UM-HSRI-78-17-1

METHODOLOGY FOR THE MEASUREMENT OF INTRUSION IN MOTOR VEHICLE ACCIDENTS

Peter Cooley
Thomas McDole
Robert Scott
Mark Huber
Errol Hoffmann

April 15, 1978

THE UNIVERSITY OF MICHIGAN
HIGHWAY SAFETY RESEARCH INSTITUTE

Prepared for the Department of Transportation, National Highway Traffic Safety Administration, under Contract No. DOT-HS-7-01805.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UM-HSRI-78-17-1		

4. Title and Subtitle	5. Report Date
Methodology for the Measurement of Intrusion in Motor Vehicle Accidents	April 15, 1978
	6. Performing Organization Code
7. Author(s) Peter Cooley, Thomas McDole, Robert Scott, Mark Huber, Errol Hoffmann	8. Performing Organization Report No. UM-HSRI-78-17-1
9. Performing Organization Name and Address Highway Safety Research Institute The University of Michigan Ann Arbor, Michigan 48109	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DOT-HS-7-01805
12. Sponsoring Agency Name and Address National Center for Statistics and Analysis National Highway Traffic Safety Administration U.S. Department of Transportation Washington, D.C. 20590	13. Type of Report and Period Covered Final 9/27/77 - 3/26/78
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This final report documents the development of a methodology for the uniform measurement and recording of intrusion into the occupant compartment, and the representation of such measurements in a coded form for machine data processing.

Other workproducts of the study include a User's Manual for Measurement of Intrusion in Motor Vehicle Accidents (UM-HSRI-78-17-2), a Coding Manual for Measurement of Intrusion in Motor Vehicle Accidents (UM-HSRI-78-17-3), and a modular data form set designed for selective use by accident investigators when measuring and recording intrusion in crash-involved vehicles. The data forms (and types of Intrusion) are: Catastrophic Crash; Internal Surfaces; Door Intrusion; Seat Intrusion; Occupant Contact with Intruded Surfaces.

Also documented is the development and presentation of a training seminar on intrusion and the use of the data forms.

17. Key Words	18. Distribution Statement
Intrusion, Crash Measurement, Data Form, Data Recording, Accident Investigation Reference Information, Coding	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

* U. S. GOVERNMENT PRINTING OFFICE : 1973 725-504/328

1.0 SUMMARY

This is the final report of a six-month study to develop a methodology for the uniform measurement of occupant-compartment intrusion. The methodology includes internal measurements of crash-involved vehicles exhibiting intrusion, and provides for recording data in a format convenient for computer file building and machine handling.

The methodology uses five modular data forms that address various types of intrusion: (1) the Catastrophic Crash (CC) form, for recording data on severe crashes in which intrusion is massive and its measurement impossible; (2) the Internal Surfaces (IS) form, used for recording individual intrusions and intruding components; (3) a supplemental Door Performance (DR) form; (4) a supplemental Seat Displacement (ST) form; and (5) a supplemental Occupant Contact with intruded surfaces (OC) form.

A training seminar for NCSS accident investigators was conducted on March 21-23, 1978. Results of the training seminar and experience gained from field trials of the methodology indicate that its design is practical and that it can be applied uniformly.

2.0 INTRODUCTION

This is a final report of a study entitled "Methodology Development for Measurement and Codification of Occupant Compartment Intrusion," conducted at the University of Michigan Highway Safety Research Institute during the period September 27, 1977 to March 26, 1978, under sponsorship of the U.S. Department of Transportation, National Highway Traffic Safety Administration, contract number DOT-HS-7-01805.

The objectives of the study were to develop a methodology for the uniform measurement of intrusion into the occupant compartment, and the representation of such measurements in a coded form for machine handling.

In addition to this final report, other workproducts of the study include a User's Manual for Measurement of Intrusion in Motor Vehicle Accidents (UM-HSRI-78-17-2), a Coding Manual for Measurement of Intrusion in Motor Vehicle Accidents (UM-HSRI-78-17-3), and five modular data forms designed for selective use by accident investigators concerned with measuring and recording intrusion in crash-involved vehicles. The forms and their uses are described in Appendix A of this report.

It has been known for many years that there is a connection between occupant injury and intrusion into the occupant compartment in motor vehicle crashes. However, even though the physical dangers of intrusion are apparent, and its connection with injuries has been established through analyses of accident data, no reliable statistics exist on the role of intrusion in producing injury. Both injury and intrusion can be expected to increase with increased crash severity.

Thus the two effects can be co-existent even when the intrusion was not a cause of an injury.

Past accident data collection programs have not provided sufficient information to adequately assess the role of intrusion in injury. The only accident data that have consistently documented problems of intrusion in crashes are data resulting from in-depth investigations sponsored by NHTSA and industry, including MDAI studies. Data from these sources have been available in computerized CPIR files.[1] These investigations, and their resulting data, have some serious deficiencies for a study of intrusion. Descriptions of intrusion lack the necessary level of detail. Furthermore, data collected in the past do not provide a means of assessing types and severities of injuries that have occurred in cases involving intrusion. Since injury and intrusion are both dependent on crash severity, any valid statistical studies of intrusion must include some measure of crash severity. Inclusion of such a crash-severity parameter would permit analyses that could isolate the effects of intrusion from other effects of the severity of the crash.

Lack of a suitable measure of crash severity--that is, one which could be reliably determined from field investigations--has long hampered studies of injury causation. This deficiency has limited past attempts to evaluate side-door strength as well as many other vehicle design features related to Motor Vehicle Safety Standards. It is one of the primary reasons for conducting the National Crash Severity Study program.

The NCSS program provides a practical sample of crash vehicles from which intrusion data can be acquired, both to satisfy analytical objectives and serve as a pilot program for future data collection activities. The sampling scheme used by the NCSS teams results in quasi-national representativeness, substantially reducing the selection bias of many previous data collection efforts. In addition, the calculation of "ΔV" in the current program will hopefully result in a

much improved measurement of crash severity. Together, these attributes of NCSS provide a unique opportunity to collect intrusion data.

Past efforts to evaluate effects of intrusion--directly or indirectly--are exemplified by several research studies that assessed the benefits of reinforced side doors. FMVSS-214 requires a minimum side door strength, usually provided by a reinforcing beam or additional strut installed in the door. Although this standard became effective on January 1, 1973, such door-strenghtening structures were introduced by General Motors in certain 1969 model cars and were in most GM cars by the 1971 model year. At least three studies of the effectiveness of the side-door reinforcing beams based on accident data were published late in 1973.

Preston and Shortridge used 1972 accident data from Texas and Denver, Colorado, along with data from in-depth investigations that used the CPIR form and were available in 1973.[2] Preston and Shortridge could find no statistically significant difference in the injury rate of occupants of cars protected with side-door beams, compared to occupants of cars without the beams.

The lack of significant differences would have resulted, of course, if the beam did not effectively protect the occupants. However, at least three other factors could also have contributed to the study result. One may have been the rarity of such equipped vehicles. In 1972, the door beam was new, and the fraction of accident cars equipped with the device was small. This, coupled with substantial missing data on injury severity in the two files of police-reported data, resulted in only a small number of side-door beam cars available for study. The second factor was that the injury scale used by police does not adequately differentiate between levels of severity. Thus, in effect, the study compared no injury with injury of any level, including trivial injury. In addition, a reliable crash severity measure was not available. Because door-beam-equipped cars were new, the distribution of their crash severities may have differed

from that of older cars not equipped with the door beam. The lack of a crash severity measure also hindered the efforts of Preston and Shortridge to use the CPIR data in comparing crush in equipped and non-equipped cars.

At about the same time, McLean studied the efficacy of several design features (FMVSS's). This included a study of side-door-reinforcement beams in two-car angle collisions reported by police in North Carolina from 1970 through 1972.[3] McLean encountered many of the same difficulties that hampered Preston and Shortridge. He found that many intervening variables confounded the assessment of door beams. These included size of car, use of restraints, and crash severity. Limitations in the amount of data prevented statistical control of all of the pertinent variables. McLean concluded that the presence of a door beam in a left-side hit protects the driver sufficiently to reduce his injury risk to that in a right-side hit without a door beam. However, this inference was drawn from lack of statistical significance in the difference of the two injury distributions, rather than from proof that the two distributions were the same.

The Center for the Environment and Man used a log linear regression analysis of 1972 and 1973 accident data from Texas to examine the effect of strengthened side doors on injury risk.[4] They found no detectable effect, but their analysis may also have been diluted by the effects of variables for which they had insufficient data or none at all.

Under a separate contract, the Center for the Environment and Man developed methodologies for evaluating four Motor Vehicle Safety Standards, including FMVSS-214.[5] The general recommendation was that the primary source of data for evaluating FMVSS-214 should be NCSS data, but that the data collection should be modified to include more detailed information on intrusion. The Transportation Center of Stanford Research Institute also developed methods of evaluating

FMVSS-214, and concluded that a key element of an evaluation should be collection of real-world accident data via the NCSS program.[6]

All of the studies reviewed above point to deficiencies in past data collection efforts that seriously limit their usefulness for studying intrusion and its effects. Most of these deficiencies have been addressed in the design of the NCSS program; hence the two methodological studies cited above suggest that the NCSS be used as a primary source of intrusion data from actual accidents. However, the accident investigation protocol and documentation used in NCSS initially did not provide the detail necessary to adequately describe intrusion, particularly with regard to the efficacy of FMVSS-214.

3.0 INTRUSION MEASUREMENT METHODOLOGY

The discussion of intrusion methodology presented here is a brief summary of basic measurement techniques. The Intrusion User's Manual (Appendix E), developed to assist the accident investigator in making intrusion measurements, discusses the measurement methodology in more detail. A companion publication is the Coding Manual which is included in Appendix F. In dealing with intrusion of the vehicle passenger compartment, the accident investigator must measure and quantitatively record damage to a three-dimensional form. This form is the interior space and boundaries of the passenger compartment. The procedures to be followed in this measurement methodology have been developed so that they may be applied simply and consistently to different crash-damaged vehicles examined by different investigators.

To measure intrusion linearly, it is first necessary to establish three orthogonal planes, or axes, for measurement reference within the vehicle. The lateral axis, or Y-axis, is transverse to the longitudinal axis. The vertical axis, or Z-axis, is perpendicular to both the longitudinal and lateral axes. The intersection of these three axes defines the origin. Not all intrusion measurements require the establishment of all three reference axes. It is necessary, however, to establish reference measurement points within the vehicle to permit reproducing these measurements in a similar vehicle if necessary.

Two types of intrusion are characteristics of most crash intrusion situations encountered by accident investigators. The first type, which for descriptive purposes we call Type A, is an intrusion that is limited to one section of the vehicle's passenger compartment. This type of intrusion permits the investigator to make the measurement by comparing the dimensions of the intrusion damage with a

measurement of the equivalent undamaged section of the same vehicle. The two measurements allow the investigator to obtain the differences, or maximum intrusion extent measurement, to be entered on the reporting form.

The second intrusion type, which we call Type B, consists of intrusions to many sections of the passenger compartment, leaving little or no possibility of measuring undamaged sections for purposes of comparison. For Type B intrusions, a similar but undamaged vehicle must be obtained for reference measurements. From such reference measurements, intrusion is calculated.

It was found that measurement of intrusion can be aided by the use of an inexpensive adjustable measuring tube. Such a tube, shown in Figure 1, may be used to establish the individual reference axes in the vehicle. The tube consists of two cylindrical sections, each calibrated, with the one of smaller diameter moveable freely within the other. For example, after the measuring tube is positioned in the vehicle to define the X-axis, a measurement from the tube to the maximum intruded internal section of the vehicle, and another identical measurement from the tube to the undamaged section of the vehicle, permits the investigator to determine the maximum extent of that intrusion damage.

Depending on how the vehicle is deformed, various locations within the passenger compartment may be used to make an intrusion measurement. In cases of roof intrusion, the measuring tube can be placed across the armrests to create a reference line transverse to the vehicle. This permits a series of vertical measurements to be taken. For side intrusion, the longitudinal axis for measurement may be established along the centerline of the vehicle, using the transmission and drive line tunnel. The center of the in-board seat tracks of bucket seats may also be used as a longitudinal reference. Many convenient locations may be used as a reference, provided the deformation at the location is not too large. All such measurements are taken within the interior of the passenger compartment.

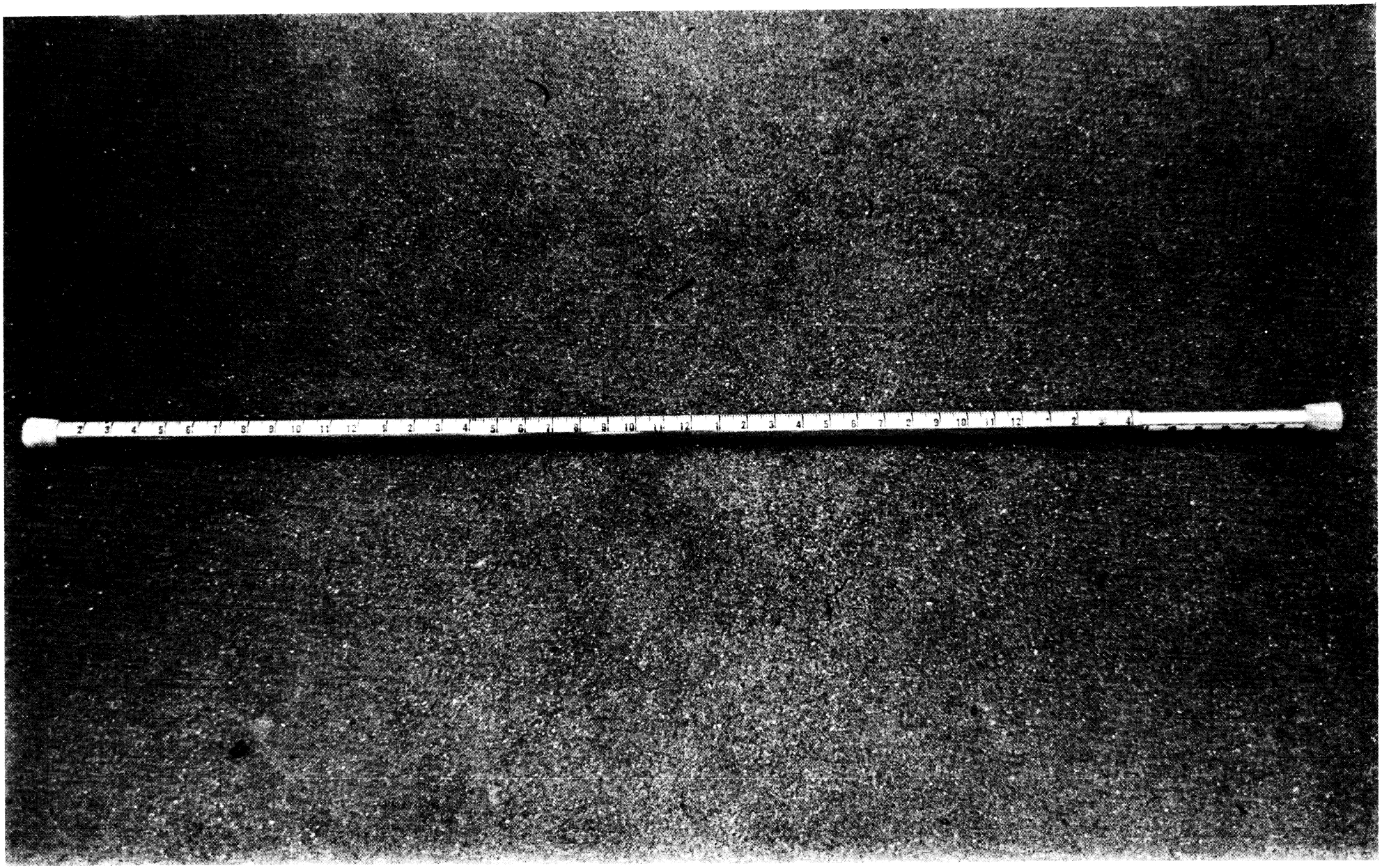


Figure 1. Intrusion Measuring Adjustable Tube

Measurement of seat intrusion requires determining the longitudinal displacement of the seat. The seat position prior to the collision may not be known because of seat track failure or postcrash movement of the seat for extrication purposes. The investigator may have to make some assumptions to assess seat intrusion in these cases. When seat track failure occurs, it is necessary to measure from the final postcrash position of the seat to some fixed location in the vehicle. Comparison with an identical measurement from an equivalent vehicle with an undamaged seat will permit an intrusion measurement. When the precrash position of a seat is not known, the investigator should assume that the seat was at the mid-position along its track.

In completing the door intrusion data form (DR), the maximum external crush to the door must first be located. This form is the only data form in the intrusion measurement protocol which is addressed to exterior rather than interior measurements. The point of maximum inward crush to the door is recorded with respect to its distance, both horizontally and vertically, from the exterior sheet metal edges to the door. The investigator records the horizontal distance from the vertical sheet metal edge parallel to the B-pillar, and the vertical distance from the horizontal door bottom sheet metal edge parallel to the rocker panel and door threshold.

It is recommended that all intrusion measurements be made to the nearest 1/4 inch. This is clearly possible in most intrusion measurements. Upon comparison of these measurement values with those from original undamaged dimensions, the difference (or actual intrusion value) should be recorded on the data form to the nearest inch. The coarser recorded value is what is coded for machine handling and analysis. A more precise measured value permits reviewing of data from "hard copies" when needed to ascertain more detailed value of intrusion on cases of special interest.

There are clearly many ways to measure intrusion, and many convenient measurement references other than those presented here. The

accident investigator is encouraged to first study the interior of the damaged vehicle which exhibits intrusion before attempting any measurements. This will enable the investigator to establish measurement points and measurement references most convenient to the particular vehicle being examined.

3.1 Requirements

A practical protocol for measuring, documenting, and coding intrusion must meet several objectives and requirements. The methodology must be capable of being used by professional accident investigators both within the NHTSA-sponsored nationally conducted National Crash Severity Study (NCSS) and the National Accident Sampling System (NASS). For such programs measurement and documentation procedures must be capable of uniform application and interpretation by various accident investigation teams. That is, the measurements to be collected and recorded must be structured so they are explicitly defined and unambiguous, thus assuring consistent use by different analysts. Methods used must be practical for use in the field under adverse conditions and consistent with currently used techniques of accident investigation. Since the NCSS program is currently operational with a well-established accident investigation protocol, intrusion data must be acquired in a compatible manner as a logical extension of the present existing protocol. The documentation should also be consistent with the modular format of the NCSS data forms, and should lend itself to efficient data processing. Lastly, the method to be used should not only describe any intrusion that occurs, but should also identify the cause of that intrusion and its consequences to occupants.

The last-mentioned objective, to identify the etiology and consequences of the intrusion, is particularly important. Two of the principal shortcomings of previous intrusion studies (described in the Introduction section) were lack of detail on the cause or causes of intrusion, and lack of identification of injuries specifically resulting from intrusion. A principal objective of the methodology presented

here is to link these three phases of intrusion, as shown in Figure 2.

Since all intrusions result from damaging external forces impinging on the vehicle, the etiology can be determined and documented by identification of the antecedent impacts and linking these impacts with resulting intrusion. The NCSS vehicle data forms dealing with crash vehicle assessment provide descriptors of the vehicle, its impacts, and damage. Here the Collision Deformation Classification (CDC), a system of coding location, type, direction of impact force, and extent of damage, is employed with impact severities classified by "ΔV".* Data forms dealing with vehicle occupants provide descriptions of injury by occupant injury classification (OIC) with identification of interior vehicle components which caused the injury. Here again links are necessary to the intrusion associated with the injury.

3.2 Description of Intrusion

Two methods of describing intrusion were developed in previous research studies addressed to the problem of intrusion. One is Vehicle Interior Deformation Index (VIDI) as developed at Southwest Research Institute and currently included in the NATO/CCMS Collision Analysis Report[7], which is an international accident investigation data protocol. The second is an intrusion protocol developed by the Office of Accident and Defects Investigations, Road and Motor Vehicle Traffic Safety Department, Department of Transport, Canada. The Canadian effort is primarily addressed to an investigation of accidents to determine injuries incurred by fully restrained occupants in crashes. Investigation data forms include a section addressed specifically to intrusion. While little information on the Canadian data forms has been published, details regarding this protocol were obtained through discussions with the Canadian Department of Transport.

*A measurement of vehicle velocity reduction as a result of impact used as an index of crash severity in the NCSS and NASS programs.

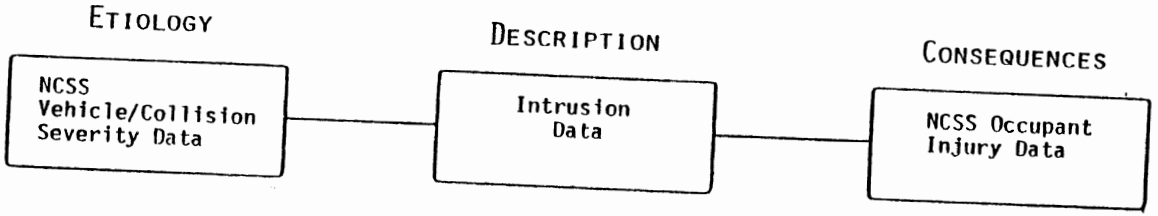


Figure 2. Objective of Intrusion Methodology

The VIDI, as developed by Southwest Research Institute, San Antonio, Texas, is a seven-character index that is patterned after the well-established and well-known Collision Deformation Classification (CDC) system. The first two character positions are alpha characters that indicate whether intrusion extended into any of ten possible seat positions, or combinations of seat positions (that is, intrusions into space associated with seated occupants within the vehicle). Each of the five remaining characters represents an eleven-level numeric code (with X used for the eleventh level) indicating relative reduction in a linear dimension of the passenger compartment. The code has one character for each of five dimensions.

While the VIDI is an excellent mechanism for providing a concise description of the gross features of intrusion, it has serious limitations for use in accident investigation studies such as the NCSS and NASS programs. The number of seat locations in the vehicle which can be used to describe the location of intrusion is limited to four if taken separately. It can also accommodate pairs of seats--that is, seat locations taken two at a time--and all four seat locations taken in total. When vehicle types such as station wagons and vans are included, this becomes a severe limitation.* Furthermore, the VIDI provides no detail on which interior (or exterior) components intruded. While the gross description might provide some correlative information on the general importance of intrusion to injury production, it does not provide the level of identification necessary to identify candidate countermeasures or to evaluate specific existing safety standards.

An entirely different method of describing intrusion is used by the Department of Transport, Canada. In the Canadian method, the vehicle is subdivided into spaces available to each occupant. Each "occupant space" is sectioned by three transverse imaginary vertical

*It is true that the use of two alpha characters could be expanded to include a large number of unique regions of the passenger compartment. This does not seem desirable, however, because of the other limitations of the VIDI.

geometric planes. One plane is located through the leg-foot region, one through the mid (thigh) region, and one through the torso region of space occupied by typical passengers when seated in the vehicle. Three longitudinal vertical planes section each occupant space through the restraint anchorages and mid-point of the space. Thus each space is sectioned by a total of nine imaginary planes. The magnitude of intrusion is then given by a subjective evaluation of the reduction of cross-sectional area of each section in percent, bracketed into seven levels. The overall reduction in volume of each occupant space is also estimated.

This method provides more detail than the VIDI and is more easily extended to a greater variety of seating configurations. Like the VIDI, it allows ready, if subjective, scaling of intrusion by the investigator, largely because the measurement is limited to seven levels.

The use of an area (or volume) measurement approach is attractive. Such an approach allows a single parameter to characterize the intrusion of several components and a complex pattern of intrusion. However, it is not clear that an area-of-volume measure is more closely associated with risk of injury than is a linear quantitative measure. Clearly, a small linear decrease in compartment size over a broad area can result in a substantial decrease in volume with little risk to the occupants. Conversely, a large linear intrusion of a large area may be more dangerous than the same intrusion of a small area. This problem no doubt cannot be resolved without substantial study, but on balance it appears that the danger of intrusion into occupant compartments that have volumes several times that of the occupants can best be described by a linear measure.

The designation of occupant spaces to indicate the location of intrusion is one of the features of the Canadian protocol that has been adopted in the intrusion protocol. The entire volume of the passenger compartment is defined by the enclosing surfaces and is divided into regions. Each region represents the volume that would be available to an occupant of a designated seating position.

The procedure adopted for the intrusion protocol developed in this study treats intrusion separately for each compartment (or external object) that reduces the volume available in any occupant space. It is important that intrusion be documented regardless of whether an occupant was actually using the space. There are two rates that are important for evaluation of intrusion, its resultant reducing of passenger compartment volume, and the frequency and severity of injuries resulting from intrusion. One rate is the incidence of intrusion in crashes--that is, the number of crashes with intrusion over the total number of crashes. The second is the proportion of crashes with intrusion which result in injury. Neither rate can be obtained without recording intrusion into unoccupied occupant space. The amount of intrusion of each component is given by a linear measure which along with the corresponding original unintruded distance in the occupant space, allows an estimate of its potential effects on passengers.

Each individaul intrusion--that is, each intrusion of a component into an occupant space--is linked to the etiology and to the injury consequence. The linking is accomplished as follows. The vehicle section of the NCSS data form contains damage data describing CDC's together with associated objects contacted. A severity measure, "ΔV" is also determined for each impact. Thus each impact has an impact number. By documenting the relevant impact number along with the description of each individual intrusion, intrusions can be linked with the specific impacts which resulted in each intrusion. Similarly, data on each occupant include a list of injuries. The description of each injury is accompanied by the cause (object or component contacted by the occupant) and is assigned an injury number. For each occupant injured, or uninjured, from contacting an intruding surface or component during a crash, there is an intrusion number and corresponding injury number listed. This permits a linking of intrusions with the consequences of those intrusions. This method of linking is shown in

Figure 3. The lower two blocks of Figure 3 indicate elements contained in presently existing NCSS forms.

A modular format has been adopted for the data forms. This is consistent with the type of format employed in the NCSS and NASS programs. Thus, if a particular type of intrusion occurred in a crash, the appropriate form, or forms, are used; if not, the forms are not used. This reduces the prospect of investigators' preparing irrelevant documentation, since they are not required to repeatedly complete many items not applicable to the crash.

If no intrusion occurs in a vehicle, no intrusion forms are completed. If intrusion did occur, it must be measured and documented. A special form, "Catastrophic Crash," is used for crashes in which the passenger compartment is destroyed or in which intrusion is so great and extensive that its measurement and description is impossible, and for which association between injury and its cause could not be established. The form created specifically for these crashes, is short and requires minimal information on intrusion. The purpose of the form is to document the frequency of such impacts, so that they do not go unrecognized and uncounted. A subjective judgment of the reduction in occupant space volume is required to place the severity of such catastrophic crashes in context and to help assure that the abbreviated Catastrophic Crash (CC) form is not used for crash vehicles that have intrusion of measurable severity.

Non-catastrophic intrusion is documented on a form for intruded internal surfaces (the IS form). This form includes the intrusion number for each individual intrusion, identification of the intruding component, the location of intrusion on the vehicle, and the impact number. The amount of intrusion measured in inches is given for the location of internal components with maximum intrusion into the occupant space. The direction of intrusion, as provided by the direction of the measurement of maximum intrusion and the original dimension of the intruded occupant space, is included to better enable the analyst to assess its potential threat to occupants. A pre-coded intrusion

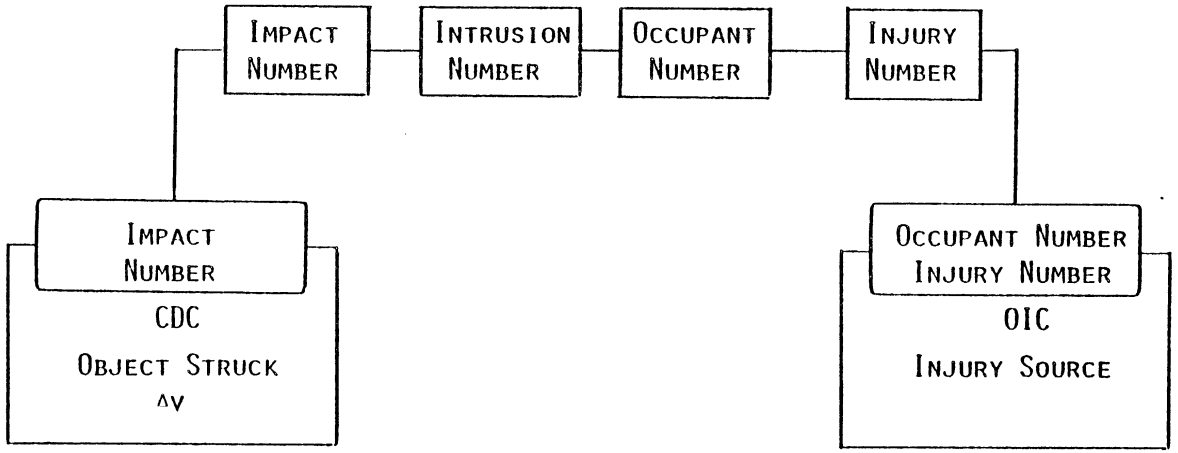


Figure 3. Linking of Etiology, Description, Consequences

number is added to the occupant, for each occupant striking an intruded surface, to complete the link between intrusion and injury.

The two data forms dealing with intrusion mentioned above (the Catastrophic Crash form (CC) and Intruded Surfaces form (IS), together with the information added to the occupant forms, provide the primary documentation of intrusion. This is shown graphically in Figure 4.

Two data forms have also been included to cover ancillary aspects of intrusion. One relates to Federal Motor Vehicle Safety Standard (FMVSS) #214 and its effect on intrusion in motor vehicle crashes. The other assesses the performance of seats in reducing occupant space in crashes.

FMVSS #214 specifies test requirements that must be met by motor vehicle manufacturers for side doors of passenger cars to minimize the injury hazard to occupants from external impacts into the sides of the passenger compartment. One primary objective of the intrusion methodology is to provide a mechanism, through accident investigation, to assess the effectiveness of this standard. FMVSS #214 is a test standard, and unfortunately very few real-life crashes duplicate the test conditions of this standard, or can be correlated directly and quantitatively with the tests required by the standard.

Tests specified by FMVSS #214 involve controlled and calibrated impacts, by a well-specified impacting instrument, into the exterior sides of doors at a specified location. Compliance with the requirements is met when inward deformation is limited to a maximum specified penetration. It was felt that features could be designed into this intrusion methodology to permit as effective an assessment as possible under the given limitations of investigating accidents in the NCSS and NASS programs. Thus the separate data form was designed specifically for exterior door panel and structure deformation.

