Data Reference Guide
Version 4
Volume IV: Signal Waveform Generator Tests

U.S. Department of Transportation
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http://www-nrd.nhtsa.dot.gov/nrd10/software

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TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

PREFACE

This guide documents the format of magnetic media (3.5 inch high density diskettes) to be submitted to the National Highway Traffic Safety Administration (NHTSA) for SWG tests. This guide is designated Volume IV. NHTSA Data Reference Guide (Signal Waveform Generator Database). Three other volumes exist; they correspond to the other NHTSA databases: I. NHTSA Data Reference Guide (Vehicle), II. NHTSA Data Reference Guide (Biomechanics), III. NHTSA Data Reference Guide (Component).

While the four databases are similar, they differ significantly as well. Your data submission will be returned as unacceptable if you submit data in the wrong format for a particular database.

The first step in creating a data submission is to determine which volume of the guide (vehicle crash tests, biomechanics tests, component tests, or signal waveform generator tests) to use. The surest method of determining which volume is appropriate for your use is to check with the Contracting Officer's Technical Representative (COTR) who should be able to identify the appropriate database format. The following guidelines will help to explain the differences between the four databases.

Information in the vehicle database relates to the performance and response of vehicles and other structures in impacts.

The biomechanics database contains information used (1) to evaluate human impact response, (2) to evaluate prototype dummy designs, or (3) to evaluate standard dummy designs in new impact environments.

A component test identifies a specific vehicle component and/or dummy part and summarizes test conditions. Component tests are conducted on various internal or external components of automobiles to provide force deflection or time series data for use in computer simulation models available to NHTSA.

Information in the signal waveform generator database relates to the evaluation of data acquisition systems at sites performing vehicle crash and biomechanics tests.

A biomechanics test always has exactly one occupant; a vehicle test may have zero occupants or many occupants but normally utilizes dummy occupants.

Raw data meeting the requirements of SAE J211/1 MAR 95, CFC 1000 is required unless submission of filtered data is authorized by the Contracting Officer's Technical Representative (COTR).

Several examples may help to illustrate where certain types of tests fit into the databases:

- Tests done as part of the new car assessment program are always vehicle tests.
- Pendulum tests to cadavers are always biomechanics tests.
- Lateral vehicle-to-vehicle impacts are vehicle tests.
- Sled tests with new dummy designs are biomechanics tests.
- Calibration tests are component tests.
- Tests featuring a car body on a sled designed to evaluate occupant response are biomechanics or vehicle tests.
- Tests using dummy components are always component tests.
- Tests (either static or dynamic) measuring deformation impact of a particular interior or exterior component of an automobile by dummy or dummy part are component tests.
- Tests evaluating data acquisition systems are signal waveform generator tests.
- Tests to record a standard waveform using new car assessment conditioning amplifiers are signal waveform generator tests.

Always check with the COTR in determining which format to use. In all cases where the COTR's advice is contrary to this guide, check with Barbara Hennessey at (202)366-4714.

When a diskette has been generated according to the appropriate guide, it should be sent via CERTIFIED MAIL to:

The COTR

-or-

Barbara Hennessey
NHTSA, NRD11, Room 6226
400 Seventh Street, S.W.
Washington, DC 20590

More than one submission may be mailed at one time. The following must be supplied for each mailing:

- A cover letter containing a description of each test on each diskette or series of diskettes. This description should contain the database into which the test should be loaded, the contractor's test reference number, the date of the tests, the test vehicles, component part and the test configuration.

- A label on each diskette listing all tests, along with the contractor's test reference numbers.

- A sheet containing a dump of the specification data for each test.

- A copy of the plot of each channel of measurement data identifying the curve number and the location and axis of each instrument. These plots do not have to be report quality since they will only be used to verify the test data for each channel.

As soon as possible after each test, a copy of the final test report (if a report has been generated) should be sent to the above address. The COTR should be consulted if different arrangements for the test film and report are required, as would be the case for a test not conducted under DOT auspices.

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INTRODUCTION

BACKGROUND

In September of 1966, the National Traffic and Motor Vehicle Safety Act (15 U.S.C. 1381) was signed into law in the United States. The Act specifies that the Secretary of Transportation shall establish appropriate Federal Motor Vehicle Safety Standards that would lead to the reduction of the number of deaths and injuries resulting from motor vehicle accidents. In prescribing standards, the Secretary was to consider: (1) relevant motor vehicle safety data, (2) whether the proposed standard is reasonable, practical, and appropriate for the particular type of motor vehicle equipment for which it is prescribed, and (3) the extent to which such standards contribute to carrying out the purposes of the Act.

In order to meet the above requirements, the National Highway Traffic Safety Administration (NHTSA) has been mandated to develop safety standards. For each proposed regulation, an extensive research program is undertaken to ensure that the proposed standard satisfies the requirements of the Act. The NHTSA vehicle (crash), biomechanics and component databases support these research programs. For each test conducted for the agency, a formatted magnetic data submission on diskette is generated. The diskette contains specifications about the test as well as the measurement data acquired from the test instrumentation. The specification data is loaded into a database which has routine database functions. Analysis techniques are developed for evaluation of the measurement data.

The signal waveform generator (SWG) database was initiated in 1986 and currently contains results from over 70 tests conducted to verify the accuracy of test sites data acquisition systems. An important attribute of this database is that it provides a standardized format that allows for exchange of data among participating researchers.

This reference guide has been written for two reasons. The first is to document the requirements for the generation of a data diskette. The second is to encourage the adoption of this standardized format so that the exchange of data by the safety research community is readily accomplished and ultimately leads to new and better ways for reducing the fatalities and injuries in motor vehicle accidents.

WHAT IS SWG TESTING?

This testing determines whether the performance of a DOT crash test contractor's DAS meets certain requirements of the Society of Automotive Engineers (SAE) recommended instrumentation practices J211 [Appendix D], as required by DOT contract specifications.

The evaluation test of a crash test facility data acquisition system (DAS) is performed by providing precise electrical signals at the sensor interface (input) to the DAS and recording those

signals with the DAS. The recorded signals are processed by special purpose signal processing software to measure the quality of DAS performance. The test contractors are required to set up their DAS in the same manner as for a regular crash test except that a NHTSA furnished signal waveform generator (SWG) is connected to the sensor interface to provide the input signals.

The SWG provides precise waveform and time reference inputs to the DAS for testing and is described in detail in the SWG operator's manual [Appendix D].

The timing accuracy, amplitude accuracy, and frequency response of each data acquisition channel under test are determined from the recorded data by the SWG signal processing software. The special purpose software developed for processing the recorded waveform data is described in the software documentation [Appendix D].

ORGANIZATION

The guide is divided into two portions: the first consists of the definitions of the data gathered during tests (for use as a reference tool by new users), and the second consists of a series of appendices. In addition to definitions, the definition section includes, for each field, the number of allowable characters, the type of field (integer, text, coded text, and real), and the acceptable units for the entry.

Included in the pocket under the front cover of the guide is a diskette containing the PC-based data entry program, ENTREEW, which may be used to generate the data files described in this document.

The data to be collected during the testing are grouped into two general categories: general test information; vehicle information and instrumentation information. The organization of the first portion of the guide corresponds to this data grouping scheme, with each chapter comprising one category of data elements:

Chapter 1, **GENERAL TEST INFORMATION**, includes the definitions of data elements identifying the test (e.g. title, contract number, date, performing contractor).

Chapter 2, **INSTRUMENTATION INFORMATION**, describes each of the data channels in the test (e.g. number of data points, signal source, signal level).

Four appendices appear at the end of this guide:

Appendix A, **MAGNETIC MEDIA FORMAT**, gives an explanation for formatting the data and provides a brief description of the data entry program, ENTREEW, which may be used to generate the required data files in either NHTSA's own binary format or in ASCII format.

