SAE International™

SURFACE VEHICLE RECOMMENDED PRACTICE

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Uniform Reference and Dimensional Guidelines for Collision Repair

RATIONALE

The purpose of this revision is to incorporate the latest global practices for presentation of vehicle dimension data used for collision repair, taking into consideration current vehicle design practices, manufacturing technologies and aftermarket collision-repair procedures, tools and equipment that have been introduced since the last update

FOREWORD

With continually higher expectations of collision repair quality, the evolution of new motor vehicle design and manufacturing technologies and increased sophistication of collision repair measuring and repair equipment, it is imperative that the repair technician have the necessary reference and dimensional measurements to achieve a cost-effective repair that will ensure customer satisfaction. Uniformity of these measurements will enable technicians and claims representatives to easily locate measurement points and more accurately complete the damage diagnosis, repair cost estimation and the repair itself.

a. Customer Expectations—Customer expectations can be considered from the perspective of two key parties: the buyers of vehicles who are involved in collisions, and the technicians who repair the vehicles.

1. Buyer Expectations—Buyer expectations of the quality of repair fall into the following five general categories:

1.1 Fit and finish, including door gaps, underhood areas, seams, fixed glass position, underbody appearance, and perceived associations between body opening gaps and potential structural problems.

1.2 Driving characteristics (tire wear, handling, etc.) will be the same after the collision.

1.3 Safety of the vehicle in a subsequent collision.

1.4 Noise and leakage (wind noise, water leaks, squeaks, rattles, noise/vibration/harshness, etc.)

1.5 Excessive wear (hinges, latches, etc.) and operating efforts.

2. Collision Repair Technician Expectations—Collision repair technician expectations fall into the following seven general categories:

2.1 Available, timely dimensional data.

2.2 Accurate data (publishing as many dimensions as possible and practicable, defining appropriate tolerances, and providing a means of resolving discrepancies between published and measured dimensions).

2.3 Simple-to-use dimensional data.

2.4 Dimensions compatible with the equipment most commonly used in the shops.

2.5 Reasonable access to measuring points on the vehicles, including identifying "hidden" reference points" (covered with tape and undercoating).

2.6 "Critical" dimensions are defined as follows: This includes selecting reference points that will remain consistent during the life of the vehicle, identifying locations and tolerances for front and rear subframes, identifying locations of bolt-on components (steering, suspension, etc.) to front or rear subframes, and the locations of these subframes to the body, identifying what reference points can be used when components are still mounted on the vehicle, and defining upper body dimensions.

2.7 Regardless of the information source, any illustrations used should be readable by the average repair technician, reproducible and representative of the vehicle design.

2.8 Regardless of the information source, the vehicle about which the information is provided should be perfectly identified through model, version and model year information.

b. New Body Structure Design and Manufacturing Systems—Relatively new body structure design and manufacturing systems include "No-Adjust-Build," Mill and Drill, Form and Pierce, and Hydropiercing. There have also been expansions in the use of front and rear engine and suspensions subframes and one-piece body side stampings. These technologies require control features (holes, slots, etc.) that may appear similar to those traditionally used by technicians but which now perform different functions for production manufacturing, inspection, and assembly. A brief summary of these new body structure designs is described in Appendix A.1.

c. New Collision Measuring Systems—Collision measuring systems have become more sophisticated and accurate in recent years. Measuring equipment includes computerized measuring systems, mechanical measuring systems, laser measuring systems and dedicated measuring systems. A brief summary of some typical systems is described in Appendix A.2.

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1. SCOPE

This SAE Recommended Practice defines, for vehicle manufacturers and collision information and equipment providers, the types of vehicle dimensional data needed by the collision repair industry and aftermarket equipment modifiers to properly perform high-quality repairs to damaged vehicles. Both bodyframe and unitized vehicles, including passenger cars and light trucks, are addressed.

1.1 Purpose

The purpose of this document is to provide a standardized format for presentation of vehicle dimension data, for use by collision information and equipment providers and collision repair technicians. This dimensional data is to be used in the accurate diagnosis and repair of collision-damaged passenger cars and light trucks.

2. REFERENCES

2.1 Applicable Publications

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J182 Motor Vehicle Fiducial Marks and Three-dimensional Reference System

SAE J1100 Motor Vehicle Dimensions

SAE J1555 Recommended Practice for Optimizing Automobile Damageability

SAE J2184 Vehicle Lift Points for Service Garage Lifting

3. DEFINITIONS

3.1 Dimensions

3.1.1 OEM Dimensions

Those dimensions which are generally supplied by vehicle manufacturers to the information and equipment providers (typically body-in-white dimensions). They are generally expressed in the vehicle manufacturer's coordinate system, using the datum planes to define the coordinate axes.

3.1.2 Universal Dimensions

Those dimensions which are generally supplied by collision information and equipment providers, for use by the collision repair industry. They should relate mathematically to the OEM Dimensions supplied by the vehicle manufacturers.

3.1.3 Dedicated Dimensions

Those dimensions which are generally supplied by, and are dedicated for use with, a specific piece of measuring equipment. They should relate mathematically to the OEM Dimensions supplied by the vehicle manufacturers.

3.1.4 Reference Dimensions

Those dimensions, which are not controlled during final production vehicle assembly, but which may otherwise be used for measurement purposes during repair of the vehicle. They may have different tolerances than OEM Dimensions, Universal Dimensions or Dedicated Dimensions, and may not necessarily relate to the datum planes.

3.1.5 Datum Planes

Three mutually orthogonal planes (Figure 1). These planes are generally defined as:

a. A vertical plane passing through the longitudinal centerline of the vehicle.

b. A vertical transverse plane, located either ahead of the vehicle or through a specific section of the vehicle, depending upon the practice of the particular vehicle manufacturer

c. A horizontal plane located at or below the floorpan.

