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INTERNATIONAL
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SURFACE VEHICLE STANDARD

SAE J386

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An American National Standard

(R) OPERATOR RESTRAINT SYSTEM FOR OFF-ROAD WORK MACHINES

Foreword—This Document has also changed to comply with the new SAE Technical Standards Board format.

This SAE Standard is technically equivalent to the limited scope of ISO 6683 in the testing of seat belt anchorage forces for earthmoving machinery. This standard, beyond ISO 6683, includes testing of seat belt anchorage forces on industrial machines and the testing of seat belt assemblies.

1. Scope—This SAE Standard provides performance and test requirements for operator restraint systems provided for off-road self-propelled work machines.

1.1 Purpose—This document applies to pelvic restraint systems (Type 1) for off-road, self-propelled work machines fitted with ROPS and commonly used in construction, earthmoving, forestry, and mining as referred to in SAE J1040 and industrial machines fitted with ROPS as referred to in SAE J1042.

1.2 Field of Application

1.2.1 This document applies to operator restraint systems that include seat systems of 70 kg mass or less.

1.2.2 For machines with seat systems of greater than 70 kg mass, such as those that include add-on control modules, it is necessary that the seat support be designed to withstand an additional force of ten times the mass of the seat system which exceeds the 70 kg mass. This force should be added to the 15 000 N test force described in 5.2.2.

2. References

2.1 Applicable Publications—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the lastest revision 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 J141—Seat Belt Hardware Performance Requirements
SAE J833—Human Physical Dimensions
SAE J1040—Performance Criteria for Rollover Protective Structures (ROPS) for Construction, Earthmoving, Forestry, and Mining Machines
SAE J1042—Operator Protection for General Purpose Industrial Machines
SAE J1163—Determining Operator Seat Location on Off-Road Work Machines

TO PLACE A DOCUMENT ORDER; (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS http://www.sae.org

2.1.2 ASTM PUBLICATION—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 4–89—Standard Methods of Force Verification of Testing Machines

2.1.3 ISO PUBLICATION—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 6683—Earth-moving machinery—Seat belts and seat belt anchorages

3. Definitions

3.1 Adjustment Hardware—Hardware designed for adjusting the belt assembly to fit the user, including such hardware that may be integral with a buckle, attachment hardware, or retractor.

3.2 Anchorage—The point where the seat belt assembly and/or extension (tether) belt is mechanically attached to the seat system and/or machine.

3.3 Attachment Hardware—Hardware for securing a seat belt assembly to an anchorage on a seat system or on a machine.

3.4 Body Block—The test device used to apply the seat belt force to the seat system (reference Figure 1).

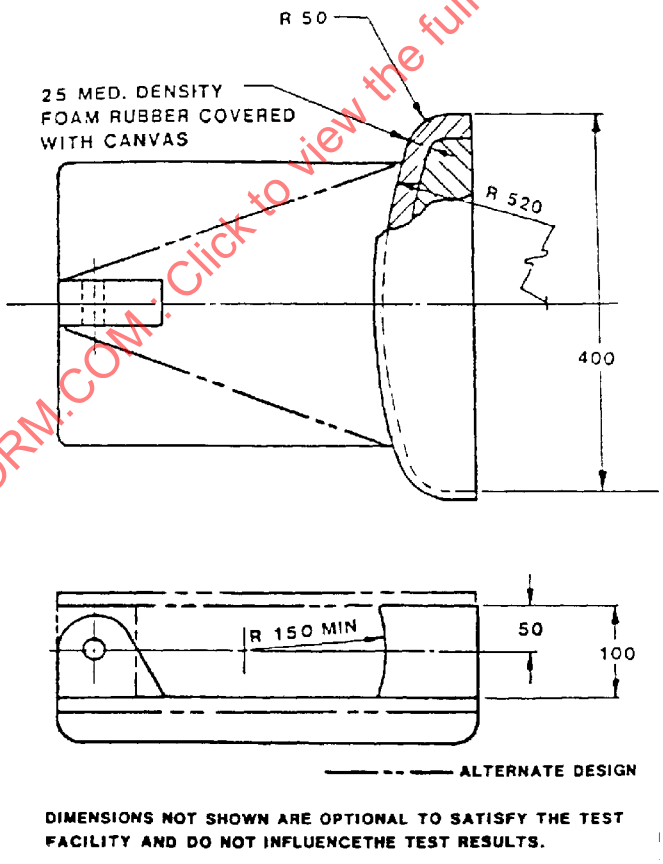


FIGURE 1—BODY BLOCK

3.5 Buckle And Latchplate—A quick-release connector which fastens the belt assembly into a loop.

3.6 Creep—The amount of unintentional lengthening of the seat belt assembly loop during use that is caused by motion of the machine, the seat, and the seat belted occupant.

