SURFACE VEHICLE STANDARD

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Superseding J224 FEB2017

Collision Deformation Classification

RATIONALE

Five-Year Review of this document. Updated for current industry nomenclature, formating, and clarification.

1. SCOPE

The purpose and scope of this SAE Recommended Practice is to provide a basis for classification of the extent of vehicle deformation caused by vehicle accidents on the highway. It is necessary to classify collision contact deformation (as opposed to induced deformation) so that the accident deformation may be segregated into rather narrow limits. Studies of collision deformation can then be performed on one or many data banks with assurance that the data under study are of essentially the same type.[1]

The seven-character code is also an expression useful to persons engaged in automobile safety, to describe appropriately a field-damaged vehicle with conciseness in their oral and written communications. Although this classification system was established primarily for use by professional teams investigating accidents in depth, other groups may also find it useful.

The classification system consists of seven characters, three numeric, and four alphameric, arranged in a specific order. The characters describe the deformation detail concerning the direction, location, size of the area, and extent which, combined together, form a descriptive composite of the vehicle damage. The individual character positions are referred to by column number for identification and computer storage compatibility as illustrated in Figure 1. The definition of each classification is provided in subsequent sections. An appendix is also provided to assist in application and interpretation.

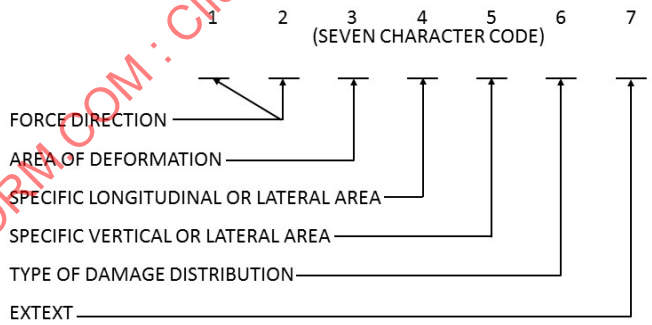

Figure 1

[1] Stonex, K., Nelson, W., Siegel, A., Garrett, J., et al., "Collision Damage Severity Scale," SAE Technical Paper 700136, 1970, doi:10.4271/700136.

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2. REFERENCES

2.1 Applicable Documents

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 +1 724-776-4970 (outside USA), www.sae.org.

Stonex, K., Nelson, W., Siegel, A., Garrett, J., et al., "Collision Damage Severity Scale," SAE Technical Paper 700136, 1970, doi:10.4271/700136.

Hendricks, D., "Collision Deformation Classification for Trucks," SAE Technical Paper 810215, 1981, doi:10.4271/810215.

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 Other Publications

Hendricks, D.L., "Collision Deformation Classification Training Program: Intermediate Level Training/Reference Module." Calspan Field Service, Inc., NHTSA DOT HS-806-061, July 1981.

3. CLASSIFICATION OF COLLISION DAMAGE

Vehicle collision damage is classified in a three-dimensional system. Column 3 defines an orthogonal set of axes for columns 4, 5, and 7 (see Appendix A). Columns 1, 2, and 6 provide additional description. Individual character positions are defined as follows:

3.1 Columns 1 and 2 - Direction of Principal Force During Impact

The principal force is the force that caused the crush and sheet metal displacement on the damaged vehicle. The direction of the principal force is determined by the resultant of forces acting on the vehicle (that is, vector analysis) at the point of application. The direction of the principal force is designated by reference to hour sectors on a conventional clockface, positioned over the point of application.

The clockface is assumed to be in a plane referenced to the horizontal plane of the car. Twelve o'clock characterizes the direction of an oncoming force relative to the vehicle applied at the frontal area of vehicle deformation. Other examples of clock positions, such as 3, 6, and 9 o'clock, refer to forces directed from the right, rear, and left, respectively. The code classifications are the hour numerals from 01 to 12. Columns 1 and 2 of the classification system are used for direction of principal force (see Figure 2). The entry of 00 indicates that the impact is not horizontal, as in a rollover or undercarriage type impact.

Table 1

Direction of End Shift	Classification	Basic Rule [2]
No shift of Damaged Area	01-12	Add 0
Vertical-Up	21-32	Add 20
Vertical-Down	41-52	Add 40
Lateral-Right	61-72	Add 60
Lateral-Left	81-92	Add 80

The direction of principal force classification is incremented to indicate vertical or lateral shifting of vehicle basic end structures which occurs during horizontal force applications. The shifting must be 4 inches (100 mm) or greater to be classified, and is not related to the extent of crush (see Appendix A). Specific increments related to direction of shift are shown in Table 1.

Codes are also provided to indicate longitudinal or lateral shifting of the top structure as a result of non-horizontal force applications (that is, 00 direction of force) to the top. Shifting should be classified when visually apparent. Specific classifications related to direction of shifting are shown in Table 2.

3.2 Column 3 - Deformation Location and Classification Code

This character of a classification expression broadly defines which projected area of the vehicle contains the deformation (see Figure 3). The windshield is included in the F projected area and the backlight is included in the B projected area. The U (undercarriage) character is defined as the bottom plane of the vehicle, including all projections, but excluding the tires and wheels. Impacts involving only the tires or wheels are classified, F, L, R, or B as determined by the projected area of initial contact (W must be entered in column 5 for these impacts).

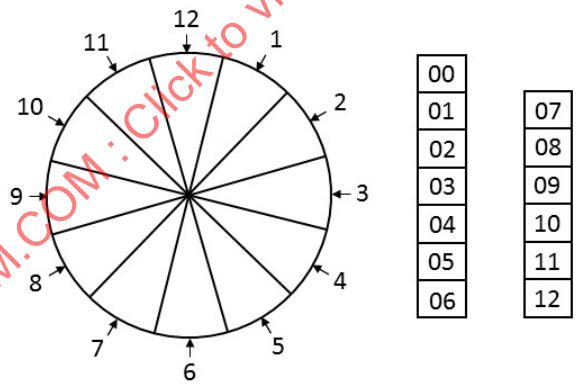
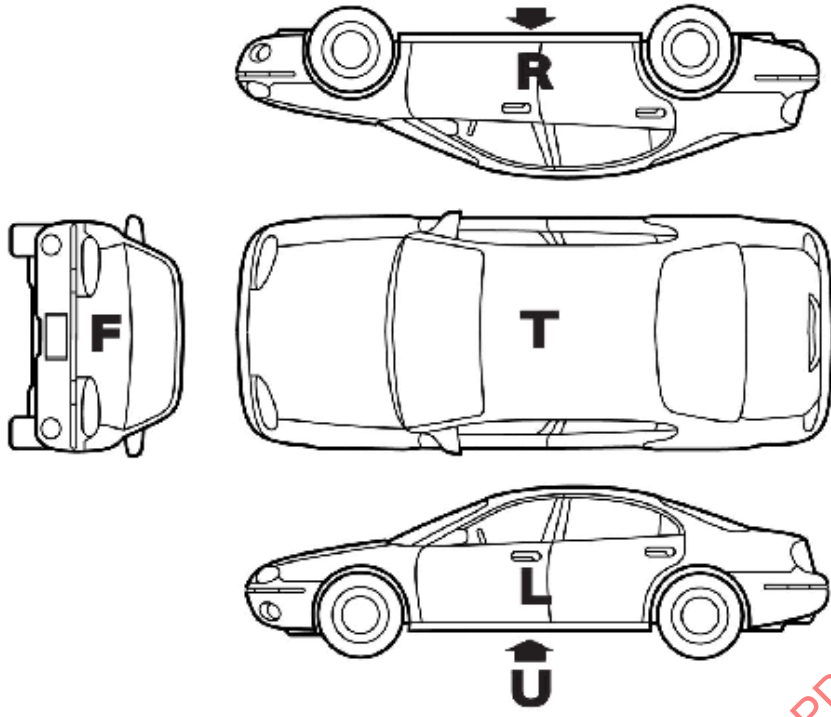


Figure 2

Table 2

Direction of Top Shift	Classification
No Shift	00
Forward	20
Rearward	40
Lateral-Right	60
Lateral-Left	80

[2] Specific increment added to horizontal resultant direction of force (see Appendix A).