Appendix B, **CODES**, is a listing of the valid codes for each field.

Appendix C, **FIELD FORMATS**, lists each field, in sequence, the data type, and the maximum field length.

Appendix D, **REFERENCE MATERIALS**, explains the rules for determining sign conventions and lists pertinent reference documents such as Instrumentation for Impact Test -- SAE J211/1, and the operator's manuals for the waveform generator and signal processing software, which provide helpful information for the preparation of data submissions.

DATA REQUIREMENTS

Data is collected during testing for eventual transmission to diskette. The format is fixed, thus the data must be transcribed with precision so that it can be read by the processing software.

Users are encouraged to utilize the data entry program, ENTREEW, which formats the specification data files automatically and performs validity checks to avoid cross field compatibility and numeric range errors, omissions and miscodings.

ENTREEW output files may be written in one of two ways; either in a special binary format, which NHTSA's in-house processing software loads directly into the NHTSA databases, or the files may be written in ASCII, for purposes of data exchange outside the agency.

(The format is described in detail in Appendix A: Magnetic Media Format.)

Empty Channels

Instrument channels having no data are not of interest. If channels are bad or empty, an indication of their status should be made in DASTAT (see Appendix B for the allowable codes for DASTAT). Further comments on the status of the data should be made in INSCOM (instrument commentary) -- a code of MN (meaningless) requires an explanation in INSCOM, for example.

CONVENTIONS FOR CODING

The coded fields SENATT, SENTYP, AXIS, and UNITS refer to the sensors that would be connected to the input of the DAS channel under test during a regular crash or sled test. SIGSRC and SIGLEV refer to the SWG outputs used to provide an input to the DAS channel under test.

Some of the coded fields include NOT APPLICABLE and OTHER codes as options. The NOT APPLICABLE code should be used only if the category is not relevant to the data being collected. If the data file is written in ASCII rather than the NHTSA ENTREE binary format, empty fields are delimited by the pipe (|) character. For text fields, a left-justified NOT APPLICABLE will be entered.

OTHER Code Option

The code option, OTHER, should be used if the data element is applicable but none of the codes is appropriate. Any time the option OTHER is chosen, a brief explanation must be included in the general comment field for that group.

EMPTY FIELDS

Some fields may be left blank if no data is available or the field is not applicable to the test.

Coded text fields may not be left blank, since there are codes which indicate when a field is either not applicable or no data is available.

MEASUREMENT UNITS

Use metric units only.

For a list of acceptable units and corresponding codes, see Table 2 - 1.

CERTIFICATION REQUIREMENTS

In order to raise and maintain the level of quality of data diskettes being submitted for inclusion in the NHTSA databases and to insure more efficient processing, a certification process is being instituted effective with this new data format. Each contractor must complete this certification process before we will accept data in the new format. To complete the certification process, contractors will follow the steps listed below:

- **Submit Data in Appropriate Format**

  Each contractor will submit data in the new format for certification approval. The diskette will be submitted in the Signal Waveform Generator Database format (or the format for which certification approval is desired). The test written to this diskette may be an old test, a new test submission, or a sample test if an old or new test is not available.

- **Repeat Submissions Until Certification is Achieved**

  The diskette will be checked for compliance with the magnetic media processing guidelines. If the data submission is found to be acceptable, a certificate will be sent to the contractor denoting compliance with the current version of the NHTSA magnetic media format. If the data submission is not acceptable, the contractor may repeat the submission until an acceptable diskette is produced.

- **Earn Certification for Each Format**

  A certificate will be required for each format: vehicle crash test, biomechanics test, component test, or signal waveform generation. A contractor submitting diskettes in more than one format will require a certificate for each. The certificate may be revoked whenever it is evident that a contractor is not maintaining the required level of quality in data submission.

- **Do Not Submit Diskettes Without Being Certified**

  Only after a contractor has completed this certification process will data be accepted for inclusion in the OCR databases.

- **Submit Certificate with Future Bids**

  For Research and Development contracts, this certificate will be kept on file in the NHTSA Office of Contracts and Procurement and must be submitted as evidence of compliance when bidding for future contracts. If a proposal on a Research and Development-sponsored RFP is received from a bidder without a valid certificate, the proposal will be rejected as non-responsive to the solicitation. Each Research and Development RFP requiring the submission of data should contain a statement to this effect.

- **Incur Costs for Unacceptable Tapes**

  For all NHTSA contracts, including Research and Development contracts, when a data submission is returned to the contractor as unacceptable because of errors, a resubmittal may be validated at a specified cost to the contractor per data resubmission. If required, payment to the Government for this shall be made by offset against the contractor's invoices. Each NHTSA contract which requires the submission of data diskettes will contain a clause to this effect.

RETURN POLICY

If a data diskette cannot be processed or has too many errors flagged by the loading and checkout programs, the submission will be returned to the contractor to be corrected and resubmitted. Two categories of errors lead to the return of a data submission.

MAJOR ERRORS

The first category is major errors. If one major error occurs during the processing of a diskette, the submission will be returned. Examples of major errors are:

- Inability to read or load the diskette.
- Missing data without which the data submission cannot be processed, such as DELT, NFP, SIGSRC, etc.
- Omitted data where data fields have been left out. Examples include leaving out an instrument channel, or data shifted as a result of a field delimiter being omitted.
- Split channels, which occur when one test is artificially split into two on the diskette with part of the measurement data filed under each.
- The rejection of one test on a diskette containing multiple tests.

MINOR ERRORS

The second class of errors is minor errors. If ten or more minor errors occur on a diskette, it will be returned. Examples of minor errors are:

- Conversion errors in the measurement data whereby one of the values cannot be read.
- Incorrect codings, such as entering a nonvalid sensor attachment code in the SENATT field.
- Missing or incorrect information not critical to the processing of the tests.
- Anything else not listed here that is flagged by the loading or checkout programs.

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1. GENERAL TEST INFORMATION

The data elements defined below comprise the first test group, General Test Information. Appendix B contains a list of valid codes.

TSTNO - Test Number

TSTNO is a preassigned code (0) which is utilized by the data processing software when loading ASCII format input files into the NHTSA SWG database.

Coded text, fixed length, 1 character.

VERNO- Version Number

VERNO is the version number of this NHTSA Signal Waveform Generator Reference Guide, which is a preassigned code (S4). This code should be chosen for all SWG tests.

Coded text, fixed length, 2 characters.

SWGNO - Wave Generator Serial Number

SWGNO is the serial number of the signal waveform generator used in the test. The original SWGs have serial numbers ranging from 1 to 10. The new SWG hardware upgrades have a serial number assigned to the PCIP-AWFG/2 card by the manufacturer, which is a six digit number.

Free text, variable length, maximum 6 characters.

TITLE - Contract or Study Title

TITLE is the title of the contract or study.

Free text, variable length, maximum 70 characters.

TSTOBJ - Test Objective

TSTOBJ is a description of the purpose of the test.

Free text, variable length, maximum 70 characters.

TSTDAT - Test Date (DD/MMM/YYYY)
TSTDAT is the date the test was performed.

Date text, fixed length, 11 characters.

CERDAT - Test Date (DD/MMM/YYYY)
CERDAT is the date the SWG certification/recertification date.

Date text, fixed length, 11 characters.

TSTPRF - Test Performer
TSTPRF is the code for the name of the organization performing the test.

Coded text, fixed length, 3 characters.

CONNO - Contract Number
CONNO is the Department of Transportation contract number (for example, DTNHxx-xx-x-xxxxx in the case of a NHTSA contract or some similar number assigned by the sponsoring organization).

Free text, variable length, maximum 17 characters.

TSTREF - Test Reference Number
TSTREF is an alphanumeric code number assigned to the test by the test performer. The test reference number follows the format DDMMYYXXXX, where XXXX are four characters designated for the contractor's use.

