

Strollers are used by a somewhat broader age range of children than are high chairs, although the age range is related to the type of stroller and its features. Full size strollers that recline fully and stroller travel systems with infant car seats are suitable for newborns. Those that provide little support, such as umbrella strollers, require the child to be capable of sitting independently (around 6 months). Use may continue through approximately age four. Many strollers have a range of seat reclining positions and so must be capable of accommodating the range of users in both upright and reclining positions.

As reported in the *Product Profile Report* the typical age range of children involved in restraint failure incidents is narrower than the general range of stroller and high chair product users. All of the children in the IDI's reviewed were under two years of age. The high chair incidents were concentrated in the 6 to 15 month age range, while stroller incidents ranged more generally from 3 to 23 months. However, for both strollers and high chairs the types of incidents in which children were actively trying to overcome the restraint system and stand or kneel showed a similar and more concentrated age range. This age range was from about 7 or 8 months old to about 15 months old, and especially in the 9-to-12 month old range. This age reflects the developmental period in which children typically become able to pull themselves to a stand but still have not acquired full balance and postural control. Children involved in restraint failure incidents that were younger than 7 or 8 months generally were involved in incidents where there was not an apparent effort to overcome a restraint. These included events such as slipping down through leg openings or pitching forward out of the seat.

The task analyses take account of the primary at-risk age group associated with a given movement affordance. The summaries presented in Section 4.3 include an indication of the product occupant age range and also note some of the major developmental milestones that may relate to the incident scenarios. Based on the characteristics of the associated scenarios, the actions of the children associated with a given analysis are classified into one of two categories: "deliberate" and "incidental." This is intended to capture the distinction among cases where the children are actively engaged in trying to accomplish the movements that the restraint system is intended to restrict versus cases where the child's behavior is more passive or undirected. Most of the interest is with the deliberate condition but some incident scenarios demand consideration of the incidental condition. Based on the information in the *Product Profile Report*, deliberate actions are generally associated with children in the 8 to 18 month age range and the incidental actions are generally associated with children in the 3 to 9 month age range.

4.3 Outcome of Task Analyses

Each of the six key movement affordances provided the basis for a task analysis. The analysis considered the scenario features and the child characteristics in conjunction with the product characteristics that supported the movements. We broke the action afforded by the product into critical movement components. In some cases, the movements related to a given affordance are sequential events and in other cases they may be alternative movements for accomplishing a given act.

The six task analyses are summarized in Tables 4 through 9. For each analysis, the movement affordance of interest is listed at the top of the table. The information in the upper section of the table indicates the relevant product type (stroller, high chair), the age range of the assumed at risk children, and the type of action (deliberate or incidental). Key developmental milestones that may relate to the action are also indicated. The related incident scenarios are listed at the upper right.

The body of each table presents information in five columns. The first column provides a short description of the movement afforded and the incident scenario context in which it occurs. The second column lists critical movement components. These are sub-component acts that comprise the general movement under consideration. The third column lists the potential problems related to the affordance of a critical movement component. The fourth column indicates the product characteristics that may be related to the potential problems. The final column indicates the anthropometric aspects that relate to the contributing product characteristics.

The tables provide a set of potential problems related to each critical movement component. These are possible design deficiencies that permit or contribute to the opportunity for the child to successfully execute the undesirable movement. The tables are useful at this level to identify functional issues related to movement affordance. However, these considerations need to be supplemented with additional quantitative data on the relationship between the relevant product dimensions and the related anthropometric characteristics of the child. Section 5 provides such information. Subsequently, countermeasure approaches for the various problems can be addressed (Section 6). It should also be noted that many of the contributing product characteristics cut across the different task analyses and critical movement components. In fact, there are a variety of general design issues that encompass many of the specific problems. A more general scheme for organizing and addressing causal problems will be presented in Section 6, after consideration of the anthropometric issues in Section 5.

Table 4. Task Analysis: Push - Pull Up

| Product Type: High Chair or Stroller | | Related Scenario(s): High Chair Push/Pull Up | | |
|--|------------------------------|--|---|--|
| Occupant: 8-18 month old child | | Stroller Stand and Fall | | |
| Action Type: Deliberate | | | | |
| Developmental: Pulls to standing (9 mos.), Rotates trunk while sitting (8 mos.), Pincer grip (9 mos.), stands/walks alone (13 mos.) | | | | |
| Movement Affordances | Critical Movement Components | Potential Problems | Contributing Product Characteristics | Relevant Anthropometry |
| <p>Push - Pull Up</p> <ul style="list-style-type: none"> - Use of chair features to leverage extraction motions, permitting standing or kneeling on the seat. Arm rests, trays, bars, or seat backs may be pushed against or grasped by the child and used to assist in moving upward. Foot rests or seat surfaces may also allow the child to push upward using the feet. Such activity may loosen or overcome motion limiting features of the product. | <p>Push Up</p> | <p>Footholds can allow pushing upward with feet Chair, tray, and bar features allow pushing upward with arms/hands Leg openings, chair shape, tray position allow range of thigh movement Locations of strap anchors allow excessive movement of rear and thighs Pushing foot rest stretches wait belt adjustment Waist Slides upward through the waist strap</p> | <p>Foot Rest Arm Rests Trays, Restraint Bars Passive Crotch Restraint/Leg Openings Strap Degree of Motion Restriction Torso Restraint - Adjustment Stability Torso Restraint - Anthropometric Fit</p> | <p>Thigh Length Leg Length Frontal Grip Reach Torso Circumference</p> |
| | <p>Pull Up</p> | <p>Seat back may provide hand holds for pulling up Moving upward may adversely affect center of gravity containment Waist slides upward through the waist strap</p> | <p>Seat Back Length Strap Degree of Motion Restriction Torso Restraint - Adjustment Stability Torso Restraint - Anthropometric Fit Seat Width Seat Depth Seat Incline</p> | <p>Hip Breadth Thigh Breadth Torso Circumference Hip Circumference Torso Depth</p> |

Table 5. Task Analysis: Turn Around

| Product Type: High Chair or Stroller | | Related Scenario(s): High Chair Turn Around Stroller Stand and Fall | | |
|--|------------------------------|--|---|---|
| Occupant: 8-18 month old child | | Action Type: Deliberate | | |
| Developmental: Pulls to standing (9 mos.), Rotates trunk while sitting (8 mos.), Pincer grip (9 mos.), stands/walks alone (13 mos.) | | | | |
| Movement Affordances | Critical Movement Components | Potential Problems | Contributing Product Characteristics | Relevant Anthropometry |
| Turn Around - The child rotates the hips, turning around within the confines of the seat. The knees are brought onto the seat and the child stands or kneels on the seat. This effort involves maneuvering to get knees and feet past any passive restrictions. Assuming that this turning can be accomplished, the more powerful hip extension can be used to overpower active and passive restraints, including slipping the hips through waist straps. | Bringing Legs Under Torso | Knees and lower legs may be pulled into the seat pan Seat & leg openings accommodate thighs and lower legs Foot rest may provide a foot hold during action | Strap Degree of Motion Restriction Passive Crotch Restraint/Leg Openings Seat Width Seat Depth | Thigh Length Leg Length Frontal Grip Reach Torso Circumference |
| | Turning Torso/Hips Around | Strap adjustment slips under pressure Straps provide little twisting resistance Turning is not resisted by torso restraint due to cylindrical shape of torso Envelope of movement allows thighs to cross, hips to rotate | Strap Anthropometric Fit Strap Adjustment Stability Strap Degree of Motion Restriction Torso Restraint - Anthropometric Fit Torso Restraint - Adjustment Stability Passive Crotch Restraint/Leg Openings | Hip Breadth Thigh Breadth Torso Circumference Hip Circumference Torso Depth |
| | Standing From Knee | Standing adversely affects center of gravity containment Seat back provides hand holds during standing Inflating torso or pushing may break or move the tray Pushing backwards increases exerted force on restraints Waist slides upward through the waist strap Thigh leverage may allow forward force from torso causing movement or breaking of tray | Strap Degree of Motion Restriction Passive Torso Restriction - Adjustment Stability Seat Width Seat Depth Seat Incline | Torso Circumference Hip Breadth Thigh Length |

Table 6. Task Analysis: Pitch Forward

| Product: High Chair or Stroller Occupant: 6-18 month old child Action Type: Incidental Developmental: Sits alone steadily (7 mos.); pulls to standing (9 mos.); stands/walks alone (13 mos.) | | Related Scenario(s): Stroller Pitch Forward High Chair Tray Release & Pitch Forward | | |
|--|---|---|---|--|
| Movement Affordances | Critical Movement Components | Potential Problems | Contributing Product Characteristics | Relevant Anthropometry |
| <p>Pitch Forward</p> <p>- An abrupt forward movement causes the child to tumble forward out of the seat. Falling forward may be due to some restraint system component giving way or to the position of the child's center of gravity allowing the body to rotate over a barrier. In high chairs, the scenario often appears related to the child operating the tray release and/or to a failure of the restraint belt anchor.</p> <p>Restraint release may occur due to a number of factors. The child may be able to over-power active or passive measures due to inadequate mechanical strength of the restraint system. Or, factors like the location and ease of release operation may allow them to be opened by hands or feet. Though the desire to escape is deliberate, release operation be unintentional. Gradual as well as sudden releases are also important to consider.</p> | <p>Release Tray or Other Barrier</p> | <p>Reaches release mechanism with feet Reaches release mechanism with hand Pushing or pulling actions activate release of tray or other component</p> | <p>Release Mechanism Location Release Mechanism Operation Tray</p> | <p>Leg Length Frontal Grip Length Torso Length</p> |
| | <p>Raise and/or Leverage Body</p> | <p>Pushes against footholds to raise center of gravity Leverages legs against seat edge or other chair components to drive center of gravity forward Product components, such as tray, belt anchor, clasps, strap adjustment may fail under force</p> | <p>Foot Rest Seat Depth Passive Crotch Restraint</p> | <p>Leg Length Thigh Length Center of Gravity</p> |
| | <p>Pitch Forward</p> | <p>Barrier to forward motion is absent Barrier to forward motion gives way Center of gravity can rotate over barrier Torso range of movement is not sufficiently restricted Waist slides through waist strap</p> | <p>Tray Restraint Bar Passive Crotch Restraint Torso Restraint - Anthropometric Fit Seat Incline Strap Adjustment Stability</p> | <p>Center of Gravity</p> |

Table 7. Task Analysis: Reaching/Leaning

| Product: High Chair or Stroller | | Related Scenario(s): Stroller Lean Over Side and Fall | | |
|--|--|--|---|--|
| Occupant: 8-18 month old child | | Stroller Lean and Reach | | |
| Occupant Type: Deliberate | | | | |
| Developmental: Sits alone steadily (7 mos.); pulls to standing (9 mos.); Rotates trunk while sitting (8 mos.); Pincer grip (9 mos.); stands/walks alone (13 mos.) | | | | |
| Movement Affordances | Critical Movement Components | Potential Problems | Contributing Product Characteristics | Relevant Anthropometry |
| Reaching - Excessive leaning and reaching may result in falls out of the product or product instability. Children may also be able to reach items that result in hand injury, such as the wheels of a stroller or hazards located near the stroller or high chair. | Leaning Torso Over Side of Seat | Hips rotate to allow forward lean Location of strap anchors allows excessive movement of rear and thighs Waist slides upward through waist strap Knees may be pulled into seat pan, raising center of gravity | Seat Width Strap Degree of Motion Restriction Torso Restraint - Anthropometric Accommodation Torso Restraint - Adjustment Stability Seat Incline Seat Sides, Armrests | Torso Length Hip Circumference Thigh Length Center of Gravity |
| | Reaching with Hands | Reaches out and touches wheels, spokes, or ground Reaches and activates some product feature (e.g., wheel lock release) Reaches out and accesses external hazards Reaches and tips product by pushing or pulling external items | Occupant Compartment - Wheel Distances Torso Restraint - Level of Motion Restriction Strap Degree of Motion Restriction | Frontal Grip Reach Torso Length Torso Circumference |
| Reaches with Feet | Extends foot and unlatches restraint Extends foot and gets caught in product mechanism (e.g., wheel) Extends foot and gets caught by external forces (e.g., ground or other obstacles) | Passive Crotch Restraint Strap Adjustment Stability Torso Restraint - Adjustment Stability Strap Degree of Motion Restriction Occupant Compartment - Wheel Distances Seat Height | Leg Length Hip Breadth Thigh Breadth Torso Circumference Hip Circumference Torso Depth | |

