Dynamic Cushioning Performance Criteria for Snowmobile Seats

RATIONALE

There is a need to clarify the recording equipment and recording filter/sampling rate. The scope was clarified with the transfer of text into the purpose section.

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1. SCOPE

This SAE Standard provides a test method, an evaluation method, and a performance criterion for shock-absorbing characteristics of a general foam-type snowmobile seat. This SAE Standard applies to seats that are similar in design, dimensions, construction, and/or intended usage as described and illustrated in SAE J33.

1.1 Purpose

The purpose of this document is to facilitate the development of seats used on snowmobiles to minimize occupant spinal injury during impacts of:

a. The occupant on the snowmobile seat

b. The snowmobile and seat on the occupant

Operators and passengers of snowmobiles can be subjected to high levels of impact with the snowmobile seat under riding conditions. This document was developed to identify the cushioning properties of snowmobile seats.

This document encompasses the significant factors that determine the effectiveness of a general seat system in limiting spinal injury during vertical impacts between the rider and the snowmobile seat. The document is intended to provide a tool for the development of safer snowmobile seats. It is recognized that the seat is only a portion of the entire vehicle protective suspension system. The seat serves as added protection to the suspension system since the latter may "bottom out" during a severe impact.

The term "seat" refers to the occupant-supporting system, as described and illustrated in SAE J33, which is not normally considered part of the vehicle suspension or frame system. In some cases, it may include more than the foam cushion.

This document provides the minimum requirements for performance of a general seat system and a description of specific means of evaluating the shock-absorbing characteristics of foam seat cushions using a specific testing procedure and a companion seat evaluation chart.

The test input and means of interpreting the results are unique to the seats of typical recreational snowmobiles. Therefore, this document is to be used for snowmobile seats only and is not to be used to evaluate seats of any other type of vehicle. In addition, it should not be applied to seats of snow vehicles of significantly different design, dimensions, construction, or intended usage from the typical recreational snowmobile illustrated in SAE J33.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J33   Snowmobile Definitions and Nomenclature

3. DEFINITIONS

3.1 SNOWMOBILE SEAT

The seat includes the cover, energy-absorbing materials, and substrates (if any).

3.2   BASELINE

The baseline is the starting reference plane of the seat from which total penetration is determined. It is taken as the top plane of the seat at the fore-aft position designated for the snowmobile occupant(s).

3.3   G

Symbol for the dimensionless ratio of any acceleration to the acceleration of gravity.

3.4 t_p

Time duration impact to peak deceleration, in milliseconds.

3.5 t_h

Time duration from impact to 1/2 value of peak deceleration, in milliseconds.

4.   DYNAMIC CUSHIONING TESTING METHOD

4.1   Purpose

This procedure provides a uniform method for measuring, with a high degree of reproducibility, dynamic cushioning properties such as the deceleration-time history profile of a standard buttocks form ("missile") impacting seat test specimens. The results from this testing method can be related to the performance requirements necessary to limit spinal injury to snowmobile riders and passengers.

4.2   Apparatus

4.2.1   Testing Machine

4.2.2   Any design of dynamic testing apparatus will suffice when the following criteria are met. See Figure 1.

4.2.2.1   The weighted missile can be held in readiness for impact, released upon command, and guided to the point of impact.

4.2.2.2   The test specimen should be supported on a foundation which under impact will not deflect more than 1% of the thickness of the specimen.