Location	Classification
Front	F
Right Side	R
Back (Rear)	B
Left Side	L
Top	T
Undercarriage	U

Figure 3

3.3 Column 4 - Specific Longitudinal or Lateral Location of Deformation and Classification Code

The plan view of the vehicle (Figure 4) illustrates the horizontal areas to be used in locating the deformation for F, B, R, or L in column 3. The letters shown at the front and rear of the vehicle can be for either the front or the rear. The letters shown on both sides can be used for either side. Classification codes for this column are orthogonal to either the longitudinal or lateral axis of the vehicle. Variations in vehicles require special definitions for the classification code P. P is defined as follows:

a. Passenger cars—from the base of windshield to the rear of the rearmost seat.

b. SUVs/crossovers/station wagons—from the base of windshield to the rear of the rearmost seat.

c. Vans—from the front seat backrest to the center of the rear wheel.

d. Pickups—from the base of windshield to the rear of the cab.

e. Soft top jeeps—from the base of windshield to the center of the rear wheel.

F and B are side deformation areas forward and rearward of P, respectively. Column 4 has meaning only in connection with column 3; that is, it is a suffix of column 3, rather than being independent of it. This column also locates the longitudinal area of damage for vehicles with top or undercarriage deformation (T or U in column 3).

The classifications F, P, B, Y, Z, and D must be used in column 4 for vehicles with top or undercarriage deformation (T or U in column 3).

3.4 Column 5 - Specific Vertical or Lateral Location of Deformation and Classification Code

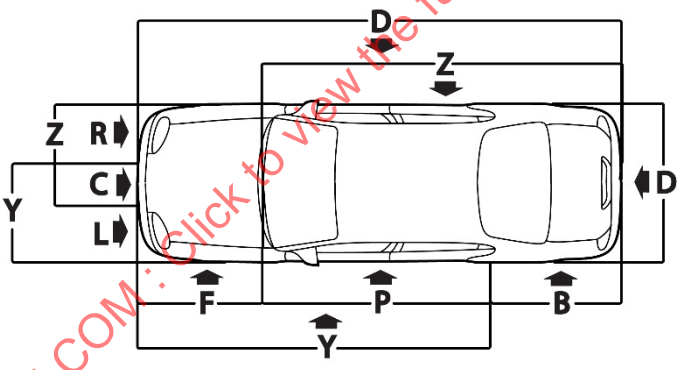
Figure 5A illustrates the classifications for the vertical location of deformations associated with impacts classified F, B, L, or R in column 3. Figure 5B illustrates the classifications for the lateral location of deformations associated with impacts classified as T or U in column 3.

3.5 Column 6 - General Type of Damage Distribution and Classification Code

Definition of the classifications is shown in Table 3 :

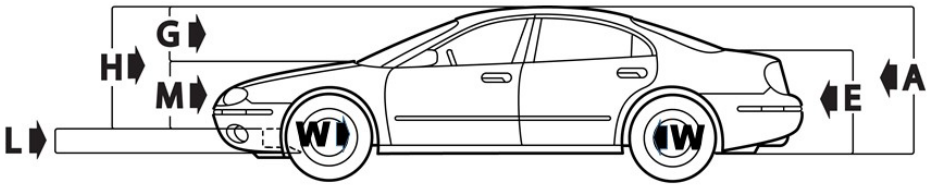
Table 3

Type	Classification
Wide Impact Area	W
Narrow Impact Area	N
Sideswipe	S
Rollover (Includes Rolling onto Side)	O
Overhanging Structures (Inverted Step)	A
Corner (Extends from Corner to ≤16 inches [410 mm])	E
Conversion in Impact Type (Requires Multiple CDC)	K
No Residual Deformation	U



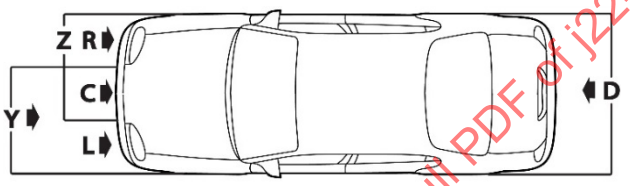
Location	Classification
Distributed - Side or End	D
Left - Front or Rear	L
Center - Front or Rear	C
Right - Front or Rear	R
Side Front - Left or Right	F
Side Center Section - Left or Right	P
Side Rear - Left or Right	B
Side or End - F + P or L + C	Y
Side or End - B + P or R + C	Z

Figure 4



Vehicle Locations - Front, Rear or Side Impacts	Classifications
All	A
Top of Frame Top of Vehicle	H
Everything Below Belt Line	E
Belt Line and Above	G
Middle - Top of Frame to Belt Line or Hood	M
Frame - Top of Frame, Bottom of Frame (Incl. Undercarriage)	L
Below Undercarriage Level (Wheels and Tires Only)	W

Figure 5A



Lateral Location - Top and Undercarriage Impacts	Classification
Distributed	D
Left	L
Center	C
Right	R
L and C	Y
R and C	Z

Figure 5B

S is used to classify these types of damage:

a. An impact which overlaps the corner of a vehicle by 4 inches or less and then swipes along the surface parallel to the direction of travel;

b. A classical sideswipe; and

c. A classical endswipe.

A is used to classify impacts where the vehicle deformation resulted from an overhanging structure shaped like an inverted step in which the vertical surfaces are at least 30 inches (760 mm) apart. Both vertical surfaces of the inverted step must have contributed to the direct damage. The resultant damage patterns do not have to occur simultaneously, but must be caused by the same struck object. An example of this circumstance is underriding the rear of some large trucks.

K is used to classify impacts where a vehicle deformation pattern sustained during a single continuous impact sequence resembles two distinct impact types (that is, front and side). Use of the character is limited to those deformation patterns where an initial wide contact area (W) converts to another impact type (generally sideswipe). For these deformation patterns, character K is substituted for W and a second collision deformation classification (CDC) is required to describe the remaining damage (see Appendix A).

U is used to classify impacts where no residual deformation of the vehicle is noted. An extent code of 1 in column 7 must be used with this character.

The use of S, O, A, E, K, and U takes precedence over N and W. W and N are used to distinguish between large and small areas of deformation which do not fall into one of the other six categories. If an area is less than 16 inches (410 mm) wide, or less than 6 inches (150 mm) high, N is the appropriate classification. For small rectangular or circular areas of deformation, if the perimeter is less than the perimeter of 64 inches (1616 mm), use the N; otherwise, use W.

3.6 Column 7 - Deformation Extent

The extent of residual deformation is classified using a nine-zone extent system as shown in Figures 6, 7, 8, and 9. Figures 6, 7, 8, and 9 are illustrative of passenger cars, SUVs/crossovers/station wagons, vans, and pick-ups, respectively. Extent zones are applied to front, rear, side, top, or undercarriage deformation, and should be selected so that they are compatible with the principal damage selection in column 3.

