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**Uniform Reference &
Dimensional
Guidelines for
Unibody Vehicles**

SAE Information Report
Issued May 1987

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MAINTENANCE REPORT

SAE J1828

Issued May 1987

UNIFORM REFERENCE & DIMENSIONAL GUIDELINES FOR UNIBODY VEHICLES

1. **PURPOSE:** The intent of this SAE Information Report is to alert automobile design engineers of the need to standardize unibody dimensional reference points, and to provide them to the aftermarket body repair, insurance, tool and equipment industries prior to the market introduction of new vehicle programs.
2. **INTRODUCTION:** With the introduction of unibody vehicles, it is imperative that the repair technician have the necessary reference and dimensional measurements to achieve reliable repair work and ensure customer satisfaction. It is also imperative that these reference points should be located in consistent areas of the engine compartment and underbody areas whenever practical. This will allow technicians and claim representatives to easily find the points and to be able to more accurately complete the processes of damage diagnosis, repair cost estimation and the repair itself.

The need for dimensional references is based on locating and determining both damaged and undamaged areas of the vehicle. Since the extent of collision damage usually progresses from the outboard to the inboard areas of the vehicle, the repair technician and claim representative must find an undamaged area from which to establish a reference for determining the best possibility of and procedures for restoring the dimensional and structural integrity of the vehicle. This reference, called a datum, is an imaginary line, typically, but not necessarily, underneath the vehicle, which is used to establish deviations in measurements to the reference points which automobile manufacturers provide for repair. Reference points frequently are the same points that the automobile manufacturer uses for statistical quality control in the assembly process. There are other dimensions that are used in conjunction with repair tools and equipment. These dimensions may be similar to those used by the automobile manufacturers.

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Comments on this Report are invited from interested parties and can be submitted in writing to SAE Headquarters.

2. (Continued):

Most of the different sets of dimensions described herein can be mathematically related to one another depending on the design of the repair equipment system. It is important that the design engineer select a set of dimensions that can be easily used with minimum repair equipment by technicians and claim representatives possessing basic measurement skills. (See Appendix A for minimum repair equipment recommendations.)

3. DEFINITIONS:

3.1 Basic Dimensions: Those dimensions which are generally supplied to the equipment manufacturers and publishers. They are generally expressed in the vehicle manufacturer's coordinate system using the datum lines as coordinate axes.

3.1.1 Datum Lines: Lines defined by three planes intersecting at right angles. These planes are generally defined as:

- a) A vertical plane passing through the longitudinal centerline of the vehicle.
- b) A vertical transverse plane located forward of the cowl.
- c) A horizontal plane located at or beneath the floorpan.

3.2 Trade Dimensions: Those dimensions which are generally published to the autobody repair trade. They are generally expressed in the coordinate system required by the measuring equipment with which they are used. By mathematical transposition they should agree with the Basic Dimensions supplied by the vehicle manufacturer.

3.2.1 General Trade Dimensions: Dimensions which are designed for use by the trade assuming that measuring tools available include only datum/centerline gages, a steel tape measure, and/or a tram gage.

3.3 Build Tolerances: The tolerances which result in the finally assembled vehicle as shipped from the assembly plant. These may be expressed as a general rule, that is, "all dimension $\pm X$ " or, when required, as a tolerance to a specific dimension, that is, "X Y $\pm X$ ".

3.4 Reference Dimensions: Dimensions which are not controlled during final assembly but may otherwise be used for measurement purposes during repair of the vehicle.

3.5 Measuring Instruments:

3.5.1 Steel Tape: A steel tape measure can be used to check point-to-point measurements when other parts on the vehicle do not interfere. The tape should be at least 12 ft (3657.6 mm) in length and preferably marked in both millimeters and inches.

