

	SURFACE VEHICLE RECOMMENDED PRACTICE	SAE J2896 JAN2012
		Issued 2012-01
Motor Vehicle Seat Comfort Performance Measures		

RATIONALE

This document provides technology, terminology, and procedural updates to performance measurements related to occupant support, penetration into the seat, and mechanical aspects of comfort in the seat. These measurements are used in the automotive seating industry and were initially described in the SAE Seating Manual (SAE J782). Measurements in this document supersede any similar measurements given in SAE J782.

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INTRODUCTION

This document provides recommended test methods for evaluating performance characteristics of motor vehicle seating related to occupant support, penetration, and comfort. It provides a means of comparing and assessing comfort-related performance of complete, prototype, or competitive benchmark vehicle seat systems.

Additionally, this document provides a framework for documenting relevant parameters of these tests in order to aid in interpretation of diverse data sets and address issues of measurement variation. In general, measurement variation in these tests arises primarily from manufacturing variability, seat set-up differences (including determination of the SgRP reference and orientation), and finally user variations in the actual test procedures. This document does not make recommendations for tolerance.

The tools and procedures for determining seat coordinate positions used in this document are based on the SAE J4002 H-Point Machine (HPM-II). Many of the measurements can be made with the SAE J826 H-point machine (HPM), however the measured values may not be identical to values taken using HPM-II. Users shall document and maintain a record noting whenever the SAE J826 HPM is used in making the measurements cited in this document.

For convenience and simplicity, many terms associated with H-point devices use human body parts in their name. However, they should not be construed as measures that indicate interaction with any or all occupants concerning accommodation, human capabilities, or comfort.

1. SCOPE

These test procedures apply to complete seat systems (production seats or prototypes built at the intended manufacturing quality); however, the procedures can be modified for subsystem or component level testing.

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.

2.2 SAE Publications

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

SAE J1100 Motor Vehicle Dimensions

SAE J2732 Motor Vehicle Seat Dimensions

SAE J182 Motor Vehicle Fiducial Marks and Three-dimensional Reference System

SAE J4002 H-Point Machine (HPM-II) - Specifications and Procedure for H-Point Determination - Auditing Vehicle Seats

SAE J4003 H-Point Machine (HPM-II) - Procedure for H-Point Determination - Benchmarking Vehicle Seats

SAE J826 Devices for Use in Defining and Measuring Vehicle Seating Accommodation

2.3 Other Publications

JASO B407 (1987) Test Code of Seating Comfort for Automobile Seats

3. DEFINITIONS

For the purposes of this document, the following definitions apply.

TABLE 1 - DEFINITIONS

Term	Definition
Biteline (seat bight)	Area close to and including the intersection of the surface of the vehicle seat cushion and seat back. See SAE J2732.
Centerline of Occupant (C/LO)	Lateral (Y) centerline of an occupant in a given designated seating position. See SAE J1100.
Cross Car	Lateral direction across vehicle (+Y, -Y). See SAE J182
H-point	Point at the pivot center of the back pan and cushion pan assemblies, located on the lateral centerline of the H-point device (HPM or HPD). See SAE J4002 and J1100. NOTE 1—When an H-point device is properly positioned within a vehicle – either in CAD or in an actual physical property – the location of the H-point relative to the vehicle is used as a vehicle reference point. If the seat is moved, the location of the H-point within the vehicle is changed. Therefore, adjustable seats will have more than one H-point location, while fixed seats will have only one H-point location. NOTE 2— H-points are often referred to as hip points or hip pivot points. However, they do not accurately represent the location of the human hip joint.
Lateral Section (Seat)	Section perpendicular to the Centerline of Occupant plane. NOTE: This section is usually the same as Cross Car.
Longitudinal Section (Seat)	Fore aft Section parallel to the Centerline of Occupant plane.
Seat Surface Reference Load	The Minimum Load used to define initial contact with a seating surface
Torso (Back) Line	Line from the H-point through the sliding thoracic pivot (B1 divot point). See SAE J1100.
Thigh line	A line in side view connecting the H-point to the knee point. See SAE J1100

4. TEST SEAT

4.1 Seat Complete

A complete seat created at the intended manufacturing quality shall be used where possible. A prototype seat system or parts may be used in cases where finished parts are not feasible for testing.