Data acquired to describe vehicle damage, particularly in coded form such as the CDC, do not specifically indicate if a door was struck. Therefore, an additional form was designed for use in cases of door

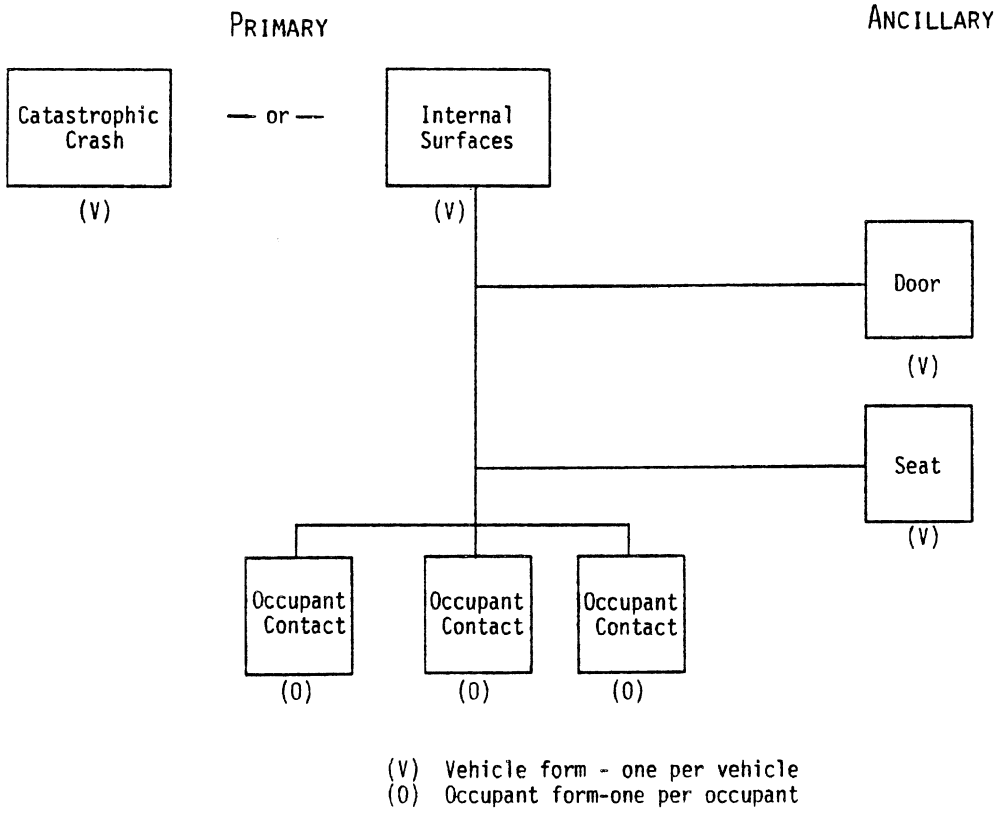


Figure 4. Forms for Documentation of Intrusion

intrusion to provide greater detail on causes of the intrusion. The "Door" form (DR) provides for the recording of data which establishes whether intrusion at a door resulted from direct impact to the door, or from distortion after impact to other external vehicle areas. The latter is more commonly referred to as induced damage. If the impact was into the door, the DR form specifies the location of the maximum external crush, thus providing a comparison of impact location with the location of the test fixture used by vehicle manufacturers in conducting compliance tests to satisfy FMVSS-214. The form also provides information on damage to components, such as hinges, latches, etc., which may have allowed an increase or contributed in some manner to intrusion.

The second ancillary area of intrusion addressed in this methodology involves seats. While seat movement or deformation is not intrusion in the sense that the perimeter of the occupant compartment is reduced directly by an exterior impact, the displacement of seats in a crash can have the same effect in reducing occupant space. Intrusion, as defined in this protocol, is inward movement of the boundary of the passenger compartment by either internal surfaces or external objects. However, seats can and do move from impact-induced forces in such a way as to reduce space available to occupants. Since there are no provisions for noting seat movement in NCSS forms, a form was developed specifically for this purpose. This form, designated as ST, is to be used when seats move so as to intrude into occupant space, either because of direct or induced crash damage, by inertial forces, or by occupant loading during a crash. The seat intrusion form, ST, provides information on seat type and configuration, direction of seat movement in the crash, and the seat structure damage or failure associated with the intruding movement of the seat.

Figure 5 is a tabulation of data forms used for documenting intrusion. The primary Internal Surfaces form (IS), together with the ancillary door and seat forms (DR and ST), and the occupant forms (OC)

CC - Catastrophic Crash
IS - Internal Surfaces
DR - Door
ST - Seat
OC - Occupant Contact

Figure 5. Intrusion Methodology Data Forms

containing injury data, provide all the information to be acquired on intrusion in a single vehicle involved in a crash with intrusion. A complete set of the forms is given in Appendix A. The data variables which comprise this protocol are discussed in Section 5.0. A summary of the key variables is shown in Table 1. By matching crash damage data (the CDC and "ΔV"), and injury data with the key intrusion variables in a digitized data file, the analyst will have the data necessary to perform a comprehensive analysis of intrusion.

Table 1. List of Key Variables

Information	Variable
If Intrusion:	
1. Intruded by	Intruded Area or Object
2. Location	Occupant Space Number
3. Etiology	Impact Number
4. Amount	Intrusion Maximum Extent
If by a Side Door:	
5. Contributing Component Failure	Component Failure
6. Location of Door Impact	X and Z coordinates
If by a Seat:	
7. Type of Seat	Seat Type
8. Direction of Movement	Direction
9. Damaged Seat Component	Cause
If Contacted by an Occupant:	
10. Resulting Injury	Injury Number

4.0 NCSS INTRUSION DATA REVIEW

Intrusion-related data acquired during the initial data collection efforts of NCSS was assessed to determine if they provided sufficient detailed information to adequately document the extent and effects of intrusion in these NCSS crashes. Our primary objective in reviewing these crashes was to identify crash types and crash severity resulting in intrusion, injuries sustained by occupants in those crashes involving intrusion, and whether it was possible to correlate occupant injuries with vehicle interior contact points. A second objective was to determine if information contained in NCSS crash data prior to April 1, 1978, in the form of the protocol used to document intrusion, could be made compatible in some way with data to be obtained by the intrusion methodology developed in this project for future use in NCSS.

In NCSS crash investigations prior to April 1, 1978, a passenger Compartment Intrusion Classification (CIC) data form was completed in crashes with intrusion. This form is shown in Appendix B.

The CIC form design provides for entries to record the area or portion of the vehicle where intrusion occurred, the intruding component, and a measurement of the maximum external extent of intrusion. Responses call for a selection from the items listed in tabular form, and are grouped to facilitate coding. These are no provisions for correlating injuries received by occupants to the intrusion itself, and the description for intrusion relates only to deformation of exterior surfaces rather than the inward movement of internal surfaces.

A total of 150 NCSS crashes with intrusion were selected from crash investigations completed prior to December 1, 1977. This review of 150 NCSS intrusion crashes constituted Task I of this project. A

tabulation of the 150 NCSS cases or crashes identified with intrusion is given in Appendix C. Each case is tabulated by case number, vehicle and accident type, damage and injuries (VDI, CIC, OIC, AIS)* and information about occupant contact, when such data exist. Additional information extracted from the "hard copy" of each case included:

Number of vehicles involved in crash
Make-model code of vehicle with intrusion
Sample category
CRASH reconstruction data
Accident type and configuration
Vehicle Damage Index (VDI)
Occupant-object contact code (OIS-AIS)
Hospital-Internal Classification of Diseases (H-ICDA)
Compartment Intrusion Classification (CIC)

In an attempt to organize these data to convey their general content relative to intrusion, a polar presentation of these crashes was constructed. This is shown in Figure 6, with each case represented by the principal direction of force (PDOF) in a circular presentation about the longitudinal axis of the vehicle by the 12 clock positions (each angular increment equal to 30^{o}), and by Vehicle Damage Index (VDI) extent code. The subset of 25 rollover crashes in these 150 NCSS crashes was excluded from this presentation. The number shown along each radial line, at discrete Vehicle Damage Index (VDI) extent code intervals (1-9), represents the number of times that combination of force direction and VDI extent code occurred in the NCSS crashes with intrusion. These were 25 crashes with intrusion resulting from rollover damage which were not included in this graphic representation because their principal direction of force (PDOF) was not consistent with this presentation. As illustrated, the greatest frequency of intrusion occurred with a principal direction of force (PDOF) of between 3-9 o'clock (clockwise) with Vehicle Damage Index (VDI) extent codes ranging from values of 2 to 4. This is not to imply that intrusion occurs

*VDI, Vehicle Damage Index; CIC, Compartment Intrusion Classification; OIC, Occupant Injury Classification; AIS, Abbreviated Injury Scale.

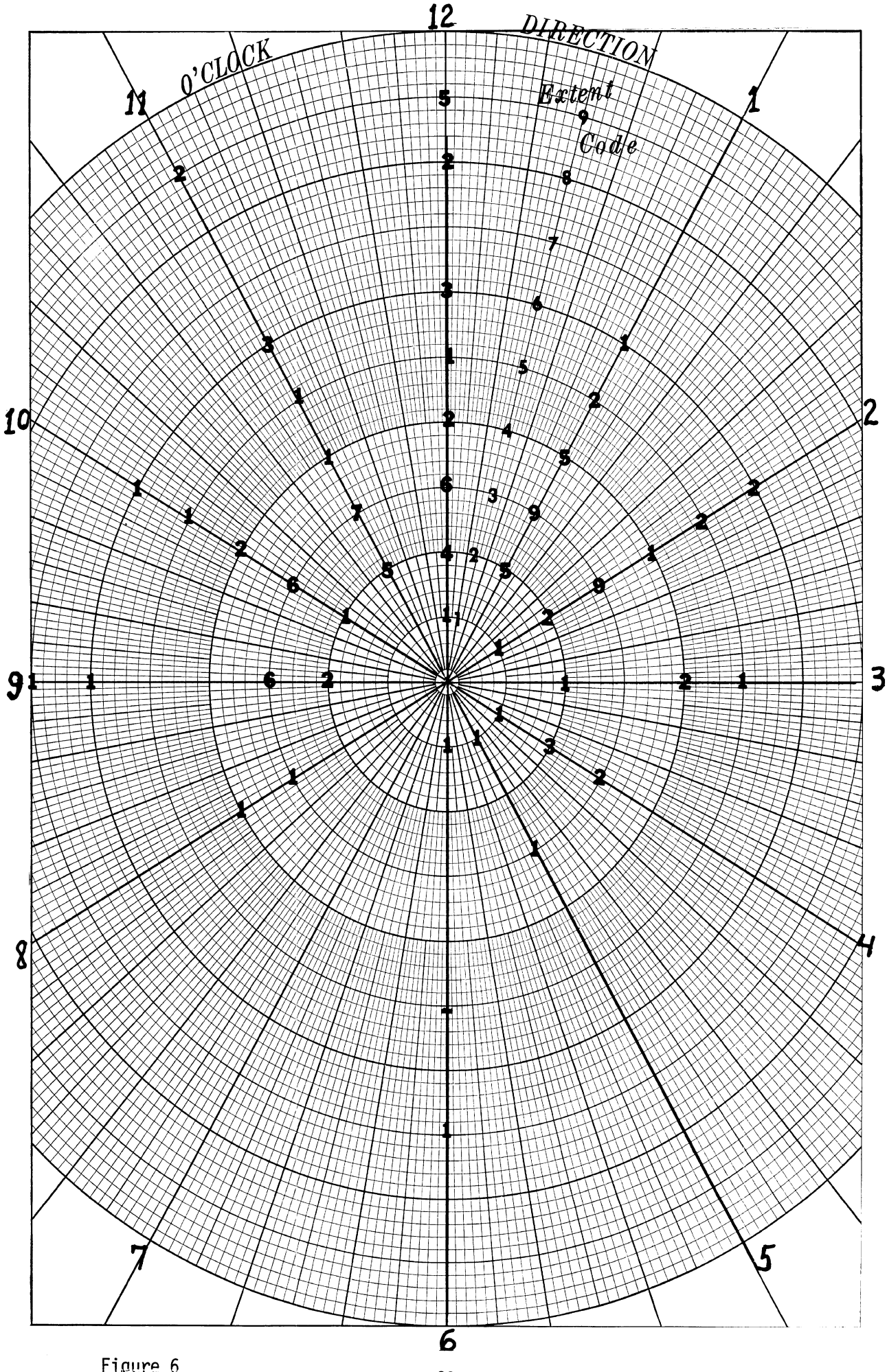


Figure 6

more frequently when the principal direction of force in a crash is between 3 and 9 o'clock, but rather that in this particular group of accidents with intrusion, the principal direction of force fell in this range, or that the general head-on crash orientation occurred most often.

A different grouping of these same cases is presented in Figure 7, which shows that approximately one-half (72) of the 150 selected NCSS cases were side intrusion. This group also included 63 cases of injury. These cases may have some significance relative to FMVSS-214, which specifies test criteria to establish side door resistance to impact. However, as previously indicated, FMVSS-214 is a test standard, rather than a performance standard, and little data are available in these cases which can be used to relate crash forces to the actual FMVSS-214 test requirements.

Of the 63 injury cases, 27 had known Occupant Injury Classification (OIC) injury codes. Three lacked OIC object contact code. In the remaining 24 cases, 10 lacked any means of correlating between the intrusion and injuries received from impact. In the remaining 14 cases, the OIC occupant contact code did identify the intruding component. This apparent correlation, however, does not unequivocally mean that the injury resulted from intrusion, or that the extent of the injury can be correlated with the extent of intrusion.

NCSS cases identified and examined in this effort were all HSRI-investigated crashes meeting NCSS sampling selection criteria. Our analysis of these cases indicated that the data relating to intrusion and injury were inadequate to evaluate the effectiveness of FMVSS-214. There were also insufficient data to correlate specific injuries with specific contact points relative to the location and degree of intrusion, as well as a lack of any quantitative measurement of the degree of intrusion within the passenger compartment. The scope, content, and detail of data relating to intrusion was found to be insufficient to relate location and extent of intrusion with resultant injuries. It is doubtful whether NCSS data relating to

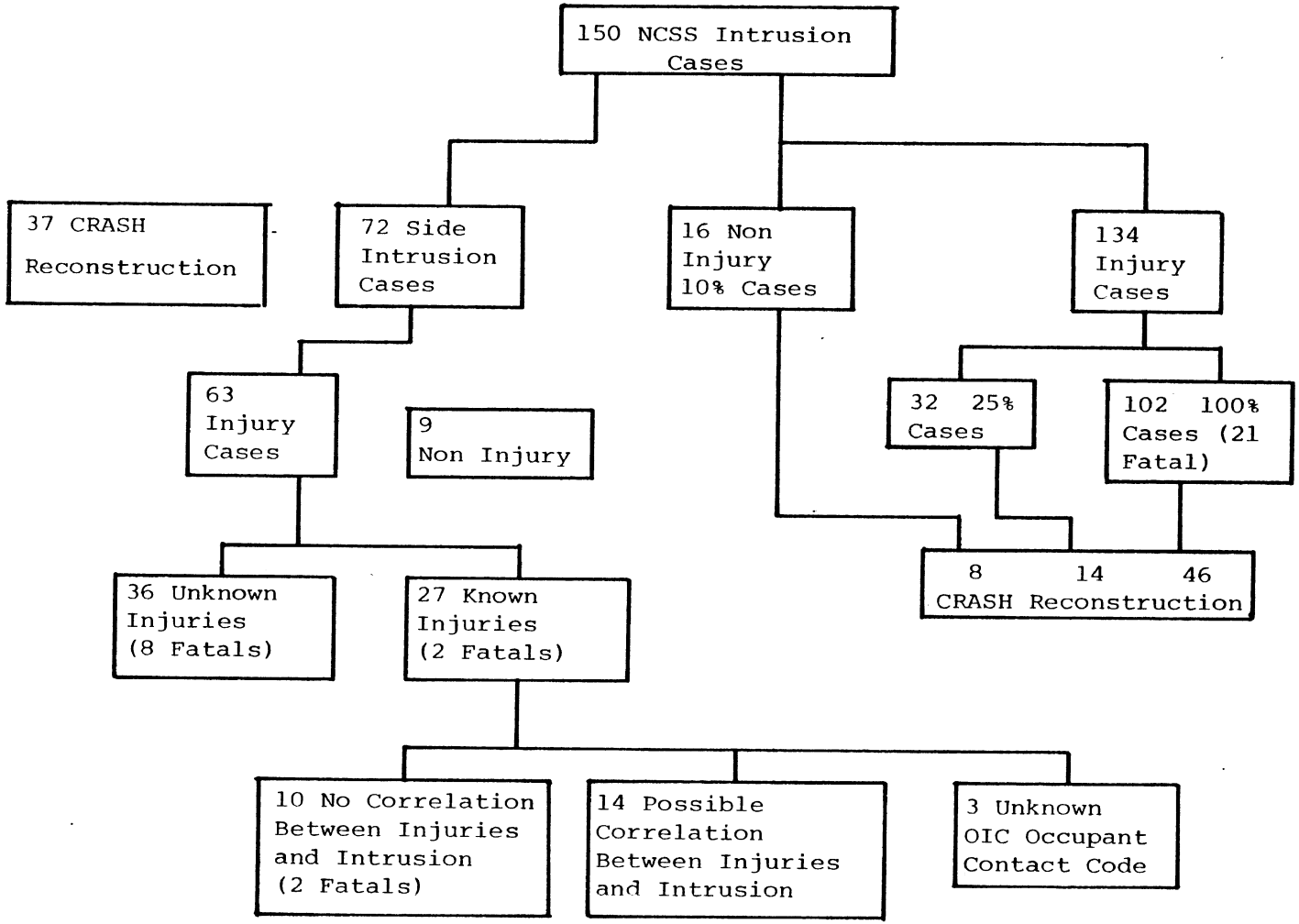

150 NCSS Intrusion Cases
37 CRASH Reconstruction
72 Side Intrusion Cases
16 Non Injury 10% Cases
134 Injury Cases
63 Injury Cases
9 Non Injury
32 25% Cases
102 100% Cases (21 Fatal)
36 Unknown Injuries (8 Fatals)
27 Known Injuries (2 Fatals)
8 14 46 CRASH Reconstruction
10 No Correlation Between Injuries and Intrusion (2 Fatals)
14 Possible Correlation Between Injuries and Intrusion
3 Unknown OIC Occupant Contact Code

Figure 7.

intrusion previously collected in NCSS can be analyzed in any meaningful way with data to be generated through the intrusion methodology developed in this project. At best, they could be used to augment the intrusion totals when data collected with this new methodology are complete. They could not be used in any multivariate analysis with new data from this intrusion methodology.

5.0 FIELD DATA RECORDING

The field data recording system developed for use with this intrusion measurement methodology is designed to be compatible with NCSS, as well as satisfy the objectives of this intrusion methodology development.

5.1 Data Elements/Variable Lists

Five separate intrusion protocols were designed to document the principal types of intrusion occurring in crashes. Two of these five constitute the major parts of the protocol. The remaining three are included to assure that most all features associated with intrusion are retained in a codified form. The two major portions of the protocol are:

(1) Intrusion: Catastrophic Crash (CC)
(2) Intrusion: Internal Surfaces (IS)

The remaining three are embodied in the following supplementary forms:

(3) Intrusion: Door (DR)
(4) Intrusion: Seat (ST)
(5) Occupant Contact with Intruded Surfaces (OC)

Each protocol contains the data elements necessary to describe the particular intrusion. These data elements, in the form of variables, are listed below. The variable name, field width, and card column numbers for each are included in the tabulation. The variables are arranged by relevant intrusion data form, with each page containing a list of variables (in chronological order) for a specific data set.

The following table summarizes the variable lists.

Variable List	No. of Variables*	No. of Cards	Total Field Width (variables)*	Total Field (with Card ID)
Card ID	8	-	14	-
Catastrophic Crash	10	1	10	24
Internal Surfaces	74	2	123	151
Doors	27	1	45	59
Seats	23	1	29	43
Occupant Contact	24	1	48	62
Totals	147*	6	228*	312

*Not including Card ID variables.

The first page details data punched Card Identification information, which is common to all data cards. This information is incorporated by reference on each of the subsequent variable lists. It constitutes the first 14 columns of each data card.

CARD IDENTIFICATION

Column		Width
1	Update Number	1
2	Team	1
3	Year	1
4-5	Month	2
6-7	Day	2
8-10	Sequence	3
11-13	Vehicle Number	3
80	I.D. Number (card)	1
Total Variables 8	Total Width	14

VARIABLE LIST - CATASTROPHIC CRASH

Variable		Width	Column No.
	Card Identification*	13	01-13
1	Type of Catastrophic Failure - #1	1	14
2	Type of Catastrophic Failure - #2	1	15
3	Type of Catastrophic Failure - #3	1	16
4	Occupant Space Volume Reduction, #11	1	17
5	Occupant Space Volume Reduction, #12	1	18
6	Occupant Space Volume Reduction, #13	1	29
7	Occupant Space Volume Reduction, #21	1	20
8	Occupant Space Volume Reduction, #22	1	21
9	Occupant Space Volume Reduction, #23	1	22
10	Occupant Space Volume Reduction, #34	1	23
	ID 3*		80
	Total Variables** - 10 Field Width:	Variables	10 columns
		Card ID	14
		Total	24

*See page 34, "Card Identification" for an explanation of the Card Identification columns.

**Not including Card ID.

VARIABLE LIST - INTERNAL SURFACES

Variable		Width	Column No.
Card	Identification	13	01-13
1	No. of Occupant Spaces	1	14-15
2	No. of Intrusions	2	16-17
3	Intruding Component - INTrusion No. 01 (INT 01)	2	18-19
4	Occupant Space - INT 01	2	20-21
5	Associated Impact Number - INT 01	1	22
6	Measurement Axis - INT 01	1	23
7	Intrusion Maximum Extent - INT 01	2	24-25
8	Occupant Space Dimension - INT 01	2	26-27
9	Intruding Component - INTrusion No. 02 (INT 02)	2	28-29
10	Occupant Space - INT 02	2	30-31
11	Associated Impact Number - INT 02	1	32
12	Measurement Axis - INT 02	1	33
13	Intrusion Maximum Extent - INT 02	2	34-35
14	Occupant Space Dimension - INT 02	2	36-37
15	Intruding Component - INTrusion No. 03 (INT 03)	2	38-39
16	Occupant Space - INT 03	2	40-41
17	Associated Impact Number - INT 03	1	42
18	Measurement Axis - INT 03	1	43
19	Intrusion Maximum Extent - INT 03	2	44-45
20	Occupant Space Dimension - INT 03	2	46-47
21	Intruding Component - INTrusion No. 04 (INT 04)	2	48-49
22	Occupant Space - INT 04	2	50-51
23	Associated Impact Number - INT 04	1	52
24	Measurement Axis - INT 04	1	53
25	Intrusion Maximum Extent - INT 04	2	54-55
26	Occupant Space Dimension - INT 04	2	56-57
27	Intruding Component - INTrusion No. 05 (INT 05)	2	58-59
28	Occupant Space - INT 05	2	60-61
29	Associated Impact Number - INT 05	1	62
30	Measurement Axis - INT 05	1	63
31	Intrusion Maximum Extent - INT 05	2	64-65
32	Occupant Space Dimension - INT 05	2	66-67
33	Intruding Component - INTrusion No. 06 (INT 06)	2	68-69
34	Occupant Space - INT 06	2	70-71
35	Associated Impact Number - INT 06	1	72
36	Measurement Axis - INT 06	1	73
37	Intrusion Maximum Extent - INT 06	2	74-75
38	Occupant Space Dimension - INT 06	2	76-77
	ID 4	1	80

(continued on next page)

Card	Identification (same as previous card)	13	01-13
39	Intruding Component - INTrusion No. 07 (INT 07)	2	14-15
40	Occupant Space - INT 07	2	16-17
41	Associated Impact Number - INT 07	1	18
42	Measurement Axis - INT 07	1	19
43	Intrusion Maximum Extent - INT 07	2	20-21
44	Occupant Space Dimension - INT 07	2	22-23
45	Intruding Component - INTrusion No. 08 (INT 08)	2	24-25
46	Occupant Space - INT 08	2	26-27
47	Associated Impact Number - INT 08	1	28
48	Measurement Axis - INT 08	1	29
49	Intrusion Maximum Extent - INT 08	2	30-31
50	Occupant Space Dimension - INT 08	2	32-33
51	Intrusion Component - INTrusion No. 09 (INT 09)	2	34-35
52	Occupant Space - INT 09	2	36-37
53	Associated Impact Number - INT 09	1	38
54	Measurement Axis - INT 09	1	39
55	Intrusion Maximum Extent - INT 09	2	40-41
56	Occupant Space Dimension - INT 09	2	42-43
57	Intruding Component - INTrusion No. 10 (INT 10)	2	44-45
58	Occupant Space - INT 10	2	46-47
59	Associated Impact Number - INT 10	1	48
60	Measurement Axis - INT 10	1	49
61	Intrusion Maximum Extent - INT 10	2	50-51
62	Occupant Space Dimension - INT 10	2	52-53
63	Intruding Component - INTrusion No. 11 (INT 11)	2	54-55
64	Occupant Space - INT 11	2	56-57
65	Associated Impact Number - INT 11	1	58
66	Measurement Axis - INT 11	1	59
67	Intrusion Maximum Extent - INT 11	2	60-61
68	Occupant Space Dimension - INT 11	2	62-63
69	Intruding Component - INTrusion No. 12 (INT 12)	2	64-65
70	Occupant Space - INT 12	2	66-67
71	Associated Impact Number - INT 12	1	68
72	Measurement Axis - INT 12	1	69
73	Intrusion Maximum Extent - INT 12	2	70-71
74	Occupant Space Dimension - INT 12	2	72-73
	ID 5	80	

Total - 74 variables

Field Width:

Variables	123
Card I.D.	28
Total	151

VARIABLE LIST - DOOR

Variable		Width	Column No.
Card Identification		13	01-13
1	Door Intrusion Increased by Component Damage	1	14
2	A. Intrusion No.	2	15-16
3	A. Component Failure No 1	1	17
4	A. Component Failure No 2	1	18
5	B. Intrusion No.	2	19-20
6	B. Component Failure No 1	1	21
7	B. Component Failure No 2	1	22
8	C. Intrusion No.	2	23-24
9	C. Component Failure No 1	1	25
10	C. Component Failure No 2	1	26
11	D. Intrusion No.	2	27-28
12	D. Component Failure No 1	1	29
13	D. Component Failure No 2	1	30
14	Left front door horizontal dimension ($_{L}A_{F}$)	2	31-32
15	Right front door horizontal dimension ($_{R}A_{F}$)	2	33-34
16	Left front door impact horizontal dimension ($_{L}B_{F}$)	2	35-36
17	Right front door horizontal dimension ($_{R}B_{F}$)	2	37-38
18	Left front door impact vertical dimension ($_{L}D_{F}$)	2	39-40
19	Right front door impact vertical dimension ($_{R}D_{F}$)	2	41-42
20	Left front rear door vertical dimension ($_{L}C$)	2	43-44
21	Right front rear door vertical dimension ($_{R}C$)	2	45-46
22	Left rear door horizontal dimension ($_{L}A_{R}$)	2	47-48
23	Right rear door horizontal dimension ($_{R}A_{R}$)	2	49-50
24	Left rear door impact horizontal dimension ($_{L}B_{R}$)	2	51-52
25	Right rear door impact horizontal dimension ($_{R}B_{R}$)	2	53-54
26	Left rear door impact vertical dimension ($_{L}D_{R}$)	2	55-56
27	Right rear door impact vertical dimension ($_{R}D_{R}$)	2	57-58
	ID 6	1	80

Total variables - 27

Field Width: Variables 45
Card ID 14
Total 59

VARIABLE LIST - SEAT

	Variable	Width	Column No.
Card Identification		13	01-13
1	Seat Type - front	1	14
2	Seat Type - second	1	15
3	Seat Type - third	1	16
4	Seat Type - fourth	1	17
5	Seat Type - fifth	1	18
6	A. Intrusion No.	2	19-20
7	A. Cause	1	21
8	A. Direction	1	22
9	B. Intrusion No.	2	23-24
10	B. Cause	1	25
11	B. Direction	1	26
12	C. Intrusion No.	2	27-28
13	C. Cause	1	29
14	C. Direction	1	30
15	D. Intrusion No.	2	31-32
16	D. Cause	1	33
17	D. Direction	1	34
18	E. Intrusion No.	2	35-36
19	E. Cause	1	37
20	E. Direction	1	38
21	F. Intrusion No.	2	39-40
22	F. Cause	1	41
23	F. Direction	1	42
	ID 7	1	80

Total of 23 variables

Total Width: Variables 29
Card ID 14
Total 43

VARIABLE LIST - OCCUPANT CONTACT

Variable		Width	Column No.
Card Identification		13	01-13
1	A. Intrusion No.	2	14-15
2	A. Associated Injury No.	2	16-17
3	A. Intrusion Extent	2	18-19
4	A. Occupant Space Dimension	2	20-21
5	B. Intrusion No.	2	22-23
6	B. Associated Injury No.	2	24-25
7	B. Intrusion Extent	2	26-27
8	B. Occupant Space Dimension	2	28-29
9	C. Intrusion No.	2	30-31
10	C. Associated Injury No.	2	32-33
11	C. Intrusion Extent	2	34-35
12	C. Occupant Space Dimension	2	36-37
13	D. Intrusion No.	2	38-39
14	D. Associated Injury No.	2	40-41
15	D. Intrusion Extent	2	42-43
16	D. Occupant Space Dimension	2	44-45
17	E. Intrusion No.	2	46-47
18	E. Associated Injury No.	2	48-49
19	E. Intrusion Extent	2	50-51
20	E. Occupant Space Dimension	2	52-53
21	F. Intrusion No.	2	54-55
22	F. Associated Injury No.	2	56-57
23	F. Intrusion Extent	2	58-59
24	F. Occupant Space Dimension	2	60-61
	ID 2	1	80

Total Variables - 24

Field Width: Variables 48
Card ID 14
Total 62

These data have been organized so as to make efficient use of card layout while retaining the desired categorical grouping of data to facilitate machine handling and analysis.

5.2 Field Form Design

A fundamental requirement in the development of this intrusion protocol is that it replace the present data form existing in NCSS relating to intrusion. To provide a smooth transition from what currently exists in NCSS to this newer intrusion protocol, the data forms were designed to be as consistent as practicable with the general characteristics of current NCSS field data forms. This was accomplished by:

(1) Formatting the data elements in the same manner as in the current NCSS forms,
(2) Printing them on yellow paper,
(3) Providing matching page, form header and identification information,
(4) Retaining the data recording methods and code table values as they exist in current NCSS forms where practicable.

The resulting data recording forms were designed to be suitable for field use and to incorporate features to facilitate their use in the data editing and reduction process.

Space was provided on each form for noting unusual circumstances surrounding responses to a particular data element, and additional pages of diagrams are provided for graphic illustration of particular types of intrusion. Copies of the forms can be found in Appendix A.

5.3 Coding and Data Handling

The data forms were designed to be self-coding to facilitate the data reduction process. Where possible, code tables were incorporated into the text of the data element involved. Card column numbers were also added. These two features are essential to facilitate the handling of these data in the coding, editing, and data reduction process.

Two documents were developed to assist in the investigation of intrusion-related crashes, proper completion of the forms, and preparation of the data for reduction:

(1) "User's Manual for Measurement of Intrusion in Motor Vehicle Accidents," and

(2) "Coding Manual for Measurement of Intrusion in Motor Vehicle Accidents."

The User's Manual was designed to assist the field investigator in understanding, measuring, and documenting evidence of intrusion. The manual includes details on; definitions; when to complete the forms; measurement of intrusion, notes on completing the individual forms; photographic requirements; and sample intrusion forms.

The Coding Manual is a companion document to assist the field investigator and the editor in achieving consistency in preparation of the data for conversion to machine form. This includes topics on; the formt of forms; card identification; and coding instructions for each of the specific data forms.

6.0 NCSS TRAINING SEMINAR

As a concluding task in this methodology development, HSRI developed and presented a training seminar on intrusion for members of all NCSS accident investigation teams.

The seminar was held on March 21-23, 1978, at the University of Michigan and was offered as the "Intrusion, Fire and Fuel Leakage Methodology Training Seminar."* The purpose of the seminar was to present three topics developed by HSRI. These topics, all relevant to NCSS investigation activities, were: (1) Intrusion; (2) Vehicle Fire Data Recording; and (3) Vehicle Fuel Leakage data recording. These latter two topics are subjects of other reports. Only the intrusion portion of the seminar is reported here. The total seminar schedule and list of attendees is shown in Appendix D.

The intrusion portion of the seminar was designed to fulfill two objectives: (1) To discuss the theory and methodology of intrusion and its measurement; and (2) To provide actual "hands-on" practice in assessing, measuring, and recording intrusion data.

