SAE
Vehicle Occupant Restraint Systems and Components Standards Manual

1996 Edition

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SAE
Vehicle Occupant Restraint Systems and Components Standards Manual

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SAE HS-13

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* = Revised
\+ = New

Introduction

This is the 4th edition of the SAE HS-13 Vehicle Occupant Restraint Systems and Components Standards Manual. It is an updated compilation of SAE Standards and Recommended Practices pertaining to active and passive systems intended to provide safety restraints for occupants of various types of vehicles. Seventy-five percent of the SAE Standards and Recommended Practices contained in this Edition are either new or revised documents. They include, among other additions and revisions, expanded coverage of air bag systems and child restraint systems. Contained in these documents are recommendations for design, engineering, testing, and installation of restraint devices used in passenger cars, trucks, construction equipment, and civil transport aircraft. The content of these reports was developed under the auspices of the SAE Technical Board, by technical committees composed of members with extensive experience in the subject field.

To assist users of the Manual, other SAE reports which are referenced in or relate to the base documents are included. Also included is a bibliography of related SAE Standards and Recommended Practices which are no longer in print. These reports are referred to in other reports, and have historical value.

Another assist to users has been provided in this edition of HS-13, by the inclusion of a Key Word Index. The index lists, alphabetically, key terminology used in the base SAE occupant restraint systems standards and recommended practices.

Also included are safety standards, pertaining to restraint systems, promulgated by the U.S. National Highway Traffic Safety Administration (NHTSA). In view of increased international interest and effort in occupant restraint systems, standards issued under the auspices of the International Standards Organization (ISO) have been added.

Finally, there is a Bibliography of technical papers on occupant restraint systems which have been presented before SAE in recent years. Information on the many papers on this subject presented in prior years is readily available. For information on this and other related SAE documents contact:

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(R) SEAT BELT HARDWARE WEBBING ABRASION PERFORMANCE REQUIREMENTS—SAE J114 JUN94 SAE Recommended Practice

Report of the Motor Vehicle Seat Belt Committee approved August 1969 and revised by the Body Engineering Committee March 1986. Completely revised by the SAE Restraints Standards Committee June 1994.

1. Scope—This SAE Recommended Practice describes the performance requirements for abrasion resistance of webbing when used in adjustment hardware normally used to adjust the length of seat belt assemblies such as those described in SAE J140. These requirements are applicable to tests conducted according to the procedure described in SAE J339. Although adjustment hardware is normally the primary source of webbing abrasion in a seat belt assembly, consideration should be given to other areas of normal webbing contact in the restraint system that may provide a more severe condition of webbing abrasion.

2. References

2.1 Applicable Documents—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J140—Seat Belt Hardware Test Procedure

SAE J339—Seat Belt Assembly Webbing Abrasion Test Procedure

3. Requirements

3.1 General—The seat belt assembly webbing abrasion test shall consist of 2500 cycles.

3.2 Adjustment Force—See SAE J140. At the completion of the abrasion test, the force required to adjust the length of the seat belt shall not exceed 50 N (11 lb) when tested with that portion of the webbing having undergone the cycle test in the adjustment area.

3.3 Tilt-Lock Adjustment—See SAE J140. At the completion of the abrasion test, the adjustment hardware of a seat belt assembly having tilt-lock adjustment normally used to adjust the length of the assembly shall lock the webbing at an angle of not less than 30 degrees between the plane of the adjustment means and the anchor webbing. This test shall be conducted in the abraded area of the webbing.

3.4 Webbing Breaking Strength—See SAE J140. At the completion of the abrasion test, the webbing breaking strength shall be determined. No breaking strength shall be less than 20 kN (4500 lb) for a Type 1 belt, 16.7 kN (3750 lb) for pelvic portion, 13.3 kN (3000 lb) for upper torso portion of a Type 2 belt, or 13.3 kN (3000 lb) for a type 2a upper torso restraint.

(R) OCCUPANT RESTRAINT SYSTEM EVALUATION —PASSENGER CARS AND LIGHT-DUTY TRUCKS —SAE J128 NOV94

SAE Information Report

Report of the Occupant Restraint Systems Committee approved December 1969. Completely revised by the SAE Restraint Systems Standards Committee November 1994.

Foreword—The purpose of this SAE Information Report is to further the development of passenger car and light-duty truck restraint systems. This report should aid that goal by:

a. Describing standardized restraint system testing methods so that results from various test laboratories can be compared.
b. Serving as a guide in the design and development of restraint systems and in the preparation of detailed procedures for testing and evaluating specific types of restraint systems.
c. Providing an orientation for research in human tolerance to impact and for the development of improved human simulators.

The evaluation procedures discussed are presented as an Information Report. Due to continuously evolving instrumentation/measurement systems, collision simulation, and data on human tolerance to impact, this report will necessarily be subject to continuing review and improvement. Nevertheless, the outlined procedures are intended to form the basis for overall evaluation of any means by which a collision energy exchange between a vehicle and its occupant(s) is measured. Where present knowledge does not allow for rigorous specifications consistent with this broad outlook, an attempt has been made to avoid arbitrary or restrictive statements. The state-of-the-art in testing, engineering judgment, and experience must provide major guidance in restraint system evaluation.

1. Scope—This SAE Information Report discusses the significant factors which measure the effectiveness of the total occupant restraint system in commonly encountered collision configurations. The total system includes the components which affect occupant injury by influencing the manner in which the collision energy management is accomplished. In addition to the elements that contribute to impact attenuation, consideration must be given to factors that encourage maximum use, such as comfort, reliability, appearance, and convenience. Hence, system evaluation necessarily involves consideration of the complete vehicle.

2. References

2.1 Applicable Documents—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J114—Seat Belt Assembly Webbing Abrasion Performance Requirements
SAE J117—Dynamic Test Procedures—Type 1 and Type 2 Seat Belts
SAE J140—Seat Belt Hardware Test Procedure
SAE J141—Seat Belt Hardware Performance Requirements
SAE J184—Qualifying a Sound Data Acquisition System
SAE J211—Instrumentation for Impact Tests
SAE J247—Instrumentation for Measuring Acoustic Impulses Within Vehicles
SAE J339—Seat Belt Assembly Webbing Abrasion Test Procedure
SAE J800—Motor Vehicle Seat Belt Assembly Installation
SAE J850—Barrier Collision Tests
SAE J885—Human Tolerance to Impact Conditions as Related to Motor Vehicle Design
SAE J972—Moving Barrier Collision Tests
SAE J1211—Recommended Environmental Practices for Electronic Equipment Design
SAE J1368—Child Restraint Anchorages and Attachment Hardware
SAE J1369—Anchorage Provisions for Installation of Child Restraint Tether Straps in Rear Seating Positions
SAE J1460—Human Mechanical Response Characteristics
SAE J1819—Securing Child Restraint Systems in Motor Vehicles

SAE Paper 791026—A Comparison Between Part 572 Dummy and Human Subject in the Problem of Submarining, Leung, Y.C., Tarriere, C., Fayon., A., Mairesse, P., Delmas, A., Banzet, P., In 23rd Stapp Car Crash Conference Proceedings, 1979.

SAE Paper 892440—Assessing Submarining and Abdominal Injury Risk in the Hybrid III Family of Dummies, Rouhana, S.W., Viano, D.C., Jedrzejczak, E.A., McCleary, J.D., In 33rd Stapp Car Crash Conference Proceedings, 1989.

SAE Paper 902317—Assessing Submarining and Abdominal Injury Risk in the Hybrid III Family of Dummies: Part II—Development of the Small Female Frangible Abdomen, Rouhana, S.W., Jedrzejczak, E.A., McCleary, J.D., In 34th Stapp Car Crash Conference Proceedings, 1990.

2.1.2 U.S. GOVERNMENT PUBLICATIONS—Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

United States Patent 3,841,163: Daniel, R.F.; Test Dummy Submarining Indicator System; October 15, 1974.