Free text, variable length, maximum 10 characters.

TSTTYP - Test Type
TSTTYP indicates the type of test conducted.

Coded text, fixed length, 3 characters.

TEMP - Ambient Temperature (degrees Celsius)
TEMP is the temperature at the test location at the time of the test.

Numeric field, integer.

RECTYP - Type of Recorder
RECTYP is the type of data recorder being used in the test.

Coded text, fixed length, 3 characters.

LINK - Data Link to Recorder
LINK is the type of connection from the SWG to the recorder.

Coded text, fixed length, 3 characters.

TOTCRV - Total Number of Curves
TOTCRV is the total number of recorded instrument channels (curves) in the test.

Numeric field, integer.

TSTCOM - Test Commentary
TSTCOM is the field used to describe any peripheral test information for which a coded field does not exist, including anomalies or problems. The reason for coding OTHER or NOT APPLICABLE in any of the coded fields in this group should be recorded in this field as well. If no comments are to be made, code the field NO COMMENTS (left justified).

Free text, variable length, maximum 70 characters.

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2. INSTRUMENTATION INFORMATION

The data elements defined below constitute the second test group, Instrumentation Information. Appendix B contains a list of valid codes.

Approximately twenty milliseconds of data prior to time zero should come with all measurement data; data shall meet the class 1000 specifications of the SAE J211 recommendation; and all data should be truncated at a common time value to avoid extending the pulse well past the period of significant activity.

The minimum sample rate shall be 10000 Hz. A sample rate should be chosen such that the DELT value does not have to be rounded off.

TSTNO - TEST NUMBER

TSTNO is a preassigned code (0) which is utilized by the data processing software when loading ASCII format input files into the NHTSA Vehicle database.

Coded text, fixed length, 1 character.

CURNO - Curve Number

CURNO is the sequential number (1,2,3 ...) assigned to a specific sensor and data curve.

Numeric field, integer.

SIGSRC - Signal Source

SIGSRC identifies the SWG output channel connected to the channel under test.

Coded text, fixed length, 4 characters.

SIGLEV - Level (millivolts)

SIGLEV specifies the nominal full scale level of the signal applied to the channel under test. The values of SIGLEV range from 5 to 5000.

Numeric field, integer.

SENTYP - Sensor Type

SENTYP indicates the type of sensor which would normally be used for collecting the measurements at the time of the test, such as AC for accelerometer. If the channel is not dedicated to a given type of sensor, the code OT for other may be used.

Coded text, fixed length, 2 characters.

SENLOC - Sensor Location

SENLOC indicates the location (seating position) of the test occupant or corresponding occupant restraint to which the sensor would normally be attached. If the sensor would be attached to the vehicle, SENLOC should be coded NA. If the sensor location is unspecified, code OT for other.

Coded text, fixed length, 2 characters.

SENATT - Sensor Attachment

SENATT indicates where the sensor is attached. For example, the code APLR would be entered for an attachment on the right A-pillar. If the sensor attachment is unspecified, code OTHR for other.

Coded text, fixed length, 4 characters.

AXIS - Axis Direction of the Sensor

AXIS is the axis direction of the sesnsitive or input axis of the sensor that would be connected to the DAS channel under test during normal crash or sled tests. The global coordinate systems are vehicle fixed; the local systems are local within the vehicle global system. With respect to the vehicle longitudinal axis, X is positive forward, Y is positive right, (toward the passenger's door) and Z is positive down. These can differ depending on the component. For example, with the steering assembly, positive X is down the column axis and Y is positive right (toward the passenger's door).

AXIS is always applicable when the measurement is a vector quantity (acceleration, force, velocity, and so forth). Figure 2-1 illustrates the body- and vehicle-based coordinate system. Note that the head accelerometer array is a local coordinate system.

Included in Appendix D are the required sign conventions for various possible measurements. Only these sign conventions are acceptable.

Coded text, fixed length, 2 characters.

UNITS - Data Measurement Units

UNITS indicates the units used to measure the signal of the sensor data. (Refer to Table 2-1 for the only acceptable units.) If the units are unspecified, code VOL for volts.

Coded text, fixed length, 3 characters.

PREFIL - Prefilter Frequency

PREFIL is the cutoff frequency in Hz of a low-pass analog anti-aliasing filter used prior to digitizing data. This frequency is defined as where filter gain equals 70 percent (-3dB).

Numeric field, integer.

INSRAT - Instrument Rating

INSRAT represents the maximum value that can be accurately measured by the recording system for a channel. INSRAT should be in the same units as the data channel.

Numeric field, integer.

CHLMAX - Channel Maximum Rating

CHLMAX represents the full-scale value of the data based upon the actual test setup, including signal conditioning, as a percentage of INSRAT.

Numeric field, integer.

NFP - Number of First Point

NFP represents the index number of the first point in the data array (less than or equal to 0). Time zero always has an index number of 0. If no data exists prior to time zero, NFP is equal to 0; if 20 data points exist prior to time zero, NFP is equal to -20. There may never be more than 10,000 points before time zero.

Numeric field, integer.

NLP - Number of Last Point

NLP represents the index number of the last point in the data array. If 1,000 points were digitized, and NFP is equal to -100, then NLP is equal to 899. NLP can never be greater than 99,999.

Numeric field, integer.

DELT - Time Increment (microseconds)
DELT is the time increment in microseconds between each data point. DELT is assumed to be constant for all data points for a given sensor (uniform sampling frequency).

Numeric field, integer.

DASTAT - Data Status
DASTAT indicates the status of the data as it appears in the data submission. This field is used to indicate a signal which is invalid (code MN for meaningless), or which becomes questionable or invalid part of the way through a signal (code CF and explained in INSCOM).

Coded text, fixed length, 2 characters.

CHSTAT - Channel Status
CHSTAT indicates whether the data channel is primary or redundant. If, for example, a dummy is instrumented with a backup triaxial accelerometer in the head, the redundant channels should be labeled R. The occupant's HIC value would be calculated using the primary head channels, labeled P.

Coded text, fixed length, 1 character.

INSCOM - Instrumentation Commentary
INSCOM is any further commentary on the instrumentation data, including any unusual conditions affecting the data or a reference to a document that describes problems with a particular curve. The contractor shall also uniquely identify the equipment used for the DAS channel under test. The reasons for coding any of the coded fields in this group OTHER or NOT APPLICABLE should be recorded in this field as well. If no comments are to be made, enter NO COMMENTS.

Free text, variable length, maximum 70 characters.