4.2.2.3   The deceleration-time profile, as illustrated in Figure 2, can be read out and recorded on an instrument, such as an oscilloscope, starting at the time of initial contact of the missile on the seat.
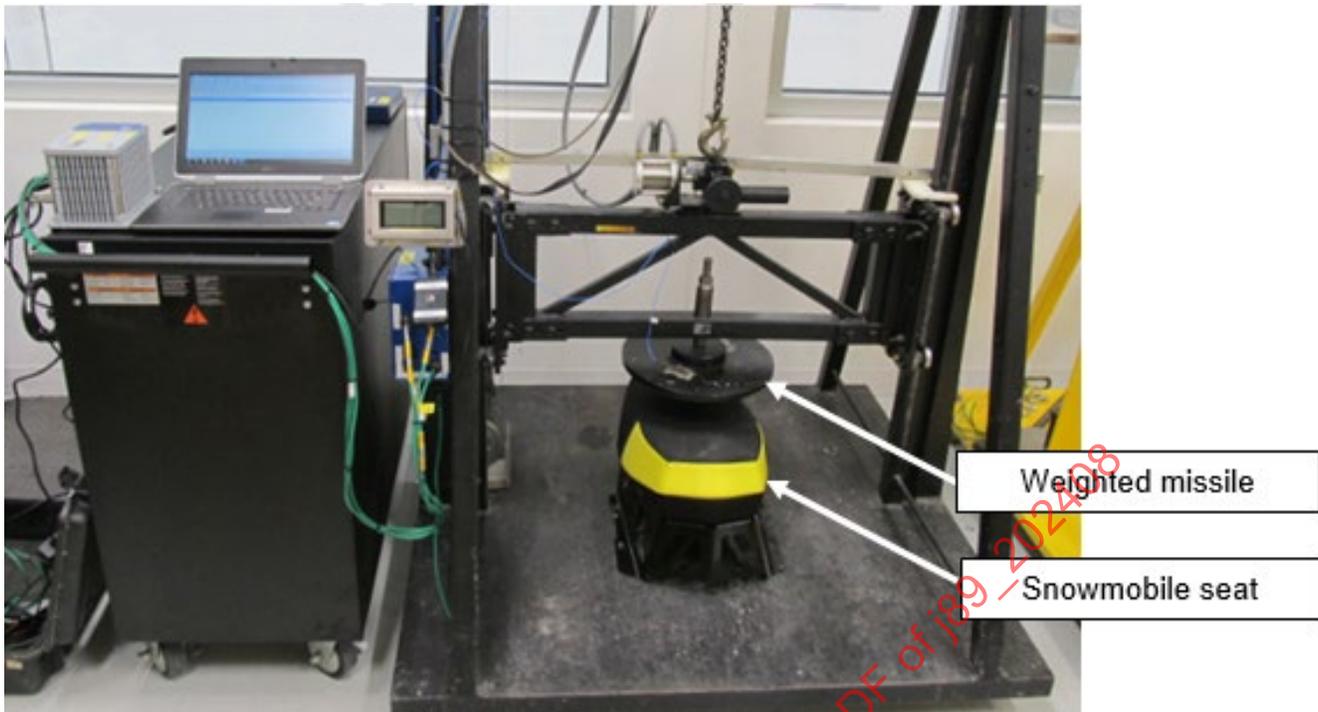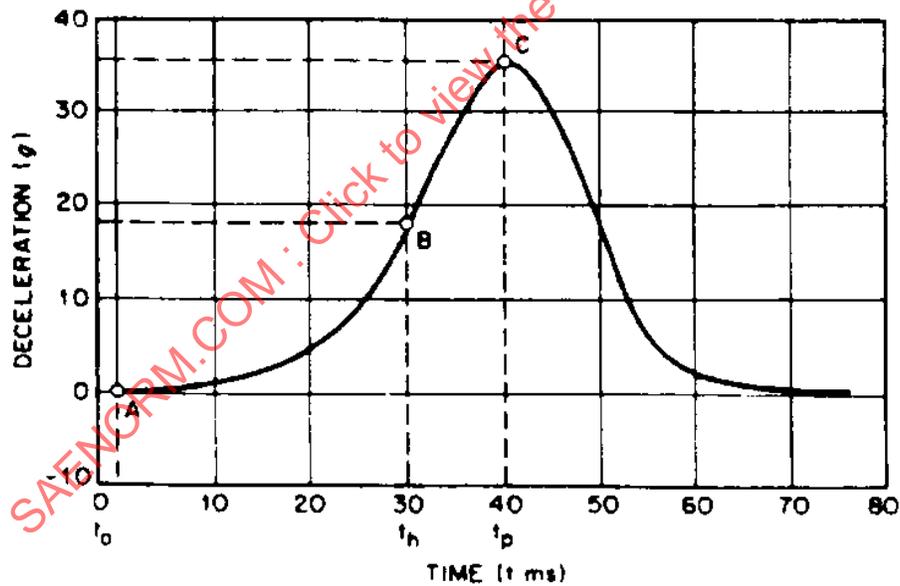
Figure 1 - Dynamic testing apparatus

TRACE ABC = G-TIME TRACE WHERE:

A = START OF IMPACT

B = ½ PEAK g (½ C)

C = PEAK DECELERATION (g MAX)

Figure 2 - Typical G-time trace

4.2.3 Sending Devices

4.2.3.1 The missile shall be equipped with an accelerometer system that shall be capable of measuring single impacts of short duration (less than 0.105 second) in the 5 to 100 g range with an accuracy of ±2% throughout the duration of the pulse.

4.2.3.2 A penetration measuring device, or some other means, is required to determine the exact starting time of the penetration. A velocity measuring device shall be used for measuring the impacting velocity of the missile if the missile is not totally free to fall under the influence of gravity.