3.7 Extension (Tether) Belt—Any strap, belt, or similar device (webbing, wire cable, solid link, etc.) that aids in the transfer of seat belt forces.

3.8 Hardware—Any metal or rigid plastic part of the restraint system.

3.9 Loop—The complete seat belt assembly as it would be installed around the seat occupant.

3.10 Operator Restraint System—The total system composed of the seat belt assembly, seat system, anchorages, and extension (tether) belts, if applicable, which transfers the seat belt force to a machine.

3.11 Polyester Yarn—Yarns spun from polyethylene terephthalate.

3.12 Retractors—Devices for storing all or part of the strap material of a seat belt assembly.

3.13 Roping—The tendency of a piece of material to twist upon itself or roll up transversely, remaining in the form of a rope instead of staying in its original strap form.

3.14 Seat Belt Assembly (Pelvic Restraint - Type 1)—Any strap or belt device fastened across the lap or pelvic girdle area designed to provide operator restraint in a machine. It includes buckles or other features, and may include the attachment hardware designed for installing the seat belt assembly to an anchorage.

3.15 Seat Index Point (SIP)—The point in the central, vertical, or longitudinal plane of the SIP measuring device when installed in the operator's seat as defined in SAE J1163.

3.16 Seat System—The total support mechanism between the machine and the operator interface. This could include the seat assembly, fixed seat support, or seat suspension (flexible seat support).

4. Technical Requirements, Testing, and Performance of Seat Belts

4.1 Seat Belt Assembly General Requirements

4.1.1 SINGLE OCCUPANCY—A seat belt assembly shall be designed for use by one, and only one, person at any time.

4.1.2 RELEASE—The seat belt assembly shall be provided with a buckle or latch readily accessible to the occupant, and designed to provide easy and rapid release of the assembly with a single motion. It shall also be capable of being released with either hand, bare or mittened. The buckle shall be designed to minimize the possibility of accidental release due to operator movement, inertia, or external forces. The buckle shall meet all the requirements described in 4.3.

4.1.3 ADJUSTMENT—The seat belt shall be self-adjusting or readily adjustable by a means within easy reach of the occupant. In all operating positions, adjustment to a snug condition shall at least accommodate the 5th percentile United States female through the 95th percentile United States winter-clothed male, reference SAE J833. To meet the previous requirements, overall length of belt may vary depending upon anchorage locations.

4.1.4 CREEP—Two seat belt assemblies of the same part number with adjusting devices included shall be tested in accordance with the requirements of 4.1.4.1 and 4.1.4.2. The creep shall not exceed 25 mm for each adjusting device in the assembly. The sum of creep amounts for all adjusting devices in the belt assembly shall not exceed 40 mm.

4.1.4.1 *Conditions*—Two seat belt assemblies of the same part number shall be conditioned for 24 h at a temperature of 20 °C ± 5 °C and 65% ± 5% relative humidity. The test shall be conducted at a temperature between 15 and 30 °C. The test apparatus shall conform to that shown in Figure 2 for test 1 and test 2.