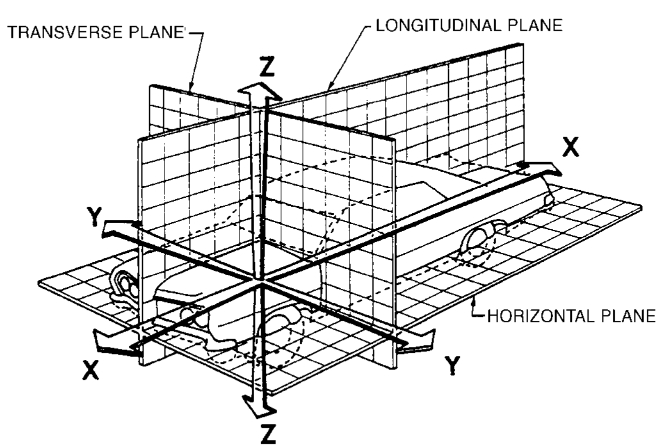

FIGURE 1 - DATUM PLANES

3.1.6 Tolerances

a. OEM Build—Tolerances developed by the OEM manufacturers, for the manufacture and assembly of the vehicles.

b. Field Repair—Tolerances, derived from and compatible with the OEM Build tolerances, that can be used to restore a damaged vehicle to pre-accident condition. These tolerances may or may not be the same as the OEM Build tolerances.

3.2 Light Truck

The classification of a self-propelled vehicle which is designed primarily to transport property or special purpose equipment, and has a maximum gross vehicle weight rating (GVWR) of 4536 kg (10 000 lb) or less. GVRW is the value specified by the vehicle manufacturer as the loaded weight of a single vehicle.

4. TECHNICAL REQUIREMENTS

4.1 Datum Planes

Regardless of the information source, three datum planes are recommended.

4.2 Dimensional Data Format

4.2.1 Views

a. From OEM vehicle manufacturer to information and equipment providers and repair technicians, measuring points should be clearly defined. The following views are recommended:

1. Plan View of the underbody and chassis (looking up, Figure 2)
2. Full Side View (Figure 3)
3. Front View (Figure 4)
4. Rear View (Figure 5)
5. Engine Compartment View (Figure 6)
6. Plan view of the retractable roof panel storage area (looking down)

b. From information and equipment providers to repair technicians, as follows:

1. The views shown are at the discretion of the information and equipment providers.
2. Symbols should be provided to clarify the direction of views and format (Figures 7 and 8).
3. Measuring points should be clearly defined.

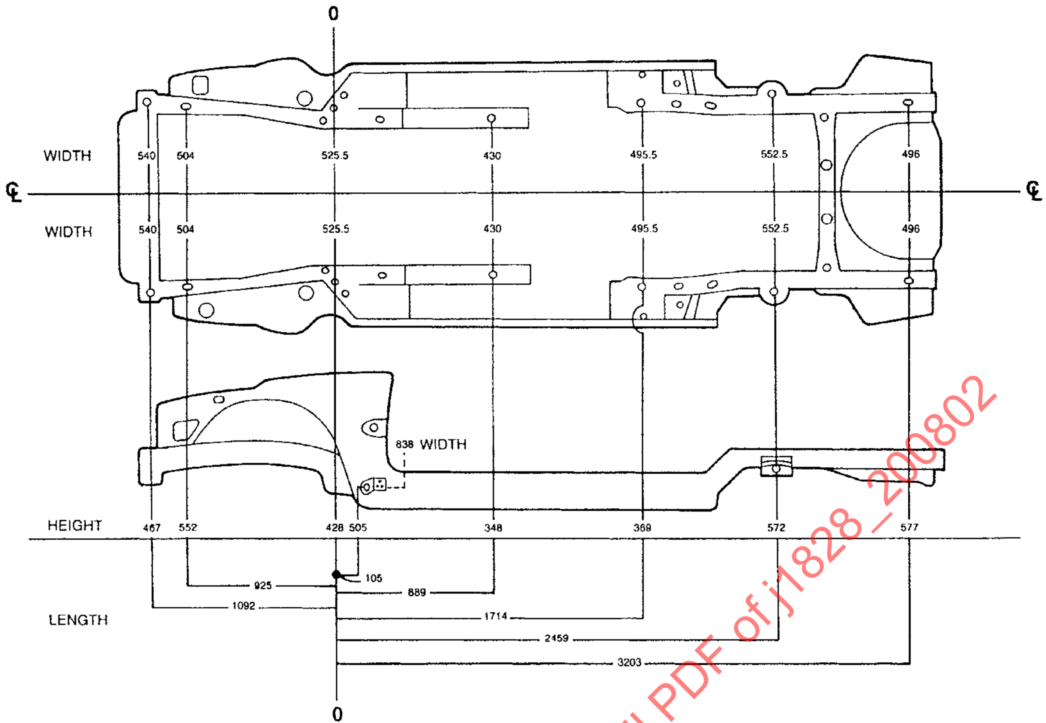

FIGURE 2 - PLAN AND SIDE VIEWS—UNDERBODY
(PLAN VIEW LOOKING UP FROM UNDERNEATH)

