OPERATOR RESTRAINT SYSTEMS FOR OFF-ROAD ϕ WORK MACHINES—SAE J386 JUN85

SAE Recommended Practice

Report of the Construction and Industrial Machinery Technical Committee, approved March 1969, completely revised, Human Factors Technical Committee, June 1985. Rationale statement available.

1. Purpose—This recommended practice provides minimum performance and test requirements for operator restraint systems for off-road work machines.

2. Scope—This recommended practice applies to pelvic restraint systems (Type 1)[1] for off-road, self-propelled work machines commonly used in construction, logging, and mining as referred to in SAE J1040c; and agricultural machines as referred to in SAE J1194; and industrial machines as referred to in SAE J1042 APR80.

3. Part I—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 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 load to the seat system (Ref. Fig. 4).

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

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

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

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

3.9 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 load to a machine.

3.10 Polyester Yarn—Yarns spun from polyethylene terephthalate.

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

3.12 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.

3.13 Seat Belt Assembly (Pelvic Restraint—Type 1)—Any strap or belt device fastened across the lap or pelvic girdle area designed to secure a person 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.

3.14 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 JAN80.

3.15 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. Part II—Seat Belt Assembly Requirements

4.1 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 mittened hand. The buckle shall be designed to minimize the possibility of accidental release due to operator movement. The buckle must also meet all the requirements described in Part II, paragraph 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 (Ref. SAE J833 JAN80). To meet the above requirements, overall length of belt may vary depending upon anchorage locations.

4.1.4 BREAKING STRENGTH—The complete seat belt assembly shall withstand a loop load force of not less than 22 200 N applied at the center of the loop by a loop load testing machine (Fig. 1).

4.1.4.1 The loop load 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.

4.1.4.2 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.

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

4.1.4.4 The machine shall be calibrated per ASTM E4-79, Standard Methods of Load Verification of Testing Machines.

4.1.5 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 JUN85, Part II.

4.1.6 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.

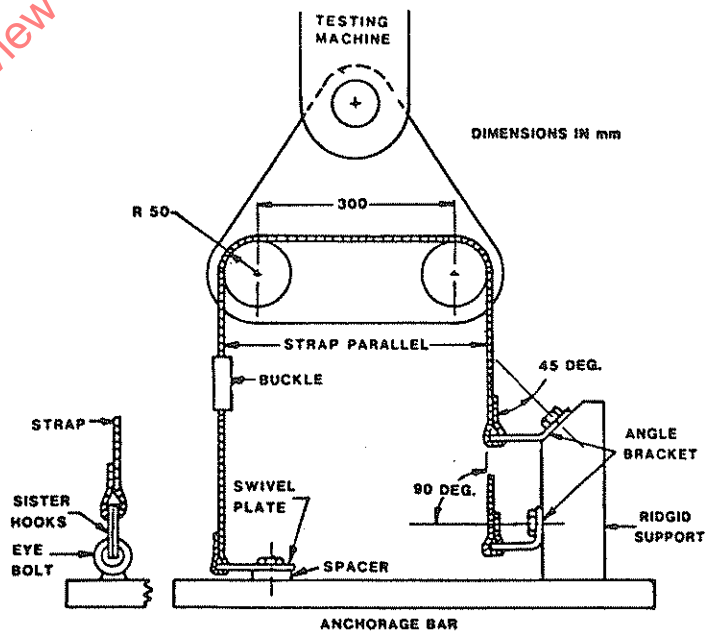


FIG.1—LOOP-LOAD TESTING MACHINE

(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.

[1] Combination pelvic/upper torso restraint systems (Type 2), restraint bars, etc. may be added at a later date.

The ϕ symbol is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

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 useable 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.