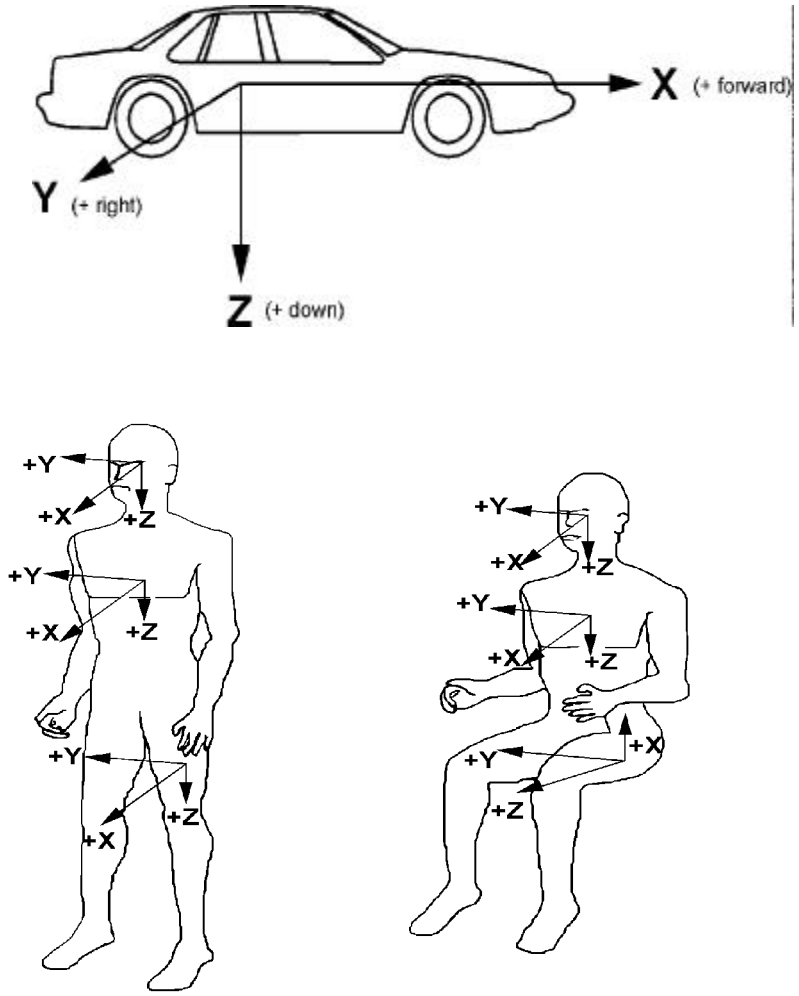


Figure 2-1: Vehicle, Body, and Head 9-Accelerometer Array

Table 2-1. Table of Units

Measurement Quantity	**Unit of Measure**	**Standard Metric Code*** (MET)
Absolute Pressure	Kilopascals	KPA
Acceleration	G's	G'S
Angular Acceleration	Degrees/second**2	DP2
Angular Displacement	Degrees	DEG
Angular Velocity	Degrees/second	DPS
Curvature	Reciprocal millimeters	RMM
Displacement	Millimeters	MM
Force	Newtons	NWT
Gauge Pressure	Kilopascals	KPG
Impulse	Newton-seconds	NSC
Noise	Decibels	DEC
Strain	Micrometers/meter	MPM
Temperature	Degrees Celsius	CEN
Time	Seconds	SEC
Torque	Newton-meters	NWM
Velocity	Kilometers/hour	KPH
Voltage	Volts	VOL

* Codes used must be in uppercase.

APPENDIX A:
MAGNETIC MEDIA FORMAT

Each data submission consists of two types of data: descriptive specification data defined in the previous sections of this Guide, and the measurement data digitized from the test instrumentation signal traces. Several disks may be required to record the specification and measurement files for a test submitted on diskette.

USING THE ENTREE PROGRAM TO CREATE SPECIFICATION FILES

NHTSA has developed the data entry program, ENTREEW, in order to facilitate preparation of the specification data defined in the previous sections of this Guide. A diskette containing the ENTREEW program, Version 4.0, is included in the front of the Guide. Because ENTREEW contains built-in, on-line checkers for data validation, it is highly recommended that specification data be generated using the ENTREEW program.

Equipment Requirements for ENTREEW

ENTREEW is a Windows-based application which has the following minimum requirements:

- IBM PC or compatible with 80386 or better processor.
- 10 Megabytes of disk space.
- Microsoft Windows 3.1 or later.
- 8 Megabytes of memory.

ENTREEW should also run properly under Microsoft Windows 95, Windows NT 3.51 or Windows NT 4.0.

ENTREEW Conversion Utilities

The ENTREEW program output file is in NHTSA's own binary format (file extension .ENT). The included EWCONV utility supports the export of binary .ENT files to the ASCII .EV4 format .EV4 files, which is the accepted data format specified under SAE J211. EWCONV also supports the import of .EV4 ASCII data files into the binary .ENT format for editing using ENTREEW.

An optional utility, EWCV32, provides the ability to convert from the older Entree V3 ASCII format to the EV4 format as specified under SAE J211. This utility is not included with the ENTREEW distribution, but is available for download from the Internet at

<URL http://www-nrd.nhtsa.dot.gov/nrd10/software/entreew>

EWCV32 requires Microsoft Windows 95, or Microsoft Windows NT 4.0 for proper execution.

ENTREEW Specification File Format Options

ENTREEW output for a given test may be formatted one of two ways: as either a single file in NHTSA's own binary format (<filename>.ENT), or as an ASCII file (<filename>.EV4) for data exchange outside the agency. Data submitted for inclusion in the NHTSA SWG Database must be written in the binary format.

The data files should be written to 3.5 inch high density floppies.

ASCII FORMAT SPECIFICATION FILE

The ASCII file for a specific test consists of groups of records from each of the categories listed below:

Record Type	Group
TEST	1
INSTRUMENTATION	2

A signal waveform test consists of specification records for TEST and INSTRUMENTATION. The EWCONV utility may be used to create the ASCII file automatically from an ENTREEW generated binary file.

Record Layout for ASCII Specification File

Appendix C lists the fields and their positions in each of the specification data records. The first line of the ASCII (.EV4) specification file should be the string

"----- EV4 -----"

or

"-----"+space+ "EV4"+space+"-----"

Each section within an EV4 file should begin with a "key" line indicating the type of records following the key. These keys have the form

"----- KEY -----"

or

"-----"+space+ "KEY"+space+ "-----"

where KEY is appropriate to a particular record type. (KEY equals TEST or INSTRUMENTATION.)

Fields within a record are delimited by the pipe character (|), records are delimited by a line feed. Comment lines may also be included in the file. A comment line should start with the # (pound) sign and end with a line feed.

The ASCII specification file should terminate with the line

"----- END -----"

Fields for which no information is available should contain one blank character. In other words, an empty field begins after the pipe delimiter of the previous field, and consists of a single blank followed by another pipe delimiter. All text should be uppercase.

Table A-1 is an example of an ASCII specification file for an SWG test.

LAYOUT FOR MEASUREMENT DATA ON DISK

Each subsequent file after the specification data files contains digitized data (meeting the requirements of SAE J211/1 MAR95 CFC1000, with no lower frequency class filtering) collected from the channels used in the tests. The order of the measurement files corresponds to the order of the instrumentation records in the instrumentation group specification records. The measurement files are made up of ASCII records of 1 data point each, delimited by a line feed character (ASCII decimal 10, hexadecimal \x0a, octal \012). The point specification will allow for any floating point format, but the preferred format is the C format %12.5E. Thus, each record will be 12 characters long, e.g. +1.23400E-01. The maximum number of points for one channel is 110,000. There cannot be more than 10,000 data points prior to time zero, nor more than 99,999 after time zero.

The name of the ASCII measurement data files should be the same given to the specification file described above (ENTREEW binary file with extension .ENT or ASCII file with extension .EV4). The file extension should be the curve number of the curve contained in the file, and should correspond to the curve number in the instrumentation record in the instrumentation specification group. There should be no leading zeros in the file extensions.

If the specification file is named TSTABC.ENT (binary) or TSTABC.EV4 (ASCII), and there are 35 measurement (curve) files, the curve files should be named TSTABC.1 through TSTABC.35.