To achieve uniformity, the deformation extent zones have been established in relation to specific points on the vehicle.

If the passenger compartment is involved in the top damage, then the extent number should reflect the extent of damage to the passenger compartment. This is true even if the hood or deck lid are involved.

If the distance from the rearmost point of the vehicle to the top of the rear window (backlight) is greater than the distance from the top of the rear window to the front door latch pillar (start of zone 9), then use the passenger car deformation rear extent zone guide for classifying rear deformation. Other vehicles are classified using the rear extent guide for SUVs/crossovers/station wagons and vans.

The extent number should not be used as a tool for determining the collision severity or energy required to duplicate the damage. For vehicles of the same basic type, it does serve as a tool for gathering together vehicles which have similar damage characteristics.

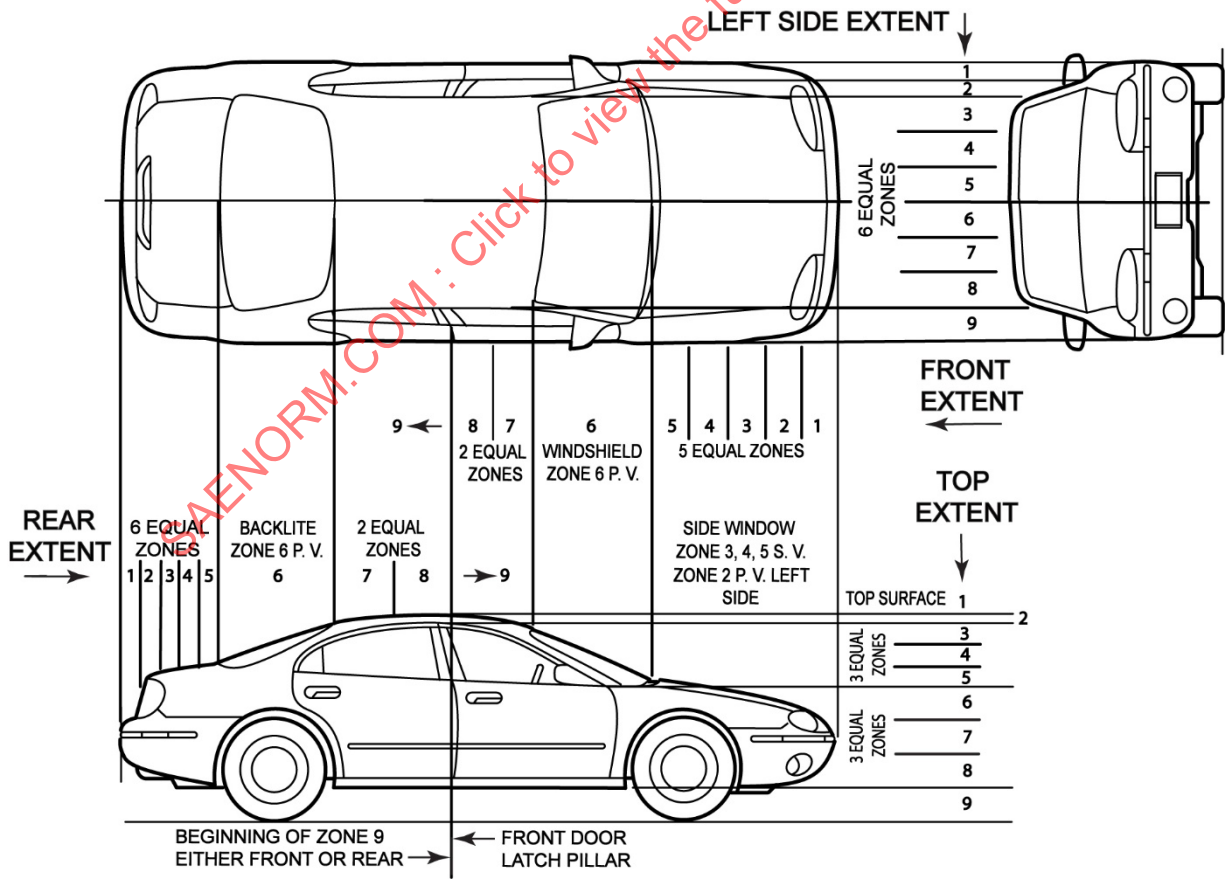


Figure 6 - Deformation extent zones (for passenger cars)

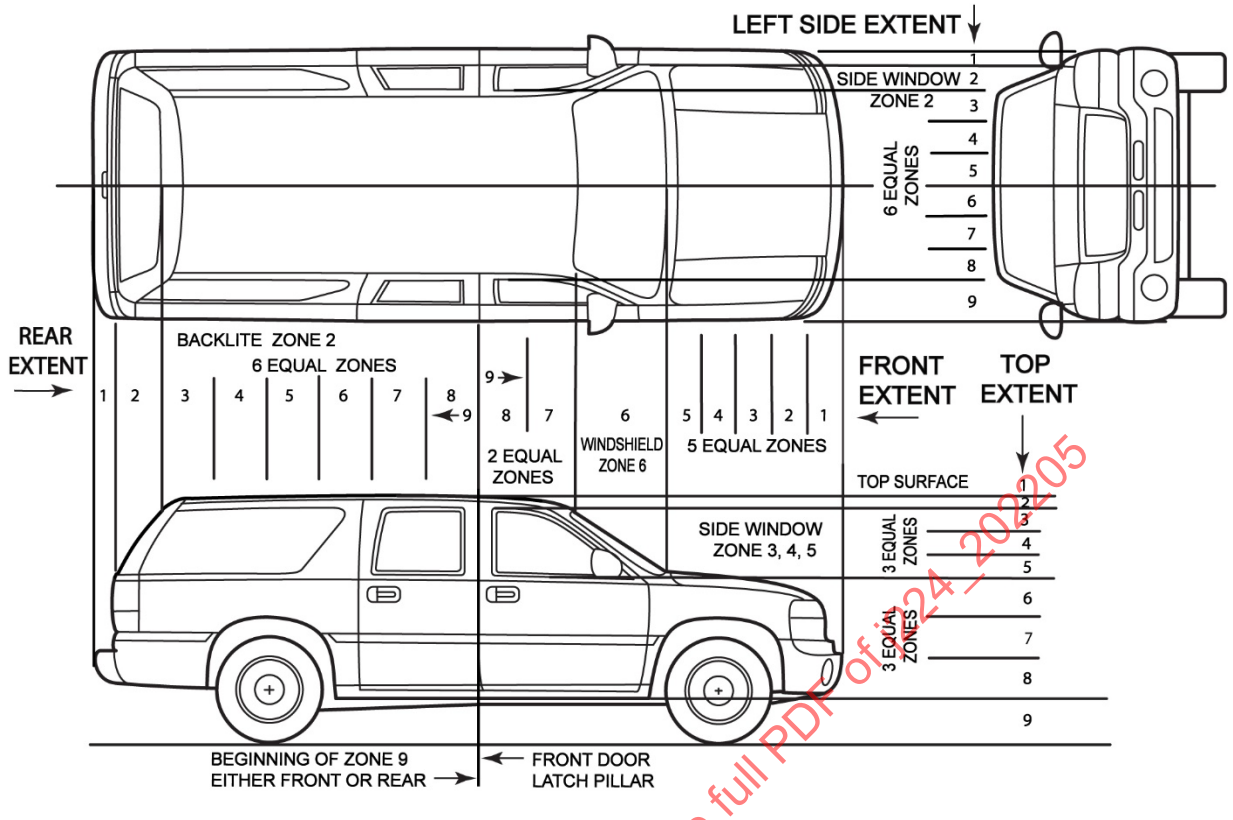


Figure 7 - Deformation extent zones (for SUVs, crossovers, and station wagons)