49 CFR Part 572: Test Dummy Specifications—Anthropomorphic Test Dummy for Applicable Test Procedures

FMVSS 208—Occupant Crash Protection
FMVSS 214—Side Impact Protection

2.1.3 OTHER PUBLICATIONS

Mertz, H.J.: Anthropomorphic Test Devices In Accidental Injury: Biomechanics and Prevention, Springer-Verlag, 1993.

3. Technical Information

3.1 Design and Testing Guidelines—The following is a suggested checklist for evaluating restraint system characteristics.

3.1.1 COLLISION CONSIDERATIONS

3.1.1.1 Injury Mitigation—A restraint system should perform in a manner which applies restraint forces to appropriate areas of the anatomy to help reduce the likelihood or severity of contact with vehicle interior surfaces other than the restraint system(s) to mitigate occupant injury, with consideration of skeletal, internal organ, and soft tissue damage, including disfigurement.

FMVSS considerations include: head acceleration, chest acceleration and compression, and femur loads. Even when numbers recorded by the anthropomorphic test device (ATD or test dummy) are acceptable for FMVSS 208, significant occupant injury is still possible, e.g., by submarining where the forces of restraint are partially channeled into the abdominal region of the occupant. Likewise, some neck injury can occur in situations where the FMVSS 208 conditions are all met. The automotive safety engineer is encouraged to review SAE J885, which deals with such issues in depth.

3.1.1.2 Kinematics of Restraint—In evaluating injury reduction, consideration should be given not only to the direct effects of restraining forces but also to the possible consequences of occupant kinematics, such as violent contact between occupants (e.g., head bumping), areas of load concentration on the human body (e.g., loading of the abdomen by submarining), and excessive body motion of one body region relative to another (e.g., head relative to torso as in whiplash).

Submarining occurs when the occupant's pelvis slips under the lap belt which then causes the forces of restraint to be applied to the abdominal region. Although pelvic load bolts, front-of-the-ilium load transducers, and iliac crest load cells can usually detect the occurrence and timing of submarining, until recently there was no way to quantify the risk of abdominal injury when submarining occurred. A new device, the Frangible Abdomen, is available for the Hybrid III small female and mid-size male dummies. It has a more correct mechanical response for low-velocity abdominal belt loading as seen in submarining, and provides some indication of the risk of abdominal injury by measurement of the abdominal penetration. In balancing the benefit of the restraint of the whole body against some risk of abdominal injury, the latter may be acceptable and indeed unavoidable. The Frangible Abdomen may offer an objective, quantitative approach to making these assessments.

Relative motion of major body regions might occur in the case of an occupant interaction with a knee bolster without upper body restraint. In this case, the thorax may move relative to the pelvis, which could cause large shear loads to build up in the lumbar spine. Thus, an attempt to balance loading over the major regions is important.

3.1.1.3 Injury Criteria—It should be recognized that the devices specified in 49 CFR Part 572 have no capability to measure simulated human physiological responses. They measure physical parameters which are correlated to probability of injury to the body region in question. In addition, injury criteria and tolerances are developed based on a limited number of tests. Yet, human tolerance to injury is known to be a distribution, that is, there is no single number at which a femur, for example, will fracture regardless of the individual involved in a collision. Tolerance is an individual matter based on a host of physiologic considerations beyond the scope of this document. There are always individuals who are more or less susceptible to injury than the average person. Therefore, care must be exercised when evaluating the data resulting from the use of an ATD in restraint tests. Use of a single number (e.g., HIC = 1000) should be avoided in favor of a balanced approach considering test severity and proximity to the "accepted" tolerance value. Appropriate human tolerances to impact are presented in SAE J885 (JUL86).

3.1.1.4 Ejection—Injury potential is generally increased when an occupant is completely or partially ejected from a vehicle during a crash. The relative ability of the restraints to retain the occupant within the body shell is therefore an important criterion of system performance.

3.1.1.5 Deployment—A restraint system or component which is stored remotely and moved rapidly into place immediately before or during an impact should to the extent possible not pose a greater hazard to the vehicle occupants or to service personnel than if the system were not present. For example, factors to be considered in these types of systems include: noise, dust, and smoke. However, it is not anticipated that such systems can be entirely free of hazard.

3.1.1.6 Durability—Restraint system components should be tested to evaluate their ability to provide acceptable performance throughout their service life. This may require real time or accelerated exposure to such factors as aging, use, sunlight, corrosion, and dirt. (See SAE J114, J117, J140, J141, J339, and J800 for specific tests applicable to seat belt assemblies.)

3.1.1.7 Component Installation—Restraint system components should be installed in the vehicle in such a manner that they do not themselves constitute a significant impact hazard.

3.1.1.8 Ambient Conditions—A restraint system should provide performance which remains acceptable throughout the range of ambient conditions to which it can reasonably be expected to be exposed during its service life. Since it is not usually feasible to vary these conditions during crash tests, it may be necessary to conduct component tests which are supplementary to and more controllable than the complete system tests specified in 3.4.1.

3.1.1.9 Egress—The restraint system should not cause excessive difficulty or delay in exiting from the vehicle after a collision, with or without outside assistance. Consideration should also be given to the occurrence of a user suspended in an overturned vehicle.

3.1.1.10 Unusual Conditions—While it is obviously desirable that a restraint system provide a high level of protection for all occupants in all accident conditions, the broad spectrum of occupant sizes, the large distribution of occupant tolerances, and the statistical nature of collision casualties must be recognized. A system which provides generally good protection is not necessarily rendered unacceptable by its performance under some extreme set of circumstances which will rarely be encountered.

3.1.2 ACCEPTABILITY CONSIDERATIONS—The following characteristics affect the probability of acceptance and proper use of the total restraint system so that its performance potential can be realized. These factors should therefore be weighed heavily in the overall evaluation of a system.

3.1.2.1 Comfort—The restraint system should embody as far as possible those features which contribute to occupant comfort. For those elements which usually contact the occupant, particular care should be paid to avoiding pressure points, rubbing, and similar sources of annoyance which discourage consistent and proper use. Measures taken to assure occupant comfort should be evaluated with respect to their effect on system performance.

3.1.2.2 Convenience—Restraint system convenience includes consideration of potential interference with normal driving functions (e.g., vision, steering, etc.), and optimizing the use, removal, adjustment, and storage of components, particularly in darkness or without reference to written instructions. These needs are best met by minimizing occupant participation or effort.

3.1.2.3 Adjustability—Restraint system adjustability concerns address the spectrum of different occupant sizes and include consideration of feasible measures to "tune" the restraint system for optimum comfort, fit, and occupant protection across this range.

3.1.2.4 Child Seat Compatibility—The restraint system should allow secure placement of child restraint devices as specified in SAE J1368, J1369, and J1819. Where inflatable restraints or non-bench seats are present, consideration should be given as to the appropriateness of such seating positions for child restraint use. Considerations should include, but are not limited to, possible interactions between the child restraint and the inflatable restraint, ability to secure the child restraint, compatibility with the belt system, etc.

3.1.2.5 Appearance—The attractiveness of system components, both in use and stored, and their effect on occupant clothing should be considered to encourage use.

3.1.2.6 Ingress—The restraint system should not impede progress nor damage the clothing of an occupant entering the vehicle.

3.1.2.7 Noise—Noise from shakes and rattles should be minimized for each type of restraint system in its stowed or non-deployed position, and for belt restraints when in use. Consideration should be taken of the noise produced by restraint systems which are deployed by pyrotechnic, mechanical, or other means as in SAE J184 and J247.

3.1.2.8 Durability—In addition to the retention of system performance specified in 3.2.1.4, it is important to ascertain that the factors which influence acceptability will not deteriorate throughout the service life of the system to an extent which would constitute a significant deterrent to maximum use. For example, consideration should be given to the effect of vibration on system acceptability as in SAE J1211.

3.1.2.9 Maintenance—The responsibilities of the user with regard to establishing and maintaining proper use should be kept to the feasible minimum and should be documented in clearly written instructions.