Right:	TSTABC.1	TSTABC.12	TSTABC.101
Wrong:	TSTABC.T0	TSTABC.012	TSTABCDAT

Table A-1. Sample ASCII Specification File

```
# This is a comment field for a sample ASCII format specification data file
----- EV4 -----
----- TEST -----
0|S4|S/N: 009|AMPLIFIER CERTIFICATION TEST|TO RECORD A STANDARD WAVEFORM
USING NCAP CONDITIONING
AMPLIFIER|07/NOV/1996|01/JAN/1996|CAL|DTNH22-93-D-11089|NO3401|SWG|21|FMT|UM
B|4|NO COMMENTS
----- INSTRUMENTATION -----
0|1|WG01|500|AC|01|HDCG|XL|G'S|1650|200|49|-749|2999|100|AM|P|NO COMMENTS
0|2|WGO2|500|AC|01|HDCG|YL|G'S|1650|200|12|-749|2999|100|AM|P|NO COMMMENTS
0|3|WGO3|500|AC|01|HDCG|ZL|G'S|1650|200|22|-749|2999|100|AM|P|NO COMMENTS
0|4|WG04|500|LC|01|FMRL|XL|NWT|1650|20000|43|-749|2999|100|AM|P|NO COMMENTS
0|5|WG05|500|AC|01|CHST|XL|G’S|1650|300|43|-749|2999|100|AM|P|NO COMMENTS
0|6|WG06|500|AC|01|CHST|YL|G’S|1650|300|43|-749|2999|100|AM|P|NO COMMENTS
0|7|WG07|500|AC|01|CHST|ZL|NWT|1650|300|43|-749|2999|100|AM|P|NO COMMENTS
0|8|WG12|500|LC|01|FMRL|XL|NWT|1650|20000|43|-749|2999|100|AM|R|NO COMMENTS
0|9|WG13|500|AC|02|HDCG|XL|G’S|1650|200|43|-749|2999|100|AM|P|NO COMMENTS
0|10|WG14|500|AC|02|HDCG|YL|G’S|1650|200|43|-749|2999|100|AM|P|NO COMMENTS
0|11|WG15|500|AC|02|HDCG|ZL|G’S|1650|200|43|-749|2999|100|AM|P|NO COMMETS
0|12|WG16|500|LC|02|FMRL|XL|NWT|1650|20000|43|-749|2999|100|AM|P|NO COMMENTS
0|13|WG08|500|AC|02|CHST|XL|G’S|1650|300|43|-749|2999|100|AM|P|NO COMMENTS
0|14|WG09|500|AC|02|CHST|YL|G’S|1650|300|43|-749|2999|100|AM|P|NO COMMENTS
0|15|WG10|500|TB|02|OTHR|NA|NWT|1650|1000|43|-749|2999|100|AM|P|NO COMMENTS
----- END -----
```

APPENDIX B: CODES

AXIS

CODE	DESCRIPTION	COMMENT
NA	NOT APPLICABLE	
RS	RESULTANT	
XG	X-GLOBAL	
XL	X-LOCAL	INCLUDES A-P
YG	Y-GLOBAL	
YL	Y-LOCAL	INCLUDES M-L
ZG	Z-GLOBAL	
ZL	Z-LOCAL	INCLUDES I-S
OT	OTHER	

CHSTAT

CODE	DESCRIPTION	COMMENT
P	PRIMARY CHANNEL	
R	REDUNDANT CHANNEL	

DASTAT

CODE	DESCRIPTION	COMMENT
AM	AS MEASURED	
CF	CHANNEL FAILED	
CM	COMPUTED	
MN	MEANINGLESS	
NO	NO DATA	
QD	QUESTIONABLE DATA	
SC	SCALING FACTOR APPLIED	
SF	SYTEM FAILED	NOTE CAUSE OF FAILURE

LINK

CODE	DESCRIPTION	COMMENT
TEL	TELEMETRY	
UCT	UMBILICAL CABLE AND TELEMETRY	
UMB	UMBILICAL CABLE	
UNK	UNKNOWN	
OTH	OTHER	

RECTYP

CODE	DESCRIPTION	COMMENT
DDA	DIGITAL DATA ACQUISITION	
DIG	DIGITAL TAPE RECORDER	
FMM	FM MULTIPLEXOR TAPE RECORDER	
FMT	FM TAPE RECORDER	
OSC	OSCILLOGRAPH	
UNK	UNKNOWN	
OTH	OTHER	

SENATT

CODE	DESCRIPTION	COMMENT
ABDI	ABDOMEN CONTACT SWITCH I	OBLIQUE-ANTERIOR
ABD2	ABDOMEN CONTACT SWITCH 2	LATERAL
ABD3	ABDOMEN CONTACT SWITCH 3	OBLIQUE-POSTERIOR
ABDO	ABDOMEN	
ABGD	AIR BAG DIAGNOSTIC CIRCUIT	
ABGL	AIR BAG LAMP	
ABGM	AIR BAG MANIFOLD	
ABSF	AIR BAG SAFING CIRCUIT	
ABSQ	AIR BAG SQUIB CIRCUIT	
ABTF	AIR BAG TRIP-SWITCH - FIREWALL	
ABTK	AIR BAG TRIP-SWITCH - KNEE	
ABTL	AIR BAG TRIP-SWITCH - LEFT	
ABTM	AIR BELT MANIFOLD	
ABTR	AIR BAG TRIP-SWITCH - RIGHT	
ABTS	AIR BAG TRIP-SWITCH - ST. COL.	
ANKL	ANKLE-LEFT	
ANKR	ANKLE - RIGHT	

SENATT (continued)

CODE	DESCRIPTION	COMMENT
APLL	A PILLAR - LEFT	
APLR	A PILLAR - RIGHT	
BAFF	BARRIER FRONT FACING	
BMPF	BUMPER - FRONT	
BMPR	BUMPER - REAR	
BPLL	B PILLAR - LEFT	
BPLR	B PILLAR - RIGHT	
BRCG	BUMPER RIGHT CG	
BRCL	BRAKE CALIPER - LEFT	
BRCR	BRAKE CALIPER - RIGHT	
CHST	CHEST	THORAX OR SPINE IN 208 COMPLIANCE
CPLL	C PILLAR - LEFT	
CPLR	C PILLAR - RIGHT	
CRBV	CEREBROVASCULAR SYSTEM	
CRDV	CARDIOVASCULAR SYSTEM	
DPLC	DASHPANEL-CENTER	
DPLL	DASHPANEL-LEFT	
DPLR	DASHPANEL - RIGHT	
DRLF	DOOR - LEFT FRONT	
DRLR	DOOR-LEFT REAR	
DRRF	DOOR - RIGHT FRONT	
DRRR	DOOR - RIGHT REAR	
DSLF	SILL - LEFT FRONT	
DSLR	SILL - LEFT REAR	
DSRF	SILL - RIGHT FRONT	
DSRR	SILL - RIGHT REAR	
ENGN	ENGINE	
FFNL	FENDER FRONT LEFT	
FFNR	FENDER FRONT RIGHT	
FLLF	FLOORPAN - LEFT FRONT	
FLLR	FLOORPAN - LEFT REAR	
FLRF	FLOORPAN - RIGHT FRONT	
FLRR	FLOORPAN - RIGHT REAR	
FLTU	FLOORPAN TUNNEL	
FMRL	FEMUR - LEFT	
FMRR	FEMUR - RIGHT	
FOTL	FOOT - LEFT	
FOTR	FOOT - RIGHT	
FRCF	FRAME CROSSMEMBER - FRONT	
FRCR	FRAME CROSSMEMBER - REAR	

SENATT (continued)

CODE	DESCRIPTION	COMMENT
FRRF	FRAME RAIL - FRONT	
FRRR	FRAME RAIL - REAR	
FRSL	FRAME SIDE RAIL - LEFT	
FRSR	FRAME SIDE RAIL - RIGHT	
FWLL	FIREWALL	
HD90	HEAD 9 ARRAY - CENTER	
HD9X	HEAD 9 ARRAY - X ARM	FORMERLY HD92, Y AND Z AXES ONLY
HD9Y	HEAD 9 ARRAY - Y ARM	FORMERLY HD9 1, X AND Z AXES ONLY
HD9Z	HEAD 9 ARRAY - Z ARM	FORMERLY HD93, X AND Y AXES ONLY
HDCG	HEAD CG	
HDOT	HEAD OTHER	USE FOR OTHER THAN 9 ACCEL. ARRAY OR CG
HDRL	HEADER - LEFT	
HDRR	HEADER - RIGHT	
HLCR	HOOD LATCH CROSSMEMBER	
KNEL	KNEE - LEFT	
KNER	KNEE - RIGHT	
LCA0	LOAD CELL A10	
LCAl	LOAD CELL A1	
LCA2	LOAD CELL A2	
LCA3	LOAD CELL A3	
LCA4	LOAD CELL A4	
LCA5	LOAD CELL A5	
LCA6	LOAD CELL A6	
LCA7	LOAD CELL A7	
LCA8	LOAD CELL A8	
LCA9	LOAD CELL A9	
LCB0	LOAD CELL B10	
LCBI	LOAD CELL B1	
LCB2	LOAD CELL B2	
LCB3	LOAD CELL B3	
LCB4	LOAD CELL B4	
LCB5	LOAD CELL B5	
LCB6	LOAD CELL B6	
LCB7	LOAD CELL B7	
LCB8	LOAD CELL B8	
LCB9	LOAD CELL B9	
LCC0	LOAD CELL C10	
LCC1	LOAD CELL C1	
LCC2	LOAD CELL C2	
LCC3	LOAD CELL C3	

