helpful in identifying the frequency range of a noise to determine which diagnostic technique is most appropriate:

- For frequency ranges below 500 Hz, the NVH Analyzer can identify one of the three sources of vibration: engine, driveline, wheels.
- For frequencies above 500 Hz, a pinpoint diagnosis for rattles, squeaks or wind noise should be used.

The ability to **control the noise**, through test driving techniques, can produce a relationship between the noise and the spike displayed on the NVH Analyzer.

For example:

> If a noise appears at a specific speed or operating condition then the technician needs to become familiar with the data displayed when there is no noise. When the noise appears then the spike that was not there before should be identified. If the spike appears above a pointer associated with a component group then diagnosis should be directed in that area.

If the frequency of a vibration or noise spike is **not** associated with an arrow, then the frequency should be multiplied by 60 to find the RPM. The components operating at that RPM can be considered for diagnosis.

The **skills** developed in using the NVH Analyzer are now applied in the next area of diagnosis, the road test.

Road Test Procedures

Install NVH Analyzer to monitor and record NVH and vehicle data (See NVH Analyzer operating and instruction manual for details).

A **tachometer** is recommended if a NVH Analyzer is not available and the vehicle is not equipped with a tach. MPH can be noted from the speedometer.

A **road test course** should be selected that allows for **safe** operating conditions that will duplicate the customer's complaint. Frequent use of the same course will allow the technician to develop experience in predicting what normal vibrations can be expected during different aspects of the road test.

Known good vehicles should be analyzed on this course for comparison with complaint vehicles. This will be most helpful when looking for spikes, related to complaints, on a NVH Analyzer display.

Engine Run-up Test

After installing the NVH Analyzer, use the engine run-up test to determine if the complaint is **related to engine speed or vehicle speed**.

With the information from the interview sheet, and the complaint verification, try to **duplicate** the symptom by creating the same vehicle and operating conditions described by the customer.

Start at idle, cold or hot, (if applicable) then increase the engine RPM with the transmission in Park or Neutral.

If the symptoms occur, record the vibration to **capture the engine RPM, frequency and amplitude** of the complaint for future reference. Further road test procedures are **not** necessary.

If a vibration occurs, but does not directly relate to an engine vibration indicator, then an **accessory** such as power steering, A/C, or water pump should be considered.

These components operate at different speeds/frequencies relative to the pulley diameter. Using the calculations outlined in Section 1 and a photo tach, you can identify the accessory that is related to a spike on the NVH display.

Shifting the vehicle into neutral when the symptoms occur will also help confirm if the complaint is engine or vehicle speed related. If the vibration goes away as the engine RPM goes to idle, further diagnosis in the engine area is required.

Brake Torque Test

Some engine related vibrations may be sensitive to **load**. Block the wheels, set the brakes and raise the engine RPM with the transmission in drive. This will apply a load on the vehicle which may cause components to move and vibrate, that would not under normal operating conditions. Use the 3d screen to easily recognize unusual or different vibration.

For example:

- motor mounts
- exhaust system contact
- engine misfire

CAUTION Use care not to overheat the engine or transmission.

Light Acceleration Test

If the above tests do not duplicate the complaint then perform the light acceleration test. Accelerate on a smooth, level surface until the symptoms are present. Record the vibration at the point when it is most noticeable.

Note if the vibration changes or disappears when cruise is maintained, after acceleration. If it occurs perform a heavy acceleration to see if the condition can be exaggerated.

Heavy Acceleration Test

Some conditions require the vehicle to be under load, for example, a propeller shaft vibration. Heavy acceleration and/or a road test course that includes a hill will be helpful to provide the load required to duplicate the complaint.

For example:

> Loading and unloading a driveline is very helpful in isolating a propeller shaft condition, especially when there is an **overlap** indicated on the NVH Analyzer for driveline and wheels. As the driveline loading changes a propeller shaft vibration will change. A condition in the wheel area will tend to stay constant.

An overlap indication is indicated on the NVH Analyzer with the word "overlap" displayed on the screen and an LED light below the screen. When this occurs, the technician should **change the vehicle condition** to eliminate the overlap and observe the spikes that remain.

Some engine related vibrations, transmitted through the exhaust, are also more noticeable **under load** than during an engine run-up test.