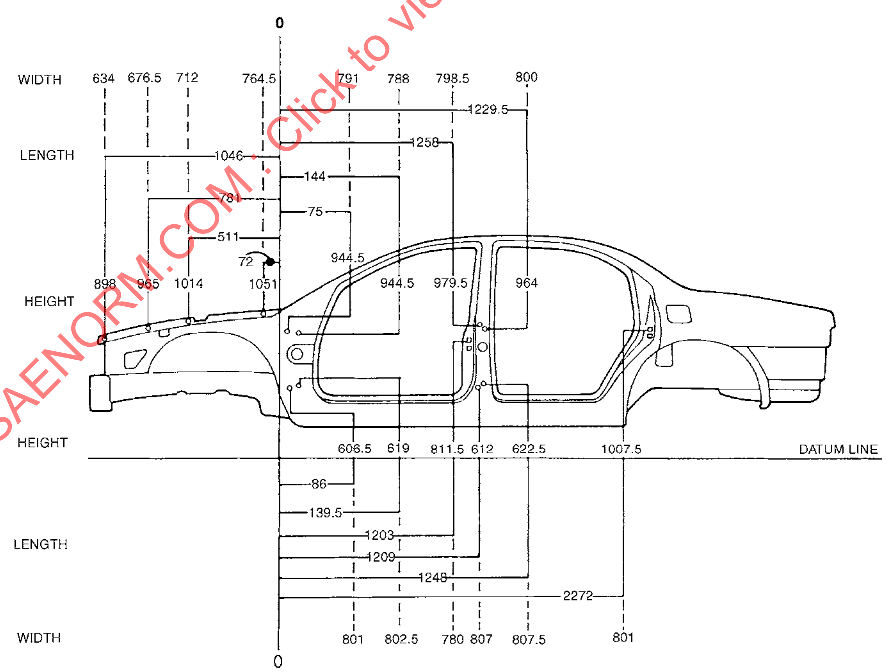

FIGURE 3 - FULL SIDE VIEW

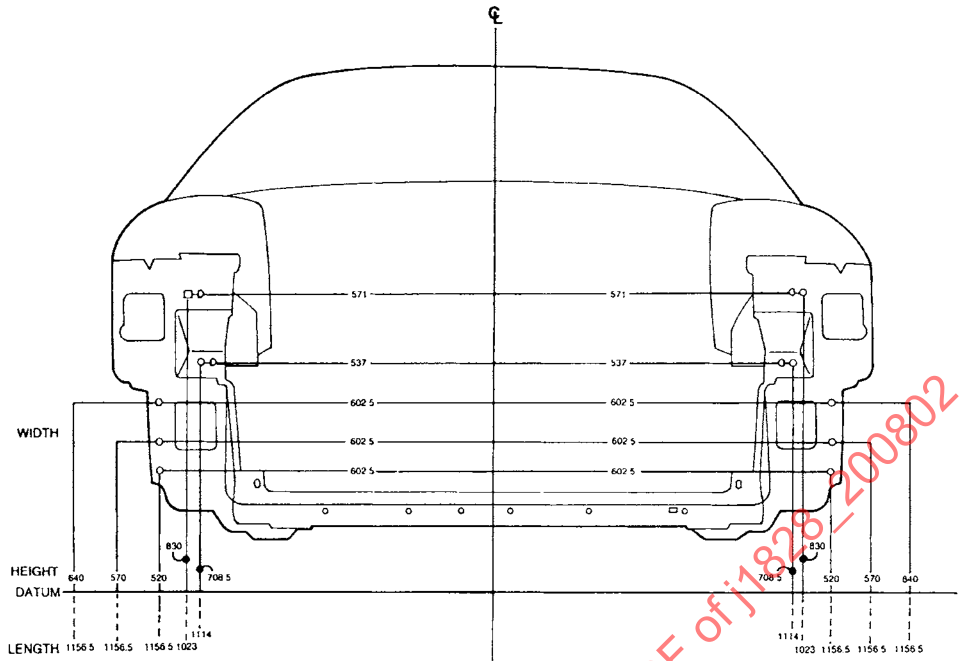

FIGURE 4 - FRONT VIEW

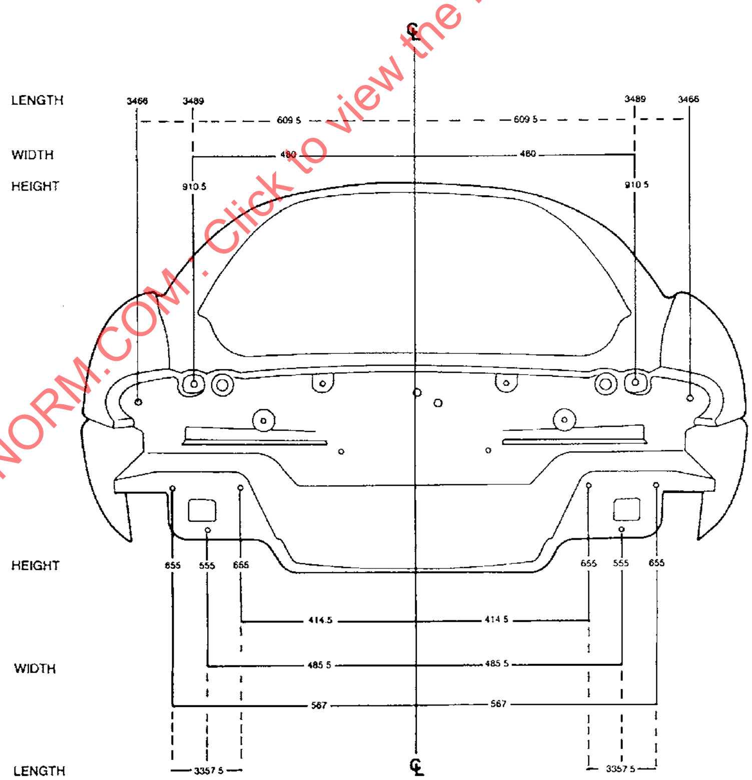

FIGURE 5 - REAR VIEW

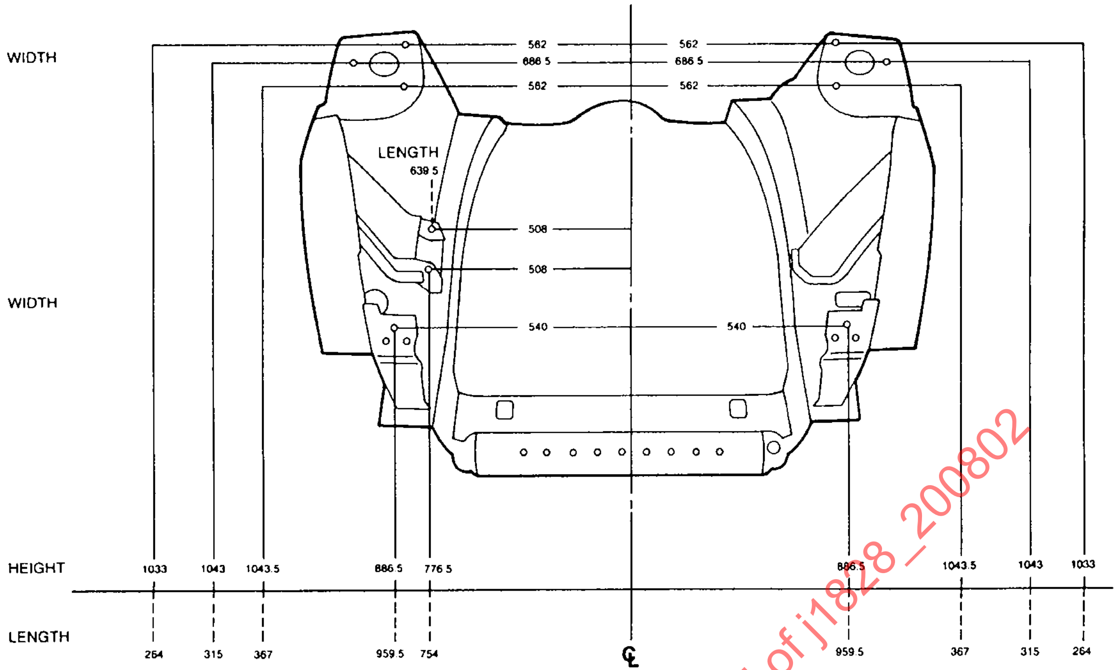

FIGURE 6 - ENGINE COMPARTMENT VIEW

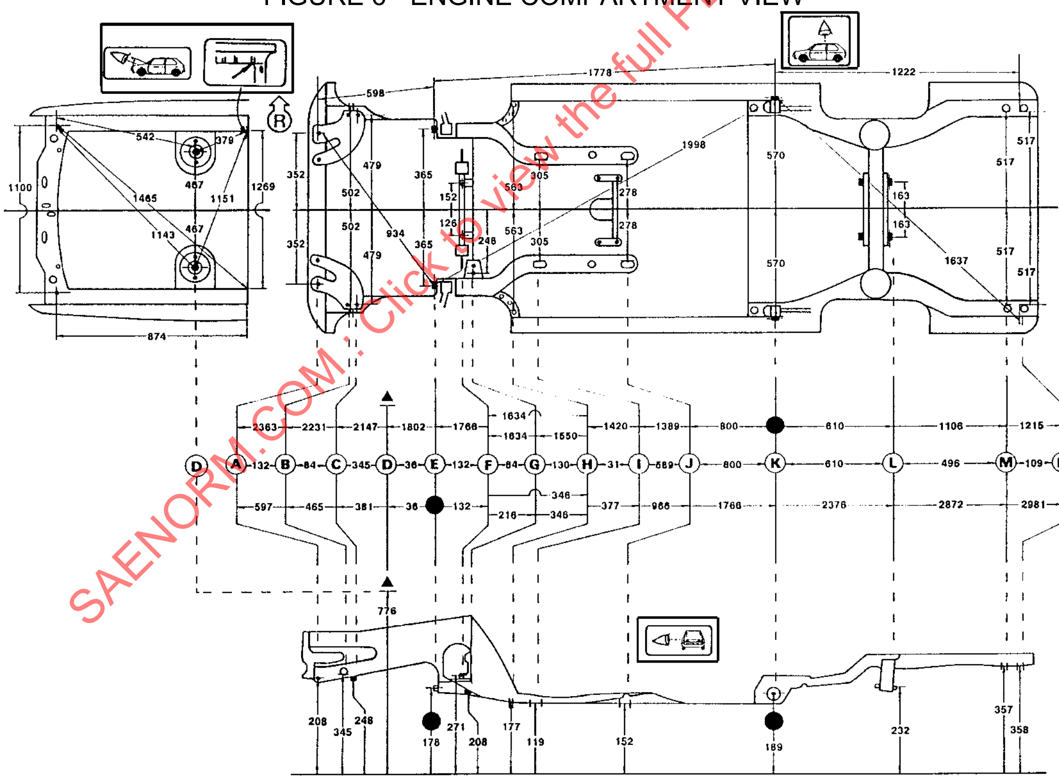

FIGURE 7 - SYMBOLS DEFINING DIRECTION OF VIEW

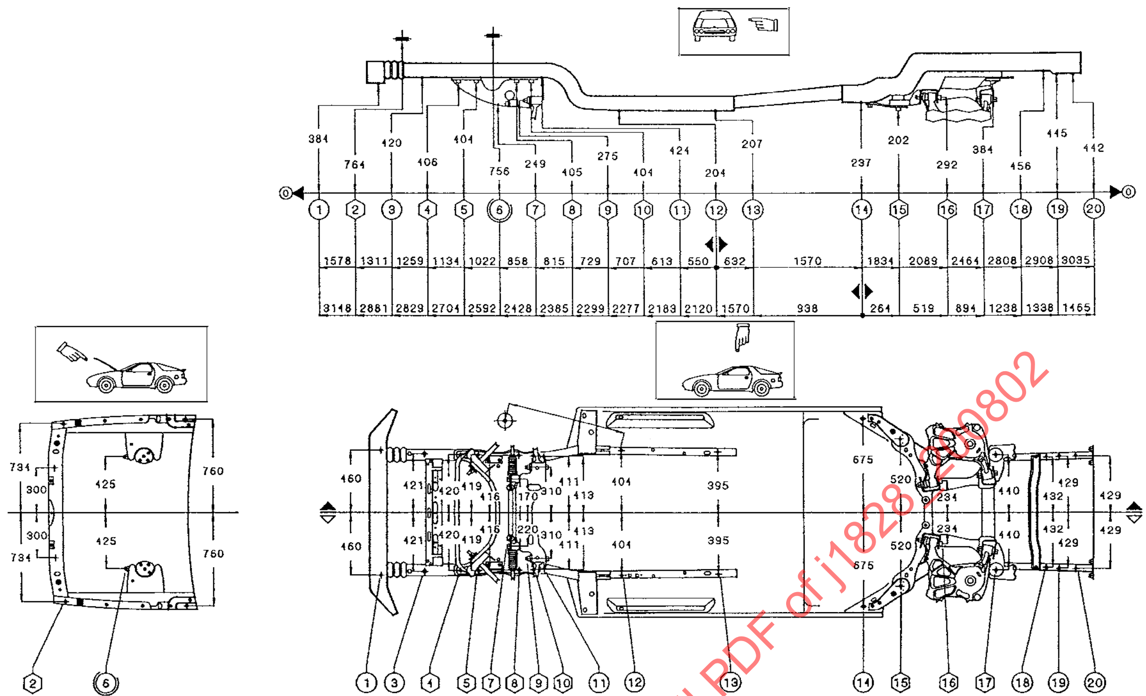

FIGURE 8 - SYMBOLS DEFINING DIRECTION OF VIEW MEASURING POINT SYMBOLS; IN-PLANE DIMENSIONS

4.2.2 Symbols

a. Measuring point symbols are preferred to printed text (Figure 8).

4.3 Types of Measuring Points

a. From OEM vehicle manufacturer to information and equipment providers and repair technicians, as follows:

1. Identify the points that are controlled, repeatable, and not likely to be changed during the production run of the vehicle.

2. Identify the master control holes used for inspection of the final body assembly, not of subassemblies.

3. Provide dimensional data for both the upper and under body structure, as well as the chassis of body-over-frame vehicles.

4. Provide dimension locations that are readily accessible for aftermarket measuring equipment that will allow measurements of: the body to itself, the chassis to itself, and the body to the chassis.

b. From information and equipment providers to repair technicians, as follows:

