U.S. Department
of Transportation
**National Highway
Traffic Safety
Administration**

NHTSA

DOT HS 812 746

June 2019

Revised THOR 50th Percentile Male Dummy Seating Procedure

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Suggested APA Format Citation:

Louden, A. E. (2019, June). *Revised THOR 50th percentile male dummy seating procedure* (Report No. DOT HS 812 746). Washington, DC: National Highway Traffic Safety Administration.

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. DOT HS 812 746	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Revised THOR 50th Percentile Male Dummy Seating Procedure		5. Report Date June 2019
		6. Performing Organization Code NHTSA/NSR-130
7. Author Allison E. Louden, National Highway Traffic Safety Administration.		8. Performing Organization Report No.
9. Performing Organization Name and Address National Highway Traffic Safety Administration Vehicle Research and Test Center P.O. Box 37 East Liberty, OH 43319		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address National Highway Traffic Safety Administration 1200 New Jersey Avenue SE Washington, DC 20590		13. Type of Report and Period Covered Final Report
		14. Sponsoring Agency Code NSR-130

15. Supplementary Notes

The author would like to thank Josh Smith, TRC, Inc., and Doug Weston, formerly of TRC, Inc., for their support of this work.

16. Abstract

NHTSA developed a seating procedure for the THOR 50th percentile male dummy (THOR-50M). The original procedure was released with a December 2015 Request for Comments (RFC), and some updates were presented at a public meeting at NHTSA's Vehicle Research and Test Center in August 2016. This report discusses the changes to the seating procedure since the original version released with the RFC. These changes were made to reflect updates to the THOR-50M, additional experience using the procedure, and comments received. Some of the revisions were minor wording changes to better clarify the steps of the procedure. The more significant revisions to the procedure are discussed in this report, and they include heel point definitions for different accelerator pedal types, seat fore/aft position, H-point tolerances, and final head angle. The revised procedures for seating the THOR-50M in the driver and right front passenger positions are detailed in the appendices.

17. Key Words THOR, THOR-50M, seating procedure		18. Distribution Statement Document is available to the public from the National Technical Information Service, www.ntis.gov.	
19. Security Classification. (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. of Pages 61	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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Executive Summary

The National Highway Traffic Safety Administration has used the THOR 50th percentile male anthropomorphic test device (THOR-50M) extensively in testing to support both biomechanics and crashworthiness research objectives. The agency is evaluating the THOR-50M for possible use in two frontal crash modes: the full frontal rigid barrier crash test and the frontal oblique crash test. Therefore, seating procedures were developed for the THOR-50M for both the driver and right front passenger seating positions.

The THOR-50M seating procedure was released publicly in December 2015.[1] A public meeting[2] was held in August 2016 at the NHTSA's Vehicle Research and Test Center (VRTC) to provide details and demonstrate the use of the seating procedure in actual vehicles, as well as to provide updates to the seating procedure regarding head angle targets and seat positioning. Updates to the THOR-50M were also presented at the public meeting, including a lengthened front neck cable, introduction of molded shoes, and an updated H-point tool.

This report discusses the changes to the seating procedure since the original version released in December 2015. These changes were made to reflect design updates to the THOR-50M, additional experience using the procedure, and comments received. Some of the revisions were minor wording changes to better clarify the steps of the procedure. The more significant revisions are discussed in this report, and they include the following:

- Revising the procedure for establishing the driver heel point to account for both suspended and floor-mounted accelerator pedals,
- Revising the procedure to allow for additional seat position fore/aft adjustment to avoid leg contact with the steering column or instrument panel,
- Widening the tolerances for the H-point target location,
- Changing the target for the head angle about the Y-axis from -2.5 degrees to 0 degrees (± 1 degree), and
- Allowing for the final head Y angle to not be leveled if all other steps are conducted.

The revised seating procedures detailing the steps for the driver and right front passenger positions are in Appendices A and B, respectively.

[1] Docket number NHTSA-2015-0019, December 2015, www.regulations.gov/document?D=NHTSA-2015-0119-0009

[2] Public Meeting, August 2016, www.federalregister.gov/documents/2016/07/19/2016-16949/public-meeting-concerning-test-device-for-human-occupant-restraint-thor

1.0 Background: THOR 50th Percentile Male ATD (THOR-50M)

The National Highway Traffic Safety Administration has been researching advanced anthropomorphic test devices (ATDs or dummies) since the early 1980s. The goal of this research has been to create a device that represents the responses of human occupants in modern restraint and vehicle environments. NHTSA began developing the THOR-50M around the same time that the Hybrid-III 50th percentile male ATD (HIII-50M) was included in 49 CFR Part 572 for use in Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The THOR-50M was designed to incorporate advances in biomechanics and injury prediction that were not included in the design of the HIII-50M. The THOR-50M is shown in Figure 1.

Figure 1: THOR 50th Percentile Male Dummy

Initially, a seating procedure was developed for the THOR-50M based on the current seating procedure defined for the Hybrid-III 50th male dummy in FMVSS No. 208. It was found that the THOR-50M did not sit the same as the Hybrid III 50th male dummy and that modifications to the procedure were needed. The seating procedure released with the December 2015 Request for Comments (RFC)[3] was developed by seating the dummy in numerous vehicles in a lab environment. In addition, the agency has used the THOR-50M extensively in testing to support both biomechanics[4] and crashworthiness research objectives in both the frontal and frontal oblique offset

[3] , Docket number NHTSA-2015-0119, December 2015. Available at: www.regulations.gov/document?D=NHTSA-2015-0119-0009

[4] Parent, D., Craig, M., & Moorhouse, K. (2017, November) Biofidelity evaluation of the THOR and Hybrid III 50th percentile male frontal anthropomorphic test devices. *Stapp Car Crash Journal,61*:227-276. Available at www.ncbi.nlm.nih.gov/pubmed/29394441

crash tests.[5] [6] Evaluation of the seating procedure from use in the crash tests led to further refinement of the procedure, and these refinements are discussed in this report. The seating procedure was developed for the THOR-50M for both the driver and right front passenger seating positions.

1.1 THOR-50M Design

In the late 1980s the University of Michigan Transportation Research Institute (UMTRI) conducted a seating study on anthropometry of motor vehicle occupants (AMVO). This study was funded by NHTSA to document the anthropometry of 50th percentile (in stature and weight) male and 5th percentile female occupants in automotive seating postures.[7] [8] The AMVO anthropometry was used as a basis for the THOR-50M design. The THOR-50M includes anatomically correct designs in the neck, chest, shoulder, spine, and pelvis to represent the human occupant response in a full-frontal or frontal offset oblique vehicle crash environment. The THOR-50M used to develop the original seating procedure was based on the September 2014 version of the THOR-50M drawing package.[9]

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[5] Saunders, J., & Parent, D. (2018, April 3). *Repeatability and reproducibility of oblique moving deformable barrier test procedure* (SAE Technical Paper 2018-01-1055). Warrendale, PA: SAE International https://doi.org/10.4271/2018-01-1055. https://doi.org/10.4271/2018-01-1055. Available at www.sae.org/publications/technical-papers/content/2018-01-1055

[6] Keon, T. (2016, April 5). Alternative approaches to occupant response evaluation in frontal impact crash testing. *SAE International Journal of Transportation Safety, 4*(1):202-217. https://doi.org/10.4271/2016-01-1540. Available at www.sae.org/publications/technical-papers/content/2016-01-1540

[7] Schneider, L. W., Robbins, D. H., Pflug, M. A., & Snyder, R. G.(1983, December). Development of anthropometrically based design specifications for an advanced adult anthropomorphic dummy family; Volume 1-Procedures, summary findings and appendices (Report No. DOT HS 806 715). Washington, DC: National Highway Traffic Safety Administration. Available at https://deepblue.lib.umich.edu/bitstream/handle/2027.42/259/72268.0001.001.pdf?sequence=2&isAllowed=y

[8] Robbins, D. H. (1985, December). Development of anthropometrically based design specifications for an advanced adult anthropomorphic dummy family; Volume 2-Anthropometric specifications for mid-sized male dummy(Report No. DOT HS 806 716). Washington, DC: National Highway Traffic Safety Administration.
and
Robbins, D. H. (1985, December). Development of anthropometrically based design specifications for an advanced adult anthropomorphic dummy family; Volume 3- Anthropometric specifications for small female and large male dummies (Report No. DOT HS 806 717). Washington, DC: National Highway Traffic Safety Administration. Appendixes 2 and 3 available on a single document available at https://deepblue.lib.umich.edu/bitstream/handle/2027.42/260/72269.0001.001.pdf?sequence=2&isAllowed=y
[Editor's note: Al three volumes, DOT HS 806 715, 716 and 717 may also be found together at https://babel.hathitrust.org/cgi/pt?id=mdp.39015037799866;view=1up;seq=3]

[9] NHTSA. (2014, September). Parts List and Drawings Part 572 Subpart THOR-M Advanced Frontal Crash Test Dummy THOR-M 50% Male Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/document/parts-list-and-drawings-part-572-subpart-thor-m-advanced-frontal-crash-test-dummy

The THOR-50M has several lumbar spine adjustments for additional flexibility. Figure 2 shows the location of the adjustment feature in the dummy and a schematic describing the named positions. The posture of the THOR-50M is the closest to that described by the AMVO study when placed in the "slouched" position.

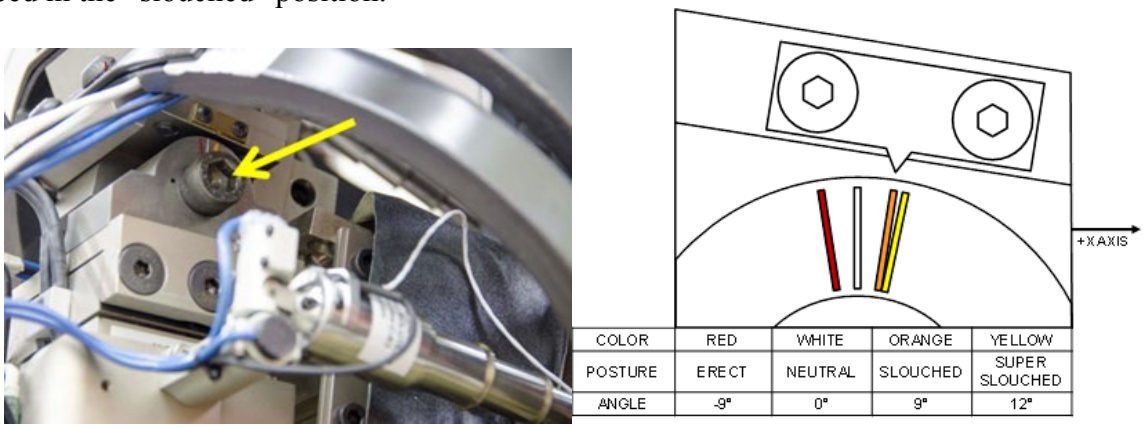


Figure 2: Lumbar Spine Adjustment

There is also a lower neck adjustment. Figure 3 shows these adjustments as shown in the qualification manual.[10] The posture of the THOR-50M is most similar to that described by the AMVO study when placed in the "neutral" position.

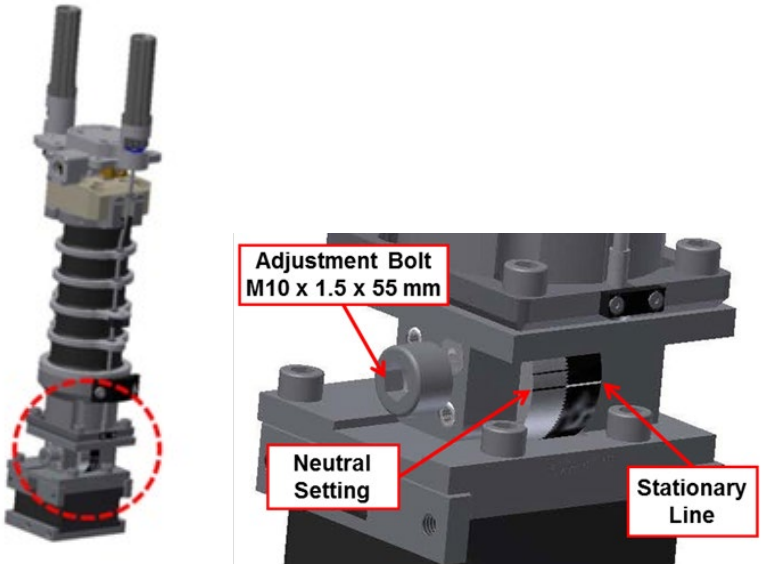


Figure 3: Neck Adjustments: Neutral Position

The THOR-50M has tilt sensors located in five locations of the dummy and are used to measure the angular positions of those body locations. The seating procedure uses the tilt sensors located

[10] NHTSA. (2016, August). THOR 50th percentile male (THOR-50M) Qualification Procedures Manual. Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/sites/nhtsa.dot.gov/files/thor-50m_qualification_august2016.pdf

in the base of head and pelvis to finalize the seating position. Figure 4 details all five tilt sensor locations.