Cruise

Cruise is often the most **common operating condition** of a complaint. It is much easier to "tune" into a particular symptom when it is continuous.

In addition to constant vibrations, beating vibrations that come and go need to be observed during cruise over a **longer period of time**. A noticeable beat may occur in 4-6 second cycles.

Although the customer may indicate that the vibration occurs at a particular speed, the road test should include several cruise speeds, (i.e. 35, 45, 55 MPH). The speed the customer mentions may be the most common operating speed and **not** the speed that produces the **greatest amplitude**.

For example:

> Tire vibrations are often most noticeable when they resonate with the suspension or steering system between 40 and 55 MPH. Driveline vibrations are often more noticeable at speeds above 50 MPH.

A road test should also include some rough road to **induce energy** into the suspension that may produce vibrations or shimmy in the steering wheel.

For example:

> A leaking front strut will cause a suspension and steering system to resonate on a rough road.

Rough road conditions may also **produce noises** such as squeaks or rattles that are not as noticeable on a smooth road.

Coasting

The advantage of coasting is that it **eliminates engine vibrations** and **load**. The vehicle environment may become quieter making it easier to notice noises that are **masked** by other sounds.

Deceleration

Deceleration is similar to coasting with the **addition** of **load** caused by engine compression. The load is a different force then load applied during acceleration. This will cause components to react differently under these conditions, producing a larger level vibration.

Turning

CV joint symptoms often appear in a turn when the joint angle increases. In many cases, the NVH Analyzer will show an overlap with a third order wheel vibration. Putting a load on the CV joint may **increase the level of the vibration**, while the third order wheel level would remain the same.

Turns are also helpful in identifying vibrations from components **which contact the body**. **Worn suspension parts** may shift with a side load.

The customer interview sheet can be very helpful to identify the need for this type of test.

Jounce Test

A technician may be able to reproduce a noise by simply **bouncing the vehicle up and down**. It should be done at each quarter of the vehicle while observing components and listening for sounds. A second person is helpful during this test.

Additional Road Test Considerations

When the symptom is at its most noticeable level, the technician can try to **control or modify the symptoms** to help isolate the source. The following chart is a list of additional items to keep in mind while trying to diagnose a complaint. You may add items as you gain experience with NVH diagnosis:

Item	Description
Vehicles w/o locking torque converters	A few of our vehicles do not have locking torque converters. The NVH Analyzer calculates MPH using RPM and the gear ratio data base. In these cases it is important to make sure the vehicle is **not** under load and that stable cruise has been established for accurate driveline and wheel arrow indicators.
Brake application	Lightly applying the brake at cruise may produce a vibration at wheel speed frequency. Pedal feel is important during this procedure. Lightly applying the parking braking will do the same as the above but only to the rear wheels. This can be helpful in isolating a front or rear brake condition. Caution: Use care not to overheat the brakes in this procedure. Damage and additional vibration may result.
4x4 vehicles	4x4 vehicles have additional driveline components that may be engaged, disengaged or removed to determine which group is contributing to the complaint,
Accessories	Turning accessories on and off may also have an impact on the symptoms. They may cause a belt to resonate or slip. This test may also effect an accessory condition caused by a worn bearing, mounting or slipping A/C clutch.
Electric cooling fans	Cooling fans often require a specific temperature level to engage. A fan imbalance or runout condition may only be identified when the fan engages at that temperature.
Power steering	Symptoms relating to power steering may be temperature related. These conditions may only be present with the system under load. For example: a vibrating high pressure hose caused by incorrect mounting or routing.

Alternative Diagnostic Methods

Although the road test or a dynamometer is ideal, and sometimes the only way to duplicate a customer complaint, the use of a **lift or safety stands** can also be helpful for diagnosis.

In order for this technique to be **safe and effective**, the following details must be considered:

- **Verification** of the customer complaint is very important to determine when diagnosis **without** a road test will produce the symptoms. Not all complaints can be duplicated without setting up the same vehicle and operating conditions. For example, the ability to apply a load to a system.
- To duplicate many driveline and suspension complaints the vehicle has to be raised maintaining the correct **operating angles**.