Intrusion training covered one and one-half days of the two and one-half day seminar. This was divided into three half-day sessions. The Tuesday morning session (first half-day of the seminar) was devoted to an introduction to intrusion, the intrusion measurement methodology, and a discussion of each of the intrusion protocols. Hand-out materials included copies of the field data forms, a measuring tube (device for assistance in measuring intrusion), and draft copies

*Methodology for assessing fire and fuel leakage in vehicle crashes was developed under a separate contract but included as part of this training seminar.

of the User's Manual and Coding Manual. The presentations consisted of lectures and demonstrations on the meaning of intrusion, which vehicles and types of intrusion qualify, measurement methodology, and the use of each of the intrusion data recording forms. Each presentation (schedule in Appendix D) was structured to permit full participation by attendees and open discussion of various features of the methodology.

The afternoon session was devoted to "field" exercises. Four vehicles exhibiting various intrusion damage, of the type relating to the different protocols, were made available to seminar attendees. Equipped with tape measures, measuring tubes, and intrusion supplemental data forms, the attendees spent the afternoon examining crash vehicles and recording intrusion data under the supervision of senior HSRI staff. This practice session acquainted the users with the process of acquiring data from actual crashed vehicles. It served as a catalyst for questions in the subsequent discussion session. The completed data forms were collected for review by the seminar staff. A review of these data forms identified points of misunderstanding. Those were addressed in the following day's discussion sessions. Topics included all aspects of the problem of intrusion, including measurement, definition, data recording, and field form use. The discussion brought out many areas of user concern and developed a satisfactory degree of user understanding of the protocol.

The balance of the seminar was devoted to other topics not related to intrusion--except for the last session. This session was devoted to questions and answers relating to any of the topics included in the seminar. Remaining questions concerning intrusion were resolved to the satisfaction of the attendees.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The objective of developing a methodology for the uniform and consistent measurement and coding of intrusion in crashes was accomplished. In developing this measurement and coding methodology, previous methods of acquiring data on intrusion were carefully reviewed. Of particular significance and relevance were two previous research studies in which methods were developed for the acquisition of data on intrusion.

One was the Vehicle Interior Deformation Index (VIDI). This is a method for the classification of intrusion in crashes incorporated into the NATO/CCMS Collision Analysis Report System of investigating and found to be not suitable as an intrusion methodology for use in the NCSS and NASS programs. The second was a much different approach towards assessing and classifying intrusion damage used in a current Canadian research project. The Canadian effort has its primary objective the study of injuries incurred by occupants who are fully restrained in moderate to severe crashes. This research was found useful in its approach of using occupant space within vehicles as the basis for describing intrusion. Imaginary planes which pass through well-defined positions within the vehicle are used to divide the interior space of the vehicle into specific occupant space compartments. Portions of this methodology were adopted for use in this intrusion measurement methodology.

A review of 150 accident cases involving intrusion investigated in the National Crash Severity Study (NCSS) during its first year of operation were analyzed for their content of data relative to intrusion. These cases were found to be inadequate for relating location

and extent of intrusion to resultant injuries. They were also found lacking in detail and measurement equivalence with this intrusion methodology. Thus they are of little value in any analysis of the combined data. At best, these data regarding intrusion from early NCSS cases could be used only to augment totals. They cannot be used in any form of multivariate analysis of the combined data.

The intrusion measurement methodology and data coding system developed in this project defines a number of specific practical measurements which are recorded in a convenient format for field investigators and for later data file building and maching handling. Non-damaged portions of the vehicle exhibiting intrusion are used for comparison "benchmark" measurement references. Where equivalent undamaged portions are not available, undamaged vehicles of the same make and model are used.

Field data forms completed by accident investigators are modular. That is, individual portions of the overall intrusion protocol are contained in specific forms which are completed for only that intrusion relevant to a specific portion of the protocol. The methodology includes crash-induced seat movement that reduces space available to occupants. For extensive and multiple intrusions which accompany severely damaged vehicles, a "catastrophic" category was created. This applies to crashes in which the passenger compartment is destroyed or in which intrusion is so extensive that its measurement, description, and association with injuries is impossible. Data on "catastrophic crashes" is brief but specific, ensuring that the frequency of this intrusion type does not go unrecognized and uncounted.

The intrusion measurement methodology is based entirely on internal vehicle measurements, with but one exception: When intrusion damage is evident to the exterior of the vehicle side doors. Here, measurements are made to locate the center and extent of the exterior side door intrusion damage. This provides a means for assessing side door intrusion with respect to Federal Motor Vehicle Safety Standard

(FMVSS) #214, "Side Door Strength - Passenger Cars." FMVSS #214 specifies minimum impact test requirements for passenger car side doors. By accurately describing door damage in crashes, a comparison may be made relative to impact force and location of the special test fixture used by vehicle manufacturers in conducting FMVSS #214 compliance tests. Damage to components, such as hinges, latches, etc., is also included. Related injuries to such side door intrusions may be correlated with the impact, or impacts, which resulted in intrusion.

Field trials of this intrusion methodology by HSRI staff accident investigators have demonstrated it to be a practical design that can be applied consistently and uniformly. The training seminar conducted March 21-23, 1978, with "hands-on" experience provided NCSS investigators in attendance, similarly demonstrated that this methodology can be applied uniformly and consistently by all NCSS accident investigation teams. Should any ambiguities or inconsistencies develop in the mass application of this methodology, HSRI is prepared to resolve them as they arise.

It is recommended that the intrusion methodology developed in this project be implemented within the NCSS program, the NASS program, and other similar accident investigation programs where practical, so that sufficient data regarding intrusion may be acquired for effective and conclusive analyses of the problem of intrusion in motor vehicle crashes.

REFERENCES

1. Accident data files based on collision performance and injury report data reporting and coding accident investigations conducted by professional accident investigators.

2. Preston, Fred and Shortridge, Ray. An Evaluation of the Effectiveness of Side-Door Beams Based on Accident Exposure. Highway Safety Research Institute, The University of Michigan, Report No. UM-HSRI-SA-73-8, September 1973.

3. McLean, A.J. Collection and Analysis of Collision Data for Determining the Effectiveness of Some Vehicle Systems. Highway Safety Research Center, Chapel Hill, North Carolina, 1973.

4. Evaluation of Motor Vehicle Safety Standards. The Center for the Environment and Man, Hartford, Connecticut, Report No. DOT-HS-801-012, December 1973.

5. Northrop, Gaylord M. Evaluation Methodologies for Four Federal Motor Vehicle Safety Standards. The Center for the Environment and Man, Hartford, Connecticut, Report No. DOT-HS-802-346, March 1977.

6. Brann, R.L., et al. Evaluation Methodologies for Federal Motor Vehicle Safety Standards. The Transportation Center, Stanford Research Institute, Menlo Park, CA, Report No. DOT-HS-802-341, March 1977.

7. Accident Investigation. NATO Committee on the Challenges of Modern Society, CCMS Report No. 26, published by the National Highway Traffic Safety Administration, U.S. Department of Transportation, July 1974.

APPENDIX A

INTRUSION METHODOLOGY DATA FORMS

UPDATE	TEAM	YEAR	MONTH	DAY	SEQUENCE
1					10

CC

NATIONAL CRASH SEVERITY STUDY

INTRUSION: CATASTROPHIC CRASH

Complete this form *ONLY* if the intrusion satisfies the definition of a CATASTROPHIC CRASH (see User's Manual, Section 2.2).

[11-13] Vehicle No. ___ 0 0

1. Complete the General Intrusion Diagram so as to depict the approximate intrusions (supplemental sketches may be required).

2. Type(s) of catastrophic vehicle damage (code not more than three):

[14] ___

[15] ___

[16] ___

CODES FOR CATASTROPHIC VEHICLE DAMAGE

Passenger compartment opened or separated:*
1 At firewall
2 At B pillar
3 At roof
9 Other--Describe at Code 9 BELOW

Vertical Compression--Extreme:
4 Roof

Longitudinal Compression--Extreme:
5 From front
6 From rear

Lateral Compression--Extreme:
7 From right hand side
8 From left hand side

9 Describe briefly: _____

_____

_____

_____

*Separation or opening need not be complete, but should be of major proportions.

3. Occupant Space Volume Reduction

	Occupant Space Number*	Approximate Volume Reduction
[17]	11 (front, left [driver])	____
[18]	12 (front, center)	____
[19]	13 (front, right)	____
[20]	21 (rear, left)	____
[21]	22 (rear, center)	____
[22]	23 (rear, right)	____
[23]	34 (third, fourth, or fifth seat/cargo area)	____

CODES FOR VOLUME REDUCTION

1 No Reduction
2 < 20%
3 20% - 40%
4 40% - 60%
5 60% - 80%
6 > 80%
7 Total (100%)
8 Not Applicable
9 Unknown

*See User's Manual, Table 6.2-1: Vehicle Configuration at Time of Crash as an aid to determining appropriate OCCUPANT SPACE NUMBERS to code.

GENERAL RULE:

A. *For a vehicle with more than two seats and with a cargo area behind the seat, code spaces 11, 12, 13, 21, 22, 23, and 34 (to denote area behind the second seat).*

B. *For a vehicle with one seat and a cargo area behind the seat, code spaces 11, 12, 13, and 34 (to denote the area behind the seat), and use Code 8 for 21 through 23.*

[80] I.D. 3

* END OF CATASTROPHIC INTRUSION DATA FORM *

UPDATE	TEAM	YEAR	MONTH	DAY	SEQUENCE
1					10

IS

NATIONAL CRASH SEVERITY STUDY

INTRUSION: INTERNAL SURFACES OF THE PASSENGER COMPARTMENT

Complete this form *ONLY* when there is intrusion of the internal surfaces of the passenger compartment. Supplemental sketches may be required.

[11-13] Vehicle No. ___ 0 0

1. Complete the General Intrusion Diagram so as to depict the intrusion(s) of the passenger compartment internal surface(s).

   A. For a 2 occupant space vehicle, sketch intrusion on the passenger car diagram and cut-away sections A, C, D.
   B. For a 4 occupant space vehicle, sketch intrusion on the passenger car diagram and cut-away sections A, C, D, E.
   C. For a 5 or 6 occupant space vehicle, complete the passenger car diagram and all cut-away sections.
   D. For a station wagon, complete the station wagon diagram and all cut-away sections. If it is a 3 seat vehicle, ink in the 3rd seat.
   E. For a passenger van, complete the van diagram and all cut-away sections. If it is a 4 or 5 seat van, ink in the 4th and 5th seat.
   F. For a pickup vehicle, complete the pickup diagram and appropriate cut-away sections depending upon the seating arrangements.

[14-15] 2. Total Number of Occupant Spaces in the Vehicle: ___ ___
99 = Unknown

[16-17] 3. Total Number of Intrusions ___ ___

4. Areas of intrusion, associated impacts and resulting maximum intrusion.

Code intrusions in this order: Occupant Space 11, then 13, 23, 21, 12, 22, seat 3 (left to right), seat 4 (left to right), and seat 5 (left to right). See User's Manual, Section 6.3 for further information.

	Intrusion Number	Intruded Area or Exterior Object	Occupant Space No.	Associated Impact No.*	Measurement Axis	Intrusion		Occupant Contact**	
						Intrusion Maximum Extent	Occupant Space Dimension	Intrusion Extent at Contact†	Occupant Space Dimension†
	A	B	C	D	DD	E	F	G	H
[18-27]	01								
[28-37]	02								
[38-47]	03								
[48-57]	04								
[58-67]	05								
[68-77]	06								
[80]	(I.D. 4)								
[01-13]	(Duplicate for Case I.D.)								
[14-23]	07								
[24-33]	08								
[34-43]	09								
[44-53]	10								
[54-63]	11								
[64-73]	12								
	13								
	14								
[80]	(I.D. 5)								

Add additional Intrusion Numbers as needed

*From Impact Number on page 1 of VEHICLE DATA FORM (V), column 54, etc.
CODES: 1, 2, 3, or 4, 6=Occupant Contact/Inertial Forces, 7=Other Impact, 8=Not Applicable, 9=Unknown.

**Noted here for convenience of measurement. Also record as needed in columns G and H of OCCUPANT CONTACT FORM (OC) as appropriate. If no occupant contact occurred for a particular intrusion, leave blank.

†At Point of Occupant Contact.

NOTE: ALL MEASUREMENTS ARE IN INCHES.

Column B: Codes for Intruded Area or Exterior Object

Individual Component

INDIVIDUAL COMPONENT:

Internal	CODE
Instrument Panel	01
Dash Panel--Cowl	02
Toe Pan	03
Steering Column	04
Windshield Header	05
A Pillar	06
Door Panel or Side Panel	07
Window Frame	08
B Pillar	09
C Pillar	10
D Pillar	11
Roof Side Rails	12
Roof or Convertible Top	13
Floor Pan	14
Backlight Header	15
Front Seat-Back Surface/ Seat-Back Back Surface	16
Second Seat-Back Surface/ Seat-Back Back Surface	17
Third Seat-Back Surface/ Seat-Back Back Surface	18
Fourth Seat-Back Surface Seat-Back Back Surface	19
Fifth Seat-Back Surface Seat-Back Back Surface	20
Windshield	21
Back Panel/Back Door Surface	22
Seat Cushion Surface/Edge	23
Console	24
Other: _____	28
Unknown Internal Surfaces	29
Exterior	
Hood	43
Objects Exterior to Car	44
Outside Surface of Car	45
Other: _____	46
Unknown Exterior Object	49
Not Applicable	98
Unknown	99

Grouped for Massive Intrusion into an Occupant Space

	CODE
Instrument Panel-01 A Pillar-06 Door Panel-07	31
Instrument Panel-01 A Pillar-06 W/S Header-05	32
Door Panel-07 B Pillar-09 Roof Rail-12	33
Instrument Panel-01 Floor Pan-14 A Pillar-06 Door Frame-07	34
Roof Rail-12 A Pillar-06 B Pillar-09 Window Frame-08	35
Roof Rail-12 A Pillar-06 B Pillar-09 C Pillar-10 Door Panel-07	36
Roof-13 Roof Rail-12 Window Frame-08 Door Panel-07	37
Backlight Header-15 Roof-13 C Pillar-10 3rd Seat Back-17	38
Roof-13 Roof Rail-12 A Pillar-06 B Pillar-09 C Pillar-10 Window Frame-08 Door Panel-07 Floor Pan-14	39
Instrument Panel-01 Toe Pan-03 W/S Header-05 A Pillar-06 Roof Rail-12 Window Frame-08 Door Panel-07 Roof-13	40
Roof-13 Roof Rail-12 C Pillar-10 Window Frame-08 Floor Panel-14 2nd Seat-17 Door Panel-07	41
Roof Rail-12 Roof-13 B Pillar-09 Window Frame-08 Floor Pan-14 Door Panel-07 2nd Seat-17 Front Seat-16	42

*Use only if all these components components intruded into a single occupant space.

Column C: Codes for Occupant Space Number

Occupant Space Number is a 2-digit code. The use of the code is determined by the vehicle seat configuration at the time of the crash.

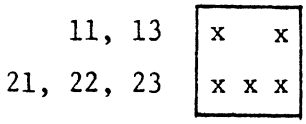
The first digit (left digit) denotes the seat row, with code values from 1-5. The second digit (right digit) denotes the position on the seat and (in some instances) the width of the seat.

Second Digit Codes:

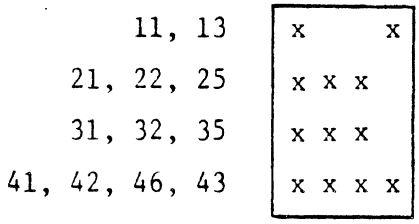
Seat Type	Code Value
Individual seat (bucket)	1=left, 3=right
Bench: Full width 3 passenger	1=left, 2=center, 3=right
Full width 4 passenger	1=left, 2=left center, 6=right center, 3=right
Partial width - left	1=left, 2=center, 5=right+ aisle space
Partial width - centered	0=left + space, 2=center, 5=right + space
Cargo area	4=entire vehicle width

EXAMPLES

Passenger Car
5 passengers



Van
12 passenger capacity



Column DD: Codes for Measurement Axis

X X Axis (fore and aft)
Y Y Axis (lateral)
Z Z Axis (vertical)

If door intrusion occurred, complete DOOR INTRUSION Form (DR).

If seat intrusion occurred, complete SEAT INTRUSION Form (ST).

If occupant contact resulted, complete the appropriate OCCUPANT CONTACT with INTRUDED SURFACES Form (OC).

END OF INTERNAL SURFACES INTRUSION DATA FORM

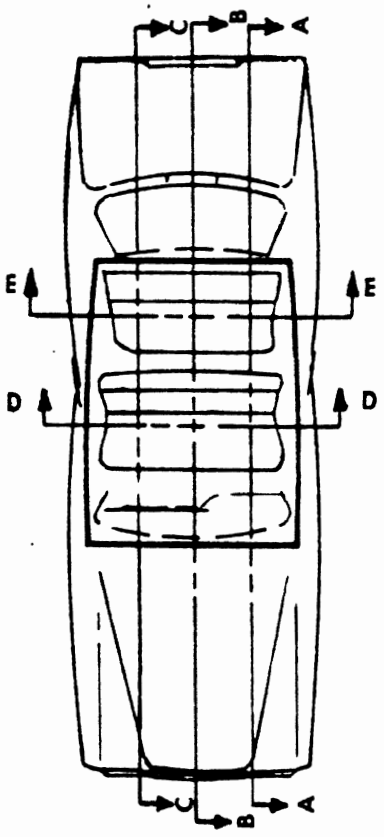
NATIONAL CRASH SEVERITY STUDY

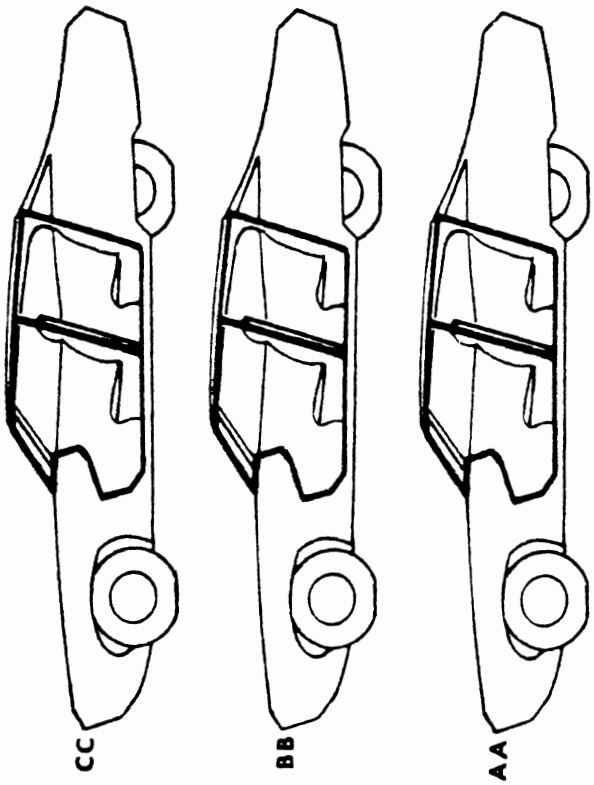
ID-1

General Intrusion Diagram

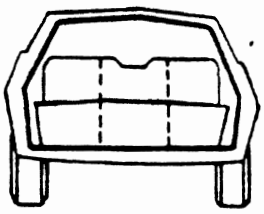
PASSENGER CAR

Sketch intrusion as accurately as possible onto plan view and applicable cross sections. Also sketch the penetrating object where appropriate.

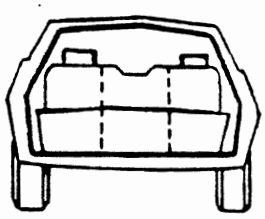




Sections AA, BB, CC are taken through the center of occupant spaces 11, 21; 12, 22; and 13, 23 respectively.



EE
Rear
Seat



DD
Front
Seat

Sketch of Penetrating Object

Note: Lateral sections are taken through the torso regions of the seats.

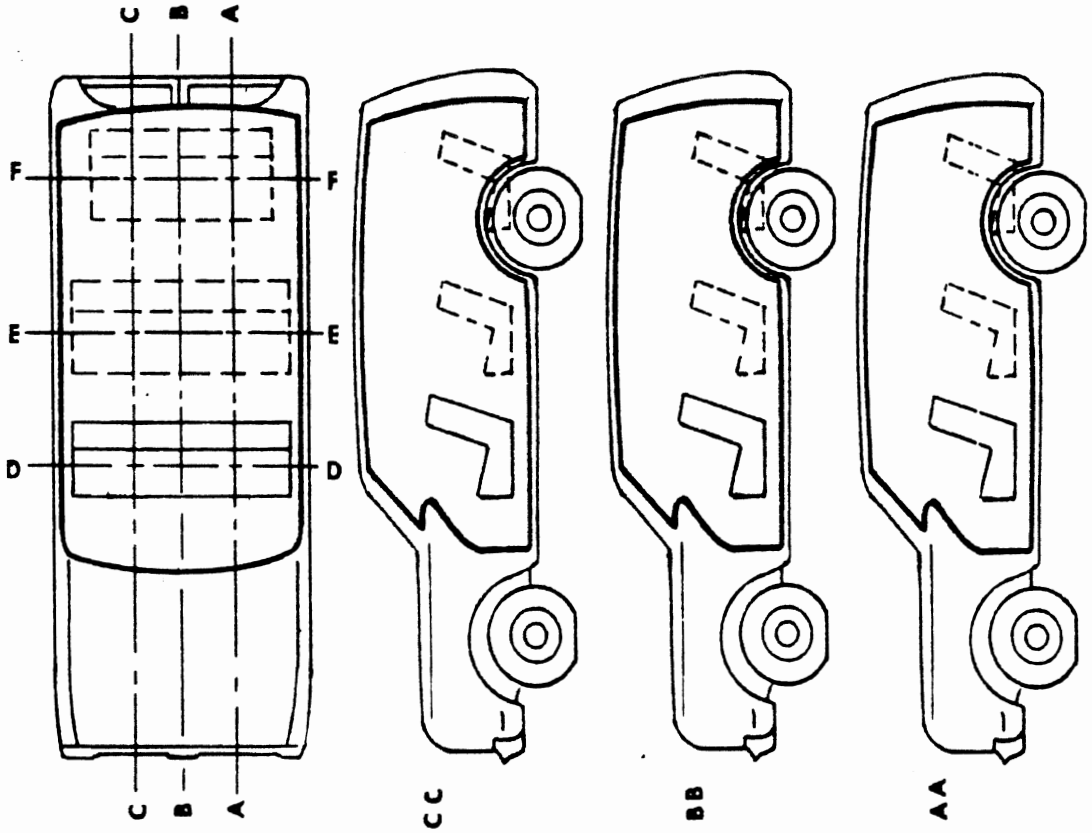
NATIONAL CRASH SEVERITY STUDY

General Intrusion Diagram

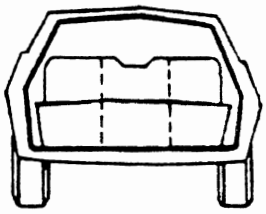
ID-2

STATION WAGON, MULTIPLE PURPOSE PASSENGER VEHICLE

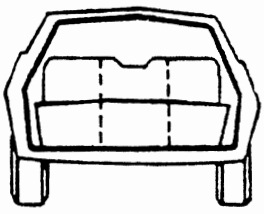
Sketch intrusion as accurately as possible onto plan view and applicable cross sections. Also sketch the penetrating object where appropriate.



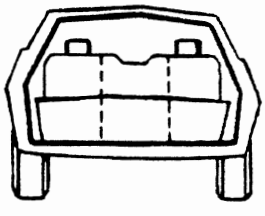
Sections AA, BB, CC are taken through the center of occupant spaces 11, 21; 12, 22; and 13, 23 respectively.



FF
Third Seat



EE
Second Seat



DD
Front Seat

Sketch of Penetrating Object

Note: Lateral sections are taken through the torso regions of the seats.

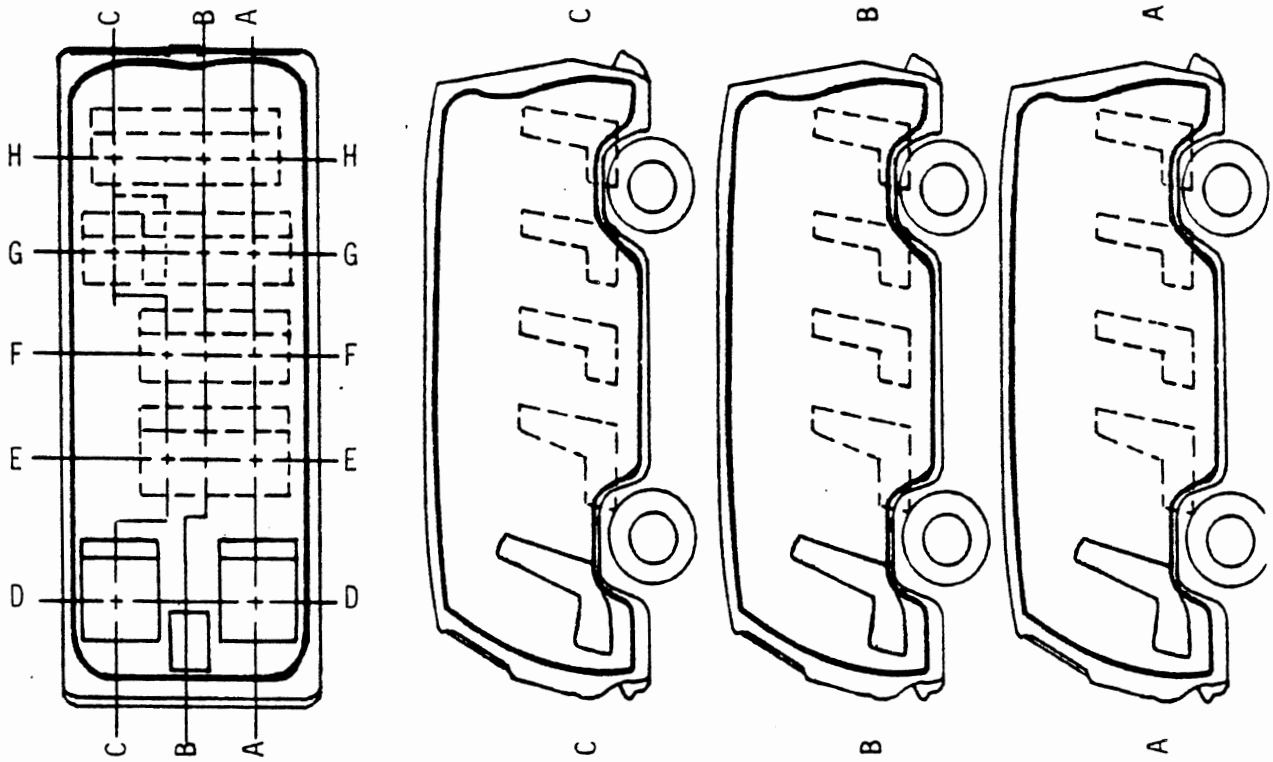
National Crash Severity Study

General Intrusion Diagram

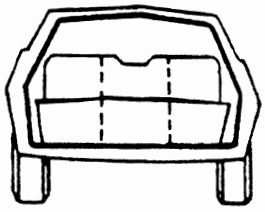
ID-3

PASSENGER VAN

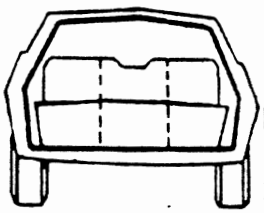
Sketch intrusion as accurately as possible onto plan view and applicable cross sections. Also sketch the penetrating object where appropriate.



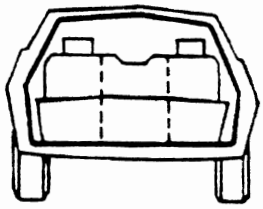
Sections AA, BB, CC are taken through the center of occupant spaces 11, 21; 12, 22; and 13, 23 respectively.



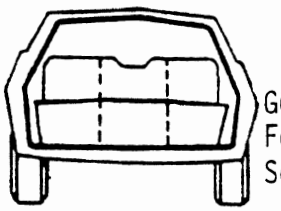
EE
Second
Seat



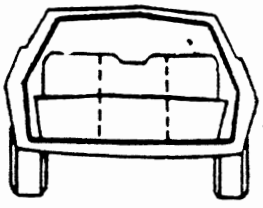
HH
Fifth
Seat



DD
Front
Seat



GG
Fourth
Seat



FF
Third
Seat

Sketch of Penetrating Object

Note: Lateral sections are taken through the torso regions of the seats.

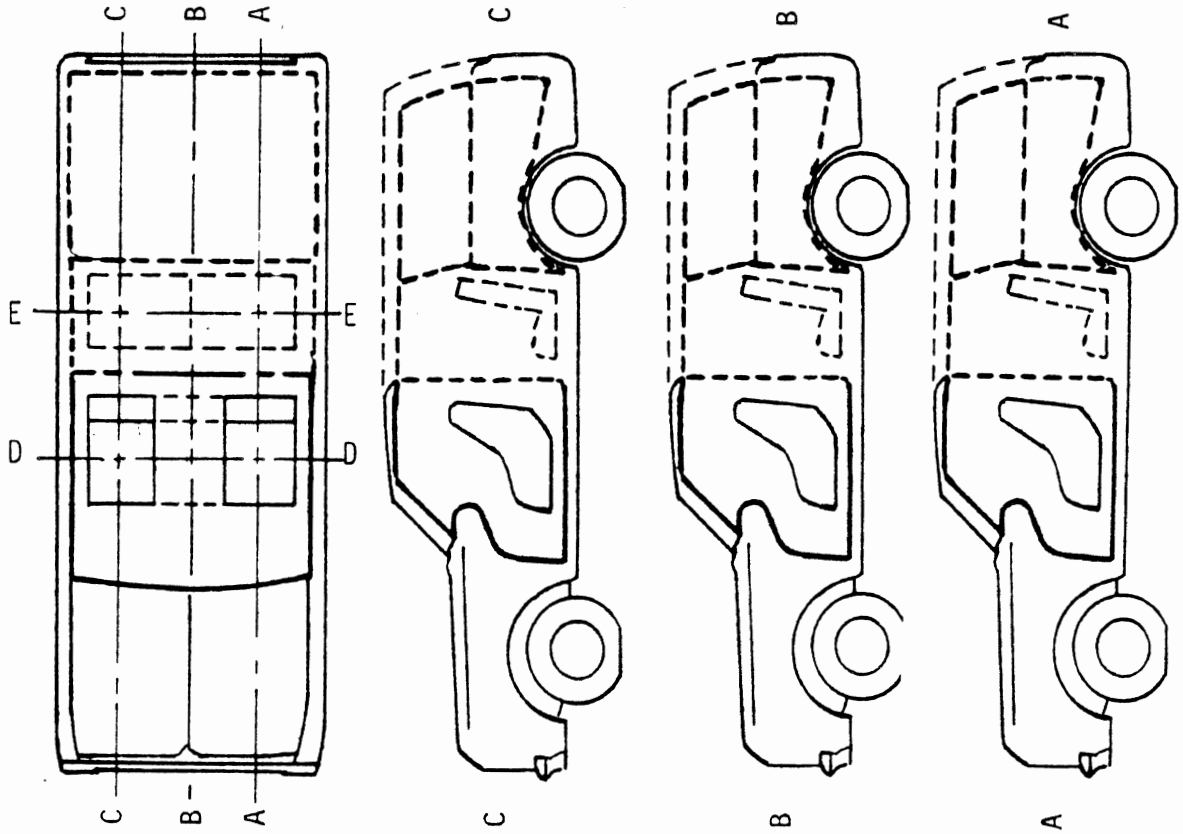
NATIONAL CRASH SEVERITY STUDY

General Intrusion Diagram

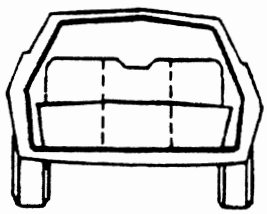
UTILITY & PICK-UP VEHICLES

ID-4

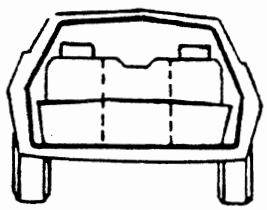
Sketch intrusion as accurately as possible onto plan view and applicable cross sections. Also sketch the penetrating object where appropriate.