4.2 Conditioning

The test seat should be conditioned, undeflected, and undistorted at 23 ± 2 °C and relative humidity of $50 \pm 5\%$ for at least 12 h before being tested. The tests shall be performed 96 h or more after the manufacture of the raw materials used in the test specimen (foam, elastic components other than metal, etc.).

Because most seats are made with open-celled foam, loading them forces air out of the foam cells. Full recovery of the foam (movement of air back into the seat to equilibrium levels) requires time. Therefore, it is recommended that seats rest up to four hours between major tests to recover fully.

4.3 Seat Setup

For seats with adjustable track and recline, the test seat should be positioned as specified by the manufacturer. If no setup information is provided, the benchmark SgRP position as described in SAE J4003 should be used.

4.4 Adjustable Features

Any non-standard adjustable features should be set to the manufacturer-specified positions. If no setting is specified, features should be set to the full off or retracted position (e.g.,st lumbar support or shortest thigh extender).

NOTE: Tests can be repeated on the same seat with the adjustable features at different settings.

5. TEST METHODS

5.1 Overall Load Deflection

For many materials, stiffness is a linear relationship which can be represented as a straight line and described with a single parameter. The mechanical behavior of seats is extremely non-linear under regular occupant loading conditions and requires more complex parameters to describe the relationship.

This test measures the deflection characteristics of motor vehicle seats or foam pads under loading and unloading conditions and provides recommended parameters to be reported from the test results.

5.1.1 Test Apparatus

5.1.1.1 Static load deflection measurement system

The deflection measurement system shall be capable of applying forces up to 1500N at a constant rate and measuring the resulting indenter position.

5.1.1.2 Seat Fixture

The seat mounting fixture shall be capable of rigidly securing the test sample in proper position and orientation under all test conditions.

5.1.1.3 Indenter (Pressing Plate)

One of the following Indenter types with a projected contact area greater than 500cm² and a fixed joint is recommended (Figure 2):

- a. Seat Cushion: Buttform, Disk, or Oval Pressing Plate
- b. Seat Back: Backform, Disk, or Oval Pressing Plate



FIGURE 1 - EXAMPLE STATIC LOAD DEFLECTION TEST EQUIPMENT

NOTE: If data is to be compared from multiple test facilities it is important to control sources of gage variation including the construction characteristics of pressing plates). See Appendix B Section B1

NOTE: If a universal swivel joint is used with the buttform or backform, a counterbalance (springs or weight, etc) is required to level the pressing plate and control the approach angle prior to loading.

NOTE: Data collected from different indenters may not be comparable. see Appendix B Section B1

5.1.2 Setup

A light muslin cover of sufficient size to prevent the machine from contacting the seat, approximately 910 mm², is recommended to avoid marking of the seat and promote smooth movement of the pressing plate. The muslin should be a plain cotton fabric having a thread count and weight typical of a durable, mid-grade, general-purpose muslin that is available from most fabric stores. The test seat shall be mounted as specified in 5.1.2.1 and 5.1.2.2 (Figure 3).

5.1.2.1 Seat Cushion

Mount the seat cushion so the applied force is perpendicular to the thigh line of the HPM Cushion Pan.

- a. The Oval Type pressing plate should be positioned laterally across the cushion.
- b. The Buttform pressing plate should be positioned with thighs facing forward.

Indenters may need to be offset forward to eliminate interference from the seat back.

- a. For the Oval and Disk Type Indenters this offset is typically measured from the loading point of the Pressing Plate to the targeted Seat H-point.
- b. For the Buttform this offset is measured from the Buttform Hip Point to the Seat H-point.

A standard offset should be applied to ensure equitable comparisons. The typical standard offset is 40mm forward of the Seat H-point. The historical offset range used in industry has varied from 40mm to 90mm.

NOTE: The seat back may also be reclined or adjusted as needed to eliminate additional interference with the indenter. If interference is still evident, offset the indenter until it is clear and document the resulting offset.

5.1.2.2 Seat Back

Mount the specimen so the applied force is perpendicular to the torso line of the back pan. For seats with a recliner mechanism, brace the seatback during loading to minimize the contribution of the recliner mechanism to the hardness measurement.

