Booster Seat Belt Fit Evaluation Guidelines for Ratings

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988 Dairy Road
Ruckersville, VA 22968
+1 434 985 4600

iihs.org

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Document Revision History

- May 2018: Updated the information on the belt fit device used to measure lap and shoulder belt locations. A Juvenile Anthropomorphic Seat belt Position Evaluation Rig (Jasper) is now used.

- September 2014: Added two new criteria for evaluating shoulder belt fit.

- August 2011: Added a rating name to the group of boosters that do not meet the criteria for *Best Bet*, *Good Bet*, or *Not Recommended*. This group of boosters is now called *Check fit*.

Overview

The Insurance Institute for Highway Safety (IIHS) evaluates belt positioning boosters on their ability to provide good lap and shoulder belt fit. The evaluation is based on static measurements of lap and shoulder belt locations on a belt fit device across a range of belt anchorage locations. The belt fit device is a Juvenile Anthropomorphic Seat belt Position Evaluation Rig (Jasper). Jasper represents a booster-age child.

Measurements result in a lap belt score and shoulder belt score that determine a booster's overall rating. For a detailed description of the measurement protocol, see the *Booster Seat Belt Fit Evaluation Protocol* (IIHS, 2018).

Lap Belt Score

An effective lap belt position allows the belt to engage the bony pelvis during a frontal crash. If the belt is located above the pelvis, it will load the vulnerable abdominal organs. If the belt is too far forward on the thighs, the body will undergo excessive excursion, and the pelvis may begin to rotate and increase the likelihood of submarining (lap belt passing above the pelvis and loading the abdominal organs).

The particular pelvic structures loaded by the lap belt are the anterior superior iliac spines (ASIS), and the equivalent ASIS locations on Jasper's pelvis serve as reference points for the lap belt score (further details are available in the protocol). The score is the distance from the ASIS reference point to the top edge of the lap belt, measured along the profile of the pelvis at the lateral location of the ASIS. The score is positive when the lap belt is positioned below the ASIS and negative when the belt is above the ASIS. The distances measured on the left and right sides of the pelvis are averaged for a single lap belt score.

The ideal location for the lap belt is an equivalent score of 20 to 50 mm (green zone). A belt located within 10 mm on either side of this zone is considered to provide fair protection (yellow zone). Scores less than 10 mm indicate the belt is located on the abdomen, and scores greater than 60 mm indicate the belt is too far forward on the thighs (Figure 1).

Shoulder Belt Score

The shoulder belt must pass across the midshoulder region to properly restrain the upper body in a frontal crash. If the belt is too far outboard, it will not prevent excessive excursion of the head and torso, and the upper body may roll out of the belt. If the belt is too close to the neck, the resulting discomfort may cause the child to re-position the belt behind the back or under the arm.

Figure 1. Graph of Rating Zones for Lap Belt Scores (mm)