Sections AA, BB, CC are taken through the center of occupant spaces 11, 21; 12, 22; and 13, 23 respectively.



EE
Rear
Seat



DD
Front
Seat

Sketch of Penetrating Object

Note: Lateral sections are taken through the torso regions of the seats.

UPDATE	TEAM	YEAR	MONTH	DAY	SEQUENCE
1					10

DR

NATIONAL CRASH SEVERITY STUDY

INTRUSION: DOOR

Complete this form as a continuation of the INTERNAL SURFACES FORM when door intrusion is present.

[11-13] Vehicle No. ___ 0 0

[14] 1. Was door intrusion increased by component damage? ____

2 No (Skip to Item 3, Column 31)
1 Yes (Answer Item 2, Column 15)

2. Damaged component causing increased door intrusion:

		Intrusion Number*	Damaged Component #1	Damaged Component #2
[15-18]	A	___ ___	___	___
[19-22]	B	___ ___	___	___
[23-26]	C	___ ___	___	___
[27-30]	D	___ ___	___	___

CODES FOR DAMAGED COMPONENT

1 A Pillar
2 B Pillar
3 Door Latch/Striker
4 Door Hinges
7 Other (Specify) _____
_____
8 Not Applicable
9 Unknown

*From Column A, Item 4--INTERNAL SURFACES INTRUSION FORM.

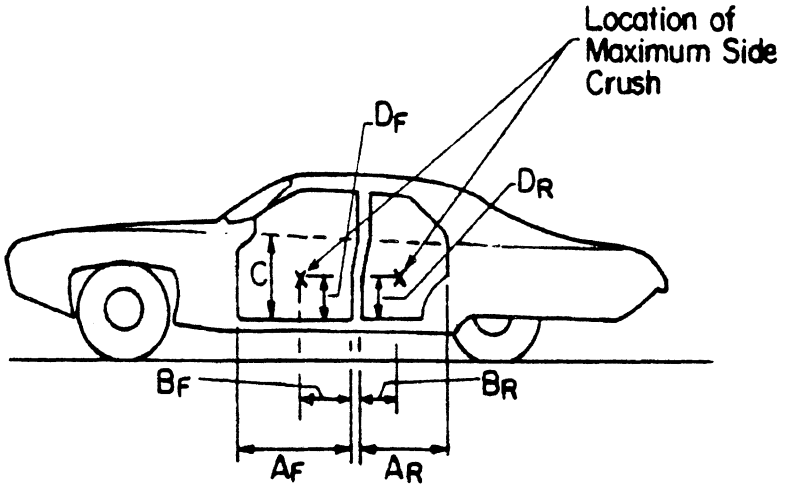
3. By using the following diagram locate the point(s) of maximum *EXTERIOR* inward crush which is directly responsible for the intrusion.

If the vehicle has 2 doors, use only dimensions subscripted F.

If the vehicle has 4 doors, use: dimensions subscripted F for front door crush; dimensions subscripted R for rear door crush; and F and R to describe either a distributed crush to both doors or two separate points of crush.

DO NOT code rear (side) door on VANS.

NOTE: Dimension C should be the same for both front and rear doors.



Dimension		Description	Left Side (Inches)	Right Side (Inches)	
Front Door	A_F*	Width of front door sheet metal.**	___	___	[31-34]
	B_F	Horizontal location of center of front door crush from B pillar door edge.	___	___	[35-38]
	D_F	Vertical location of center of front door crush from lower door edge.	___	___	[39-42]
	C*	Height of door sheet metal from lower edge to edge of window (beltline).	___	___	[43-46]
Rear Door	A_R*	Maximum width of rear door sheet metal.	___	___	[47-50]
	B_R	Horizontal location of center of rear door crush from B pillar door edge.	___	___	[51-54]
	D_R	Vertical location of center of rear door crush from lower door edge.	___	___	[55-58]

*Should be identical for right and left sides of an undamaged vehicle.

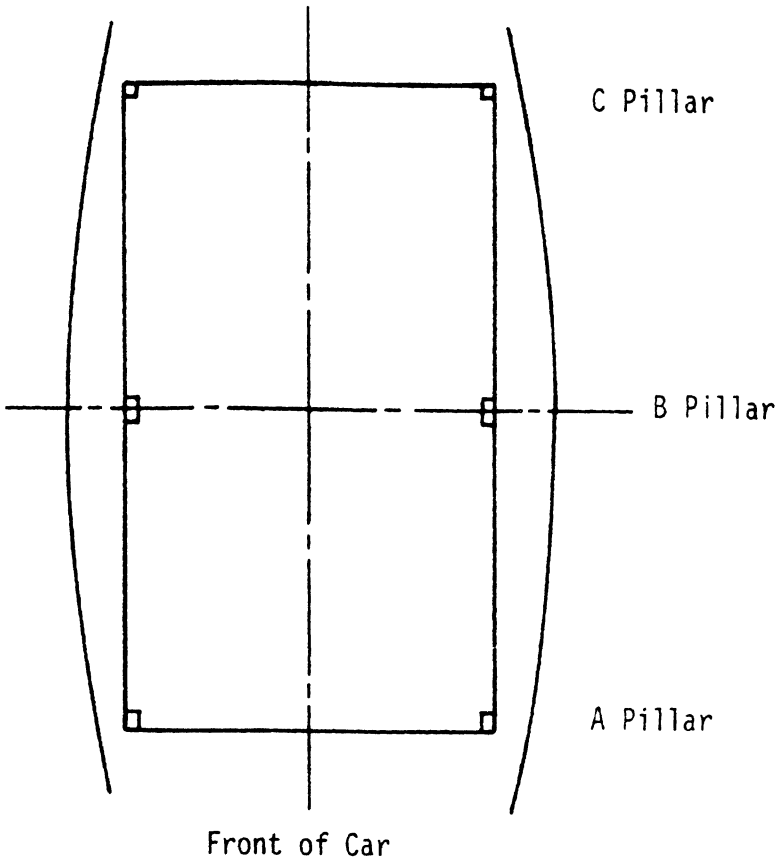
**See User's Manual, Section 5.3 for measurement procedure.

CODE:

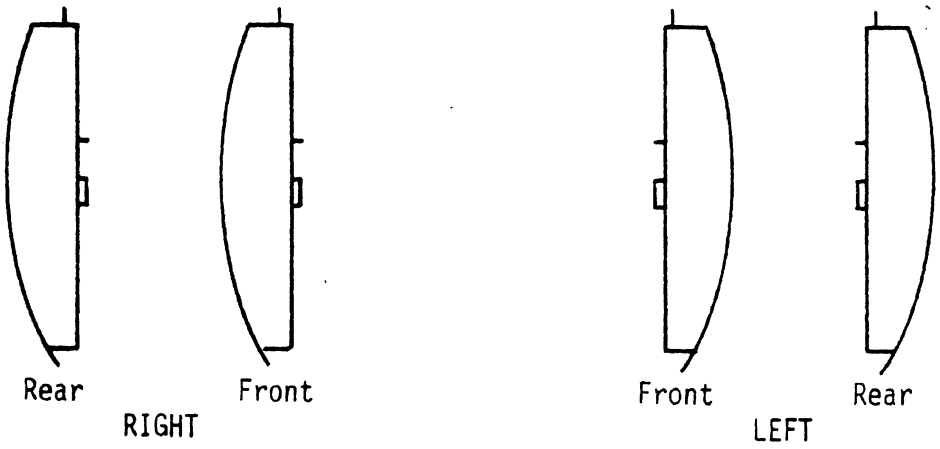
77 Distributed Damage
78 Non-direct Impact
97 Undamaged
98 NA (2 door car)
99 Unknown

I.D. 6 [80]

4. Sketch the door(s) area internal surface intruded contour at the horizontal plane showing the maximum intrusion (internal) and crush (external). This plane must lie between the bottom of the door and the beltline.



5. Sketch the door(s) internal surface intruded contour at the vertical plane showing the maximum intrusion and crush.



* END OF DOOR INTRUSION FORM *

UPDATE	TEAM	YEAR	MONTH	DAY	SEQUENCE
1					10

ST

NATIONAL CRASH SEVERITY STUDY

INTRUSION: SEAT

Complete this form *ONLY* if seat intrusion has occurred. (If occupant contact occurred as a part of seat intrusion, also refer to FORM OC to note injuries, if any.)

[11-13] Vehicle No. ___ 0 0

1. Sketch the seat intrusion on the attached seat intrusion diagram. Include all necessary dimensions to quantify the final seat position and seat back angles (if these are considered to be intrusion sources).

2. SEAT TYPE

[14] A. Front ___
7 Other: _____

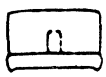
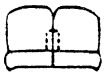
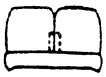
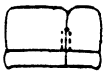
[15] B. Second (Rear) ___
7 Other: _____
8 No Rear Seat

[16] C. Third ___
7 Other: _____
8 No Third Seat

[17] D. Fourth ___
7 Other: _____
8 No Fourth Seat

[18] E. Fifth ___
7 Other: _____
8 No Fifth Seat

CODES FOR SEAT TYPE
(May or may not have arm rests)

Bench	1	
Split Bench with or without Folding Back	2	
Bench with Separate Back Cushions Front or Rear	3	
Bench with Folding Backs	4	
Bench with one folding back (may be right or left) or 60/40 split bench	5	
Bucket Type Front or Rear	6	
Unknown Type	9	

3. SEAT INTRUSION

		Intrusion No.*	Cause	Direction
[19-22]	A.	___ ___	___	___
[23-26]	B.	___ ___	___	___
[27-30]	C.	___ ___	___	___
[31-34]	D.	___ ___	___	___
[35-42]	E.	___ ___	___	___
	F.	___ ___	___	___

CODES FOR CAUSE

1 Failure of seat adjusters
2 Failure of seat tracks
3 Failure of seat back folding locks
4 Deformed by impact of passenger from rear
5 Deformed by impact of passenger from front
6 Deformed by inertial forces due to own mass
7 Deformed by intrusion of passenger compartment
8 Other (Specify) _____
9 Unknown

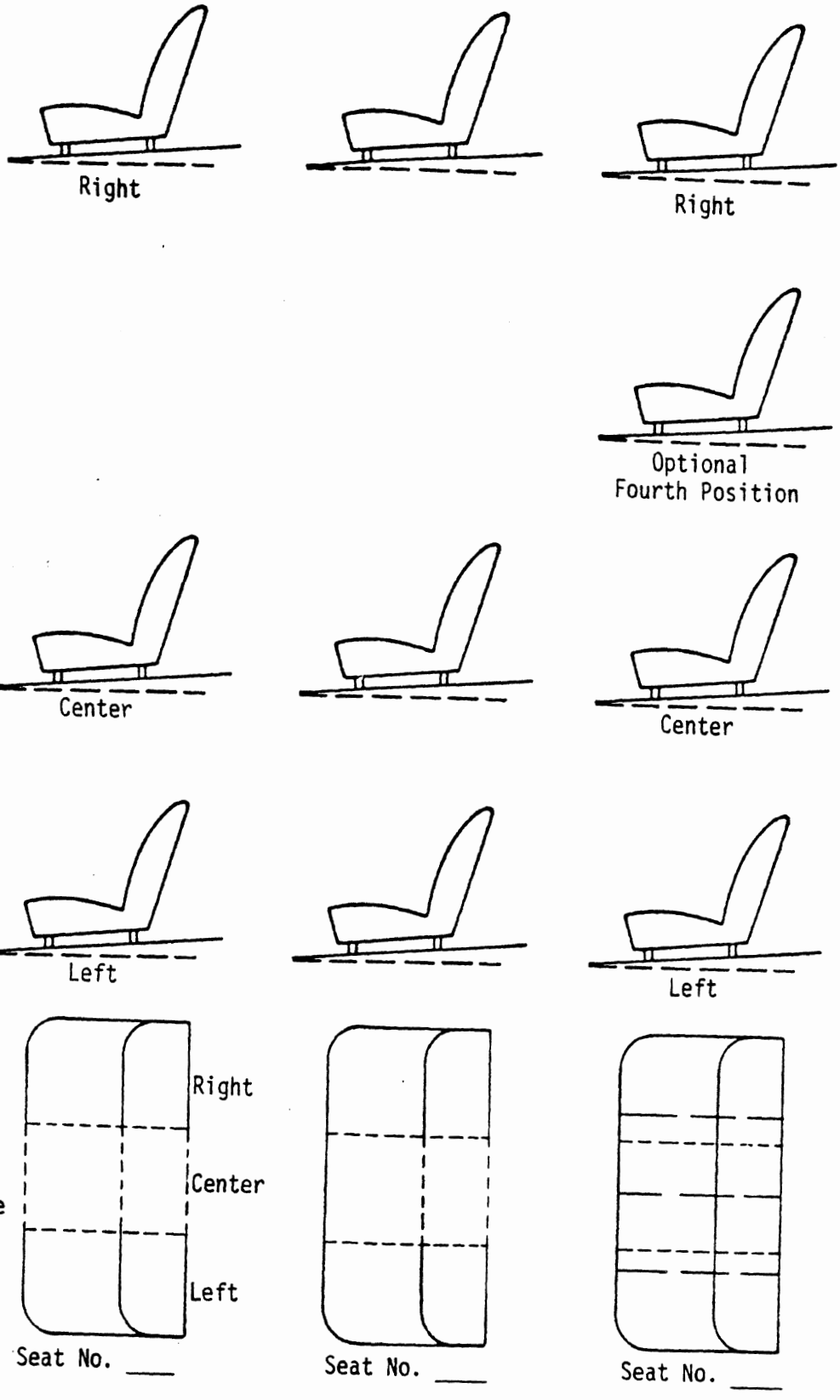
CODES FOR DIRECTION

1 Forward
2 Rearward
9 Unknown

*From Column A, Item 4--INTERNAL SURFACES INTRUSION FORM.

[80] I.D. 7

SEAT INTRUSION DIAGRAM



(ADD SEAT ROW DIAGRAMS AS NEEDED.)

* END OF SEAT INTRUSION FORM *

APPENDIX B

NCSS COMPARTMENT INTRUSION CLASSIFICATION (CIC) DATA FORM

TEAM	YEAR	MONTH	DAY	SEQUENCE

V2

U.S. DOT/NHTSA NATIONAL CRASH SEVERITY STUDY

PASSENGER COMPARTMENT INTRUSION CLASSIFICATION SUPPLEMENT

(Complete form only if intrusion occurred)

			CIC#1	CIC#2	CIC#3
	Area of Intrusion				
	Left side	1			
	Right side	2	—	—	—
	Front	3			
	Rear	4			
	Roof	5			
	Floor pan	6			
	Not Applicable	8			
	Unknown	9			
	Specific Horizontal Area of Severest Intrusion				
	Front - Left	01	— —	— —	— —
	- Center	02			
	- Right	03			
	- Distributed	04			
	Side - Front door	05			
	- Rear door (area)	06			
	- Rear area, stationwagon	07			
	- Distributed	08			
	Rear - Left	09			
	- Center	10			
	- Right	11			
	- Distributed	12			
	Not Applicable	98			
	Unknown	99			
78	Intruding Component (Choose three, starting with component causing maximum extent of intrusion.)		— —	— —	— —
	Instrument panel	01			
	Dash panel	02	— —	— —	— —
	Toe pan	03	— —	— —	— —
	Steering column	04			
	Windshield header	05			
	A pillar	06			
	Door panel or side panel	07			
	Window frame	08			
	B pillar	09			
	C pillar	10			
	D pillar	11			
	Roof side rails	12			
	Roof or convertible top	13			
	Floor pan	14			
	Backlight header	15			
	Rear seat back	16			
	Not Applicable	98			
	Unknown	99			
	Maximum Extent of Intrusion (Inches)				
	Actual Measure	01-97	— —	— —	— —
	Not Applicable	98			
	Unknown	99			

2/77

APPENDIX C

NCSS ACCIDENT CASES IDENTIFIED WITH INTRUSION

CASE NO.	NUMBER VEHICLES	MAKE MODEL	SAMPLE CRITERIA	CRASH	ACCIDENT TYPE	VDI	OIC/AIS/OC/I's	CIC	OCC. CONTACT GRAPHICS YES NO SELF EX. NONE - NO APPARENT CONTACT
N-31	2	14108	3	D	Side	10LPEW3	Unknown-possible inj. coded on police report	1/05/07,09/18	(-2,-15)floor mounted gear shift snapped off
N-09	1	11501	1	D	F.O. Side Rollover	11LFEN3 00TPGO4	Inj. info requested	1/06/08/01 2/06/08/02 5/98/06,12,13/16	Yes - Steering wheel (-17,-12) Left door panel (-43,-13) Left toe pan (-24,-29)(-16,-28) Instrument panel (+7,-8)
N-11	2	11408	2	NO MV	Front/side rear	12FLEN2 11LBEW2	Inj info requested	1/06/07,09/02	Yes - center of instrument panel just below centerline windshield upper left corner center of right side-upper
N-26	1	11401	2	D	F.O. side	01RFEW2 04RPAW3	Inj info requested	2/06/07,09,12/07	Yes - st. wheel (-16,+3)(-16,-6) R.V. mirror (0,+9) Floor mounted shifter Ashtray (-5,-10)
N-24	1	13201	3	D	Fixed object/front	02FREW1	No inj	2/03/03/01	No contact
F-13	1	12102	1	NO	Fixed object/side	01RFEW3 11LZES1	Occ 1 - Unknown Occ 2 TRFS 2 18 821.0 FIFS 2 18 802.2 HWLI 1 46 873.0	2/98/07,06,02/10	Yes
F-24	2	11103 Veh 1	1-F	D	Front/side	12FDEW5 Occ 1 Occ 2	KLCI 1 01 924.0 LLAI 1 01 916.0 CWPM 1 02 919.1 CCCH 4 01 861.0 FSCI 1 03 920.0 KRCI 1 01 924.0	3/01/03/02 3/03/03/03	Yes
		11306 Veh 2				03RYAW5 Occ 1 Occ 2 Occ 3 F	HROE 2 99 872.1 WLFJ 2 99 814.0 TRLI 1 99 890.1 HSKB 5 99 850.0 MRLL 4 17 864.0 MLLQ 4 17 865.0 NPDV 6 19 839.0 HIRB 5 19 852.0 CCLA 5 15 901.0	2/08/09,07,06,12/99 No reference point from which to measure	Yes
G-5	2	13401	2	NO MV	RO Ang./side	09LPEW3 00TPGO3	FILD 1 99 873.7 BUOM 1 99 847.0 HWKB 1 99 850.0	1/01/07,09/04 5/04/05,06,13/05	Yes
G-53	2	11302	1-F	D	Fr/sides	09LYAW3	No autopsy, unknown	1/06/07/14 1/05/07,05/13 1/01/01,02/06	Yes

G-63	2	12101	2	NO LV	Fr/side	09LZMW3 09LFMW1	No inj. info	1/08/07,09/10	Yes
H-09	4	66109	3	NO MV	4 veh. chain	12FRHW6	No injuries	3/03/06/2	Yes
H-15	2	13201	1	D	Fr/rear	00RDAO3 05BLEW1 00TDHO1 Occ 1 Occ 2	HLKB 2 32 850.0 HLLI 1 32 873.0 TBCI 1 02 924.0 HSLI 1 03 873.0 HSKB 1 03 850.0 ELLI 1 46 881.0	2/08/07,10,12/03	Yes
H-31	2	88109	1	NO LV	Fr/rear	06BDAA7 10LPAN2 10LFEN1	HLKB 1 99 850.0 HPLI 1 99 873.0 PBCI 1 99 925.0 TRCI 1 99 924.0 FSLI 1 99 873.0 HLKB 2 99 850.0 HLLB 1 99 873.0	5/12/16/12 1/05/07,14/03	No
F-43	2	11101	1	NO LV	Ang/front	01FZEW3 03RDAW4	HUKB 2 99 850.0 NPPM 1 99 847.0 SLFS 2 02 811.0 HIKB 5 18 850.0 HICB 5 18 851.0 FRCI 1 18 920.0	3/04/03/2 2/04/06,07,09/12	Yes
L-41	1	12218	2	NO RO	R.O.	00TYAO3	HLLI 1 99 873.0 BSOM 1 99 847.1	5/04/5,6,8,9,12, 13/04 1/05/6,8,9,12,13/08 2/05/6,8,12,13/02	None
E-35	1	11301	1	NO R.O.	R.O.	00TZHO3 01RBEW3	FSCI 1 03 920.0 FSAI 1 03 910.0	5/04/05,13/06 1/05/06/05	Yes
F-8	1	12102	2	NO R.O.	R.O.	00TYGO5 00FDMO1 00RREO2 Occ 1 Occ 2	HSKB 1 11 850.0 HPCI 1 99 920.0 BIOM 1 25 847.2 HRAI 1 99 910.0 KLAI 1 99 916.0 HRCI 1 08 920.0	5/04/13/13 5/04/06/12	Yes
I-07	1	14108	2	D	Fixed Obj./front	12FZEW3	No occupant info	6/03/03/02 6/02/14/01	Yes
G-33	2	14108	1	N LV	Head on	02FLEW5	MSRR 3 02 868.0 RRFS 3 99 813.1 FILI 2 99 873.7	1/01/01,02/10 6/04/14/07 5/02/09,12/06	Yes
J-49	1	1202	1-F	NO RO	R.O.	01FREN3 12FYEN2 00XYAO3	No autopsy performed occ. ejected	5/08/13/05 3/03/98/12	Yes

G-26 039	1	11102	1	D	Fixed obj/front	01FREW4 Occ 1 Occ 2	CLFS 3 02 807.0 KRLJ 1 10 891.0 FCCI 1 02 920.0 FIFS 3 04 802.3 HAAI 1 03 910.0	3/03/03,01,14/14	Yes
I-39	1	12102	1-F	NO RO	R.O.	00RBAW9 00FDAO2 Occ 2 Occ 3 Occ 4 Occ 5 Occ 6	BIOM 1 99 847.2 FSCI 1 99 920.0 HSLI 1 32 873.7 WULI 1 46 883.0 PSPM 1 99 847.1 NPFV 3 99 805.0 SLFJ 3 99 811.0 HSKB 2 99 850.0 HSLI 1 99 873.0 BSPM 1 99 847.1 HWNW 6 32 800.1 SRFS 2 99 810.0 CUFS 2 99 807.0	2/07/07,08/07 5/98/10,12,13/22	Yes
G-54	1	86119	1	NO R.O.	R.O./(semi)	00BDEW2 12FLGS6	HRFS 41 800.1 CRFS 46 807.0	4/11/98/02	Yes
D-15 005	2	11302	2	NO LV	Fr./side	03FZEW2	SLPM 1 27 919.2 MWPM 1 27 919.1 CUFS 2 15 807.0 BWLI 1 31 876.0 CULI 1 31 876.0	2/06/07,10/01	None
D-11 020	1	12118	2	NO-YFO	Fix.Ob./side	09LPEW7 01FYEN1	VLFS 4 99 829.0 HUKB 3 99 850.0	1/05/07/39	Yes-Probable roof line left side console, left rocker panel and door side panel
D-43 021	2	66109	1	NO- LV	Front/side	03RYMW4	PRFS 2 15 808.0 HRLI 1 46 872.0 WBLI 1 46 882.0 broken glass	2/08/06,07,09/10	Yes-Hair & blood on rt. roof rail above door. Rt. lower dash deformed inward. Door (rt.) & armrest deformed inward
D-19 023	2	11302	3	NO MV	Front/side	11FDEW2	FRAI 1 02 910.0 Not injured	6/03/03/4	Yes-steering wheel. Upper wheel, spokes & center
D-38 024	2	11318	1	D	Angle side	02RYEW3	Injuries unknown for both occ's female in R.F. seat lost fetus. Litigation-we were advised not to interview	2/05/06,07,09/05	Yes-rt. inst. panel. Floor shift. rt. door panel. rt. w/shield, rt. door glass
D-25 027	1	11401	2	NO YFO	Fix.Ob/side	10LDEW2	XLCI 1 15 923.0 TLCI 1 15 924.0	1/05/07/06	Yes-left door panel/control
D-41 029	3	11402	1	D	3 car/multiple	12FDEW3 10LZEW1	WLFJ 2 02 814.1 FSLI 1 03 873.7 LLLI 1 01 891.0	3/04/03/04	Yes-all of steering wheel. Lower dash on either side of steering wheel, mostly to right of wheel
D-27 033	2	13102	2	NO SS	Head on	12FLEE6	4 occs. no injuries	3/01/03/01	None
D-17 035	2	12205	3	D	Front/side	02RYEW2	Not injured	2/05/07/01	None

D-3 037	2	66109	1	NO MSI	Front/side	03LZEW4	Occ #1 was out of veh FLLE 2 08 870.0 UUUU 8 99 919.8	1/06/07,10,09/18 1/08/06/09	Yes-steering wheel (whole thing) R.V. mirror, center of upper dash. Top of rt. door panel just below glass.
D-35 042	2	11506	1	NO	Front/side	01RFEW2 12FDEW1 03RBEW1	PLCI 1 15 922.0 FSCI 1 02 920.0	1/03/03,14/04	Yes-steering wheel. Console cracked-may have been prior to accident
D-45 043	2	13408	1	D	Head on	11FLEW6	TLFS 2 01 821.2 FSCI 1 03 920.0	3/01/04/01	Yes-windhshield both sides. Dash on top cracked, both sides. Ashtray & radio bent, glove box cracked
M-41	2	13407	1-F	D	Front/side	04RFAW9 05RYAW9	Have not received injury info or autopsy report yet	2/05/06,07,12/14 6/03/03,14/99	Yes-windshield just rt. of center. Dash rear center
M-51	2	62209	1-F	D&T	Front/side	09LYAW6	Same as above	1/05/06,07,08/15 3/01/01,02,04/11 6/01/03,14/15	Yes-car mangled badly. Whole left area, door, A-pillar, dash, whole rt. dash area
L-45	2	11401	1	D	Angle/side	10LYAW4 09LYAW4 00TCGW2	CCH 3 99 903.5 HPLA 3 18 873.0 SLDJ 3 15 831.0 HPLI 2 99 873.0 CRCI 1 99 922.0 FCFR 2 99 802.0 HSKB 2 99 850.0 FIFS 2 15 802.2 FILI 2 15 873.7 TRVI 3 99 890.0 LRFS 3 99 820.0 LLLT 2 41 891.0	1/05/06,07,09/27 5/98/12,13/19 6/01/03,04/05	Yes-lft. A-pillar, rt. frt. glass & panel just below glass. Lft. door roof rail. Center of W/ shield, low.
I-04	2	14101	1	NO Yaw- ing	Front/side	02RYEW3	HAKB 2 32 850.0 HPLI 1 23 873.0 SRCI 1 15 923.0	2/05/06,07,14/11	Yes-shift lever bent (floor). Broken rt. front door glass. Roof rail bent rt. door, may have been previous damage.
J-26	2	11318	1-F	NO LV	Angle/side	12FLAE9	Fatal not documented	1/04/06,09,12/13 3/01,03,05,14/7	Yes-hair on torso belt clip 7" behind A-pillar.
L-44	2	11318	1	D	Angle frontal	11FLMW2	HSCB 3 03 851.0 CLCI 1 02 922.0 WLFJ 2 16 816.0 FCFR 1 03 802.0 BSOM 1 90 847.1 WRSJ 1 04 842.0	3/01/03/01	Yes (-29 + 5 door panel) Dash (-17.5-3) St.wh. (-18,-12) W.shield (-16,+5)(+6,-5)
K-02	2	12104	2	D	Front/side	02RFEW3 03RPEW2	2 occs. injuries but not coded	2/05/07,98,98/03	None

F-21	2		13401	2	D	Head on	11FYEW2 Driver R.F. Pass. Rear Ct. Infant	FLLI 1 03 873.7 HSCI 1 03 920.0 HSLI 1 03 873.7 WLSJ 1 99 842.0 HSLI 1 25 873.7 HSCI 1 25 920.0 FILD 1 90 873.7	1/01/14/05	Yes-w/shield upper far left. lower spoke on steering wheel. Far lft. on instru. panel. Far lft. on lower dash.
I-33	2		11402	1	D	Front/side	10LYEW3	Not injured	1/05/07,09,12/04 1/06/07,09,12/05	None
I-29	2		11401	2	D	Front/side	09LPEW2	Not injured	1/05/07/03	Yes-dash (-28,-12) Side panel lft.(-26,-11)
M-15	1		11310	1	NO RO	Rollover	00XDAO9	ELLJ 1 44 881.0 PBCI 1 44 922.0 BBCI 1 44 922.0	6/98,06,05/08 2/05/05,07/07	Yes
H-37	1		12102	1	NO YFO	Fix.Ob./front	01FZEW2	KRCJ 1 01 924.0 HACI 1 08 920.0 HACI 1 02 920.0 WLFJ 2 04 814.0	3/01/03/04	Yes-glove box (25-6) W/shield (3,1.5)(+9,+7) Mirror Dash (-9,-5)
K-07	2		13206	1-F	NO LV	Angle/frontal	11FDHW6 09LDAW3	No autopsy	01/05/06,07,08/99	None
L-35	1		66109	2	D	Fix.Ob./side	01RPAW3 10LPEN2	Not injured	02/06/08,07,12/09	Yes-glove box (+1.5,+5) W/shield (+5,+13) Visor (+9,+12) Glass (+8,+4)
L-01	1		11307	1	NO RO	R.O.	00TYAO6 00RDAO3	Unknown injuries	05/98/13,12,15/08 02/08/10,08,06,07/07	Yes-lft. glass (-27,-9)
J-40	2		12118	1	NO SS	Sideswipe	12FLES8	HAKB 2 03 850.0	3/01/03/04	Yes-headlight switch 2" right of lft door. 8" below centerline of dash. St. column rotated to the left
J-39	1		66109	2	NO R.O.	Rollover	00TDAO3	CACI 1 02 922.0 XBCI 1 15 922.0 BWCI 1 15 922.0 FLLI 1 23 873.7 WLLI 1 23 882.0 YBLI 1 23 877.0 LLFS 2 15 823.0 HLAI 1 01 873.7 ELLI j 23 881.0	5/98/05,06,13/09	Yes-w/shield 16" to rt. of A-pillar, 5" below roof rail. Center dash (0,0). Lower rt. dash. Ashtray. Rt. st. wheel rim bent, one spoke broken.
L-24	1		13401	1	NO RO	Rollover	00TZAO3	Unknown injuries	5/98/06,10,13/09	None
L-34	1		12108	1	NO RO	Rollover	00TPAO4	MWHA 3 32 902.4 FBVE 2 18 900.3 HSCI 1 18 920.0 Not injured LRCI 1 04 924.0 SRCI 1 15 923.0	5/98/06,12,13/07	Yes-rt. door panel dented 11" in back of A-pillar 4" below glass. Hair of rt. visor at far rt. hinge/