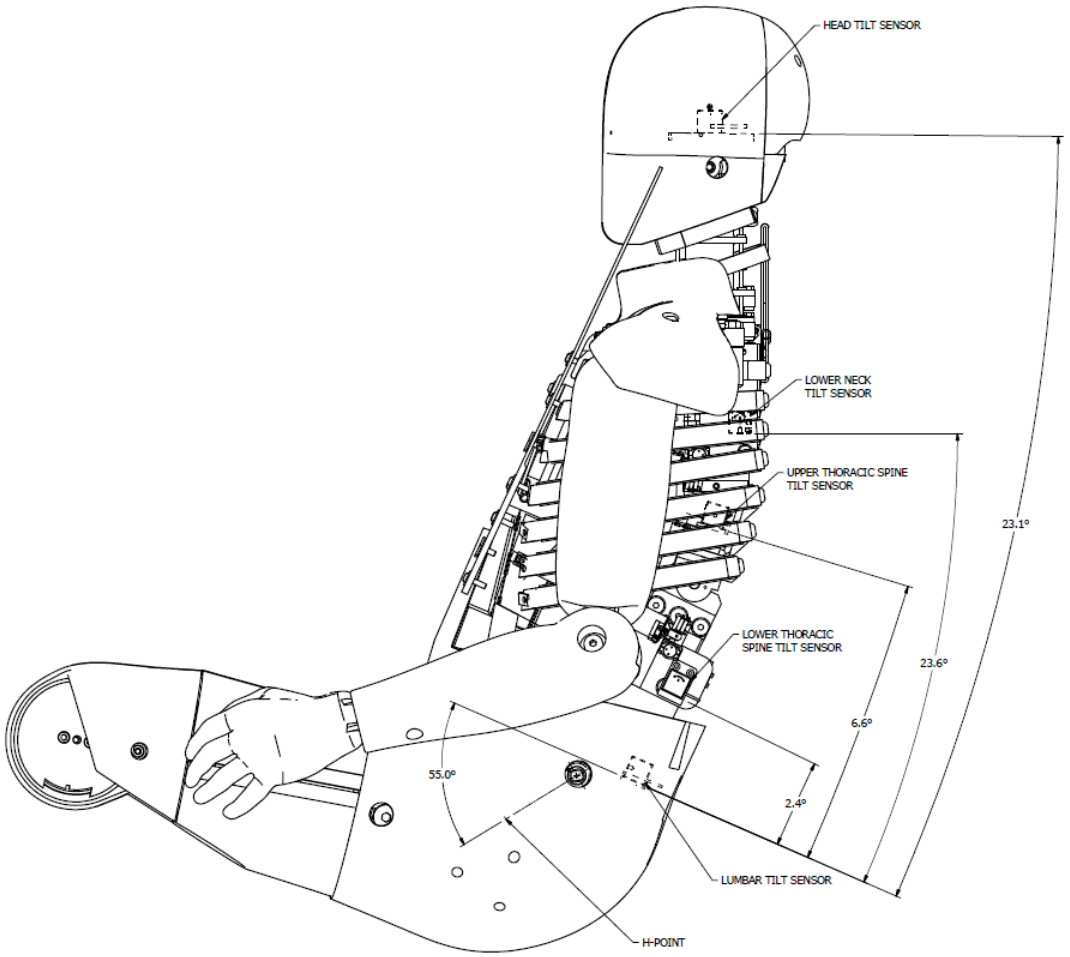


Figure 4: THOR-50M Tilt Sensor Locations

2.0 THOR-50M Dummy Updates

Since the original seating procedure[11] was published, several updates were made to the THOR-50M design that required the seating procedure to be revisited. The updates were reported in the public meeting held at the VRTC in August 2016.[12]These updates contributed to some of the changes to the seating procedure: a lengthened front neck cable, introduction of molded shoes, and an updated H-point tool.

[11] Docket Number, 2015._www.regulations.gov/document?D=NHTSA-2015-0119-0009
[12] Public Meeting, August 2016.

Front Neck Cable: In the THOR-50M, the neck is connected to the head via three separate load paths (two cables – anterior and posterior – and a pin joint centered between the cables). After the THOR-50M seating procedure referenced in the RFC was developed, the agency discovered that the anterior (front) neck cable was too short. The decreased length of the cable caused the neck to be forced forward (anteriorly) into a bent configuration (Figure 5, left) after performing the pre-test neck setup procedure. The front neck cable has since been lengthened[13] to allow for proper pre-test alignment of the head and neck without preloading the anterior neck springs and subsequent bending of the neck (Figure 5, right).

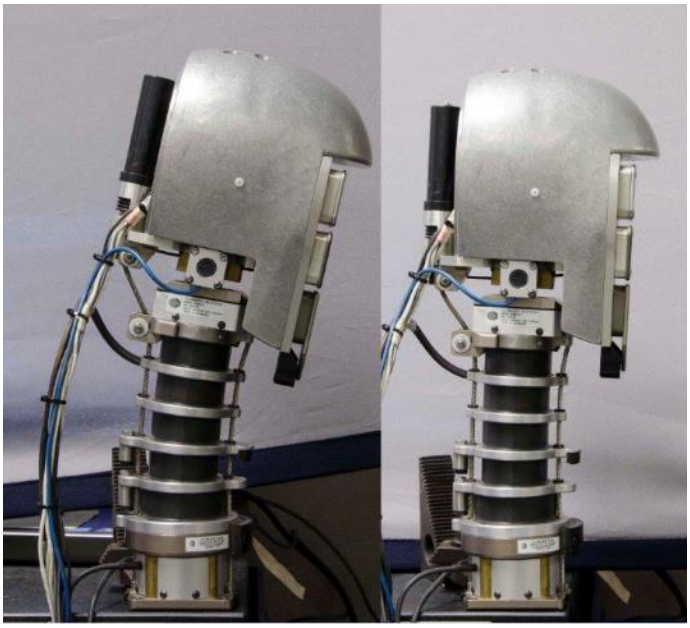


Figure 5: THOR-50M Neck Adjustment: Front Cable Length

Molded Shoe: The THOR-50M design described by the September 2014 drawing package includes an instrumented foot, with the intention that the user install a MIL-spec shoe similar to that used for the Hybrid III family of ATDs when used in vehicle crash tests. This design was updated in the THOR-50M Drawing Package-August 2016[14] to include a molded component that integrated the foot and the shoe, referred to as the molded shoe (Figure 6). While there were no major changes to the seating procedure to account for the molded shoe, there were some clarifications to the heel point definitions.

[13] NHTSA. (2016, August). Parts List and Drawings, THOR-50M Advanced Frontal Crash Test Dummy, THOR-50M Male (a.k.a. "THOR-50M Drawing Package, August 2016"). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/NVS/Biomechanics%20&%20Trauma/THOR%20Advanced%20Crash%20Test%20Dummy/THOR-50M%20Drawing%20Package-August%202016.pdf

[14] Ibid.

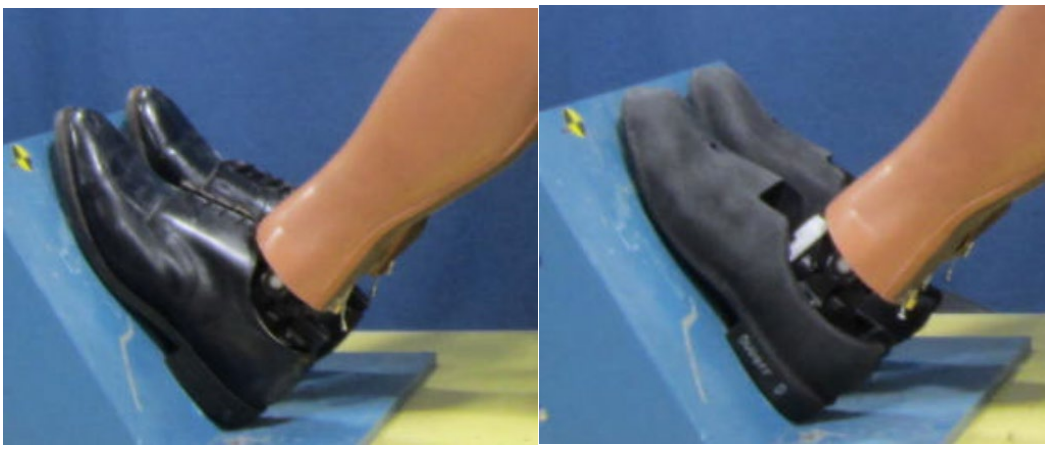


Figure 6: THOR-50M Military Shoe and Molded Shoe

H-point Tool: At the August 2016 public meeting presentation, a re-designed H-point tool was introduced. This tool is used to measure the pelvis angle along with the H-point location. This tool was designed to be installed at the same angle as the pelvis tilt sensor installed on the dummy's pelvis block (Figure 7). The pelvis angle is used as a reference measurement to position the dummy in the vehicle seat and can be measured using either the pelvis tilt sensor or the re-designed H-point tool.

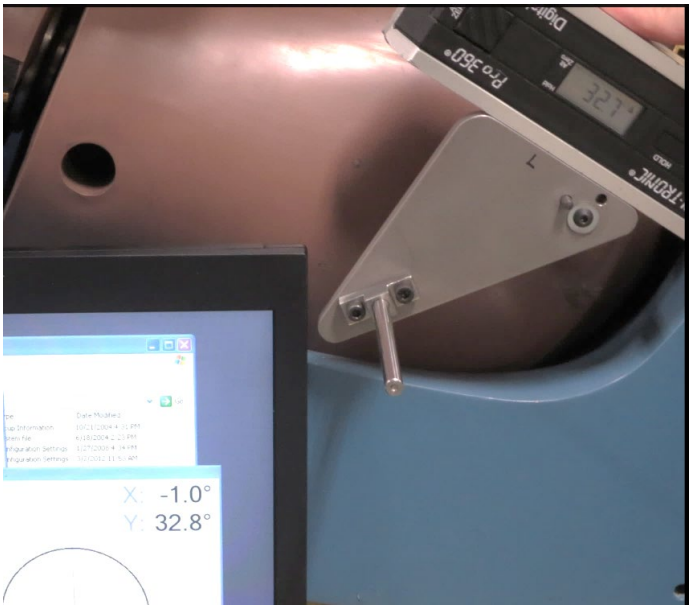


Figure 7: Close-up of Redesigned H-Point Tool

3.0 Seating Procedure Revisions

The seating procedure released with the RFC in December 2015 was subsequently revised to reflect the design updates made to the THOR-50M, additional experience using the procedure, and comments received from the RFC and public meeting. Some of the revisions were minor wording changes to better clarify the steps of the procedures. The more significant revisions are discussed in the following sections of this report.

3.1 Seating Procedure Highlights

The revised procedures for seating the THOR-50M in the driver and right front passenger positions are detailed in Appendices A and B, respectively. Listed below are the key steps for those seating procedures.

- Setup the seat
- Adjust the steering wheel (driver only)
- Locate and mark heel points
- Determine the H-point location with the seat at mid-track using the SAE J826 3D H-point manikin (i.e., H-point machine)[15]
- Create the Seat Tracking Point (STP)
- Calculate the THOR-50M target H-point at seat mid-track to be 20 millimeters forward and 20 millimeters above the H-point machine measurements
- Place dummy in the seat at rearmost position
- Position legs in line with the heel placement points and footrest (if applicable)
- Move the seat forward until it is 25 millimeters rearward of mid-track. Make additional seat position adjustments if needed due to knee contact
- Calculate the target dummy H-point position relative to the seat using the STP and H-point machine measurements
- Position the dummy to achieve the target H-point position and pelvis angle (use tilt sensors)
- Verify that the head angles of the dummy are within the target specifications
- If not, adjust the dummy's H-point
- If still not, adjust the seatback
- Position the right foot on the right heel point (RHP)
- Position the left foot on the footrest or left heel point (LHP)
- If there is still leg room, move the seat forward until a knee contacts a surface or the seat mid-track position is reached, whichever occurs first
- Verify that the H-point location/pelvis angle and the head angles are maintained
- Verify that the feet are in their proper locations
- Place the seatbelt on dummy and place hands on steering wheel (driver only)

NHTSA used a portable 3-D coordinate measuring machine (FARO Arm) to document the measurements required by this procedure. Use of such a device is highly recommended to seat the dummy efficiently and accurately.

[15] SAE J826, Defining and Measuring Vehicle Seating Accommodation. Warrendale, PA: SAE International.

3.2 Heel Point/Pedal Type

Seating procedures for different dummies have a lot of the same key features, including setting the seats, adjusting the lumbar and leg supports, and setting the steering wheel. However, the THOR-50M seating procedure introduces a new step to define the heel point. This step was added originally to this procedure to help place the dummy's feet in a more uniform method. It was identified through testing that the original procedure for the driver position did not account for different types of accelerator pedals (i.e., suspended and floor-mounted), as different accelerator pedal types produced different final heel points used to place the right heel on the floor pan. To address this discrepancy, updates were implemented to this step in the THOR-50M procedure with the intent of producing similar placement of the dummy's heel/foot independent of accelerator pedal types.

A suspended pedal is defined as a pedal suspended from the toe board or firewall and that is free hanging without touching the floor pan. This is the most common type of accelerator pedal, and they vary in size and shape. A floor-mounted pedal is defined as a pedal that is hinged at the floor pan or toe board. They are typically long and narrow and the toe/foot typically touches near the top to accelerate the vehicle. Figure 8 shows a suspended pedal and a floor-mounted pedal.

Figure 8: Suspended and Floor-Mounted Accelerator Pedals

The objective of the original procedure was to place the ball and heel of the dummy's foot at realistic locations for a driver's foot, while keeping the legs in a vertical plane. For the THOR-50M, the ball of the foot is approximately 200 millimeters from the heel of the foot. For the suspended pedal type, the pedal reference point (PRP) is defined as the center of the pedal. The right heel point (RHP) is established a known distance from the PRP (200 mm), translated to the floor, which allows the heel to be placed by a repeatable method. This heel point positioned the ball/toe of the foot at the PRP, with the remainder of the top part of the foot covering the accelerator pedal.