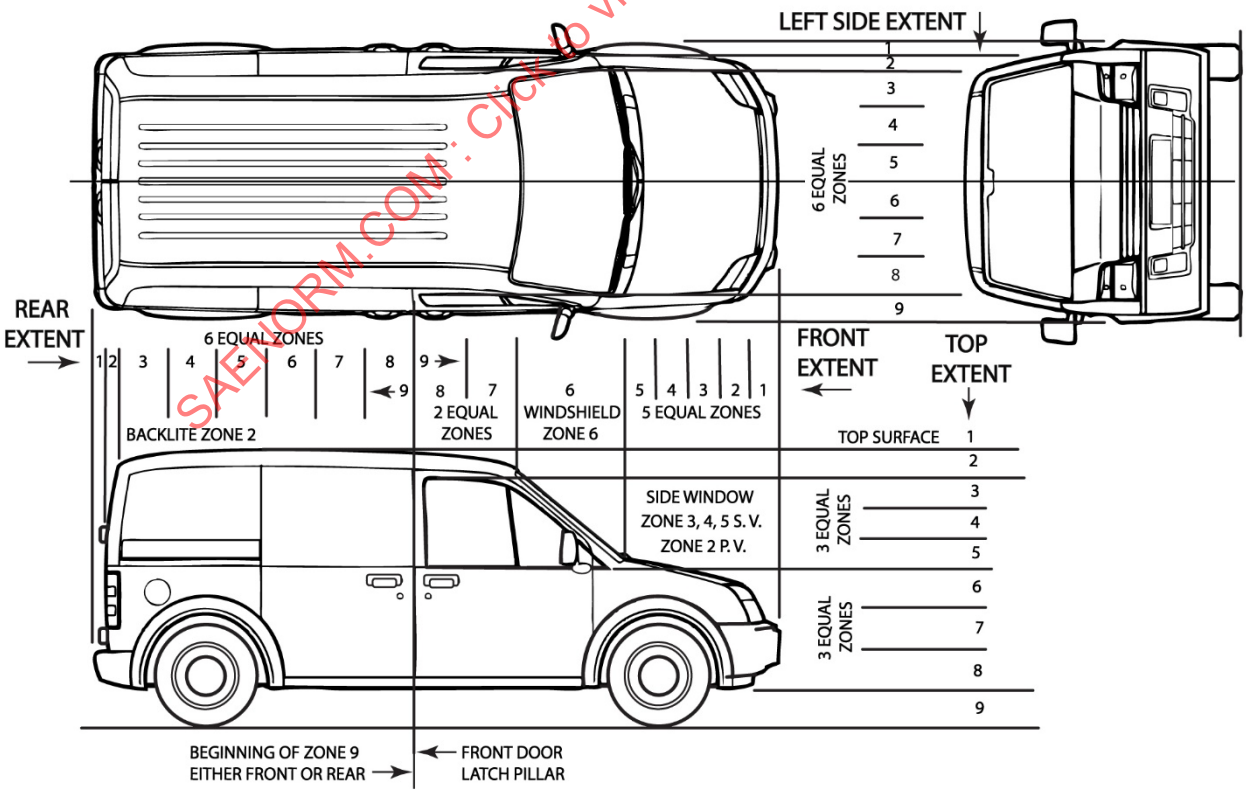


Figure 8 - Deformation extent zones (for vans)

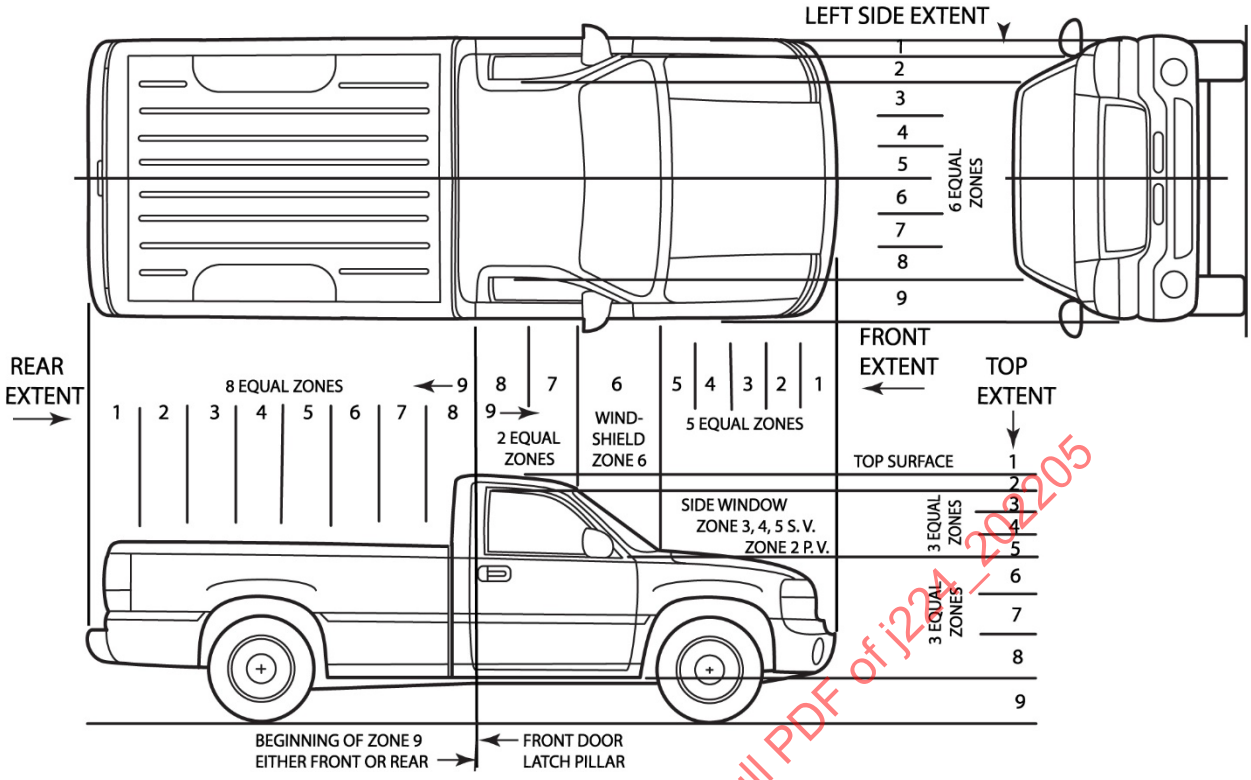


Figure 9 - Deformation extent zones (for pickup trucks)

4. NOTES

4.1 Revision Indicator

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 a document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revision. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE DATA COLLECTION AND ARCHIVING STANDARDS COMMITTEE

APPENDIX A

A.1 INTRODUCTION

This appendix is auxiliary and supplemental to SAE J224 MAR80. This appendix is intended as an aid to facilitate the use of SAE J224 MAR80 and promote uniform interpretation of difficult or commonly misused classifications. The latter objective is achieved by providing an explanation of the concepts inherent in the recommended practice and specific sections contained therein. Subdivisions of this appendix are numbered to correspond with sections of the recommended practice. This appendix does not include all possible situations which could and do occur in the field. The recommended practice, therefore, is the final document from which all classification decisions should be made.