Table 8. Task Analysis: Slide Down

| Product Type: High Chair or Stroller Occupant: 6-18 month old child Action Type: Deliberate or Incidental Developmental: Sits alone steadily (7 mos.), Rotates trunk while sitting (8 mos.), stands/walks alone (13 mos.) | | Related Scenario(s): Stroller Slip Through Leg Opening High Chair Slip Through Leg Opening High Chair Slide Down and Entrap | | |
|---|---|---|--|--|
| Movement Affordances | Critical Movement Components | Potential Problems | Contributing Product Characteristics | Relevant Anthropometry |
| <p>Slide Down</p> <ul style="list-style-type: none"> - Sliding down entails moving out of the seat pan toward the footrest area. The child's head may become entrapped by the tray or by restraint system components. Sliding down may be hampered to some degree by active and passive crotch restrictions and/or the constriction provided by waist belts or trays. If a crotch blocking feature exists, the child must first get both feet into one leg opening. Thus, pulling the knee and foot into the seat pan area becomes a prerequisite action. Smaller children may become entrapped by the tray even with the crotch restraint in place between the legs. | <p>Pulling Legs into Seat</p> | <p>Knees and lower legs may be pulled into the seat pan, free of the leg divider</p> | <p>Passive Crotch Restraint/Leg Openings Strap Anthropometric Accommodation Seat Width Seat Depth Seat Incline</p> | <p>Thigh Length Leg Length Torso Circumference</p> |
| | <p>Turning Torso/Hips Around</p> | <p>Strap adjustment slips under pressure Straps provide little twisting resistance Turning is not resisted by torso restraint due to cylindrical shape of torso Envelope of movement allows thighs to cross, hips to rotate</p> | <p>Strap Degree of Motion Restriction Seat Width Passive Crotch Restraint/Leg Openings</p> | <p>Hip Breadth Thigh Breadth Torso Circumference Hip Circumference Torso Depth</p> |
| | <p>Sliding Through the Leg Opening</p> | <p>Both legs may pass through one leg opening Crotch restraint is not effective until after point of potential head entrapment (by the tray) Inflating torso or pushing may break or move the tray Sliding child may become entrapped by tray Sliding child may become entrapped by leg opening Loose fit against torso may allow relative motion</p> | <p>Passive Crotch Restraint/Leg Openings Seat Incline Torso Restraint - Anthropometric Accommodation Torso Restraint - Adjustment Stability Tray</p> | <p>Torso Circumference Hip Breadth Thigh Breadth Thigh Length</p> |

Table 9. Task Analysis: Horizontal Slide

| Product Type: Stroller (reclining) Occupant: 3-9 month old child Action Type: Incidental Developmental: Limited prone mobility (3 mos.); creeping (6 mos.); crawling (7 mos.) | | Related Scenario(s): Stroller Horizontal Slide | | |
|--|-------------------------------|--|--|--|
| Movement Affordances | Critical Movement Components | Potential Problems | Contributing Product Characteristics | Relevant Anthropometry |
| Horizontal Slide -With stroller seat reclined (horizontal) to form a bed, child may slide along the surface of the bed. The child may slide out through leg holes or slide toward the head end, causing the stroller to tip. Restraints typically are waist belts intended to limit motion and possibly even deter attempts to roll. Though openings in the sides and ends of the product as well as material choice may contribute to hazards, they are not an integral concern with the restraint design. | Turning Torso/Hips Around | Too loose - strap does not go small enough to fit Child inflates torso during adjustment causing poor fit Poor adjustability - difficult to adjust or tighten | Strap Usability Strap Adjustment Stability | Torso Circumference Hip Circumference |
| | Child Motion while Restrained | Strap adjustment slips under wriggle pressure Straps provide little twisting resistance Strap may allow large position changes Waist and hips slide through the waist strap | Strap Degree of Motion Restriction Strap Anthropometric Accommodation Strap Adjustment Stability | Torso Circumference Hip Circumference |

5. ANTHROPOMETRIC RELATIONSHIPS

The quantitative relationship of child characteristics with corresponding product features is a concern for restraint system performance. This section summarizes some of the anthropometric dimensions of children that appear to be of general importance based on the task analysis. The section also summarizes the range of dimensions for selected product features, based on the product sample measurements presented in Appendix C. Some specific comparisons of interest are included in this section. However, there are many possible relationships that may need to be considered by a product designer when dealing with specific product and restraint system designs in relation to potential hazards. The intent of this section is to provide useful summary data and examples. Comprehensive child anthropometry data may be found in Schneider, Lehman, Pflug, & Owings (1986), Snyder, Schneider, Owings, Reynolds, Golomb, & Schork (1977), Snyder, Specer, Owings, & Schneider (1975), and Weber, Lehman, & Schneider (1985). Product dimensions of interest are shown in Appendices B and C and the range of measures for the twenty sample products may be found in Appendix C. The twenty sample products are felt to provide a good representation of typical high chair and stroller products and restraints. There may be additional products with unique features or more extreme dimensions.

Table 10 summarizes major anthropometric measures for children in several age ranges. The data are derived from Weber et al. (1985), except for the hip circumference measure (not provided in Weber et al.), which was taken from Snyder et al. (1977). For each anthropometric measure, data are shown for children in four age categories, nominally 0.5, 1.0, 2.0, and 4.0 years old. The youngest group of 0.5-year-olds (3-9 month age range) corresponds to the youngest product users (except for certain strollers appropriate to very young infants) and typical at-risk range for the "incidental movement" actions. The 1.0 year old group (9-15 months) is the peak risk range for the typical "deliberate" actions. The 2.0 year old group (21-27 months) represents the age at which many children begin transitioning from high chair use; most begin using a booster chair by age two or three. The 4.0 year old group (45-54 months) represents the approximate upper age limit for stroller use. For the hip circumference measures, the age groups were defined somewhat differently, since Snyder et al. used different age categorizations than Weber et al. The four age groups for hip circumference were 3-8 months, 12-15 months, 20-23 months, and 42-54 months.

For each anthropometric measure, Table 10 shows the mean size and the standard deviation of the measure for each of the four age groups. The values for the means and standard deviations were taken from Weber et al. (1985) and Snyder et al. (1977). The column in Table 10 showing the lower bound presents the value that is two standard deviations below the mean. The column showing the upper bound presents the value that is two standard deviations above the mean. These were *not* the "maximum" and "minimum" values from Weber et al. or Snyder et al. but were based instead on the standard deviations. Weber et al. and Snyder et al. provided the actual minimum and maximum values observed in the sample of subjects. However, since the minimums and maximums are each based on a single case, this can lead to extreme values and anomalous relationships between age categories (for example, the maximum value listed for knee-sole length for 0.5 year olds is *larger* than that listed for 4.0 year olds). Therefore we have taken plus-and-minus two standard deviations around the mean as a reasonable set of boundaries for describing the range of variation for a particular age group.

Table 10. Anthropometric Measures for Children in Several Age Ranges

| Measurement | Age* (years) | Lower Bound** | Mean*** | Upper Bound** | Standard Deviation*** |
|---------------------------------------|--------------|---------------|---------|---------------|-----------------------|
| Shoulder-Elbow Length | 0.5 | 4.1 | 5.1 | 6.1 | 0.5 |
| | 1.0 | 5.1 | 5.9 | 6.7 | 0.4 |
| | 2.0 | 6.0 | 6.8 | 7.6 | 0.4 |
| | 4.0 | 7.2 | 8.2 | 9.2 | 0.5 |
| Elbow-Hand Length | 0.5 | 5.7 | 6.9 | 8.1 | 0.6 |
| | 1.0 | 7.0 | 7.8 | 8.6 | 0.4 |
| | 2.0 | 8.0 | 9.0 | 10.0 | 0.5 |
| | 4.0 | 9.5 | 10.7 | 11.9 | 0.6 |
| Waist (Torso) Circumference | 0.5 | 12.5 | 15.1 | 17.7 | 1.3 |
| | 1.0 | 13.6 | 16.0 | 18.4 | 1.2 |
| | 2.0 | 15.7 | 18.1 | 20.5 | 1.2 |
| | 4.0 | 17.1 | 19.3 | 21.5 | 1.1 |
| Abdominal (Torso) Depth, Seated | 0.5 | 4.8 | 5.6 | 6.4 | 0.4 |
| | 1.0 | 5.1 | 5.9 | 6.7 | 0.4 |
| | 2.0 | 5.1 | 5.9 | 6.7 | 0.4 |
| | 4.0 | 5.2 | 6.2 | 7.2 | 0.5 |
| Hip Breadth, Seated | 0.5 | 4.9 | 6.1 | 7.3 | 0.6 |
| | 1.0 | 5.9 | 6.7 | 7.5 | 0.4 |
| | 2.0 | 6.1 | 7.3 | 8.5 | 0.6 |
| | 4.0 | 6.9 | 7.9 | 8.9 | 0.5 |
| Thigh Breadth, Seated (both thighs) | 0.5 | N/A | N/A | N/A | N/A |
| | 1.0 | N/A | N/A | N/A | N/A |
| | 2.0 | 6.4 | 7.6 | 8.8 | 0.6 |
| | 4.0 | 6.7 | 7.9 | 9.1 | 0.6 |
| Thigh Breadth, Standing (both thighs) | 0.5 | 4.7 | 5.7 | 6.7 | 0.5 |
| | 1.0 | 5.2 | 6.0 | 6.8 | 0.4 |
| | 2.0 | 5.6 | 6.6 | 7.6 | 0.5 |
| | 4.0 | 6.3 | 7.1 | 7.9 | 0.4 |
| Thigh Depth, Seated | 0.5 | 1.7 | 2.5 | 3.3 | 0.4 |
| | 1.0 | 1.9 | 2.7 | 3.5 | 0.4 |
| | 2.0 | 2.2 | 3.0 | 3.8 | 0.4 |
| | 4.0 | 2.3 | 3.3 | 4.3 | 0.5 |
| Rump-Sole Length | 0.5 | 9.6 | 11.6 | 13.6 | 1.0 |
| | 1.0 | 11.9 | 13.9 | 15.9 | 1.0 |
| | 2.0 | 14.7 | 17.1 | 19.5 | 1.2 |
| | 4.0 | 19.3 | 21.7 | 24.1 | 1.2 |
| Rump-Knee Length | 0.5 | 5.1 | 6.7 | 8.3 | 0.8 |
| | 1.0 | 6.6 | 7.8 | 9.0 | 0.6 |
| | 2.0 | 8.2 | 9.8 | 11.4 | 0.8 |
| | 4.0 | 10.7 | 12.3 | 13.9 | 0.8 |
| Knee-Sole Length | 0.5 | 5.5 | 6.9 | 8.3 | 0.7 |
| | 1.0 | 7.0 | 8.0 | 9.0 | 0.5 |
| | 2.0 | 8.4 | 9.6 | 10.8 | 0.6 |
| | 4.0 | 10.5 | 11.9 | 13.3 | 0.7 |
| Shoulder Height, Seated | 0.5 | 9.6 | 11.4 | 13.2 | 0.9 |
| | 1.0 | 10.3 | 12.1 | 13.9 | 0.9 |
| | 2.0 | 11.2 | 12.6 | 14.0 | 0.7 |
| | 4.0 | 12.2 | 14.0 | 15.8 | 0.9 |
| Hip Circumference | 3-8 mo | 13.8 | 17.0 | 20.2 | 1.6 |
| | 12-15 mo | 15.7 | 18.3 | 20.9 | 1.3 |
| | 20-23 mo | 15.5 | 18.7 | 21.9 | 1.6 |
| | 42-54 mo | 18.2 | 21.0 | 23.8 | 1.4 |

* - For all measures other than hip circumference, ages are in years. Age groupings are \pm 3 mos., except for 4.0, which is -3 and +6 mos. For Hip Circumference, age brackets are shown in months.

** - Equal to two standard deviations above or below the mean

*** - Mean and standard deviation taken from Weber, Lehman, & Schneider (1985), except for hip circumference, taken from Snyder et al. (1977)

The values for the children in the 0.5 year and 1.0 year groups indicate the characteristics of users for which the product restraint systems must be highly effective. These are the most at-risk groups for restraint system-related incidents. The values for the 2.0 year and 4.0 year groups provide consideration of users that must be accommodated by the product in terms of its normal functional use. For example, a stroller seat needs to accommodate an 8.9 inch seated hip breadth (upper 4.0 year old), plus outerwear clothing. However any freedom of movement beyond 6.7 inches (mean seated hip breadth for 1.0 year olds) represents potentially undesirable latitude for the average one year old in light clothing.

Some anthropometric dimensions show greater diversity over the 0.5-to-4.0 year old age range than do others. The *mean* values in Table 10 for 4.0 year old children are from 10% to 90% greater than the *mean* values for 0.5 year olds. The *upper bound* values for 4.0 year olds are from 50% to 170% greater than the *lower bound* values for 0.5 year olds. The largest percentage differences are generally for measures associated with the length of the limbs, particularly the legs. The smallest difference was for seated torso depth. In terms of the absolute magnitude of differences, the waist and hip circumference measures show age differences comparable in size to the leg-related measures. Figure 4 illustrates these points graphically. The bar chart for each measure shows the value for the smallest design user (lower bound for 0.5 month old group), the mean for the 1.0 year old group, and the upper bounds for the older design user groups (2.0 years and 4.0 years).

Some of the key product dimensions to which anthropometric data may relate are shown in Table 11. These are selected example measures drawn from Appendix C. For each measure shown, the table shows the minimum and maximum values among the high chair sample products and the minimum and maximum values among the stroller sample products. This is not a statistical sample and does not represent the measurements of products on the market and in U.S. homes. These measures give some indication of the range of product variance on important product dimensions, although relatively small and non-random samples should not be assumed to precisely reflect the universe of stroller and high chair products. As the table shows, there is a considerable range of differences among many of these measures. For example, both within high chairs and within strollers, the maximum seat depth is almost twice the minimum seat depth. There are also substantial differences in seat depths between product types, with the seat depth values for strollers being about double that for high chairs. All of the measures presented in Table 11 are linear dimensions except for the seat compartment volume, which was derived from the dimensions of the seat width and depth and vertical leg opening.