NOTE New vibrations may occur on a lift that do not exist on the road. This is due to the change in loading of the suspension and possible interaction of the vehicle with the lift. The lift is now carrying the weight of the vehicle not the tires and wheel bearings.

CAUTION **Balance is critical** in safely operating a vehicle in a shop. Normal vibrations may cause a vehicle to move out of position or fall.

- Operating one drive wheel while the other is stationary is a technique used to isolate a symptom. The front wheels on a FR vehicle or the rear wheels on a FF vehicle cannot simulate operating movement and will not contribute to the vibrations in a vehicle. This can be helpful if the vibration complaint that was verified goes away.

It is important to remember that the wheel will rotate at **twice** the speed indicated on the speedometer, due to the differential.

For example:

If the speedometer is indicating 40 MPH and one drive wheel is stationary while the other is turning, then the turning wheel is rotating at 80 MPH.

If the stationary wheel is on the ground the vehicle could move causing severe damage. This is especially true in vehicles with limited slip differentials.

NOTE **Traction Control** must be turned **off** on vehicles so equipped. Due to the differential in wheel speed the system will activate.

The **advantages** of this type of diagnosis include:

- The ability to perform a good **visual inspection** while the vehicle is operating. For example, observing runout of a wheel or tire.
- The ability to use tools such as a stethoscope or a screw driver to **amplify a vibration** on specific components

WORKSHEET #4A
Road Test

Vehicle	Year/Prod. Date	Engine	Transmission

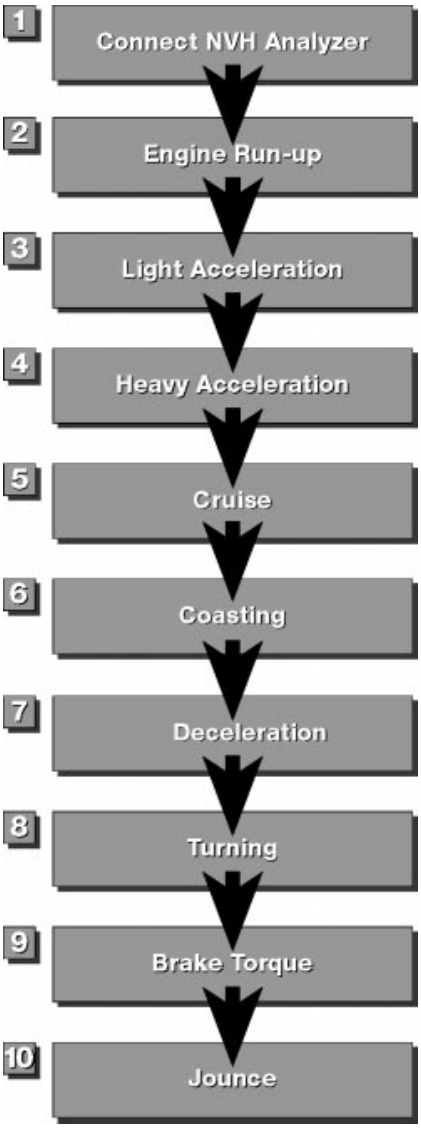
Diagnostic Description: **Road Test with the NVH Analyzer Vibration Function**

The road test is a **diagnostic procedure** designed to **duplicate** and **manipulate** the symptoms in order to gain as much **additional knowledge** as possible. This knowledge will help identify the source of the symptom by a **process of elimination**.

This worksheet is the **third** in the series of worksheets that is used to diagnose the conditions placed in the **shop vehicles** by your instructor.

Road Test Procedures

Fig. 2-23



Instructions

1. The technician should use all the information collected during the Verification of the complaint (worksheet #1) and the Classification Flow Chart (worksheet #2) to establish a **road test plan** that is most likely to **duplicate** the symptom/s. The symptom/s can then be **manipulated** and **measured** with the NVH Analyzer. (Refer to Section 2 of the technician handbook.)
2. Consider the possible sources of the complaint from the information in step #1 and **develop a strategy** for **analyzing** the NVH data during the road test.
3. **Connect** the NVH Analyzer to the vehicle, perform the road test and **save** the data relating to the symptoms.
4. **Take notes** regarding the road test procedures and results for **review** with the saved data.