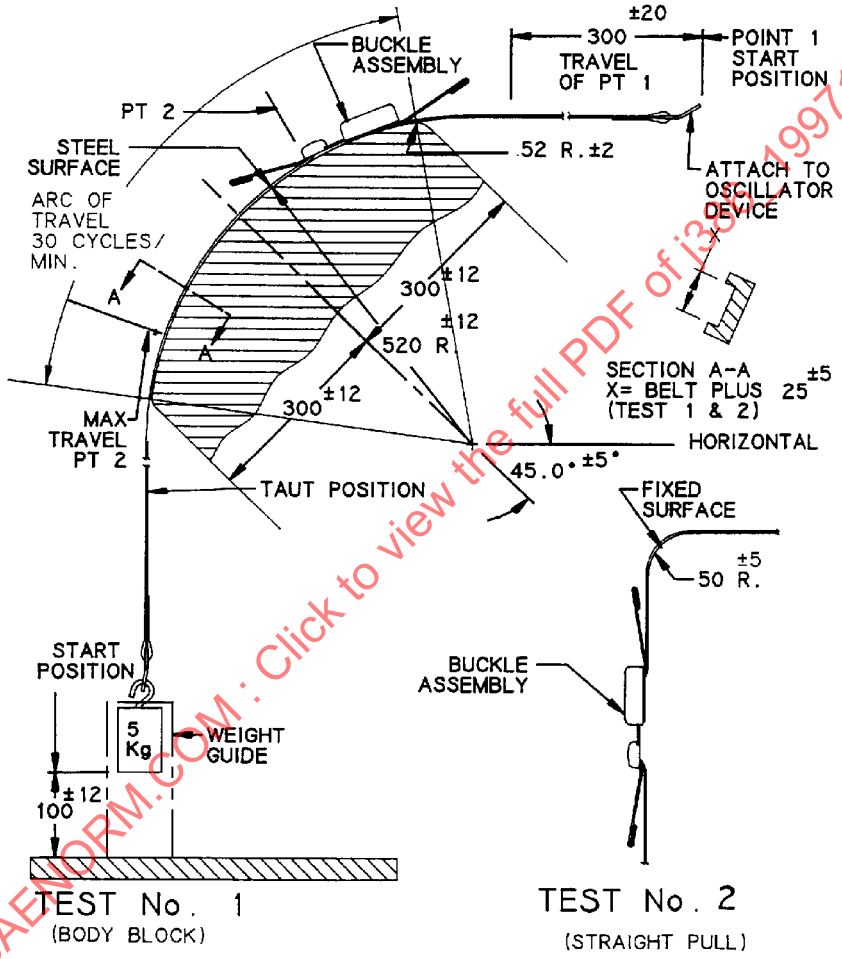


FIGURE 2—CREEP TEST APPARATUS

4.1.4.2 *Test Procedure*—Mount the belts as shown in Figure 2 for test 1 and test 2.

a. Apply a 5 kg mass to the lower end of each belt assembly.
b. Apply a reciprocating motion, total amplitude of 300 mm ± 20 mm to the top end of each belt assembly.
c. If there is a free end serving as reserve strap, it shall not be fastened or clipped to the section subjected to the 5 kg mass.
d. Ensure that on the test bench, the strap in the slack position maintains contact with the full length of the body block.
e. Guide the 5 kg mass vertically in a manner to prevent swaying of the mass and twisting of the belt during test.
f. The attachment shall be fixed to the 5 kg mass as in the machine.
g. Before start of test, complete 20 cycles of the reciprocating motion to remove initial slack.
h. Mark the force-bearing strap material at each adjuster in preparation for measuring creep.
i. Complete 1000 cycles at a frequency of 0.5 Hertz at the reciprocating motion of 300 mm ± 20 mm. The 5 kg mass shall be applied only during the time corresponding to a shift of 100 mm ± 12 mm of each half cycle. (Refer to Figure 2.)
j. Measure the distance the strap material has moved at each adjusting device.

4.1.5 BREAKING STRENGTH—The complete seat belt assembly shall withstand a loop force of not less than 22 200 N applied at the center of the loop by a loop force testing machine (Figure 3).