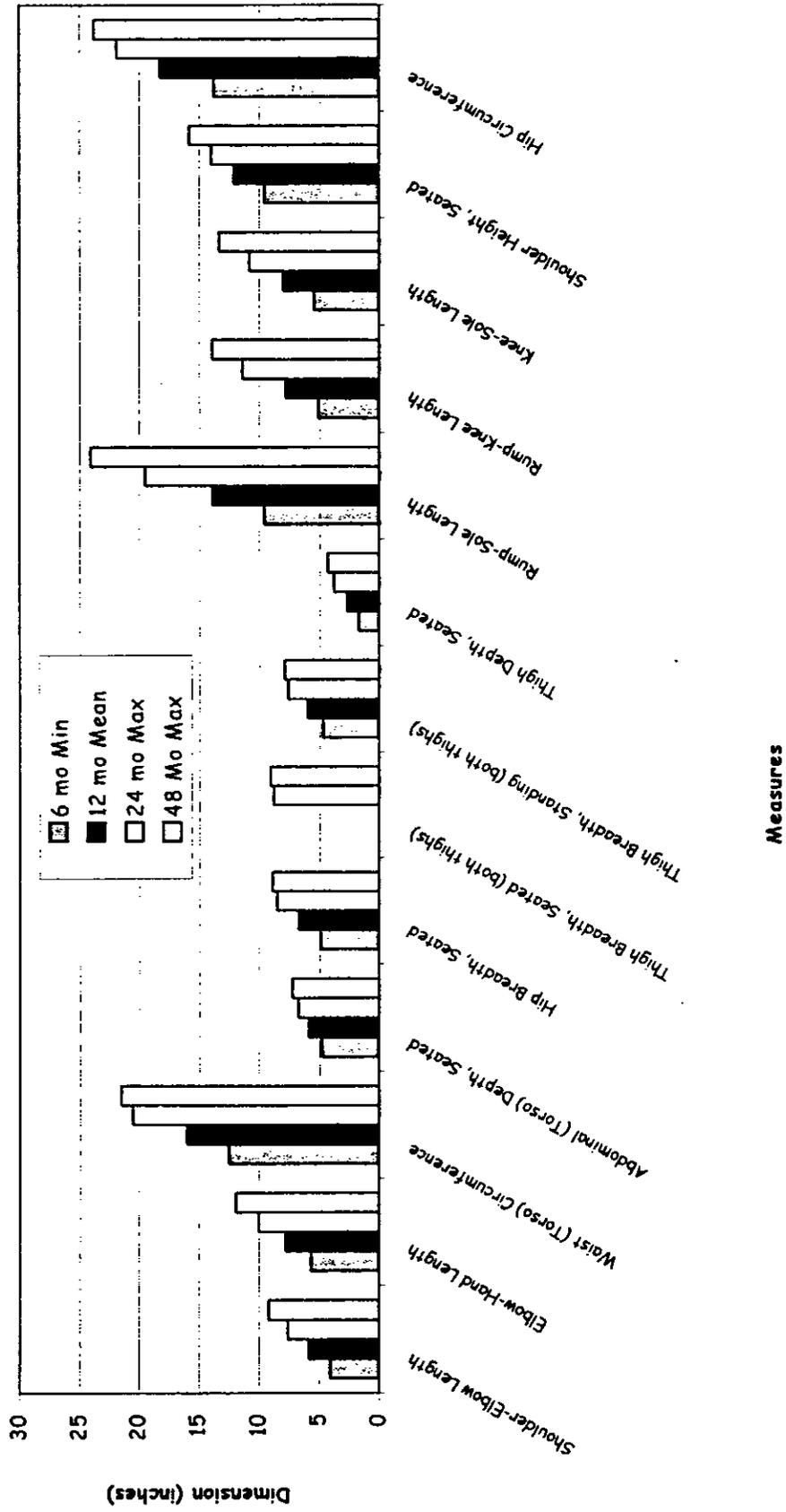


Figure 4. Range of Key Anthropometric Measures for Target Age Ranges

Table 11. Summary of Key Product Dimensions (in inches)

Seat Depth (Max & Min)

| Product Type | Total |
|--------------|-------|
| High Chair | 8.5 |
| | 4.0 |
| Stroller | 19.5 |
| | 10.5 |

Arm Rest Height (Max & Min)

| Product Type | Total |
|--------------|-------|
| High Chair | 9.0 |
| | 5.0 |
| Stroller | 9.0 |
| | 5.5 |

Seat Width (Max & Min)

| Product Type | Total |
|--------------|-------|
| High Chair | 13.0 |
| | 10.5 |
| Stroller | 15.0 |
| | 11.0 |

Seat Back Width (Max & Min)

| Product Type | Total |
|--------------|-------|
| High Chair | 17.5 |
| | 10.0 |
| Stroller | 16.0 |
| | 11.5 |

Back Height (Max & Min)

| Product Type | Total |
|--------------|-------|
| High Chair | 21.5 |
| | 15.0 |
| Stroller | 21.5 |
| | 16.5 |

Seat-Foot Rest Distance (Max & Min)

| Product Type | Total |
|--------------|-------|
| High Chair | 8.0 |
| | 5.3 |
| Stroller | 14.0 |
| | 6.5 |

Horizontal Thigh Openings (Max & Min)

| Product Type | Total |
|--------------|-------|
| High Chair | 6.0 |
| | 5.0 |
| Stroller | 6.0 |
| | 5.0 |

Vertical Thigh Openings (Max & Min)

| Product Type | Total |
|--------------|-------|
| High Chair | 8.0 |
| | 4.5 |
| Stroller | 7.8 |
| | 7.0 |

Seat Linear Dimension, derived (Max & Min)

| Product Type | Total |
|--------------|-------|
| High Chair | 17.5 |
| | 12.1 |
| Stroller | 25.8 |
| | 16.7 |

Seat Compartment Volume, derived (Max & Min in Cubic Inches)

| Product Type | Total |
|--------------|-------|
| High Chair | 884 |
| | 189 |
| Stroller | 2,267 |
| | 809 |

Distance to Wheels (Max & Min)

| Data | Product Type |
|--|--------------|
| | Stroller |
| Max of Min Forward Compartment/Wheel Distance | 21 |
| Min of Min Forward Compartment/Wheel Distance | 12 |
| Max of Min Rearward Compartment/Wheel Distance | 22 |
| Min of Min Rearward Compartment/Wheel Distance | 8 |

Figures 5 through 9 illustrate some of the relationships between selected anthropometric measures and product dimensions. Figure 5 portrays the range of observed seat widths for high chairs and shows the relationship of these measures to the hip breadth dimensions for the range of anticipated children using the seats. It is evident from this illustration that even the narrowest seat permits a large area of potential movement for smaller users. The wider seats are well in excess of what is required to accommodate even the maximum user. The widest high chair seat was about double the hip breadth of the mean one year old. Even allowing for diapers and clothing, it is evident from the figure that seat width is much larger than that required for the at-risk age groups for restraint failure incidents. Figure 6 portrays the same information for stroller seats. The maximum seat width is two inches greater than the maximum observed for high chairs. The maximum observed stroller seat width was about triple the hip breadth of the smallest anticipated user, and more than double the hip breadth of the mean one-year-old. Figures 7 and 8 (drawn to the same scale as Figures 5 and 6) illustrate thigh length. Comparing Figures 6 and 8 it may be noted that an average 4.0 year old could fit crosswise in many strollers (rump-knee length is less than seat width). The average 2.0 year old could fit this way for all of the high chair samples. Thus, if the knees can be drawn into the seat compartment the child could turn

completely around entirely within the seat. In this orientation, the high chair tray does not constraint movement.

Figure 7 illustrates certain profile measures of interest for high chairs. Observed distances from seat backs to crotch barriers range from an adjustable minimum of 4 inches up to a fixed maximum distance of 8.5 inches. Even the largest four year old (and most children are out of the high chair by about age three) has a torso depth of 7 inches. The crotch barrier depths also tend to be long relative to the thigh length of smaller users. The rump-knee length is about 5 inches for the smallest six month olds. While a crotch restraint barrier is necessary for all high chair users, and must accommodate all users, the information we reviewed suggests that it is the younger (6-9 month old) children who are at particular risk for incident scenarios in which the child slips down in the seat (either through a leg opening or sliding forward with head entrapment by the tray). Figure 8 portrays the same information for stroller seats. None of the crotch restraints on strollers are located near the torso of even the largest anticipated users. This may reflect a desire to allow the child more freedom of movement in the stroller and a less critical need to constrain the center of gravity than for high chairs and places more reliance on straps for restraining children who are attempting to stand or kneel. Whatever the reason for the large crotch barrier depths, the thigh length (rump-knee distance) for many children is less than the distance to the leg opening, allowing free movement of the legs.

Figure 9 summarizes dimensional data on seating compartments (the drawing is not to scale). The illustration shows how a volume of space is defined by the width of the seat, the depth of the seat, and the height of barriers above the seat that limit leg movement (vertical thigh openings). Differences in several linear dimensions can result in very large differences in three-dimensional volume, as reference to Table 11 indicates. While strollers provide larger spaces than high chair, there is still a large degree of variance within each product type. The dimension of particular interest is diagonal distance (from corner to corner of the seating compartment volume), since this is the greatest linear dimension along which the child could orient the legs. The lower bound 0.5 year old's entire leg (rump-sole length) is 2.5 inches shorter than the minimum diagonal for a high chair. The thigh of the largest 2.0 year old fits within this space as well (rump-knee distance), so that the legs could be drawn up. To the extent that restraint systems allow leg and torso movement within the compartment, so that the child can orient with respect to the axis of the diagonal, the dimensions of the space are large relative to the child's legs. The diagonal distances are typically even larger for strollers, in the greatest case even exceeding the entire leg length (rump-sole distance) of the largest 4.0 year olds.

The data and illustrations in this section indicate the degree of anthropometric variation and the match of product dimensions to the largest and smallest users as well as the most at-risk user groups. Potential mismatches for movement affordances related to incident scenarios should be avoided. Section 6 addresses the means for precluding these incidents.