G-60	1		43409	1	NO R.O.	Rollover	02FREE0 00XDA01	Injuries unknown	8/98/98/98 (roof) 5/04/13/99	Yes-floor shift bent to rt.
M-31	2		66109	2	D	Front/side	01RZEW3	Injuries unknown 2 occupants	2/08/07,09/09	Yes-lower dash (-6,-15) w/shield (-7,+9)
M-27	1		12102	1	NO NPI	Fix.Ob./front	12FDLW9	Injuries	3/01/03/04	Yes-w/shield (-4,+8), st. wheel rim smashed in at top. Lighter. Extreme lft. on dash (from to to bottom.
M-34	3		11102	1	NO LV	3 veh multiple	12-FLAE9	Injuries unknown	1/05/06,07,08,09/ 12	Yes-dash (-22,-13), st. wheel (deformed up & to the lft)
J-10	1		11306	2	NO R.O.	Rollover	01FLEW3 00TPAO2	Injuries unknown	5/98/05,12,13/04 3/01/03/03	Yes-w/shield (+6,+6), parking brake pedal & release deformed
H-5	1		11501	1	D	Fix.ob./side	02RFEW3	Driver uninjured R.F. passenger injuries unknown	3/01/03,06,07/08	Yes-rt. lower dash. Rt. door panel bowed out 6". Vent crack & armrest contacted.
E-7	2		12101	2	D	Head on	01FZEW6 11LFEW2	3 occupants veh #1 Injuries unknown	3/03/03/02	Yes-w/shield-either side of mirror. Lower dash to lft. of st. wheel. St. wheel. Glove box. Rt. door panel. Center of dash radio & lighter. Turn signal lever.
			11401				11FDEW3 02RZMW2	Injuries unknown	3/03/02,03,14/06 2/06/07/06	Yes-w/shielf. left side directly above st. wheel. Lower dash either side of st. column. St. wheel.
F-38	1		11507	NO NPI	Fixed ob./side		11LYAW3	3 occupants Injuries unknown	3/01/01,06,14/09	Yes-st. wheel. Radio. Console & floor shifter. Extreme lft. dash, top to bottom.
G-26 039	1		11102	1	D	Car/ob/fr	01FREW4	CLFS 3 02 807.0 KRLJ 1 10 891.0 FCC1 1 02 920.0 FIFS 3 04 802.3 HAAI 1 03 910.0	3/03/03,14,01/14	Yes
I-44 005	1		95208	1	NO	RO	00RDAO3 00TYAO6 00LYAO3	WRFS 2 03 816.1 WRLI 1 03 883.0 WRAI 1 03 914.0	3/03/98 08(w/shield)	Yes
J-43 014	2		66108	2	D	Fr/s	09LDEW3 01FREW2	LLFS 2 15 823.2 FSLI 1 23 873.7 ELCI 1 15 923.0	1/05/06,07,08/10	Yes
J-47 015	1		12108	3	NO	RO	00TPAO2 00RDAO2	Occupant not injured	5/03/13,12/04	None
L-30	2		12101	2	NO MV	Fr/OR	01FYEW4 01FREN2 06BDEW2	No injury info yet B on UD-10	3/04/02/06 6/01/03/05	Yes
H-21	3		11318 Veh 1	1	NO MV#2	3 chain	12FDEW4	No info yet	6/02/03,14/04 6/03/14/02	Yes
			14118 Veh 3				01RDEW3	No info yet	02/05/07/04	Yes
J-42	2		13202	1	NO LVMV	Fr/tree	12FCEN3 12FDEW1	No info yet A on UD-10	3/04/01,02,04/09	Yes

D-7	2		11108	1	NO LV	Fr/Ang.R	12FRAW8	HUKB 4 34 850.0 FIFS 4 34 801.0 CRFS 3 01 807.0	5/03/13,05/09	Yes
D-48	2		12108	1-F	NO LV	Ft/side	08LDAW4 11LFMN1	No data on fatal no Autopsy MRCK 3 99 866.0 MLLQ 3 99 865.0 CLCP 3 99 922.0	2/08/12,07,09/20	Yes
E-29	3		12108	1	D	Head on	01FYEW5 03RFMN1	FCFR 1 03 802.0 FCLI 1 03 873.2 YLLI 1 99 894.0 LRFS 2 99 823.0 QRFS 2 99 829.0 WLFS 2 99 814.0 HSCI 1 99 920.0 WLCI 99 923.0	3/01/04/05 1/98/01/09	Yes
H-49	2		57108	3	NO-MV	Front/side	04RZEW2	1 occupant sought own treatment. Injuries unknown	2/06/07/02	Yes-windshield (+11,+7)
L-15	2		11401	1-F	D	Angle/front	11FYEW9	1 occ. no autopsy lgt. multiple trauma, primarily left side of body	1/08/01,02,03,04,05, 06,07,08,09,10,12, 13,14,16/20 5/08/99/13 6/01/99/15	Yes-A-pillar, left door, left side of dash. St. wheel.
I-01	1		12102	3	D	Fix.Ob./side	11LFEW3 09LPAW3 01FDES1	HLKB 1 23 850.0 CLCI 1 18 922.0 Occ. R.F. #2 - not injured R.R. Occ. #3 - not injured	1/06/07/01	Yes-w/shield (-22,+8) St. wheel, left.
I-11	2		12118	3	D	Angle/side	10LYEW3 03RBLN1	Not injured	1/05/07/01	None
K-22	1		12106	1	D	Fix.Ob./front Falling tree/top	12FCEW2 00TDHW4 Driver Front rt. Rear left	CRFS 2 02 807.0 FCFR 1 02 802.0 PBCI 1 27 922.0 BIFV 3 90 805.4 CRFS 3 01 807.0 HSKB 1 03 850.0 HRLI 1 34 873.0 QBCI 1 25 924.0 QRCI 1 25 924.0	5/10/13,15/11	Yes-w/shield (+3,+9)(+15,+9) R.V. Mirror (0,+11) Dash (-10,0)(0,-4)(+15,0)(+15,-15) St. wheel (-9,-11)(-18,-15)
K-41	2		11308	1	D+T	Front/side	02RYAW4	CRFS 3 15 807.0 CROP 3 15 860.0 KLSJ 1 01 844.0	2/03/01,06,07/15 2/05/01,06,07/15	Yes-w/shield (+14,+3) Dash (+20,-4(range area)) Rt. door panel 12" behind A-pillar. Door & dash severely intruded.
L-07	2		12202	2	D	Front/side	04RPEW3	Not injured	2/06/07/02	Yes-glove box (+12,-11)

I-28	2		12118	1	D	Car/veh side	02RYEW3 01FREE3	SRDJ 1 18 831.0	2/05/07/06/13 3/03/03/01/04 5/98/13/04	Right A-pillar (+12,+3) w/shield transmission selector
H-48	3		11401	1	DO	Car/veh/angle side	05RZAW3	Injuries unknown	2/06/07/10/08	R.F. back seat on seat
K-13	2		12206	1	NO Yielding object	car/object	00TPHW6 12FDLW2	SRDJ 2 18 831.0	5/98/05/13/12/06/19	Roof - A-pillar, left side
J-35	1		11302	1	NO Yielding object	car/object/side	10LYAW3	Injuries unknown	1/05/07/09/08/12	Left C-pillar - left side dash board
K-21	2		11402 12102	1	D.O.	Car/veh. front	12FYEW6 12FYEW6	Injuries unknown	3/01/03/04/07 3/01/04/02/03/14 1/05/08/06/07/09	Rearview mirror (+16,+7) w/shield glove box, st. wheel, left A-pillar
K-08	2		11401 11307	1	DO	Car/veh/angle front	08LYEW3 00LBMS1 11FDEW2 03RFEW1	HSKB 5 HLFS 4 HSLB 4 FSLI 2 HLHE 1 FSCE 1	1/05/07/08/06/11 03/01/03/98/98/03	Left door panel, st. wheel
M-06	2		88109	1	NO/RO	Rollover	12FLEE9 00ROAD2	1 occupant unknown injuries	2/05/07/06/09/10	Lft. door panel, rearview mirror, lft. dash(headlight switch), right door handle, st. wheel deformed
H-43	3		11401 11401 11302	1	NO Non horizontal force	Car/veh side	01RDEW3	No injuries HACI 1 873.	2/06/09/07/05	Dent in center dash, glove box sprung, rt. door interior, w/shield rt. side
M-36	1		11302	1	NO RO	Rollover	00TDAO2	2 occupants injuries unknown	5/98/13/06/08/05	Rt. w/shield, rt. A-pillar, Rt. door interior, rt. glove compartment
M-50	2		11501	1	NO	car/veh front	11FLEW5 10LYAW5	Injuries unknown	1/08/07/06/08/18 3/01/01/02/03/30	Severe intrusion-unable to code
H-17	1		11302	1	NO Yielding object	Car/object front	12FZEW3 12FOOO0	Injuries unknown	3/03/03/04/08	+15,+6 w/shield, -9,-13 w/shield, st. column, radio & tape player, glove box
I-46	2		13401	1-F	NO Multi impacts	Car/veh side	02RFEW5 03RYAW3 04RBEN2 00TPGN1	Occupant died- no autopsy	2/06/10/07/04	St. column, lft. side instrument panel, split, rt. wing window, rt. armrest interior, rt. A-pillar
J-45	2		11302	1	NO Yielding Fixed Object	Car/veh side	06BBEW5 12FLEE1	Unknown injuries	02/05/14/08/03/19	Rt. A-pillar, w/shield, toepan, left st. wheel, front seat buckled upward
H-25	1		11317	1	NO Yielding object	Car/object front	02FYEW2	ERCJ 1	3/01/04/06	Temp controls, st. column shaft, left door interior panel
J-12	1		11103	1	NO Yielding object	Car/object front	12FDHN1 12FYHN2	Injuries unknown	8/98/03/03 3/01/03/02	-5 broken dash, st. column, +6 crack dash, +16 glove box, center vent on hump broken
I-13	1		11320	1	D	Fix.Ob./front	12FYEW4	Closed head inj. facial lacerations no exact details yet	3/01/03/02	Yes-st. wheel (-18,0)(-18,-10)(-17,-15) dash(-10,-11), w/shield (-13,+12)
K-30	2		13202	1	D	Angle/side Fix.Ob./ front	01FLEW2 04RPMN2	Unknown injuries 2 occupants	2/05/07,08/06	Yes-w/shield (15,15)(14,12), st. wheel (-9,-2), dash (-7,-9) (23,-3)(17,-4) (4,0), rt. door panel (22,4), floor pan (0,-14)

J-4	2	12206	1	NO-RO	Angle/front rollover	02RFEW3 00XDAO2	2 occupants, driver slight injuries. R.F. pass. not injured	5/98/09,13/01	None
J-09	2	12108	1		Front/side	02FDEW3 11FLEN1	1 occupant, unknown injuries	2/05/06,07/07	Yes-lft sunvisor (-6,+10), R.V. mirror (-4,9)
J-23	1	12102	1	D	Fix.Ob./front	10FLEW5	1 occ. no injury info	1/01/04,06,08,14/11 1/05/07/05 1/08/13/02	Yes-parking brake handle (-30,-19)
J-28	1	83409	1	NO RO	Rollover	00TRHO2 00XDAO2	1 occ., no injury info	5/98/09,13/08	Yes-left door panel
J-30	1	11302	1	NO NPI	Fixed ob./front undercarriage	00UDXW4 01FDEW3	1 occ., no injury info	1/06/07,09/08 5/98/13/03 6/04/01,02,03,04, 14/18	No
I-2	1	12108	1-F	NO RO NPI	Rollover Fixed ob./front Fixed obj./side	11LYAW3 00TPGO6 01FREE5	SLFS 3 02 810.0 WRLI 1 99 881.0 UUAI 1 99 918.0 2nd occ. injuries unk. HILB 6 34 851.1 HIFS 5 34 801.1 HRCB 5 34 851.0	5/04/05,06,08,12, 13/15 1/05/06,12/14	Yes-st. wheel, dash (-18,-12)(-14,-12)(-3,-6), roof (-8,+24)(-8,+18)(12,0)
I-5	1	11301	1-F	D	Fixed ob./front	01FZEW4	WLFJ 9 02 829.0 KRLI 2 01 891.0 FWAI 1 03 910.0 Occ. died, cardiac arrest, initially alert & oriented	6/04/03/01 6/04/03/02	Yes-st. wheel (-22,-11)(-11,-10), w/shield (-6,+9), dash (-7,-11)(+5,-7)(-9,-11)
M-29	3	12102	1-F	D	3 car multiple	02RPEW3 07BLMW1	No injury info on 4 occs., R.F. occ killed, possible ruptured aorta	2/08/07,08,10/09	Yes-w/shield (0,10), dash (-20,-14)(-13,-14)(15,-16), rt. door panel (from A-pillar & below top of glass)(-24,-6)(-21,-18)
M-44	2	12106	1-F	NO RO	Front/rear Fixed ob./front Rollover	01FREW2 00XDAO9 11FDEW3	2 occs., driver moderate to light inj., r.f. pass.-killed no autospy report	5/05/05,06,10,12, 13/12 6/01/03,14/10	Yes-r.v. mirror, rt. door panel & glass, rt. dash, console, rt. w/ shield, st. wheel
M-48	1	11507	2	D	Fixed ob./front	12FCEW3	ERFJ 3 02 812.5 ERLI 1 02 881.0 FULI 1 99 873.7	3/04/03,14/14	Yes-st. wheel, radio (-5,-10), brake pedal (-18,-24), acc. pedal (-14,-20), dash (-11,-6)(-13,-10)
L-08	3	11401	1	D	3 car multiple	10LPEW3 05BRMN1	PRFS 2 27 808.2 FSLI 1 99 873.7 ELPM 1 15 840.0	1/05/07,08,09/16 1/06/07,08,09/16	Yes-lft door panel
L-18	1	11104	1	D	Rollover Fixed ob./side	00XDAO2 03RFEW2	Injuries unknown	5/06/12,13/05 2/06/07,09/04	None
L-31	1	88109	2	NO NPI	Fixed ob./front Rollover	00FDGW7 00LDEO9	Unknown injuries - 1 occupant	5/04/05,06,12,13/20	Yes-w/shield (-10,+12)

L-40	1	12106	1	D	Fixed ob./front undercarrage	12FDEW3 12UCXW2	BIFV 3 90 805.4 BSFV 3 90 805.2 HSAI 1 02 910.0	3/04/01,02,03/04	Yes-st. wheel (-20,-5), dash (-24,-15)(-10,-15)(-20,-8)
L-43	2	12104	1	D	Head on	11LZAW3	Unknown injuries	1/06/07,10/17	Yes-sunvisor (-15,+10), w/shield (-18,+7), dash (-26,-14)(-24,-14)(-9,-12)
F-37	2	11501	1	D	Angle/frontal	01FYEW3 Veh 1	PLDJ 3 15 835.0 CBPM 1 02 919.1 KLPM 1 01 919.6	6/01/14/05	Yes-lft door panel, close to A-pillar, st. wheel
Both vehicles had instrusion		12102				02FLEW4 Veh. 2 Occ. 3 Occ. 2 Occ. 1 driver	SRCI 1 99 923.0 FSLI 1 03 873.0 YRCI 1 01 924.0 OLCI 1 99 925.0 TBCI 1 90 924.0 HSLI 1 03 873.0 CRFS 1 27 807.0 FILI 1 02 873.7 SLSJ 1 02 840.0	6/01/14/06 1/01/06/04	Yes-w/shield lft & right. Lft door panel, st. wheel, dash, center
G-52	1	11306	1	D	Fixed ob./front	01FZEW3	ERFJ 3 03 813.1 ERLJ 3 03 881.0 KRLJ 3 01 891.0	6/03/14/05	Yes-w/shield, lft st. wheel, upper dash, lower, just left of center
H-38	1	13406	1	NO RO	Fixed ob./side Rollover	09LBEN3 00XDAO3	3 occs., driver ejected & admitted to Hosp., R.F. & R.R. pass. treated & released	5/04/05,06,11,12, 13,15/13	Destroyed by fire - unknown
H-28	1	12101	2	NO RO	Fixed ob./side Rollover	09LPAN2 09LPAS1 00LDAO3	1 occ., treated & released, no injury info	1/06/07,10,12,13/11 5/98(roof)/05,06,12, 13/11	Yes-w/shield (-20,+9)(-2,+10), lft door panel (-29,-4)(-29,-11.5)(-29,-11),lft lower dash (-19,-11),lft A-pillar (-29,+11)
H-40	2	12106	3	NO RO	Front/rear Rollover	06BLEE1 00FYAO4	2 occs., not injured	5/12/05,06,12,13/ 09	None
H-45	2	75119	2	D	Head on	01FZEW4 Ctr.F Rt.F Bucket Seat Car	FULI 1 03 873.7 Driver UUUV 9 99 919.8 Not injured	6/02/03/02	Yes-w/shield (-13,+10) (+14,+11), base of st. column, knob on dash (-7,-7), glove box (+14,-8)
L-29	3	12118	1-F	NO-LV	3 veh multiple	02FDEW6 03RBAW2	PAFS 2 02 808.2 ERSJ 2 03 840.0 HSLI 2 03 873.0 HSKB 5 03 850.9 HSFS 4 18 800.1 QLFS 3 39 824.0	3/03/02,03,06/08 5/98/13/13	Yes-w/shield (+20,+6)(-2,+4)(+2,+7), dash (-2,-2)(+3,-2)(-5,-9)(-9,-8)(0,-8)(+5,-20) (+20,-20), A-pillar (+22,+10)
L-21	1	13408	1-F	D	Fixed ob./front	01FRAW7	Driver & ct. rear occ. unknown injuries, R.F. pass. killed-no autopsy	4/03/02,03,05,06/18	Yes-multiple sites on rt & center of dash & instrument panel

M-34	2		12202	1	NO-MV	Front/side	10LPAW4	4 occupants - unknown injuries	1/08/07,09,12/25 6/02/03,14/03 5/08/12,13/10	Yes-multiple contacts dash & instrument panel, lft & rt door panel, r.v. mirror
M-49	2		11318	2	NO-MV	Side/rear fixed ob./side	04BLES1 03RFEN3	No injury info	2/05,02,06,07/05	Yes-lower rt dash (17,-12), rt door panel
L-44	2		11318	1	D	Head on	11FLMW2	HSCB 3 03 851.0 CLCI 1 02 922.0 WLFJ 2 16 816.0 FCFR 1 03 802.0 BSOM 1 90 847.1 WRSJ 1 04 842.0	3/01/03/01	Yes-lft door panel (-29,-5), w/ shield (-16,+5)(+6,+5), st. wheel (-18,-4)(-12,-6), dash (-17.5,-3)
J-48 011	2		95208	1-F	D+T	Front/side	02RZAW9 9900000	HSKB 5 99 850.0 HPRB 5 99 852.0 HALA 4 99 873.1	1/06/06,07,13/99 2/06/05,06/99 Car "blew" apart	Yes-w/shield (-12,+9)(-12,+4)
L-03	1		11506	1	D	Fixed ob./side	10LDAW6 01RDES2	HSKB 5 18 850.1 HSFS 4 18 800.1 CBOP 4 15 860.0	1/05/06,07,12/40 1/05/02,03,07/98	Yes-entire lft door & A-pillar area
G-34	2		12106	1	D	Angle/side	11FLEW3	2 occupants-unknown injuries	6/01/03/03	Yes-lft door panel, upper lft A-pillar, st. wheel, lower dash, extreme lft lower dash just rt of center
K-06	2		11507	2	NO-?	Fixed ob./front motorcycle/side	12FREW2 03RPHN7	3 occupants-unknown injuries	2/05/05,07/09	Yes-w/shield 17" from lft A-pillar, 8" above dash, 11" from rt A-pillar, 10" above dash, floor shifter
J-38	2		13201	1	NO-MV	Angle side	11FDEW6	FIVD 1 01 873.7 XBAI 1 99 918.0 XBLI 1 99 881.0 FIVS 1 01 873.7	3/01/03,04,14/06	Yes-lft door glass, tooth imbedded in top of dash 2.5" rt of lft A-pillar, lft door panel bowed out 6"
G-19	1		11508	1	D	Fixed ob./front	01FZEW5	3 occupants-unknown injuries	6/04/14/07 6/03/03/06	Yes-lft & rt door panels, w/shield 3 places, rt side of instrument panel, st. wheel.
K-28	1		13102	3	NO-RO	Rollover	00TPAO2	Not injured	5/98/12,13/02	None
H-14	2		11302	2	D	Head on	11FLEW4	FLLE 1 02 873.7	6/01/03,14/07 1/01/01,04/04	Yes-st. wheel
K-12	2		12202	1	NO-NPI	Angle/frontal	02RDEW6	KIFJ 2 02 823.0 CALI 1 02 922.0 FILI 1 02 873.7	2/05/05,06,09,12, 13/30 5/05/05,06,10,12/22 6/05,03,14/14	Yes-r.v. mirror (-4,+10), emergency brake pedal, lft door panel-probable
L-13	1		14106	2	NO-RO	Rollover fixed ob./side	09LPAW3 00RPAO2 00TPHO5	Unknown injuries	5/01/05,12,13/22 1/05/05,12,13/11	Yes-dash (0,-8), multiple unspecified sites
M-41	2		13406	1-F	D+T (possible)	Front/side	04RFAW9 05RYAW9	Driver-unknown injuries R.F. pass. killed, no autopsy	2/05/06,07,12/14 6/03/03,14/99	Yes-w/shield rt side, rt instrument panel, rt A-pillar, rt door panel

L-22	1		67109	1	NO-RO	Rollover	00LDAO3 00TYHO2 00RFEO3	Unknown injuries	1/08/07,09,12/02	Yes-possible lft door panel contact
M-05	2		14108	1	NO-LV RO	Train/front Train/side Rollover	11FDEW9 12LYAS2 00TPAO3	QRFS 3 01 824.7 LRFS 3 01 823.0 LRFS 3 01 823.3	6/04/03,04,14/19 5/98/06,12,13/19 01/08/07,08/17	Yes-roof, lft side, armrest on lft door panel, lower dash to lft of st. wheel, center of instru. panel, top of dash rt side, lower dash rt side
I-21	1		66109	1	NO-RO	Rollover	00LDAO9 00TPAO2	HSLI 1 99 873.0 SRCI 1 99 923.0 OWCI 1 99 925.0 OUCI 1 99 925.0	1/05/06/05 5/08/05,12,13/07	None
I-37	1		11301	1-F	NO-RO	Rollover	00TPAO4	HUUU 5 99 854.0 SLFS 2 99 810.0 MLAI 1 99 911.0 Ejected XBLI 1 99 884.0 YPCI 1 99 924.0 WLFS 1 99 816.0	5/98/06,09,10,12, 13/14 1/05/07/02	None
K-25	1		11318	1-F	D	Fixed ob./side	03RPAW5 11LBAN3 10LFEN2	Unknown injuries- fatal no autopsy	2/05/06,07,09,12, 13/14 1/06/10/04	Yes-lft door panel (-22,-3), st. wheel (-4,-4), rt door glass (16,+4), rt door panel (16,0), 16" measurements & -22 are in back of A-pillars on either side
K-16	3		12208	1	NO-RO	3 car multiple veh #2 rollover	02FLEW3 00XDAO2	MWCI 1 02 922.0	5/04/05,06,13/06	Yes-sunvisor (-1,+7), top header (-1,+8)
K-18	2		11318	1	NO-SS	Sideswipe Fixed ob/front	12FLAS9 01FCEW3	2 occupants-unknown injuries	6/03/02,14/09 3/03/02,14/09	Yes-st. wheel (-12,-13), lft dash (-21,-12), rt dash (-10,+15), w/shield (+20,+3), rt door panel (+24,-4)
D-20 006	1		11307	1	D	Fixed ob./front	11FCEW3	SRLI 2 04 880.0 ARFS 2 01 812.2 QRSJ 2 39 845.0	2/03/02/06	Yes
D-23 007	1		13408	3	D	Fixed ob./rear	06BREW5	NPPM 1 28 919.0 BIPM 1 25 847.8 LLCI 1 01 924.0	4/11/17/14	None
D-26 008	1		11306	1	D	Fixed ob./side	04RYAW3	PRFS 2 40 808.0 NPOM 1 25 847.0 FIFS 1 99 873.7 HWKB 2 32 850.0 HPLI 2 32 873.0 NPOM 1 99 847.0	3/03/12/06 5/03/04/08	Yes
D-30 009	2		11308	2	D	Fr/side	10LZEW3	HLCI 2 99 920.0 FRCI 1 08 920.0 LBCI 1 01 927.0 FSCI 1 15 920.0	1/08/07,09/02	Yes-r.v. mirror
D-13 010	1		13401	2	NO- YFO	Fixed ob./front	12FCEN2 12RYES2 12FLEN1	FCLI 1 03 873.7	3/01/98/02	Yes-w/wiper lft side, r.v. mirror

D-33 011	2	12118	3	D	Fr/side	11FDEW	NPPM 1 99 847.0	3/01/03/02	None
D-22 013	4	86109	3	D	4 vehs. multiple not chain	04RBMW2 10FLEE1 05BYEW1	No injuries	4/11/07/99	Yes
D-37 015	2	12118	3	NO-MV	Fr/side	04RYEW2	ORPM 1 15 919.8	2/05/07,08/02	Yes-rt armrest, r.f. window broken, probable occ. contact
D-12 016	1	11402	3	NO-RO	Rollover	00LDAO3 00TYHO3 00RDEO1	Unknown injured	1/08/10,12/06 5/98/13/08	Yes-r.v. mirror knocked off, a.c. vent below st. column loosened, may or may not be contacts
D-51 018	1	11318	1	NO-RO	Rollover	00TPGO3 02RFEW1 12FDLW1	HRKB 3 08 850.0 BIFV 3 99 805.2 PPCI 1 99 922.0	5/98/13/02	Yes-sm dent lft sunvisor, blood tissue & hair on r.v. mirror, dent on rt door side panel just below glass, hazard switch knocked off

APPENDIX D

INTRUSION, FIRE AND FUEL LEAKAGE METHODOLOGY SEMINAR

(Schedule and List of Attendees)

HIGHWAY SAFETY RESEARCH INSTITUTE

INTRUSION, FIRE AND FUEL LEAKAGE METHODOLOGY TRAINING SEMINAR

Seminar Schedule

March 21, 1978, Tuesday

Time	Event/Topic	By
8:00-8:30	Registration - Chrysler Center for Continuing Engineering Education - Room 153	
8:30	Introduction	T. McDole
8:35	Welcome	P. Cooley
8:40	Welcome	S. Lee
8:45	Introduction to Intrusion	P. Cooley
9:15	Measurement Techniques	M. Huber
9:45	Coffee Break	
10:00	Completing the Data Forms a) Catastrophic b) Intrusion c) Door d) Seat e) Occupant Contact	T. McDole/Staff
11:30	Coding	R. Scott
12:00	Lunch - North Campus Commons	
1:00	Welcome to Highway Safety Research Institute - Seminar Room, HSRI	R. Hess
1:05	Introduction to Field Practice	P. Cooley
1:15	Field Practice - Highway Safety Research Institute, High Bay Area Examples to Examine, Measure and Record	M. Huber/Staff
3:00	Coffee Break	
4:00	Discussion - High Bay Area	

March 22, 1978, Wednesday

Time	Event/Topic	By
8:30	Intrusion - Discussion of Field Exercises - Chrysler Center, Room 153	M. Huber, P. Cooley/ Staff
10:00	Coffee Break	
10:15	Fuel Leakage	
	Methodology	P. Cooley/Staff
	Data Form	T. McDole
12:00	Lunch - North Campus Commons	
1:00	Fire -- Chrysler Center, Room 153	
	Methodology	P. Cooley
	Data Forms	T. McDole
3:00	Coffee Break	
3:15	Fire, Continued	
5:00	Session End	

March 23, 1978, Thursday

8:30	Calspan/NHTSA -- Chrysler Center, Room 153	
	Calspan -- Data Requirements for April 1 Extension of NCSS, Light Trucks	J. Garrett
	NHTSA - NCSS Announcements	S. Lee
	Data Flow and Processing	J. Hedlund
	Panel -- Any Questions?	HSRI/Calspan/NHTSA
12:00	End of Conference	

- List of Attendees -

Intrusion, Fire and Fuel Leakage Training Seminar

March 21, 22, 23, 1978

Cruz Burroro - Dynamic Sciences
Hohn Didion - Dynamic Sciences
Ray Hughes - Dynamic Sciences
Jack Baird - Dynamic Sciences
Trish Moore - University of Kentucky
Jim Post - University of Kentucky
John Fightmaster - University of Kentucky
Vince Sayer - University of Kentucky
June Dorsett - University of Kentucky
Bert Morrow - University of Miami
Chuck Kurucz - University of Miami
Joe Metka - University of Miami
Vilma Harns - University of Miami
Carol Disaurenzio - University of Miami
Tony Magaro - Southwest Research Institute
Barry Beattles - Southwest Research Institute
John Garrett - Calspan Corp.
Don Hendricks - Calspan Corp.
Bob Hockreiter - Calspan Corp.
Nick Tumbas - University of Indiana
Ron Drahos - University of Indiana
N. McDonald - University of Indiana
Scott Lee - NHTSA
Jim Kistle - NHTSA
Jim Hedlund - NHTSA
Sharon Boyd - NHTSA
Jeanne Mungenast - NHTSA
Mike Monk - NHTSA
George Booth - NHTSA
Dan Cohen - NHTSA
Pete Cooley - HSRI
Tom McDole - HSRI
Bob Scott - HSRI
Mark Huber - HSRI
Mark Welch - HSRI
Tom Post - HSRI
Pete Levine - HSRI
Dan Stein - HSRI
Ian Chapman - HSRI
Cathe Bell - HSRI
Carol Whitney - HSRI
Mickey Compton - HSRI
Bruce Bertram - HSRI

3/20/78

APPENDIX E

USERS MANUAL FOR MEASUREMENT OF INTRUSION IN MOTOR VEHICLE ACCIDENTS

UM-HSRI-78-17-2

USERS MANUAL FOR MEASUREMENT OF INTRUSION IN MOTOR VEHICLE ACCIDENTS

Thomas McDole
Errol Hoffman

April 1, 1978

HIGHWAY SAFETY RESEARCH INSTITUTE
THE UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN 48109

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle	5. Report Date
Users Manual for Measurement of Intrusion in Motor Vehicle Accidents	April 1, 1978
	6. Performing Organization Code
7. Author(s) Thomas McDole, Errol Hoffman	8. Performing Organization Report No. UM-HSRI-78-17-2
9. Performing Organization Name and Address Highway Safety Research Institute The University of Michigan Ann Arbor, Michigan 48109	10. Work Unit No. 11. Contract or Grant No. DOT-HS-7-01805 13. Type of Report and Period Covered Final Report
12. Sponsoring Agency Name and Address National Center for Statistics and Analysis National Highway Traffic Safety Administration U.S. Department of Transportation Washington, D.C. 20590	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This document, along with the companion "Coding Manual for Measurement of Intrusion in Motor Vehicle Accidents," provides the necessary information and instructions to measure, record, and encode data necessary to quantitatively describe vehicle interior intrusion.

This "Users Manual" defines intrusion, describes the measurement philosophy and procedures, and documents the methodology for recording intrusion on the various intrusion data forms as currently used in the April 1978 revision of the National Crash Severity Study (NCSS) project.

Types of intrusion to be documented include: the Catastrophic Crash; Internal Surfaces; Door Intrusion; Seat Intrusion; and Occupant Contact with Intruded Surfaces.