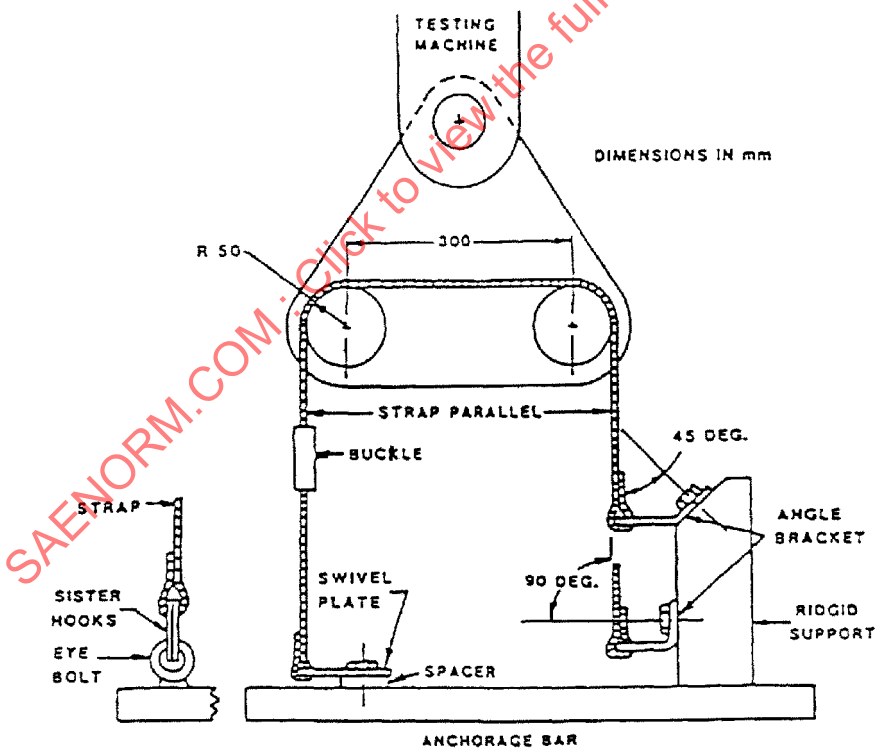


FIGURE 3—LOOP FORCE TESTING MACHINE

4.1.5.1 The loop force testing machine shall have a double-roller block attached to one head; the other head being an anchorage bar designed with anchorage points to accept seat belt assembly attachment hardware or adapters.

4.1.5.2 The double-roller block shall consist of two rollers sufficiently long so that the seat belt assembly touches only the rollers during testing. The rollers shall be mounted on anti-friction bearings, and shall have sufficient capacity so that there is no brinelling, bending, or other distortion of parts which may affect results.

4.1.5.3 The anchorage points on the anchorage bar shall be spaced so that the strap material is parallel in the two sides of the loop.

4.1.5.4 The machine shall be calibrated per ASTM E 4-89.

4.1.6 MARKING (LABELING)—Each seat belt assembly and/or each section of belt assembly shall be permanently and legibly labeled with year of manufacture, model or style number, and name or trademark of manufacturer or importer, and shall state compliance with SAE J386.

4.1.7 USAGE AND MAINTENANCE INSTRUCTIONS—Seat belt assemblies when packaged separately, shall be accompanied by written instructions for:

a. Proper installation, including the proper manner of threading the strap into the attachment hardware when threadable hardware is supplied.
b. Proper wearing of the installed assembly.
c. Proper maintenance (including cleaning procedures) and periodic inspection for wear or damage.

4.2 Strap Material Requirements

4.2.1 MATERIAL—The strap material shall have a resistance to mild acids, alkalies, mildew, aging, moisture, and sunlight equal to or better than that of untreated polyester yarn.

4.2.2 STIFFNESS—To minimize roping, the strap material shall be woven and/or treated to produce stiffness in the transverse direction. The stiffness shall be effective for the usable life of the strap. The strap shall be flexible in the longitudinal direction to permit adjustment at –40 °C.

4.2.3 COLOR—Preferred colors are those which are recommended by the strap material manufacturer as being less sensitive to ultraviolet rays.

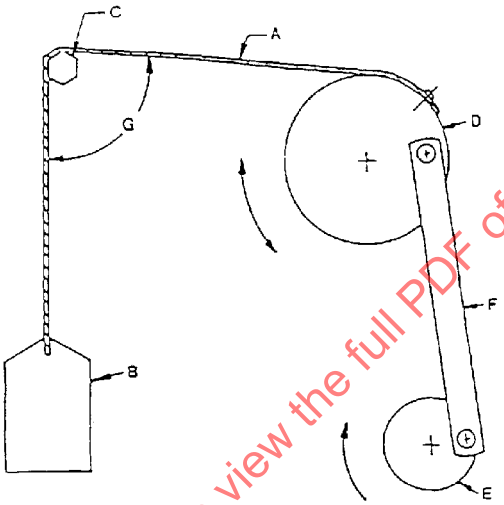
4.2.4 WIDTH—The strap material shall not be less than 46 mm in width when measured under a no-force condition.