4.2.4 Missile

The missile shall be a rigid segment of a hemisphere; the sphere having a radius of 245 mm (9.65 inches) and the segment having a radius of 178 mm (7 inches). See Figure 3. The top surface of the missile must be designed to accommodate weights to provide total missile mass capability of 90.7 kg (200 pounds).
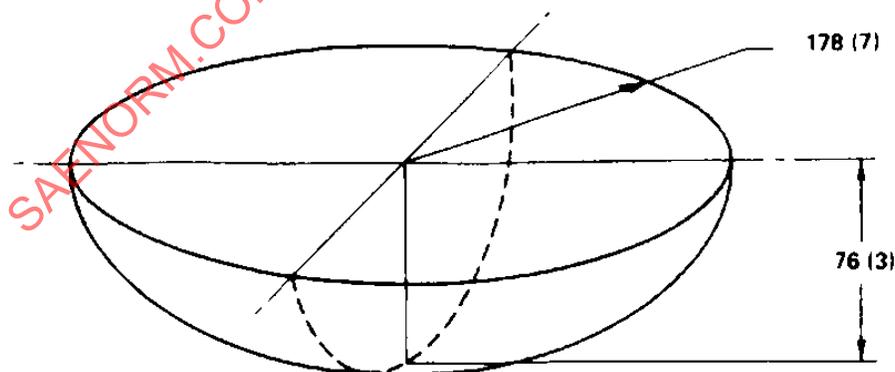
4.2.5 Recording Equipment

The acceleration-time recording equipment should be capable of recording impacts compatible with the accuracy of the accelerometer. Some type of triggering device will be necessary for the recording device.

A low pass filter that accurately represents all frequency content of the analog signal below the 150 Hz cutoff frequency. The minimum sample frequency shall be 500 Hz. The frequency response of the acceleration sensor shall minimally be 200 Hz.

4.2.6 Test Specimen

Any seat, or supporting component, for which dynamic cushioning data is desired. At least two specimens shall be tested for each set of conditions. The specimens shall be conditioned at 21 °C ± 6 °C (70 °F ± 10 °F) for a minimum of 8 hours prior to testing.

If the test specimen is attached to a gas tank or structure (other than lying flat on a flat tunnel), it shall be attached to a fixture simulating the identical mounting as it is in the snowmobile it is intended for. If it is attached to a gas tank in the snowmobile, then the fixture shall include a gas tank. The gas tank used in the fixture shall be a production gas tank, empty of fluid, and cannot be more than 3 years old.

SEGMENT OF SPHERE OF RADIUS = 245 (9.65)
NOTE: DIMENSIONS ARE mm (in)

Figure 3 - Seat impact form

4.3   Procedure

4.3.1   Prewarm the recording equipment as recommended by the manufacturer.

4.3.2   Place the test specimen in position under the missile such that the designated driver seating position, as defined in SAE J33, coincides with the center of the missile. The mass of the missile shall total 90.7 kg (200 pounds).

4.3.3   Determine the baseline by contacting the specimen with the missile and adjust the recording apparatus to read zero penetration.

4.3.4   Set the missile propelling mechanism at a position to obtain the desired impact velocity of 3.15 m/s (124 in/s) (equivalent to 500 mm [20 inches] free fall) at the impact surface of the specimen.

4.3.5   Calibrate the G-time recorder according to the recommended procedure of the manufacturer.

4.3.6   Release the missile and record the acceleration-time profile using the recommended procedures of the equipment manufacturer. Three consecutive strikes shall be made at a maximum of 2-minute intervals on the same impact area.

4.3.7   Each designated passenger seating position (if the snowmobile is designed for passengers), as defined in SAE J33, and each designated seating position of the operator shall be tested.

5.   EVALUATION

The following procedure shall be applied to each designated seating position.

5.1   Data

Using the deceleration time, trace from the third impact on each of the specimens, record the peak deceleration (point C), the time from impact to peak deceleration (point t_p), and the time from impact to 1/2 peak deceleration (point t_h) for the designated seating position. Calculate and record the average value for C, t_p, and t_h. Using these average values, calculate and record the percent distortion using Equation 1:

$$\% \text{ distortion} = \frac{2t_h - t_p}{t_p} \times 100\% \qquad \text{(Eq. 1)}$$

5.2   Chart Usage

On the seat evaluation chart (see Figure 4), plot the previous calculated average values of peak deceleration (C) and time from impact to peak deceleration (t_p). If this point lies above the 90% distortion line, the seat fails. If the point lies below the 30% distortion line, the seat passes. If the data point lies within the region of 30 to 90% distortion, then the point must be evaluated with respect to its calculated percent distortion. If the data point lies above its distortion value, the seat fails. If the data point lies below its distortion value, the seat passes.

As an example of the previous procedure:

t_p = 40 ms

t_h = 30 ms

G_{max} = 35 g

Then see Equation 2:

$$\% \text{ distortion} = \frac{2(30) - 40}{40} \times 100\% = 50\% \qquad \text{(Eq. 2)}$$