The floor-mounted pedals are mounted to the floor pan and typically have a hinge at the base of the pedal mount. Because of the typical length and angle of floor-mounted pedals, using the center of the pedal as the PRP placed (1) the dummy's right heel more rearward on the floor pan, (2)

the foot in a more horizontal position, and (3) the ball of the foot above the PRP. This method raised the right knee higher than the left knee and resulted in an awkward overall foot placement. Figure 9 shows an example of the foot at the RHP created by the center method.

Figure 9: Floor-Mounted Pedal: Heel at RHP Using the Center Method

The revised procedure for floor-mounted pedals defines the PRP as the center of the pedal's width at 75 percent of the pedal's overall height. The RHP is then established on the floor pan 200 millimeters from the PRP. Figure 10 shows a floor-mounted pedal marked with the PRP and the RHP.

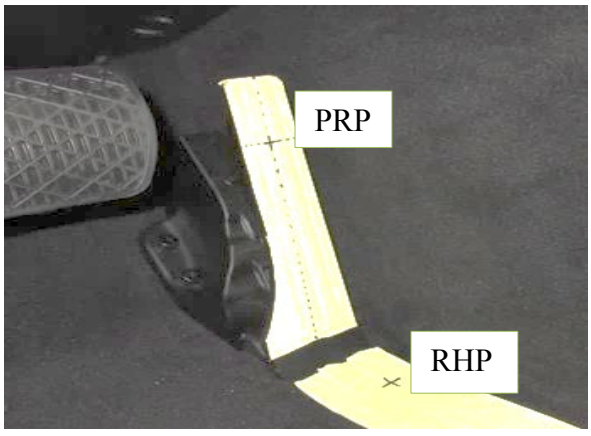


Figure 10: Floor-Mounted Pedal Method: PRP and RHP

See Appendix A for more details on how to determine the PRP and heel points for both the suspended (Step 7) and floor-mounted (Step 8) accelerator pedals.

3.3 Seat Fore/Aft Position

The original seating procedure starts with placing the dummy in the seat at the rearmost (fore/aft) travel position. The seat is slid forward to 25 millimeters rearward of mid-track (previously determined) or to the detent closest to this position that is not greater than 25 millimeters rearward of mid-track. If there is contact with the steering wheel and/or instrument panel, adjust the knees laterally not more than 5 millimeters to avoid the contact. Figure 11 shows interference with the instrument panel on the passenger side of the vehicle, and the arrow shows an example of where to adjust the dummy.

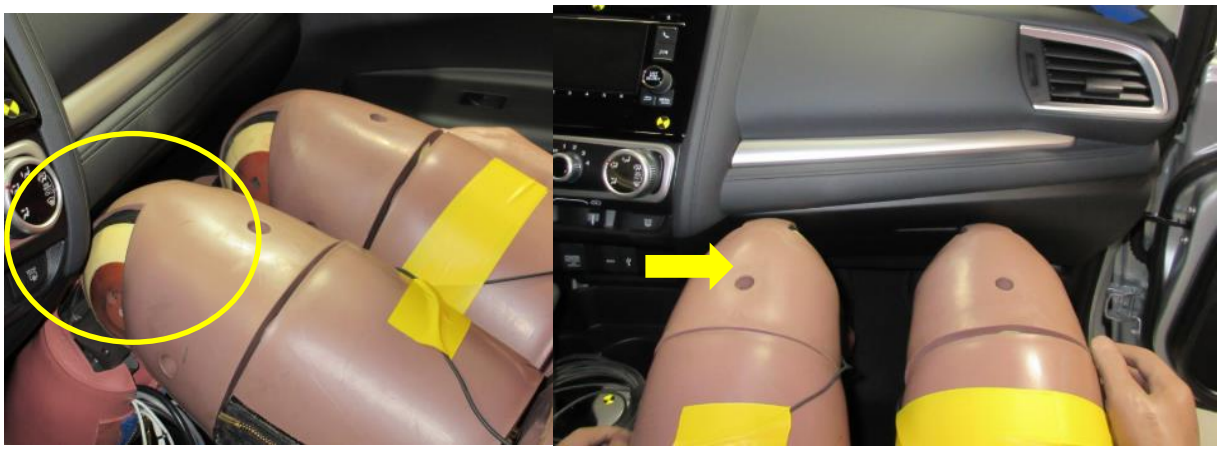


Figure 11: Knee Interaction with the Instrument Panel

However, additional experience using the seating procedure in both the lab and crash tests[16,17] demonstrated that the 25-millimeter rearward of mid-track seat position could not be obtained in all vehicles. There were instances that the dummy contacted the instrument panel at a greater distance than 25 millimeters rearward of mid-track. Therefore, the seating position procedure was revised to address this issue. A step was added to allow the seat to be positioned more rearward (in 25 mm increments) if there was contact between the legs and the steering column or instrument panel. The revised procedure for positioning the seat can be found in Appendix A for the driver (step 18.5) and Appendix B for the right front passenger (step 14.5).

3.4 H-Point Tolerances

To seat the THOR-50M, the dummy's H-point must be positioned within a certain distance of the target H-point, which is based on the H-point machine measurements. The original procedure had a tolerance of ± 5 millimeters on both the X (horizontal) and Z (vertical) positions. There were many comments about the tolerance being hard to achieve in both directions. The dummy seatings associated with research crash tests[18,19] and seating tests that were conducted in the lab were analyzed, and it was determined that the ± 5-millimeter tolerance was not always obtained.

[16] Saunders & Parent, 2018.
[17] Keon, 2016.
[18] Saunders & Parent, 2018.
[19] Keon, 2016

The final H-point locations of both the driver and passenger dummies were assessed, and the maximum deviations from the target H-point locations were 9 millimeters for the X-axis and 10 millimeters for the Z-axis. As a result, it was determined that the tolerances should be expanded to ± 10 millimeters for both the X and Z directions.

3.5 Final Head Position

As noted previously, the dummy's front neck cable was lengthened which allows for the neck to be in a more vertical orientation. The head is positioned using the tilt sensors mounted in the center of the head. In the seating procedure released with the RFC, the original target measurements for the head angles were 0 ± 1 degree rotation about the X-axis (i.e., the dummy should not lean left or right) and -2.5 ± 1 degree rotation about the Y-axis (i.e., the dummy should lean slightly forward). The target for rotation about the Y-axis was not zero originally, due to the short front neck cable (see Chapter 2.0) and frequent head interaction with the headrest. After the dummy modifications, the dummy's head and neck were more vertical; thus, the seating procedure was changed to specify a more level final head position. Even though the intent of the seating procedure is to place the head in a level position, the way the THOR dummy's head and body interact with the head rest and seatback does not allow for the head to achieve the zero-degree target in all vehicles. In the revised seating procedure, there is still the flexibility to adjust the seatback by one detent (or up to 2 degrees), if necessary, to adjust the dummy's head to the recommended angle or to minimize the angle. However, the revised procedure allows for the final head rotation about the Y-axis to not be level, if all the other steps are conducted. The revised procedure gives preference to maintaining the target H-point position and to maintaining the design angle of the seatback with only a slight adjustment.

A small survey was conducted with the revised THOR-50M in several vehicles that were used to develop the original procedure to see if the neck cable changed the overall head position. Table 1 shows the head angle results from the initial trial and from the second trial with the new neck cable. In four of the five vehicles, the head angle about the Y-axis was closer to the 0 ± 1 degree target than to the original target when the new neck cable was used.

Table 1: Head Angle Results

Vehicles	Original Front Cable Head Angle	Updated Front Cable Head Angle	Overall Difference
2014 Suzuki SX4	1.6	0.1	1.5
2015 Toyota Sienna	-3.4	0.8	-4.2
2015 Honda Fit	-3.4	-0.5	-2.9
2015 Chevy Malibu	-2.7	-3.2	0.5
2016 Mazda CX5	-5.2	-3.8	-1.4

The revised procedure for head angle positioning can be found in Appendix A for the driver (step 18.11) and Appendix B for the right front passenger (step 14.11).

After the head, pelvis, and H-point are positioned, the legs are positioned. The head, pelvis, and H-point locations are re-measured and assessed, then the seat can be moved forward if it is not at mid-track and there is no steering wheel/instrument panel interference. See steps 18.13 in Appendix A (driver) and 14.13 in Appendix B (right front passenger) for details.

4.0 Summary

The THOR seating procedure released with the RFC in December 2015 was subsequently revised to reflect design updates made to the THOR-50M, additional experience using the procedure, and comments received from the RFC and public meeting. The dummy was modified with a lengthened front neck cable that allows the head and neck to be more upright/vertical, introduction of molded shoes, and an updated H-point tool. Some of the revisions to the seating procedure were minor wording changes to better clarify the steps of the procedures. The more significant revisions to the procedure were discussed in this report, including heel point definitions for different accelerator pedal types, seat fore/aft position, H-point tolerances, and final head angle.

Appendix A: THOR 50th Percentile Male Dummy Seating and Positioning Procedures: Driver Position

Seating and Positioning Procedures for the THOR 50th Percentile Male Dummy (THOR-50M) – Driver Position

1 Determine the seat type

Visually inspect the seats to determine type (i.e., bucket or bench)

_____Bench
_____Bucket

2 Position lumbar supports

Position the seat's adjustable lumbar supports to the lowest, retracted, or deflated adjustment positions

_____*N/A* No lumbar adjustment

3 Position additional supports

Position any adjustable parts of the seat that provide additional support so that they are in the lowest or most open adjustment position

_____*N/A* No additional support adjustment

4 Position leg supports

Position an adjustable leg support system in its rearmost position

_____*N/A* No adjustable leg support system

5 Mark the centerline of the seat using a vehicle longitudinal, vertical (XZ) plane (complete ONLY the one that is applicable to seat being marked)

5.1 Bucket Seat: For future reference, locate and mark the line on the seat cushion that is the intersection of the XZ plane which passes through the centerline of the seat and the seat cushion upper surface

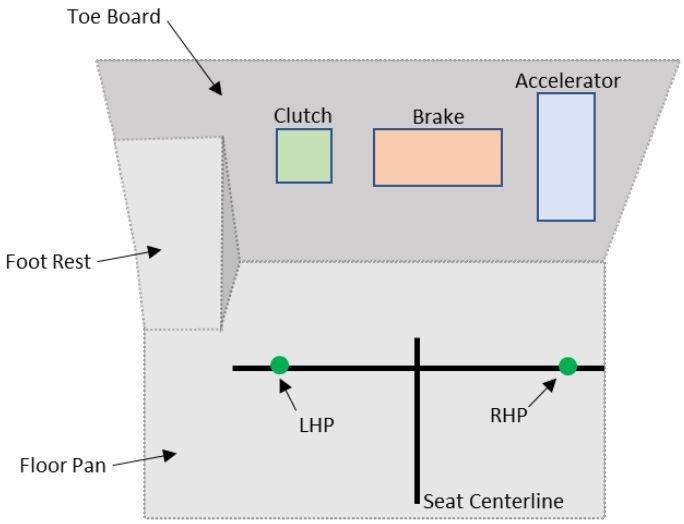
5.2 Bench Seat: For future reference, locate and mark the line on the seat cushion that is the intersection of the XZ plane which passes through the centerline of the steering wheel and the seat cushion upper surface

6 Determine the type of accelerator pedal in the vehicle in order to mark the Right Heel Point (RHP). It is suggested to do the measurements using a Coordinate-Measuring Machine (CMM).

6.1 Is it a suspended accelerator pedal? If so, use the procedures detailed in step 7, and then go to step 9.

6.2 Is it a floor-mounted accelerator pedal? If so, skip step 7 and use the procedures detailed in step 8, and then go to step 9.

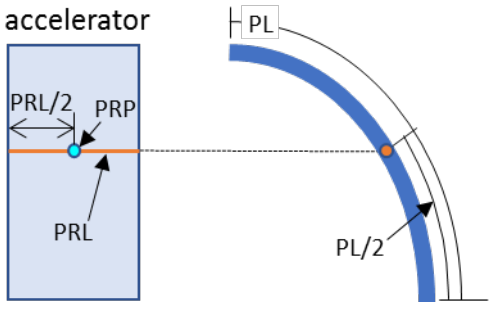
7 Locate and mark the Heel Points (RHP and LHP) on the floor pan with a <u>suspended accelerator pedal</u>. (For a floor-mounted pedal, proceed to step 8.)