4.2.5 ENDS—The ends shall be protected or treated to prevent unraveling, and shall not pull out of the adjustment hardware at maximum size adjustment.

4.2.6 STRENGTH—Condition three specimens for at least 24 h in an atmosphere having a relative humidity between 48 and 67% and a temperature of 23 °C ± 2 °C. After conditioning, the new material shall have a tensile breaking strength of not less than 26 700 N. The testing machine shall be verified to have an error of not more than 1% in the range of the tensile strength of the strap material (reference ASTM E 4-89). The distance between centers of the grips of the machine at the start of the test shall be between 100 and 250 mm. After placing the specimen in the grips, the strap material shall be stretched continuously at a uniform rate to failure. The rate of grip separation shall be 50 to 100 mm/min. Each failure force value shall be not less than the 26 700 N tensile breaking strength requirement.

4.2.7 ELONGATION—Elongation shall not exceed 20% at 11 100 N when measured during the test for strap material breaking strength as in 4.2.6.

4.2.8 ABRASION—The strap material from three seat belt assemblies shall be tested for resistance to abrasion by rubbing over the hexagon bar prescribed in Figure 4 in the following manner. The strap material shall be mounted in apparatus shown schematically in Figure 4. One end of the strap material, A, shall be attached to a weight, B, which has a mass of 2.3 kg ± 0.05 kg. The strap material shall be passed over the new abrading edges of the hexagon bar, C, and the other end attached to an oscillating drum, D, which has a stroke of 330 mm. Suitable guides shall be used to prevent movement of the strap material along the axis of the hexagonal bar, C. The drum shall be oscillated for 5000 strokes (2500 cycles) at a rate of 60 strokes ± 2 strokes (30 cycles ± 1 cycle) per minute. The abraded strap material shall be conditioned and tested for breaking strength as described in 4.2.6. The median value for the breaking strength determined on abraded specimens shall be not less than 20 000 N tensile strength.



A - STRAP MATERIAL
B - WEIGHT
C - HEX ROD
STEEL, SAE 51416
ROCKWELL HARDNESS, B-97 TO B-101
SURFACE, COLD DRAWN FINISH
SIZE, 6.35 ± 0.1
RADIUS ON EDGES, 0.5 ± 0.1
D - DRUM DIAMETER, 400
E - CRANK
F - CRANK ARM
G - ANGLE BETWEEN STRAP MATERIAL, 85 ± 2 DEG

FIGURE 4—ABRASION TEST FOR STRAP MATERIAL

4.3 Buckle Requirements

4.3.1 CORROSION RESISTANCE, TEMPERATURE RESISTANCE, COMPRESSION, LATCH OPERATION, ADJUSTMENT FORCE, TILT LOCK ADJUSTMENT—Satisfy the requirements of SAE J141.

4.3.2 RELEASE—The buckle of the seat belt assembly shall release when a force of not more than 130 N is applied to the releasing mechanism.

4.3.2.1 Three samples of a given buckle shall be tested. After subjection to the force described in 4.1.5, the force shall be reduced and maintained at a loop force of 670 N. The buckle shall be located so that it does not touch the rollers of the test machine during the test, but, to facilitate testing, the buckle should be between the rollers or near a roller in one leg of the loop. The buckle release force shall be measured by applying a force on the buckle in a manner and direction typical of that which would be employed by a seat belt user.

4.3.2.2 A buckle designed for lift lever application of buckle release shall at least permit the insertion of a cylinder 10 mm in diameter and 38 mm in length to at least the midpoint of the cylinder along the lift lever's entire length in the actuating portion of the buckle release. The release force shall be applied on the centerline of the buckle lever or finger tab in a direction that produces maximum releasing effect.