- 3.5.2 Tram Gauge: A tram gauge is an adjustable bar with two or more movable pointers used to take point-to-point measurements where obstructions make the use of a steel tape inappropriate and/or inaccurate. (See Appendix B, Fig. 1.)
- 3.5.3 Center Line Gauge (minimum of four): Self-centering gauges are sighting rather than measuring instruments. Most gauges have two adjustable cross bars with a center pin and/or ring that remains centered as the cross bars are extended. Each gauge has 2 adjustable arms or hooks for attachment to the vehicle and for height adjustment. Another type of self-centering gauge uses a single horizontal bar with a center pin. It is attached with chains. (See Appendix B, Figs. 2 through 6.)
- 3.5.4 Strut Tower Gauge: Most Unibody vehicles employ strut towers to provide the upper mounting surface for the suspension system. It is important that the strut towers be checked when the car has been involved in a collision. Roadability and wheel alignment are dependent on proper positioning of the strut towers. To measure the tower position, a strut tower gauge should be used in conjunction with the center line gauges. A strut tower gauge, while designed primarily to measure front strut towers, can also be used on rear towers when accessibility permits. Rear strut towers are usually measured with a steel tape, a tram or center-line gauges. (See Appendix B, Fig. 7.)
4. MEASUREMENT GUIDELINES: The following are guidelines which should be considered by automotive and design engineers.
- 4.1 Provide dimensional drawings specific to each model - include the following views and information using the datum lines already specified; (refer to Appendix C for examples).
- 4.1.1 Top View: Engine compartment.
- 4.1.2 Bottom: Floor pan & suspension mounting including front and rear side rails.
- 4.1.3 Side: Including door, window and interior dimensions.
- 4.2 Provide cross sectional views of the vehicle through the windshield, center and rear pillar area of quarter panel, radiator core support, front and rear suspension mounting areas, highlighting multiple panel overlap areas.
- 4.3 All specifications should be able to be measured by center-line gauges, tram and tape measure.
- 4.4 Specifications should be standardized to measure from center to center of all holes or bolts.
- 4.5 Provide specific dimensions to suspension mounting holes where the holes are pierced after welding. This is sometimes referred to as a "net build" concept which reduces assembly tolerance stockup in production.
- 4.6 Supply templates or specific reference dimensions with repair parts to locate necessary attachment holes which have not been drilled or pierced.

- 4.7 Include reference points which are visible prior to sheet metal disassembly that is, dimples, holes, notches, etc. (required for damage diagnosis). These references can be located behind or underneath cosmetic mouldings, rubber gaskets and seals.
- 4.8 Reference points should include the maximum overall length of structural components that is, frame rails. (Reference holes located in crush zones should be avoided if possible.)
- 4.9 Advise location of spot weld, size, spacing and critical locations or when spot welds should be omitted (in the case a gas metal arc weld is specified as a repair operation to replace the production spot weld).
- 4.10 Provide reference marks for welded hinges, doors and deck lids (necessary for replacement part locations).
- 4.11 Provide specifications for under hood and deck lid dimensions, using reference marks or dimples to a specific point.
- 4.12 Provide specifications regarding lower ball joint location while the suspension is loaded (curb weight) referencing vehicle center-line.
- 4.13 Provide specifications regarding lower ball joint location in an unloaded (full rebound) position from a rearward reference point.
5. UNITS OF MEASUREMENT: Dual dimensions should be used whenever possible. Primary numbers should be metric with secondary numbers in the English system that is, 671.5 mm (26 7/16 in).
6. REQUIRED DIMENSIONS:
- 6.1.1 Floor Pan: Four locations on the underbody nearest to the extremities of the passenger compartment and accessible from the bottom of the vehicle.
- 6.1.2 Front Suspension:
- Location of the lower front rails in front crossmember area.
- Location of front suspension crossmember attachment points.
- Provide three dimensional specifications locating the front and rear suspension upper and lower mounting points.
- Location of any other front suspension attachments which affect steering geometry.
- Provide three dimensional specifications locating the rack and pinion mounting holes and brackets.

6.1.3 Rear Suspension:

Location of rear side rails behind rear wheels.

Location of rear suspension attachments.