7.1 Place adjustable pedals in the full forward position (towards the front of the vehicle).

____N/A the pedals are not adjustable.

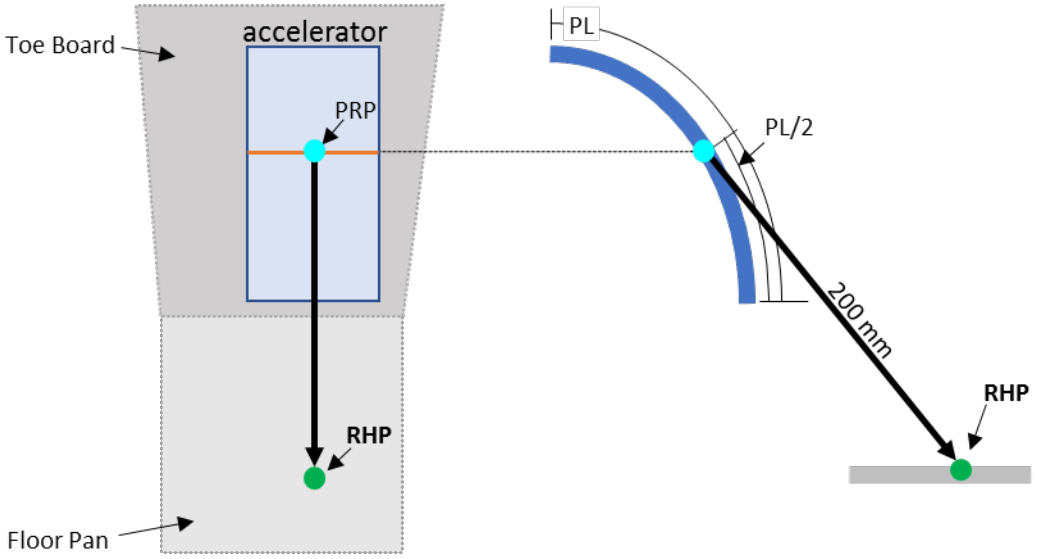
7.2 Using the diagram and steps below, locate the Pedal Reference Point (PRP) on the accelerator pedal (using a measurement device such as a flexible tape measure, CMM, and/or calipers).



7.2.1 Measure the accelerator pedal length (PL) along the surface of the pedal from the top edge to the bottom edge. Establish the pedal reference line (PRL) by marking a line in the y-direction on the pedal surface at the mid-point of the PL.

7.2.2 Measure the accelerator pedal width along the PRL. Establish the pedal reference point (PRP) by marking the midpoint of the PRL.

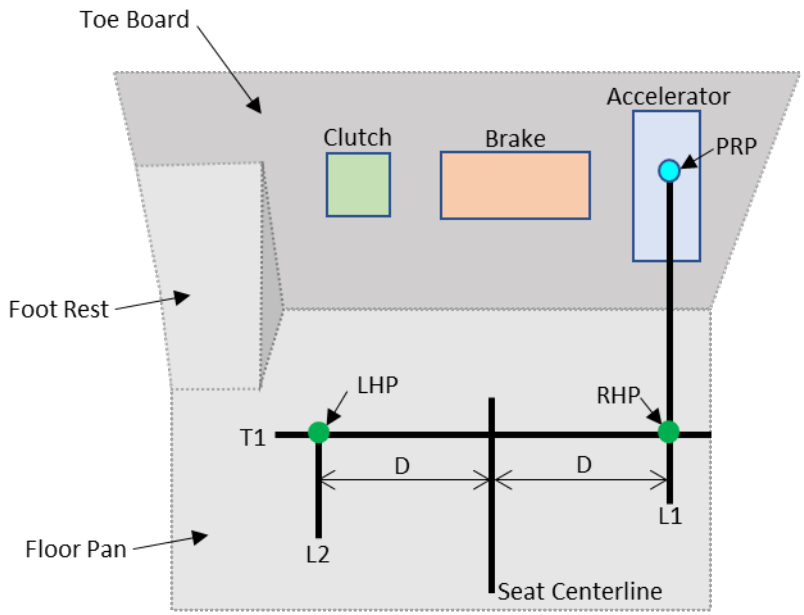
7.3 Using a measurement device (CMM, 200 mm bar, calipers), locate a point on the floor pan that is 200 mm from PRP and is in the vehicle's longitudinal, vertical (XZ) plane which passes through PRP. This is the right heel point (RHP).



7.4 Mark a line on the pedal and the floor pan that passes through PRP and RHP. This line shall be referred to as L1 and should be in the same vehicle XZ plane as PRP and RHP.

7.5 Translate and mark the seat centerline on the floor pan. The lines on the seat and floor pan should be in the same vehicle XZ plane.

7.6 Measure the distance in the y-direction (D) from the seat centerline to L1. Record the value:_____.



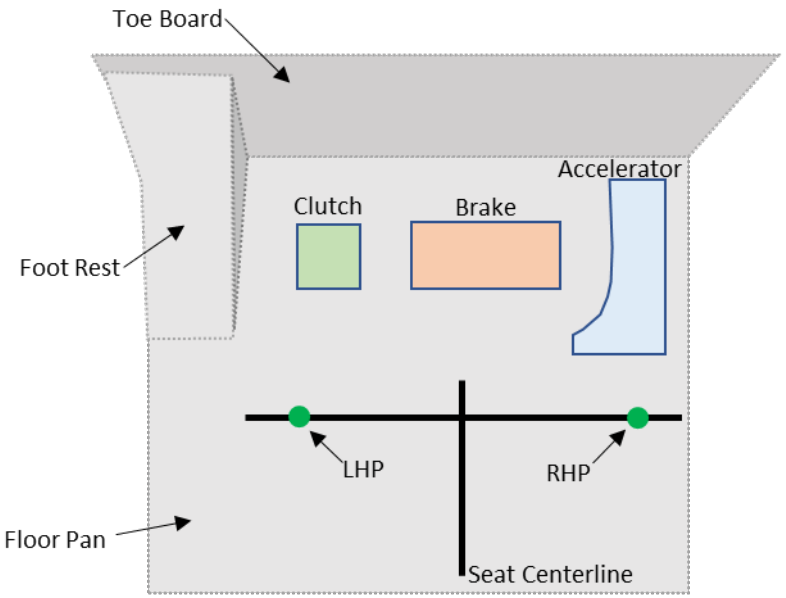
7.6.1 Measure and mark a point on the floor pan to the left of the seat centerline that is the same distance from the seat centerline as RHP and in the same vehicle lateral, vertical (YZ) plane, and label that the left heel point (LHP).

7.6.2 Construct a line on the floor pan through RHP and LHP; call it T1.

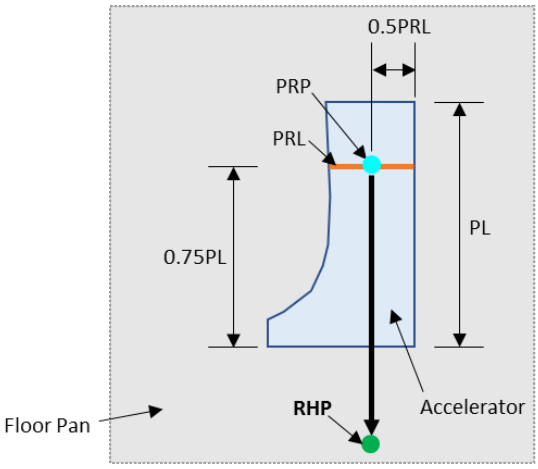
7.6.3 Construct a line on the floor pan that is in a vehicle XZ plane and that passes through LHP. This line shall be referred to as L2.

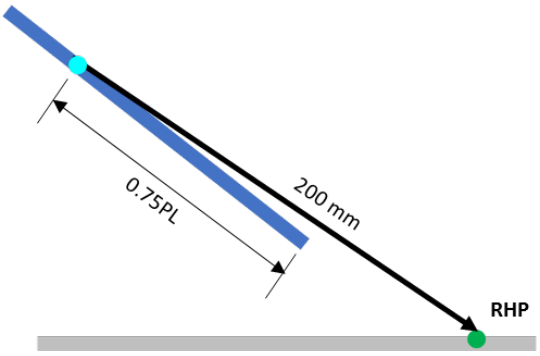
7.7 Mark two lines on the floor pan parallel to line T1; the first 10 mm forward and the second 10 mm rearward of T1. This zone between these two lines will be used for placement of both the left and right heels and will be referred to as the heel point zone.

8 Locate and mark the Heel Points (RHP and LHP) on the floor pan with a <u>floor-mounted accelerator pedal</u>. (Use step 7 for a suspended pedal.)



8.1 Using the diagram below, locate the Pedal Reference Point (PRP) and the Right Heel Point (RHP) using a measurement device such as a tape measure, CMM, 200 mm bar, and/or calipers. Use the active part of the pedal, which is defined as the moveable part of the floor-mounted pedal.





8.1.1 Determine the overall pedal length (PL) on the active pedal, as measured along the surface of the moveable pedal. Record the length:_____. Calculate 75% of this length (0.75PL). Establish the pedal reference line (PRL) by marking a line in the y-direction on the pedal surface at 0.75PL from the bottom edge of the pedal.

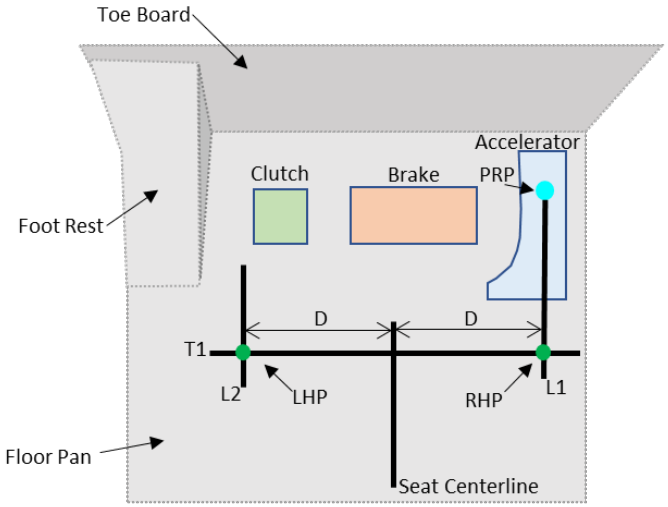
8.1.2 Measure the length of the PRL in the y-direction and mark the center point of the PRL. This is the PRP.

8.1.3 Using a measurement device (CMM, 200mm bar, calipers), locate a point on the floor pan that is 200 mm from PRP and in the vehicle's longitudinal, vertical (XZ) plane which passes through PRP. This is the right heel point (RHP).

8.2 Mark a line on the pedal and the floor pan that passes through PRP and RHP. This line shall be referred to as L1 and should be in the same vehicle XZ plane as PRP and RHP.

8.3 Translate and mark the seat centerline on the floor pan. The lines on the seat and floor pan should be in the same vehicle XZ plane.

8.4 Measure the distance in the y-direction (D) from the seat centerline to L1. Record the value:_____.



8.4.1 Measure and mark a point on the floor pan to the left of the seat centerline that is the same distance from the seat centerline as RHP and in the same vehicle lateral, vertical (YZ) plane, and label that the left heel point (LHP).

8.4.2 Construct a line on the floor pan through RHP and LHP; call it T1.

8.4.3 Construct a line on the floor pan that is in a vehicle XZ plane and that passes through LHP. This line shall be referred to as L2.

8.6 Mark two lines on the floor pan parallel to line T1; the first 10 mm forward and the second 10 mm rearward of T1. This zone between these two lines will be used for placement of both the left and right heels and will be referred to as the heel point zone.

9 Mark the range of seat travel

Prior to marking the seat for fore/aft travel, move the seat through its full range of motion using all available controls. Separately, operate each control to determine whether it moves the seat and/or seat cushion primarily in the fore-aft or up-down directions.

9.1 Mark a point (seat cushion reference point - SCRP) on the side of the seat cushion that is between 150 mm and 250 mm from the front edge of the seat cushion. For seat cushions that move up and down independently from the seat housing, mark the point on the side of the cushion in an area that will not be obscured by the seat housing when the seat cushion is at its lowest height position.

9.2 Draw a horizontal line (seat cushion reference line - SCRL) through the SCRP.

9.3 Using only the controls that primarily move the seat in the fore-aft direction, move the SCRP to the lowest rearmost position.

9.4 If the seat cushion adjusts fore-aft, independent of the seat back, using only the controls that primarily move the seat cushion in the fore-aft direction, move the SCRP to the rearmost position.

__ *N/A* No independent fore-aft seat cushion adjustment

9.5 Using any part of any control, other than the parts just used for fore-aft positioning, determine the range of angles of the SCRL and set the SCRL at mid-angle. Record the maximum, minimum, and mid-angles in the table below.

SCRL (deg)	Max	Min	Mid
Driver			

9.6 If the seat and/or seat cushion height is adjustable, using any part of any control other than the parts which primarily move the seat or seat cushion fore-aft, put the SCRP in its lowest position with the SCRL angle at the mid-angle found in 9.5.

__ *N/A* No seat height adjustment

9.7 Using only the controls that primarily move the seat in the fore-aft direction, verify the seat is in the rearmost position.

9.8 Using only the controls that primarily move the seat in the fore-aft direction, mark the fore-aft seat positions. Mark each position so that there is a visual indication when the seat is at a particular position.

For manual seats, move the seat forward one detent at a time and mark each detent.

For power seats, mark only the rearmost, middle, and foremost positions. Label three of the positions with the following: F for foremost, M for mid-track (if there is no mid-track, label the closest adjustment position to the rear of mid-track), and R for rearmost.

Measure the SCRP fore-aft location for each seat position on the table below.

	SCRL Mid-Angle (deg)	Rearmost		Mid-track		Foremost		SCRP Height (mm) Spacing measurement between detents (if applicable)
		X	Z	X	Z	X	Z	X
Driver								

9.8.1 While at mid-track, also mark a position that is 25 mm rearward of mid-track.

10 Position the head restraint

10.1 Using any adjustment of the head restraint, position it to its highest setting.

10.2 Using any adjustment of the head restraint, position it to the full rearward setting. If it rotates, rotate it such that the head restraint extends as far rearward as possible.

__*N/A* The test vehicle is equipped with automatically adjusting head restraints or there is no head restraint adjustment.