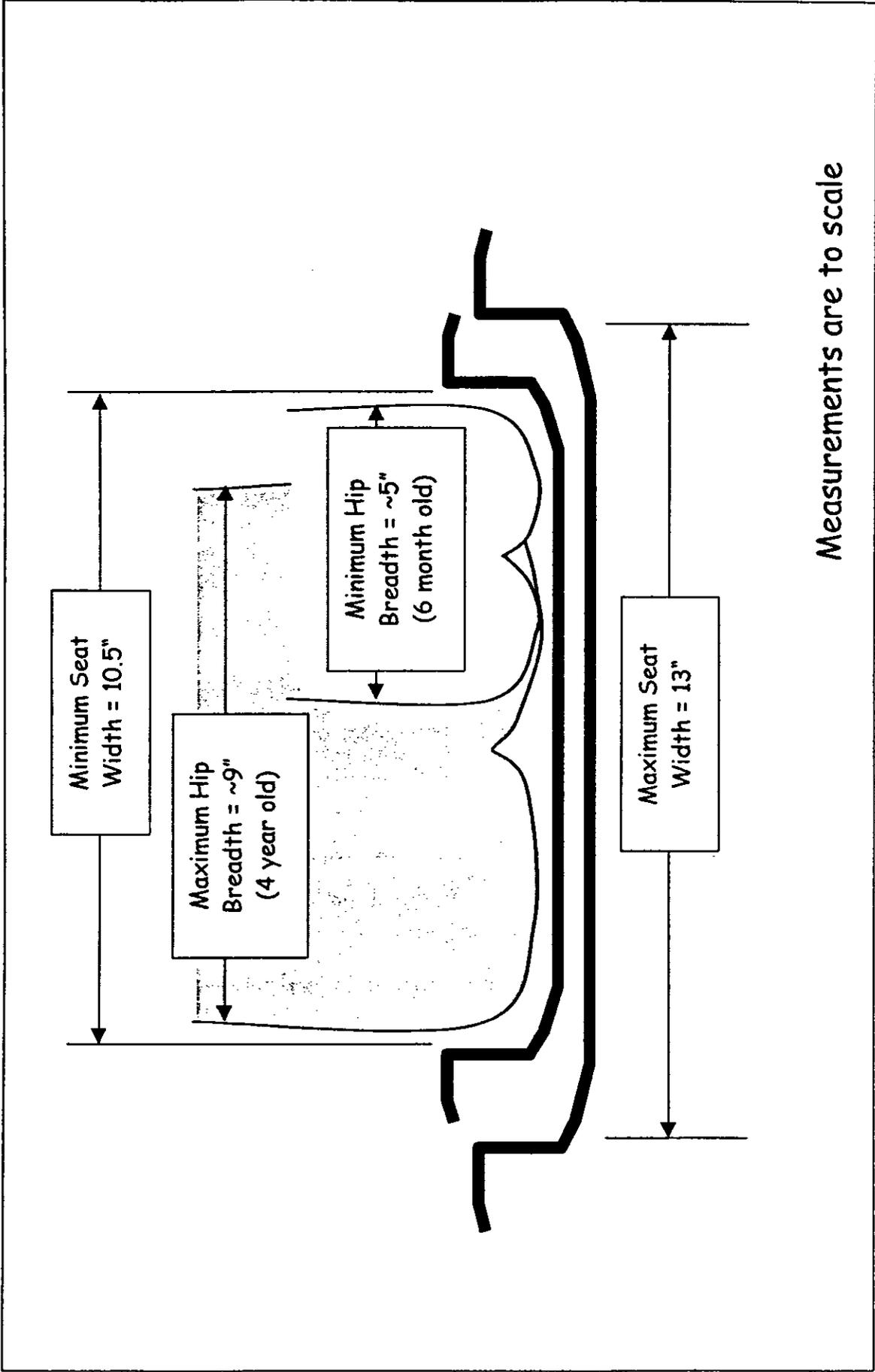


Figure 5. Observed Seat Width and Related Anthropometry for High Chairs

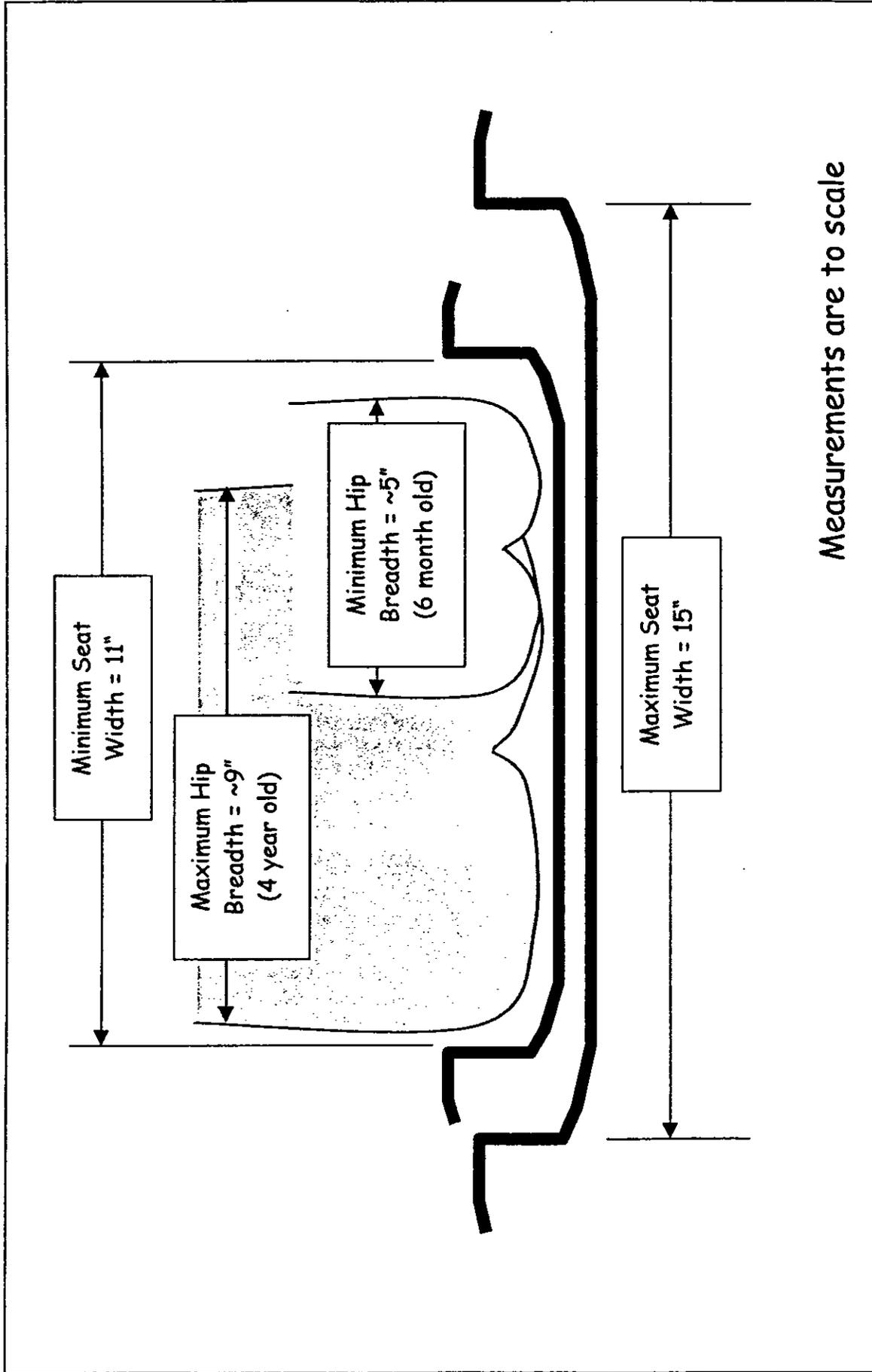


Figure 6. Observed Seat Width and Related Anthropometry for Strollers

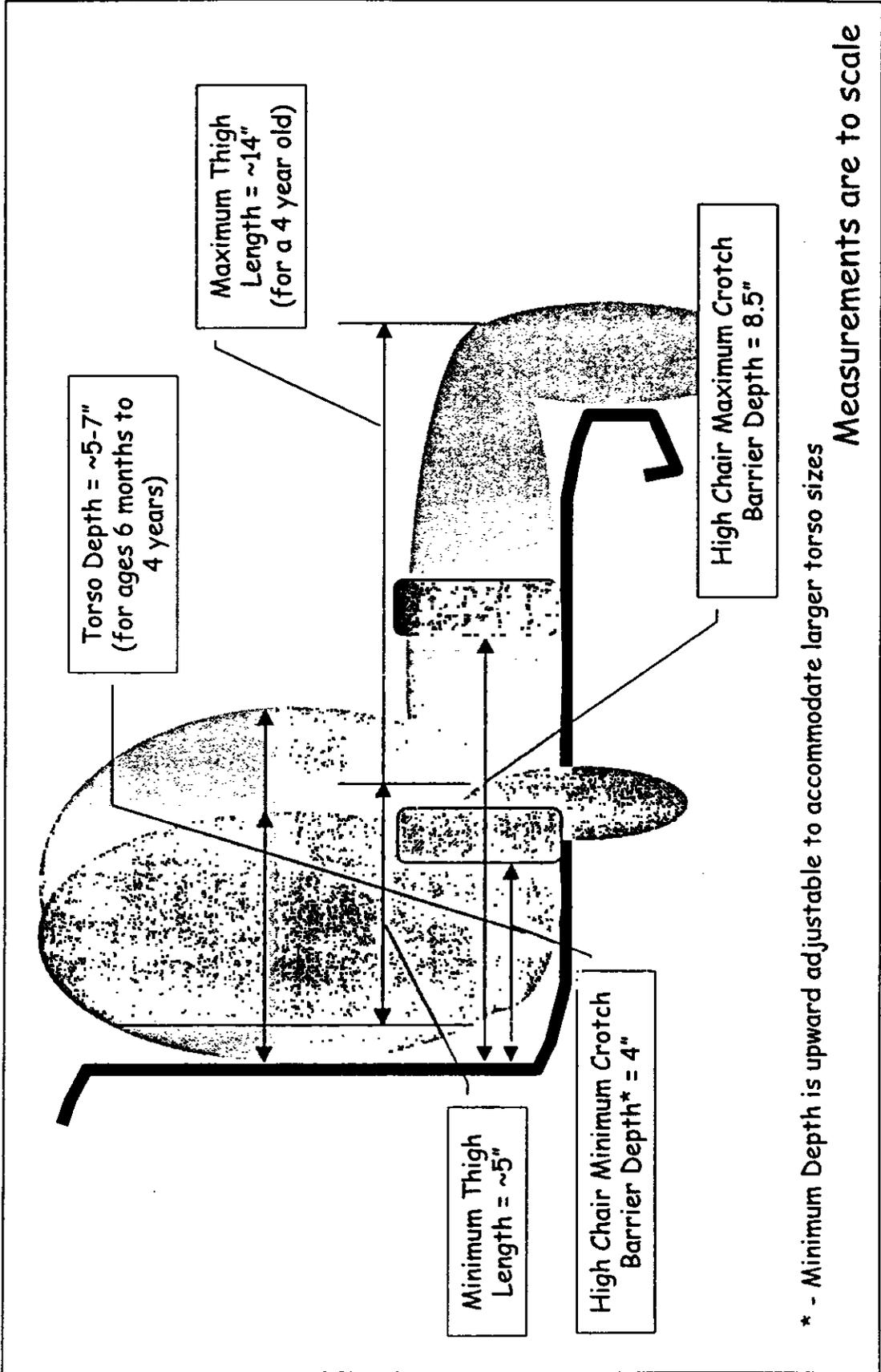


Figure 7. Profile Measures of Interest for High Chairs

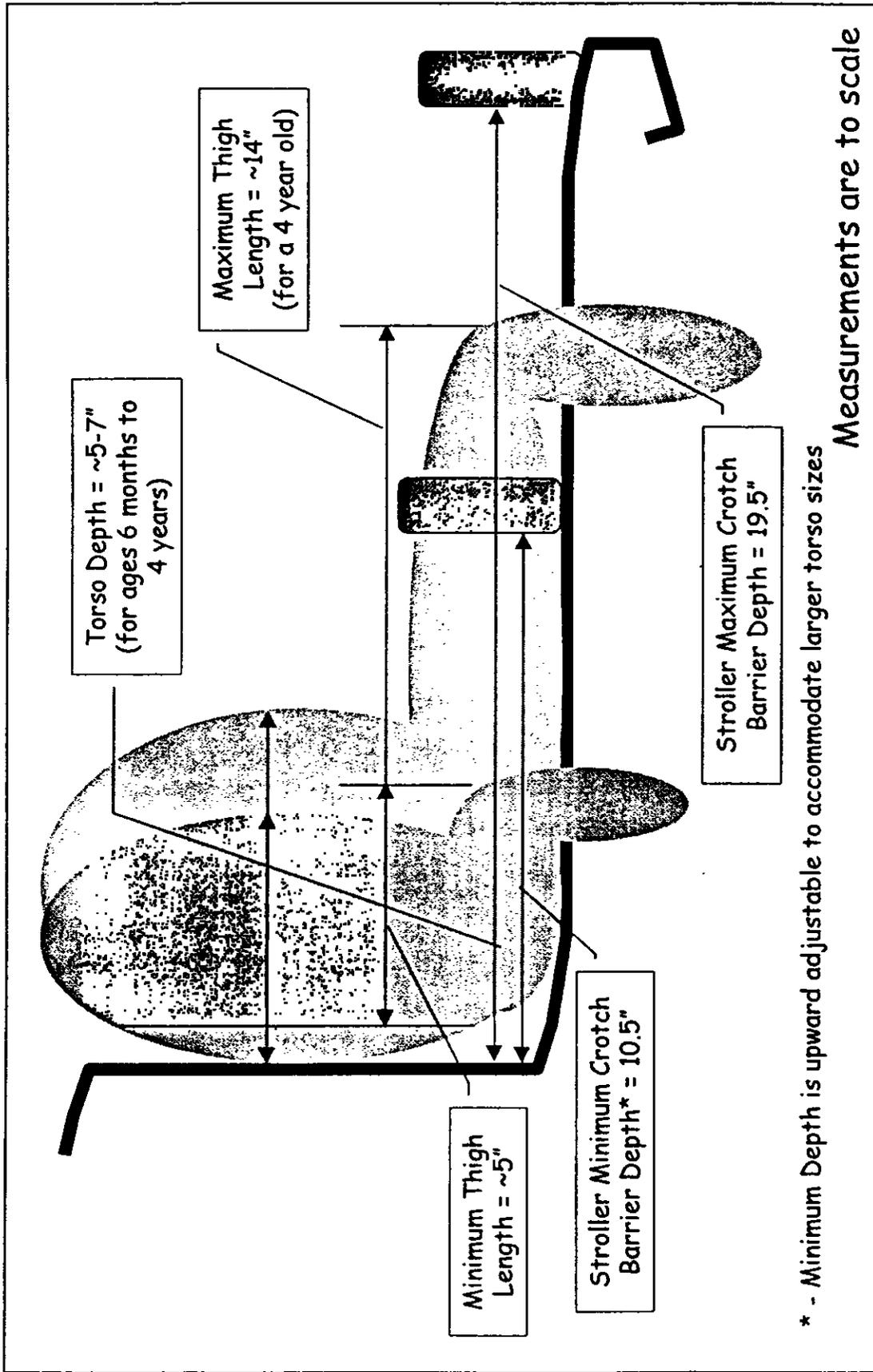


Figure 8. Profile Measures of Interest for Strollers

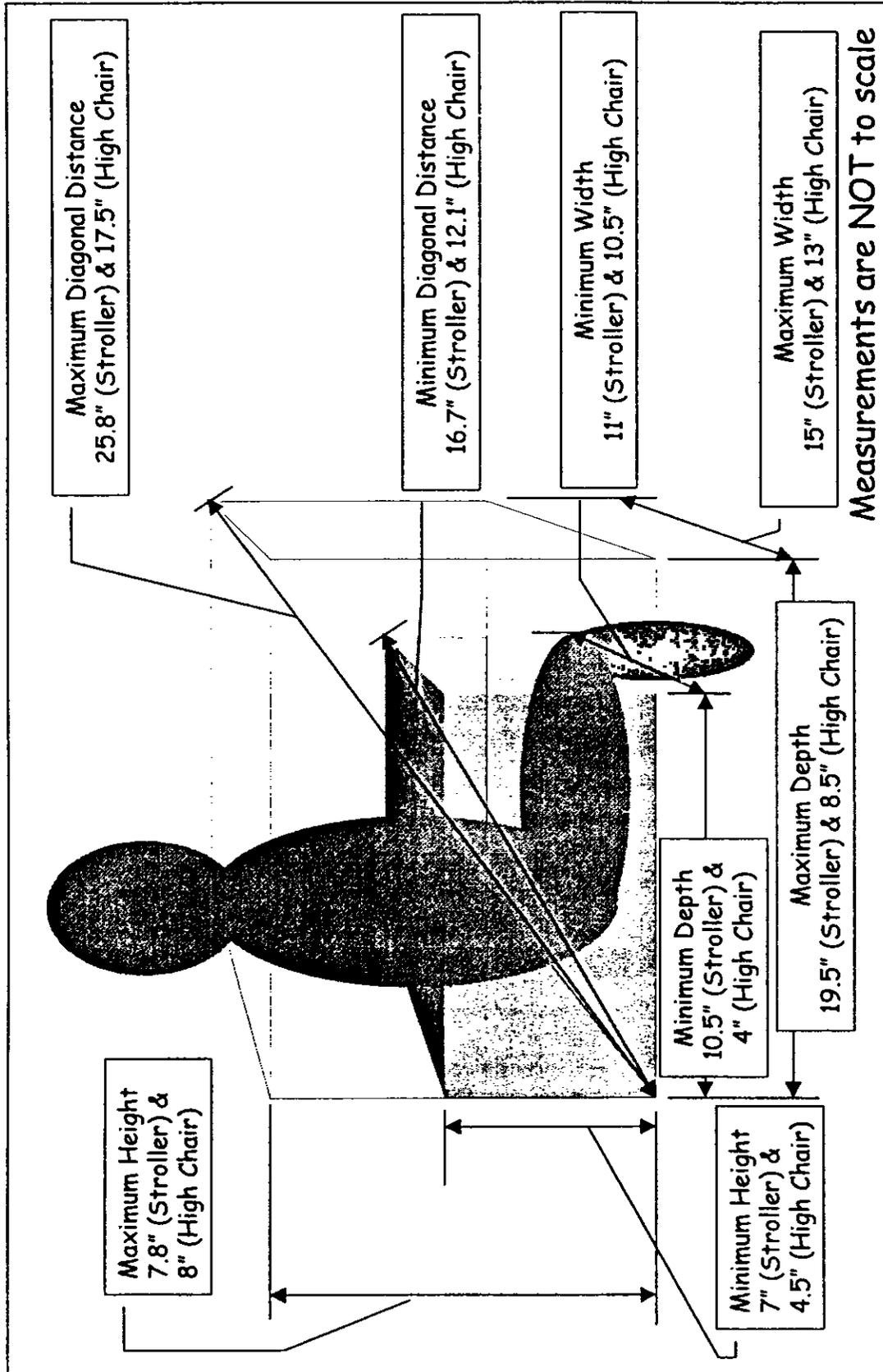


Figure 9. Product Seating Compartment Dimensions for High Chairs and Strollers

6. RECOMMENDATIONS

The following recommendations are made as suggested countermeasures or design practices that could be considered for evaluation. They should not be taken as recommendations for immediate practice or universal application. There may be trade-offs among design considerations, there may be manufacturing or cost impediments, or there may be the potential for the introduction of unforeseen new hazards or performance problems. While the recommendations are put forth as worthy of consideration because they address underlying causal problems with restraint system failures, any of these require more complete exploration. Some of the concepts are described in general terms and would require more detailed design. Therefore, the recommendations are viewed as offering a variety of approaches that have the potential for improving high chair and stroller restraint systems and that should be explored.

6.1 General Design Considerations

While the task analysis revealed numerous specific concerns related to movement of the child and room for movement in the product, many of these problems clustered around a set of six general design considerations that confront any designer of restraint systems for high chairs and strollers. These six design issues are:

- The cylindrical body shape of children
- The use of the thighs as effective levers
- The envelope of permitted movement of the knees and legs
- Maintaining the hip position within the chair seat
- Containment of the center of gravity
- Footholds

These general considerations are not independent of each other in terms of related design and countermeasure issues. However, each may be described as a general design issue that should be addressed. While there may be other issues related to restraint system effectiveness, these represent broad themes for design consideration. Each of these general design considerations is described below, prior to presenting specific design recommendations.

6.1.1 The Cylindrical Body Shape Of Children

This issue relates to the critical movements of pushing up, turning the hips and torso around, sliding down, and horizontal slide.

Restraint designs must confront the fact that children in the critical age range for restraint-failure incidents are characterized by chest, waist, hip and lower torso circumferences that are quite similar, so that the body shape is almost cylindrical. For the mean 10-12 month old, the chest circumference and waist circumference differ by only 2.4", in contrast to a 5.6" difference for 13-14 year olds (Snyder et al, 1975). Chest breadth, waist breadth, and lower torso (hip area) breadth are all within 0.8" of each other for the 10-12 month olds. Due to this cylindrical shape, twisting or longitudinal motions will be difficult to combat with straps or passive restraints that encircle the torso. The cylindrical body shape will allow movement in either of these dimensions with limited restriction provided by the restraints. Obviously, torso/waist restraints should fit snugly as one defense, but this is not sufficient. Eliminating the afforded freedom of motion or

eliminating bearing surfaces that allow pushing or turning would also be beneficial. The primary means available to designers to limit twisting and longitudinal motion of the body within the confines of the waist strap and other torso-restrictive measures is to maintain an orthogonal orientation of the thighs to the user's back (i.e., a right angle) and to limit the thighs' rotation around the longitudinal axis of the user's back as well.

6.1.2 The Use Of The Thighs As Effective Levers

This issue relates to the critical movements of pushing up, leaning, and pitching forward.

The thigh is the longest rigid body segment of the child. As such, it represents both a powerful tool for exerting force in overcoming a restraint and also a potentially effective target for controlling movement through restraint devices. The thighs may be used to defeat restraints by straightening out the body and/or rotating the torso over the seat edge. The thighs may exhibit leverage through either extension or contraction. Excessive seat dimensions may also allow the thighs to be used to push against the sides of the seat or crotch restraints to gain mechanical advantage. Restraint system strategies that limit the movement of the thighs may preclude a number of possible effective actions by the child.

6.1.3 The Envelope Of Permitted Movement Of The Knees And Legs

This issue relates to the critical movements of pushing up, turning around, sliding down, and pitching forward.

A key component of many escape scenarios is the movement of knees/legs into the seating area. When the knees are drawn into the seat compartment there is more freedom to turn around and to then more easily slide through restraints or kneel and stand. If the thighs can be pulled into the seating compartment, the lower legs can as well. With the knees drawn up, the heels can be placed on the seat surface and used to push the body upward. If even one leg can be drawn into the seat compartment, it can then be extended back down through the opposite leg opening, permitting the "slip through leg opening" incident scenario. Given all of these possibilities, there must be a general design objective of limiting the envelope of movement through which the knees and legs are free to move. This envelope must be treated as a three-dimensional space, since by rotating the hips the child could draw the knees in in any plane, not just vertically. The ability to move the left hip into the right-rear corner of the seat, for example, the diagonal dimensions of the seating compartment volume become the critical measures of anthropometric accommodation. The afforded motion of the hips defines the user's ability to use the maximum linear distance of the seating compartment to accomplish this critical task. And, although the overall seat depth is part of this equation, providing a passive crotch restraint effectively reduces the seat depth. That is, movement of the knee past the crotch restraint must occur to facilitate the torso rotation and/or full leg entry into the seating compartment as a prerequisite for various escape scenarios to be accomplished.

6.1.4 Maintaining The Hip Position Within The Chair Seat

This issue relates to the critical movements of pushing up, turning around, sliding down, leaning/reaching, and pitching forward.

When a child is properly seated in a chair, the hips are flat against the chair back, with the buttocks at the juncture of the chair seat and chair back. Virtually all of the restraint failure

scenarios require movement of the hips from this position. The hips may raise up (as in standing), rotate (as in turning around), roll laterally (as in leaning), or move forward (as in sliding down). Movement of the hips can increase the envelope within which the knees are free to move. To the extent that the hips are kept in place against the seat back, this will limit opportunities to execute the actions required for incident occurrence. Linear or rotational movement in any direction might promote restraint failure. The design of the seat, as well as the primary restraints, may contribute to maintaining the hip against the chair seat.