3.2 Equipment

3.2.1 ANTHROPOMORPHIC TEST DEVICES (ATDS)—For the impact tests specified in 3.4, restraint systems should be evaluated with the aid of an anthropomorphic test device which conforms to 49 CFR Part 572, Subpart E (Test Dummy Specifications—Hybrid III Test Dummy) for frontal and rear impact tests, and 49 CFR Part 572, Subpart F (Test Dummy Specifications—Side Impact Dummy 50th Percentile Male or equivalent) for side impact tests. Other test devices not specified in 49 CFR Part 572, may nevertheless be useful qualitative tools in reaching evaluation judgments (BIOSID, Hybrid III with additional instrumentation, etc.). Attention is called to the following general considerations and limitations which apply to ATDs.

3.2.1.1 Size—The test device which conforms to 49 CFR Part 572, Subpart E is representative of the 50th percentile adult male. Hybrid III devices are now available which represent occupants of other sizes. In general, the restraint system should exhibit sufficient performance to provide comparable protection for the range of occupant sizes for which it is intended.

3.2.1.2 Articulation—Test devices conforming to 49 CFR Part 572, Subpart E provide a representative range of motion for the major body members, although the articulation is necessarily somewhat less sophisticated than that of the human being. In general, motions of the test device will be reasonably adequate for severe impact conditions but less reliable for low-energy impacts, where such factors as muscular forces and internal damping can have a proportionately larger influence on the relative displacement of body elements during the collision event.

3.2.1.3 Clothing—Frictional forces between the test device and components of the vehicle can have important effects on relative motion of the test device. Body elements likely to be in substantial contact with the seat, vehicle interior, or restraining devices should therefore be clothed in material which will provide friction coefficients representative of typical occupant clothing. In the absence of special considerations, cotton is recommended. While it is recognized that loose, multiple-layer clothing can affect friction, form-fitting stretch garments are recommended to minimize interference with photographic analysis.

3.2.1.4 Dynamic Compliance—Correlation work is ongoing between static and dynamic compliance of ATDs and human response data of the type contained in SAE J1460. While these test devices can generally be used to make quantitative predictions of human injury, the response of some body regions is either unknown or not accurately reproduced in the ATD. There are many reasons for this, such as the multiplicity of conditions under which the human tolerance data have been obtained, the scarcity of such data, and the difficulty of developing mechanical parts which have the same dynamic properties as the human body. Impact data measured by using such a test device can nevertheless be of considerable value in evaluating restraint systems because of considerations such as the following:

a. Where possible, the evaluation desired should be relative to some similar restraint system whose performance with the same test device is known or can be determined. The relative performance is thus less likely to be obscured by differences between the test device and the human being.
b. If typical crash loads are to be kept within human tolerance limits, the dynamic deflections of restraining elements will usually have to be quite large relative to the involved elements of the human body. Under these conditions, inaccuracies in the compliance rates of the test device will have only a relatively minor effect on the loads developed, since these devices are usually the stiffer elements in the interaction with_the restraint system or the vehicle interior.

It is, however, important to inspect test information closely in order to detect misleading results due to details of the construction of the test device which are significantly different from those of the human body (for example, metal edges which might cut restraint devices).

3.2.1.5 Instrumentation—Many different physical parameters can currently be measured using the ATD specified in 49 CFR Part 572, Subpart E including, but not limited to: acceleration of the head, chest, and pelvis, forces and moments on the upper and lower neck, compression of the chest, and loads on the femur and tibia. In addition, instrumentation specifically developed to address occupant submarining under belt systems is available (pelvic load bolts, frangible abdomen, front-of-the-ilium load transducers, and iliac crest load transducers). Careful consideration should be given to the instrumentation used in the ATD for a particular test.

3.2.1.6 Occupant Kinematics—While instrumentation on the dummy provides the engineer with useful information, reliance should not be placed only on the numbers generated by the dummy's transducers. The kinematics (motion) of the dummy during the test should be monitored using high-speed photography or videography. The images thus provided may enable the engineer to evaluate how test-to-test variation might affect the numbers generated by the transducers (for example, if minimal differences in excursion might allow the dummy to contact some part of the vehicle interior).

3.2.2 TEST VEHICLE OR EQUIVALENT—The dynamic response of vehicles to a given impact can vary widely due to such factors as vehicle weight, structural design, body style, and engine size and location. These variations have significant effects on the performance of occupant restraining elements. Though it is not possible to test for all conceivable crash conditions, it is instructive to include the whole vehicle in the impact testing of a restraint system, or to use an adequately verified simulation of the complete vehicle, such as a sled buck with similar interior trim, subjected to a similar acceleration pulse. Exclusive of test devices and instrumentation, the vehicle should be tested at curb weight. It is also necessary to take into account any significant effects which optional equipment might have on the structural crush characteristics of the vehicle. (Adjustment for the weight of any equipment required for this reason is covered in 3.3.2.1.)

3.2.3 INSTRUMENTATION—Instrumentation appropriate for measuring accelerations, velocities, penetrations, distances, forces, and event timing is described in SAE J211 (OCT88). For correlation, acceleration data from the anthropomorphic test device should be recorded at 1000 Hz. However, to aid in the interpretation of results, it is recognized that some filtering of recorded data may be needed.

Complete high-speed video or photographic coverage is an integral part of a restraint system test program. It will frequently be advisable to remove a door or other section of the vehicle body to permit better photographic coverage, in which case struts should be employed as needed to make the structural integrity representative of the complete vehicle and to restore equivalent lateral restraint.

3.3 Test Preparation

3.3.1 INSTALLATION OF RESTRAINT SYSTEM COMPONENTS—Restraint system components should be installed, employed, and adjusted as they are intended to be used (in accordance with the manufacturer's recommendations).

Where seat belts of the types covered by SAE J114, J117, J140, J141, J339, and J800 form a part of the restraint system, belts should be adjusted to a pre-load of approximately 9 to 18 N (2 to 4 lb) per anchor. For manually adjustable shoulder belts, pre-load is obtained with a 76.2 mm (3 in) cube between the belt and the sternum, which is removed before the test is run. If a locking type retractor is present, the tension that results from the retractor's internal spring should be used for a pre-load tension setting. Belts and test devices should be jostled about during the tightening process so as to minimize the effects of friction on the pre-load reading.

3.3.2 INSTALLATION OF ANTHROPOMORPHIC TEST DEVICES

3.3.2.1 Number of Occupants—Occupant restraint conditions should be evaluated for each designated seating position. However, the dynamic response of a vehicle will vary with load and with the manner in which the load is restrained. In addition, a full complement of anthropomorphic test devices makes good photographic coverage quite difficult, and conditions of symmetry or previous experience may make it unnecessary to test all seating positions simultaneously.

With these and similar considerations in mind, the test vehicle should be loaded to 270 kg ± 25 kg (600 lb ± 50 lb) above curb weight including all test devices, instrumentation, optional equipment, and ballast for a vehicle with four, five, or six designated seating positions. This load should be reduced by 70 kg (150 lb) for vehicles with less than four seating positions and increased by 70 kg (150 lb) for vehicles with more than six seating positions.

3.3.2.2 Occupant Placement—With an anthropomorphic test device normally occupying the driver's position, consideration should be given to additional devices located at any appropriate seating position to evaluate restraint conditions and to bring into play any interaction between occupants. Adjustable seats and seatbacks should be at the seat position appropriate for the size dummy used. Tests at other seat adjustment positions should also be considered if engineering judgment determines or predicts that the seat position has a significant effect on the manner in which the occupant engages the restraints.

3.3.2.3 Posture—Details of the restraint system and vehicle being tested should be considered together with the vehicle manufacturer's instructions for proper use in order to select from the range of normal seating postures and positions those which appear to be most appropriate for evaluating the system. To the extent possible, the test results should then be examined to assure that the system has exhibited a sufficient margin of performance to cover other reasonable postures and positions.

In the absence of considerations specific to the particular vehicle and restraint system, the driver should be centered on the center of the steering wheel with the hands on the wheel rim at the horizontal centerline. Where the space provided for other outboard occupants is similar to the driver space, these dummies should be located approximately the same distance from the vehicle centerline as the driver. Test devices in center seats should be on the car centerline except that where the front seat foot well area is effectively divided into two compartments, both feet should be in the passenger's portion of the foot well. Passengers' arms should be placed on the lap with the hands overlapping.