- a. The Oval Type pressing plate should be positioned vertically on the seat back.
- b. The Oval and Disk Type should be offset so the loading point corresponds to a predetermined Lumbar Apex measured above the Seat H-point. Typical offset is 150mm above H-point. The historical offset range used in industry has varied from 100mm to 200mm.
- c. The Backform pressing plate should be positioned so the equivalent H-point is aligned to the seat H-point.

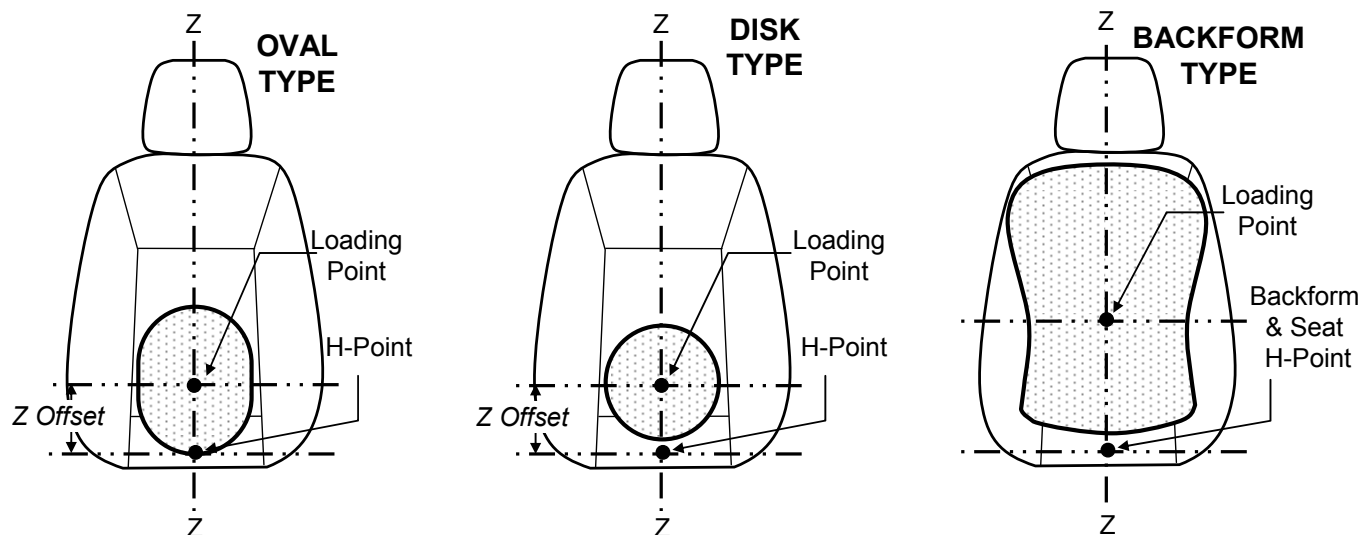


FIGURE 2A - SEAT BACK PRESSING PLATES

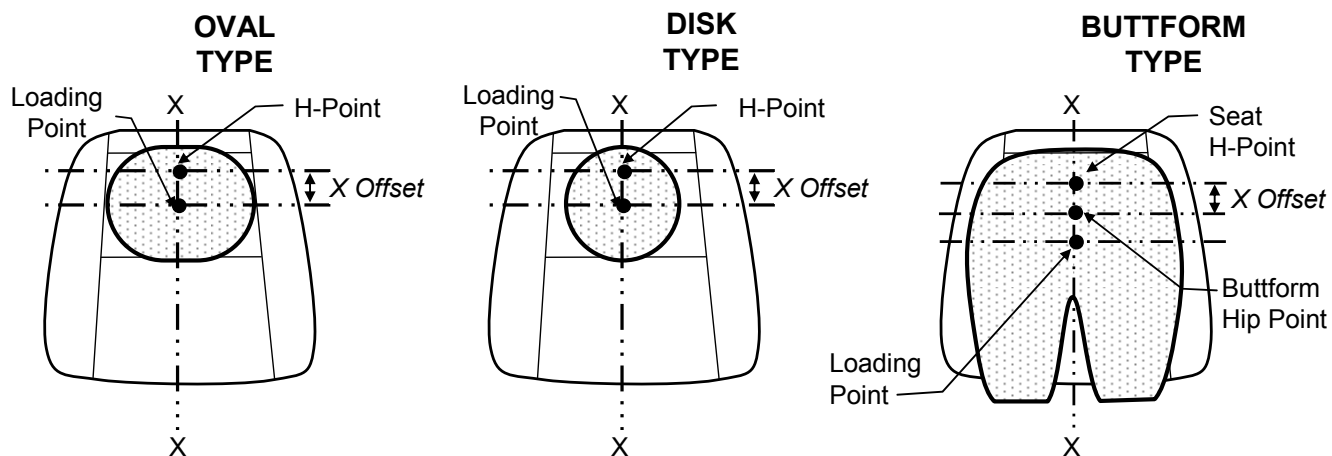


FIGURE 2B - SEAT CUSHION PRESSING PLATES

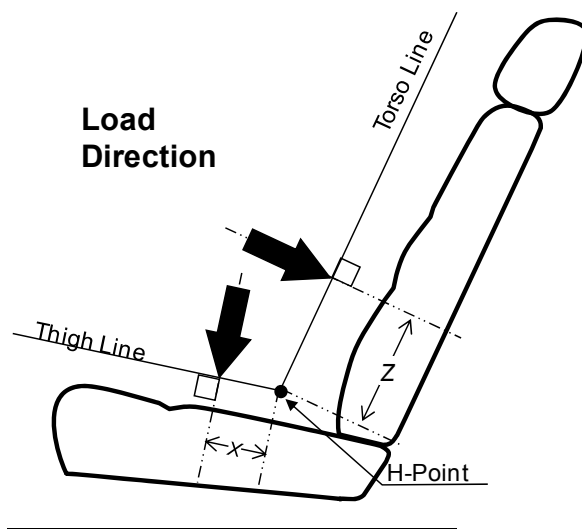


FIGURE 3 - SEAT CUSHION AND SEAT BACK SETUP

5.1.3 Load Force Application

The following parameters shall be used for the static load deflection measurement system:

- Set maximum loading force to:
 - a. Seat Cushion: 1100 N (247.8 lbf)
 - b. Seat Back: 550 N (123.9 lbf)

NOTE: These recommended maximum force values are based on Pressing Plates with a projected contact area greater than 500cm². To prevent undesired seat penetrations, maximum force values should be modified for any other type or size indenter.