6.1.5 Containment Of The Center Of Gravity

This issue relates to the critical movements of pitching forward, leaning/reaching, and horizontal slide.

The child's center of gravity is important in two respects. First, if the center of gravity is allowed to rotate over a barrier (e.g., restraint bar or chair arm), and the lower torso is not adequately restrained, the child may pitch over the barrier. Second, if the position of the center of gravity is allowed to move beyond a point in three-dimensional space that exceeds the product's ability to offset it, the product and user will tip over. Containment of the center of gravity needs to be considered for all alternative modes of product use, including partially or fully reclined seats. Center of gravity containment is a particular concern where the restraint system allows a wide range of upper torso movement, raising of the hips and body to elevate the center of gravity, or movement of the torso towards the head end of the seat when it is in a fully or partially reclined mode.

6.1.6 Footholds

This issue relates to the critical movements of pushing up, turning around, and pitching forward.

Accessible footholds provide a bearing surface on which pressure can be exerted to lift the body or legs upward. This facilitates moving the torso upward through the restraints and provides leverage for the legs and thighs. Without such a bearing surface, the child must rely on the upper body to provide the direction, stabilization, and force needed to accomplish body movements. While various surfaces or structural components of high chairs or strollers may serve as affording surfaces for pushing with the feet, the footrests on many products provide the most obvious example. Footrests not only afford pushing, they also provide a standing surface, upon which to turn around and from which to reach with an arm or leg. Crotch restraints, restraint bars, or the underside of high chair trays also may provide effective pushing surfaces if they can be reached with the feet. Ideally a high chair or stroller would not allow a child in the at-risk age group to reach any effective pushing surface with the feet. We believe that one role of footrests on strollers is to keep the feet from being caught in wheels and on the ground. This function needs to be retained. We also believe that, on highchairs, the purpose of a footrest is more likely as climbing aid for older users and possibly for comfort while in the seat. The footrest does not appear to serve an important functional role for children in the at-risk age group but may facilitate pushing, twisting, or turning.

6.2 Design Recommendations

In this section, we provide specific design recommendations as countermeasures to the problems we have identified in restraint system effectiveness. As noted earlier, these recommendations are made as suggested countermeasures or design practices that should be considered for evaluation.

They should not be taken as recommendations for immediate practice or universal application. Thorough analysis of each is required to fully consider whether there is any potential for introducing new hazards or limitations on functional performance. The recommendations are felt to offer a variety of approaches that should be explored to potentially improve high chair and stroller restraint systems.

In the discussion of the recommendations, reference is sometimes made to children in the "at-risk age group" for restraint failure incidents. This is understood to refer to the peak risk groups as discussed earlier in Section 4.2.3. The peak risk group for incidents that involve deliberate actions by the child is typically from about 8 to 18 months old. For incidental actions, the range is typically 3 to 9 months old, although in the case of high chairs, the youngest user is assumed to be about 6 months old.

Where child anthropometric dimensions are described in the discussion of a recommendation, the data are taken from Weber et al. (1985).

Various design recommendations are discussed below under headings that correspond to various component elements of the product: belts, seats, crotch restraints, trays, leg restraints, footholds, and barriers.

Belts

Location of the waist belt anchor points: The location of the waist belt anchor points should be as close to the intersection of the seat and back as possible. The separation of the anchor points should approximate the hip width of the smallest intended users, which is about five inches for 6 month olds.

Shoulder strap function and anchor points: Shoulder straps are unlikely to provide reliable deterrence to deliberate escape from the restraint system because children can free their shoulders by wriggling or pushing them out of the way with their hands. When they are used in conjunction with other design aspects (e.g., inclined seat pan and/or seat back, seat back wings), they may be somewhat more effective, but are still of questionable utility. The inherent problem is in the mobile torso of children. Potentially more effective shoulder restraints that use lateral or diagonal straps may present entrapment hazards. However, shoulder straps may serve an effective function in preventing forward pitch or excessive lean. Five-point restraint designs that anchor the rear of the shoulder straps to the waist belt or to a tether do not greatly restrict upper torso movement.

Seats/Seat Compartments

Seat pan design: Most high chairs, and many strollers, have a relatively flat seat pan, but other seat designs may contribute to child containment. Sling seats (perhaps similar in design to those used as toddler swings on playground equipment) would conform to the child's seat and would offer no firm surface on which to stand and escape from the restraint. This would require the child to rely mainly on upper body strength to accomplish an escape. Bucket seats (similar to those used in infant car seat applications) would restrict lateral hip and torso movement, reduce surfaces that the feet could press against, keep the center of gravity low, make it more difficult to rotate the body, and provide a less favorable surface for standing. Providing an incline to the seat surface will harness gravity to force the hips to the juncture of the seat pan and seat back and may make it more difficult to raise the hips from the seat back. However, care must be taken that this does not change the escape dynamics. If the seat back is reclined, users may move headward

during escape attempts and may exceed the center of gravity containment potential of the product even before a full escape occurs (i.e., the product and the occupant may tip toward the head end prior to being free of the restraint).

Customizable seat fit: Seat dimensions are often far larger than those required to accommodate children throughout the at-risk age range. The extra room makes it easier for children to rotate while belted and to use the seat as a surface to push against as aid to moving up through the waist belt. To the extent that seat dimensions can be customized to accommodate a given user with minimal excess area, torso movement within the belt will be more difficult. One possibility is that products come with inserts that nest inside the primary seat, so that the consumer can adapt the seat to the child. Another possibility is inflatable conformable components, analogous to pump-up sneakers. A concern here is that such products may require installing, removing, and storage of these fit components and may lead to loss or failure to use them in contrast to built-in features. Inserts or other means of customization must remain compatible with the primary restraint system.