1. At the discretion of the provider, define three levels of confidence associated with the location tolerances of the measuring reference points. For example:

   a. Class A—The OEM final assembly master control holes and slots.

   b. Class B—Points supplied by the OEM vehicle manufacturer, other than OEM Master Control holes or slots.

   c. Class C—Reference dimensions not supplied by the OEM manufacturer.

2. Consider defining symbols for the three Classes of confidence intervals, to be shown on published data sheets or on computer database displays.

4.4 Measurement Point Locations (Center of Hole versus Edge of Hole)

a. From OEM vehicle manufacturer to information and equipment providers and repair technicians, as follows:

1. Centerlines of holes or slots are recommended.

2. Hole and slot sizes should be identified.

b. From information and equipment providers to repair technicians, as follows:

1. The optimum location is measuring-equipment specific.

2. Hole and slot sizes may be shown at the discretion of the provider.

4.5 Type of Measurement (In-Plane versus Point-to-Point versus XYZ Coordinates, Normal to Datum Planes versus Diagonal)

a. From OEM vehicle manufacturer to information and equipment providers and repair technicians, as follows:

1. XYZ dimensions are recommended.

2. Point-to-point dimensions are not recommended (these are derived by the information and equipment providers.)

b. From information and equipment providers to repair technicians, as follows:

1. The optimum type of measurement is equipment-specific.

2. Separate views are recommended for in-plane and point-to-point dimensions (Figures 8 and 9).

3. Symbols may be a useful way to identify the different types of measurements.

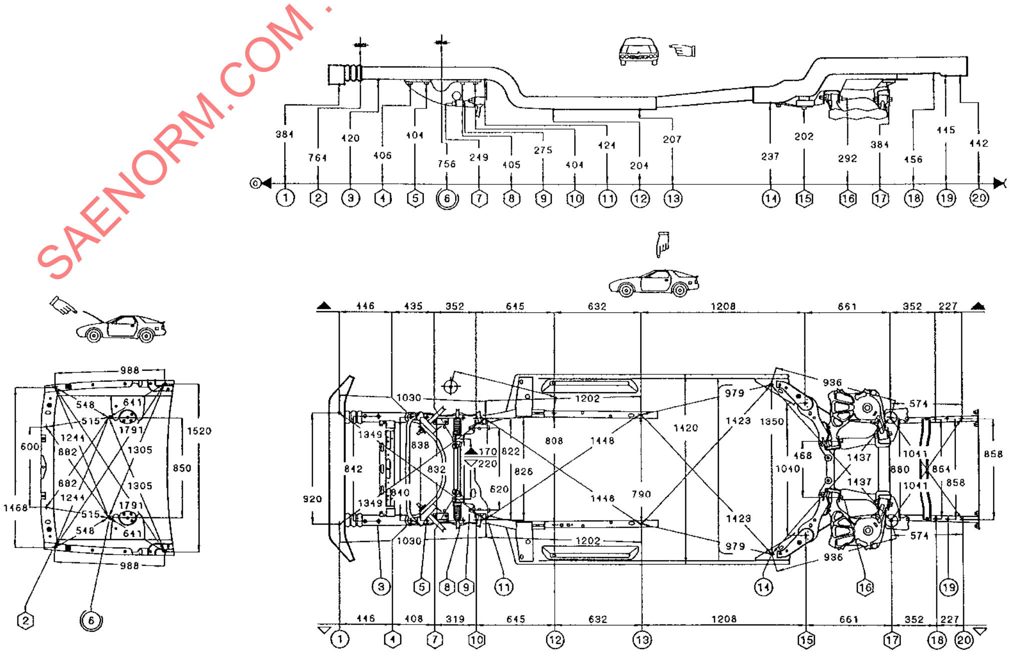

FIGURE 9 - POINT-TO-POINT DIMENSIONS

4.6 Cross-Car versus Measurements from Centerline

a. From OEM vehicle manufacturer to information and equipment providers, as follows:

   1. Dimensions should be measured from the datum planes.

   2. Critical dimensions (such as top of strut tower) should be measured from the vehicle centerline.

b. From OEM vehicle manufacturer to repair technicians. Both cross-car and centerline dimensions should be provided.

c. From information and equipment providers to repair technicians, as follows:

   1. Dimensions should be compatible with the particular equipment they are used with.

   2. Separate views should be developed for each type of dimension scheme.

4.7 Description of Measurement Point Locations

Regardless of the information source, descriptions should be simple, easy to use, readily accessible to the technician, utilize a minimum amount of text (rely on symbols, pictorials, and or illustrations) and include the hole or slot dimensions.