11 Set the seat for a test dummy

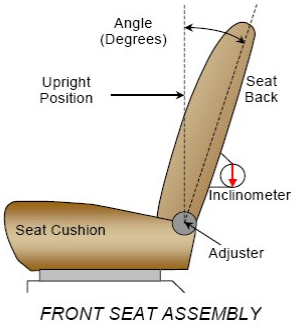
Using the reference marks on the seat, set the seat in the mid-track, lowest height, and mid seat cushion angle positions as follows:

11.1 If the seat or seat cushion height is adjustable, using other than the controls that primarily move the seat or seat cushion fore and aft, set the height of the SCRP to the minimum height, with the SCRL set as closely as possible to the mid-angle determined in previous steps.

11.2 Using the control that primarily moves the seat fore and aft, move the SCRP to the mid-track position.

11.3 Set the seat back angle at the manufacturer's nominal design riding position for a 50th percentile male adult occupant.

If the position is not specified, set the seat back in the position that produces a torso (back) angle of 25° from vertical when measured with the SAE J826 H-point machine. For seat backs with discrete positions, if a torso (back) angle of 25° from vertical cannot be achieved, set the seat back in the detent that yields a torso (back) angle as close as possible to 25° from vertical. Describe the method used to achieve the nominal design riding position and record the seat back angle.



FRONT SEAT ASSEMBLY

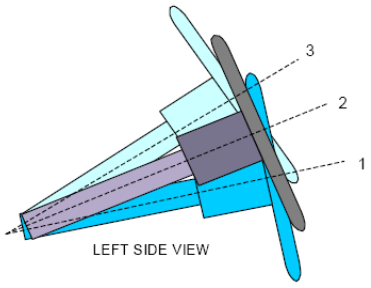
_____
_____
_____
_____

Seat Back Angle _____°

___*N/A* The seat back does not adjust.

12 Set the steering wheel to the mid-position

Use the markings to position the steering wheel hub at the geometric center of full range of driving positions including any telescoping positions. For steering columns with discrete positions and no detent at the mid-angle, position the column in the next lowest detent from the mid-angle.



STEERING COLUMN ASSEMBLY

Complete the following table:

	Degrees	Fore/Aft Position (mm)
Lowermost - Position 1		
Geometric Center – Position 2		
Uppermost – Position 3		
Telescoping Steering Wheel Travel		
Test Position		

___*N/A* The steering wheel does not adjust.

13 Set adjustable seat belt upper anchorages

Use the markings to position an adjustable seat belt upper anchorage at the manufacturer's nominal design position for a 50th percentile male adult occupant or highest position if not provided. Fill in the following table:

Seat	Total # of Positions	Placed in Position #
Driver		

__*N/A* The seat belt upper anchorage does not adjust.

14 Retract the armrest

Retract any folding armrest

__*N/A* No armrest or armrest is fixed, not retractable.

15 Determine the H-point location with the H-Point machine;

Position the three-dimensional H-point manikin (i.e., H-point machine) specified in Society of Automotive Engineers (SAE) Surface Vehicle Standard J826, revised July 1995, Devices for Use in Defining and Measuring Vehicle Seating Accommodation in the seat as follows:

15.1 Place a 910 mm^2 piece of muslin cotton cloth over the seat area (the muslin cloth shall be comparable to 48 threads/in^2 and density of 2.85 lb/yd). Tuck the muslin cloth a sufficient amount to prevent hammocking of the material.

15.2 Place the seat and back assembly of the H-Point machine such that its plane of symmetry is coincident with the centerline marking on the seat.

15.3 Install the lower leg and foot segments.

15.4 Set the length of the lower leg segments at 414 mm (16.3 in) and the length of the thigh bar at 401 mm (15.8 in).

15.5 Leg and foot placement

15.5.1 Insert the pin so that the right foot angle is not less than 87°.

15.5.2 Place the right foot on the un-depressed accelerator pedal with the sole of the foot on the pedal and the heel as far forward as allowable. Do not place the heel on the toe board.

15.5.3 Adjust the left leg to be the same distance from H-point machine centerline as the right leg.

15.5.4 With the T-bar level, place the left foot on the toe board with the rearmost point of the heel resting on the floor pan as close as possible to the point of intersection of the planes described by the toe board and the floor pan and not on the wheel well projection. If the foot cannot be positioned on the toe board, set it on the floor pan.

__Foot on toe board
__Foot on floor pan

15.6 Apply the lower leg weights.

15.7 Apply the thigh weights.

15.8 Tilt the back pan forward against the forward stop and draw the H-point machine away from the seatback using the T-bar.

15.9 Re-positioning the H-point machine.

15.9.1 Allow the H-point machine to slide rearward until a forward horizontal re-straining load on the T-bar is no longer required due to the seat pan contacting the seat back.

__The seat pan does not slide rearward. Go to step 15.9.2.

15.9.2 Slide the H-point machine rearward by a horizontal rearward load applied at the T-bar until the seat pan contacts the seat back.

15.10 Apply a 10 kg load at the intersection of the hip angle quadrant and the T-bar housing along a line from the above intersection to a point just above the thigh bar housing.

15.11 Again apply a 10 kg load at the intersection of the hip angle quadrant and the T-bar housing along a line from the above intersection to a point just above the thigh bar housing.

15.12 Carefully return the back pan to the seat back.

15.13 Install the right and left buttock weights.

15.14 Install the eight torso weights, alternating the installation between right and left.

15.15 Tilt the back pan forward until the stop is contacted.

15.16 Rock the H-point machine from side to side over a 10° arc (5° to each side of the vertical centerline) for three complete cycles. Restrain the T-bar during rocking so that the seat pan does not change position. Minimize any inadvertent exterior loads applied in a vertical or fore-aft direction. The feet are free to move during this rocking motion.

15.17 Without applying a forward or lateral load, lift the right foot off the floor the minimum amount necessary until no additional forward foot movement is obtained.

15.18 Lower the right foot until the heel is in contact with the floor pan and the ball of the foot is in contact with the floor, toe board, or undepressed accelerator pedal.

15.19 Without applying a forward or lateral load, lift the left foot off the floor the minimum amount necessary until no additional forward foot movement is obtained.

15.20 Lower the left foot until the heel is in contact with the floor pan and the ball of the foot is in contact with the floor or toe board.

15.21 Is the seat pan level?

__Yes. Go to step 15.23.

__No. Go to step 15.22.

15.22 Apply a sufficient lateral load to the top of the seatback pan to level the H-point machine seat pan on the seat.

15.23 Holding the T-bar to prevent the H-point machine from sliding forward on the seat cushion, return the seatback pan to the seatback.

15.24 Holding the T-bar to prevent the H-point machine from sliding forward on the seat cushion, apply a rearward force perpendicular to the back angle bar just above the torso weights until either 66 N (15 lb) of force is reached or the hip angle is increased by 3°, whichever occurs first. Minimize the exterior downward or side forces applied to the H-point machine. Release the force. Repeat this step until the resulting hip angle is identical. Complete as many force applications as necessary and record the results in the following table:

Force App.	Hip Angle
1	
2	
3	
4	
5	

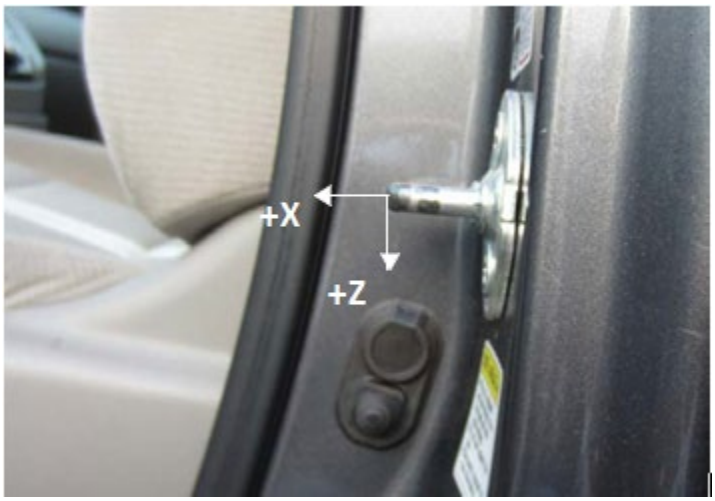
15.25 Is the H-point machine level?
__Yes. Go to step 15.26.

__No. Go back to step 15.15 and repeat steps to re-level H-point machine.

15.26 Record the H-point location in the table below:

H-point Machine H-point Location and Torso Angle	
Torso Angle	°
X (positive (+) forward of striker)	(mm)
Z (positive (+) below striker)	(mm)

Reference: X-axis is positive forward of striker
Y-axis is positive right of striker
Z-axis is positive below striker



15.27 Create a Seat Tracking Point (STP): Place a target point 20 mm forward of the H-point machine H-point on a rigid part of the seat and record its location in the table below. This reference point will be used to locate the dummy H-point relative to the seat if the seat cannot be set to the mid-track position.

Seat Tracking Point (STP) Location at Mid-track	
X (positive (+) forward of striker)	(mm)
Z (positive (+) below striker)	(mm)

15.28 Remove the H-point machine.

16 Calculate the THOR-50M H-point target at seat mid-track

16.1 The THOR-50M H-point is offset 20 mm forward and 20 mm above the H-point machine H-point as determined in the table below:

THOR-50M Target H-point at Mid-track				
H-point machine H-point (from step15.26) +/- 20 mm = THOR-50M H-point at mid-track				
X (positive (+) forward of striker)	( )	+	20 mm	mm
Z (positive (+) below striker)	( )	-	20 mm	mm

If steps 1-16 were completed prior to seating, verify that measurements have been recorded prior to placing dummy in seat.

17 Once the H-point has been determined and the following things are verified, position a THOR-50M in the driver seat of the test vehicle.

17.1 Follow the procedures in the THOR-50M Qualification Manual for setting the joint torques. Also, make sure the neck is placed in the neutral position setting and the spine box is placed in the slouched position before placing the dummy in the vehicle.

17.2 Verify the head and pelvis tilt sensors installed in the dummy are reading correctly about the X and Y axes.

17.3 Record the lumbar spine pitch change joint and neck pitch change joint settings below:

Lumbar spine pitch change joint: _____
Neck pitch change joint: _____

17.4 Verify the seat back and base angles, the steering wheel location, and the seat belt height adjustment are in the correct locations.

18 Positioning the test dummy in the seat

18.1 Move the seat to the full rearward position and place the test dummy in the seat with the thighs resting on the seat cushion.

18.2 Position the test dummy in the seat such that its plane of symmetry (i.e., mid-sagittal plane) is coincident with the centerline marking on the seat cushion, seat back, and head restraint and its H-point is approximately above the STP.

18.3 Bend the upper torso forward and then lay it back against the seat back. Push the shoulders of the dummy fully rearward. Using the installed tilt sensors, position the dummy so that it sits squarely and level in both the X- and Y-axes in the seat.

18.4 To the extent practicable keep the left and right thighs and legs in vertical planes and align the centerline of the right foot with the centerline of the accelerator pedal. Initially set the feet perpendicular to the legs and then place the right foot as far forward as possible in the direction of the pedal centerline.

18.4.1 Does this vehicle have a footrest?

___Yes. Starting with the left foot and leg inboard of the footrest, rotate the leg about the hip the minimal amount needed to maximize coverage of the sole of the shoe over the footrest (when viewed longitudinally), while keeping the centerline of the foot in a vertical plane and the leg as vertical as practicable. Ignore the LHP.

___No. Adjust the left leg so the knees are an equal distance from the seat centerline, as measured from the centerline of the knee, while keeping the leg as vertical as practical. Align the foot with the LHP (± 10 mm).

18.5 Lift the feet and slide the seat forward to 25 mm rearward of mid-track or the detent closest to this position that is not greater than 25 mm rearward of mid-track. Adjust the feet if necessary. If there is knee/leg contact with the steering wheel, steering column, or instrument panel, adjust the knee/leg making contact inboard or outboard the minimal amount required to create clearance (not more than 10 mm).

Is there still interference between the dummy's knees/legs and the knee bolster/ instrument panel?

__No. Go to step 18.6.
__Yes. Lift the feet and slide the seat to 50 mm rearward of mid-track or the detent closest to this position that is not greater than 50 mm rearward of mid-track. If there is still interference (within 5 mm), continue to move the seat rearward in 25 mm increments until there is no longer interference.

18.6 Verify the SCRP position, then measure location of the STP and record it under Trial 1 in the table below (subsequent trials may be needed, depending on the outcome of step 18.13):

Seat Tracking Point Location Trial 1	
X (positive (+) forward of striker)	(mm)
Z (positive (+) below striker)	(mm)
Seat Tracking Point Location Trial 2 (if applicable)	
X (positive (+) forward of striker)	(mm)
Z (positive (+) below striker)	(mm)
Seat Tracking Point Location Trial 3 (if applicable)	
X (positive (+) forward of striker)	(mm)
Z (positive (+) below striker)	(mm)

18.6.1 Calculate and record the Seat Tracking Point Difference (STPD)

STPD = Location of STP from step 18.6 – location of STP from step15.27

Record in table below:

Trial 1				
	Results from 18.6	-	Results from 15.27 =	STPD
X (positive (+) forward of striker)	( )	-	( )	mm
Z (positive (+) below striker)	( )	-	( )	mm

Trial 2 (if applicable)				
	Results from 18.6	-	Results from 15.27 =	STPD
X (positive (+) forward of striker)	( )	-	( )	mm
Z (positive (+) below striker)	( )	-	( )	mm

Trial 3 (if applicable)				
	Results from 18.6	-	Results from 15.27 =	STPD
X (positive (+) forward of striker)	( )	-	( )	mm
Z (positive (+) below striker)	( )	-	( )	mm

18.6.2 Calculate and record the THOR-50M target H-point for each seat position as the seat is moved forward (per step 18.5), following the corresponding steps.