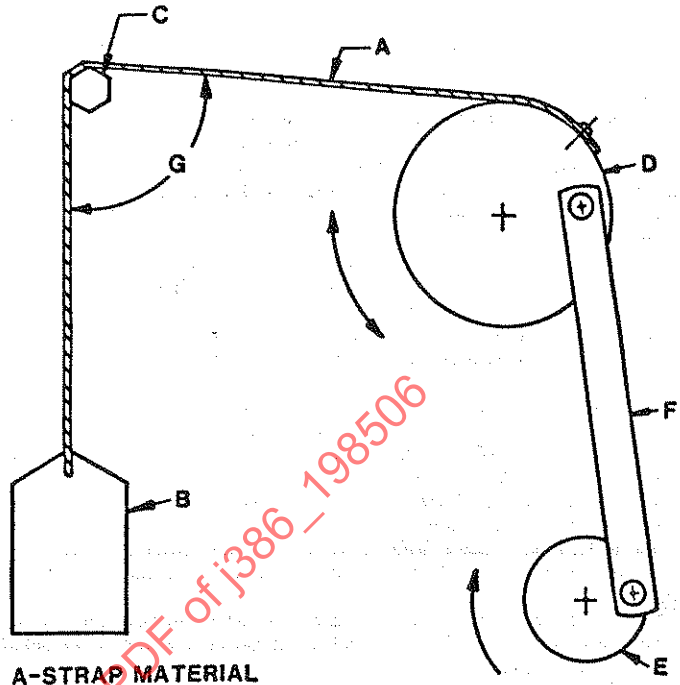
4.2.4 WIDTH—The strap material shall not be less than 46 mm in width when measured under a no-load condition.

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 ±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 (per ASTM E4-79, Standard Methods of Load Verification of Testing Machines). 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—100 mm min. Each failure load 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 in Part II, paragraph 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 Fig. 2 in the following manner. The strap material shall be mounted in the apparatus shown schematically in Fig. 2. One end of the strap material, A, shall be attached to a weight, B, which has a mass of 2.3 ±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 ±2 strokes (30 ±1 cycles) min. The abraded strap material shall be conditioned and tested for breaking strength as described in Part II, paragraph 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-HEXAGONAL ROD
STEEL, SAE 51416
ROCKWELL HARDNESS, B-97 TO B-101
SURFACE, COLD DRAWN FINISH
SIZE, 6.35±0.1mm
RADIUS ON EDGES, 0.5 0.1mm
D-DRUM DIAMETER 400mm
E-CRANK
F-CRANK ARM
G-ANGLE BETWEEN STRAP MATERIAL, 85±2 DEG.

FIG. 2—ABRASION TEST FOR STRAP MATERIAL

4.3 Buckle Requirements

4.3.1 CORROSION RESISTANCE—Satisfy the requirements of SAE J141, paragraph 3.2.2.

4.3.2 TEMPERATURE RESISTANCE—Satisfy the requirements of SAE J141, paragraph 3.3.

4.3.3 COMPRESSION—Satisfy the requirements of SAE J141, paragraph 3.7.

4.3.4 LATCH OERATION—Satisfy the requirements of SAE J141, paragraphs 3.8.1 and 3.8.2.

4.3.5 ADJUSTMENT FORCE—Satisfy the requirements of SAE J141, paragraph 4.1.

4.3.6 TILT LOCK ADJUSTMENT—Satisfy the requirements of SAE J141, paragraph 4.2.

4.3.7 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.

4.3.7.1 Three samples of a given buckle shall be tested. After subjection to the force described in Part II, paragraph 4.1.4, the force shall be reduced and maintained at a loop load 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.

4.3.7.2 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 actuation 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.

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

4.3.8 PADDING—If a buckle is used which is less than the width of the strap material, 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, paragraph 3.1.1.

4.4.2 CORROSION RESISTANCE—Satisfy the requirements of SAE J141, paragraph 3.2.

4.4.3 ATTACHMENT HARDWARE

4.4.3.1 *Design*—Satisfy the requirements of SAE J141, paragraph 3.1.3.