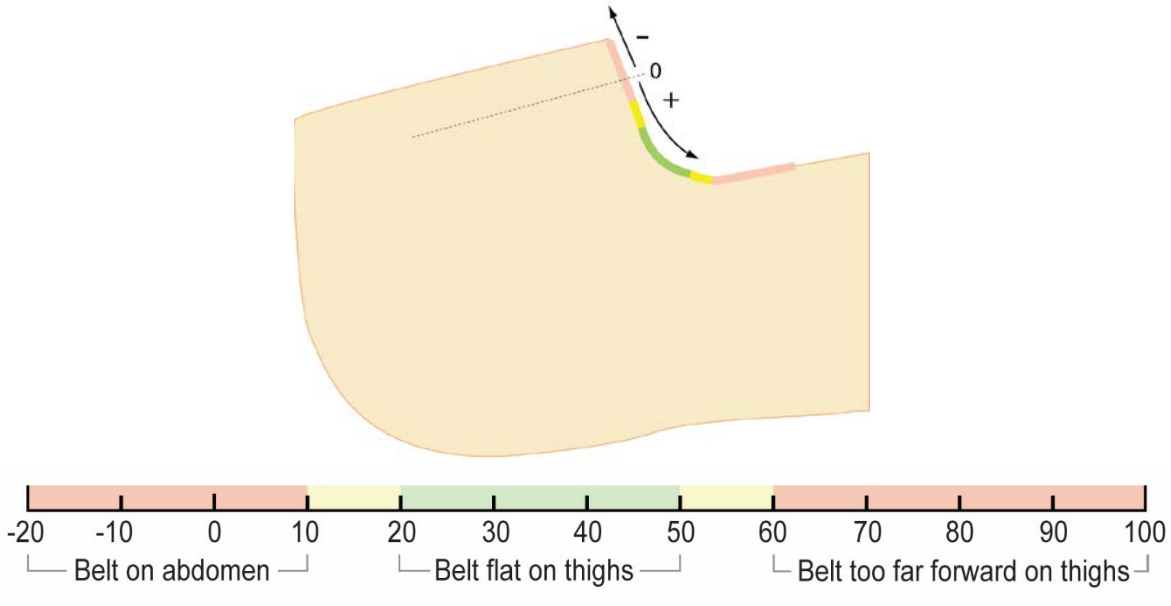
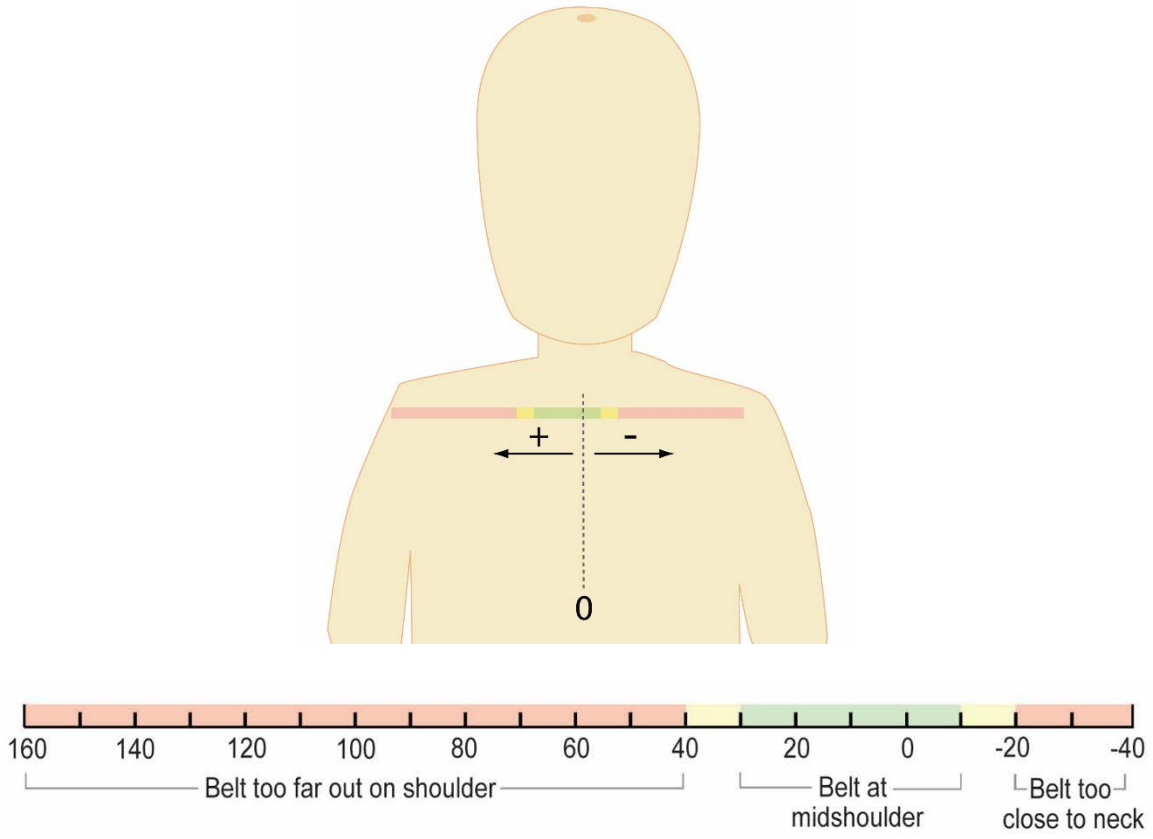