3.3.2.4 Joint Adjustment—Friction at articulated joints of the anthropomorphic test devices should be adjusted to approximately 1 g at all points of articulation, using the torso as the reference base.

3.3.3 INSTALLATION OF INSTRUMENTATION—Major elements of the instrumentation load and any ballast required to reach the specified vehicle loading should be fixed securely to the vehicle structure in the normal cargo-carrying area. Alternate locations may sometimes be necessary to avoid damage to instrumentation during the crash.

Instrumentation applied to the ATDs should not significantly alter the mass, center of gravity, or freedom of motion of each body member as specified in 49 CFR Part 572. Similarly, the application of instrumentation to the vehicle should not significantly affect its crush characteristics or the behavior of restraining elements. Guidance as to the specific measurements which should be made in evaluating risk of injury for an occupant in a similar collision using a similar restraint system is contained in SAE J885.

3.4 Vehicle Impact Test Conditions

3.4.1 CRASH TESTS—Under actual collision conditions, vehicles can conceivably be subjected to high acceleration levels from any direction. In developing and evaluating occupant restraint systems, it is a practical necessity to select and use as standard collision configurations only a very few of the more important types of impact exposure. At present only the configurations specified as follows have been shown to have the significance, reproducibility, and practicality to justify recommending them for general use. Test results should, therefore, be examined carefully to evaluate the system for comparable performance in the face of special conditions or reasonable variations. These might include such major factors as the direction and speed of impact, area of contact, the compliance and weight of the impacting objects, or lesser factors such as seat position, window position, etc. Note that performance at a single impact speed may not be enough to protect all occupants (e.g., the elderly will likely be injured at lower speed than younger individuals).

3.4.1.1 Frontal Impact—Frontal impact of the test vehicle into a fixed barrier should be conducted in accordance with SAE J850. Impact speed is typically 48.3 km/h (30 mph).

3.4.1.2 Rear Impact—Rear impact of the test vehicle by a moving barrier should be conducted in accordance with SAE J972. The impact speed is typically 48.3 km/h (30 mph).

3.4.1.3 Side Impacts—Side impact of the test vehicle by a moving barrier should be conducted in accordance with FMVSS 214. The impact speed is typically 53.9 km/h (33.5 mph).

3.4.1.4 Rollover—Despite continuing efforts, no satisfactory procedures for realistic simulation of rollovers has been developed. Restraint system performance for these collisions must, therefore, be evaluated on a relative basis using judgment, experience, or special tests appropriate to a particular system. Attention should be directed to recognized hazards such as the likelihood of occupant ejection or the presence of sharp or protruding hardware in the roof area and side structure.

3.4.2 SIMULATIONS—For many purposes in restraint system testing the impacts specified previously may be reproduced with an impact simulator, provided that all significant variables are adequately reproduced and verified. These variables might include factors such as impact pulse, structural performance, and vehicle attitude.

3.4.2.1 Different Occupant Sizes—To evaluate protection for the spectrum of occupants for which a seating position is designed, consideration, either by engineering judgment or impact simulations, should be given to the following possible scenarios:

a. Mid-size male dummy in driver and right front passenger, mid-seating positions.
b. Small female dummy in driver and right front passenger, full forward and up, full rearward and down seating positions.
c. Large male dummy in driver and right front passenger, full rear and down seating positions with unreinforced components and body.
d. Three- and six-year-old child dummies in the right front passenger, full forward, mid- and full-rear seating positions.
e. Mid-size male, small female, large male, and six-year-old child dummies in any forward-facing rear seating position for which they are not specifically excluded in the vehicle owner's manual and in which the dummy can be realistically positioned.
f. A representative child seat and/or infant carrier in any seating position not specifically excluded for their use in the vehicle owner's manual or in the child restraint manufacturer's installation instructions (see SAE J1368, J1369, and J1819).
g. SID or BIOSID dummy in driver and second row left (if forward-facing) seating positions with seats at the mid-point of travel.

3.4.2.2 Adjustable Hardware—Hardware which is adjustable by the occupant (adjustable upper anchor, tilt steering wheel with supplemental inflatable restraints, etc.) should be considered over its full range of motion. Simulations should be performed if engineering judgment concludes that a certain adjustment might degrade system performance (e.g., adjustable upper anchor in full up position for small female in rear-most adjustable seat position).

3.4.3 MULTIPLE IMPACTS—The configurations specified previously are representative of severe single-impact collisions in which the entire energy exchange takes place in a fraction of a second. A significant proportion of collisions involve multiple impacts of reduced individual severity occurring over a period of up to several seconds before the vehicles come to rest. In view of the random nature of such collisions, no special test is recommended. However, the restraint system should be examined to determine if special tests are needed to verify its ability to provide adequate protection if the total energy exchange takes place in multiple impacts producing the same total speed change as the single impact specified.

3.4.4 RELIABILITY OF TEST RESULTS—It is difficult to obtain impact test results which are accurate and reproducible within the usual limits of engineering test work. An unusual degree of care is, therefore, required in attributing significance to any one piece of test information. Investigators are encouraged to utilize other pertinent SAE documents to supplement the information on total restraint system evaluation discussed in this report.

4. Notes

4.1 Keywords—Restraint, injury, tolerance, testing, collision, impact, anthropomorphic test device or ATD, dummy, seat belt, airbag, supplemental inflatable restraint

(R) SEAT BELT HARDWARE TEST PROCEDURES—SAE J140 JUN95

SAE Recommended Practice

Report of the Motor Vehicle Seat Belt Committee approved April 1970 and revised February 1973. Completely revised by the SAE Restraints Systems Standards Committee June 1995.

1. Scope—This SAE Recommended Practice describes test procedures for evaluating hardware used in motor vehicle seat belt assemblies. Related hardware performance requirements are described in SAE J141.

Test procedures and performance requirements for retractors will be covered in separate SAE Recommended Practices to be issued later.

2. References

2.1 Applicable Documents—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J141—Seat Belt Hardware Performance Requirements

SAE J339—Seat Belt Assembly Webbing Abrasion Test Procedure

2.1.2 ASTM PUBLICATIONS—Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM B 117—Method of Salt Spray (Fog) Testing

ASTM D 756—Service Conditions

ASTM E 4—Standard Methods of Load Verification of Test Machines

2.2 Related Publication—The following publication is provided for information purposes only and is not a required part of this document.

2.2.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J114—Seat Belt Assembly Webbing Abrasion Performance Requirements

3. Definitions

3.1 Seat Belt Assembly—Any strap, webbing, or similar device designed to secure a person in a motor vehicle with the intention of minimizing the risk of bodily harm in a collision (other than a system designed solely to accommodate children), including all buckles, adjusting mechanisms, fasteners, and related hardware.

3.2 Pelvic Restraint—A seat belt assembly or portion thereof intended to restrain movement of the lower torso by directing forces to the pelvic girdle.

3.3 Upper Torso Restraint—A portion of a seat belt assembly intended to restrain forward movement of the upper torso.

3.4 Type 1 Seat Belt Assembly—A seat belt assembly which provides pelvic restraint.

3.5 Type 2 Seat Belt Assembly—A seat belt assembly which provides both pelvic and upper torso restraint.

3.6 Type 2A Seat Belt Assembly—A seat belt assembly consisting of either a separate upper torso restraint intended for use only with a Type 1 seat belt assembly or knee bolster, or an upper torso restraint which may be connected to a Type 1 seat belt assembly for use as a Type 2 seat belt assembly.

3.7 Type 4 Seat Belt Assembly—An automatic seat belt system.

3.8 Hardware—Any metal or rigid plastic part of the seat belt assembly.

3.8.1 BUCKLE—A quick release connector between two parts of a seat belt assembly.

3.8.2 ATTACHMENT HARDWARE—All load-bearing hardware designed for securing the webbing portion of a seat belt assembly to a motor vehicle structure or intermediate structural component including but not limited to retractors, end fittings, bolts, studs, nuts, or other attachment means but not including those components permanently fixed to the vehicle.