X: THOR-50M Target H-point for 18.6.2 = (THOR-50M Target H-point from 16.1) + (STPD from 18.6.1)

Z: THOR-50M Target H-point for 18.6.2 = (THOR-50M Target H-point from 16.1) + (STPD from 18.6.1)

Trial 1				
	Results from 16.1	-	Results from 18.6.1 = Current Target H-point	
X (positive (+) forward of striker)	( )	+	( )	mm
Z (positive (+) below striker)	( )	+	( )	mm

Trial 2 (if applicable)				
	Results from 16.1	-	Results from 18.6.1 = Current Target H-point	
X (positive (+) forward of striker)	( )		( )	mm
Z (positive (+) below striker)	( )	+	( )	mm

Trial 3 (if applicable)				
	Results from 16.1	-	Results from 18.6.1 = Current Target H-point	
X (positive (+) forward of striker)	( )	+	( )	mm
Z (positive (+) below striker)	( )	+	( )	mm

18.7 Confirm, using the tilt sensors, that the dummy is positioned such that a horizontal, lateral line passing through the dummy's hip pivot center is perpendicular to the center XZ plane of the seat – adjust the dummy if necessary.

18.8 Verify/Measure the pelvis angles using the tilt angle sensors installed in the test dummy. Verify that the pelvis angles are 0°± 1° (about the X-axis) and 33° ± 2.5° (about the Y-axis).

18.9 Confirm that the H-point is within ± 10 mm of the target location in the horizontal (X) and the vertical (Z) directions – adjust the dummy if necessary.

18.10 Are the pelvis angles within specification (described in step 18.8)?

__Yes. Go to step 18.11.

__No. Go back to step 18.7 and repeat steps to re-adjust pelvis angles while maintaining the H-point position within specification.

18.11 Verify/Measure the head angles using the tilt angle sensors installed in the test dummy. Verify that the head angles are 0°± 1° (about the X axis) and 0°± 1° (about the Y-axis).

18.11.1 Are the head angles within specification?

__Yes. Go to step 18.12 (foot placement).

__No and head is not touching head rest. Go back to step 18.7; adjust the pelvis while maintaining the H-point target position within specification.

__No and head is not touching head rest, but the pelvis has already been re-adjusted. Go to step 18.11.2.

__No and head is touching head rest. Go to step 18.11.2.

__No and seat back has been adjusted already.
Record final head angles X:____°
Y:____°

18.11.2 Has seatback angle been adjusted?

___No. Adjust seatback a maximum of 1 detent for manual seats and not more than 2° from the manufacturer's recommended angle found in step 11.3, to bring the head angles within/or as close as possible to specification. Return to step 18.7.

Record original seatback angle before adjustment: ____ °

Record the new seatback angle: _____°

___Yes. Make no further adjustment.

Record final head angles X: _____°
Y: _____°

Go to step 18.12.

18.12 Foot Placement

18.12.1 Right Foot Placement

Without inducing pelvis or torso movement, position the right foot in contact with the accelerator pedal such that the midline of the foot is in the same vertical plane as L1 (longitudinal line parallel with vehicle centerline which passes through PRP) and the heel is resting on RHP or within the heel point zone (as determined in step 7).

To the extent practicable, keep the right thigh and the leg in a vertical plane. Rotate the toe towards the shin of the dummy to minimize the compression of the accelerator pedal while maintaining contact with the pedal.

The heel shall remain as close as practicable to RHP but always within the heel point zone (RHP ± 10 mm fore-aft).

18.12.2 Left Foot Placement – Does the vehicle have a footrest?

__Yes. The LHP created in step 7 is not used. Place the foot on the footrest. Go to steps 18.12.3 and 18.12.4.

__No. Go to step 18.12.5.

18.12.3 Place the heel on the floor pan at the intersection of the foot rest and the floor pan. To the extent practicable, keep the left thigh and leg in a vertical plane, rotate the leg about the hip the minimal amount needed to maximize contact with the sole of the shoe and the footrest while keeping the midline of the foot in a vertical plane.

If the foot sole of the foot cannot rest on the footrest due to the footrest angle, rotate the ankle as far forward as possible, while maintaining the heel location at the intersection of the floor pan and the footrest.

18.12.4 When the foot is placed on the footrest, does the footrest elevate the left heel more than 20 mm above (vertical axis) the right heel?

__No. Go to step 18.13.

__Yes. Position the foot off the footrest using step 18.12.5.

18.12.5 If there is not a footrest or the foot cannot be placed due to Step 18.12.4;

To the extent practicable keep the left thigh and the leg in a vertical plane throughout the procedure. With the midline of the foot in the same vertical plane as L2, place the heel on LHP or as close as possible within the heel point zone. If the left heel cannot be placed within the heel point zone, place the heel as near to LHP as practicable while keeping the midline of the foot in the same vertical plane as L2. Rotate the foot towards the toe board (plantar flexion) to the maximum extent practicable while maintaining the heel position. Check which of the following that applies (ONLY check one):

__The left foot reaches the toe board without adjusting the foot or leg. Record final knee spacing below and go to step 18.13.

__The foot does not reach the toe board and does not contact the brake or clutch pedal with foot rotated forward as far as possible (plantar flexion). Record final knee spacing below and go to step 18.13.

__The left foot contacts the brake or clutch pedal.

__Rotate the foot about the leg (abduction) the minimal amount needed to avoid pedal contact. If the heel is not in the heel point zone, move the heel forward to the middle of the heel point zone

and LHP to the extent practicable. Rotate the foot towards the toe board (plantar flexion) to the maximum extent practicable while maintaining the heel position. If the foot still contacts the brake or clutch pedal, continue to the next step; otherwise, record final knee spacing below and go to step18.13.

___Rotate the leg outboard about the hip the minimum distance necessary to avoid pedal contact. If the heel is not in the heel point zone, move the heel forward to the middle of the heel point zone to the extent practicable. Rotate the foot towards the toe board (plantar flexion) to the maximum extent practicable while maintain the heel position. Record final knee spacing below and go to step18.13.

Final Knee Spacing: _____mm

18.13 Verify that the head and pelvis angles and the H-point location are within the specifications (steps 18.8, 18.9, and 18.11). For a seat that is not in mid-track, if the dummy leg/knee to knee bolster/instrument panel clearance is greater than 5 mm, the seat should be moved forward. If there is leg/knee contact with the steering wheel, steering column, knee bolster, or instrument panel, adjust the leg/knee making contact inboard or outboard the minimal amount required to create clearance (not to exceed 10 mm).

____Seat is already at mid-track and dummy is within specified head/pelvis angles and H-point location. Go to step 18.14.

____Dummy leg/knee to knee bolster/instrument panel clearance is greater than 5 mm. Adjust the seat forward, without going forward of mid-track, until a clearance of 5 mm or less is achieved.

Record seat position: _____mm rearward of mid-track.

Return to step 18.6 and repeat the steps to go through the trials.

___ Dummy leg/knee to knee bolster/instrument panel clearance is not greater than 5 mm. No adjustments required.

Record seat position: _____mm rearward of mid-track.

Go to step 18.14.

18.14 Arm and belt placement. Verify the shoulders of the dummy are rotated fully rearward.

18.14.1 Place the right upper arm adjacent to the torso with the centerline as close to a vertical plane as possible.

Is the seat belt used for this test?

__Yes. Go to step 18.14.2.

__No. Go to step 18.14.8.

18.14.2 Fasten the seat belt around the dummy.

18.14.3 Remove all slack from the lap belt portion.

18.14.4 Pull the upper torso webbing out of the retractor and allow it to retract; repeat this four times.

18.14.5 Apply a 2 to 4-pound tension load to the lap belt.
__pounds of load applied

18.14.6 Is the belt system equipped with a tension-relieving device?

__Yes. Go to step 18.14.7.

__No. Go to step 18.14.8

18.14.7 Introduce the maximum amount of slack into the upper torso belt that is recommended by the vehicle manufacturer in the vehicle owner's manual.

18.14.8 Place the left upper arm adjacent to the torso with the centerline as close to a vertical plane as possible.

18.14.9 Place the right hand with the palm in contact with the steering wheel at the rim's horizontal centerline and with the thumb over the steering wheel.

18.14.10 Place the left hand with the palm in contact with the steering wheel at the rim's horizontal centerline and with the thumb over the steering wheel.

18.14.11 Tape the thumb of each hand to the steering wheel using masking tape with a width of 6 mm. The length of the tape shall only be enough to go around the thumb and steering wheel one time.

Driver THOR Seating Worksheet

Vehicle				**Technician**			
VIN #				**Position**			
ATD				**Date**			
SEATING #							
SCRL Angle	Max			**THOR Tilt Sensors**		**X**	**Y**
	Min -			Head	0°±1°		
	Difference	0		T1	record for ref		
	/2	0		T6	record for ref		
	Min +	0		T12	record for ref		
	Mid Angle	0		Pelvis	0°±1°/33°±2.5°		
Seat Back Angle Set @	° W/Level on Seat Cushion		**HEAD REST POST**			**REST POST**	
Seat Pan Angle Set @	° W/Level on Seat Cushion		**ANGLE @ OSCAR**			**ANGLE**	
			Seat Fore/Aft Mid Postiion			**Seat Fore/Aft Set Postiion**	
						mm rearward of mid position	
Pelvis Angle	THOR 33° +/-2.5°		Manual Inclinometer		Tilt Sensor		

	Measurements From Passenger Striker				
Name	**Meas X**	**Meas Y**	**Meas Z**	**3D Distance**	**Deg**
SBU					
SBL					
STRIKER					
FOSB					
ROSB					
PCP-(Pedal Center Point)					
RHP -(Right Heel Point)					
LHP -(Left Heel Point)					
DRIVER OSCAR H-POINT					
DRIVER RIGHT HEAD CG					
DRIVER LEFT HEAD CG					
DRIVER LEFT EAM					
DRIVER NS					
DRIVER RIGHT IOF					
DRIVER LEFT IOF					
DRIVER TN					
DRIVER TC					
DRIVER C1					
DRIVER SHT 1					
DRIVER SHT 2					
DRIVER E1					
DRIVER P1					
DRIVER H-POINT					
DRIVER OK					
DRIVER IK					
DRIVER OA					
DRIVER IA					
DRIVER OH					
DRIVER IH					
DRIVER OP					
DRIVER R					
DRIVER H					
DRIVER H-POINT TOOL ANGL					
DRIVER W1					
DRIVER W2					
DRIVER WS ANGLE					
DRIVER D1					
DRIVER C2					
DRIVER C3					
DRIVER D2					
DRIVER D3					
DRIVER HR					
DRIVER HS					
DRIVER AD					
DRIVER HD					
DRIVER TS					
DRIVER HH					
DRIVER KK					
DRVER SH					
DRIVER TORSO ANGLE					
DRIVER HRA					

15.26

Oscar H-point location

Torso Angle		°
X (Positive (+) forward of striker)		mm
Z (Positive (+) below striker)		mm

15.27

Seat Tracking Point (STP) location at mid-position

X (Positive (+) forward of striker)		mm
Z (Positive (+) below striker)		mm

16.1

THOR Target H-point at Mid-position

	Oscar H-point (15.26)	+/-	20mm	=	THOR H-Point at Mid-position	
X (Positive (+) forward of striker)	0	+	20	=	20	mm
Z (Positive (+) below striker)	0	-	20	=	-20	mm

18.6

Seat Tracking Point location

X (Positive (+) forward of striker)		mm
Z (Positive (+) below striker)		mm

Seat Tracking Point location Trial 2 (if applicable)

X (Positive (+) forward of striker)		mm
Z (Positive (+) below striker)		mm

Seat Tracking Point location Trial 3 (if applicable)

X (Positive (+) forward of striker)		mm
Z (Positive (+) below striker)		mm

DRIVER

Fill in cells to calculate H-point Location

THOR H-Point Target at Mid-Position

THOR H-point Target

18.6.1

Trial 1

	Results from (18.6)	-	Results from (15.27)	=	STPD	
X (Positive (+) forward of striker)	0	-	0	=	0	mm
Z (Positive (+) below striker)	0	-	0	=	0	mm

Trial 2

	Results from (18.6)	-	Results from (15.27)	=	STPD	
X (Positive (+) forward of striker)	0	-	0	=	0	mm
Z (Positive (+) below striker)	0	-	0	=	0	mm

Trial 2

	Results from (18.6)	-	Results from (15.27)	=	STPD	
X (Positive (+) forward of striker)	0	-	0	=	0	mm
Z (Positive (+) below striker)	0	-	0	=	0	mm

18.6.2

Trial 1

	Results from (16.1)	+	Results from (18.6.1)	=	Current H-point Target	
X (Positive (+) forward of striker)	20	+	0	=	20	mm
Z (Positive (+) below striker)	-20	+	0	=	-20	mm

Trial 2

	Results from (16.1)	+	Results from (18.6.1)	=	Current H-point Target	
X (Positive (+) forward of striker)	20	+	0	=	20	mm
Z (Positive (+) below striker)	-20	+	0	=	-20	mm

Trial 3

	Results from (16.1)	+	Results from (18.6.1)	=	Current H-point Target	
X (Positive (+) forward of striker)	20	+	0	=	20	mm
Z (Positive (+) below striker)	-20	+	0	=	-20	mm

Appendix B: THOR 50th Percentile Male Dummy Seating and Positioning Procedures: Right Front Passenger Position

Seating and Positioning Procedures for the THOR 50th Percentile Male Dummy (THOR-50M) – Right Front Passenger Position

1 Determine the seat type

Visually inspect the seats to determine type (i.e., bucket or bench).