Limit seat width to required maximum: Seat widths on strollers and high chairs may exceed the width required to accommodate the largest likely users (e.g., 3 to 4 year olds). This may allow a great deal of latitude for movement, especially by children in the peak risk range for restraint failure incidents (6-18 months) who are smaller than the largest anticipated users. We believe that there does not appear to be any functional reason for substantially exceeding the width required by the largest users. Taking the upper bound four year old as the oldest intended user, the hip breadth is about 9 inches. Thus, we believe that seat width should not exceed 9 inches plus an adequate allowance for clothing.

Lateral seat barriers: Deeper seat sides or armrests may serve to passively constrain the movement of the hips and thighs within the seating compartment. Arm rests, extended seat wings, webbing, or other features that form the side of the seat compartment may provide barriers to leaning over the side of seat. Leaning could result in a fall or entanglement, and reaching while leaning could result in contact with stroller wheels or other hazards. To the extent wings or webbing come forward in the compartment, the child also must lean forward when leaning to the side, thus limiting the child's ability to overhang the side. Throughout the age range of most interest (9-36 months), the typical seated center of gravity remains at about 8 inches high (it is fairly constant because although children's seated height grows over this age range, the location of the center of gravity as a proportion of seated height also drops over this age range). Assuming the child is centered approximately five to six inches from the edge of the seat, this means that an armrest or other barrier six to seven inches high would generally preclude overleaning as long as the buttocks is not raised off of the seat.

Crotch Restraints

Crotch barrier adjustability: Crotch barrier adjustability is an important feature because the crotch barrier is the primary means of limiting the downward slide of the cylindrical torso through the waist belt and also limits rotation of the hips and legs. Many products have non-adjustable crotch restraints that are located well forward of the crotch position of at-risk children. For crotch straps, the strap anchor position and the length of the strap should be adjustable to maximize the likelihood of maintaining thigh separation and limiting the extent to which the body can slide downward. Rigid crotch barriers should also provide adjustability that allows them to be positioned close to the user's crotch. The minimum distance from the seat back to which the barrier can be positioned should be small enough to restrain a six month old child. Using seated

torso depth as a design criterion, this minimum is approximately 5 inches (lower bound 6 month old).

Crotch barrier shape: The high chair passive crotch barrier usually takes the form of a post extending from the seat to the underside of the tray or vice versa. The effectiveness of the barrier could be improved if it was extended forward along the thighs, having more of a paddle or divider shape. Such a shape would promote better separation of the legs. It would not allow the child to rotate the thighs or legs around the barrier. The restriction to thigh movement would limit hip and leg freedom of movement. While the post shape may be adequate to address the concern of a child “submarining” down the seat and under the tray, a more extended paddle shape might better address this and a variety of other key movements.

Trays

High chair tray that slides at downward angle: A high chair tray may be designed to slide toward the child at downward angle (relative to the seat) rather than horizontally. To promote a snug fit, having a tray that reduces both vertical leg opening and seat depth dimensions as it is moved toward the user would tend to reduce movement affordance of the hips and thighs. The downward movement path also serves another purpose. When the tray is moved forward for placing a child in the seat, the tray effectively raises. This allows less restricted entry of the legs into the leg holes during the seating process as well as a snug fit on the thighs as the tray is moved back into the most snug position. Obviously, the tray would need to remain horizontal as it moved towards the torso, for practical purposes. Figure 10 illustrates this concept.

Tray release location: The release mechanism for the tray should not be reachable by children’s feet or hands. The mechanism also should not operate in the direction of motion likely to be activated by the child. Some high chairs have tray release mechanisms on the underside of the tray that are operated by pulling the release lever in a direction away from the seat. If the child is able to kick this mechanism (even inadvertently) the tray may not remain engaged. Since a child may slide forward as far as the crotch restraint, the leg reach should be measured from this point. The mean crotch height for a two year old is over 13 inches and the mean crotch height for a three year old is over 15 inches. Mechanisms nearer than this may be reachable by foot. Locations that are reachable by hand depend on the degree of upper torso restraint provided by the tray and primary restraint system.

Swing-away tray: High chair trays could be designed to swing away from the front of the seat in order to permit easy access when removing the child from the seat. This would address one of the high chair incident scenarios in which the child pitched from the seat during a brief period in which the adult caregiver was placing the tray somewhere. The design would have to be such that the tray moves in the horizontal plane, in order to avoid spilling material that might be on the tray surface.

Tray underside: Children may push against the underside of the tray with their feet, which can provide leverage for moving up in the seat. Pushing on the tray could also conceivably contribute to tray failure. The underside of the tray should be smooth and offer no lips or protuberances against which the feet can push.

Leg Restraints

Leg opening dimensions: The dimensions of the leg openings may be defined by various product components, including passive crotch restraints, crotch straps, trays, and restraining bars.

The components may be rigid or flexible. The smaller the leg openings, the less latitude there is for leg movement and for drawing the knees in to the seating compartment. Leg openings are sometimes quite large relative to child leg dimensions. Larger openings may aid in placing the child in the seat or removing the child, but the leg openings should limit leg freedom. Vertically, the seated thigh depth for a mean four year old is 3.3 inches, and the maximum four year old is a little over 4 inches. Therefore the height of the opening should exceed this as little as possible, allowing for entry and egress during those phases of use. As an example, the width of a single thigh (using one-half the seated thigh width as a measure) for a mean four year old is about 4 inches, and the upper bound four year old is about 4.7 inches. Although the leg opening needs to accommodate the child's foot during placement or egress, a 4" high X 5" wide opening would provide a diagonal dimension of 6.4 inches. The foot length of three to four year olds is approximately six inches (without shoes), so even without flexion most feet would fit such an opening. The leg opening is generally treated as a two-dimensional aspect. However, to the extent that the upper surface is extended (e.g., a high chair tray) and the crotch restraint is back from the seat edge, there is also a linear dimension to the opening, at least in the forward direction. This dimension provides a further barrier to drawing back the knees. Providing a linear extent to the leg opening, perhaps even a short sleeve-like element, may improve the ability to restrict leg movement.

Minimize diagonal dimensions: Since children may be mobile within the seat, the area within which the legs are free to move should not be estimated based on the implicit assumption that the child is sitting in a forward facing position with the back against the seat back. The child may slide and pivot in the seat. Therefore, as discussed in Section 5.0 and illustrated in Figure 8, the appropriate dimension to consider is the diagonal corner-to-corner distance within the seating compartment volume. For example, if the child slides and pivots so that the hip is in the right rear corner of the seat and the legs are oriented toward the upper left leg opening, the diagonal dimension runs from the right rear corner of the seat to the upper left corner of the left leg opening. Since this is the largest dimension of which the child can take advantage, the seat compartment should be designed so as to minimize this dimension. Dimensions that exceed the rump-knee length of a child would allow the knees to be drawn up into the seat compartment if the child is appropriately oriented. This dimension is as small as 5.1 inches for the lower bound six month old and is 7.8 inches for the mean one year old. While these values are small relative to most current product dimensions, there is benefit to minimizing the linear diagonal to the extent possible.

Ankle stabilization: Although we believe that immobilization of the legs can be an effective tool in providing restraint, it is most effective when the seat pan and seat back are at a nearly right angle to each other. As the angle increases (e.g., as the back is laid down on a stroller bed) this effectiveness is likely to diminish as well. To simplify the analogy mechanically, this situation would be similar to restraining a cylinder lying on the stroller bed by placing a strap around the middle of it. One could imagine how ineffective this would be at preventing motion lengthwise within the bed area. Although quite unconventional (and perhaps controversial), one potentially effective method to provide better positional maintenance than waist straps would be to immobilize the ankles of very young (i.e., 3-6 months) users. If one or both of the child's ankles was immobilized, motion along the length of the stroller bed and perhaps even twisting or rolling could be eliminated. Obviously, such an alternative would require further analysis of hazards and effectiveness as well as user acceptability of such a restraint method.

Footholds

Eliminating Footrests and Pushing Surfaces: Surfaces that afford an opportunity for the child to push against with the feet allow the torso to be forced up through the seat belt. Footholds may also aid in twisting and turning efforts. Footrests are a primary concern in this regard. Since a footrest serves little useful purpose during the time a child is seated in a product, elimination should not lead to a great loss of functionality. If a footrest is in place on a product, the distance from the seat edge to the footrest should be long enough so that a child less than 18 months old could not easily reach it. This determination may be based on the relationship of the distance from the seat edge to the footrest versus the knee-sole length and also the distance from the crotch restraint to the footrest versus the crotch height. Although footrests are the most obvious features that provide a surface to push the feet against, any portion of the chair structure that can be pushed against is a concern, including cross-members, angled surfaces, wheels, and crotch barriers.

Stroller wheel guards. One function that may be served by the footrest on a stroller is to shield the feet (and possibly the hands) from contact with the stroller wheels. Since the footrest may be undesirable in affording a standing and pushing surface, it may be preferable to replace it with devices specifically designed to shield the wheels from feet and hands. The bearing surfaces should be eliminated to alleviate pushing.

Barriers

Pivoting restraint bar: Restraint bars analogous to those used on amusement rides may be viable alternatives to current passive (and perhaps active) restraints. U-shaped bars that pivot near the neckline and ratchet into a secure position with the base of the U resting on the thighs near the hips may be possible to not only immobilize the hips, but to hold the shoulders to some extent as well. T-shaped bars that pivot from under the seat may also be feasible. Such a bar could even serve as a climbing aid (i.e., ladder step) for older, unassisted high chair users to gain access to these products. Such bars could fold down out of the way for easy access/installation of the user and good securement of the hips and thighs when ratcheted into place. Rigid wings that fold in from the sides and join over the abdomen of the user to capture the hips, waist, and shoulders may be another alternative to current strap and passive restraint designs. Figure 11 illustrates some of these concepts. The common feature to these ideas is that a rigid folding barrier restricts the hips and other parts of the torso, rather than relying on a cylindrical belt. For high chairs and strollers, designs must not unduly limit the desired range of functional movement and must not introduce potential entrapment hazards.

Tray-mounted restraint: An integral restraint on the back of the feeding tray may improve containment of the center of gravity and help restrict rotating or leaning the actions. Figure 12 illustrates the concept. Such a mechanism on the back of the feeding tray would provide a higher (relative to the seat surface) barrier to forward motion without the need for shoulder straps. Such a surface would spread compression force over a larger area of the torso, allowing greater compression to be delivered to the front of the torso, thus holding the user more securely without excessive discomfort caused by more densely focused restraining forces. Concurrently, however, the child would be able to exert more force on the tray and chair using the same distribution of force.