SENATT (continued)

CODE	DESCRIPTION	COMMENT
LCC4	LOAD CELL C4	
LCC5	LOAD CELL C5	
LCC6	LOAD CELL C6	
LCC7	LOAD CELL C7	
LCC8	LOAD CELL C8	
LCC9	LOAD CELL C9	
LCD0	LOAD CELL D10	
LCD1	LOAD CELL D1	
LCD2	LOAD CELL D2	
LCD3	LOAD CELL D3	
LCD4	LOAD CELL D4	
LCD5	LOAD CELL D5	
LCD6	LOAD CELL D6	
LCD7	LOAD CELL D7	
LCD8	LOAD CELL D8	
LCD9	LOAD CELL D9	
LPBI	LAP BELT - INBOARD	
LPBO	LAP BELT - OUTBOARD	
NEKL	NECK - LOWER	
NEKU	NECK - UPPER	
POLE	POLE	
PULM	PULMONARY SYSTEM	
PVCN	PELVIS - CENTER	
PVHP	PELVIS - H-POINT	TROCHANTERION
PVIL	PELVIS - ILIAC	
PVPS	PELVIS PUBIC SYMPHYSIS	
PVSA	PELVIS, SACRUM	
RAXL	REAR AXLE	
RBLA	RIB - LOWER ABDOMEN	
RBLL	RIB - LEFT LOWER	
RBLM	RIB - LEFT MIDDLE	
RBLU	RIB - LEFT UPPER	
RBRL	RIB - RIGHT LOWER	
RBRM	RIB - RIGHT MIDDLE	
RBRU	RIB - RIGHT UPPER	
RBUA	RIB - UPPER ABDOMEN	
REDK	REAR DECK	
ROLC	ROLLOVER CART	
RRLF	ROOF RAIL LEFT FRONT	
RRLR	ROOF RAIL LEFT REAR	

SENATT (continued)

CODE	DESCRIPTION	COMMENT
RRRF	ROOF RAIL RIGHT FRONT	
RRRR	ROOF RAIL RIGHT REAR	
SECF	SEAT - CENTERFRONT	
SECR	SEAT - CENTER REAR	
SELF	SEAT - LEFT FRONT	
SELR	SEAT - LEFT REAR	
SERF	SEAT - RIGHT FRONT	
SERR	SEAT - RIGHT REAR	
SHBE	SHOULDER BELT EXTENS'N	
SHBT	SHOULDER BELT	
SHLL	SHOULDER - LEFT	
SHLR	SHOULDER - RIGHT	
SLED	SLED	
SNML	STERNUM - LOWER	
SNMU	STERNUM - UPPER	
SPNL	SPINE - LOWER	T12
SPNM	SPINE - MIDDLE	T04
SPNU	SPINE - UPPER	T01
STCL	STEERING COLUMN	
STLF	SEAT TRACK - LEFT FRONT	
STLR	SEAT TRACK - LEFF REAR	
STRF	SEAT TRACK - RIGHT FRONT	
STRR	SEAT TRACK - RIGHT REAR	
SULF	SUSPENSION - LEFT FRONT	
SULR	SUSPENSION - LEFT REAR	
SURF	SUSPENSION - RIGHT FRONT	
SURR	SUSPENSION - RIGHT REAR	
SWHB	STEERING WHEEL HUB	
SWRM	STEERING WHEEL RIM	
TBLL	TIBIA - LEFT LOWER	
TBLU	TIBIA - LEFT UPPER	
TBRL	TIBIA - RIGHT LOWER	
TBRU	TIBIA - RIGHT UPPER	
TIBL	TIBIA - LEFT	
TIBR	TIBIA - RIGHT	
TRFC	TRUCK FLOOR - CENTER	
TRFL	TRUCK FLOOR - LEFT	
TRFR	TRUCK FLOOR - RIGHT	
VECG	VEHICLE CG	
OTHR	OTHER	

SENLOC

CODE	DESCRIPTION	COMMENT
01	LEFT FRONT SEAT	
02	RIGHT FRONT SEAT	
03	RIGHT REAR SEAT	
04	LEFT REAR SEAT	
05	CENTER FRONT SEAT	
06	CENTER REAR SEAT	
07	LEFT THIRD SEAT	STATION WAGON/VAN
08	CENTER THIRD SEAT	STATION WAGON/VAN
09	RIGHT THIRD SEAT	STATION WAGON/VAN
NA	NOT APPLICABLE	
OT	OTHER	OR OUT OF POSITION

SENTYP

CODE	DESCRIPTION	COMMENT
AA	ANGULAR ACCELEROMETER	
AC	ACCELEROMETER	
AD	ANGULAR DSPLCMENT TRANSDUCER	
AV	ANGULAR VELOCITY TRANSDUCER	
DS	DISPLACEMENT TRANSDUCER	
ET	EVENT TIME INDICATOR	ON/OFF STYLE SWITCH
HL	HIGH LEVEL	
LC	LOAD CELL	
PR	PRESSURE TRANSDUCER	
SG	STRAIN GAUGE	
TB	TIME BASED CHANNEL	
VL	VELOCITY TRANSDUCER	
OT	OTHER	

SIGSRC

CODE	DESCRIPTION	COMMENT
WG01	CHANNEL 1 OF SWG	
WG02	CHANNEL 2 OF SWG	
WG03	CHANNEL 3 OF SWG	
WG04	CHANNEL 4 OF SWG	
WG05	CHANNEL 5 OF SWG	
WG06	CHANNEL 6 OF SWG	
WG07	CHANNEL 7 OF SWG	
WG08	CHANNEL 8 OF SWG	
WGO9	CHANNEL 9 OF SWG	
WG10	CHANNEL 10 OF SWG	
WG11	CHANNEL 11 OF SWG	
WG12	CHANNEL 12 OF SWG	
WG13	CHANNEL 13 OF SWG	
WG14	CHANNEL 14 OF SWG	
WG15	CHANNEL 15 OF SWG	
WG16	CHANNEL 16 OF SWG	
WGE1	EVENT TIME INDICATOR (TIME ZERO)	
WGE2	EVENT TIME INDICATOR (DELAYED TIME ZERO)	
WGH1	HIGH LEVEL SIGNAL OF GROUP 1 WAVEFORM	
WGH2	HIGH LEVEL SIGNAL OF GROUP 2 WAVEFORM	
WGI1	EVENT TIME INDICATOR (INVERTED TIME ZERO)	
WGI2	EVENT TIME INDICATOR (INVERTED DELAYED TIME ZERO)	