17. Key Words	18. Distribution Statement
Crash, Intrusion, Measurement, Data Form, Data Recording, Coding, Accident Investigation Reference Information	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
		49	

CONTENTS

1.0 Introduction 1

2.0 Definitions 2

2.1 Intrusion 2
2.2 Catastrophic Crash 2
2.3 Seat Intrusion 2
2.4 External Object Intrusion 4
2.5 Occupant Space 4
2.6 Occupant Space Number 5
2.7 Individual Intrusion 6
2.8 Applicable Vehicle Types 6
2.9 Door Intrusion 7

3.0 Sample Intrusion Forms 8

4.0 When to Complete Intrusion Forms 24

5.0 Measurement Methodology 26

5.1 Passenger Compartment Internal Surfaces Intrusion 26
5.2 Measurement of Seat Intrusion 36
5.3 Measurement of Door Intrusion 36
5.4 Penetration by External Objects 39

6.0 Notes on the Intrusion Supplementary Forms 40

6.1 Intrusion--Vehicle Data Form 40
6.2 Intrusion--Catastrophic Crash 40
6.3 Intrusion--Internal Surfaces 42
6.4 Intrusion--Door 46
6.5 Occupant Contact 47
6.6 Intrusion--Seats 47
6.7 External Object Penetration 48

7.0 Photographic Documentation 49

1.0 INTRODUCTION

For some time it has been known that there is a relationship between intrusion of the passenger compartment of a vehicle in an accident and the degree of severity of injuries of the vehicle occupants. Several researchers have noted that it is not necessarily a causal relationship, that is, injuries may be a result of the same factors producing intrusion but only indirectly related to intrusion. Such primary factors may be velocity change (ΔV), mean deceleration, direction and location of impact and resultant vehicle motion. Hence, to date, it has not been established whether, and to what extent, intrusion is of importance as a source of occupant injury.

The intrusion report types and the associated methodology described in this manual have been designed to determine the importance of intrusion as an injury source (both "potential" and actual) and also to investigate a number of specific forms of intrusion, particularly side intrusion and the performance of side structures complying with FMVSS 214. The data shall also be useful in determining the importance of intrusion in vehicles of different size and seating configuration.

Four types of intrusion are considered here. They are:

1. Intrusion associated with the Catastrophic Crash
2. Intrusion of the Internal Surfaces of the Passenger Compartment
3. Door Intrusion
4. Seat Intrusion

While these latter two categories are subsets of Internal Intrusion, separate data forms permit greater detail in describing door and seat intrusion. While not fully documented, penetration by exterior objects is also considered. Special consideration is also given to occupant contacts and resulting injuries associated with intrusion.

2.0 DEFINITIONS

2.1 Intrusion

Intrusion occurs:

a. When the internal boundary of the passenger compartment is moved inward due to direct or indirect damage (i.e., the result of a crushing force applied to the exterior surfaces of the vehicle);

b. When a foreign object exterior to the vehicle penetrates the internal boundary of the passenger compartment;

c. When there is a reduction, or compromise of occupant interior space, including a displacement of the steering wheel, so as to reduce occupant space;

d. Where there is seat distortion and/or movement.

2.2 Catastrophic Crash

A catastrophic crash is a crash in which the passenger compartment integrity has failed completely (such as gross ruptures, tears, openings, avulsions, and/or excessive passenger compartment compression or separation) such that the intrusion is practically beyond measurement. (The shearing off of the greenhouse is not a catastrophic crash.) Figure 2-1 shows a vehicle with catastrophic intrusion.

2.3 Seat Intrusion

Seat intrusion exists when the seat(s) have moved relative to their initial position so as to reduce the space available in a given occupant space. This may be the result of inertia forces on the seat, movement caused by crush of the passenger compartment, or by loading by other occupants or cargo. Note that forward movement of seat backs on older vehicles not equipped with seat back latches is not to be considered an intrusion.

FIGURE 2-1. EXAMPLE OF CATASTROPHIC INTRUSION

2.4 External Object Intrusion

An external object is an object external to the passenger compartment (trees, poles, etc.) and includes components of the case vehicle, such as the hood, which penetrate the interior boundary of the vehicle.

2.5 Occupant Space

2.5.1 An individual occupant space is that space (volume) defined by the manufacturer for the seating of an adult occupant and normally available to the occupant. The boundary surfaces are the six planes (Figure 2-2) defined by the appropriate combinations of the following undeformed surfaces: (1) the interior side(s) of the vehicle; (2) a plane extending upwards at the boundary between manufacturer designated seating positions; (3) the headliner (or interior roof surface); (4) the seat-back surface and cushion surface (including cushion edges); (5) the seat-back back surface (extended to the headliner); (6) the instrument-panel surface, windwhield, cowl surface and toe pan surface; (7) the floor-pan surface; (8) the rear surface (back panels/back door surface).

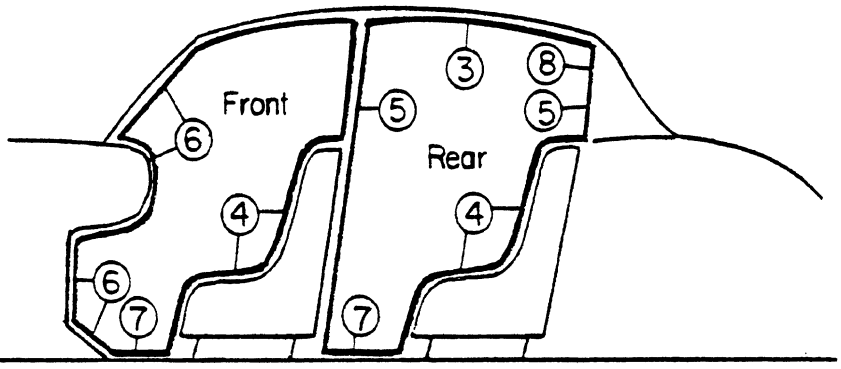


FIGURE 2-2. OCCUPANT SPACE BOUNDARIES IN A PASSENGER VEHICLE

2.5.2 The cargo area is: (1) that seat row which is vacant because the seats have been removed; or (2) the area behind the last row of seats which is normally designated and/or designed by the manufacturer for cargo.

2.6 Occupant Space Number

The occupant space number defines the location of the occupant space for which intrusion is being described. As all intrusions of the passenger compartment are to be documented, there need not be a passenger within the occupant space. The occupant space numbering system is as follows.

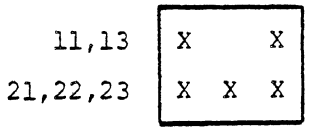
CODES for Occupant Space Number. The correct occupant space number is determined by the vehicle seat configuration at the time of the crash. Occupant space number is a 2 digit code. The first digit (left digit) denotes the seat row (code values from 1-5). The second digit (right digit) denotes the position on the seat and (in some instances) the width of the seat.

Second Digit Codes:

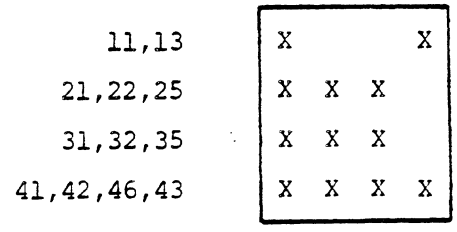
Seat Type	Code Value
Individual Seat (Bucket)	1=Left, 3=Right
Bench:	
Full Width 3 Passenger	1=Left, 2=Center, 3=Right
Full Width 4 Passenger	1=Left, 2=Left Center, 6=Right Center, 3=Right
Partial Width--Left	1=Left, 2=Center, 5=Right + Aisle Space
Partial Width--Center	0=Left + Space, 2=Center, 5=Right + Space
Cargo Area	4=Entire Vehicle Width

Examples:

PASSENGER CAR
(5 Passenger)



VAN
(12 Passenger Capacity)



2.7 Individual Intrusion

An individual intrusion is defined as a single component intruding into a single occupant space. The number of such intrusions to be documented is the number of intruding components crossed with the number of occupant spaces into which they intruded. That is, the numbers of components intruding each occupant space are summed across all occupant spaces.

Examples:

1. The roof is crushed down across the entire width of the front seat. If the seat contains three passenger positions then three occupant spaces were intruded, each by a single component. In this instance, the same component intruded in all three spaces. Thus, the number of intrusions is three.

2. The left-front occupant (driver) space is intruded by both the left front door and the A-pillar. The two components intruding into a single occupant space comprise two intrusions.

Individual intrusions of one inch or less will not be documented. An exception to the documenting of individual intrusions is discussed in Section 6.3 (Combined Components).

2.8 Applicable Vehicle Types

The following are the classes of vehicles to be included in the intrusion data collection.

Vehicle Classes	Seat Capacity Minimum	Seat Capacity Maximum
Passenger Cars	2	6
Station Wagons	3	9
Multi-Purpose Passenger Vehicle	3	9
Utility Vehicles	2	6
Pick-Up Cars	2	3
Pick-Up Trucks	2	6
Passenger Vans	2	12

2.9 Door Intrusion

Door intrusion occurs when the interior surface of a side structure meeting the definition of FMVSS 214 intrudes into an occupant space. Door intrusion is possible on all two and four door vehicles. It is not applicable to the rear (right) side door on passenger vans. A door must be physically present to be included in door intrusion. Door intrusion is also not applicable to the back doors on vans, station wagons, etc.

UPDATE	TEAM	YEAR	MONTH	DAY	SEQUENCE
1					10

CC

NATIONAL CRASH SEVERITY STUDY

INTRUSION: CATASTROPHIC CRASH

Complete this form *ONLY* if the intrusion satisfies the definition of a CATASTROPHIC CRASH (see User's Manual, Section 2.2).

[11-13] Vehicle No. ___ 0 0

1. Complete the General Intrusion Diagram so as to depict the approximate intrusions (supplemental sketches may be required).

2. Type(s) of catastrophic vehicle damage (code not more than three):

[14] ___

[15] ___

[16] ___

CODES FOR CATASTROPHIC VEHICLE DAMAGE

Passenger compartment opened or separated:*
1 At firewall
2 At B pillar
3 At roof
9 Other--Describe at Code 9 BELOW

Vertical Compression--Extreme:
4 Roof

Longitudinal Compression--Extreme:
5 From front
6 From rear

Lateral Compression--Extreme:
7 From right hand side
8 From left hand side

9 Describe briefly: _____

_____

_____

_____

*Separation or opening need not be complete, but should be of major proportions.

3/78 CC-1
HSRI

3. Occupant Space Volume Reduction

	Occupant Space Number*	Approximate Volume Reduction
[17]	11 (front, left [driver])	___
[18]	12 (front, center)	___
[19]	13 (front, right)	___
[20]	21 (rear, left)	___
[21]	22 (rear, center)	___
[22]	23 (rear, right)	___
[23]	34 (third, fourth, or fifth seat/cargo area)	___

CODES FOR VOLUME REDUCTION

1 No Reduction
2 < 20%
3 20% - 40%
4 40% - 60%
5 60% - 80%
6 > 80%
7 Total (100%)
8 Not Applicable
9 Unknown

*See User's Manual, Table 6.2-1: Vehicle Configuration at Time of Crash as an aid to determining appropriate OCCUPANT SPACE NUMBERS to code.

GENERAL RULE:

A. *For a vehicle with more than two seats and with a cargo area behind the seat, code spaces 11, 12, 13, 21, 22, 23, and 34 (to denote area behind the second seat).*

B. *For a vehicle with one seat and a cargo area behind the seat, code spaces 11, 12, 13, and 34 (to denote the area behind the seat), and use Code 8 for 21 through 23.*

[80] I.D. 3

* END OF CATASTROPHIC INTRUSION DATA FORM *

3/78 CC-2
HSRI

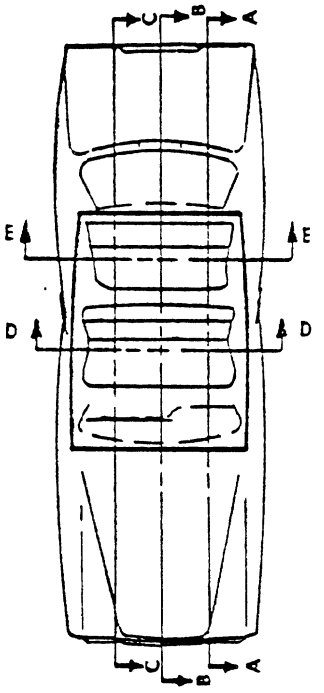
NATIONAL CRASH SEVERITY STUDY

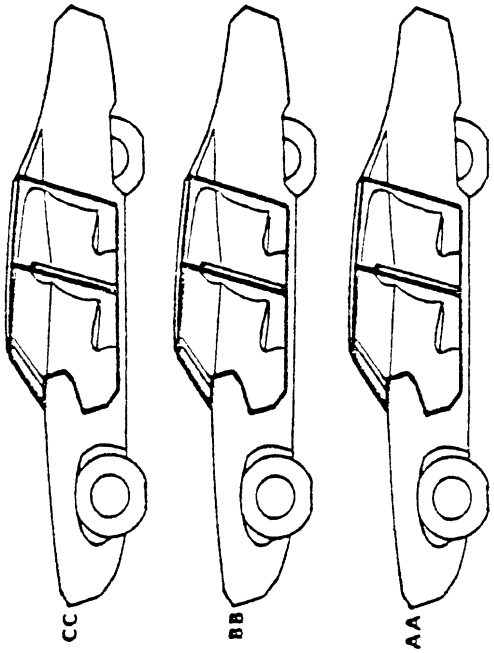
ID-1

General Intrusion Diagram

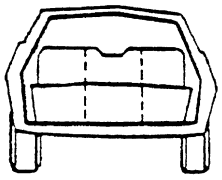
PASSENGER CAR

Sketch intrusion as accurately as possible onto plan view and applicable cross sections. Also sketch the penetrating object where appropriate.

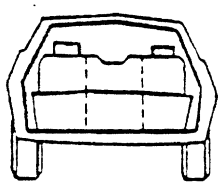




Sections AA, BB, CC are taken through the center of occupant spaces 11, 21; 12, 22; and 13, 23 respectively.



EE
Rear
Seat



DD
Front
Seat

Sketch of Penetrating Object

Note: Lateral sections are taken through the torso regions of the seats.

3/78 ID-1
HSRI

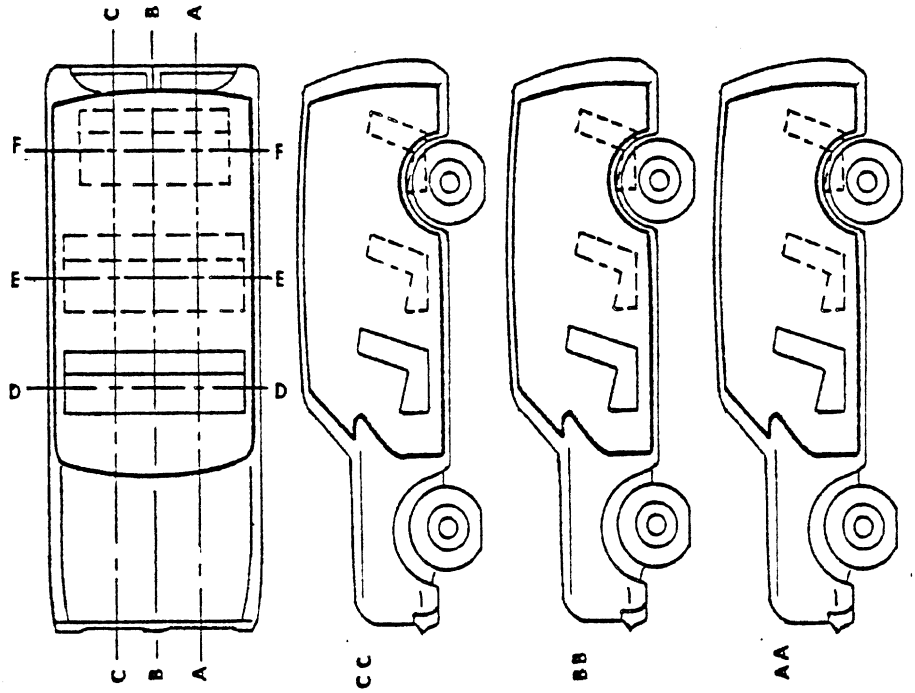
NATIONAL CRASH SEVERITY STUDY

ID-2

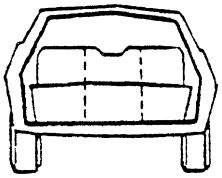
General Intrusion Diagram

STATION WAGON, MULTIPLE PURPOSE PASSENGER VEHICLE

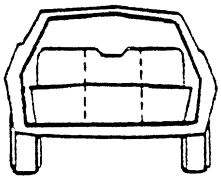
Sketch intrusion as accurately as possible onto plan view and applicable cross sections. Also sketch the penetrating object where appropriate.



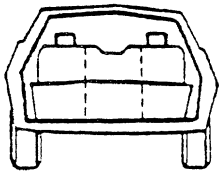
Sections AA, BB, CC are taken through the center of occupant spaces 11, 21; 12, 22; and 13, 23 respectively.



FF
Third Seat



EE
Second Seat



DD
Front Seat

Sketch of Penetrating Object

Note: Lateral sections are taken through the torso regions of the seats.

3/78 ID-2
HSRI

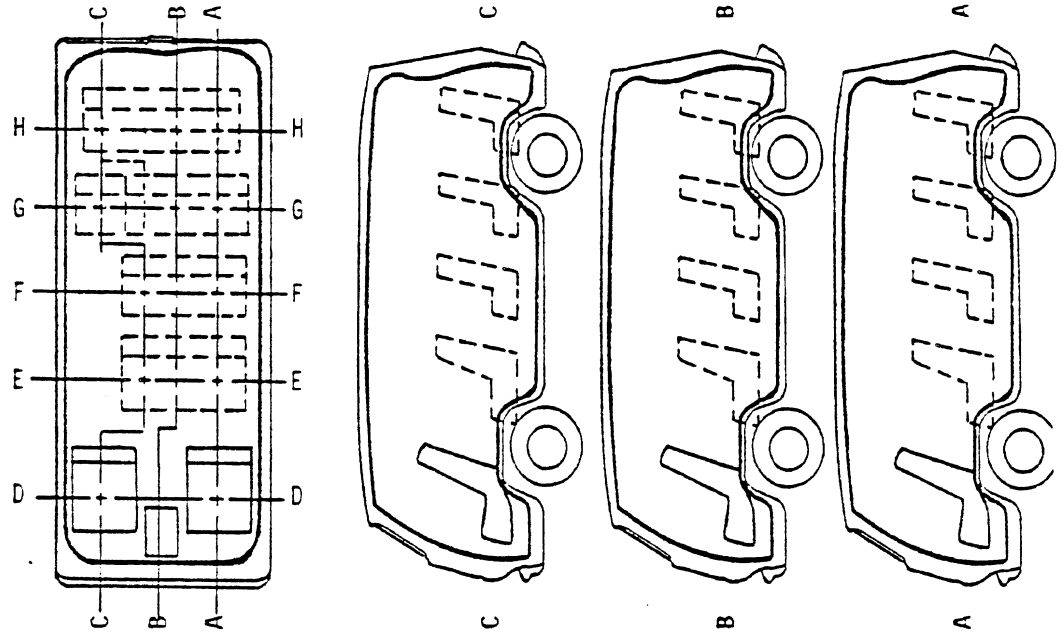
NATIONAL CRASH SEVERITY STUDY

General Intrusion Diagram

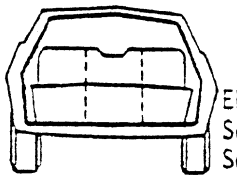
PASSENGER VAN

ID-3

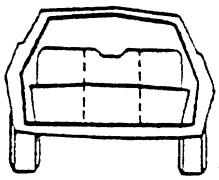
Sketch intrusion as accurately as possible onto plan view and applicable cross sections. Also sketch the penetrating object where appropriate.



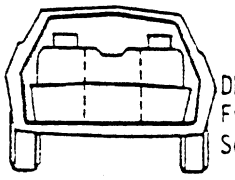
Sections AA, BB, CC are taken through the center of occupant spaces 11, 21; 12, 22; and 13, 23 respectively.



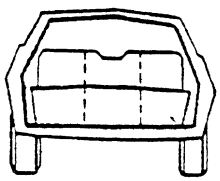
EE
Second
Seat



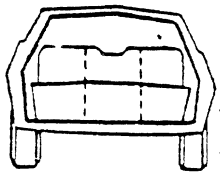
HH
Fifth
Seat



DD
Front
Seat



GG
Fourth
Seat



FF
Third
Seat

Sketch of Penetrating Object

Note: Lateral sections are taken through the torso regions of the seats.

3/78 ID-3
HSRI

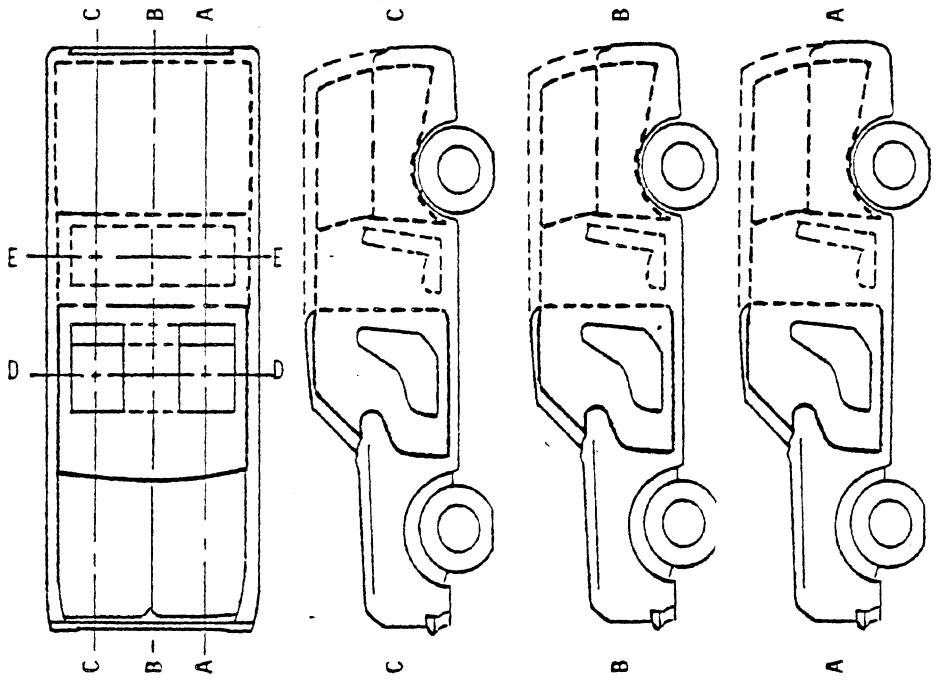
NATIONAL CRASH SEVERITY STUDY

ID-4

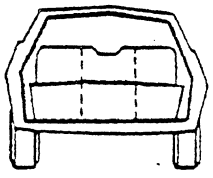
General Intrusion Diagram

UTILITY & PICK-UP VEHICLES

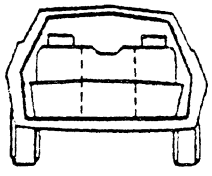
Sketch intrusion as accurately as possible onto plan view and applicable cross sections. Also sketch the penetrating object where appropriate.



Sections AA, BB, CC are taken through the center of occupant spaces 11, 21; 12, 22; and 13, 23 respectively.



EE
Rear
Seat



DD
Front
Seat

Sketch of Penetrating Object

Note: Lateral sections are taken through the torso regions of the seats.

3/78 ID-4
HSRI

UPDATE	TEAM	YEAR	MONTH	DAY	SEQUENCE
1					10

IS

NATIONAL CRASH SEVERITY STUDY

INTRUSION: INTERNAL SURFACES OF THE PASSENGER COMPARTMENT

Complete this form *ONLY* when there is intrusion of the internal surfaces of the passenger compartment. Supplemental sketches may be required.

[11-13] Vehicle No. ___ 0 0

1. Complete the General Intrusion Diagram so as to depict the intrusion(s) of the passenger compartment internal surface(s).

   A. For a 2 occupant space vehicle, sketch intrusion on the passenger car diagram and cut-away sections A, C, D.
   B. For a 4 occupant space vehicle, sketch intrusion on the passenger car diagram and cut-away sections A, C, D, E.
   C. For a 5 or 6 occupant space vehicle, complete the passenger car diagram and all cut-away sections.
   D. For a station wagon, complete the station wagon diagram and all cut-away sections. If it is a 3 seat vehicle, ink in the 3rd seat.
   E. For a passenger van, complete the van diagram and all cut-away sections. If it is a 4 or 5 seat van, ink in the 4th and 5th seat.
   F. For a pickup vehicle, complete the pickup diagram and appropriate cut-away sections depending upon the seating arrangements.

[14-15] 2. Total Number of Occupant Spaces in the Vehicle: ___ ___
99= Unknown

[16-17] 3. Total Number of Intrusions ___ ___

4. Areas of intrusion, associated impacts and resulting maximum intrusion.

Code intrusions in this order: Occupant Space 11, then 13, 23, 21, 12, 22, seat 3 (left to right), seat 4 (left to right), and seat 5 (left to right). See User's Manual, Section 6.3 for further information.

	Intrusion Number	Intruded Area or Exterior Object	Occupant Space No.	Associated Impact No.*	Measurement Axis	Intrusion		Occupant Contact**	
						Intrusion Maximum Extent	Occupant Space Dimension	Intrusion Extent at Contact†	Occupant Space Dimension†
	A	B	C	D	DD	E	F	G	H
[18-27]	01								
[28-37]	02								
[38-47]	03								
[48-57]	04								
[58-67]	05								
[68-77]	06								
[80]	(I.D. 4)								
[01-13]	(Duplicate for Case I.D.)								
[14-23]	07								
[24-33]	08								
[34-43]	09								
[44-53]	10								
[54-63]	11								
[64-73]	12								
	13								
	14								
[80]	(I.D. 5)								

Add additional Intrusion Numbers as needed

*From Impact Number on page 1 of VEHICLE DATA FORM (V), column 54, etc.
CODES: 1, 2, 3, or 4, 6=Occupant Contact/Inertial Forces, 7=Other Impact, 8=Not Applicable, 9=Unknown.

**Noted here for convenience of measurement. Also record as needed in columns G and H of OCCUPANT CONTACT FORM (OC) as appropriate. If no occupant contact occurred for a particular intrusion, leave blank.

†At Point of Occupant Contact.

NOTE: ALL MEASUREMENTS ARE IN INCHES.

Column B: Codes for Intruded Area or Exterior Object

Individual Component

INDIVIDUAL COMPONENT:

Internal	CODE
Instrument Panel	01
Dash Panel--Cowl	02
Toe Pan	03
Steering Column	04
Windshield Header	05
A Pillar	06
Door Panel or Side Panel	07
Window Frame	08
B Pillar	09
C Pillar	10
D Pillar	11
Roof Side Rails	12
Roof or Convertible Top	13
Floor Pan	14
Backlight Header	15
Front Seat-Back Surface/ Seat-Back Back Surface	16
Second Seat-Back Surface/ Seat-Back Back Surface	17
Third Seat-Back Surface/ Seat-Back Back Surface	18
Fourth Seat-Back Surface Seat-Back Back Surface	19
Fifth Seat-Back Surface Seat-Back Back Surface	20
Windshield	21
Back Panel/Back Door Surface	22
Seat Cushion Surface/Edge	23
Console	24
Other: _____	28
Unknown Internal Surfaces	29
Exterior	
Hood	43
Objects Exterior to Car	44
Outside Surface of Car	45
Other: _____	46
Unknown Exterior Object	49
Not Applicable	98
Unknown	99

Grouped for Massive Intrusion into an Occupant Space

	CODE
Instrument Panel-01 A Pillar-06 Door Panel-07	31
Instrument Panel-01 A Pillar-06 W/S Header-05	32
Door Panel-07 B Pillar-09 Roof Rail-12	33
Instrument Panel-01 Floor Pan-14 A Pillar-06 Door Frame-07	34
Roof Rail-12 A Pillar-06 B Pillar-09 Window Frame-08	35
Roof Rail-12 A Pillar-06 B Pillar-09 C Pillar-10 Door Panel-07	36
Roof-13 Roof Rail-12 Window Frame-08 Door Panel-07	37
Backlight Header-15 Roof-13 C Pillar-10 3rd Seat Back-17	38
Roof-13 Roof Rail-12 A Pillar-06 B Pillar-09 C Pillar-10 Window Frame-08 Door Panel-07 Floor Pan-14	39
Instrument Panel-01 Toe Pan-03 W/S Header-05 A Pillar-06 Roof Rail-12 Window Frame-08 Door Panel-07 Roof-13	40
Roof-13 Roof Rail-12 C Pillar-10 Window Frame-08 Floor Panel-14 2nd Seat-17 Door Panel-07	41
Roof Rail-12 Roof-13 B Pillar-09 Window Frame-08 Floor Pan-14 Door Panel-07 2nd Seat-17 Front Seat-16	42

*Use only if all these components components intruded into a single occupant space.

Column C: Codes for Occupant Space Number

Occupant Space Number is a 2-digit code. The use of the code is determined by the vehicle seat configuration at the time of the crash.

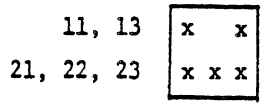
The first digit (left digit) denotes the seat row, with code values from 1-5. The second digit (right digit) denotes the position on the seat and (in some instances) the width of the seat.

Second Digit Codes:

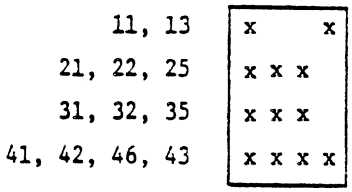
Seat Type	Code Value
Individual seat (bucket)	1=left, 3=right
Bench: Full width 3 passenger	1=left, 2=center, 3=right
Full width 4 passenger	1=left, 2=left center, 6=right center, 3=right
Partial width - left	1=left, 2=center, 5=right+ aisle space
Partial width - centered	0=left + space, 2=center, 5=right + space
Cargo area	4=entire vehicle width

EXAMPLES

Passenger Car
5 passengers



Van
12 passenger capacity



Column DD: Codes for Measurement Axis

X X Axis (fore and aft)
Y Y Axis (lateral)
Z Z Axis (vertical)

If door intrusion occurred, complete DOOR INTRUSION Form (DR).

If seat intrusion occurred, complete SEAT INTRUSION Form (ST).

If occupant contact resulted, complete the appropriate OCCUPANT CONTACT with INTRUDED SURFACES Form (OC).

END OF INTERNAL SURFACES INTRUSION DATA FORM

UPDATE	TEAM	YEAR	MONTH	DAY	SEQUENCE
1					10

DR

NATIONAL CRASH SEVERITY STUDY

INTRUSION: DOOR

Complete this form as a continuation of the INTERNAL SURFACES FORM when door intrusion is present.

[11-13] Vehicle No. ___ 0 0

[14] 1. Was door intrusion increased by component damage? ____

2 No (Skip to Item 3, Column 31)
1 Yes (Answer Item 2, Column 15)

2. Damaged component causing increased door intrusion:

		Intrusion Number*	Damaged Component #1	Damaged Component #2
[15-18]	A	___ ___	___	___
[19-22]	B	___ ___	___	___
[23-26]	C	___ ___	___	___
[27-30]	D	___ ___	___	___

CODES FOR DAMAGED COMPONENT
1 A Pillar
2 B Pillar
3 Door Latch/Striker
4 Door Hinges
7 Other (Specify) _____
8 Not Applicable
9 Unknown

*From Column A, Item 4--INTERNAL SURFACES INTRUSION FORM.

3/78 DR-1
HSRI

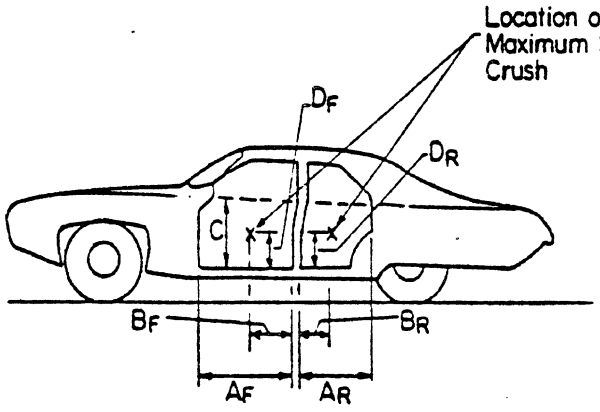
3. By using the following diagram locate the point(s) of maximum *EXTERIOR* inward crush which is directly responsible for the intrusion.