NOTE—If the seat belt is attached to a seat, the seat is not attachment hardware.

3.8.3 ADJUSTABLE HARDWARE—The hardware designed for adjusting the size of a seat belt assembly to fit the user, including hardware that may be integral with a buckle, attachment hardware, or retractor.

3.9 Laboratory Ambient Conditions—Conditions at 23 °C ± 2 °C (73.4 °F ± 3 °F) and a relative humidity between 48 and 67%.

4. Test Procedure

4.1 General—All components shall be conditioned for 4 h under laboratory ambient conditions prior to conducting the test sequence outlined in Table 1.

NOTE—The humidity requirement is not applicable to components in Groups 3 and 4.

4.2 Corrosion Resistance—Three seat belt assemblies shall be tested in accordance with ASTM B 117 published by the American Society for Testing and Materials (ASTM). The period of test shall be 50 h for all attachment hardware at or near the floor, consisting of two periods of 24 h exposure to salt spray each followed by 1 h drying. The period of test shall be 25 h for all other hardware, consisting of one period of 24 h of exposure to salt spray followed by 1 h drying. In the salt spray chamber, the parts from the three assemblies shall be oriented differently, at those orientations most likely to develop corrosion on the larger areas. At the end of the 1 h drying interval at the conclusion of the test, the seat belt assembly shall be washed thoroughly with water to completely remove the salt. After drying for at least 24 h under ambient laboratory conditions, attachment hardware shall be examined for ferrous corrosion on significant surfaces, that is, surfaces that can be contacted by a sphere 19 mm (0.75 in) in diameter. Other hardware shall be examined for ferrous and nonferrous corrosion which may be transferred either directly or by means of the webbing to a person or his or her clothing during use of a seat belt assembly incorporating the hardware.

4.3 Temperature Resistance—Three seat belt assemblies having plastic or nonmetallic hardware shall be subjected to the conditions prescribed in procedure D of ASTM D 756. The dimension and weight measurements shall be omitted. Buckles shall be unlatched during conditioning. The hardware parts, after conditioning, shall be used for all applicable assembly tests.

4.4 Attachment Hardware

TABLE 1—TEST SEQUENCE

Test Method	SAE J140 Paragraph Ref.	Sequence of Tests Group[1] 1	Sequence of Tests Group[1] 2	Sequence of Tests Group[1] 3	Sequence of Tests Group[1] 4
Conditioning, General	4.1	1	1	1	—
Corrosion	4.2	4	—	2	1
Temperature resistance	4.3	5	—	3	—
Strength	4.4	11	—	5	2
Hook retention	4.5	—	—	4	—
Buckle release					
Loop test	4.6	12	—	—	—
Access	—	6	—	—	—
Compression	4.7	9	—	—	—
Buckle latch—cycle and false latch	4.8	10	—	—	—
Tilt lock	5.2	2,7	2,5	—	—
Adjustment	5.1	3,8	3,6	—	—
Abrasion—system	—	—	4	—	—
Webbing tensile strength	6.1	—	7	—	—

1 Group 1—Components from three assemblies for evaluation of a buckle or other adjustment means excluding retractors.
Group 2—Components from three assemblies which are normally used to adjust the size of a seat belt assembly, excluding retractors, for system abrasion as described in SAE J339.
Group 3—Components from three assemblies for evaluation of attachment hardware.
Group 4—Bolts, bolt systems, or other substitute attachment means.

4.4.1 PELVIC RESTRAINT—Attachment bolts or other substitute attachment means used to secure the pelvic restraint of a seat belt assembly to a motor vehicle shall be tested in a manner similar to that shown in Figure 1. The force shall be applied at an angle of 45 degrees to the axis of the bolt through attachment hardware from the seat belt assembly, or through a special fixture which simulates the loading applied by the attachment hardware. When bolts are used, the attachment hardware or simulated fixture shall be fastened by the bolt to the anchorage shown in Figure 1, which has a standard 7/16-20 UNF-2B or 1/2-13 UNC-2B threaded hole (or metric equivalent, M12) in a hardened steel plate of at least 10 mm (0.4 in) in thickness. The bolt shall be tested when installed two full turns from the fully seated position (see Figure 1). The appropriate force required by SAE J141 shall be applied. The bolts or other attachment means from each of three seat belt assemblies shall be tested. Other attachment means shall be tested in a manner which simulates usage.

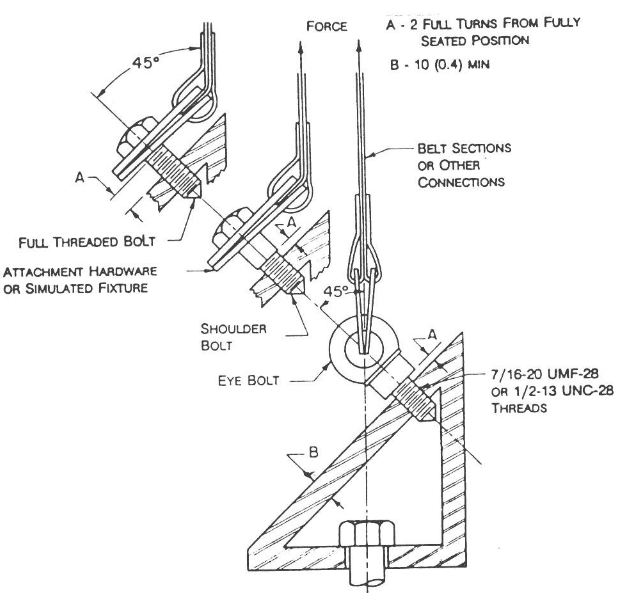

FIGURE 1—ATTACHMENT HARDWARE TEST FIXTURE

4.4.2 UPPER TORSO RESTRAINT—Attachment bolts or other attachment means used to secure the upper torso portion of a seat belt assembly to a motor vehicle shall be tested in a manner similar to that shown in Figure 1. The force shall be applied at an angle of 45 degrees to the axis of the fastener or bolt through attachment hardware from the seat belt assembly, or through a special fixture which simulates the loading applied by the attachment hardware as installed in the vehicle. The attachment hardware or simulated fixture shall be fastened by the bolt(s) or fastener(s) to the anchorage shown in Figure 1, which has the appropriate mating hole(s) or attachment(s) in a hardened steel plate of at least 10 mm (0.4 in) in thickness. Bolt(s) shall be tested when installed two full turns from the fully seated position. The appropriate force required by SAE J141 shall be applied. Bolts and/or fasteners from each of three seat belt assemblies shall be tested.

4.5 Single Attachment Hook Retention—Three single attachment hooks for connecting webbing to an eye bolt shall be tested in the following manner: the hook shall be held rigidly so that the retainer latch or keeper, with cotter pin or other locking device in place, is in a horizontal position as shown in Figure 2. A force of 665 N ± 9 N (150 lbf ± 2 lbf) shall be applied vertically upward as near as possible to the free end of the retainer latch, and the movement of the latch at the point of force application shall be measured. The vertical force shall be released, and a force of 665 N ± 9 N (150 lbf ± 2 lbf) shall be applied horizontally as near as possible to the free end of the retainer latch. The movement of the latch at the point of force application shall be measured. Alternatively, the hook may be held in other positions, provided that the forces and the movements of the latch are measured at the points indicated in Figure 2.

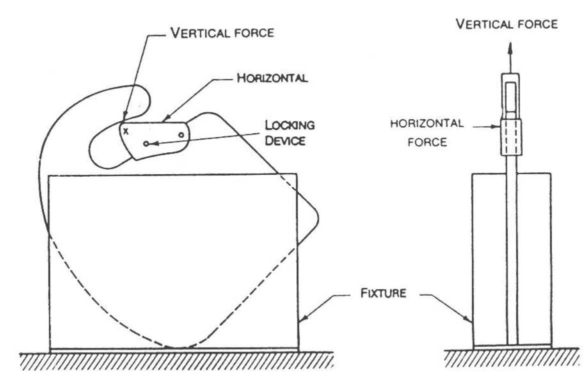

FIGURE 2—SINGLE ATTACHMENT HOOK RETENTION

4.6 Buckle Release—Three seat belt buckle assemblies shall be tested to determine buckle release force. After the force applicable to the seat belt assembly being tested in the procedure of Section 7 has been reached, the force shall be reduced and maintained at 665 N ± 50 N (150 lbf ± 10 lbf).