6.1.4 Drivetrain:

Location of engine and transmission attachment points.

Location of applicable crossmember attachment points.

6.1.5 Other Body Dimensions:

Location of body rail extremities.

Location of at least one reference point at upper cowl.

6.2 Additional Body Dimensions: The additional body dimensions should be adequate to define the upper body for proper fit of body sheet metal.

6.2.1 Passenger Compartment: Three dimensional measurements at rockers and beltline.

- in windshield pillar area
- in center pillar area
- in rear pillar area

6.2.2 Body Extremities:

Three dimensional measurements of radiator core support.

Three dimensional measurements of rear back panels.

6.2.3 Body Openings: Body openings dimensions should be given as diagonal dimensions to define the general shape of the body opening. They should be given as reference dimensions only.

7. PERFORMANCE REQUIREMENTS: Not Applicable

8. APPENDICES:

8.1 APPENDIX A - REFERENCES

8.2 APPENDIX B - SUPPLEMENTAL DRAWINGS

8.3 APPENDIX C - EXAMPLES OF UNIBODY MEASUREMENTS

APPENDIX A

REFERENCES

1. Recommended Practice For Body & Chassis Dimensioning

ETI Designation BRPG-79-2

Equipment & Tool Institute
Glenview, Illinois, 1980

2. Minimal Equipment For Unibody Structural Damage Diagnosis & Repair

Allstate Insurance Company
Allstate Plaza
Northbrook, Illinois, 1986

3. 1986 Taurus/Sable Body Collision Repair Manual

Ford Motor Company
The American Road
Dearborn, MI 48121

4. Toyota Repair Manual For Collision Damage - CAMRY

SV1 - Series Oct., 1982
Toyota Motor Sales U.S.A., Inc.
19001 S. Western Avenue
Torrance, CA 90509

5. Frame & Body Dimensions & Specification Charts

1981 Domestic Cars, 1981 KLM
Automotive Publishing Inc.
P.O. Box 26093
San Diego, CA 92126

APPENDIX B

SUPPLEMENTAL DRAWINGS

■ Tram Gauge

A tram gauge is an adjustable bar with two or more movable pointers used to take point-to-point measurements where obstructions make the use of a steel tape inappropriate and inaccurate.

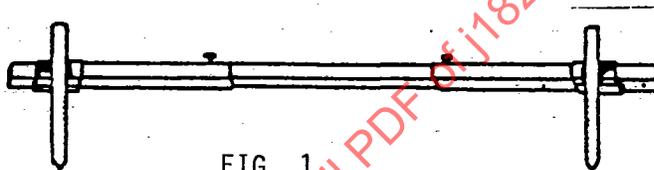


FIG. 1

■ Center Line Gauge (minimum of four)

Self-centering gauges are sighting rather than measuring instruments. Most gauges have two adjustable cross bars with a center pin and/or ring that remains centered as the cross bars are extended. Each gauge has 2 adjustable arms or hooks for attachment to the vehicle and for height adjustment. Another type of self-centering gauge uses a single horizontal bar with a center pin. It is attached with chains.