4.4.3.2 *Temperature Resistance*—Plastic or other non-metallic hardware parts of a seat belt assembly when subjected to the conditions specified in SAE J140a, paragraph 3.3, shall not deteriorate in any manner to cause the seat belt assembly to operate improperly or fail to comply with the requirements of Part II, paragraphs 4.1.2, 4.1.3, and 4.1.4.

4.4.3.3 *Strength*

4.4.3.3.1 Attaching (Mounting) Bolts—Attaching (mounting) bolts shall withstand a load of 22 200 N when tested in accordance with SAE J140a, paragraph 3.4.1.

4.4.3.3.2 End Fittings (Mounting Brackets)—End fittings (mounting brackets) shall withstand a loop load of 22 200 N when tested on equipment similar to that shown in Fig. 1. During the test, the attaching bolts shall be parallel to or at an angle of 45 deg or 90 deg to the strap material, whichever results in an angle nearest to 90 deg 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[2]—Retractors shall meet the seat belt assembly strength requirements of Part II, paragraph 4.1.4. 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 non-locking retractor, shall have the strap material fully extended from the retractor at the start of the seat belt assembly strength test.

5. Part III—Machine Related Requirements, Testing, and Performance

5.1 Machine Related Requirements

5.1.1 ATTACHMENT—Where a suspension system supports the seat assembly, the seat belt assembly shall be attached in such a manner that the loop size does not change as the seat assembly oscillates relative to the machine.

5.1.2 EXTENSION (TETHER) BELTS—If the means of attachment joining the seat assembly to the seat system cannot withstand the seat belt assembly load of Part III, paragraphs 5.2.2, 5.2.3, or 5.2.4, extension (tether) belts may be used. Extension belt length may be adjustable, and must meet the seat belt assembly load requirement of Part III, paragraphs 5.2.2, 5.2.3, or 5.2.4, in all operating positions.

5.1.3 SEAT BELT ASSEMBLY INSTALLATION

5.1.3.1 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 45 deg to 75 deg as shown in Fig. 3 for all operating positions. Where practical, the preferred angle through the SIP is toward the more vertical.

5.1.3.2 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.

5.1.3.3 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 assembly does not have to be installed if installation would have no effect on the test result.

5.2.1.3 The seat system shall be adjusted to the operating position which produces the most severe loading condition to the operator restraint system assuming no structural deflection.

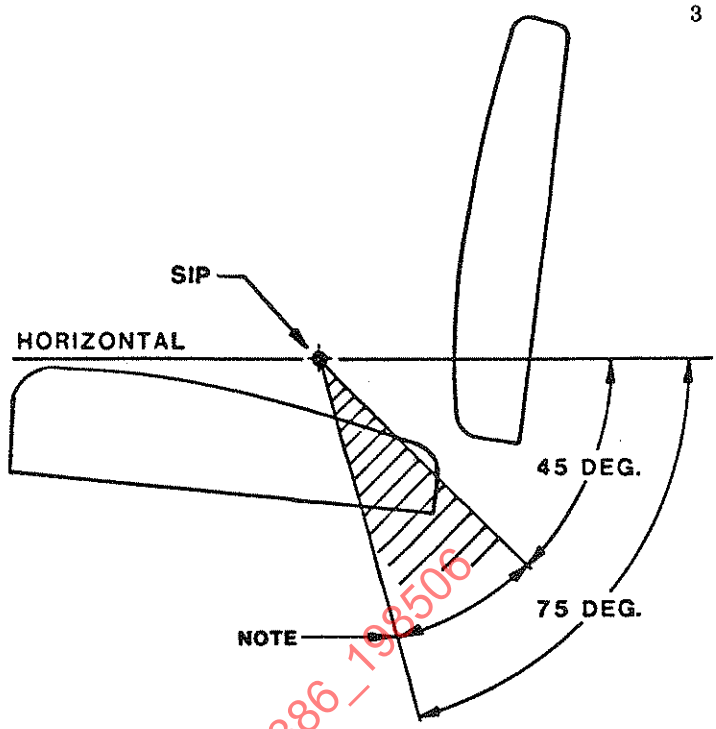
5.2.1.4 After the load is applied to the seat system, the load application device shall not be repositioned to compensate for any changes that may occur to the load application angle.