NOTE: Data collected from different indenters may not be comparable. A detailed description of the pressing plate should be specified to reduce gage variation. see Appendix B Section B1

- Set indenter speed to a rate of 200 mm/min.

The historical range used in industry has varied from 150 to 300mm/min

- Changeover time from loading to unloading should be instantaneous.
- Position the indenter to a point at least 5mm above initial contact and set the force scale to zero.

Run a force-deflection test using the above test rates, changeover times, and maximum load. Record the force-position data taken during the application and removal of the force on the test specimen.

Allow the specimen to rest for no more than 60 sec before running subsequent trials. Typically 3 total trials are collected.

5.1.4 Results and Output

5.1.4.1 Overall Load-Deflection Graph

- Plot the applied force on the Y-axis versus indenter position on the x-axis.
- Set the Seat Surface Reference Load (defined as 5N) position to zero

Figure 4 shows a typical force-deflection plot.

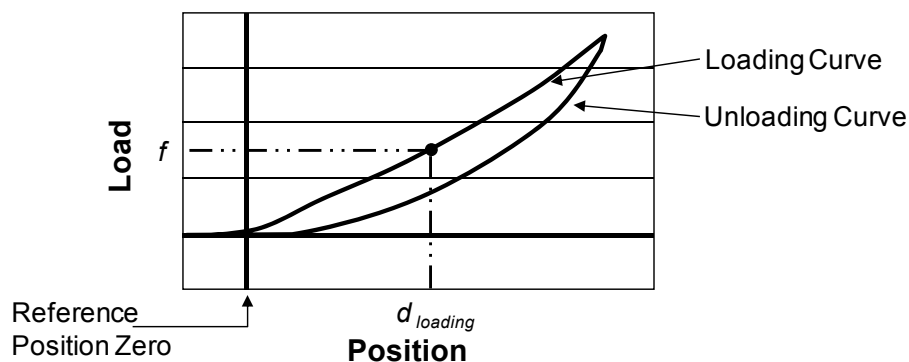


FIGURE 4 - LOAD DEFLECTION CURVE

5.1.4.2 Deflection Measures

Calculate and record the deflection at a given force on the load deflection curve based on the loading curve, unless otherwise specified.