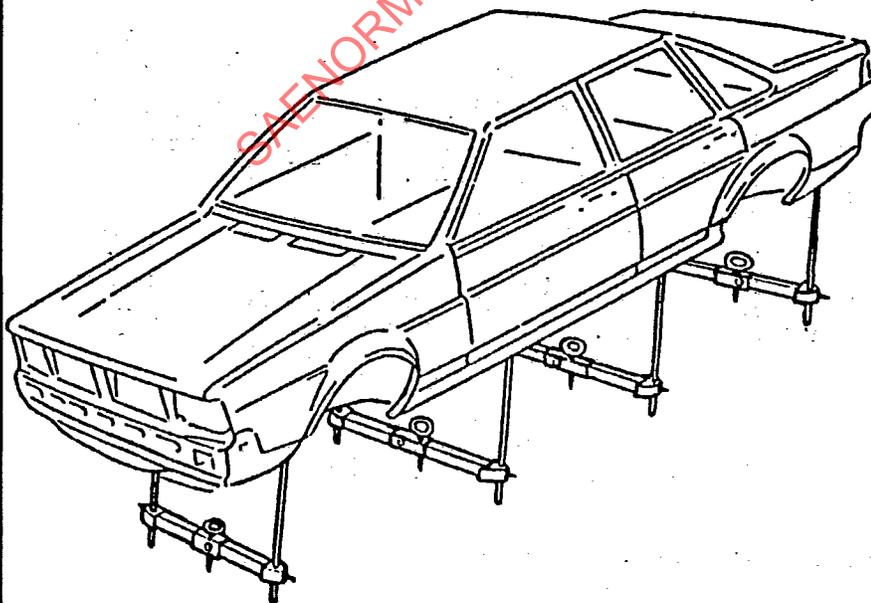


FIG. 2

When installed on the vehicle and sighted, the user gets the effect of looking through several rifle sights. If one or more of the sights or plns is out of line with the others, it indicates that the area of the vehicle to which the gauge is attached is out of position.

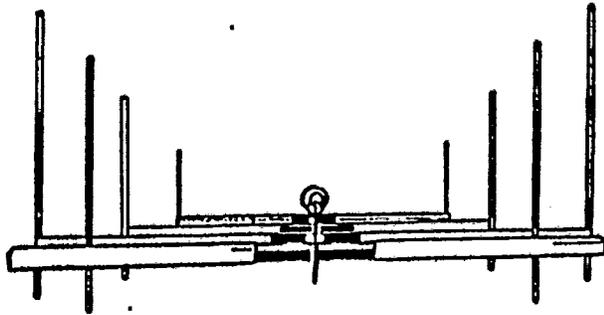


FIG. 3

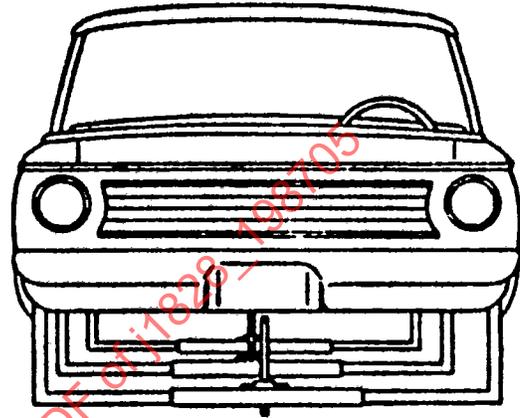


FIG. 4

The horizontal bars must also be observed. When no damage exists, all the bars should be parallel. Misalignment of one or more of the horizontal bars indicates structural damage.