4.6.1 For push button buckles, the release force shall be measured at the point of maximum mechanical advantage, but no closer than 4.0 mm (0.15 in) from the edge of the release button opening.

4.6.2 For lift cover buckles, the force shall be applied on the centerline of the buckle lever or finger tab so as to produce maximum releasing effect. A hole 2.5 mm (0.1 in) in diameter may be drilled through the buckle tab or lever on the centerline between 3.0 and 3.3 mm (0.12 to 0.13 in) from its edge, and a small loop of soft wire may be used as the connecting link between the buckle tab or lever and the force-measuring device.

4.6.3 For buckles of other types, the release force shall be applied in a manner so as to simulate usage.

4.7 Buckle Compression—The buckle of a Type 1 or Type 2 seat belt assembly shall be subjected to a specified compressive force of 1776 N ± 90 N (400 lbf ± 20 lbf) applied anywhere on the longitudinal centerline of the buckle and anywhere along lines at approximately 60 degrees to this centerline, with the point of intersection of these lines centered over the release mechanism. The force shall be applied through a cylindrical bar 19 mm (0.75 in) in diameter, at least 100 mm (4.0 in) long, and curved to a radius of 150 mm (6.0 in). The bar shall be placed with the longitudinal centerline of the bar directly above the lines through the longitudinal centerline of the buckle and at 60 degrees to it (see Figure 3). Buckles from three seat belt assemblies shall be tested.

4.7.1 The buckle and latch plate shall be assembled and a tensile force of 333 N ± 22 N (75 lbf ± 5 lbf) shall be applied to the connected assembly during the application of the compressive force.

4.7.2 The latch plate shall be disengaged from the buckle and the compressive force applied to the buckle again.

4.8 Buckle Latch Operation

4.8.1 The buckles from three seat belt assemblies shall be fully latched with their latch plates and unlatched at least 10 times. Then each buckle, with the latch plate withdrawn from the buckle, shall be clamped or firmly held against a solid surface so as to permit normal movement of buckle parts without movement of the buckle assembly. The release mechanism shall be moved 200 times through the maximum possible travel against its stop with a force of 133 N ± 13 N (30 lbf ± 3 lbf) at a rate not to exceed 30 cpm, actuating the mechanism in a manner which simulates actual usage. After completion of this portion of the test, the 133 N (30 lbf) force shall be reduced to a force of just sufficient magnitude to assure full travel to the stop for an additional 10 000 cycles. The performance of each buckle shall then be evaluated with respect to 4.8.1 of SAE J141.

4.8.2 A buckle shall be examined to determine whether partial engagement is possible by means of any technique representative of actual use. If partial engagement is possible, the maximum force of separation when in such partial engagement shall be determined.

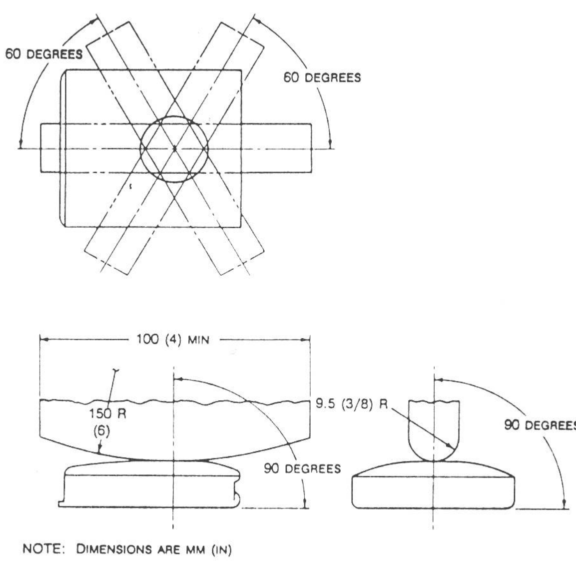

FIGURE 3—BUCKLE COMPRESSION

5. System Test Procedures Related to Hardware

5.1 Adjustment Force—Three buckles or other manual adjusting devices normally used to adjust the length of the assembly shall be tested. This test shall be conducted within 1 h after conditioning under laboratory ambient conditions. With no load on the anchor end, the webbing shall be drawn through the adjusting device at a rate of 500 mm ± 50 mm (20 in ± 2 in) per minute, and the maximum force shall be measured to the nearest 1 N (0.25 lbf) after the first 25 mm (1.0 in) of webbing movement. The webbing shall be precycled 10 times prior to measurement.

5.2 Tilt-Lock Adjustment—This test shall be conducted on buckles or other manual adjusting devices employing a tilt-lock feature to adjust the length of the assembly, using webbing intended for use in the adjusting device. Three buckles or devices shall be tested within 1 h after conditioning the webbing for 4 h at laboratory ambient conditions. The base of the adjustment mechanism and the anchor end of the webbing shall be oriented in planes normal to one another with the webbing vertical as in Figure 4. The buckle base shall be horizontal and downward at the start of the test. The webbing shall be drawn through the adjustment mechanism so as to increase belt length at a rate of 500 mm ± 50 mm (20 in ± 2 in) per minute, while the plane of the base is rotated at a speed of 1.1 rpm ± 0.2 rpm in a direction so as to lock the webbing. Rotation shall be stopped when the webbing locks and subsequently supports a 9 kg (20 lb) mass, but the pull on the webbing shall be continued until there is a resistance of at least 89 N (20 lbf). The locking angle between the anchor end of the webbing and the base of the adjustment mechanism shall then be measured to the nearest degree. The webbing shall be precycled 10 times prior to measurement.

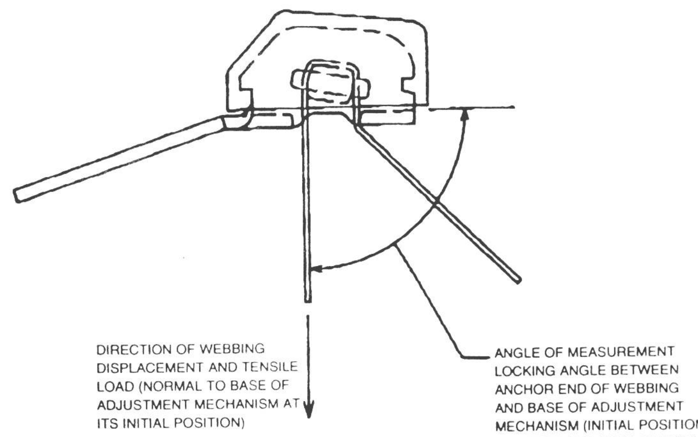

FIGURE 4—TILT-LOCK ADJUSTMENT

6. Webbing Breaking Strength—Webbing from three seat belt assemblies shall be conditioned in accordance with 4.1 and tested for breaking strength in a testing machine of capacity verified to have an error of not more than 1% in the range of the breaking strength of the webbing in accordance with ASTM E 4-82.

The machine shall be equipped with split drum grips illustrated in Figure 5, having a diameter between 50 and 100 mm (2.0 and 4.0 in). The rate of grip separation shall be between 50 and 100 mm/m (2.0 and 4.0 in/m). The distance between the centers of the grips at the start of the test shall be between 100 and 250 mm (4.0 and 10.0 in). After placing the specimen in the grips, the webbing shall be stretched continuously at a uniform rate to failure. Each value shall be not less than the applicable breaking strength requirement in 6.1 of SAE J141.