   For example:

   > Note if the symptom was most noticeable in a left turn on a hill. The analyzer will display MPH and RPM but cannot tell you the additional information about the road test that you my have performed to duplicate the symptom. With several possible saved samples you may become confused without good notes.

5. **Review** the data saved on all the displays using the skills developed during NVH data analysis worksheets #3A, #3B & #3C.
6. **Identify** the spikes on the 2d and 3d displays that are associated with the symptoms and **compare** the conclusions with the data on the barchart display.
7. Determine the **source** of the symptoms, including the **order**, that will be the focus for the **pinpoint diagnosis**.
8. **Print** the screens and **attach** with the space provided to support your conclusions.
9. **Add the notes** from the road test that will help **identify** the source of the complaint and the pinpoint diagnosis area.
10. **Compare** your results with the plan you formulated in step #1 and #2.
11. **Remove** the “bugs”, **retest** and **compare** your results. Attach screen print to the space provided.

Questions

1. **List** the road test procedures you plan to use to **measure** and **duplicate** the complaint.

   _____

   _____

2. What is the advantage of making the **road test plan prior** to performing the test?

   _____

   _____

3. What **page** in Section 2 did you find the details of the road test?

   _____

4. **Outline** the strategy you plan to use to **analyze** the NVH data during the road test.

   _____

   _____

   _____

5. **Where** did you connect the **data link cable** to the vehicle?

6. How did you determine this **location**?

7. **Where** did you locate the **accelerometer** and why?

8. List **two** items that are important to consider when **positioning** the accelerometer. Explain each.

9. **How many people** should be involved in a road test and why?

10. **How many events** should be saved and why?

11. What are **two** advantages of taking the **printer** along for the road test, if available?

12. **How many large spikes** are displayed on the 2d display?

13. **Record** the frequency and amplitude of the **significant** spikes on the chart below.

	FIRST ORDER Freq/Ampl	SECOND ORDER Freq/Ampl	THIRD ORDER Freq/Ampl
ENGINE	/	/	/
DRIVELINE	/	/	/
WHEELS	/	/	/

14. What is the **incremental movements** of the cursor on the:

- 62.5 Hz scale _____
- 125 Hz scale _____
- 250 Hz scale _____
- 500 Hz scale _____

15. What happens to the **cursor** if you **hold** your finger on the key?

_____

16. On the **barchart** display which component sources indicate a large level of vibration/energy?

_____

17. **Manipulating** the vibration during the road test can be seen **best** on which display? Explain.

_____

18. Which display would show a **beating symptom** the best? Explain.

_____

19. What is the **next display** you would look at once a beating symptom has been observed in question 18? Explain?

_____

20. Which vibration **changes** frequency when **different gears** are selected with a **constant vehicle speed**?

_____

21. What are the advantages of the **time indicator**? Explain.

_____

Conclusion

1. Based on the information used to set up the road test and the data from the NVH Analyzer, what is your **plan of action** for the **pinpoint diagnosis**?

2. Did you notice an **improvement** in the vehicle condition after the “bugs” were **removed**?

3. Did the NVH Analyzer **indicate** an improvement? How much?

4. Upon **discovering** the “bugs” was your **plan** for pinpoint diagnosis **on track**? Explain.

2D	BARCHART	3D
BEFORE		
ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE
AFTER		
ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE
COMMENTS		