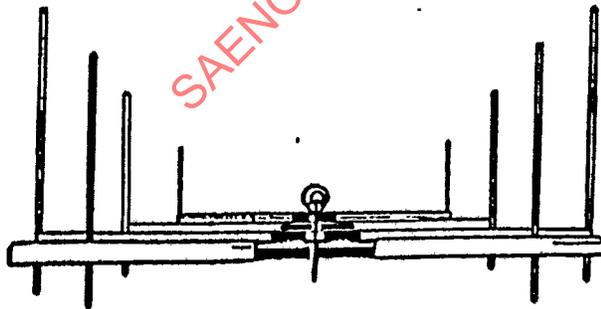


FIG. 5

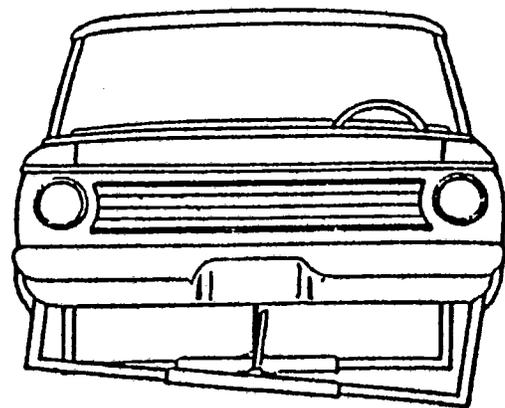


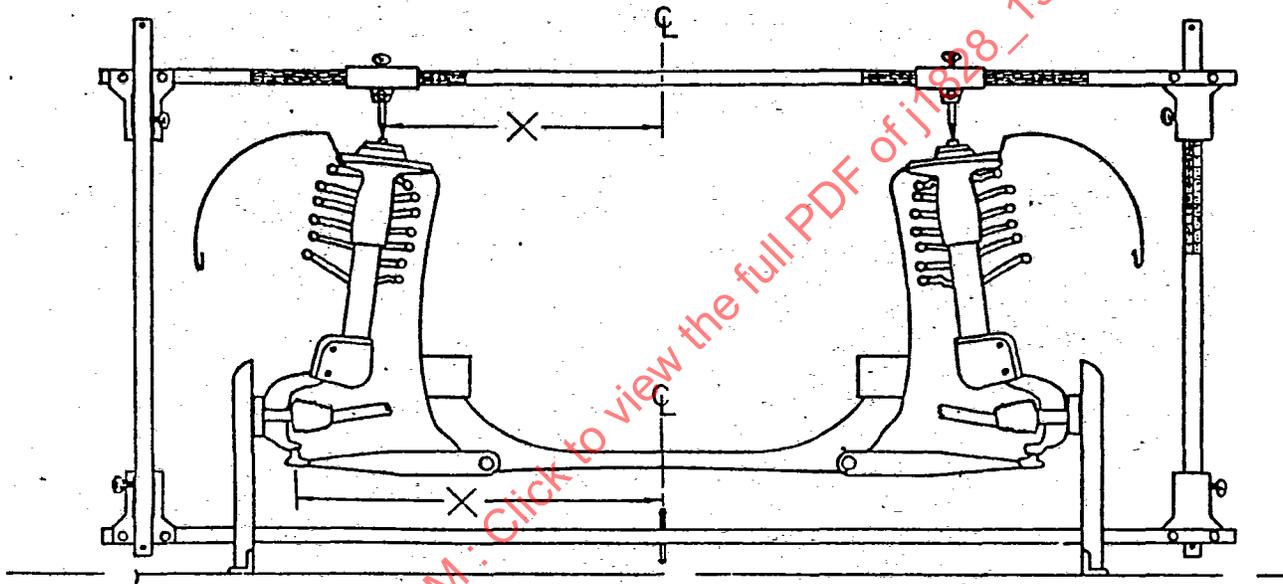
FIG. 6

HOW CENTER LINE GAUGES ARE USED

■ Strut Tower Gauge

Most Unibody vehicles employ strut towers to provide the upper mounting surface for the suspension system. It is important that the strut towers be checked when the car has been involved in a collision. Roadability and wheel alignment are dependent on proper positioning of the strut towers. To

measure the tower position, a strut tower gauge should be used in conjunction with the center line gauges. A strut tower gauge, while designed primarily to measure front strut towers, can also be used on rear towers when accessibility permits. Rear strut towers are usually measured with a steel tape, a tram or center-line gauges.