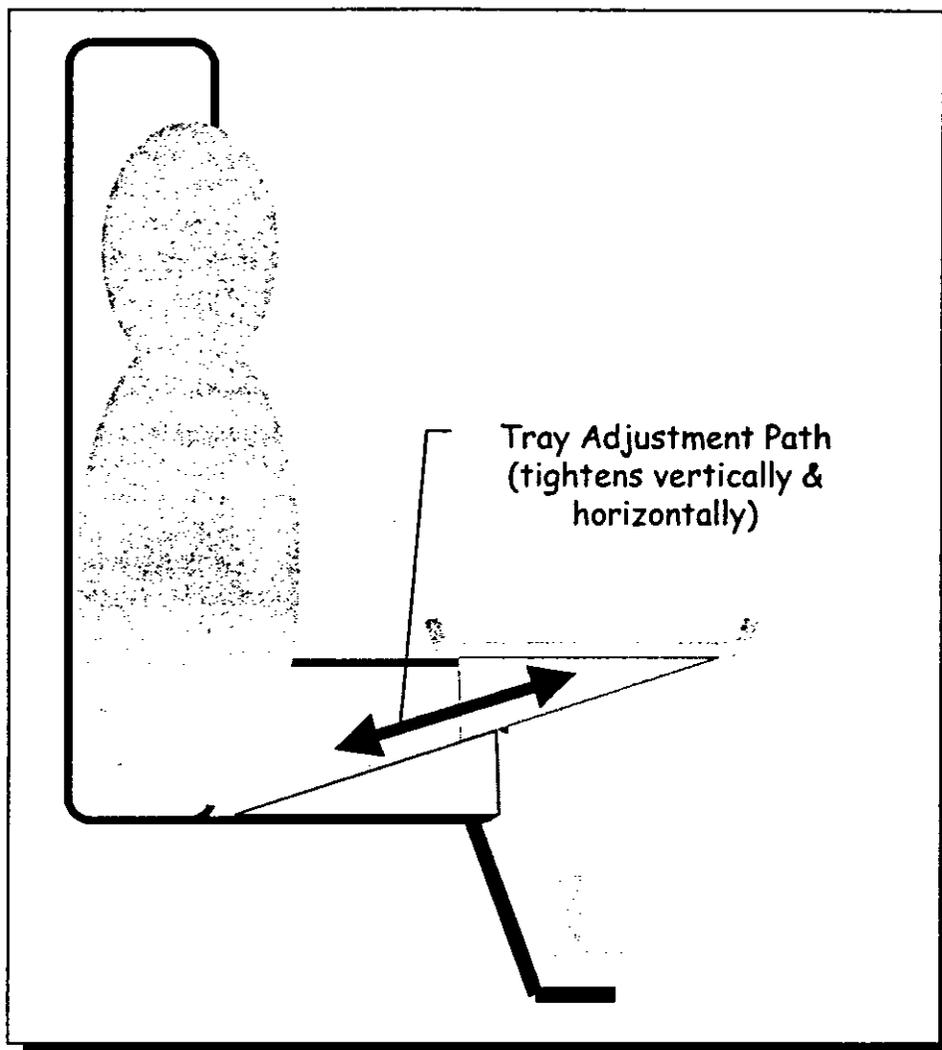


Figure 10. Design Concept for Tray that Slides Downward and Inward

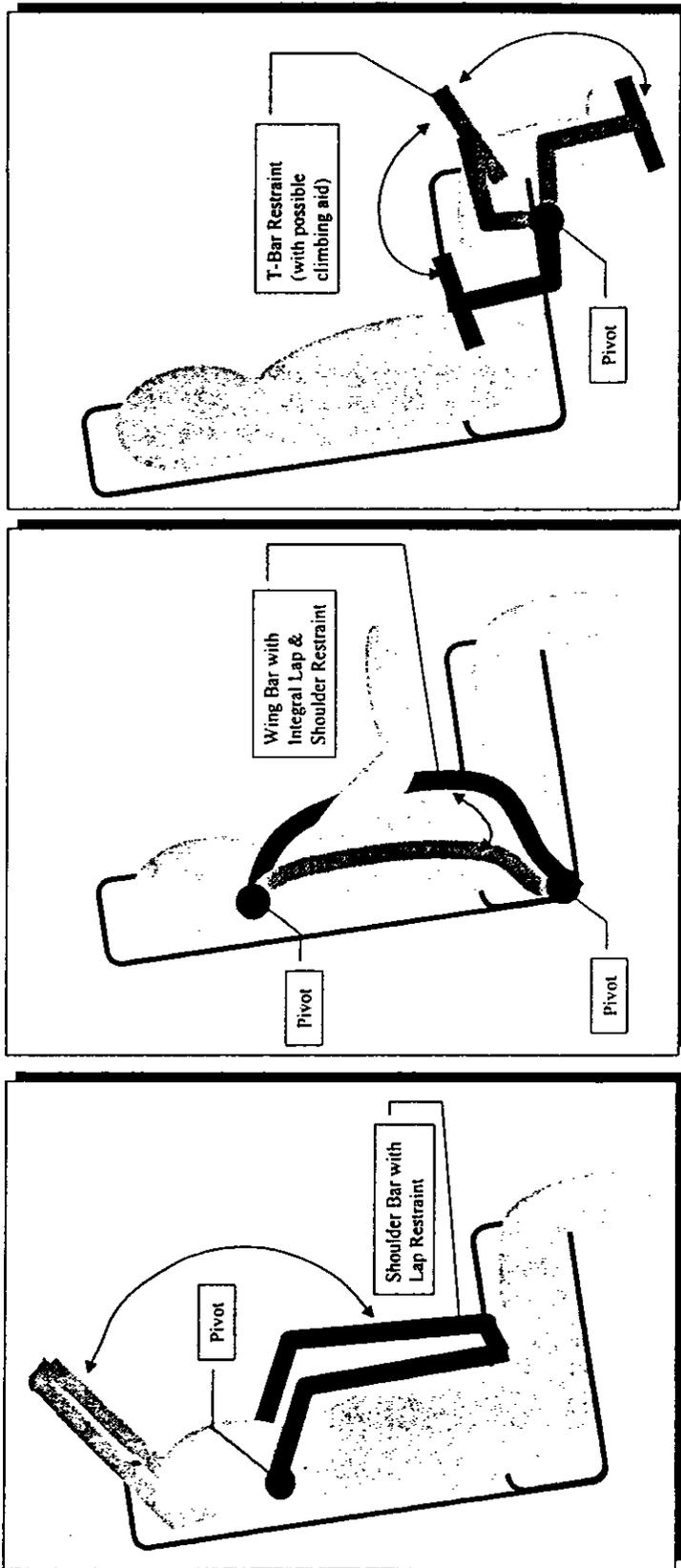


Figure 11. Design Concepts for Pivoting Restraint Bars

6.3 Standards and Testing

Based on the findings and conclusions of this report, we believe the following changes to standards and testing for high chair and stroller products should be considered. There currently exist an ASTM standard for each product type. The high chair standard is ASTM F 404-99a, *Standard Consumer Safety Specification for High Chairs*. The stroller standard is ASTM F 833-99, *Standard Consumer Safety Performance Specifications for Carriages and Strollers*. The recommendations presented here regarding standards and testing are organized around these existing standards documents.

6.3.1 Potential High Chair Standard Modifications:

- A new section should be added to Section 5 (General Requirements) relating to footholds.
 - Generally, this section should eliminate horizontal surfaces within reach of occupants' feet while sitting in the seat. Ninety fifth percentile 4-year old knee-sole length is 13.3 in. (338 mm). Thus, adequate separation of horizontal frame members and the seat front would be at least 15 in. (380 mm).
 - Wording for such a section could be as follows:
 - “Footholds accessible to occupants while sitting in the product shall be eliminated. Footrests shall not be provided. Horizontal frame members shall be at least 15 in. (380 mm) below the front edge of the seat.”
- Revise the amount of movement restriction during the tests described in Sections 9.8.4.1 (i.e., horizontal pull on one leg of the CAMI dummy) and 9.8.4.3 (i.e., vertical pull on the CAMI dummy), respectively.
 - It is recommended that a separation from either of these surfaces during tests analogous to those defined in Sections 9.8.4.1 and 9.8.4.3 should be less than 2 in. (5 cm).
 - The benchmarks of being able to pull the dummy horizontally “past the front edge of the seat” or upward with “the bottom of its feet touching or off the seat” are excessive.
 - ◆ Affording the motion necessary to reach either of these stages of release is contrary to the task of restraint.
 - ◆ Essentially, the level of restraint is analogous to the freedom of motion afforded to the hips of a restrained occupant and either of these metrics suggests hip motion of at least 6 inches (horizontally or vertically) from the seat and back surfaces.
 - ◆ Pull forces and recommended repetition patterns were not explored in depth, but seem adequate to test retention with the exception of the use of the CAMI dummy as the test probe.
- We believe the CAMI dummy is inadequate to effectively test the restraint performance of these (and perhaps other) products.
 - The CAMI dummy possesses soft legs with no stiffening skeletal structure like that of a child, making both of these requirements/tests inappropriate for assessment of the adequacy of the restraint system to perform satisfactorily.
 - ◆ Although the CAMI provides analogous dimensions and weight, it does not simulate bending and rotational capabilities of a child.
 - ◆ Children’s ability to bend and rotate are crucial in evaluating their ability to overcome various active and passive restraint means.

- ◆ A dummy design that possesses stiff thigh analogs should be considered to replace the CAMI.
 - ◆ Actual dimensions of such a replacement should be researched.
 - ◆ It may be feasible to create such a dummy design that simulates only the lower torso and thighs with necessary attachment points to perform the necessary tests.
 - One could envision a “part task” dummy that could be constructed from PVC pipe and common fasteners to fulfill this test role and more adequately test restraint means.
 - ◆ A report by Lee, Breeze, Bird, and Page (1994) suggests a design for an alternative (and much cheaper) dummy design.
 - It is recommended that this design not be used due to a key flaw in its composition. The dummy lacks an analog to thighs that play a significant role in the ability to provide restraint, especially to those occupants deliberately trying to escape.
- Based on feedback from consumers (Lerner et. al, 2001), Section 6.8.5 should be modified to include a caveat allowing deliberate detachment of the restraint for cleaning purposes.
 - Inability to adequately clean restraint components may lead to deliberate and irreversibly permanent removal of those components for sanitary or aesthetic reasons, whereas allowing temporary removal and re-installation could avert such situations.
 - Possible wording might be, “Owner removal and re-installation may be allowed. Intuitive attachment means shall be provided to avoid incorrect installation.”
 - Section 6.9.1.1(2) defines a maximum distance for the minimum adjustment point of the passive crotch restraint that is unnecessarily excessive (i.e., 8.5 in. [216 mm]). That is, passive crotch restraints need not get closer to the seat back than 8.5 inches to be acceptable.
 - This 8.5 inch-dimension is independently adequate to afford easy ability for children at the lower end of the at-risk age range to pull legs and feet into the seat area.
 - This restriction should be modified to provide better restriction of leg position (i.e., to prohibit pulling them into the seat area).
 - With torso depth varying between ~5 and 7 inches, the passive crotch restraint should be positioned to minimize these affordances. In fact, thigh length of 6-month old users may be approximately 5 inches as well.
 - Wording of this section should be modified as follows:
 - ◆ “Adjust the seat back to the most upright position and the passive crotch restraint to the position closest to the seat back. The distance between the front surface of the non-compressed seat back and passive crotch restraint shall be less than 5 in. (127 mm) when measured horizontally 2.0 in. (50 mm) above the lowest point on the non-compressed seating surface.”
 - ◆ This distance may be too small for the largest intended users. Manufacturers may choose to provide adjustability to greater distances to accommodate them.
 - Section 6.9.1.1 should not allow adherence to either 6.9.1.1(2) or 6.9.1.1(3). Both specifications should be enforced for all products in this category.
 - The implication in the specification is, “if the passive crotch restraint is too far away from the seat back, the manufacturer may provide leg openings that restrict what passes through them.”
 - ◆ This implied intent is insensitive to the problem of children pulling legs into the seat area and then standing and/or falling from the product.

- Assuming that the recommendation to eliminate footrests from these designs, Section 9.7.2 should be modified accordingly. The remaining text should be as follows:
 - “Gradually apply the static load of 40 lbf (178 N) to the forward most horizontal frame member.”
- Addition of a section that limits seat dimensions should be considered.
 - Such a section should not only deal with the basic width and depth of the seat, but the effective size as a function of the passive restraint position.

6.3.2 Potential Stroller Standard Modifications

- It is recommended that the CAMI dummy be replaced with a more appropriate dummy analog (i.e., with stiff thigh members) as described for the high chair standard.
- Section 7.5.2.1 describes a horizontal pull test for occupant retention.
- Unlike the high chair analogy (Sections 9.8.4.3 and 9.8.4.4 of ASTM F404-99A), there is no test for vertical release other than the pitching rotation tests described in Sections 7.5.2.5 through 7.5.2.7.
 - It is recommended that a vertical release test be implemented for this product as well. Wording similar to the high chair analogy should be appropriate.
 - This test should be inserted between Sections 7.5.2.3 and 7.5.2.4 and may read as follows:
 - ◆ “7.5.2.4 Apply a pull force that is 45 lbf (200 N) greater than the weight of the dummy vertically upwards in line with the approximate centerline of the dummy’s torso. Gradually apply the force within 5 s and maintain for an additional 10 s.”
 - ◆ “7.5.2.5 Repeat 7.5.2.4 four times with a maximum interval of 2 s between tests.”
 - ◆ Sections 7.4.2.4 through 7.5.2.8 should be renumbered accordingly.
- A new section (perhaps Section 5.8) should be added to Section 5 (General Requirements) relating to footholds.
 - Generally, this section should eliminate horizontal surfaces within reach of occupants’ feet while sitting in the seat. Ninety-fifth percentile 4-year old knee-sole length is 13.3 in. (338 mm). Thus, adequate separation of horizontal frame members and the seat front would be at least 15 in. (380 mm).
 - Although preventing contact with wheels or the ground is desirable, no need for a footrest is justified while sitting in the product.
 - Wording for such a section could be as follows:
 - ◆ “Footholds accessible to occupants while sitting in the product shall be eliminated. Footrests shall not be provided. Horizontal frame members shall be shielded to eliminate footholds within 15 in. (380 mm) below the front edge of the seat.”

7. CONCLUSIONS

Based on the analysis provided in this report, we believe that the problems of high chair and stroller restraint system failure are amenable to treatment. Primary restraint belts may be improved to better restrain children or to foster more consistent and appropriate use by adult caregivers. However belt modification by no means appears to be the entire solution, given child anthropometry, child behavior, and the need to maintain much broader functional aspects of the product than simply providing restraint. Five-point restraint systems, in particular, are of interest because they are increasingly seen on products. Their benefit is questionable for several of the common incident scenarios, although no data on this were available. Five-point restraints may help to some degree but are unlikely to be a reliable fix because the shoulder straps may not be highly resistant to intentional escape efforts. However there are a variety of additional countermeasures that appear to be worthy of consideration that are described within this document. In addition to restraint strap configuration and anchorage points, potential targets in terms of product design include the seat compartment dimensions, crotch restraints, trays, leg restraints, footholds, and barriers.

Whatever countermeasure approach is pursued, the key to successfully addressing the problem is to recognize that there are critical movements that must be executed to accomplish an escape and that a product and restraint system may afford the opportunity for a given action to be executed to varying degrees. These opportunities for key child actions should be denied to the extent possible. A child may use a variety of product features in overcoming restraints, and restraint effectiveness likewise requires consideration of the entire product as a restraint system, not just the primary restraint components.

Current standards and testing have certainly reduced the number and severity of various safety-related mishaps for strollers and high chairs. However, in addition to design considerations on the part of product manufacturers, we believe that standards and testing of these products may be improved to provide better assessment of restraint effectiveness.

8. BIBLIOGRAPHY

Lee, V., Breeze, R., Bird, R., & Page, M. (1994). *Child Restraints for Nursery Goods: Pushchairs*. Report to the Consumer Safety Unit, U.K. Department of Trade and Industry. Leicestershire, U.K.: Research Institute for Consumer Ergonomics, Loughborough University of Technology.