SAE J224 MAR80 differs considerably from SAE J224A; however, the revised system does not render SAE J224A classifications obsolete. SAE J224A and SAE J224 MAR80 files are compatible since the new classifications of SAE J224 MAR80 can be collapsed for comparative purposes. Other differences between the two recommended practices consist of improved definitions in SAE J224 MAR80 for more consistent application.

Individuals working with SAE J224 MAR80 may be categorized as either classifiers or users. Classifiers are defined as individuals who make the original assessment of a CDC from firsthand inspection of the vehicle, and/or photographs, and/or sketches. This category includes individuals who check or edit original assessments. Users are defined as individuals who examine the assessments (in individual form or as mass data) made by classifiers to evaluate or compare types or groups of damage. Both categories of individuals must have a complete understanding of SAE J224 MAR80 to apply it correctly.

Damage patterns, where subjective evaluations are likely to occur, should be recognized by users to permit appropriate interpretation in the examination and application of these classifications. Appendix sections contain cautionary notes to the users at the end of each section pertaining to codes for that column of the CDC expression. Since CDC classifications are a descriptive composite of the damaged vehicle, the user is also cautioned not to separate code or column features. The latter practice very often results in inadvertent errors. For example, in searching for the Fs in column 3, the user may assume that since the frontal area of the vehicle is involved, all occupant kinematics will be parallel to the longitudinal axis of the vehicle. However, the F character in column 3 does not preclude lateral forces (for example, 9 o'clock) which can cause occupant kinematics to become lateral, rather than longitudinal.

A.2 PURPOSE AND SCOPE

It is important to note that vehicle damage specified for classification in SAE J224 MAR80 is limited to contact damage as opposed to induced damage. Contact damage is defined as all damage sustained in the vehicle area physically touching or in contact with the striking/struck, object/vehicle. Induced damage is all damage sustained beyond the limits of the contact area (that is, all non-contact damage).

Due to recent advances in the field of accident reconstruction, there is increasing pressure to include induced damage in damage classification systems. With certain impact types, for example, it is necessary to measure and report contact and induced damage to obtain an accurate reconstruction of accident events. Reconstructionists would prefer to note these additional measurements in the classification system and thereby achieve uniformity between the areas of reconstruction and damage reporting. In the area of reconstruction, however, induced damage is not uniformly reported. Induced damage is not required for certain impact types and is non-existent in others (that is, frontal impact with contact extending across the entire front). As a result, induced damage does not provide a firm basis for comparison. If reporting of induced damage is necessary for reconstruction, it must be reported separately and independently of direct contact damage.

The primary reason for not including induced damage in the classification system, however, is not related to uniformity of current reporting techniques. The criterion of using contact damage has been continued in SAE J224 MAR80 in order to maintain continuity with SAE J224A and previous classification systems. It is extremely important that data collected in current and future studies have a firm basis of comparability, over time, with previous studies.

A.3 CLASSIFICATION OF COLLISION DAMAGE

To obtain a more complete understanding of the intent of the classification system, it may be of assistance to visualize the vehicle as being contained within or surrounded by a rectangular box. Impacts are classified according to the sides or planes of the box onto which they are most appropriately projected. For example, the two ends of the vehicle (that is, the front and rear) are contained within lateral vertical planes of the box, the two sides within longitudinal vertical planes, and the top and undercarriage within horizontal planes. Column 3 of the classification system specifies which plane of the box is involved. An F character in column 3, therefore, indicates the frontal, lateral-vertical plane.

Column 3 in SAE J224 MAR80 also defines a three-dimensional, orthogonal set of axes which should guide the coder in completing columns 4, 5, and 7. The damaged area is classified in columns 4 and 5 along two orthogonal axes in the projected plane of deformation (that is, appropriate surface of box) as specified by column 3. For example, in a frontal impact, the projected plane of deformation is the lateral vertical plane (that is, front surface of box). Columns 4 and 5 provide additional description, indicating the extent of lateral and vertical involvement within the frontal plane. The deformation extent is classified in column 7 along an axis perpendicular to the projected plane of deformation. These relationships are summarized in Table A1.

Table A1

Column 3 Classifications	Column 3 Projected Plane	Orthogonal Axes Column 4	Orthogonal Axes Column 5	Orthogonal Axes Column 7
F or B	Lateral-Vertical	Lateral	Vertical	Longitudinal
L or R	Longitudinal-Vertical	Longitudinal	Vertical	Lateral
T or U	Horizontal	Longitudinal	Lateral	Vertical

General Notes: There are several aspects of the CDC system which are related to general usage patterns rather than individual codes or columns. These areas are noted below:

a. Primary and Secondary CDC Designations—In cases of multiple CDC classifications to the same vehicle, specific classifications receive a designation of primary or secondary on the basis of the following guidelines (listed in a descending order of priority):

   1. Energy management considerations—The CDC classification describing that impact which absorbed the greatest amount of energy or which resulted in the greatest amount of energy dissipation is designated the primary CDC. All other classifications are designated as secondary.

   2. Greatest change in occupant space—If two or more classifications are approximately equal with respect to energy management considerations, the classification associated with the greatest change in occupant space is designated as the primary CDC. All other classifications are designated as secondary.

b. Multiple Impacts in the Same Vehicle Area—If two or more significant impacts are located in the same area of the vehicle, these impacts should be described with a single CDC classification. The classification is based on the final appearance of the damaged area. In special situations, a second collision can be separated, if the first damage is still identifiable; for example, a second collision of a narrow object upon a widely distributed first collision damage. If the impacts are separated, a CDC classification is assigned for the initial impact and an unknown CDC is assigned for the second impact.

c. Unknown CDC Classifications—If the damage pattern resulting from a specific impact is not defined, an unknown CDC classification is assigned. The appropriate expression is 99-0000-0. The latter expression is intended for use in block form. That is, if a portion of the classification is unknown, the entire classification is considered unknown, and 99-0000-0 is used. Do not, for example, attempt to use a classification of 12-F000-0.

The vehicle must have been investigated or photographed to be classified. Estimations of partial or complete classifications from police reports, third-party descriptions, etc., are not permissible, because of the inaccuracies which can develop.

A.3.1 Columns 1 and 2 - Direction of Principal Force During Impact

These characters of a CDC expression define the force which produced the deformation pattern classified in the remaining columns. Definition, however, is related to the direction of force, rather than the magnitude of force. A paradox arises, in that the direction of force is an analytical quantity, usually determined on an analytical basis; however, for the CDC classification, it is always determined on a subjective basis. This is resolved by providing direction of force classifications containing 30 degree increments rather than smaller and more precise increments. A knowledge of vector addition is helpful for making principal direction of force (PDOF) determinations.

A.3.1.1 Force Vectors

The difference between scalar quantities and vector quantities is fundamental to an explanation of vectors.

A scalar quantity has only magnitude and can be added algebraically. Dollars, weights, time, distance, volume, etc., are scalar quantities. An example of algebraic addition, for example, 3 ft^3 + 2 ft^3 = 5 ft^3.

A vector quantity has both magnitude and direction, and must be added by geometric methods. Examples of vectors are: velocity vectors (for example, an airplane flying due north at 200 mph), displacement vectors (for example, a person walking 25 feet to the west), force vectors (for example, a 15 lbf acting straight down on a nail).

The resultant of two or more vectors is that single vector which would have the effect of all the vectors acting together. Resultant vector determinations for PDOF in this recommended practice will generally involve only two vectors.