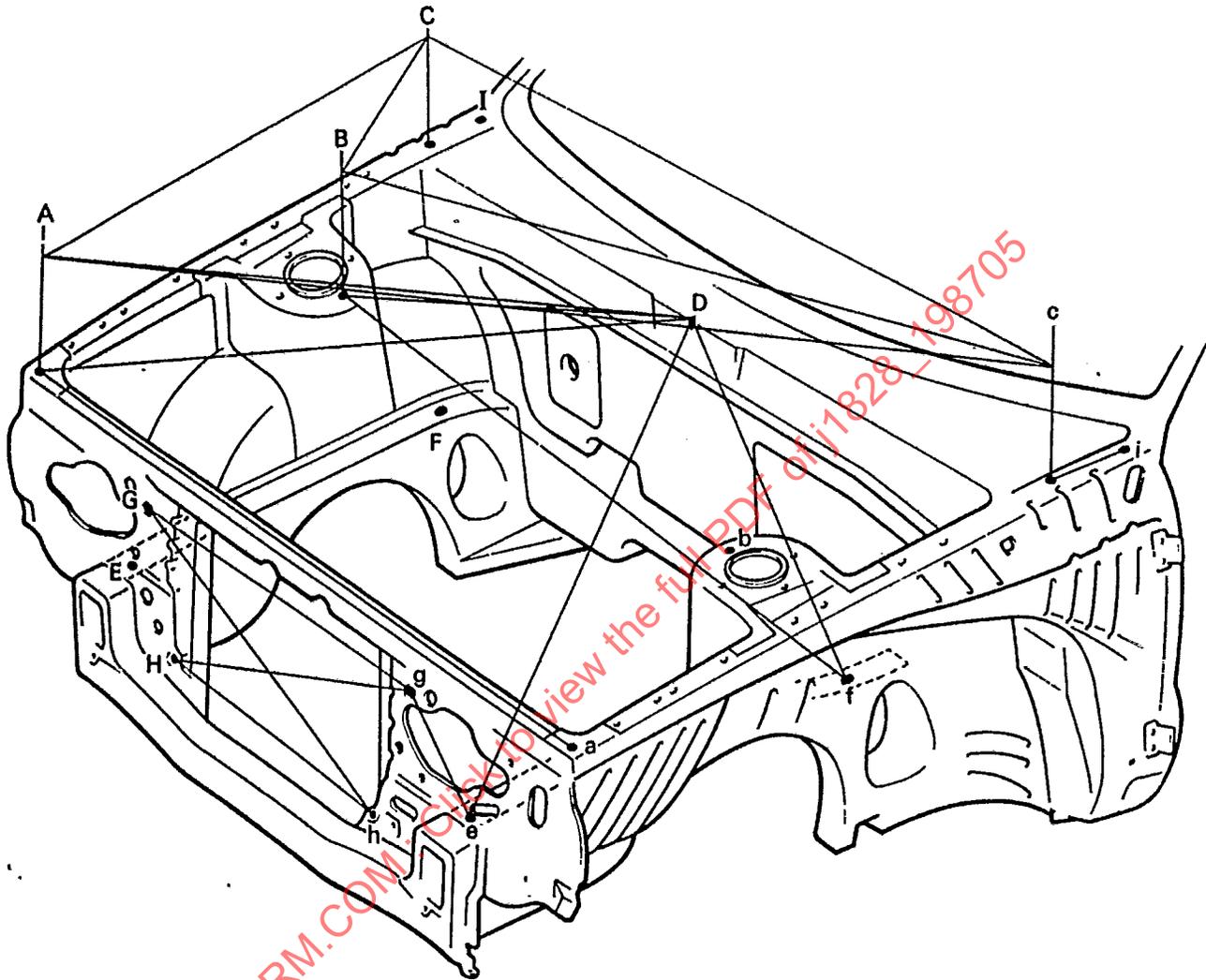
These items are of absolute necessity. Accurately returning the Unibody structure to its original

dimensions is critical for body fit and proper road handling performance.

FIG. 7 - STRUT TOWER GAUGE

APPENDIX C

EXAMPLES OF UNIBODY MEASUREMENTS



(See Reference No. 4, Appendix A.)

									mm (in.)
A - a	A - C	A - c	B - b	B - c	B - D	B - f	B - C	C - c	C - i
1,381 (54.37)	889 (35.00)	1,649 (64.92)	965 (37.99)	1,219 (47.99)	561 (22.09)	988 (38.90)	370 (14.57)	1,397 (55.00)	133 (5.24)
D - A	D - e	D - f	G - g	G - h	g - e	H - h	H - g	-	-
1,114 (43.86)	1,039 (40.91)	695 (23.43)	784 (30.87)	795 (31.30)	185 (7.28)	730 (28.74)	795 (31.30)	-	-