WORKSHEET #4B
Road Test

Vehicle	Year/Prod. Date	Engine	Transmission

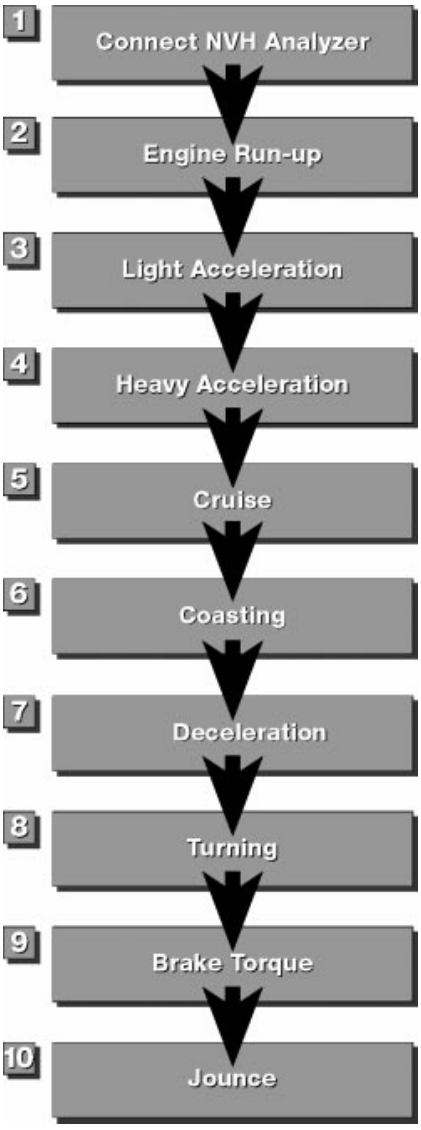
Diagnostic Description: **Road Test with the NVH Analyzer Microphone Function**

The **microphone** (optional) is added to the Toyota Diagnostic Tool Set to assist in **diagnosing noise complaints**. It uses the same menus, displays and key strokes as the vibration function.

This worksheet is designed to demonstrate the **functions** of the noise analyzer with the microphone.

Road Test Procedures

Fig. 2-24



Instructions

1. On the same vehicle you diagnosed in worksheet #4A, connect the NVH Analyzer with the microphone and **select** the NOISE function on the NVH MAIN MENU.
2. Road test the vehicle **duplicating** the symptom and **review** the data on all the displays.
3. **Move** the microphone around the vehicle and **note** any changes.
4. **Save** representative displays that provide the **clearest** view of the spikes associated with the complaint.
5. **Print** each display and **compare** them to the print outs captured in worksheet #4A. Attach screen print to the space provided.

Questions

1. Are there any **differences** in the menu structures, key strokes or displays? Please list.

2. What **frequency ranges** are available for diagnosis?

3. How is the **amplitude** measured?

   What are the **ranges**?

4. When the microphone was moved around the vehicle did you note any **significant change**?

5. What **conclusions** can you draw about the use of the microphone in finding the **location** of a noise?

6. Where is the **best location** for the microphone for noise diagnosis?

7. What **types** of noises can be diagnosed with the microphone? Explain.

8. What type of noises cannot be diagnosed with the microphone? Explain.

9. How would you **resolve** noise complaints that are **not** diagnosed with the NVH Analyzer?

   Where do you get the **information**?

10. What are the **similarities** between the microphone and the accelerometer for diagnosis?

11. What **principle** in Section 1 of the text explains the **phenomenon** in question 10?

2D	BARCHART	3D
BEFORE		
ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE
AFTER		
ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE	ATTACH SCREEN PRINT HERE
COMMENTS		

Summary

At this point in the diagnosis, the technician has used the following to classify the complaint:

- Interview sheet
- Flow chart
- Road test with NVH Analyzer

The classification process has reduced a large list of possible symptoms to just a few which fit the complaint.

The technician can now use the specific characteristics associated with the symptom to perform the pinpoint diagnosis, which will be the subject of the next section. (See Section 1 details on the characteristics associated with a specific classification)

Case Study: Part III

The interview sheet was used to choose the following road test from the procedures outlined on the road test reference card:

- *40 - 60 MPH*
- *Cruise*

The NVH Analyzer "Vibration Selection" was used during the road test to capture the data. The technician selected the vibration function because the complaint was described as a vibration and a noise. We know that a noise is also a vibration which can be displayed on the tool. (Section 1)

The displays shown were selected based on the information gathered during the verification of the complaint.