4.3.2.3 Buckles having other designs for release shall have adequate access to actuate release.

4.3.3 PADDING—If a buckle is used which is less than the width of the strap material, and in an area which may be uncomfortable to the operator, a pad must be provided under the buckle. This pad must cover the entire buckle area and is to be the full width of the strap. It must be permanently fastened to the assembly in such a manner that it is not injurious or uncomfortable to the operator, does not hinder operation of any part of the seat belt, and does not present any rough surfaces to the operator's clothing.

4.4 Hardware Requirements

4.4.1 GENERAL—Satisfy the requirements of SAE J141.

4.4.2 CORROSION RESISTANCE—Satisfy the requirements of SAE J141.

4.4.3 ATTACHMENT HARDWARE

4.4.3.1 *Design*—Satisfy the requirements of SAE J141.

4.4.3.2 *Temperature Resistance*—Plastic or other nonmetallic hardware parts of a seat belt assembly when subjected to the conditions specified in SAE J140, shall not deteriorate in any manner to cause the seat belt assembly to operate improperly or fail to comply with the requirements of 4.1.2, 4.1.3, and 4.1.4.

4.4.3.3 *Strength*

a. Attaching (Mounting) Bolts—Attaching (mounting) bolts shall withstand a force of 22 200 N when tested in accordance with SAE J140.
b. End Fittings (Mounting Brackets)—End fittings (mounting brackets) shall withstand a loop force of 22 200 N when tested on equipment similar to that shown in Figure 3. During the test, the attaching bolts shall be parallel to or at an angle of 45 or 90 degrees to the strap material, whichever results in an angle nearest to 90 degrees between the strap material and the end fitting. Exception: Eye bolts shall be mounted vertically.

4.4.4 ADJUSTMENT HARDWARE—Any adjustment shall be capable of being made with mittened hands.

4.4.5 RETRACTORS[1]— Retractors shall meet the seat belt assembly strength requirements of 4.1.5. When a locking retractor is included in a seat belt assembly, it shall be locked at the start of the seat belt assembly strength test. A seat belt assembly utilizing a nonlocking retractor shall have the strap material fully extended from the retractor at the start of the seat belt assembly strength test.

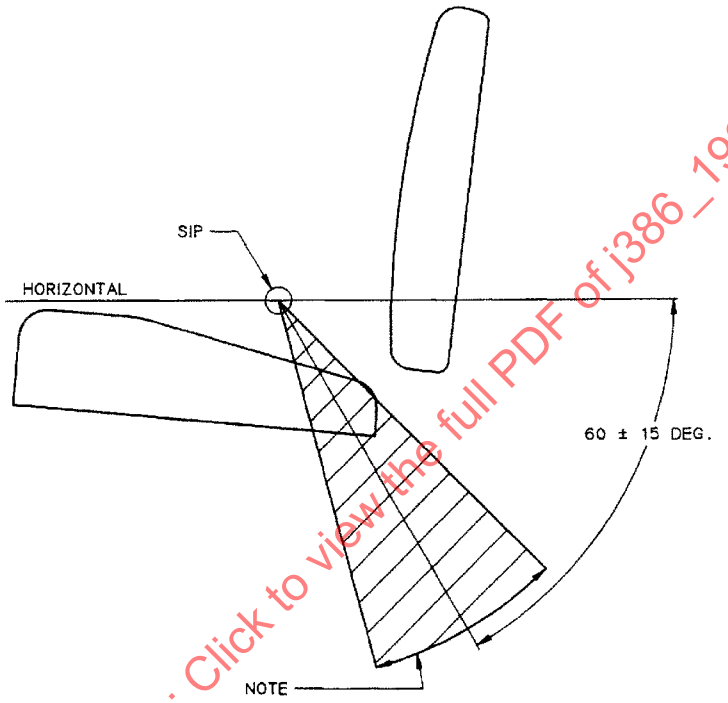
1. Requirements, testing, and performance of retractors may be added at a later date.

5. Technical Requirements, Machine Related

5.1 Anchorages

5.1.1 Anchorages on the seat system or machine shall be such that the belt assembly can be readily installed or replaced and shall comply with the force requirement of 5.2.2.

5.1.2 If the seat does not swivel or have a suspension system, the seat belt assembly may be anchored to the seat or to the machine at any point within the cross-hatched zone shown in Figure 5.