TSTPRF

CODE	DESCRIPTION	COMMENT
AUT	AUTOLIV AUSTRALIA	
BAS	BUNDESANTALT FUER STRASSENWESE	
CAL	CALSPAN	
CAN	TRANSPORT CANADA	
DYS	DYNAMIC SCIENCE	
ENS	ENSCO	
FOI	FEDERAL OUTDOOR IMPACT LABORATORY	
FRD	FORD MOTOR COMPANY	
GMC	GENERAL MOTORS CORP.	
HDL	HEIDELBERG	
IIH	INSURANCE INSTITUTE FOR HIGHWAY SAFETY	
KAR	KARCO ENGINEERING	
MCR	MCR TECHNOLOGY	FORMERLY MINICARS
MCW	MEDICAL COLLEGE OF WISC	
MGA	MGA RESEARCH	
MSE	MOBILITY SYSTEMS	
NTC	NTS - CALIFORNIA	FORMERLY AETL -CALIFORNIA
NTV	NTS - VIRGINIA	FORMERLY AETL - VIRGINIA
ONS	ONSER	
SWR	SWRI	
TNO	TNO-RD.VEH. RES'RCH INST.	
TRC	TRC OF OHIO	
TTI	TEXAS TRANSP. INSTITUTE	
UVA	UNIVERSITY OF VIRGINIA	
VWG	VOLKSWAGEN AG	
OTH	OTHER	

TSTTYP

CODE	DESCRIPTION	COMMENT
SW2	SIGNAL WAVEFORM GENERATOR HARDWARE UPGRADE	
SWG	SIGNAL WAVEFORM GENERATOR	
UNK	UNKNOWN	
OTH	OTHER	

UNITS

CODE	DESCRIPTION	COMMENT
CEN	DEGREES CELSIUS	TEMPERATURE
DEC	DECIBELS	SOUND
DEG	DEGREES	ANGULAR DISPLACEMENT
DP2	DEG/SEC(2)	ANGULAR ACCELERATION
DPS	DEG/SEC	ANGULAR VELOCITY
G'S	G'S	ACCELERATION
KPA	KILOPASCALS	ABSOLUTE PRESSURE
KPG	KILOPASCALS	GAUGE PRESSURE
KPH	KILOMETERS/HOUR	VELOCITY
MM	MILLIMETERS	DISPLACEMENT
MPM	MICROMET/MET	STRAIN
NON	DIMENSIONLESS	DIMENSIONLESS
NSC	NEWTON-SECONDS	IMPULSE
NWM	NEWTON-METERS	TORQUE
NWT	NEWTONS	FORCE
PST	PERCENT STRAIN	STRAIN
RMM	RECIPROCAL MM	CURVATURE
SEC	SECONDS	TIME
VOL	VOLTS	VOLTAGE
OTH	OTHER	OTHER

VERNO

CODE	DESCRIPTION	COMMENT
S4	SWG VERSION 4	DATA VERSION

APPENDIX C:
FIELD FORMATS

1. TEST INFORMATION

FIELD NAME	DATA TYPE	MAXIMUM FIELD LENGTH/RANGE
TSTNO	predefined text=0	1 char
VERNO	predefined coded text=S4	2 char
SWGNO	free text	6 char
TITLE	free text	70 char
TSTOBJ	free text	70 char
TSTDAT	date text (DD/MMM/YYYY)	11 char
CERDAT	date text (DD/MMM/YYYY)	11 char
TSTPRF	coded text	3 char
CONNO	free text	17 char
TSTREF	free text	10 char
TSTTYP	coded text	3 char
TEMP	integer	-99 to 99
RECTYP	coded text	3 char
LINK	coded text	3 char
TOTCRV	integer	1 to 200
TSTCOM	free text	70 char

2. INSTRUMENTATION INFORMATION

FIELD NAME	DATA TYPE	MAXIMUM FIELD LENGTH/RANGE
TSTNO	predefined text=0	1 char
CURNO	integer	1 to 200
SIGSRC	coded text	4 char
SIGLEV	integer	5 to 5000
SENTYP	coded text	2 char
SENLOC	coded text	2 char
SENATT	coded text	4 char
AXIS	coded text	2 char
UNITS	coded text	3 char
PREFIL	integer	0 to 99999
INSRAT	integer	-999999 to 999999
CHLMAX	integer	0 to 100
NFP	integer	-10000 to 0
NLP	integer	0 to 99999
DELT	integer	0 to 999999
DASTAT	coded text	2 char
CHSTAT	coded text	1 char
INSCOM	free text	70 char

APPENDIX D: REFERENCE MATERIALS

REFERENCE MATERIALS

Your Contracting Officer's Technical Representative (COTR) can help you obtain copies of the following reference materials:

Society of Automotive Engineers, Inc., "Instrumentation for Impact Tests," SAE J211/1 MAR95, March 1995, 10 p.

MGA Research Corporation, "Operator's Manual for Waveform Generator Model RPG-6236-A," U.S. Department of Transportation, National Highway Traffic Safety Administration, Washington, DC, February 1988, DOT-HS-807-218, 36 p.

MGA Research Corporation, "Waveform Generator Signal Processing Software," U.S. Department of Transportation, National Highway Traffic Safety Administration, Washington, DC, September 1988, DOT-HS-807-312, 172 p.

COORDINATE SYSTEM

USING THE COORDINATE SYSTEM CORRECTLY

The rules for determining the sign conventions described below will enable anyone involved in NHTSA-sponsored testing to determine the proper sign and coordinate axis for any measured quantity.

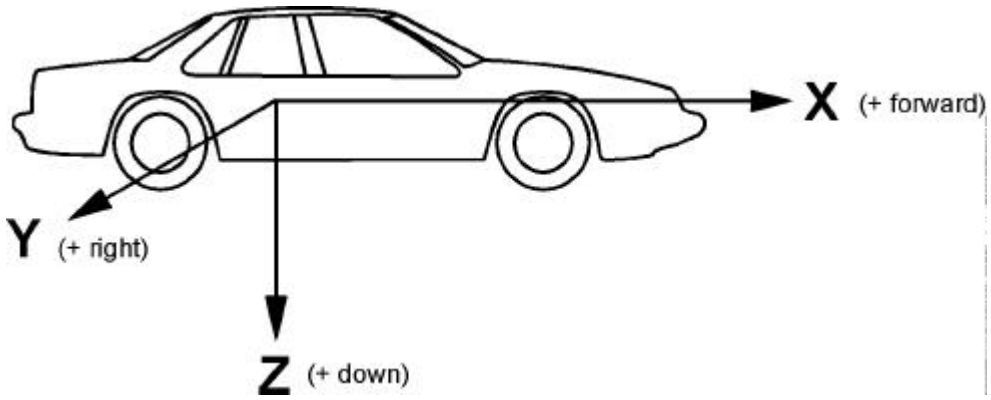
All coordinate systems are orthogonal, three-dimensional, and right handed. The global coordinate systems for the vehicle and the test occupants are shown in Figure D-1. The coordinate system for the nine accelerometer head array is shown in Figure D-2, along with the proper SENATT codes. Table D-1 lists the polarity of the sensor output from various dummy manipulations when using this coordinate system.