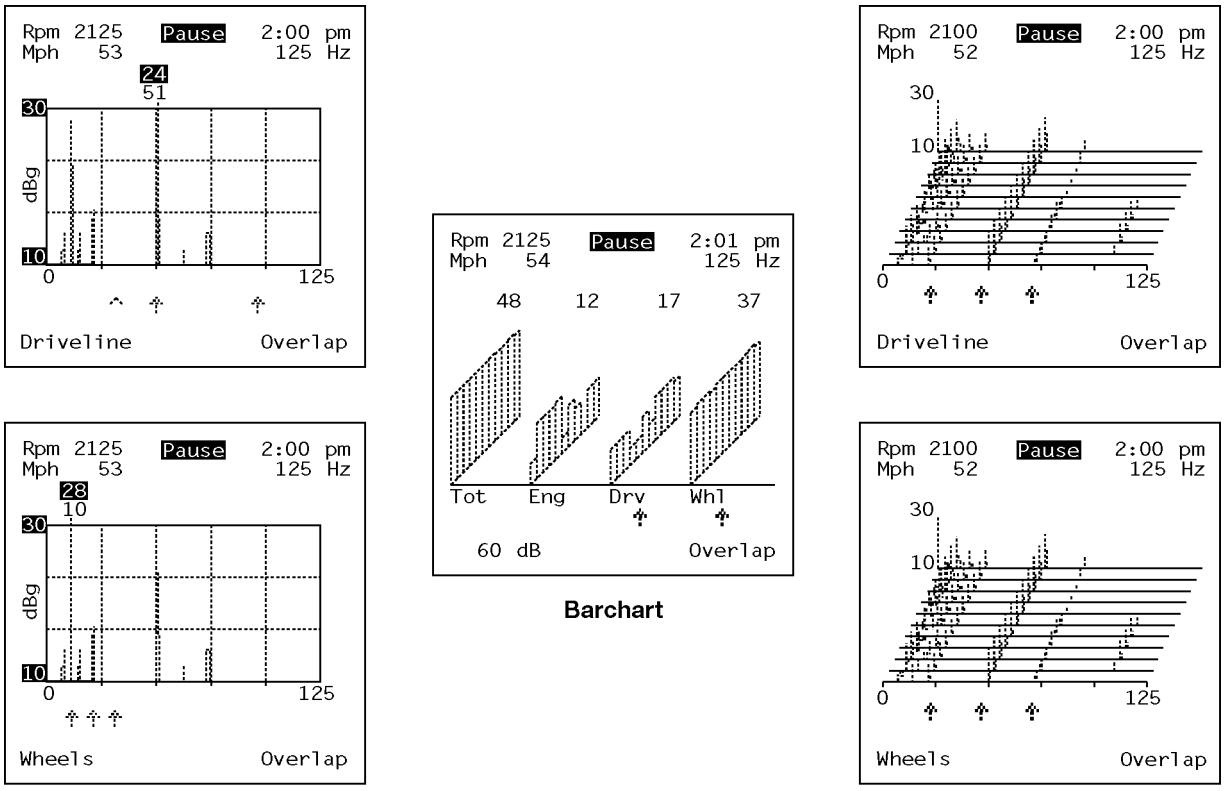
- *Barchart display shows the largest amount of energy divided between the **wheel and driveline** areas, with very little energy visible in the engine area.*
- *2d display shows **two large spikes** in the 125 Hz frequency range.*
  - *The default frequency band (125 Hz) clearly displays the two spikes in question*
  - *The default amplitude window eliminates spikes that may normally appear in a 4Runner*
  - *The cursor is moved over the spikes in question to display the exact frequency and amplitude*
  - *The F3 key is toggled to see if the engine, driveline or wheel arrows line up with the spikes*
  - *Two displays are captured and printed for future reference, because at 55 MPH the 12 Hz frequency spike lines up with the wheel arrow and the 54 Hz frequency spike line up with the driveline arrow. This information supports the data shown on the barchart display.*

Case Study: Part III
Continued

The 3d display is consulted during the road test to follow the movement of the largest spikes while the operator alters the symptoms observed between 40 and 60 MPH. We verify that the spikes in question are ***vehicle speed sensitive*** *versus engine speed sensitive. When the driver shifts the vehicle to neutral, at the point when the symptoms are most noticeable, the spikes remained.*

4Runner Scenario

Fig. 2-25



The data indicates that there are ***two possible conditions*** *contributing to the complaint. One in the area of* ***wheels*** *and the other in the area of* ***driveline****.*

The road test eliminated the engine as a source of the complaint and maximized the symptoms for measuring.

The next section will deal with the pinpoint diagnosis of the ***steering shimmy*** *and the* ***body booming*** *in the* ***driveline and wheel areas****.*