5.1.4.3 Coefficient of Hysteresis Loss

Calculate and record the hysteresis loss using Equation 1 (Figure 5).

$$\alpha = 100 \bullet \left(\frac{L_A - U_A}{L_A} \right)$$

EQUATION 1

Where

α = Coefficient of Hysteresis Loss (%)

L_A = Area under the Loading Curve

U_A = Area under the Unloading Curve

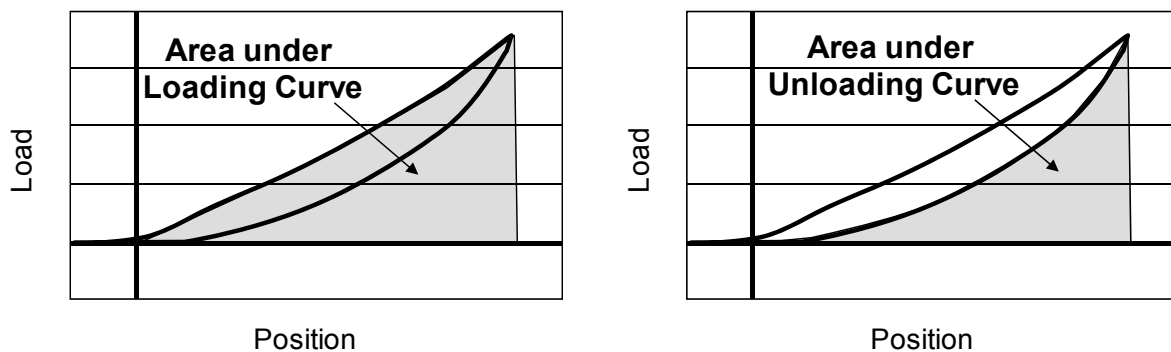


FIGURE 5 - AREA UNDER LOADING AND UNLOADING CURVES

5.1.4.4 Hysteresis Loss at a given Load

Calculate and record the difference in the unloading and loading deflection, $f(d_2 - d_1)$, at a given load (Figure 6).

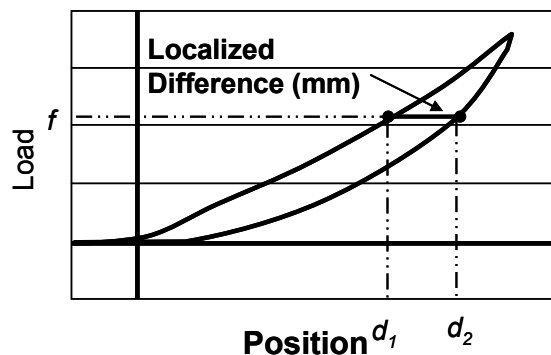


FIGURE 6 - HYSTERESIS LOSS AT GIVEN LOAD

5.1.4.5 Static Spring Constant

Calculate and record the static spring constant as the slope of a line tangent to the curve at a given force. Typically, this is based on the loading curve (Figure 7). Document whenever the unloading curve is used.

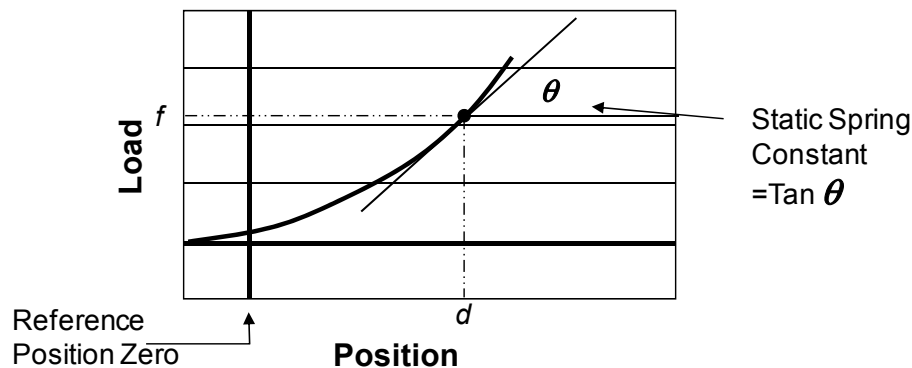


FIGURE 7 - STATIC SPRING CONSTANT (TANGENT METHOD)

Alternative measures to the static spring constant tangent method are also used:

- the slope (m) of a line between two specified loads, f_1 and f_2 or
- the relative deflection from d_2 to d_1 measured between two standard loads, f_1 and f_2 (Figure 8a).