__Bench

__Bucket

2 Position lumbar supports

Position the seat's adjustable lumbar supports to the lowest, retracted, or deflated adjustment positions.

__*N/A* No lumbar adjustment

3 Position additional supports

Position any adjustable parts of the seat that provide additional support so that they are in the lowest or most open adjustment position.

__*N/A* No additional support adjustment

4 Position leg supports

Position an adjustable leg support system in its rearmost position.

__*N/A* No adjustable leg support system

5 Position the head restraint

5.1 Using any adjustment of the head restraint, position it to its highest position.

5.2 Using any adjustment of the head restraint, position it to the full rearward position. If it rotates, rotate it such that the head restraint extends as far rearward as possible.

__*N/A* The test vehicle is equipped with automatically adjusting head restraints or there is no head restraint adjustment,

6 Mark the centerline of the seat using a vehicle longitudinal, vertical (XZ) plane (complete ONLY the one that is applicable to seat being marked)

6.1 Bucket Seat: For future reference, locate and mark the line on the seat cushion that is the intersection of the XZ plane which passes through the centerline of the seat and the seat cushion upper surface.

6.2 Bench Seat: For future reference, locate and mark the line on the seat cushion that is the intersection of the XZ plane which passes through the seat cushion upper surface and is the same lateral distance from the vehicle centerline as the steering wheel center.

7 Mark the range of seat travel

Prior to marking the seat for fore/aft travel, move the seat through its full range of motion using all available controls. Separately, operate each control to determine whether it moves the seat and/or seat cushion primarily in the fore-aft or up-down directions.

7.1 Mark a point (seat cushion reference point - SCRP) on the side of the seat cushion that is between 150 mm and 250 mm from the front edge of the seat cushion. For seat cushions that move up and down independently from the seat housing, mark the point on the side of the cushion in an area that will not be obscured by the seat housing when the seat cushion is at its lowest height position.

7.2 Draw a horizontal line (seat cushion reference line - SCRL) through the SCRP.

7.3 Using only the controls that primarily move the seat in the fore-aft direction, move the SCRP to the lowest rearmost position.

7.4 If the seat cushion adjusts fore-aft, independent of the seat back, using only the controls that primarily move the seat cushion in the fore-aft direction, move the SCRP to the rearmost position.
__ *N/A* No independent fore-aft seat cushion adjustment

7.5 Using any part of any control, other than the parts just used for fore-aft positioning, determine the range of angles of the SCRL and set the SCRL at mid-angle. Record the maximum, minimum, and mid-angles in the table below.

SCRL (deg)	Max	Min	Mid
Passenger			

7.6 If the seat and/or seat cushion height is adjustable, using any part of any control other than the parts which primarily move the seat or seat cushion fore-aft, put the SCRP in its lowest position with the SCRL angle at the mid-angle found in 7.5.

__*N/A* No seat height adjustment

7.7 Using only the controls that primarily move the seat in the fore-aft direction, verify the seat is in the rearmost position

7.8 Using only the controls that primarily move the seat in the fore-aft direction, mark the fore-aft seat positions. Mark each position so that there is a visual indication when the seat is at a particular position.

For manual seats, move the seat forward one detent at a time and mark each detent.

For power seats, mark only the rearmost, middle, and foremost positions. Label three of the positions with the following: F for foremost, M for mid-track (if there is no mid-track, label the closest adjustment position to the rear of mid-track), and R for rearmost.

Measure and record the SCRP fore-aft location for each seat position on the table below.

	SCRL Mid-Angle (deg)							**SCRP Height (mm)** Spacing measurement between detents (if applicable)
		Rearmost		**Mid-track**		**Full forward**		
		X	**Z**	**X**	**Z**	**X**	**Z**	**X**
Passenger								

7.8.1 While at mid-track, also mark a position that is 25 mm rearward of mid-track.

8 Set the seat for a test dummy

Using the reference marks on the seat, set the seat in the mid-track, lowest height, and mid seat cushion angle position as follows:

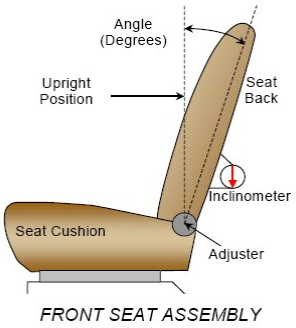
8.1 If the seat or seat cushion height is adjustable, using other than the controls that primarily move the seat or seat cushion fore and aft, set the height of the SCRP to the minimum height, with the SCRL set as closely as possible to the mid-angle determined in previous steps.

8.2 Using the control that primarily moves the seat fore and aft, move the SCRP to the mid-track position.

8.3 Set the seat back angle at the manufacturer's nominal design riding position for a 50th percentile male adult occupant.

If the position is not specified, set the seat back in the position that produces a torso (back) angle of 25° from vertical when measured with the SAE J826 H-point machine. For seat backs with discrete positions, if a torso (back) angle of

25° from vertical cannot be achieved, set the seat back in the detent that yields a torso (back) angle as close as possible to 25° from vertical. Describe the method used to achieve the nominal design riding position and record the seat back angle.



FRONT SEAT ASSEMBLY

_____
_____
_____
_____

Seat Back Angle_____°

__*N/A* The seat back does not adjust.

9 Set adjustable seat belt upper anchorages

Use the markings to position an adjustable seat belt upper anchorage at the manufacturer's nominal design position for a 50th percentile male adult occupant or highest position if not provided. Fill in the following table:

Seat	Total # of Positions	Placed in Position #
Front Passenger		

__*N/A* The seat belt upper anchorage does not adjust.

10 Retract the armrest

Retract any folding armrest

__*N/A* No armrest or armrest is fixed, not retractable.

11 Determine the H-point location with the H-Point machine

Position the three-dimensional H-point manikin (i.e., H-point machine) specified in Society of Automotive Engineers (SAE) Surface Vehicle Standard J826, revised July 1995, Devices for Use in Defining and Measuring Vehicle Seating Accommodation in the seat as follows:

11.1 Place a 910 mm^2 piece of muslin cotton cloth over the seat area (the muslin cloth shall be comparable to 48 threads/in^2 and density of 2.85 lb/yd). Tuck the muslin cloth a sufficient amount to prevent hammocking of the material.

11.2 Place the seat and back assembly of the H-Point machine such that its plane of symmetry is coincident with the centerline marking on the seat.

11.3 Install the lower leg and foot segments.

11.4 Set the length of the lower leg segment at 414 mm (16.3 in) and the length of the thigh bar at 401 mm (15.8 in).

11.5 Leg and foot placement

11.5.1 Tighten the pins so that the foot angle is not more than 130°.

11.5.2 With the T-bar level, place the left foot on the toe board with the rearmost point of the heel resting on the floor pan as close as possible to the point of intersection of the planes described by the toe board and the floor pan and not on the wheel well projection. If the foot cannot be positioned on the toe board, set it on the floor pan.

__Foot on toe board

__Foot on floor pan

11.5.3 With the T-bar level, place the right foot on the toe board with the rearmost point of the heel resting on the floor pan as close as possible to the point of intersection of the planes described by the toe board and the floor pan and not on the wheel well projection. If the foot cannot be positioned on the toe board, set it on the floor pan.

__Foot on toe board

__Foot on floor pan

11.5.4 Space the lower legs 270 mm (10.6 in) apart, equally spaced about the centerline of the H-point machine.

11.6 Apply the lower leg weights.

11.7 Apply the thigh weights.

11.8 Tilt the back pan forward against the forward stop and draw the H-point machine away from the seatback using the T-bar.

11.9 Re-positioning the H-point machine.

11.9.1 Allow the H-point machine to slide rearward until a forward horizontal restraining load on the T-bar is no longer required due to the seat pan contacting the seat back.

___The set pan does not slide rearward. Go to step 11.9.2.

11.9.2 Slide the H-point machine rearward by a horizontal rearward load applied at the T-bar until the seat pan contacts the seat back.

11.10 Apply a 10-kg load at the intersection of the hip angle quadrant and the T-bar housing along a line from the above intersection to a point just above the thigh bar housing.

11.11 Again apply a 10-kg load at the intersection of the hip angle quadrant and the T-bar housing along a line from the above intersection to a point just above the thigh bar housing.

11.12 Carefully return the back pan to the seat back.

11.13 Install the right and left buttock weights.

11.14 Install the eight torso weights, alternating the installation between right and left.

11.15 Tilt the back pan forward until the stop is contacted.

11.16 Rock the H-point machine from side to side over a 10° arc (5° to each side of the vertical centerline) for three complete cycles. Restrain the T-bar during rocking so that the seat pan does not change position. Minimize any inadvertent exterior loads applied in a vertical or fore-aft direction. The feet are free to move during this rocking motion.

11.17 Without applying a forward or lateral load, lift the right foot off the floor the minimum amount necessary until no additional forward foot movement is obtained.

11.18 Lower the right foot until the heel is in contact with the floor pan and the ball of the foot is in contact with the floor or toe board.

11.19 Without applying a forward or lateral load, lift the left foot off the floor the minimum amount necessary until no additional forward foot movement is obtained.

11.20 Lower the left foot until the heel is in contact with the floor pan and the ball of the foot is in contact with the floor or toe board.

11.21 Is the seat pan level?

__Yes. Go to step 11.23.

__No. Go to step 11.22.

11.22 Apply a sufficient lateral load to the top of the seatback pan to level the H-point machine seat pan on the seat.

11.23 Holding the T-bar to prevent the H-point from sliding forward on the seat cushion, return the seatback pan to the seatback.

11.24 Holding the T-bar to prevent the H-point machine from sliding forward on the seat cushion, apply a rearward force perpendicular to the back angle bar just above the torso weights until either 66 N (15 lb) of force is reached or the hip angle is increased by 3°, whichever occurs first. Minimize the exterior downward or side forces applied to the H-point machine. Release the force. Repeat this step until the resulting hip angle is identical. Complete as many force applications as necessary and record the results in the following table:

Force App.	Hip Angle
1	
2	
3	
4	
5	

11.25 Is the H-point machine level?

__Yes. Go to step 11.26.

__No. Go back to step 11.15 and repeat steps to re-level H-point machine.

11.26 Record the H-point location and torso angle in the table below:

H-point Machine H-point Location and Torso Angle	
Torso Angle	°
X (positive (+) forward of striker)	(mm)
Z (positive (+) below striker)	(mm)

Reference: X-axis is positive forward of striker
Y-axis is positive right of striker
Z-axis is positive below striker

11.27 Create a Seat Tracking Point (STP): Place a target point 20 mm forward of the H-point machine H-point on a rigid part of the seat and record its location in the table below. This reference point will be used to locate the dummy H-point relative to the seat if the seat cannot be set to the mid-track position.

Seat Tracking Point (STP) Location at Mid-track	
X (positive (+) forward of striker)	(mm)
Z (positive (+) below striker)	(mm)

11.28 Remove the H-point machine.

12 Calculate the THOR-50M H-point Target at Mid-track

12.1 The THOR-50M H-point is offset 20 mm forward and 20 mm above the H-point machine H-point as determined in the table below:

THOR-50M Target H-point at Mid-track				
H-point machine H-point (11.26) +/- 20 mm = THOR-50M H-point at mid-track				
X (positive (+) forward of striker)	( )	+	20 mm	mm
Z (positive (+) below striker)	( )	-	20 mm	mm

If steps 1-12 were completed prior to seating, verify that measurements have been recorded prior to placing dummy in seat.

13 Once the H-point has been determined and the following things are verified, position a qualified THOR-50M in the right front seat of the test vehicle.

13.1 Follow the procedures in the THOR-50M Qualification Manual for setting the joint torques. Also, make sure the neck is placed in the neutral position setting and the spine box is placed in the slouched position before placing the dummy in the vehicle.

13.2 Verify the head and pelvis tilt sensors installed in the dummy are reading correctly about the X and Y axes.

13.3 Record the lumbar spine pitch change joint and neck pitch change joint settings below:

Lumbar spine pitch change joint: _____

Neck pitch change joint: _____

13.4 Verify the seat back and base angles and the seat belt height adjustment are in the correct locations.

14 Positioning the test dummy in the seat

14.1 Move the seat to the full rearward position and place the test dummy in the seat with the thighs resting on the seat.

14.2 Position the test dummy in the seat such that its plane of symmetry (i.e., mid-sagittal plane) is coincident with the centerline marking on the seat cushion, seat back, and head restraint and such that it's H-point is approximately above the STP.

14.3 Bend the upper torso forward and then lay it back against the seat back. Push the shoulders of the dummy fully rearward. Using the installed tilt sensors, position the dummy so that it sits squarely and level in the both the X and Y axes in the seat.

14.4 Foot and leg alignment:

Align the legs such that the following occurs:

To the extent practicable keep the left and right thigh and the leg in a vertical plane; adjust the knees such that they are 225 mm apart (centerline to centerline) and equidistant from the seat centerline. Initially set the feet perpendicular to the legs and equidistant from the seat centerline.