4.8 Symmetrical Dimensions

Regardless of the information source:

a. If dimensions are symmetrical, it is necessary to dimension only one side.

b. If dimensions are not symmetrical, dimension both sides.

4.9 Tolerances

a. Regardless of the information source, measurements must be controlled and repeatable.

b. From OEM vehicle manufacturer to information and equipment suppliers, and from OEM vehicle manufacturer to repair technician:

   1. Multiple tolerances should be defined for different areas of the vehicle (Figure 10).

   2. Both longitudinal and lateral dimensions should have tolerances defined.

   3. Tolerances are on measurements from the datum planes to any other hole or feature on the vehicle.

   4. Tolerances should be classified into two levels, as follows:

      a. Class A—Tolerances (typically ±3.0 mm or less), to be determined by the OEM vehicle manufacturer, that are used by the OEM in the final assembly of the body structure.

      b. Class B—Tolerances, that may be greater than Class A, which can be used to facilitate collision repair.

   5. The OEM vehicle manufacturer should define the master control holes and slots.

   6. The OEM vehicle manufacturer should define unique tolerances for different models.

   7. The OEM vehicle manufacturer should establish communication channels to keep the information and equipment providers and repair technicians continually appraised of changes in measurement-point location tolerances.

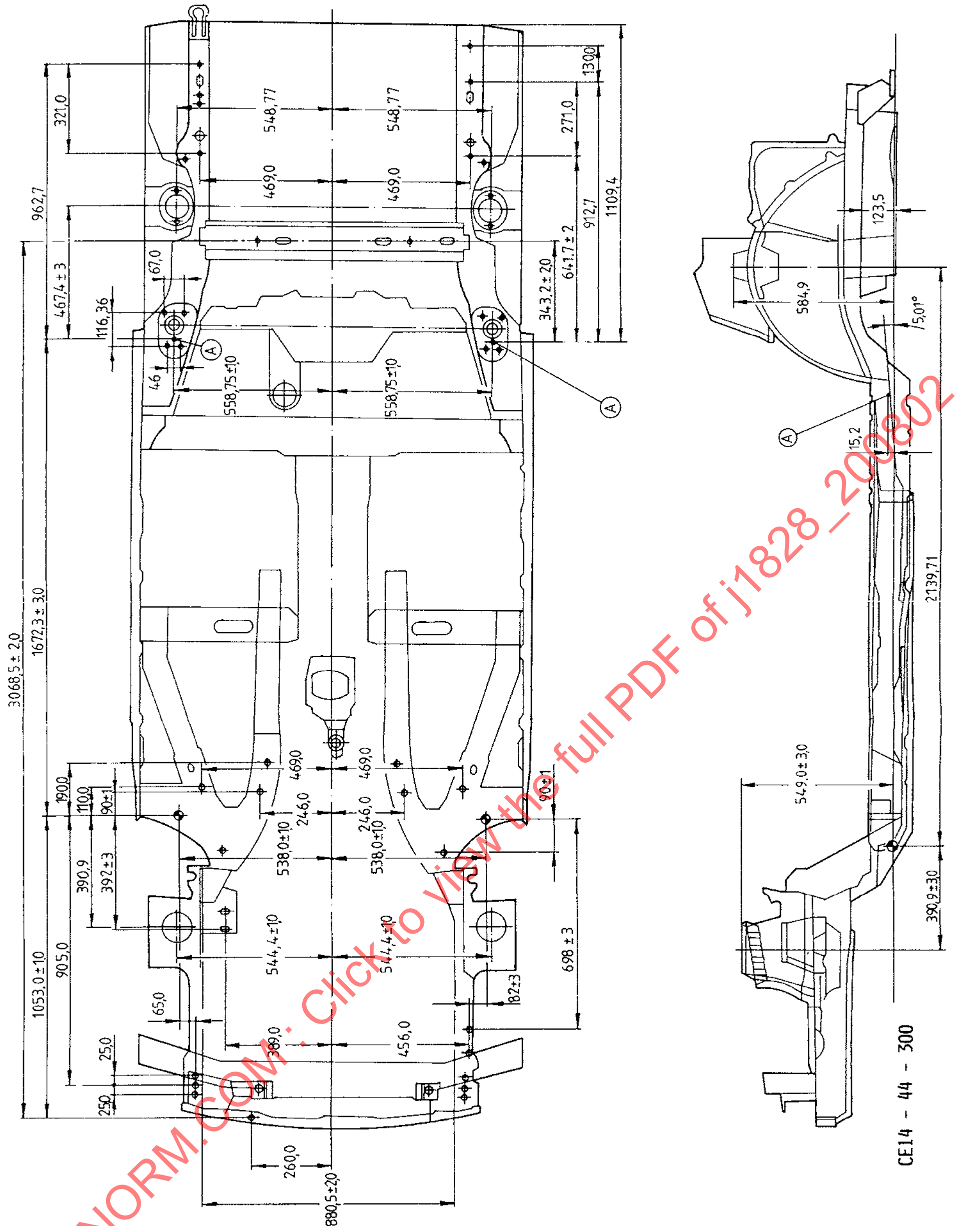

FIGURE 10 - MULTIPLE TOLERANCES

c. From Information and equipment providers to repair technicians, as follows:

1. Tolerances should be classified into three levels, as follows:

a. Class A—Tolerances (typically ±3.0 mm or less) to be determined by the OEM manufacturer, that are used by the OEM in the final assembly of the body structure.

b. Class B—Tolerances, to be determined by the OEM manufacturer, that may be greater than Class A, which can be used to facilitate collision repair.

c. Class C—Tolerances, that are not provided by the OEM vehicle manufacturer, which can be used to facilitate collision repair.