If the vehicle has 2 doors, use only dimensions subscripted F.

If the vehicle has 4 doors, use: dimensions subscripted F for front door crush; dimensions subscripted R for rear door crush; and F and R to describe either a distributed crush to both doors or two separate points of crush.

DO NOT code rear (side) door on VANS.

NOTE: Dimension C should be the same for both front and rear doors.



	Dimension	Description	Left Side (Inches)	Right Side (Inches)	
Front Door	A_F*	Width of front door sheet metal.**	— —	— —	[31-34]
	B_F	Horizontal location of center of front door crush from B pillar door edge.	— —	— —	[35-38]
	D_F	Vertical location of center of front door crush from lower door edge.	— —	— —	[39-42]
	C*	Height of door sheet metal from lower edge to edge of window (beltline).	— —	— —	[43-46]
Rear Door	A_R*	Maximum width of rear door sheet metal.	— —	— —	[47-50]
	B_R	Horizontal location of center of rear door crush from B pillar door edge.	— —	— —	[51-54]
	D_R	Vertical location of center of rear door crush from lower door edge.	— —	— —	[55-58]

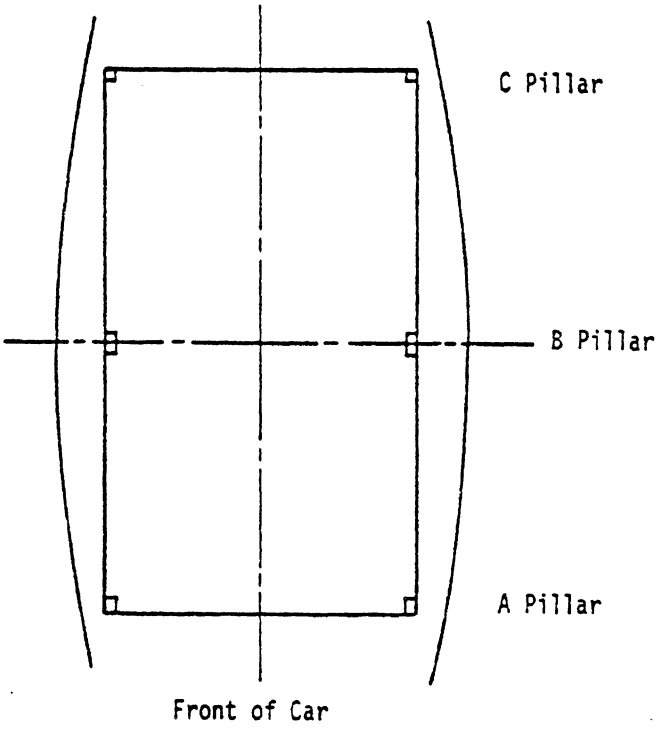
*Should be identical for right and left sides of an undamaged vehicle.

**See User's Manual, Section 5.3 for measurement procedure.

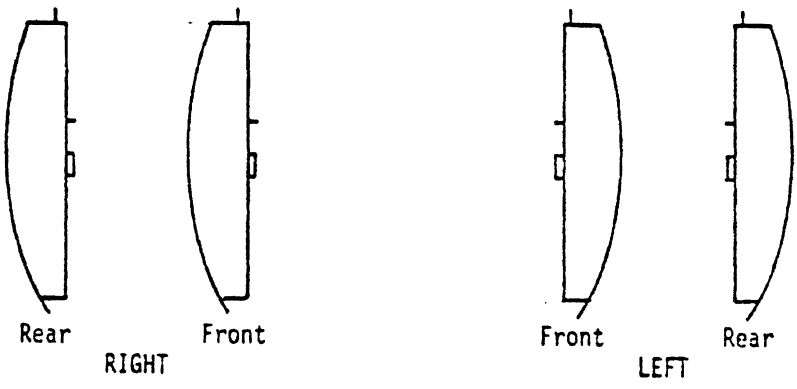
CODE:
77 Distributed Damage
78 Non-direct Impact
97 Undamaged
98 NA (2 door car)
99 Unknown

I.D. 6 [80]

4. Sketch the door(s) area internal surface intruded contour at the horizontal plane showing the maximum intrusion (internal) and crush (external). This plane must lie between the bottom of the door and the beltline.



5. Sketch the door(s) internal surface intruded contour at the vertical plane showing the maximum intrusion and crush.



* END OF DOOR INTRUSION FORM *

3/78 DR-3
HSRI

UPDATE	TEAM	YEAR	MONTH	DAY	SEQUENCE
1					10

ST

NATIONAL CRASH SEVERITY STUDY

INTRUSION: SEAT

Complete this form *ONLY* if seat intrusion has occurred. (If occupant contact occurred as a part of seat intrusion, also refer to FORM OC to note injuries, if any.)

[11-13] Vehicle No. ___ 0 0

1. Sketch the seat intrusion on the attached seat intrusion diagram. Include all necessary dimensions to quantify the final seat position and seat back angles (if these are considered to be intrusion sources).

2. SEAT TYPE

[14] A. Front ___
7 Other: _____

[15] B. Second (Rear) ___
7 Other: _____
8 No Rear Seat

[16] C. Third ___
7 Other: _____
8 No Third Seat

[17] D. Fourth ___
7 Other: _____
8 No Fourth Seat

[18] E. Fifth ___
7 Other: _____
8 No Fifth Seat

CODES FOR SEAT TYPE
(May or may not have arm rests)

Bench	1
Split Bench with or without Folding Back	2
Bench with Separate Back Cushions Front or Rear	3
Bench with Folding Backs	4
Bench with one folding back (may be right or left) or 60/40 split bench	5
Bucket Type Front or Rear	6
Unknown Type	9

3. SEAT INTRUSION

		Intrusion No.*	Cause	Direction
[19-22]	A.	___ ___	___	___
[23-26]	B.	___ ___	___	___
[27-30]	C.	___ ___	___	___
[31-34]	D.	___ ___	___	___
[35-42]	E.	___ ___	___	___
	F.	___ ___	___	___

*From Column A, Item 4--INTERNAL SURFACES INTRUSION FORM.

CODES FOR CAUSE

1 Failure of seat adjusters
2 Failure of seat tracks
3 Failure of seat back folding locks
4 Deformed by impact of passenger from rear
5 Deformed by impact of passenger from front
6 Deformed by inertial forces due to own mass
7 Deformed by intrusion of passenger compartment
8 Other (Specify) _____
9 Unknown

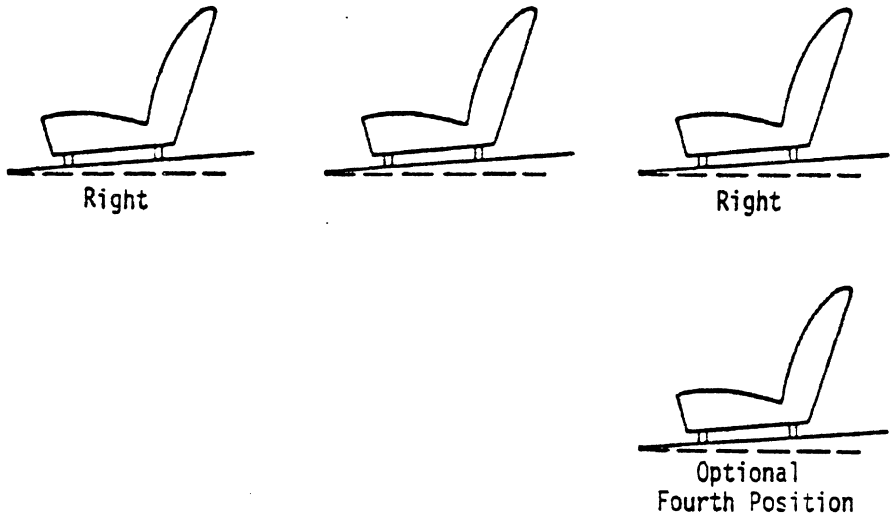
CODES FOR DIRECTION

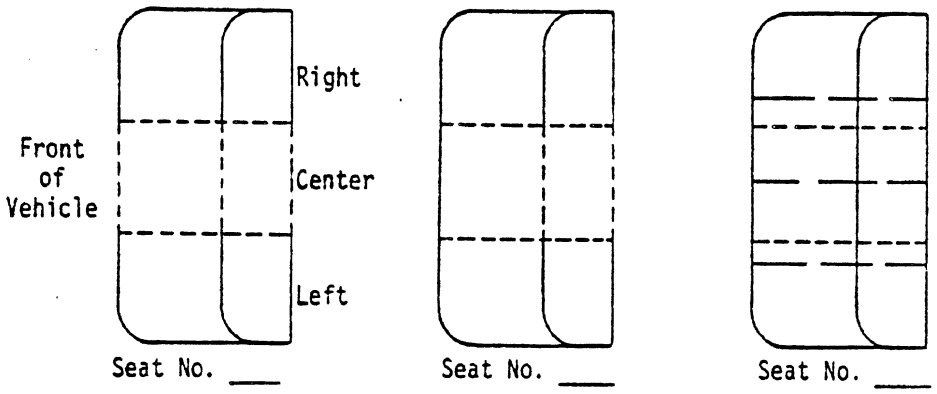
1 Forward 3 Left 9 Unknown
2 Rearward 4 Right

[80] I.D. 7

3/78 ST-1
HSRI

SEAT INTRUSION DIAGRAM





(ADD SEAT ROW DIAGRAMS AS NEEDED.)

* END OF SEAT INTRUSION FORM *

3/78 ST-2
HSRI

UPDATE	TEAM	YEAR	MONTH	DAY	SEQUENCE
1					10

OC

National Crash Severity Study

INTRUSION: OCCUPANT CONTACT WITH INTRUDED SURFACES

[11-13] Occupant No. ___

Complete this section *ONLY* if there is evidence that an occupant(s) contacted an intruded internal surface (including seats) of the passenger compartment. An injury need not have resulted from the contact.

		Intrusion Number*	Associated Injury Numbers** 1	2	Intrusion Extent at Point of Contact (Inches)† (G)	Occupant Space Dimension†† (Inches) (H)
[14-21]	A					
[22-29]	B					
[30-37]	C					
[38-45]	D					
[46-53]	E					
[54-61]	F					

*From INTERNAL SURFACES INTRUSION FORM, item 4, column A.

**From OCCUPANT DATA PAGE(S), CASE SUMMARY REPORT.
Code 0 if no injury was received from the contact.

†From INTERNAL SURFACES INTRUSION FORM, item 4, column G.

††From INTERNAL SURFACES INTRUSION FORM, item 4, column H.

[80] I.D. 2

* END OF OCCUPANT CONTACT FORM *

HSRI
3/78 OC

4.0 WHEN TO COMPLETE INTRUSION FORMS

This accident study requires that the intrusion supplementary forms be completed whenever there is any intrusion of the passenger compartment as defined in DEFINITION 2.1. The data forms and types of intrusion considered here are: a Catastrophic Crash; Internal Surface Intrusion; Seat Intrusion; Door Intrusion; Occupant Contact with Intruded Surfaces. These forms are to be completely ONLY if that particular form of intrusion has occurred. If there was no intrusion of the passenger compartment, then do not complete any intrusion forms.

A decision flow chart for completion of the intrusion supplementary forms is shown in Figure 4-1.

Note that data on intrusions must be recorded whether or not a passenger is seated within the particular occupant space, except that if intrusions of the internal surfaces of the passenger compartment are one inch or less in maximum extent, do not complete the Internal Surfaces Intrusion form.

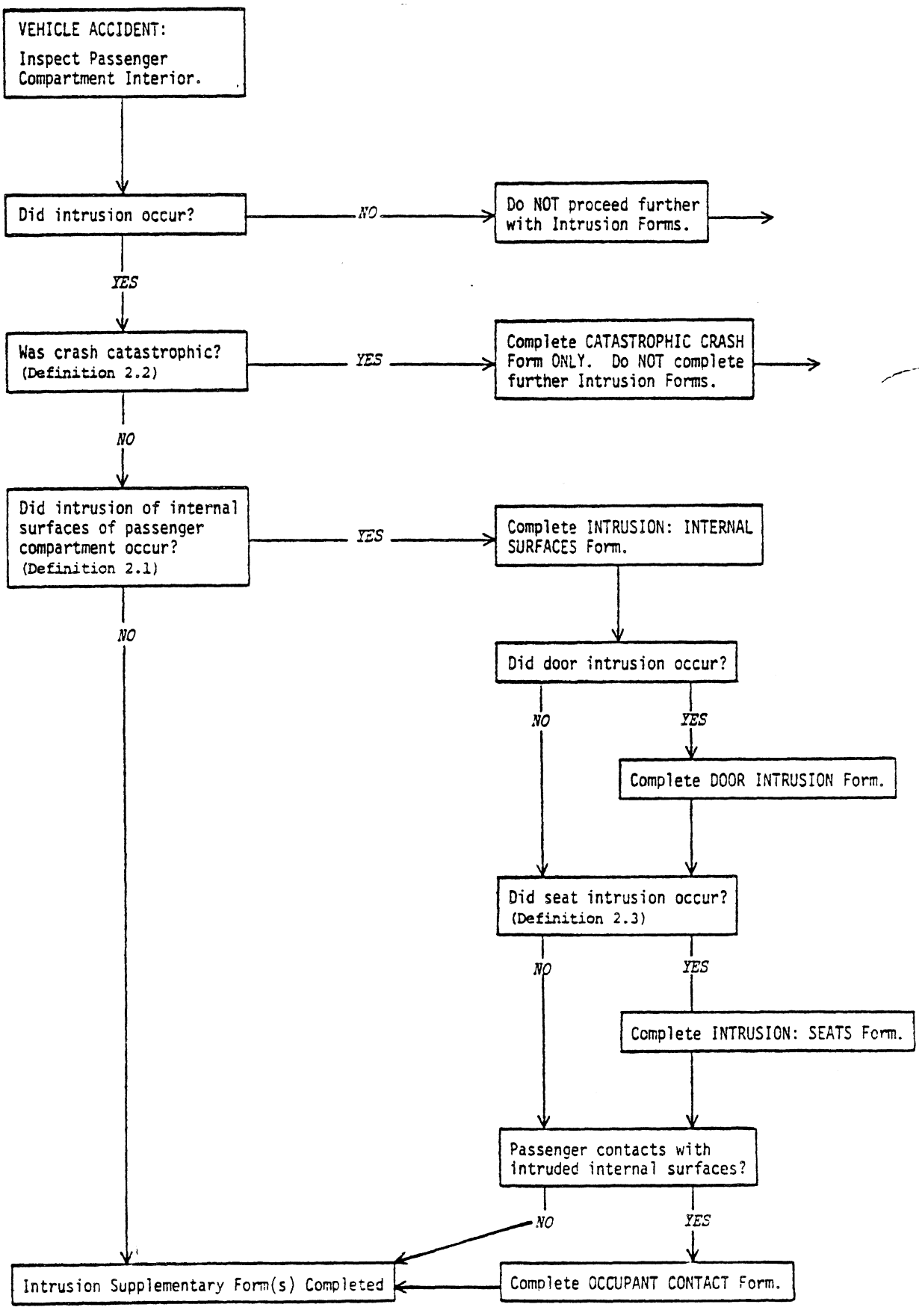


FIGURE 4-1. DECISION TREE FOR USE OF INTRUSION SUPPLEMENTARY FORMS.

5.0 MEASUREMENT METHODOLOGY

In order to measure intrusion of any portion of the passenger compartment, whether it be from the internal surfaces, seats, or door surface, it is necessary to have available original vehicle dimensions so that the change (intrusion) may be determined. These original dimensions are generally not available in a convenient form from motor vehicle manufacturers. Thus it is best for the investigator to obtain this data from measurement of a "reference" vehicle--either an equivalent vehicle or undamaged portions of the case vehicle.

5.1 Passenger Compartment Internal Surfaces Intrusion

5.1.1 Types of Intrusion

Two types of intrusion most often occur in accidents. They are:

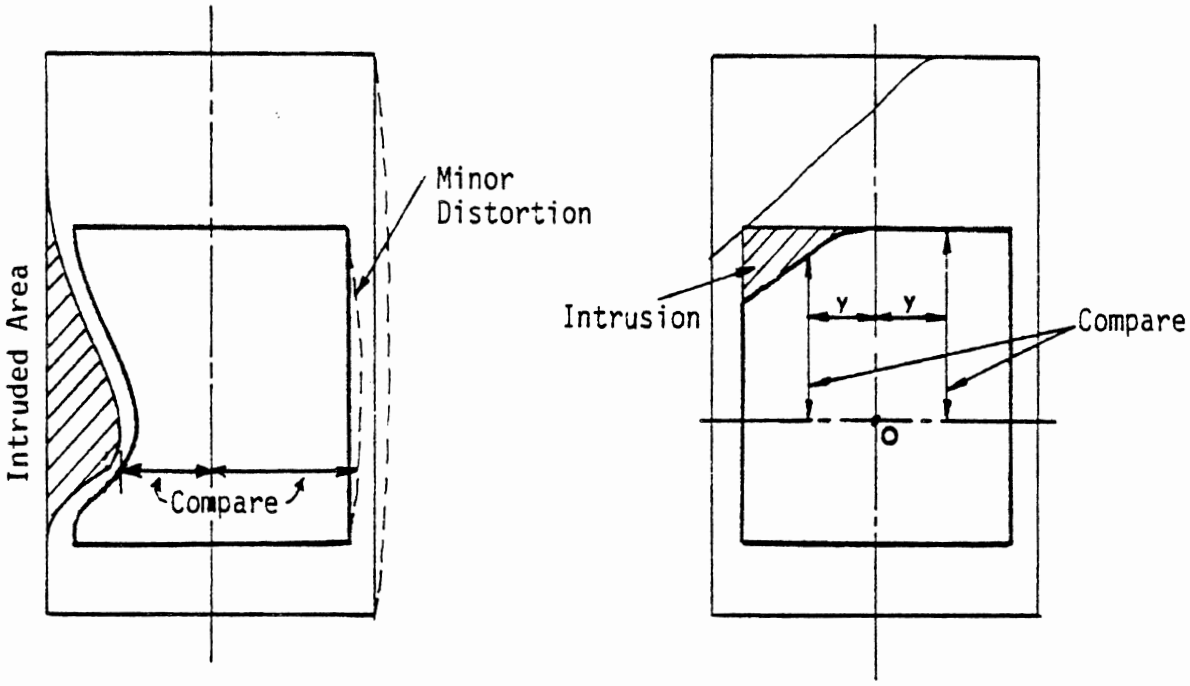
Type A: Intrusion which is limited to one part of the passenger compartment and where the other side of the vehicle remains relatively free of distrotion. This is likely to be the case in the majority of accidents. In many cases it will be possible to obtain a measure of the "original" vehicle dimension by using the fact that the vehicle is symmetrical about a longitudinal center-line.

Type B: Intrusion which occurs in many sections of the passenger compartment with little of the vehicle remaining free of distortion. In this case, it will be necessary to obtain "original" dimensions by comparison with a second (unintruded) vehicle of the same type.

Examples of Types A and B intrusions are shown in Figure 5-1.

5.1.2 Frame of Reference. In order to compare one side of a vehicle with the other or compare two vehicles, a coordinate system within the vehicle needs to be defined.

Type A Intrusion:



Type B Intrusion:

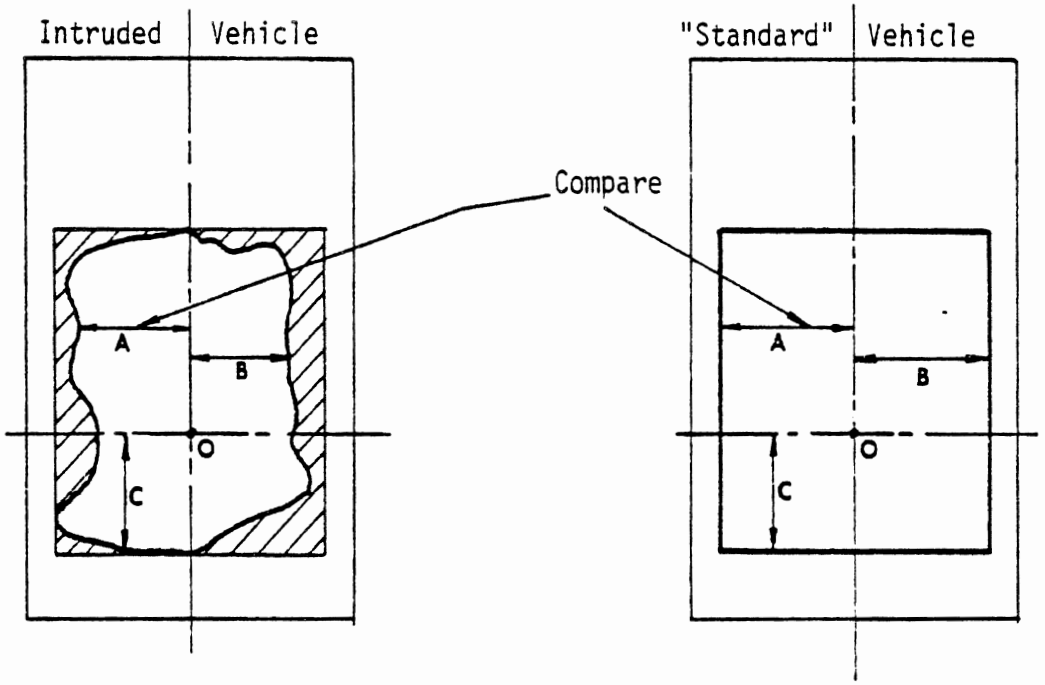


FIGURE 5-1. Examples of Two Basic Types of Intrusion Presenting Different Problems of Measurement.

This system is defined by an orthogonal set of axis (x-y-z) and an origin 0 as shown in Figure 5-2. The position of the origin is typically on the longitudinal center-line of the vehicle and has an arbitrary location both vertically and longitudinally. *The important feature is that its location be identical for the intruded and "reference" vehicle.*

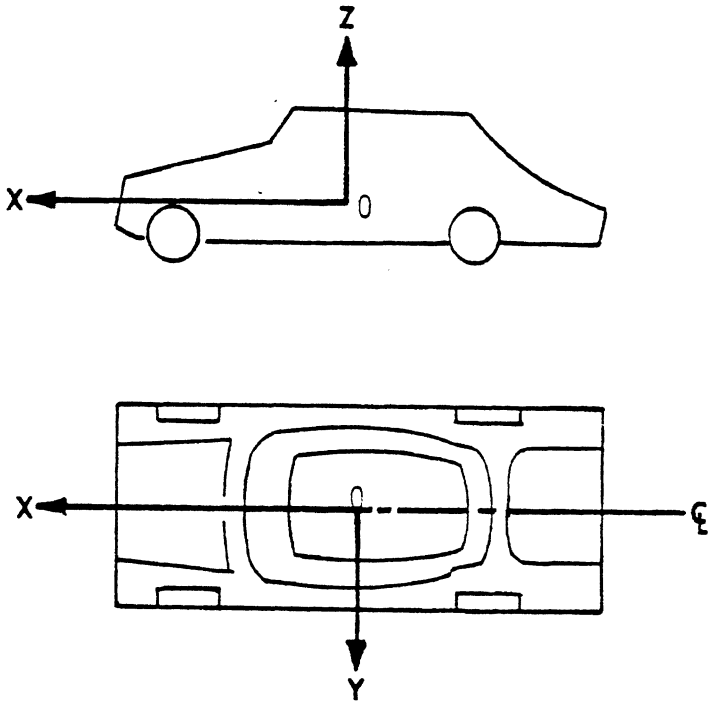


FIGURE 5-2. ORTHOGONAL AXIS IN A VEHICLE

The x-axis (defining a vertical* plane) is on the longitudinal center-line of the vehicle. This could be set up along the transmission drive shaft tunnel for a rear wheel drive vehicle or along a center-line which is equidistant from the sides of the vehicle in a front wheel drive vehicle.

The y-axis (defining another vertical plane)is in a transverse direction. This plane may be set up in any convenient longitudinal location which can be readily established in the "reference" vehicle,

---

*Although stated as vertical here, when the vehicle is inclined the plane rotates and retains its reference to the floor plane of the vehicle.

The y-axis (defining another vertical plane) is in a transverse direction. This plane may be set up in any convenient longitudinal location which can be readily established in the "reference" vehicle, i.e., through the centers of the B-pillars, instrument panel surface, C-pillar, etc.

The z-axis, defining a horizontal plane, is orthogonal to x and y axes. A location at the top of the transmission drive shaft tunnel may be convenient in many cases. The point established by these intersecting planes defines the origin O.

The problem of establishing a frame of reference and measuring intrusion is simplified to some extent since:

*In a frontal collision, there is rarely intrusion at the rear, and vice-versa for a rear collision.

*Side impacts generally damage only one side of the vehicle (except in the case of multiple rollover).

*Roof impacts leave the floor pan undistorted.

Not all intrusions require the establishment of all three axes (planes).

5.1.3 Setting Up the Frame of Reference Within a Vehicle - Use of a Measurement Aid

In many cases intrusion is relatively minor and measurement is simple. However, when vehicle intrusion is large in magnitude and/or severe distortion of the internal surfaces has occurred, it is likely that it will be necessary to have to set up a frame of reference from which to take measurements. A simple extending-tube device (to which is attached an inclinometer) has been designed to aid in these measurements (Figure 5-3).

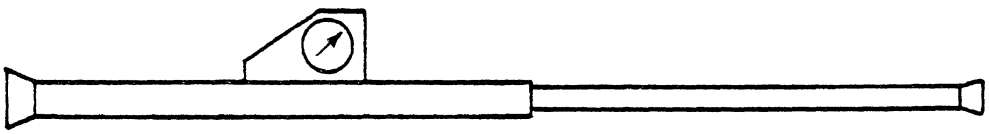


FIGURE 5-3: MEASURING TUBE

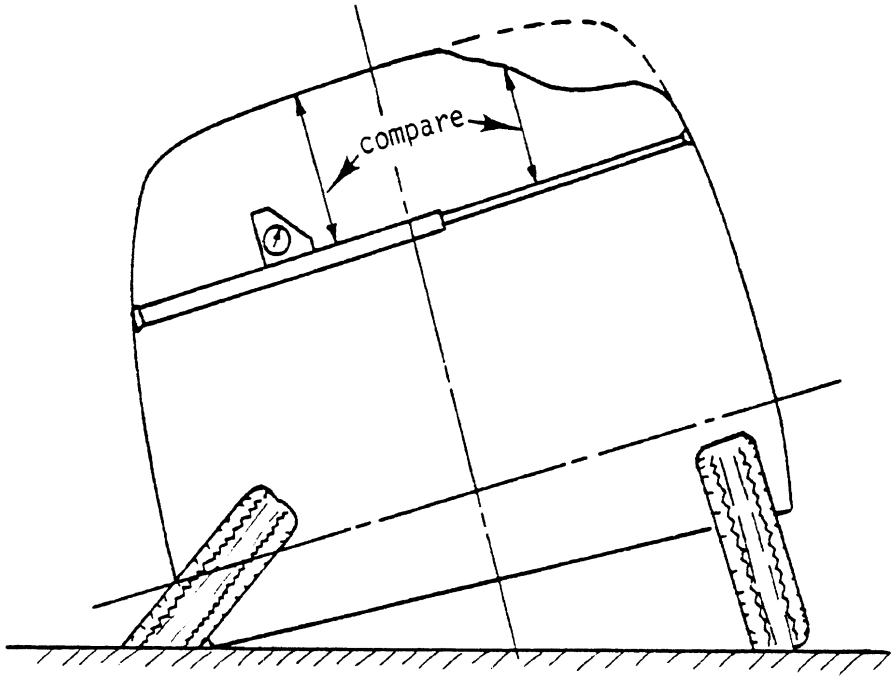
The procedure for establishing the reference planes is as follows:

(1) A "z-axis (vertical)" can be found, for example, by scribing a line on the headliner from the rear-view mirror through the dome light to the center of rear window and locating a second point on the center-line of the transmission drive shaft tunnel. Placing the measuring tube between these two lines will establish a z (vertical) axis. If the tube is then erected anywhere within the vehicle at the same inclination angle a "vertical" or z-axis is obtained.

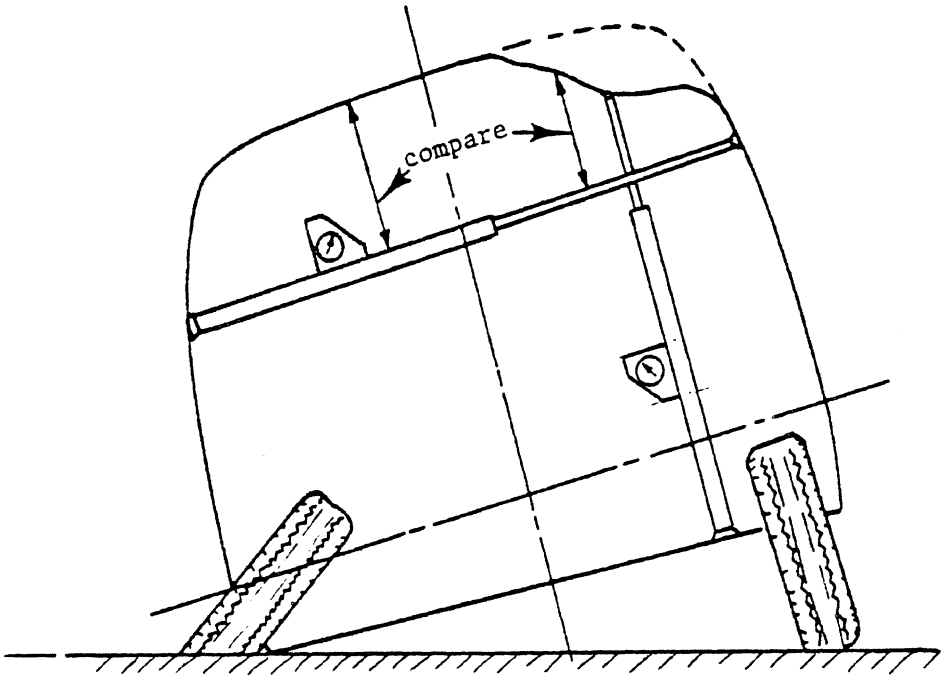
(2) A "y-axis" reference (in lateral or horizontal direction) is obtained by laying the tube between two points, or opposite sides of the vehicle: i.e., the door sills.

(3) The "x-axis" reference (for the longitudinal direction) may be obtained by laying the tube along the door sill and reading the inclinometer.

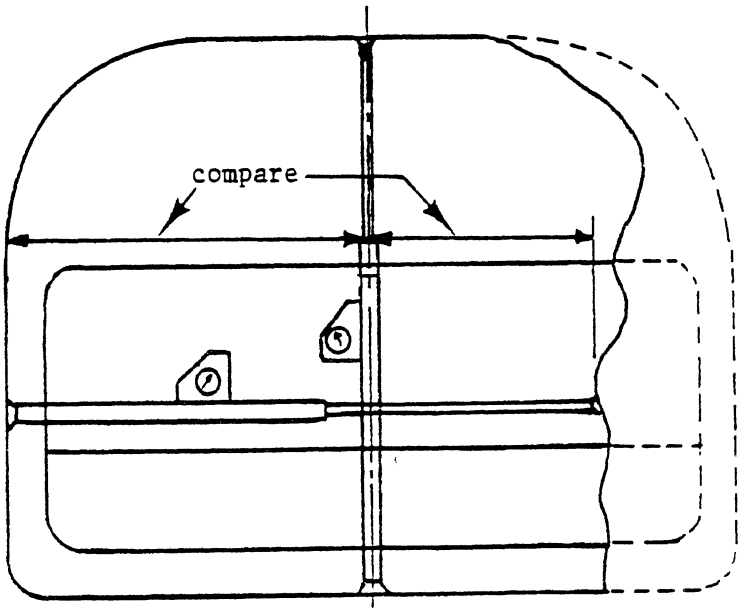
Examples: 1. To measure a roof intrusion.