The equilibrant of a number of vectors is that vector which balances all of the vectors together. It is equal in magnitude but opposite in direction to the resultant. This is also referred to as being colinear.

Parallelogram Method of Vector Addition—The resultant of two vectors acting at any angle may be represented by the diagonal of a parallelogram drawn with the two vectors as adjacent sides.

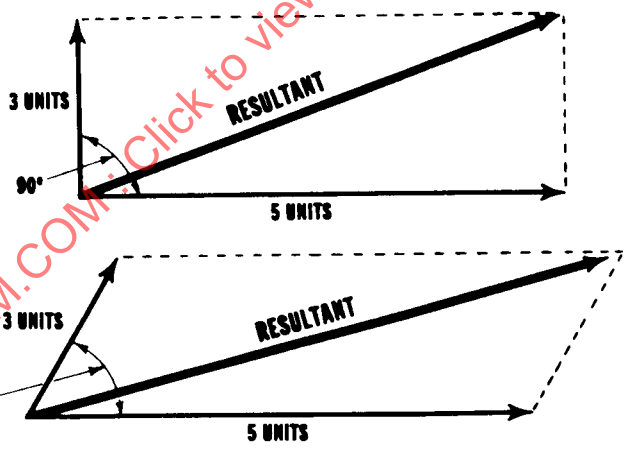


Figure A1

Vector Polygon Method of Vector Addition—This method of finding the resultant consists of drawing each vector to scale beginning at some arbitrary point. Each succeeding vector is drawn with the tail attached to the arrow end of the previous vector. The line drawn to complete the triangle or polygon is equal in magnitude to the resultant. The resultant is represented by the straight line directed from the tail end or starting point of the first arrow to the arrow end of the last vector added.

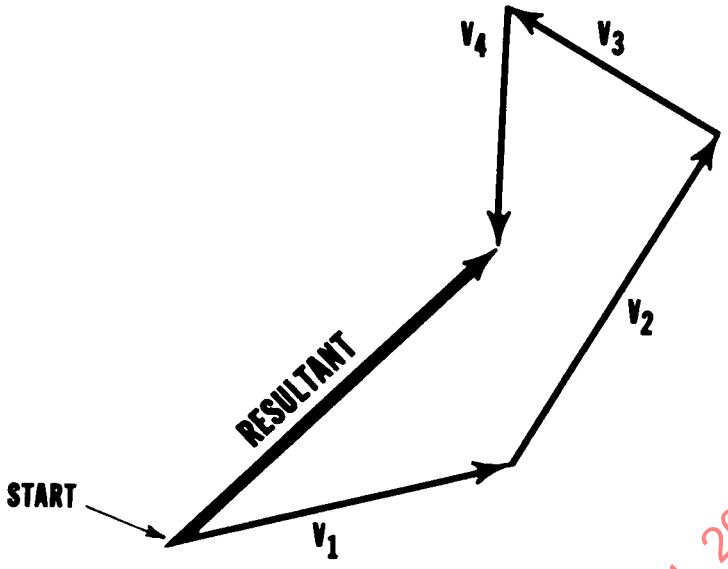


Figure A2

A.3.1.2 Determination of Principal Direction of Force Using Vectors

Although classifiers generally do not calculate direction of force assignments, it is important to understand the basic theory associated with these columns. A brief theoretical discussion is provided below, followed by a discussion of how direction of force is determined in the field.

Theory: The force assessments used with CDC classifications are vector quantities. That is, they are the resultant of all impact forces acting on the vehicle during the contact sequence. As vector quantities, impact forces have both magnitude (algebraic product of Mass x Acceleration) and direction. With respect to force analyses, these properties may be represented by scaled linear arrows. The length of the arrow indicates the magnitude of force and the direction of the arrow indicates the direction of force.

The length of force arrows for a large truck and a small car traveling at the same speeds would be considerably different due to the mass (weight) differences. Likewise, two vehicles of equal weight but different speeds would have different length force arrows proportional to the speeds.

Figure A1 demonstrates simplistic vector analyses for a typical 90 degree intersection impact configuration. Note that required computations are not shown. Assume that all force arrows are correctly scaled representations of the amount or magnitude of force produced.

Schematic “a,” in Figure A1, depicts the impact configuration (zero steer angle and tracking characteristics are assumed for both vehicles). Schematic “b,” demonstrates parallelogram analysis of the forces exerted on Vehicles #1 and #2 during the impact sequence. In each case, F_N is the component of force which acts, or is exerted normal (that is, perpendicular) to the contact surface and F_T is the component of force which acts tangentially to the contact surface (F_T is related to the frictional or picketing interaction between contact surfaces). The arrows or vectors F_{R1} and F_{R2} are the resultant forces acting on Vehicles #1 and #2, respectively. Note that the equilibrant to the resultant on one vehicle is also the resultant for the other vehicle. Both vehicles respond to these forces. That is, the vehicles follow post-impact trajectories determined or influenced by the resultant directions of force (assuming that snagging and spinout phenomena are minimal).

The quantities F_{R1} and F_{R2} are shown in schematic “c” as they apply to each vehicle. The angular position of the arrow is determined by acceleration characteristics of both vehicles. It can be rotated in either a clockwise or counter-clockwise direction by altering these characteristics for the respective vehicles. The direction of the forces, F_{R1} and F_{R2}, are coded in CDC classifications for these vehicles (after translation to the appropriate 30 degree sectors of the clock face).