4.10 Suspension Locating Points

Both the OEM vehicle manufacturer and the information and equipment suppliers should provide the following:

a. XYZ Dimensions for the mounting points of the suspension to the body or chassis.

b. Ball joint locations should be used for diagnosis and checking only.

4.11 Steering Gear Locating Points

Both the OEM vehicle manufacturer and the information and equipment suppliers should provide XYZ dimensions for the mounting points of the steering gear assembly to the body or chassis.

4.12 Engine/Drivetrain Locating Points

Both the OEM vehicle manufacturer and the information and equipment suppliers should provide XYZ dimensions for the mounting points of the engine and drivetrain to the body or chassis.

4.13 Body-to-Chassis Locating Points

Both the OEM vehicle manufacturer and the information and equipment suppliers should provide the following:

a. XYZ dimensions for the mounting points of the body to the chassis or front or rear subframes.

b. Dimensions for subframes should be used for diagnosis or checking only.

4.14 The vehicle manufacturer and the information and equipment suppliers should provide XYZ dimensions for the mountings points of the door hinges and the door lock to the body.

4.15 Scale

Regardless of the information source, all body dimensions should be in metric scale only.

5. DESIGN GUIDELINES

5.1 Master Control Locators

Master control locators should, where feasible, be accessible for use by collision repair technicians. Welded-on panels, bolt-on components and sealers should not restrict access for measuring equipment.

5.2 Body Center Marks

From OEM vehicle manufacturer to both information and equipment suppliers and collision repair technicians. Stamped or molded features at the centerline of the following areas of the vehicle structure will facilitate diagnosis and repair (Figure 11):

a. Lower radiator support core

b. Upper radiator support core

c. Cowl top

d. Front roof

e. Front of floorpan

f. Center of floorpan

g. Rear of floorpan

h. Rear roof

i. Lower back panel or crossmember

6. COMMUNICATIONS

6.1 Recommended Information

OEM vehicle manufacturers should communicate, on a timely basis to information and equipment suppliers, relevant engineering release drawings and illustrations that identify master control locators, for use in the publication of vehicle dimension data to collision repair technicians. The following data should be communicated:

6.1.1 Pre-Production Data

Pre-production data of design-intent nominal dimensions and tolerance classes, identified as “preliminary” information, to allow publication and distribution by vehicle introduction date.

6.1.2 Post-Production Data

Post-production data of typical production dimensions and tolerance Classes, after the manufacturing process is judged by the OEM vehicle manufacturer to have achieved stability.