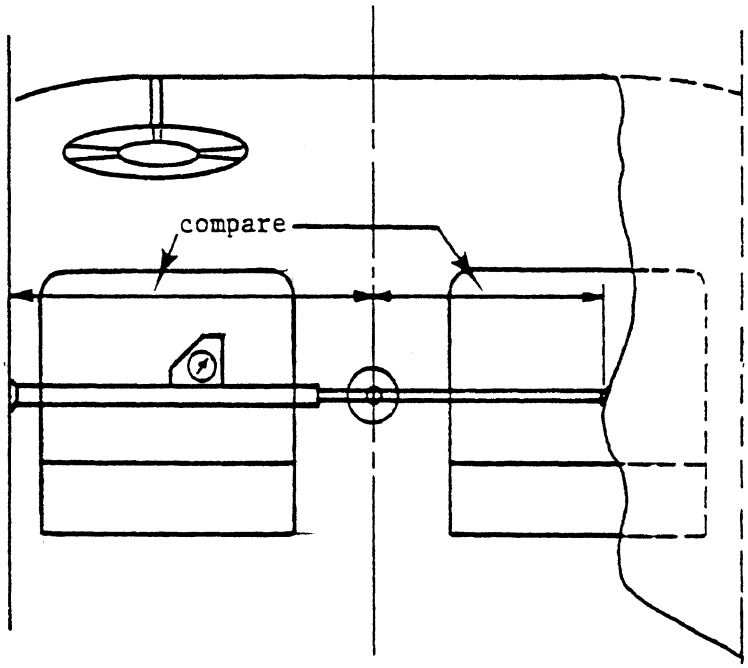


If necessary, the z-axis may also be erected to aid the measurement (see below).



2. To obtain side intrusion measurements relative to a vertical plane.





From experience gained in measuring several "simple" intrusions, the measuring tube (or similar device) may only be necessary for more complex patterns of deformation.

5.1.4 Possible Benchmarks for Use in Measurement. As intrusion is a measurement to be made relative to the original (unintruded) dimension, it is not necessary to make all measurements relative to some standard reference or benchmark position within the vehicle. Each vehicle (and/or measurement) will possibly require a different origin for measurement. This will be determined largely by the pattern of intrusion. The location of the reference frame is, to an extent, decided by the investigator. There are however a number of useful locations within the vehicle which will allow ready comparison for Types (a) and (b) intrusions (see Section 5.1).

(1) Side Intrusion: In this case a "vertical", established along the centerline of the vehicle is required. Suggested locations are:

(a) Along the centerline of the vehicle.

(b) At the center of the inboard seat tracks of bucket seats--if there is floor pan distortion.

(c) At center of inboard seatbelt floor anchorages.

(2) Roof Intrusion: A "horizontal" is required for measurement. This may be established by:

(a) By establishing a y axis as previously described.

(b) By resting the telescoping tube across the arm rests, (providing there is little side distortion), and measuring vertically from this tube (see Figure 5-4).

(c) From the lower edge of the windows.

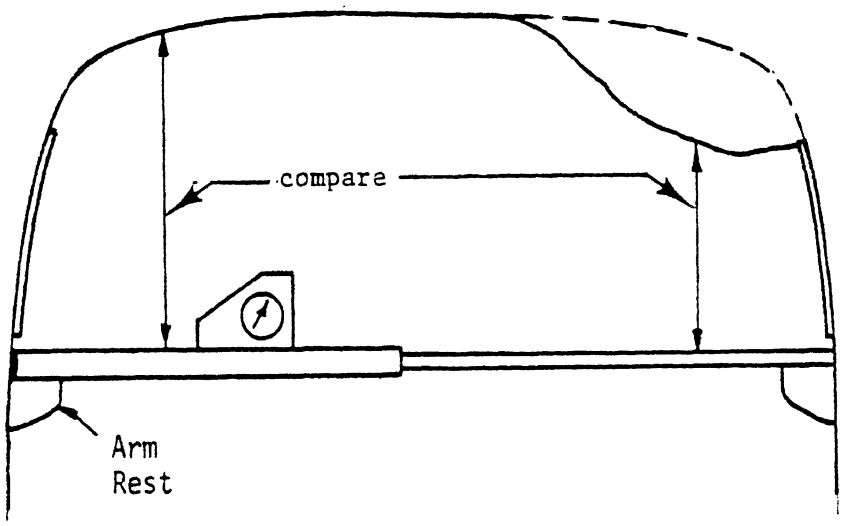


FIGURE 5-4: MEASURING ROOF INTRUSION BY RESTING THE MEASURING TOOL ON THE ARMRESTS

(3) Front or Rear End Intrusion: Measurement here is usually simplified by the fact that an accident in which frontal intrusion occurs is very unlikely to have rear intrusion, and vice versa. Hence there is generally available a horizontal (lateral) axis from which longitudinal measurements can be made. Examples are:

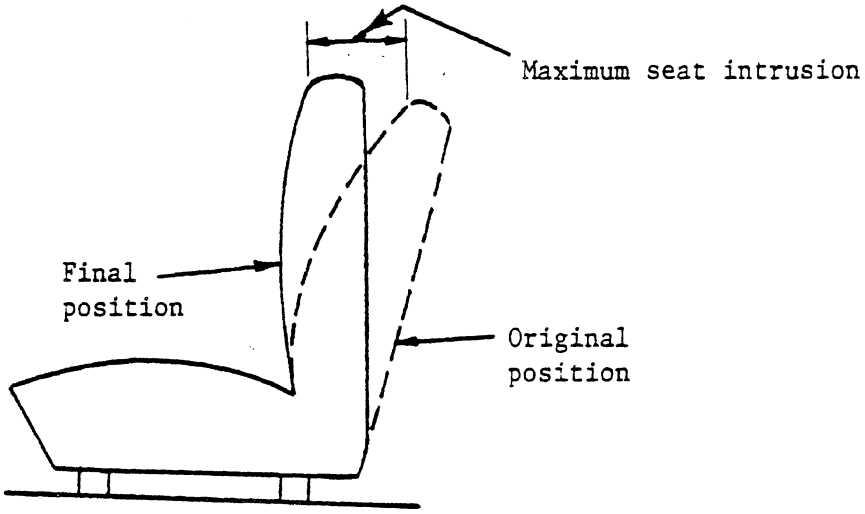
(a) Rear window header.
(b) Front edge of rear seat.
(c) Line joining centers of B-pillars.
(d) Line joining similar points on A-pillars.

(4) Documentation of Measurements: When type (b) intrusions are measured in the accident vehicle, it is important for the investigator to sketch, and/or note the benchmarks or references used. In general, the "reference" vehicle will be measured later, or may be measured by another investigator. Therefore, the method of measurement must be explicitly and thoroughly documented. Also, the values of the measurement--original dimension and intruded dimension--must be recorded so that the Intrusion Maximun extent may be calculated.

5.1.5 Accuracy of Measurement. From the foregoing sections, it is apparent that certain inaccuracies will arise in the process of measurement, particularly when it is necessary to find "original" vehicle dimensions as in Type (b) intrusions. It is suggested that investigator's make their measurements to the nearest ¼ inch for both the intruded and original dimensions.

5.1.6 Calculating Intrusion Maximum Extent. The Intrusion Maximum Extent is found by subtracting the intruded dimension from the original dimension. After finding the magnitude of the intrusion, it should be recorded to the nearest inch. For example, in the roof intrusion shown below, if A = 25½" and B = 15¼" then intrusion = 25½" - 15¼" = 10¼". This should be recorded on the data form as 10".

(a) Seat remains attached to tracks and floor pan.



(b) Seat detached from floor pan.

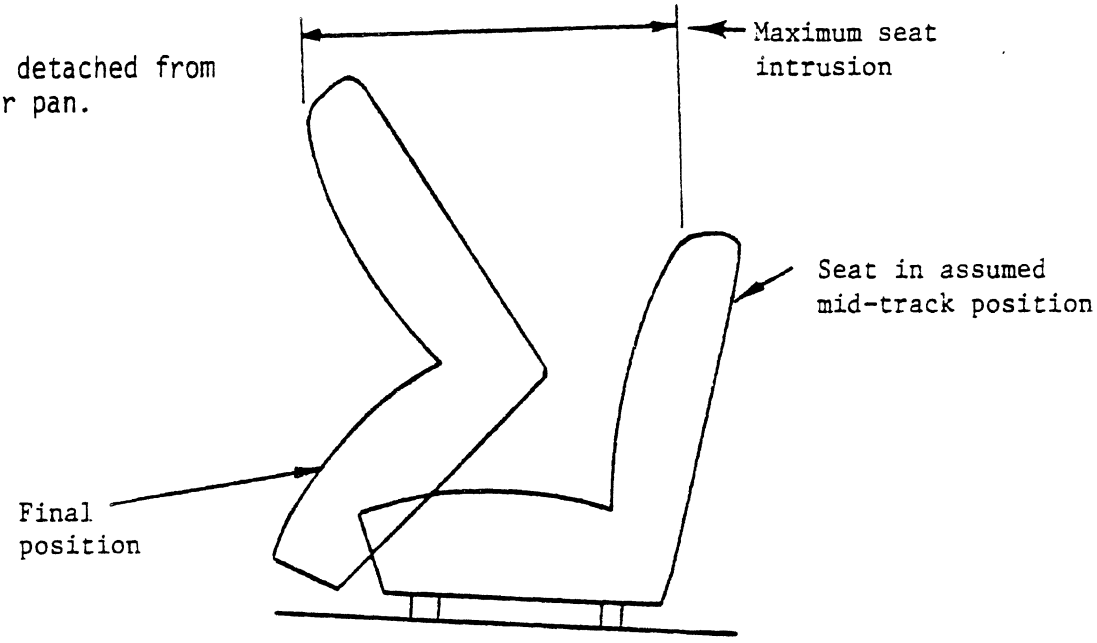


FIGURE 5-5: MEASUREMENT OF MAXIMUM SEAT INTRUSION

5.2 Measurement of Seat Intrusion

Measurement of seat intrusion involves a number of measurement difficulties due to the fact that, after the accident, the original seat position may not be accurately known due to (1) movement of the seat during extrication and (2) failure of the seat track, seat itself, or failure of the various adjusting mechanisms. This problem exists for both the original longitudinal position and original seat-back angle (in cases where it is adjustable). To overcome this problem it may be necessary to make a number of assumptions in the measurement procedure.

The seat intrusion form requires completion of the sketches of seat intrusions. On each of these diagrams place measurements of longitudinal displacements of the seat (where these are apparent) and measure the seat back displacements (angles). In order to determine intrusion when failure of the seat tracks or seat back has occurred it will be necessary to measure the final position of the seat relative to some fixed location within the vehicle, such as a point on the B-pillar, and compare this dimension with that in an unintruded seat. In situations where it is not possible to determine the location of the seat before the crash, assume that it was placed midway along the seat track. Figure 5-5 gives an example of seat intrusion.

5.3 Measurement of Location of Maximum External Door Crush

Door intrusion is caused by a crushing force applied to the outside sheet metal of the door. The purpose of these following measurements are to locate the center of the resulting exterior damage in reference to the door edges. The location of door crush is the only exterior measurement required in all of the intrusion forms.

Dimensions A and C are used to describe the overall size of the door. They are generally made so as to give the maximum dimensions of the door when measured through the center of the crush.

Dimensions A presents some measurement problems as the door edges are not necessarily straight lines. Generally this dimension should be made at a point approximately through the center of the impact using the B-pillar edge of the door as the reference line.

Dimension C (height) is measured from the lower-outside edge of the door to the belt-line.

For the convenience of measuring, dimension B, front and rear should have their origin at the B-pillar edge of the door, and dimension D should have its origin at the bottom door edge.

This procedure covers doors with concentrated impacts. If the damage is distributed, a modified procedure must be used. If the crush is vertical of approximately uniform depth as occurs if a vertical pole is struck in the door, a vertical measurement for D would not be defined. In this case, code D with 77 (distributed damage.) If the line of crush is horizontal,as might result from a high bumper, then the B measurement is undefined and B should be coded with 77 (distributed damage). If the line of crush is at an angle of less than 45 degrees from the vertical, code D with 77, and measure B to the mid-height of the damaged area. Conversely, for lines of crush of more than 45 degrees from the vertical code B with 77 and D with the mid-height.

If the crushing force is indirect, hence leaving no contact mark, then measurements cannot be made to locate its center. Thus code B_F, D_F, B_R, D_R = 78 as needed to indicate non-direct (to the door surface) impact force.

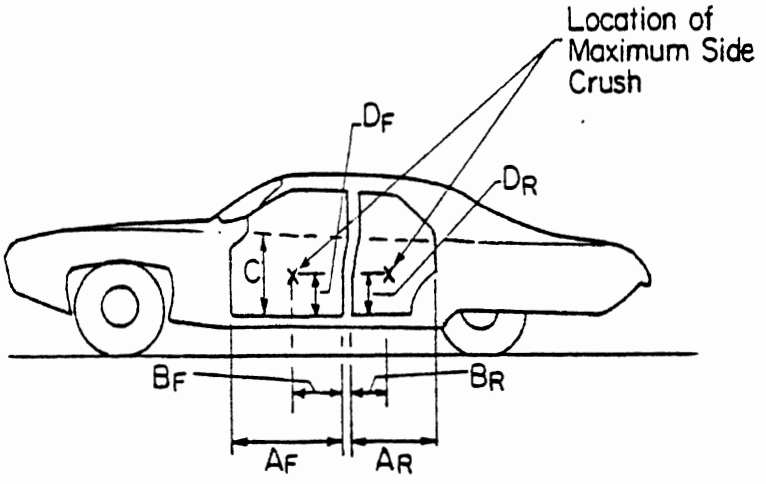
By using the following diagram, locate the point(s) of maximum <u>exterior</u> inward crush which is directly responsible for the intrusion.

If the vehicle has 2 doors, use only dimensions subscripted F.

If the vehicle has 4 doors, use: dimensions subscripted F for front door crush; dimensions subscripted R for rear door crush; and F and R to describe either a distributed crush to both doors or two separate points of crush.

DO NOT code rear (side) door on VANS.

NOTE: Dimension C should be the same for both front and rear doors.



Dimension		Description
Front Door	A_F*	Width of front door sheet metal.**
	B_F	Horizontal location of center of front door crush from B pillar door edge.
	D_F	Vertical location of center of front door crush from lower door edge.
	C*	Height of door sheet metal from lower edge to edge of window (beltline).
Rear Door	A_R*	Maximum width of rear door sheet metal.
	B_R	Horizontal location of center of rear door crush from B pillar door edge.
	D_R	Vertical location of center of rear door crush from lower door edge.

*Should be identical for right and left sides of an undamaged vehicle.

**See User's Manual, Section 5.3 for measurement procedure.

5.4 Penetration by External Objects

No measurement is required in this case. Sketches of the penetrating object are however required; this should show clearly the size of the object relative to the vehicle, the point of entry into the passenger compartment and the final resting position.

6.0 NOTES ON THE INTRUSION SUPPLEMENTARY FORMS

6.1 Intrusion (Columns, 73-78, NCSS Form V)

These entries denote which SUPPLEMENTARY FORMS have been COMPLETED, and *must be answered for all crashes investigated.*

If column 73, CATASTROPHIC CRASH,is marked yes, classifying the intrusion as catastrophic (according to the definition in Section 2.2) then complete the INTRUSION: CATASTROPHIC CRASH form only -- but do not proceed beyond that form.

If the intrusion is non-catastrophic then the response to column 73 is no, and the INTRUSION: INTERNAL SURFACES form must be completed along with whatever additional supplementary intrusion forms are appropriate.

6.2 Intrusion: Catastrophic Crash

Crashes which are extremely severe and which involve extreme magnitudes of intrusion are of little research value as far as a study of intrusion-related injuries are concerned. However, as such cases will arise in this study, it is necessary to record a few details of the type of structural failure which has occurred,and some approximate measure of the intrusion of each passenger space. These minimal data will allow the determination of the significance of this type of accident. Figure 2-1 illustrates intrusion which could be described as catastrophic.

Note the specifications for occupant spaces as used throughout the intrusion supplementary forms. The coding system to handle all types of occupant space configurations is discussed earlier in Section 2.6. Note that because of space limitations and the nature of catastrophic crashes, only certain seat positions will be coded here. This coding is limited to the first two seats (rows), with the remainder being coded 34 (whether seat position or cargo area are available). This special coding is given in Table 6.2-1.

Table 6.2-1. Vehicle Configuration at Time of Crash.
Catastrophic Crash Only.

Type of Vehicle*	Vehicle Passenger Capacity or Number of Seats	Applicable Occupant Spaces to Code	Occupant Spaces Coded not Applicable (P)
1,6,11	2 passenger-not internal cargo	11,13	12,21,22,23,34
1,31,41,6,12	2 passenger w/cargo area behind seat	11,13,34	12,21,22,23
2,32	4 passenger	11,13,21,23	12,22,34
2	5 passenger	11,13,21,22,23	12,34
5,11	1 seat	11,12,13	21,22,23,34
2,13	2 seat	11,12,13,21,22, 23	34
43	3 seat	11,12,13,21,22, 23,34	
45,46	4 seat w/ or w/o cargo area	11,12,13,21,23, 34	
5,12,21,6,33	1 seat w/ internal cargo area	11,12,13,34	21,22,23
3,22,42	2 seat w/ internal cargo area	11,12,13,21,22, 23,34	
4,23,44	3 seat w/ internal cargo area	11,12,13,21,22, 23,34	

*Vehicle Types (used only in this table)

1. sports car
2. passenger car
3. station wagon-2 seat
4. station wage-3 seat
5. station wagon-1 seat with other seats folded
6. pickup car

11. pickup truck
12. pickup truck w/internal cargo area
13. pickup truck w/crew cab

21. carryall-1 seat w/cargo area
22. carryall-2 seat w/cargo area
23. carryall-3 seat

31. utility-2 passenger
32. utility-2 seat
33. utility-3 passenger

41. van-2 passenger
42. van-2 seat
43. van-3 seat
44. van-3 seat w/cargo area
45. van-4 seat
46. van-4 seat w/cargo area
47. van-5 seat w/o cargo area
48. van-5 seat w/cargo area

Definitions: Passenger refers to maximum vehicle occupancy (manufacturer rating). Seat refers to a seating row capable of holding 2 or more passengers.

6.3 Intrusion: Internal Surfaces

If intrusion of any of the internal surfaces (as described in Section 2.1) has occurred, this form must be completed.

Prior to recording the data on the form, sketches of the intruded areas should be made. A diagram of various sections of the occupant compartment is provided in the General Intrusion Diagrams for this purpose. Sketches should be completed through each occupant space. For example, a 6-seat vehicle will require completion of longitudinal sections (through center-line of occupant spaces) A, B, C and lateral sections D, E (through torso region). A 4-seat vehicle will require completion of sections A, C, D, E only.

The number of occupant spaces is the normal manufacturer designated seating capacity of the case vehicle at the time of the crash--not the number of occupants in the vehicle at the time of the crash. Note that some seats may be removed prior to the crash, thus the limitation "at the time of the crash."

The occupant space coding system is described in Section 2.6. Do not confuse this section with Table 6.2-1, as Table 6.2-1 is intended for a specific purpose, i.e., catastrophic crashes only.

Data are required for each intrusion of the internal surfaces of the passenger compartment. If there are more than fourteen intrusions, continue the matrix (on the back of the forms if necessary), starting with intrusion number 15.

It should be noted that a single impact may produce more than one intrusion and also that an intrusion may be the result of more than one impact. The intrusion numbers are reference codes only and are <u>not</u> impact numbers.

The intrusions are listed in the following order, irrespective of severity or of occupant injury. Intrusions occurring to occupant space 11 (if any) are listed first. Intrusions are then listed for space 13, 23, 21, 12 and finally space 22. Intrusions for seats 3, 4, and 5 are listed from left to right and from seat 3 to seat 4 and

seat 5. Occupant spaces where no intrusion has occurred are not recorded. Thus a left side hit may produce intrusion only for space 21. Space 21's intrusions should be listed as intrusions 1, 2, etc., depending on how many components intruded.

The "intruded area" (Column B) is obtained from codes shown on the table accompanying the data forms. Each intruding component is treated as a separate intrusion. However, if several components are intruded into an occupant space as a result of a single crushing force (impact) and it is apparent that the association of injuries with individual intruding components would be highly improbable, then all those intruding components are to be coded as a unit using the appropriate combined component code as given on the data form. *NOTE: Assignment of a group code implies that all components listed for the group code intrude concurrently. To qualify, there must be at least three components in the group. Where a group component is used to aggregate several intruding components (resulting from a single impact) special measurement rules must be used. All measurements are taken orthogonally to the reference plane. Therefore, the investigator must: (1) choose the single component of the group which accounts for the most significant reduction in occupant space; (2) measure and record the intrusion from this component so as to best depict the change in space available to an occupant of that space; (3) note on the margin of the data form the single component to which the measurement was made and the direction of the measurement.*

The "Associated Impact Number" (Column D) is obtained from page 1 of the Vehicle Data Field Form (V). It is essential that this column be completed so as to provide linking between the various forms in the investigation. Code 6 is used to denote inertial or occupant loading of seats, resulting in intrusion of the seat--intrusion which cannot be ascribed to a particular CDC.

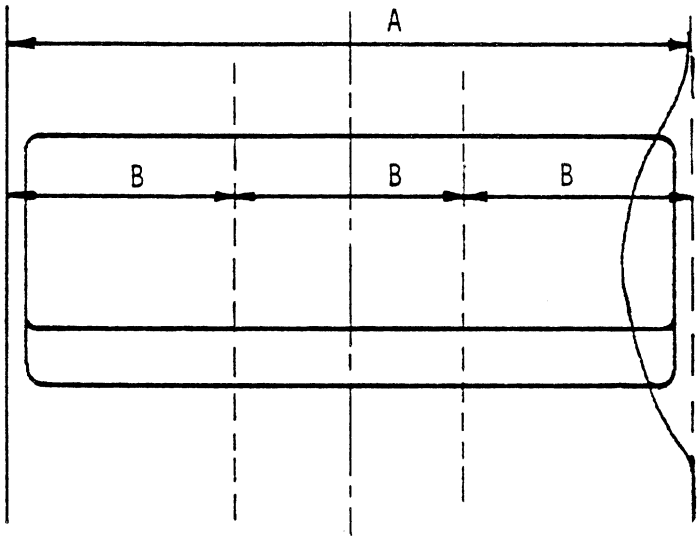
The "Measurement Axis" (column DD) is used to document the axis along which the measurement was taken; i.e., x, y or z. The correct codes here are x, y or z. This is the only place alpha codes are used on the data form.

The "Intrusion Maximum Extent" (Column E) is calculated by subtracting the intruded dimension from the original dimension (see Section 5.1.6). The measurement reference points and dimensions used to calculate this value should be noted marginally for each intrusion and measurement.

If a component has intruded into multiple spaces, the intrusion measurements must be made along the same axis for each occupant space.

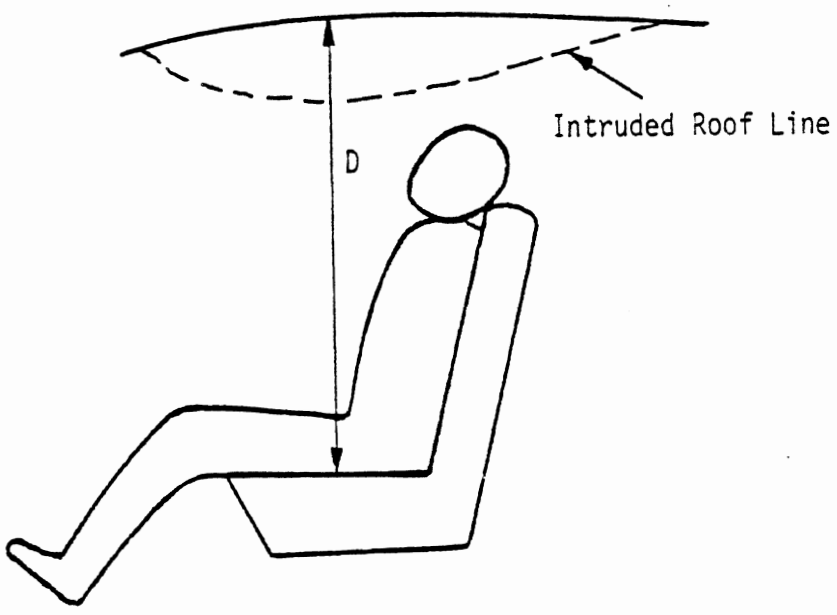
The "Occupant Space Dimension" (Column F) is that dimension of occupant space which is normally available to an occupant in an undamaged vehicle. The value of this dimension is obtained by measuring--in the same direction as the original vehicle dimension--between the boundary surfaces of the occupant space. These boundary surfaces are described in Section 2.5. In certain instances and dependent upon the choice of location of the reference plane, the original vehicle dimension and the occupant space dimension may be the same.

If occupant contact with the intruded surface has occurred (or is suspected) measurements and dimensions G and H similar to E and F above must be made. Provisions are made for recording these on this data form for later transfer to the Occupant Contact Data Form. The major difference between dimensions E and F, and dimension G (Intrusion Extent at (Point of) Contact--and dimension H--Occupant Space Dimension), is that they are to be made at the point on the intruded surface where the contact occurred as opposed to the maximums references in E and F.



EXAMPLE OF OCCUPANT SPACE DIMENSION

The occupant space dimension B, available for each front seat occupant, may be taken as A/3 where A=distance between the intruded internal panels of the door at the armrest level. For a seat capable of holding two or four persons (manufacturer's rating) R=A/2 or R=A/4, respectively. Thus in a two seat vehicle, for example, an occupant volume boundary lies on the center line of the vehicle.



The relevant original dimension is the space available between the seat surface and the internal surface of the roof (headline) before the intrusion occurred (Dimension D).

6.4 Intrusion: Door

The intrusion study is particularly interested in the performance of FMVSS 214. If side intrusion in a door has occurred, the Door Intrusion form must be completed irrespective of whether the door is equipped with a side door beam or not. The exception to this is the right hand rear door on passenger vans.

To compare side-intrusion of vehicles with, and without side guard beams it is necessary to have numerical data on the location of the external crush. Sketch the intrusion at the level on each door showing maximum intrusion of the internal surface. (This should be within the region from the bottom of the door to the belt-line.) Further, it is necessary to locate the center of the

crushing force which caused the door intrusion. The specifics of measuring and recording of these dimensions are given in Section 5.3.

6.5 Occupant Contact

Completion of this form will require careful observation by the investigator to determine whether an occupant has contacted an intruded internal surface of the passenger compartment. A line entry (on this form) should be completed for each occupant contact regardless of whether an injury resulted. It may be necessary to obtain information from vehicle occupants for completion of this section.

Although this form may be difficult to complete in the field, it is essential that it be done where relevant. Only through these data can any relationship be established between intrusions and associated injuries. The measurements (Columns G and H) are to be transferred from the same columns on the Internal Surfaces Form.

The data here are linked to other forms via the intrusion number and the occupant number (from Columns 11-13 of Occupant Data on page 5 of the Case Summary). The injury numbers are those listed for the individual occupants on forms OCC and OI of the Occupant Data Section.

6.6 Intrusion: Seats

Complete this form only if seat intrusion has occurred (according to the definition in Section 2.3).

If major movement of the seats has occurred, make measurements relative to some fixed location within the vehicle. Measurement methodology is discussed in Section 5.2. Include the location of this reference position on the sketch so that comparison data may be found from another vehicle. The seat numbering on this diagram refers to the occupant spaces as previously defined.

Note that this section also requires the direction of seat movement. For example, a rearward movement of the front seat back would be an intrusion of the rear seat occupant space, whereas a

forward movement would be an intrusion of the front occupant space. The intruding component would be, in the case of rearward movement, the seat back back surfaces. Forward movement would cause the seat back cushion surface to intrude. Lateral motion of seats is also possible.

6.7 External Object Penetration

Complete a sketch of the intruding object(s) on the appropriate General Intrusion Diagram form provided.

7.0 PHOTOGRAPHIC DOCUMENTATION

The following photographic requirements will assist the user in the documentation and interpretation of intrusion.

In addition to the normal set of interior photographs, supplementary photographs should be taken which document the nature and extent of the intrusion. Two views of each intrusion depicting the magnitude of the intrusion and overall perspective will be most useful.

Also, each point of occupant contact associated with an intrusion must be marked so as to be identifiable in the photographs. This is most readily accomplished by placing an X, consisting of two crossed pieces of tape, at the point of contact.

APPENDIX F

CODING MANUAL FOR MEASUREMENT OF INTRUSION IN MOTOR VEHICLE ACCIDENTS

UM-HSRI-78-17-3

CODING MANUAL FOR MEASUREMENT OF INTRUSION IN MOTOR VEHICLE ACCIDENTS

Robert Scott

April 1, 1978

HIGHWAY SAFETY RESEARCH INSTITUTE
THE UNIVERSITY OF MICHIGAN
ANN ARBOR, MICHIGAN 48109

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle	5. Report Date
Coding Manual for Measurement of Intrusion in Motor Vehicle Accidents	April 1, 1978
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Robert Scott	UM-HSRI-78-17-3
9. Performing Organization Name and Address	10. Work Unit No.
Highway Safety Research Institute The University of Michigan Ann Arbor, Michigan 48109	11. Contract or Grant No. DOT-HS-7-01805
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	Coding Manual, Final Report
National Center for Statistics and Analysis National Highway Traffic Safety Administration U.S. Department of Transportation Washington, D.C. 20590	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This document, along with the companion "Users Manual for Measurement of Intrusion in Motor Vehicle Accidents," provides the necessary information and instructions to accident investigators for the measurement, recording, and encoding data necessary to quantitatively describe interior intrusion.

This "Coding Manual" outlines the coding process for each of the intrusion data forms and describes the necessary code values for intrusion data elements as currently used in the April, 1978 revision of the National Crash Severity Study (NCSS).

Types of intrusion to be documented include: The Catastrophic Crash; Internal Surfaces; Door Intrusion; Seat Intrusion; and Occupant Contact with Intruded Surfaces.

17. Key Words	18. Distribution Statement
Crash, Intrusion, Measurement, Data Form, Data Recording, Accident Investigation Reference Information	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
		18	

CONTENTS

Introduction	1
Intrusion Forms Format	2
Card Identification	4
Coding Instructions	6
Catastrophic Intrusion Form	6
Internal Surfaces Intrusion Form	8
Door Intrusion	13
Seat Intrusion	15
Occupant Contact with Intruded Surfaces	17

INTRODUCTION

This manual provides coding instructions for occupant compartment intrusion forms included in the documentation protocol for the National Crash Severity Study (NCSS).

When developing the forms and coding procedures for documenting intrusion, the general approach used in the existing National Crash Severity Study was followed as much as possible. The forms are modular. That is, separate forms are used to address subjects that may not be applicable to every case. Thus the investigator need complete only those forms which are necessary to describe and document each specific vehicle. Those items (variables) which are necessary for analysis are recorded in a manner to facilitate keypunching directly from the form. Additional card identification information which is necessary for automatic-data processing is included on each form. Where possible, the coding conventions used in other NCSS forms have been followed. For example, codes for missing data are 9 or 99 (for two digit variables), and 8 or 98 is used for "non-applicable".

A primary objective incorporated in the intrusion forms is the ability to link a description of intrusion with the cause of intrusion, and most important, with the consequence of intrusion--injury.

The "Users Manual" is referred to several times in this coding manual. The full reference for the "Users Manual" is "Users Manual for Measurement of Intrusion in Motor Vehicle Accidents," Highway Safety Research Institute, The University of Michigan, Contract No. DOT-HS-7-01805, March 1978.