7. Test Procedures for Assembly Performance

7.1 Type 1 Seat Belt Assembly—Three complete seat belt assemblies including webbing, straps, buckles, adjustment and attachment hardware, and retractors, arranged in the form of a loop as shown in Figure 6, shall be tested in the following manner:

7.1.1 The testing machine shall conform to the requirements specified in Section 6. A double roller block shall be attached to one head of the testing machine. The block shall consist of 2 rollers, 100 mm (4.0 in) in diameter, and sufficiently long so that no part of the seat belt assembly touches parts of the block other than the rollers during the test. The rollers shall be mounted on antifriction bearings and spaced 300 mm (12.0 in) between centers, and shall have sufficient capacity so that there is no brinnelling, bending, or other distortion of parts which may affect the results. An anchorage bar shall be fastened to the other head of the testing machine.

7.1.2 The attachment hardware furnished with the seat belt assembly shall be attached to the anchorage bar. The anchor points shall be spaced so that the webbing is parallel to the two sides of the loop. The attaching bolt shall be parallel, or at an angle of 45 or 90 degrees to the webbing, whichever results in the greatest angle between webbing and attachment hardware, except that eye bolts shall be vertical, and attaching bolts of a seat belt assembly designed for use in specific models of motor vehicles shall be installed to produce the maximum angle in use indicated by the installation instructions.

Rigid adapters between the anchorage bar and attachment hardware shall be used, if necessary, to locate and orient the adjustment hardware. The adapter shall have a flat support face perpendicular to the threaded hole for the attaching bolt, and adequate in area to provide full support for the base of the attachment hardware connected to the webbing. If necessary, a washer shall be used under a swivel plate or other attachment that would crush or damage the webbing as the attaching bolt is tightened.

7.1.3 The length of the assembly loop from attaching bolt to attaching bolt shall be adjusted to be about 1300 mm (51.0 in) or as near thereto as possible. A force of 0.25 kN (55.0 lbf) shall be applied to the loop to remove any slack in the webbing at the hardware. The force shall be removed, and the heads of the testing machine shall be adjusted for an assembly loop between 1220 and 1270 mm (48.0 to 50.5 in) in length. The length of the assembly loop shall then be adjusted by applying a force between 88 and 98 N (20.0 and 22.0 lbf) to the free end of the webbing at the buckle, or by the retractive force of an automatic locking or emergency locking retractor. A seat belt assembly that cannot be adjusted to this length shall be adjusted as closely as possible. An automatic locking or emergency locking retractor, when included in a seat belt assembly, shall be locked at the start of the test with a tension in the webbing slightly in excess of the retractile force in order to keep the retractor locked.

The buckle shall be in a location such that it does not touch the rollers during the test, but, to facilitate conducting the buckle release test of 4.6, the buckle should be between the rollers or near a roller in one leg.

7.1.4 The heads of the testing machine shall be separated at a rate of 50 to 100 mm (2.0 to 4.0 in) per minute so as to apply a force to the assembly loop as specified in Section 7 of SAE J141. The extension of the loop shall be determined from measurements of head separation before and after the force is applied. The force shall be decreased to 665 N ± 50 N (150 lbf ± 10 lbf), and the buckle release force shall be measured as prescribed in 4.6.

7.1.5 After the buckle is released, the webbing shall be examined for cutting by the hardware. If the yarns are partially or completely severed in a line for a distance of 10% of the webbing width, the cut webbing shall be tested for breaking strength as described in Section 5, with the cut located in the free length between the grips. If there is insufficient webbing on either side of the cut to conduct such a test for breaking strength, the cut webbing shall be sewn to a length of webbing taken from another seat belt assemb'y and repositioned in the hardware. A tensile force of 11.1 kN ± 0.1 kN (2500 lbf ± 25 lbf) shall be initially applied to the cut webbing. The initial force shall be reduced to zero, and the webbing then tested for breaking strength as required in 7.1.3 or 7.2.6 of SAE J141.

7.1.6 A seat belt assembly containing an emergency locking retractor or automatic locking retractor shall also be tested with the webbing fully extended. If a Type 1 seat belt assembly includes an automatic locking retractor or emergency locking retractor, the webbing and retractor shall be subjected to a tensile force of 11.1 kN ± 0.1 kN (2500 lbf ± 25 lbf) with the webbing fully extended from the retractor.

7.2 Type 2 Seat Belt Assembly—All components of three seat belt assemblies shall be tested in the following manner:

7.2.1 The pelvic restraint between anchorages shall be adjusted to a length between 1220 and 1270 mm (48.0 and 50.0 in), or as near to this length as possible, if the design of the pelvic restraint does not permit its adjustment to this length. An automatic locking or emergency locking retractor, when included in a seat belt assembly, shall be locked at the start of the test with a tension in the webbing slightly in excess of the retractile force in order to keep the retractor locked. The attachment hardware shall be oriented to the webbing as specified in 6.1.2 and illustrated in Figure 6. A tensile force of 11.1 kN ± 0.1 kN (2500 lbf ± 25 lbf) shall be applied to the components in any convenient manner and the extension between anchorages under this force shall be measured. The force shall be reduced and the buckle release force measured as prescribed in 4.6.

7.2.2 The components of the upper torso restraint shall be subjected to a tensile force of 6.7 kN ± 0.7 kN (1500 lbf ± 15 lbf) following the procedure previously prescribed for testing pelvic restraint, and the extension between anchors under this force shall be measured. If the testing apparatus permits, the pelvic and upper torso restraints may be tested simultaneously. The force shall be reduced to 665 N ± 50 N (150 lbf ± 10 lbf), and the buckle release force measured as prescribed in 4.6.

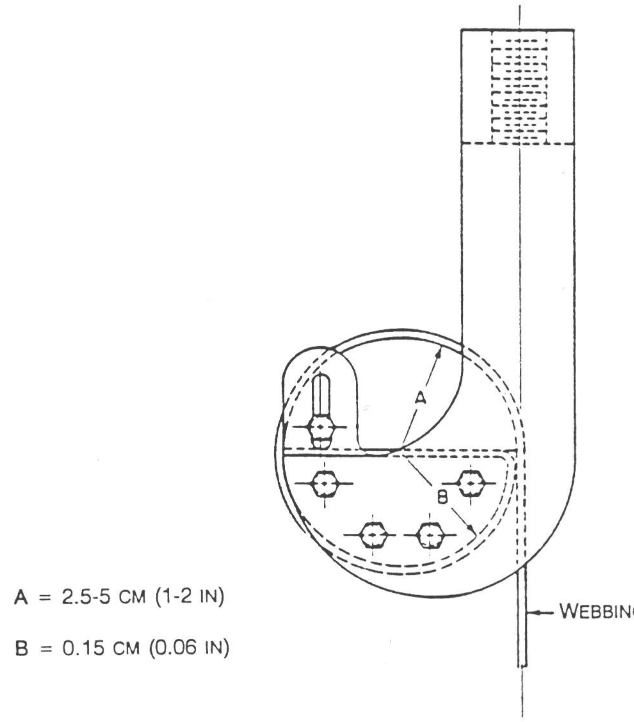

FIGURE 5—WEBBING BREAKING STRENGTH

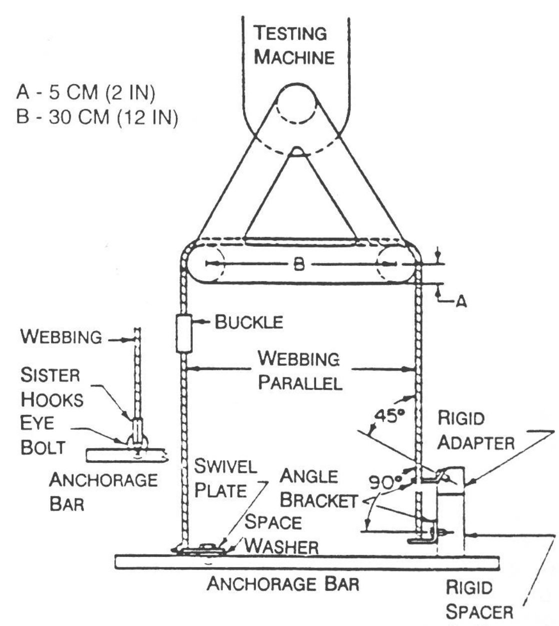

FIGURE 6—SEAT BELT ASSEMBLY TEST

(R) SEAT BELT HARDWARE PERFORMANCE REQUIREMENTS—SAE J141 JUN95

SAE Recommended Practice

Report of the Motor Vehicle Seat Belt Committee approved February 1973. Completely revised by the SAE Restraints Systems Standards Committee June 1995.