Figure 2. Graph of Rating Zones for Shoulder Belt Scores (mm)



***Note**:* Figure 2 is specific to the seating position with the D-ring location over the right shoulder of Jasper.

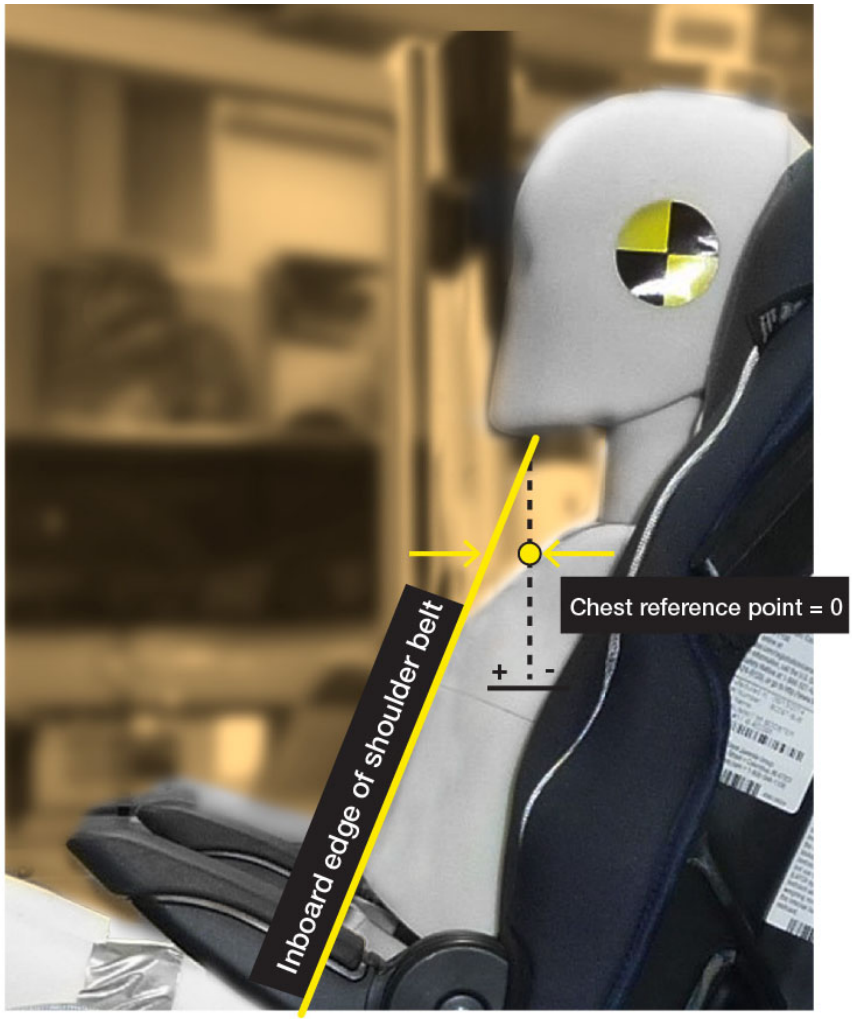
The reference point for shoulder belt measurements is a point on the centerline of the front surface of Jasper's chest (further specified in the protocol). The shoulder belt score is the lateral distance between the chest reference point and inboard edge of the shoulder belt. Rating boundaries for the shoulder belt score were determined by correlating values measured on Jasper with the shoulder belt positions measured on children.