VEHICLE GLOBAL COORDINATE SYSTEM

- X is positive forward
- Y is positive right (toward the passenger side door)
- Z is positive down

OCCUPANT GLOBAL COORDINATE SYSTEM (all occupant types - OCCTYP)

- X is positive forward (posterior to anterior)
- Y is positive right
- Z is positive down



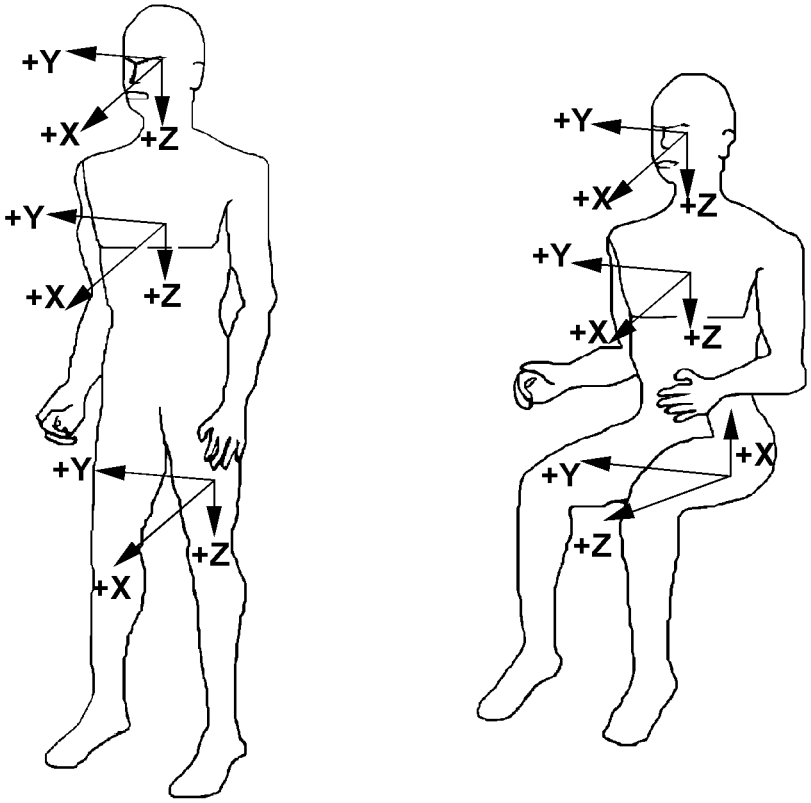


Figure D-1: Vehicle and Body-Based Coordinate Systems

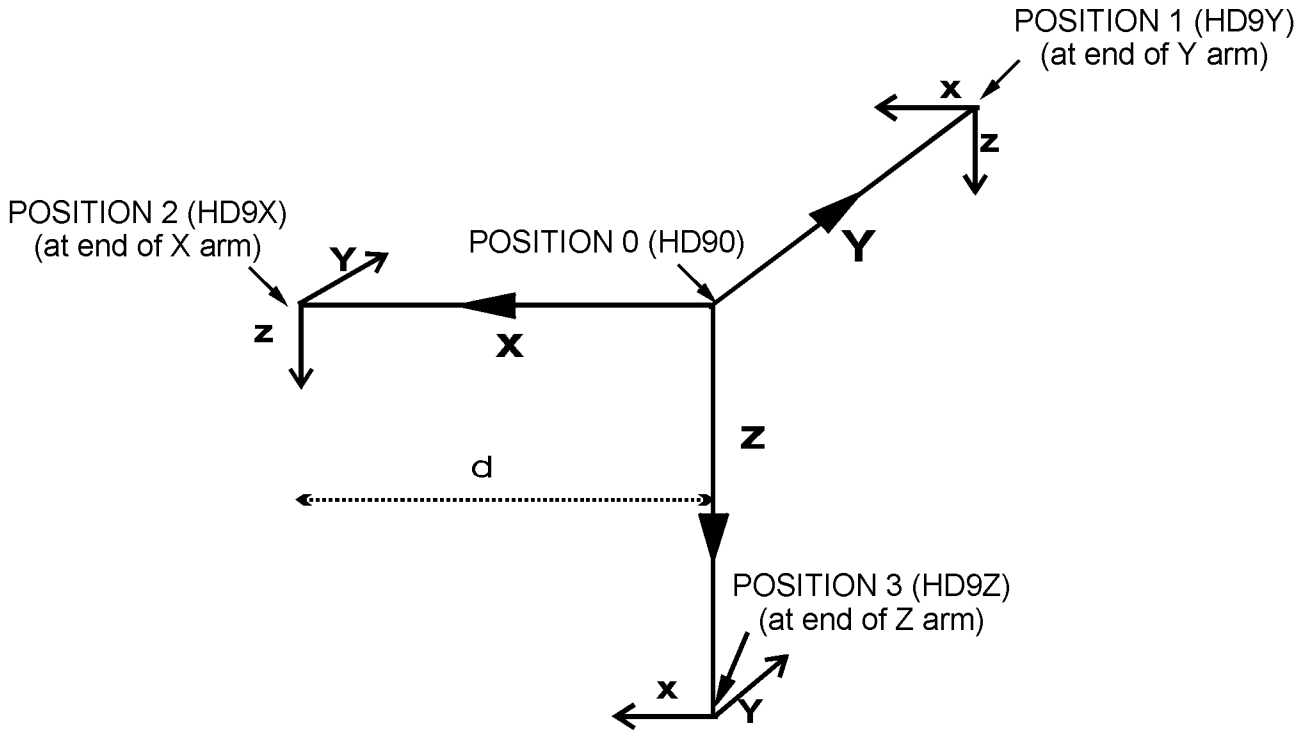


Figure D-2: Coordinate System for 9-Accelerometer Array

TABLE D.1
Dummy Manipulations for Checking Recorded Load Cell
Polarity Relative to Sign Convention

Load Cell	Measure	Dummy Manipulations	Polarity
Upper and lower neck loads	Fx	Head readward, chest forward	+
	Fy	Head leftward, chest rightward	+
	Fz	Head upward, chest downward	+
	Mx	Left ear toward left shoulder	+
	My	Chin toward sternum	+
	Mz	Chin toward left shoulder	+
Left shoulder loads (BIOSID)	Fx	Left shoulder forward, chest rearward	+
	Fy	Left shoulder rightward, chest leftward	+
	Fz	Left shoulder downward, chest upward	+
Right shoulder loads (BIOSID)	Fx	Right shoulder forward, chest rearward	+
	Fy	Right shoulder rightward, chest leftward	+
	Fz	Right shoulder downward, chest upward	+
Clavicle loads	Fx	Shoulder forward, chest rearward	+
	Fz	Shoulder downward, chest rearward	+
Upper and lower lumbar spine	Fx	Chest rearward, Pelvis forward	+
	Fy	Chest leftward, pelvis rightward	+
	Fz	Chest upward, pelvis downward	+
	Mx	Left shoulder toward left hip	+
	My	Sternum toward front of legs	+
	Mz	Right shoulder forward, left shoulder rearward	+
Sacrum load (BIOSID)	Fy	Left H-point pad leftward, chest rightward	+
Left iliac load (BIOSID)	Fy	Left iliac rightward, chest leftward	+

TABLE D.1 (continued)

Load Cell	Measure	Dummy Manipulations	Polarity
Right iliac load (BIOSID)	Fy	Right iliac rightward, chest leftward	+
Pubic load (side impact)	Fy	Right H-point pad leftward, left pad rightward	(-)
Crotch belt loads	Fx	Pubic rearward, pelvis forward	(-)
	Fz	Pubic upward, chest downward	(-)
Iliac lap belt loads	Fx	Upper iliac spine rearward, chest forward	(-)
	My	Upper iliac spine rearward, chest forward	+
Left side abdominal load (Eurosid-1)	Fy	Left side of abdomen rightward, chest leftward	+
Right side abdominal load (Eurosid-1)	Fy	Right side of abdomen leftward, chest rightward	(-)
Femur loads (dummy in seated position, femurs horizontal)	Fx	Knee upward, upper femur downward	+
	Fy	Knee rightward, upper femur leftward	+
	Fz	Knee forward, pelvis rearward	+
	Mx	Knee leftward, hold upper femur in place	+
	My	Knee upward, hold upper femur in place	+
	Mz	Tibia leftward, hold pelvis in place	+
Knee clevis	Fz	Tibia downward, femur upward	+
Upper tibia loads	Fz	Tibia downward, femur upward	+
	Mx	Ankle leftward, hold knee in place	+
	My	Ankle forward, bottom of knee clevis rearward	+
Lower tibia loads	Fx	Ankle forward, knee rearward	+
	Fy	Ankle rightward, knee leftward	+
	Mx	Ankle leftward, hold knee in place	+
	My	Ankle forward, bottom of knee clevis rearward	+