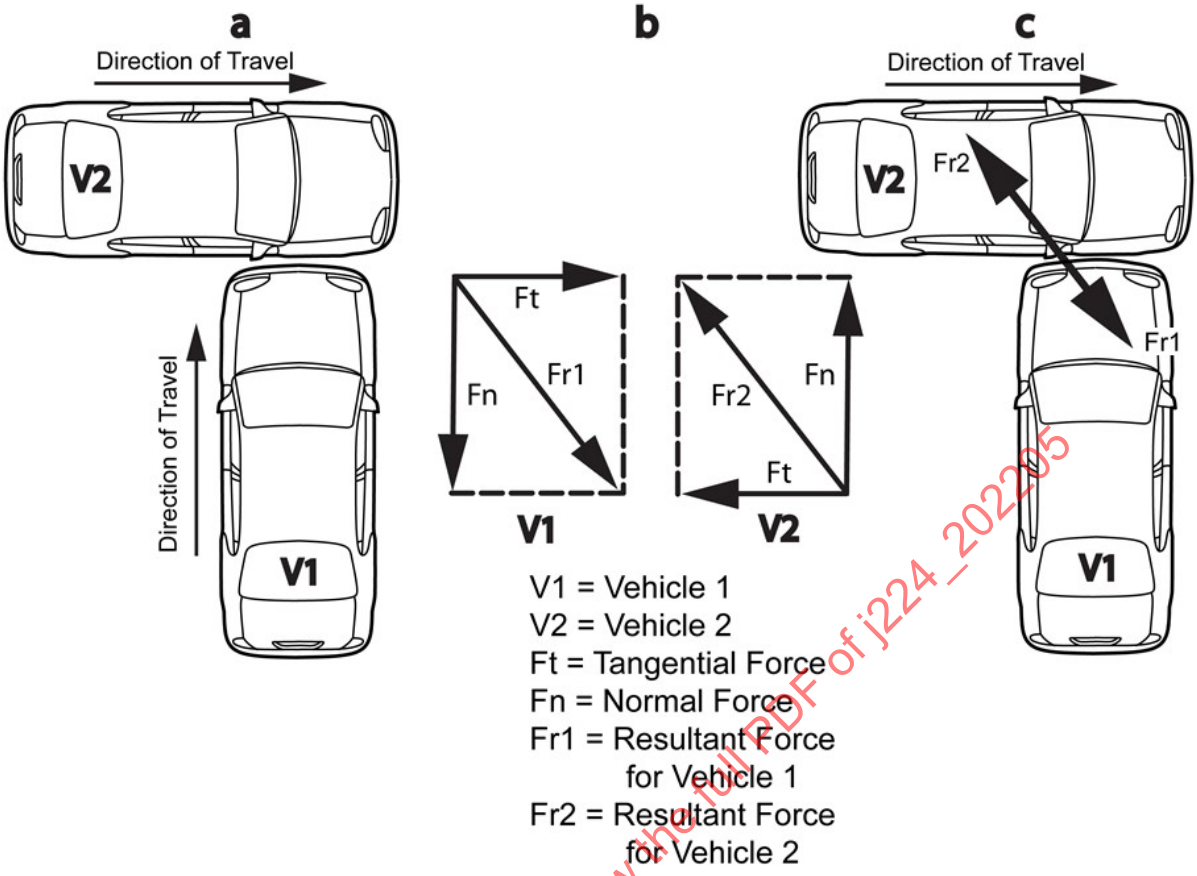


Figure A3

Note that, in schematics “b” and “c,” the resultant forces acting on Vehicles #1 and #2 are equal in magnitude and opposite in direction. In any given impact sequence involving two vehicles, the resultant directions of force must be colinear. That is, the resultant directions of force must be 180 degrees opposed. Although these statements represent extensive simplification of complex events, they are merely a restatement of Newton’s Third Law. For the purpose of achieving uniform CDC applications, the concept of colinearity should be maintained.

Application: It is difficult to compute accelerations during vehicle field inspections and/or if all the accident involved vehicles are not available. Resultant directions of forces are, therefore, assigned to each vehicle on the basis of subjective evaluations. The investigator, however, should examine all available inputs to assure the highest possible degree of accuracy for force assignments. Indicators of the direction of force are available in each area of investigation in the following respects, which have equal importance:

a. Human: Occupants respond to the resultant direction of force acting on the vehicle. Documentation of occupant trajectories, therefore, allows assessment of the relative direction of force (that is, 180 degrees opposing to the occupant path of travel). Caution is required when determining the effects of post-impact vehicle rotation.

b. Environment: Primary indicators of relative directions of force are pre- and post-impact vehicle trajectories (including vehicle attitudes on these trajectories). As noted previously, vehicles respond to resultant direction of force produced by the impact. Documentation of trajectories allows the investigators to make assessments of the relative components of force associated with each vehicle, and, therefore, acting on each vehicle.

c. Vehicle: The primary indicator of the direction of force is the direction of sheet metal crush and vehicle bending. Estimate the relative angle of the crush pattern with respect to the longitudinal axis of the vehicle. Caution is required in interpreting crush patterns associated with vehicle rotation following maximum engagement.

A.3.1.3 Shifting of Vehicle Structure

Shifting of a vehicle structure is defined as a change in direction of the structure as opposed to (or in addition to) crushing of the structure. Classification of shifting permits a more complete description of a damaged vehicle and is combined with the direction of principal force for conciseness. Classifications previously assigned in accordance with SAE J224A remain valid since current classifications may be collapsed to that format. Structural shifting is classified in the following respects:

End Structure Shifting: Vertical or lateral shifting of vehicle and structures which occurs during a horizontal force application is noted in those instances where the amount of shifting is 4 inches (100 mm) or greater (see Figure A2). Determination of the amount of shifting is made at the end structure locations. The basic rule to remember is: the direction of force classification is incremented, depending upon the type of shifting, by the addition of 20, 40, 60, or 80 to the horizontal direction of force determination. For example, the direction of principal force for a frontal impact at 12 o'clock is classified 12 if there is less than a 4 inch (100 mm) shift of the forward end of the chassis frame rails or equivalent structure in either the vertical or lateral planes. (Note: Bumper movement may not be an accurate indicator of basic structure movement.) If the forward end of the chassis frame rails or equivalent structure is shifted beyond the limit of 4 inches, the direction of force is incremented to indicate the direction of shift, but not the amount. For the example noted above (that is, 12 o'clock direction of force), vertical shifting is indicated by the classification 32 (that is, add 20) if the basic movement is upward, or the classification 52 (that is, add 40) if the basic movement is downward. Lateral shifting is indicated by classification 72 (that is, add 60) for movement to the right, or the classification 92 (that is, add 80) for movement to the left.

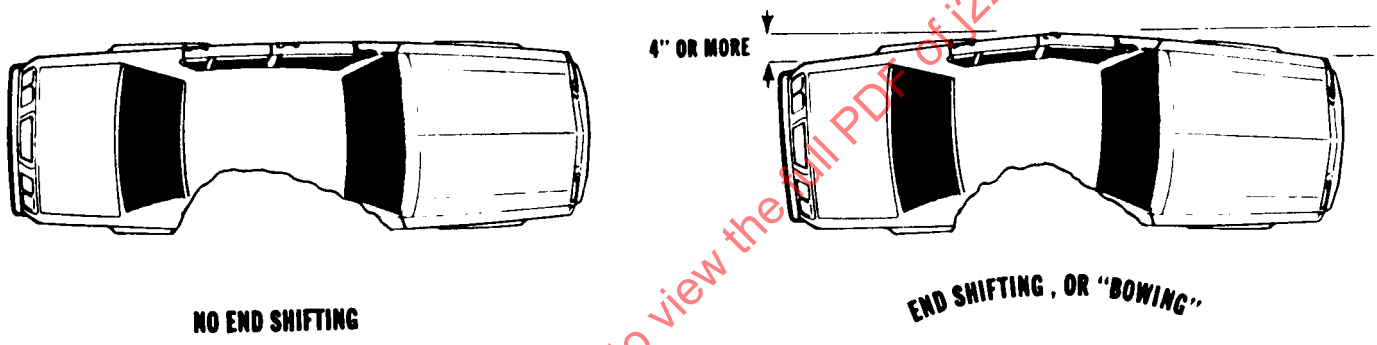


Figure A4

For front or rear impacts, the impact site should also shift the required minimum distance of 4 inches (100 mm) before the direction of force is incremented.

It is extremely important to differentiate between the concepts of crush and shifting. For example, in a 3 o'clock impact to the right passenger compartment area, the right doors and right B pillar may be crushed to the left. The direction of force classification 03 is not incremented to code 63, however, unless there is a relative shifting of the basic end structures to the right, producing a bowing effect in the vehicle that is 4 inches (100 mm) or greater (see Figure A2). This bowing effect can be determined by examining the left side of the vehicle.

For those cases where shifting occurs in both the vertical and lateral planes, record the direction of shifting on the basis of the most obvious movement. If shifting in the lateral plane is greater than shifting in the vertical plane, record lateral shifting. If shifting in these planes is equal, give preference to the vertical plane (that is, record vertical shifting).

Top Structure Shifting: Recording longitudinal or lateral shifting of the top structure is reserved for the circumstance of non-horizontal force applications (00 o'clock). It is fully anticipated that shifting will also occur during instances of horizontal force applications; however, top structure involvement in horizontal force applications is adequately characterized within the current alphameric system (that is, columns 3 to 6) and the direction of probable shift is adequately characterized within the 01 to 12 o'clock direction of force classifications (that is, columns 1 to 2).