5.2.1.5 The seat belt assembly load shall be applied using a body block similar to that shown in Fig. 4.

5.2.2 CONSTRUCTION MACHINE TEST PROCEDURE—With the test set-up free of slack, a load of 22 200 N shall be applied to the seat belt assembly in the forward and upward direction. The initial angle of load application shall be that angle, between 45 deg and 75 deg from the horizontal, which produces the most severe loading condition to the operator restraint system (see Fig. 5). The load shall be obtained in not more than 30 S and maintained for not less than 10 s.

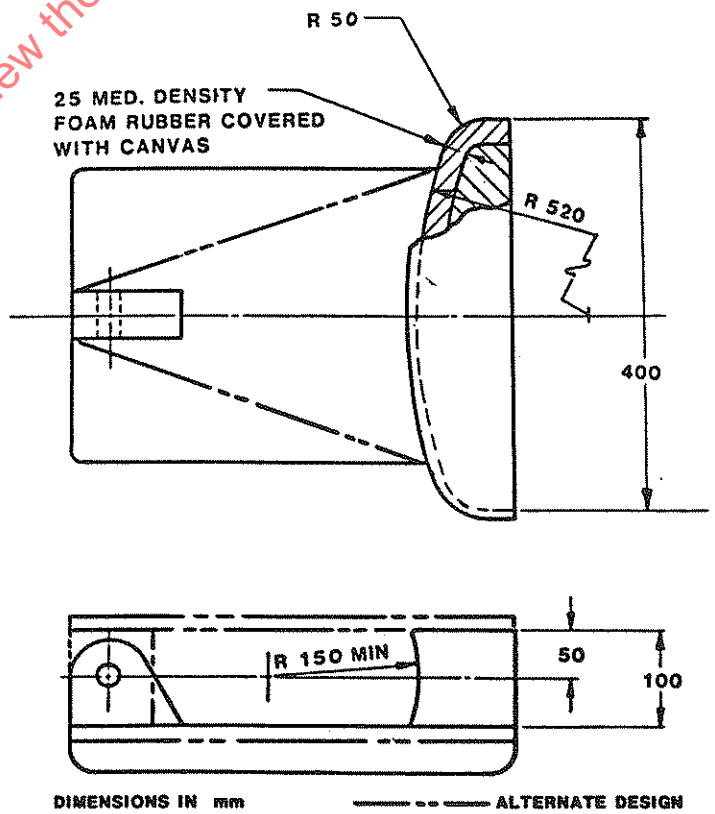
5.2.3 AGRICULTURAL TRACTOR TEST PROCEDURE—With the test set-up free of slack, a load of 4450 N shall be applied to the seat belt assembly in the forward and the upward direction. A simultaneous and parallel force equal to four times the force of gravity on the mass of the seat system shall be applied to the center of gravity of the seat system in the forward and upward direction. The initial angle of the load applications shall be 45 ±10 deg from the horizontal, (see Fig. 6). Also, (using the same seat system) with the test set-up free of slack, a load of 2250 N shall be applied to the seat belt assembly in the rearward and upward direction. A simultaneous and parallel force equal to two times the force of gravity on the mass of the seat system shall be applied to the center of gravity of the seat system in the rearward and upward direction. The

[2] Requirements, testing, and performance of retractors (such as non-locking and locking) may be added at a later date.



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

FIG. 3—LOCATION OF SEAT BELT ASSEMBLY WITH RESPECT TO SIP



DIMENSIONS NOT SHOWN ARE OPTIONAL TO SATISFY THE TEST FACILITY AND DO NOT INFLUENCETHE TEST RESULTS.

FIG. 4—BODY BLOCK