Record the value and the method used. Typically, this value is based on the loading curve. If not, specify that the unloading curve was used.

NOTE: The reference position zero can be recalculated based on the given force f_1 when graphically comparing multiple load deflection curves using the Relative Deflection Method. (Figure 8b)

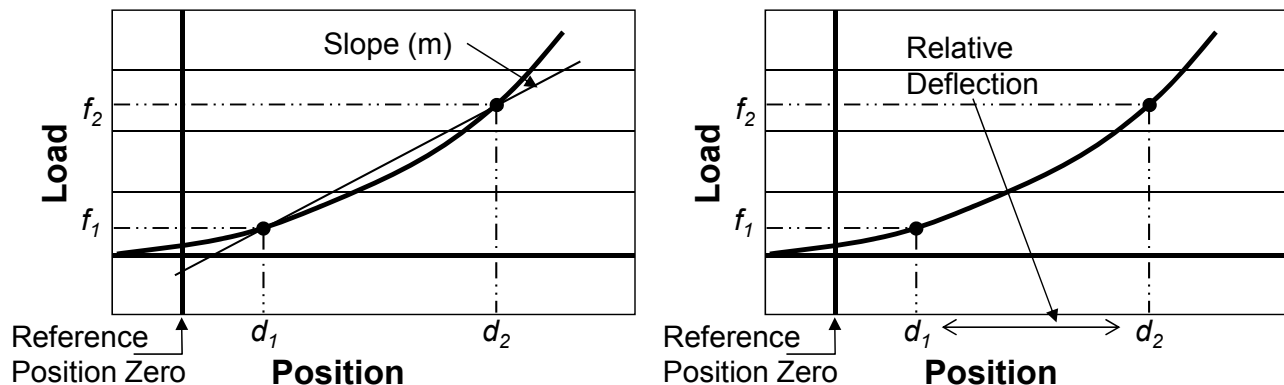


FIGURE 8A – STATIC SPRING CONSTANT (SLOPE AND RELATIVE DEFLECTION METHODS)

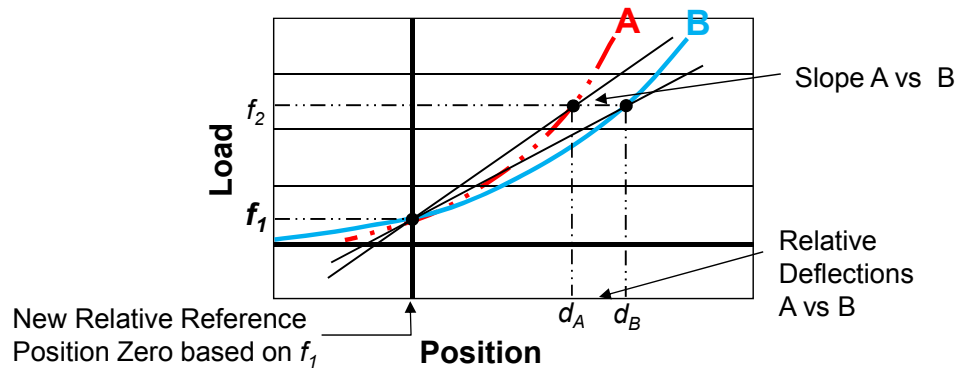


FIGURE 8B – RELATIVE DEFLECTION COMPARISON METHOD

5.2 Hardness Profile

The support provided by a seat system is determined by the shape of the seat surface, the support structure (frame), and the loading characteristics of these materials. This test measures the contour or hardness profile of motor vehicle seats or foam pads under standard loading conditions.



FIGURE 9 – EXAMPLE HARDNESS PROFILE TEST EQUIPMENT

5.2.1 Test Apparatus

5.2.1.1 Static Load Deflection Measurement system

The Load Deflection Measurement System shall be capable of applying loads up to 250N at a constant rate and measuring the resulting load vs. deflection (Figure 9).

5.2.1.2 Seat Fixture

The seat mounting fixture shall be capable of securing the test sample in proper position and orientation under test conditions.