SAE J224 MAR80 indicates that shifting of the top structure should be classified when visually apparent. As a practical guideline, the amount of shifting should be of an order of magnitude that can be detected in photographs or slides (that is, a shift of 1 inch (25 mm) or more). In the latter circumstance, the direction of shifting is indicated by incrementing the non-horizontal force classification (that is, 00 by 20 upward, 40 downward, 60 to the right, and 80 to the left).

It is important to distinguish between the concepts of top crush and top shifting. If a heavy object is dropped directly on the top center area of the vehicle, the area will crush straight down. This action may result in the roof side rails shifting inward, the upper A-pillars shifting rearward, and the upper C-pillars shifting forward. The latter circumstance, however, would not be reported as shifting of the top structure. These are normal characteristics associated with a vertical crush pattern. Instances of shifting of the top structure should involve components of force in the longitudinal or lateral planes of the vehicle.

A.3.1.4 User's Note

The directions of principal force are categorized into twelve sectors, each 30 degree in angle, and designated with the clockface numbers. A direction of impact force falling upon any one of the boundaries between clock sectors could be interpreted to be in either sector and still be essentially correct. For instance, an impact exactly 15 degrees clockwise of straight ahead falls on the division between the 12 o'clock and 1 o'clock sectors. The user should recognize that there are practical limits with which the direction of force can be assessed and deviations of as much as +5 degrees can occur in even expert judgments. Consequently, in the example given above, 12 or 1 o'clock would both be valid assessments. Therefore, when a user is searching for impacts within the 1 o'clock sector, some consideration should be given to examining similar classifications having a 12 o'clock or 2 o'clock direction of force.

A.3.2 Column 3 - Deformation Location and Classification Code

As noted in SAE J224 MAR80, this character of a CDC classification broadly defines which area of the vehicle contains the contact deformation. The character is determined by using the projected area of initial contact or the surface or the vehicle which was initially struck or contacted. It is important to note that the area of initial contact is a projected area. Therefore, if the area of initial contact does not lie in one of the six indicated planes (that is, F, R, B, L, T, or U), it must be projected to the appropriate plane. For example, assume that an automobile underrides the rear of a stopped truck, and the only resultant damage to the automobile involves contact to the windshield (12 o'clock direction of force). Since the windshield does not lie within one of the designated planes, it must be projected to the appropriate plane; in this case, the frontal plane.

Relating this discussion to the six-sided box concept may provide additional insight as to the intent of column 3. Remember that the vehicle may be viewed as being contained within a six-sided rectangular box. In this context, column 3 is determined by which plane or side of the box is initially penetrated by the direction of force. For the example noted above, the 12 o'clock direction of force initially penetrates or crosses the frontal surface of the box. Therefore, the windshield damage is classified as F in column 3.

Past experience has indicated that there are several impact configurations which are difficult to classify with respect to column 3. A series of guidelines for each configuration has been developed to improve the consistency of classifications as follows:

Angled Horizontal Impacts (that is, 45 degrees): Angled impacts (45 degrees) initially involving the corner area and then extending into the front and side or rear and side area are difficult to classify. These impacts should be classified F, B, L, or R in accordance with the following guidelines (listed in a descending order of priority):

a. If the projected area of initial contact can be determined, use the appropriate character.

b. If the projected area of initial contact cannot be determined, use the direction of principal force to determine the appropriate character. If the direction of force is less than 45 degrees from the 12 o'clock or 6 o'clock directions, use F or B. If the direction of force is greater than 45 degrees, use L or R.

c. If the direction of force cannot be determined with sufficient accuracy, use the projected area of greatest contact to determine the appropriate character. If the length of contact across the front or rear of the vehicle exceeds the length of contact along the side, use F or B, respectively. Use L or R if the length of contact along the side is greater.

Rollover Configurations: Similar consideration should be given to top versus side deformation in a rollover sequence.[3] In the latter circumstance, however, principal emphasis is given to the projected area of primary contact (that is, area of greatest crush) rather than initial contact. Also, damage to the greenhouse area (P in column 4) is given priority over other vehicle areas such as F and B. Contact damage is classified in accordance with the following guidelines (listed in order of descending priority):

a. If the projected area of primary contact can be determined, use the appropriate character.

b. If the projected area of primary contact cannot be determined, use the angle of force in the vertical plane (above or below the horizontal clockface) to determine the appropriate character. If the direction of force is less than 45 degrees from the vertical axis, use T. If the direction of force is greater than 45 degrees from the vertical axis, use L or R.[4]

c. If the direction of force cannot be determined with sufficient accuracy, use the projected area of greatest contact to determine the appropriate character. If the deformation area on the left or right side exceeds the deformation area on the top, use L or R, respectively. Use T if the deformation area is greater on the top.

Undercarriage Impacts: The undercarriage classification (U) available in column 3 is most often associated with a non-horizontal (00) direction of force in columns 1 and 2. Horizontal directions of force (01 to 12) are permissible; however, they are typically associated with a sideswiping action to the undercarriage. Impacts which result in snagging of undercarriage components (or vehicle undercarriage interaction with high decelerations in the occupant compartment environment), tend to produce significant vertical components of force, and the 00 classification should be used. As a basic guideline, use the 00 classification whenever the resultant direction of force is 15 degrees or greater from the horizontal plane of the vehicle, for undercarriage involvements.

Wheel and Tire Impacts: As noted in SAE J224 MAR80, impacts to tires and wheels are excluded from the undercarriage classification. For these impacts, the characters, F, L, R, or B are used in conjunction with the character W in column 5. The specific deformation location is determined by the projected area of initial contact (that is, impact to front tread area of right front tire is assigned an F character). Extent zone classifications (column 7) are assigned in the normal manner (that is, they are referenced to the plane of the first letter).

As a practical guideline, do not assign a CDC classification to these impacts unless resultant damage is noted (that is, blowout, rim deformation, etc.). It should also be noted that most CDC classifications assigned to tire and/or wheel impacts will be secondary to other impacts the vehicle sustains.

A.3.2.1 User's Note

For vehicles with similar damage patterns, there should be no differences in column 3 without one classification being in error. Although angled impacts and rollovers are sometimes difficult to classify with respect to determining which area of the vehicle contains the contact damage, guidelines provided in this document should result in consistent interpretations.

A.3.3 Column 4 - Specific Longitudinal or Lateral Locations of Deformation and Classification Code

This character of a classification expression defines the longitudinal or lateral area containing the deformation. As with column 7, the basic method requires a mathematical interpretation for a number of the indicated areas (that is, L, C, R, Y, and Z for front or rear impacts). Other areas (that is, P in side impacts) are defined in SAE J224 MAR80 with respect to specific points on the vehicle for various vehicle and body style types. Since P is defined in the latter circumstance, other related areas (that is, F, B, Y, and Z in side impacts) vary with P and are not considered to be defined mathematically. All areas, whether determined mathematically or defined by SAE J224 MAR80, have finite limits which are intended as the absolute boundaries for that area. Therefore, if contact damage extends beyond the indicated boundary of a specific area, that character should not be used for the CDC classification. For example, L, C, and R are equal thirds on the front or rear of the vehicle. If an impact to the left frontal area of a vehicle involves more than the indicated width of L, Y should then be used, instead of L.

[3] In general, one CDC classification is assigned to a rollover sequence, regardless of the number of rolls.
[4] F or B may also be used to describe the damage in end-over-end rollovers.