1. Scope—This SAE Recommended Practice describes performance requirements for hardware used in motor vehicle seat belt assemblies when tested in accordance with the test procedures specified in SAE J140.

Test procedures and performance requirements for retractors will be covered in separate SAE Recommended Practices to be issued later.

2. References

2.1 Applicable Documents—The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J140—Seat Belt Hardware Test Procedure

SAE J114—Seat Belt Assembly Webbing Abrasion Performance Requirements

SAE J339—Seat Belt Assembly Webbing Abrasion Test Procedure

3. Definitions

3.1 Seat Belt Assembly—Any strap, webbing, or similar device designed to secure a person in a motor vehicle with the intention of minimizing the risk of bodily harm in a collision (other than a system designed solely to accommodate children), including all buckles, adjusting mechanisms, fasteners, and related hardware.

3.2 Pelvic Restraint—A seat belt assembly or portion thereof intended to restrain movement of the lower torso by directing forces to the pelvic girdle.

3.3 Upper Torso Restraint—A portion of a seat belt assembly intended to restrain forward movement of the upper torso.

3.4 Type 1 Seat Belt Assembly—A seat belt assembly which provides pelvic restraint.

3.5 Type 2 Seat Belt Assembly—A seat belt assembly which provides both pelvic and upper torso restraint.

3.6 Type 2A Seat Belt Assembly—A seat belt assembly consisting of either a separate upper torso restraint intended for use only with a Type 1 seat belt assembly or knee bolster or an upper torso restraint which may be connected to a Type 1 seat belt assembly for use as a Type 2 seat belt assembly.

3.7 Type 4 Seat Belt Assembly—An automatic seat belt system.

3.8 Hardware—Any metal or rigid plastic part of the seat belt assembly.

3.8.1 BUCKLE—A quick release connector between two parts of a seat belt assembly.

3.8.2 ATTACHMENT HARDWARE—All load-bearing hardware designed for securing the webbing portion of a seat belt assembly to a motor vehicle structure or intermediate structural component including but not limited to retractors, end fittings, bolts, studs, nuts, or other attachment means but not including those components permanently fixed to the vehicle.

NOTE—If the seat belt is attached to a seat, the seat is not attachment hardware.

3.8.3 ADJUSTABLE HARDWARE—The hardware designed for adjusting the size of a seat belt assembly to fit the user, including hardware that may be integral with a buckle, attachment hardware, or retractor.

4. Requirements for Hardware

4.1 General

4.1.1 HARDWARE—All hardware which contacts, under normal usage, an occupant, his or her clothing, or his or her seat belt assembly, webbing shall be free from burrs and sharp edges, and shall be designed and located in the assembly that the possibility of injury to the occupant shall be minimized.

4.1.2 BUCKLE RELEASE MECHANISM—The buckle release mechanism shall be designed to minimize the possibility of accidental release. A buckle, with the release mechanism in the normal position, shall have only one opening into which the latch plate can be inserted on the end of the buckle which is designed to receive and latch the latch plate.

4.1.3 ATTACHMENT HARDWARE

4.1.3.1 The attachment hardware shall be designed to prevent attaching bolts and other parts from becoming inadvertently disengaged from the vehicle.

4.1.3.2 Reinforcing plates or washers furnished for universal floor installations shall be of steel, free from burrs and sharp edges on the peripheral edges adjacent to the vehicle, not less than 1.5 mm (0.06 in) in thickness, nor less than 2850 mm^2 (4.0 in^2) in projected area. The distance between any edge of the plate and the edge of the attachment hole shall be at least 15 mm (0.6 in), and any corner shall be rounded to a radius of not less than 6 mm (0.25 in), or cut at a 45 degree angle along a hypotenuse not less than 6 mm (0.25 in) in length.

4.1.3.3 Attaching bolts for Type 1 assemblies or the pelvic portion of a Type 2 assembly shall have threads, when installed, having a fit equivalent to or tighter than 7/16-20 UNF-2A or 1/2-13 UNC-2A, or the metric equivalent, M12.

4.2 Corrosion Resistance

4.2.1 Attachment hardware of a seat belt assembly after being subjected to the conditions specified in 4.2 of SAE J140, shall be free of ferrous corrosion on significant surfaces, except for permissible ferrous corrosion at peripheral edges or edges of holes on underfloor reinforcing plates and washers. The test for corrosion resistance shall not be required for attachment hardware made from corrosion-resistant steel containing at least 11.5% chromium.

4.2.2 Surfaces of buckles and metallic parts, other than attachment hardware, of a seat belt assembly, after being subjected to the conditions specified in 4.2 of SAE J140, shall be free of ferrous or nonferrous corrosion which can be transferred either directly or by means of webbing to the occupant or his or her clothing when the assembly is worn.

4.3 Temperature Resistance—Plastic or other nonmetallic hardware parts of a seat belt assembly, when subjected to the conditions specified in 4.3 of SAE J140, shall not deteriorate in any manner to cause the assembly to operate improperly or fail to comply with applicable requirements of Section 4.

4.4 Attachment Hardware Strength—Applicable test procedures of SAE J140 shall be used to determine attachment hardware strength. When more than one attachment bolt is used to secure a single piece of hardware to the vehicle, they shall be tested as a system and shall withstand the following applicable specified forces.

4.4.1 Attachment hardware other than the attaching bolts shall withstand the following tensile forces:

4.4.1.1 One end of the pelvic portion of a seat belt assembly, 11.1 kN (2500 lbf).

4.4.1.2 Common attachment for pelvic and upper torso portions of a seat belt, 13.3 kN (3000 lbf).

4.4.1.3 Upper torso portion of a seat belt assembly, 8.8 kN (2000 lbf).

4.4.1.4 Ends of two seat belt assemblies, 26.7 kN (6000 lbf).

4.4.2 Bolts used to secure the ends of seat belts to motor vehicles shall withstand the following forces:

4.4.2.1 One end of the pelvic portion of a seat belt assembly, 22.2 kN (5000 lbf).

4.4.2.2 Common attachment for pelvic and upper torso portions of a seat belt assembly, 26.7 kN (6000 lbf).

4.4.2.3 Upper torso portion of a seat belt assembly, 17.8 kN (4000 lbf).

4.4.2.4 Ends of more than one seat belt assembly, 40 kN (9000 lbf).

4.5 Single Attachment Hook—Retention—A seat belt assembly, having single attachment hooks of the quick disconnect type for connecting webbing to an eye bolt, shall be provided with a retaining latch or keeper which shall not move more than 2 mm (0.08 in) in either the vertical or horizontal direction when tested by the procedure specified in 4.5 of SAE J140.

4.6 Buckle Release

4.6.1 The buckle of a Type 1 or Type 2 seat belt assembly shall release when a force of not more than 133 N (30.0 lbf) is applied as prescribed in 4.6 of SAE J140.

4.6.2 A buckle designed for push button application of buckle release force shall have a minimum area of 45 mm^2 (0.7 in^2) with no linear dimension less than 10 mm (0.4 in) for applying the release force. A buckle designed for lift cover application of buckle release force shall permit the insertion of a cylinder 10 mm (0.4 in) in diameter and 58 mm (1.5 in) in length to at least the midpoint of the cylinder along the cylinder's entire length in the actuation portion of the buckle release. A buckle having other designs for release shall have adequate access for two or more fingers to actuate release.

4.7 Buckle Compression—A buckle shall withstand a compressive force of 1.88 kN (400 lbf) applied as prescribed in 4.7 of SAE J140, and shall be operable and shall meet the applicable requirements of 4.8 of this document, and the requirements for release effort after tensile force in 4.6 of SAE J140, upon removal of the compressive force.