6.1.3 Engineering changes affecting pre-production or post-production dimensional data.

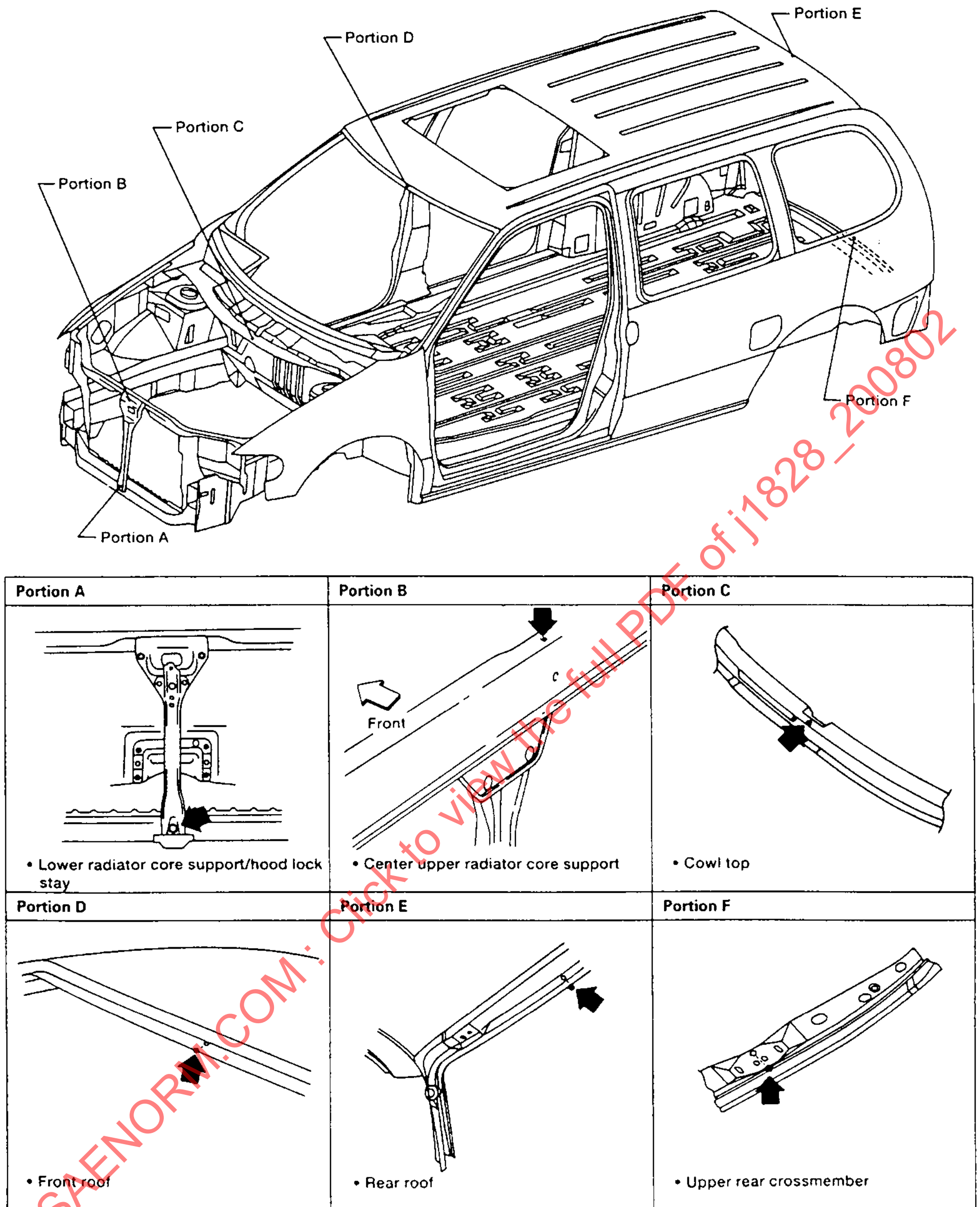

FIGURE 11 - BODY CENTER MARKS

6.2 Translation of OEM Computer-Aided Design Files

Provisions should be established, for translating OEM vehicle manufacturer electronic Computer-Aided Design files of the engineering release drawings and illustrations, into formats capable of being utilized by the information and equipment suppliers.

6.3 Feedback Communications Channels

OEM vehicle manufacturers should establish feedback communication channels that provide information and equipment suppliers the means of resolving discrepancies that may arise between the dimensional data provided by the OEM vehicle manufacturers and production vehicles measured in the field.

7. NOTES

7.1 Marginal Indicia

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE SAE UNIFORM REFERENCE AND DIMENSIONAL GUIDELINES WORKING GROUP
OF THE SAE SERVICE DEVELOPMENT TECHNICAL COMMITTEE

APPENDIX A

A.1 NEW BODY STRUCTURE DESIGN AND MANUFACTURING SYSTEMS

A.1.1 No-Adjust-Build

a. No-Adjust-Build is a design and manufacturing concept that relies on the use of specific master control holes, slots, and surfaces on components that exactly position the part in X-Y-Z space (Figure A1). These features are identified on new designs at the earliest phases of vehicle development, and are used consistently throughout the design, manufacture, inspection, and assembly of the parts.

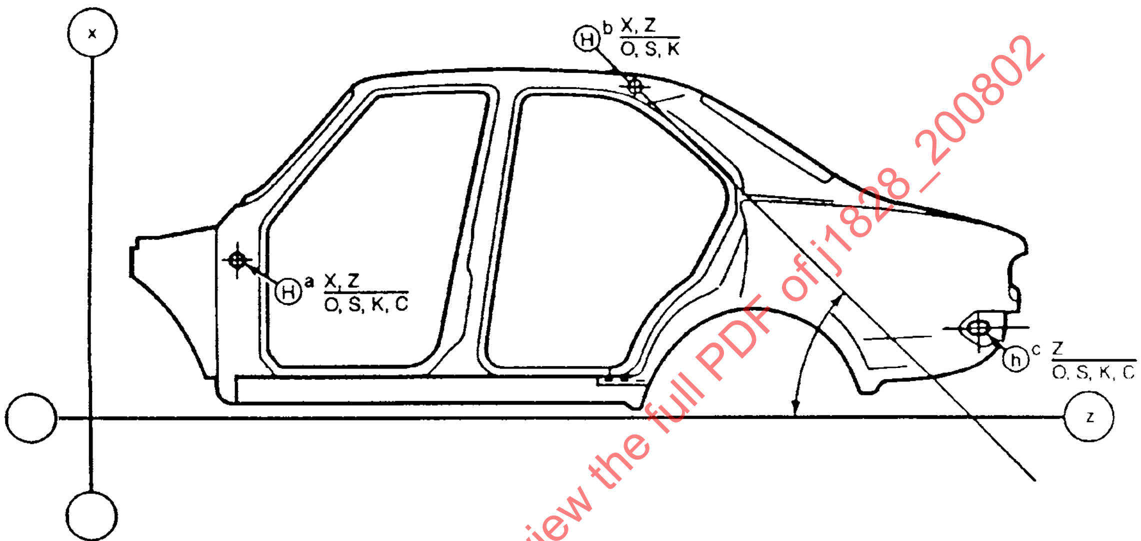

FIGURE A1 - NO-ADJUST BUILD

b. During the manufacturing process, the features are stamped or molded into the part at the earliest phases, and are used as reference points for all subsequent manufacturing operations. During the final assembly process, the assembly fixtures are also the inspection fixtures for the parts. If the locator features on the component or subassembly will not fit into the fixture, the part is rejected. The assembly fixtures cannot be shimmed, to compensate for variation in part dimensions.

c. For assembly of bolt-on components, the No-Adjust-Build features only permit the assembly operators to install the component one way—the correct way. The concept can be applied to any component, ranging from rigid structural body stampings to flexible plastic components.

d. These No-Adjust-Build features provide more reference points for diagnosis and repair of damaged vehicles.

A.1.2 Form and Pierce Manufacturing

a. The Form and Pierce process consists of a series of machines that check, gage, and map each car body to insure outer body attachment/alignment without shims.

b. The basic concept sets or “positions” doors, fenders, hood, and decklid or hatchback to the “body-inwhite” structure. This is accomplished by providing customized mounting positions for each panel. Once these machines establish the proper location for a panel, each station “forms” a raised surface with a “pierced” hole used later in the assembly process to locate and secure the body panels (Figures A2a through A2d).

c. It is this variation of the mounting surface which insures a “customized” fit between each exterior body panel. When the process is complete, attaching locations (consisting of a “raised surface” and a locating “hole”) can be seen that represent the proper location for up/down, cross-car, and fore/aft of the panel.