The ideal location for the shoulder belt is an equivalent score of -10 to 30 mm (green zone). A belt located within 10 mm on either side of this zone is considered to provide fair protection (yellow zone). Scores less than -20 mm indicate the belt is too close to the neck, and scores greater than 40 mm indicate the belt is too far out on the shoulder (Figure 2).

Additional Shoulder Belt Criteria

The shoulder belt must be in a good position both laterally, as measured by the shoulder belt score, and longitudinally, to adequately restrain the child in a frontal crash. The shoulder belt must lie across the chest, such that the shoulder belt fore-aft distance from the chest reference point to the inboard edge of the shoulder belt is less than 10 mm (Figure 3).

Figure 3. Fore/Aft Distance from the Chest Reference Point to the Inboard Edge of the Shoulder Belt



Additionally, the shoulder belt must not be in contact with Jasper's face. If the belt touches the face, the resulting discomfort may cause the child to re-position the belt behind the back or under the arm. Because a good shoulder belt score may not be sufficient to ensure the belt is clear of contact with the face, this explicit additional criterion is required.

Overall Rating

The overall rating for each booster is based on the entire range of lap belt scores and shoulder belt criteria (scores for each of the four anchorage test conditions). Table 1 indicates the criteria for each of the three overall rating categories. Boosters not meeting the criteria are placed in a category called *Check fit*.

Table 1. Criteria for the Overall Ratings for Boosters

Overall rating	Criteria
Best Bet	All lap belt scores are ≥ 10 mm and ≤ 60 mm, and All shoulder belt scores are ≥ -10 mm and ≤ 30 mm, and All fore-aft distances are < 10 mm, and The shoulder belt is not in contact with the face
Good Bet	All lap belt scores are ≥ 10 mm and ≤ 60 mm, and All shoulder belt scores are ≥ -20 mm and ≤ 40 mm, and All fore-aft distances are < 10 mm, and The shoulder belt is not in contact with the face
Not Recommended	All lap belt scores are < 10 mm, or All lap belt scores are > 60 mm, or In all four anchorage test conditions, **one** of the following is true: • The shoulder belt score is < -20 mm or > 40 mm • The shoulder belt fore-aft distance is ≥ 10 mm • The shoulder belt is in contact with the face

The *Booster Seat Belt Fit Evaluation Protocol* (IIHS, 2018) includes measurements across a wide range of lap and shoulder belt anchorage locations. Boosters rated as *Best Bets* can be expected to provide good lap and shoulder belt fit for nearly all booster-age children in all vehicles.

Boosters rated as *Good Bets* also should perform well in the majority of cases, although there may be a small number of child/vehicle combinations where shoulder belt fit is not ideal.

Boosters rated as *Not Recommended* will provide poor lap and/or shoulder belt fit in almost all scenarios.

Boosters that do not meet these criteria can provide both good and poor fit, depending on the child and vehicle, and are rated as *Check fit*. These boosters should be checked to make sure that they do position the lap and shoulder belt properly in the particular child/vehicle combination.

References

Insurance Institute for Highway Safety. (2018). *Booster seat belt fit evaluation protocol (Version IV).* Arlington, VA.

Reed, M.P., Ebert, S.M., Sherwood, C.P., Klinich, K.D., & Manary, M.A. (2009). Evaluation of the static belt fit provided by belt-positioning booster seats. *Accident Analysis & Prevention*, *41*(3), 598–607

Reed, M.P., Ebert-Hamilton, S.M., Klinich, K.D., Manary, M.A., and Rupp, J.D. (2008). *Assessing child belt fit; Volume I: Effects of vehicle seat and belt geometry on belt fit for children with and without belt positioning booster seats* (Report no. UMTRI-2008-49-1). Ann Arbor, MI: University of Michigan Transportation Research Institute.