14.5 Lift the feet and slide the seat forward to 25 mm rearward of mid-track or the detent closest to this position that is not greater than 25 mm rearward of mid-track. Adjust the feet as necessary. If there is knee/leg contact with the knee bolster or instrument panel, adjust only the knee/leg that is interacting with the knee bolster/instrument panel inboard or outboard the minimum amount required to create clearance (not to exceed 10 mm), without the inner thigh crossing the centerline of the seat.

Is there still interference between the dummy's knees/legs and the knee bolster/instrument panel?

__No. Go to step 14.6.

__Yes. Lift the feet and slide the seat to 50 mm rearward of mid-track or the detent closest to this position that is not greater than 50 mm rearward of mid-track. If there is still interference (within 5 mm), continue to move the seat rearward in 25 mm increments until there is no longer interference.

14.6 Verify the SCRP position, then measure the location of the STP and record it under Trial 1 in table below (subsequent trials may be needed, depending on the outcome of step 14.13):

Seat Tracking Point Location Trial 1	
X (positive (+) forward of striker)	(mm)
Z (positive (+) below striker)	(mm)
Seat Tracking Point Location Trial 2 (if applicable)	
X (positive (+) forward of striker)	(mm)
Z (positive (+) below striker)	(mm)
Seat Tracking Point Location Trial 3 (if applicable)	
X (positive (+) forward of striker)	(mm)
Z (positive (+) below striker)	(mm)

14.6.1 Calculate and record the Seat Tracking Point Difference (STPD)

STPD = Location of STP from step 14.6 – location of STP from step 11.27

Record in table below:

Trial 1			
	Results from 14.6	- Results from 11.27 = STPD	
X (positive (+) forward of striker)	( )	- ( )	mm
Z (positive (+) below striker)	( )	- ( )	mm

Trial 2 (if applicable)			
	Results from 14.6	- Results from 11.27 =	STPD
X (positive (+) forward of striker)	( )	- ( )	mm
Z (positive (+) below striker)	( )	- ( )	mm

Trial 3 (if applicable)			
	Results from 14.6	- Results from 11.27 =	STPD
X (positive (+) forward of striker)	( )	- ( )	mm
Z (positive (+) below striker)	( )	- ( )	mm

14.6.2 Calculate and record the THOR-50M target H-point for each seat position as the seat is moved forward (per step 14.5), following the corresponding steps.

X: THOR-50M Target H-point for 14.6.2 = (THOR-50M Target H-point from 12.1) + (STPD from 14.6.1)

Z: THOR-50M Target H-point for 14.6.2 = (THOR-50M Target H-point from 12.1) + (STPD from 14.6.1)

Trial 1			
	Results from 12.1	- Results from 14.6.1 =	Current Target H-point
X (positive (+) forward of	( )	+ ( )	mm
Z (positive (+) below striker)	( )	+ ( )	mm

Trial 2 (if applicable)			
	Results from 12.1	- Results from 14.6.1 =	Current Target H-point
X (positive (+) forward of	( )	( )	mm
Z (positive (+) below striker)	( )	+ ( )	mm

Trial 3 (if applicable)			
	Results from 12.1	- Results from 14.6.1 =	Current Target H-point
X (positive (+) forward of	( )	+ ( )	mm
Z (positive (+) below striker)	( )	+ ( )	mm

14.7 Confirm, using the tilt sensors, that the dummy is positioned such that a horizontal, lateral line passing through the dummy's hip pivot center is perpendicular to the center XZ plane of the seat – adjust the dummy if necessary.

14.8 Verify/measure the pelvis angles using the tilt angle sensors installed in the test dummy. Verify that the pelvis angles are 0°± 1° (about the X-axis) and 33° ± 2.5° (about the Y-axis).

14.9 Confirm that the H-point is within ± 10 mm of the target location in the horizontal (X) and the vertical (Z) directions – adjust the dummy if necessary.

14.10 Are the pelvis angles within specification (described in step 14.8)?

__Yes. Go to step 14.11.

__No. Go back to step 14.7 and repeat steps to re-adjust the pelvis angles while maintaining the H-point position within specification.

14.11 Verify/Measure the head angles using the tilt angle sensors installed in the test dummy. Verify that the head angles are 0°± 1° (about the X axis) and 0°± 1° (about the Y-axis).

14.11.1 Are the head angles within specification?

__Yes. Go to step 14.12 (foot placement).

__No and head is not touching head rest. Go back to step 14.7; adjust the pelvis while maintaining the H-point target position within specification.

__No and head is not touching the head rest, but the pelvis has already been re-adjusted. Go to step 14.11.2.

__No and head is touching head rest. Go to step 14.11.2.

__No and seatback has been adjusted already.

Record final head angles X:____°

Y:____°

14.11.2 Has the seatback angle been adjusted?

__No. Adjust seatback a maximum of 1 detent for manual seats and not more than 2° from the manufacturer's recommended angle found in step 8.3, to bring the head angles within/or as close as possible to specification. Return to step 14.7.

Record original seatback angle before adjustment: ____ °

Record the new seatback angle: _____°

__Yes. Make no further adjustment.

Record final head angles X:____°

Y:____°

Go to step 14.12.

14.12 Foot Placement

14.12.1 To the extent practicable without inducing pelvis or torso movement, keep the thighs and the legs in vertical planes throughout the procedure. If possible, maintain a knee spacing of 225 mm, as measured between the centerline of the knees, with the knees being equidistant from the seat centerline. Also, if possible, position and maintain the feet equidistant from the centerline of the seat.

14.12.2 For each foot, check which of the following that applies (ONLY check one):

__The foot can be placed flat on the toe board with the heel resting on the floor pan as close as possible to the intersection of the floor pan and toe board.

__The foot cannot be placed flat on the toe board. Set the foot perpendicular to the leg and place it as far forward as possible with the heel resting on the floor pan and the foot perpendicular to leg.

__The vehicle has a wheelhouse projection and the foot cannot be placed on the toe board. Do not set the foot on the wheelhouse projection. Set the foot perpendicular to the leg and move the leg laterally the minimum amount needed to avoid the wheelhouse projection, while maintaining the dummy's head and pelvis angle and H-point location specifications. Make sure the foot and leg are still in same vertical plane. Place the foot as far forward as possible with the heel resting on the floor pan.

14.12.3 If either of the dummy's legs contact the vehicle's interior, shift only the knee with clearance issues inboard or outboard the minimum required to avoid contact (not to exceed 10 mm), without the inner thigh crossing the centerline of the seat. Maintain the dummy's head and pelvis angle and H-point location specifications, and try to maintain the leg and foot in the same vertical plane.

__N/A- there was no leg contact.

__Knees were shifted for clearance.

Final Knee Spacing:_____ mm

14.13 Verify that the head and pelvis angles and the H-point location are within the specifications (steps 14.8, 14.9, and 14.11). For a seat that is not in mid-track, if the dummy leg/knee to knee bolster/instrument panel clearance is greater than 5 mm, the seat should be moved forward. If there is leg/knee contact with the knee bolster/instrument panel, adjust the leg/knee making contact inboard or outboard the minimal amount required to create clearance (not to exceed 10 mm).

___Seat is already at mid-track and dummy is within specified head/pelvis angles and H-point location. Go to step 14.14.

__ Dummy leg/knee to knee bolster/instrument panel clearance is greater than 5 mm. Adjust the seat forward, without going forward of mid-track, until a clearance of 5 mm or less is achieved.

Record seat position: _____ mm rearward of mid-track.

Return to step 14.6 and repeat the steps to go through the trials.

___Dummy leg/knee to knee bolster/instrument panel clearance is not greater than 5 mm. No adjustments required.

Record seat position: _____mm rearward of mid-track.

Go to step 14.14.

14.14 Arm and belt placement. Verify the shoulders of the dummy are rotated fully rearward.

14.14.1 Place the left upper arm adjacent to the torso with the centerline as close to a vertical plane as possible; Place the left-hand palm in contact with the outside of the left thigh and the little finger in contact with the seat cushion.

Is the seat belt used for this test?

__Yes. Go to step 14.14.2.

__No. Go to step 14.14.8.

14.14.2 Fasten the seat belt around the dummy.

14.14.3 Remove all slack from the lap belt portion.

14.14.4 Pull the upper torso webbing out of the retractor and allow it to retract; repeat this four times.

14.14.5 Apply a 2 to 4-pound tension load to the lap belt.

__pounds of load applied

14.14.6 Is the belt system equipped with a tension-relieving device?

__Yes. Go to step 14.14.7.

__No. Go to step 14.14.8.

14.14.7 Introduce the maximum amount of slack into the upper torso bet that is recommended by the vehicle manufacturer in the vehicle owner's manual.

14.14.8 Place the right upper arm adjacent to the torso with the centerline as close to a vertical plane as possible; Place the right-hand palm in contact with the outside of the right thigh and the little finger in contact with the seat cushion.

Passenger THOR Seating Worksheet

Vehicle				**Technician**			
VIN #				**Position**			
ATD				**Date**			
SEATING #							
SCRL Angle	Max			**THOR Tilt Sensors**		**X**	**Y**
	Min -			Head	0°±1°		
	Difference	0		T1	record for ref		
	/2	0		T6	record for ref		
	Min +	0		T12	record for ref		
	Mid Angle	0		Pelvis	0°±1°/33°±2.5°		
Seat Back Angle Set @		° W/Level on Seat Cushion	**HEAD REST POST**			**REST POST**	
Seat Pan Angle Set @		° W/Level on Seat Cushion	**ANGLE @ OSCAR**			**ANGLE**	
			Seat Fore/Aft Mid Postiion			**Seat Fore/Aft Set Postiion**	
						mm rearward of mid position	
Pelvis Angle	THOR 33° +/-2.5°		Manual Inclinometer		Tilt Sensor		

	Measurements From Passenger Striker				
Name	**Meas X**	**Meas Y**	**Meas Z**	**3D Distance**	**Deg**
SBU					
SBL					
STRIKER					
FOSB					
ROSB					
PASSENGER OSCAR H-POINT					
PASSENGER RIGHT HEAD CG					
PASSENGER LEFT HEAD CG					
PASSENGER RIGHT EAM					
PASSENGER NS					
PASSENGER RIGHT IOF					
PASSENGER LEFT IOF					
PASSENGER TN					
PASSENGER TC					
PASSENGER C1					
PASSENGER SHT 1					
PASSENGER SHT 2					
PASSENGER E1					
PASSENGER P1					
PASSENGER H-POINT					
PASSENGER OK					
PASSENGER IK					
PASSENGER OA					
PASSENGER IA					
PASSENGER OH					
PASSENGER IH					
PASSENGER OP					
PASSENGER R					
PASSENGER H					
PASSENGER W1					
PASSENGER W2					
PASSENGER WINDSHIELD ANGLE					
PASSENGER D1					
PASSENGER D2					
PASSENGER D3					
PASSENGER H-POINT TOOL ANGLE					
PASSENGER HR					
PASSENGER HS					
PASSENGER AD					
PASSENGER HD					
PASSENGER HH					
PASSENGER KK					
PASSENGER SH					
PASSENGER TORSO ANGLE					
PASSENGER HRA					

11.26

Oscar H-point location

Torso Angle		°
X (Positive (+) forward of striker)		mm
Z (Positive (+) below striker)		mm

11.27

Seat Tracking Point (STP) location at mid-position

X (Positive (+) forward of striker)		mm
Z (Positive (+) below striker)		mm

12.1

THOR Target H-point at Mid-position

	Oscar H-point (11.26)	+/-	20mm	=	THOR H-Point at Mid-position	
X (Positive (+) forward of striker)	0	+	20	=	20	mm
Z (Positive (+) below striker)	0	-	20	=	-20	mm

14.6

Seat Tracking Point location

X (Positive (+) forward of striker)		mm
Z (Positive (+) below striker)		mm

Seat Tracking Point location Trial 2 (if applicable)

X (Positive (+) forward of striker)		mm
Z (Positive (+) below striker)		mm

Seat Tracking Point location Trial 3 (if applicable)

X (Positive (+) forward of striker)		mm
Z (Positive (+) below striker)		mm

PASSENGER

Fill in cells to calculate H-point Location

THOR H-Point Target at Mid-Position

THOR H-point Target

14.6.1

Trial 1

	Results from (14.6)	-	Results from (11.27)	=	STPD	
X (Positive (+) forward of striker)	0	-	0	=	0	mm
Z (Positive (+) below striker)	0	-	0	=	0	mm

Trial 2

	Results from (14.6)	-	Results from (11.27)	=	STPD	
X (Positive (+) forward of striker)	0	-	0	=	0	mm
Z (Positive (+) below striker)	0	-	0	=	0	mm

Trial 2

	Results from (14.6)	-	Results from (11.27)	=	STPD	
X (Positive (+) forward of striker)	0	-	0	=	0	mm
Z (Positive (+) below striker)	0	-	0	=	0	mm

14.6.2

Trial 1

	Results from (12.1)	+	Results from (14.6.1)	=	Current H-point Target	
X (Positive (+) forward of striker)	20	+	0	=	20	mm
Z (Positive (+) below striker)	-20	+	0	=	-20	mm

Trial 2

	Results from (12.1)	+	Results from (14.6.1)	=	Current H-point Target	
X (Positive (+) forward of striker)	20	+	0	=	20	mm
Z (Positive (+) below striker)	-20	+	0	=	-20	mm

Trial 3

	Results from (12.1)	+	Results from (14.6.1)	=	Current H-point Target	
X (Positive (+) forward of striker)	20	+	0	=	20	mm
Z (Positive (+) below striker)	-20	+	0	=	-20	mm

DOT HS 812 746
June 2019

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

14062-052919-v3