NOTE: RANGE OF SEAT BELT ANCHORAGE MOUNTINGS THROUGH THE SIP TO THE HORIZONTAL THROUGHOUT ALL OPERATING POSITIONS (FORE AND AFT, VERTICAL, TILT AND SUSPENSION TRAVEL).

FIGURE 5—LOCATION OF SEAT BELT ANCHORAGE WITH RESPECT TO SEAT INDEX POINT (REFERENCE SAE J1163)

5.1.3 If the seat is supported by a suspension system, the seat belt assembly shall be attached in such a way that the loop size of the belt does not change as the seat belt oscillates through its suspension's travel.

5.1.4 EXTENSION (TETHER) BELTS—Belts, cables, or similar flexible devices may be used to transfer the seat belt assembly forces from the seat anchorages to the machine. The extension belt length may be adjustable.

5.1.5 Extension belts must meet the seat belt assembly force requirements of 5.2.2 in all operating positions.

5.1.6 SEAT BELT ASSEMBLY INSTALLATION

5.1.6.1 The seat belt assembly shall be located such that when the seat belts are in a straight line through the SIP, the angle formed from the horizontal will be in the range of 60 degrees ± 15 degrees as shown in Figure 5 for all operating positions. Where practical, the preferred angle through the SIP is toward the more vertical.

5.1.6.2 The seat belt assembly is intended to remain in the pelvic girdle area under operating, collision, and rollover conditions, thereby restraining the operator's hips and lower torso area to the seat assembly.

5.1.6.3 Seat belt assemblies should be inspected by the user regularly. Replace the seat belt assembly immediately if damage such as worn or damaged hardware, nicked or frayed strap, buckle or retractor malfunction, or loose stitching is found.

5.2 Machine Related Testing and Performance

5.2.1 TEST SET-UP

5.2.1.1 The seat system shall be tested on-machine or in a manner equivalent to an on-machine condition.

5.2.1.2 The seat system shall be adjusted to the operating position which produces the most severe loading condition to the operator restraint system, prior to any subsequent structural deflection.

5.2.1.3 After the force is applied to the seat system, the force application device shall not be repositioned to compensate for any changes that may occur to the force application angle.

5.2.1.4 The seat belt assembly force shall be applied using a body block similar to that shown in Figure 1. If a retractor is included in the assembly, refer to 4.4.5.

5.2.2 TEST PROCEDURE FOR CONSTRUCTION AND INDUSTRIAL MACHINES—With the test set-up free of slack, a force of 15 000 N shall be applied to the seat belt assembly in the forward and upward direction. The initial angle of force application shall be that angle, 60 degrees ± 15 degrees from the horizontal, which produces the most severe loading condition to the operator restraint system (see Figure 6). The force shall be attained in not more than 30 s and maintained for not less than 10 s.

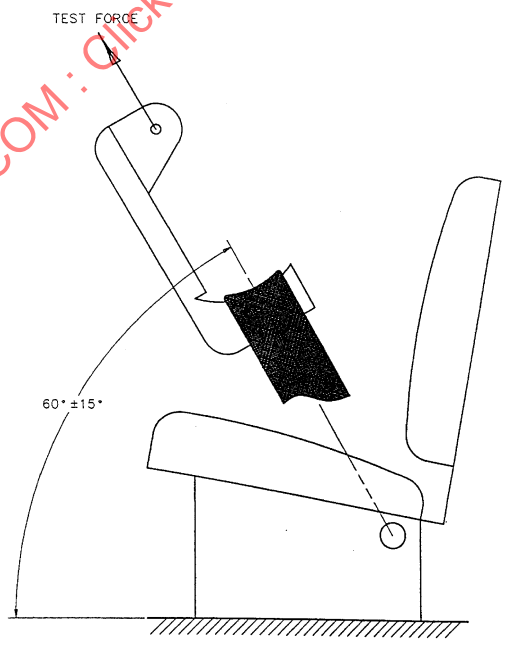


FIGURE 6—CONSTRUCTION AND GENERAL-PURPOSE INDUSTRIAL MACHINES TEST PROCEDURE