Lerner, N., Huey, R., & Kotwal, B. (2001). *Product Profile Report*. Interim Report under Contract CPSC-S-00-5205. Washington, DC: U.S. Consumer Product Safety Commission.

Schneider, L., Lehman, R., Pflug, M., & Owings, C. (1986). *Size and Shape of the Head and Neck from Birth to Four Years*. . Report UMTRI-86-2. Ann Arbor, Michigan: The University of Michigan Transportation Research Institute.

Snyder, R., Schneider, L., Owings, C., Reynolds, H., Golomb, D., & Schork, M. (1977). *Anthropometry of Infants, Children, and Youths to Age 18 for Product Safety Design*. Report UM-HSRI-BI-77-17. Ann Arbor, Michigan: The University of Michigan, Highway Safety Research Institute.

Snyder, R. Spencer, M., Owings, C., & Schneider, L. (1975). *Physical Characteristics of Children As Related to Death and Injury for Consumer Product Design*. Report UM-HSRI-BI-75-5. Ann Arbor, Michigan: The University of Michigan, Highway Safety Research Institute.

Weber, K., Lehman, R., & Schneider, L. (1985). *Child Anthropometry for Restraint System Design*. Report UMTRI-85-23. Ann Arbor, Michigan: The University of Michigan Transportation Research Institute.

9. APPENDICES

Four appendices are attached to this report. They are:

Appendix A: Product Samples Reviewed

Appendix B: Coding Form for Product and Restraint System Measurements

Appendix C: Database of Sample Product Dimensions and Restraint Configurations

Appendix D: Adult Caregiver Factors Related to Nonuse or Misadjustment of Restraint System Features

APPENDIX A:

PRODUCT SAMPLES REVIEWED

Product Samples Reviewed and Associated CPSC In-Depth Investigations

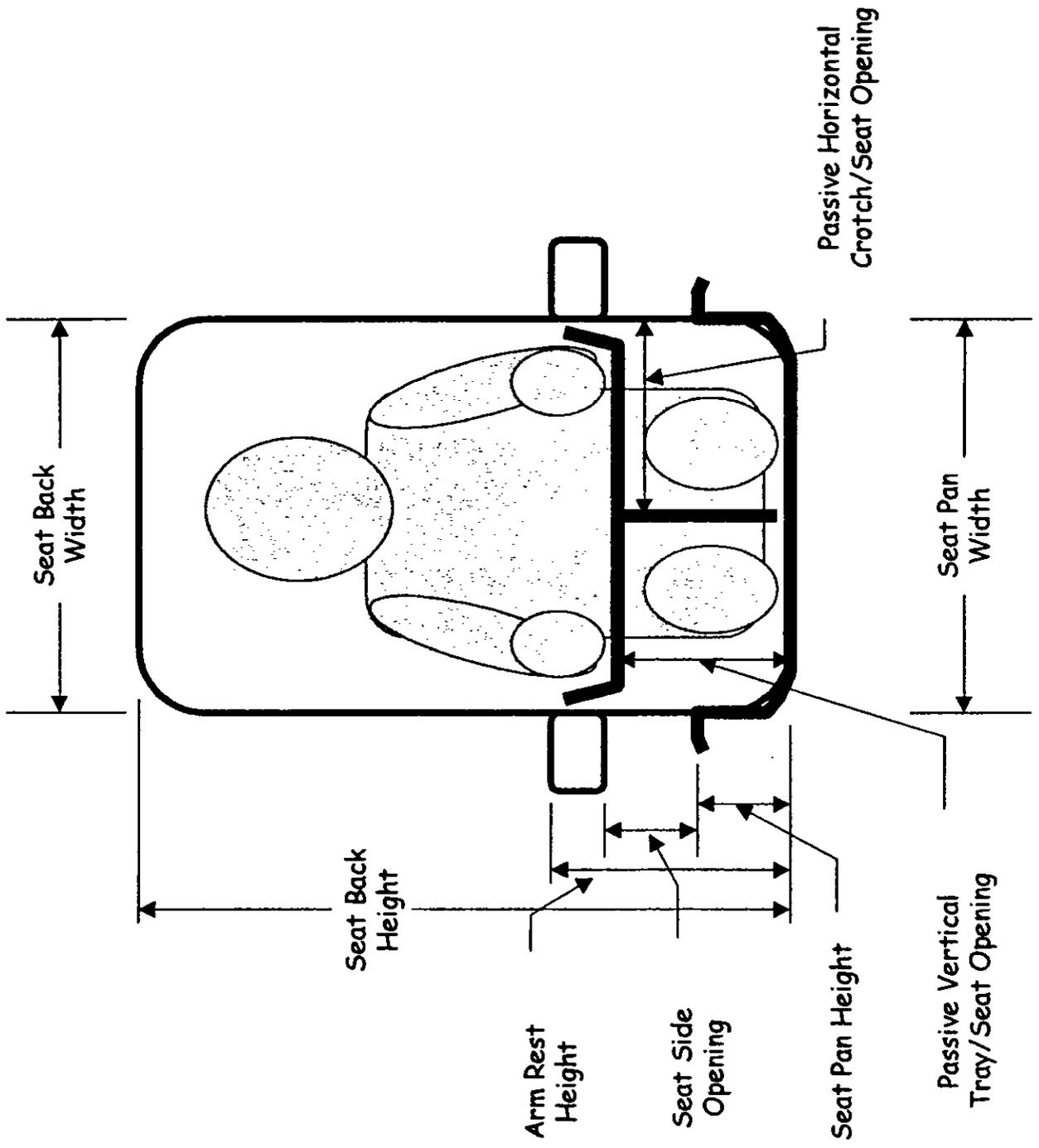
| Product | Sample # | Associated Report |
|--------------------|------------------------|--------------------------|
| Strollers | | |
| [REDACTED] | 00-860-6012 | 000210HCC3157 |
| | 00-860-6140 | 000824HAA3392 |
| | 00-830-3852 | 000901HAA2795 |
| | 00-860-6189 | 000824HAA3393 |
| | 00-800-2347 | 000907HAA0014 |
| | 01-810-3651 | 000927HAA0082 |
| | 01-830-4526 | 001011HAA2022 |
| | 01-830-5076 | 001011HCC2028 |
| | 01-840-6672 | 010102HAA3124 |
| | ----- | No associated incident |
| High Chairs | | |
| [REDACTED] | 00-800-2913 | 000620HBB0771 |
| | 00-830-5353 | 000615HBB2620 |
| | 99-830-3431 | 980926CCC2854 |
| | 01-810-3302 | 001012HAA0035 |
| | 01-840-6272 | 001129HAA3081 |
| | 01-830-4119 | 001130HAA2120 |
| | 01-830-4120 | 001207HAA2134 |
| | 01-830-6672 | 010103HAA2170 |
| | ----- | No associated incident |
| ----- | No associated incident | |

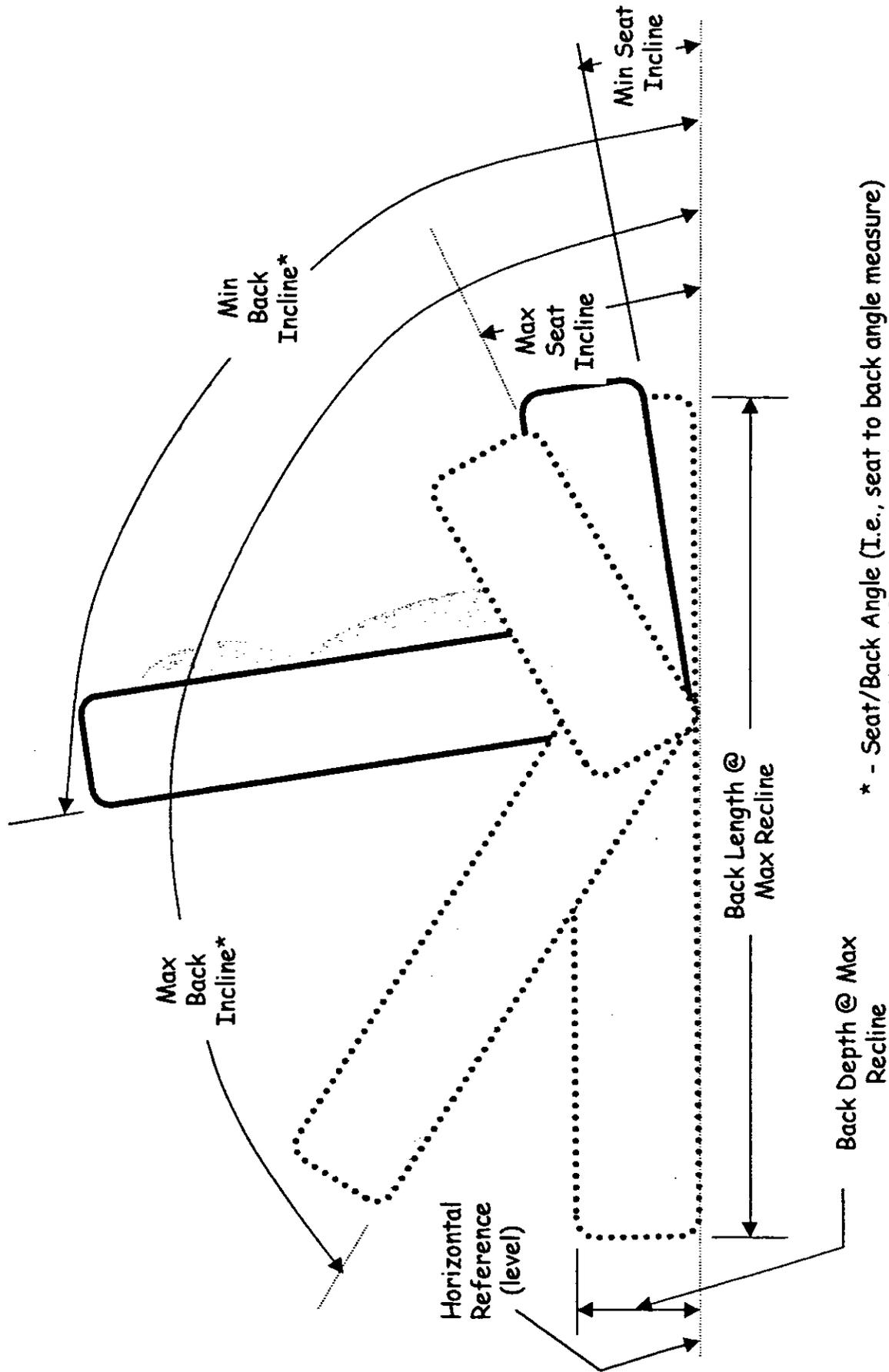
APPENDIX B:

**PRODUCT AND RESTRAINT
SYSTEM MEASUREMENTS**

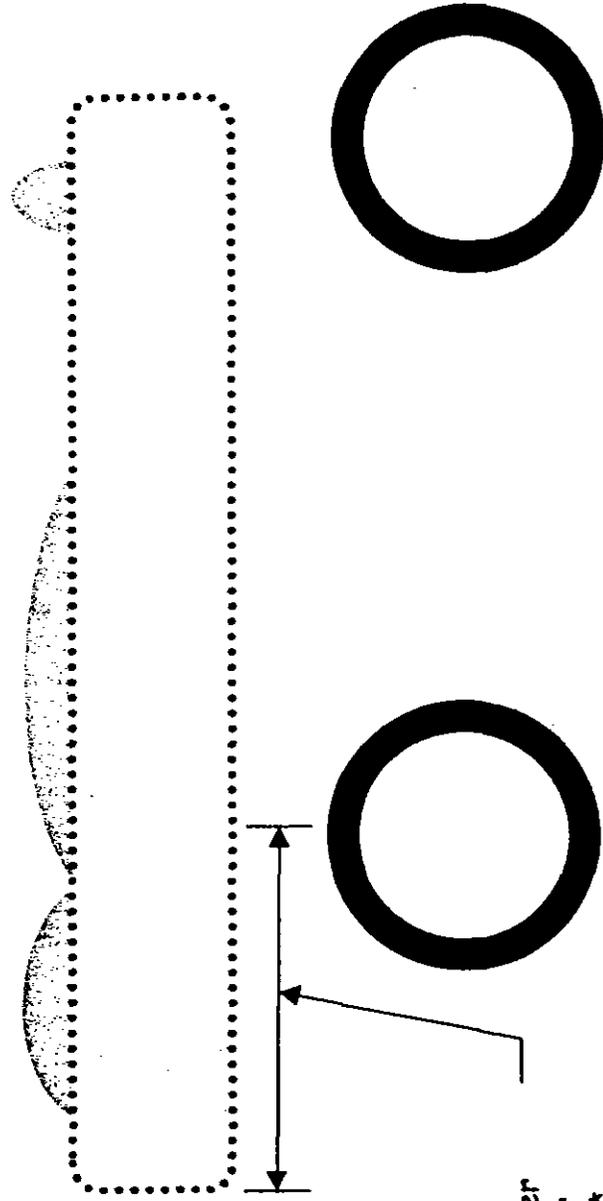
Measurement of Stroller and High Chair Task Analysis Dimensions

- Stroller or High Chair?
- Make: _____
- Model: _____
- Sample ID: _____
- Coder: _____
- Coding Date: ___/___/___



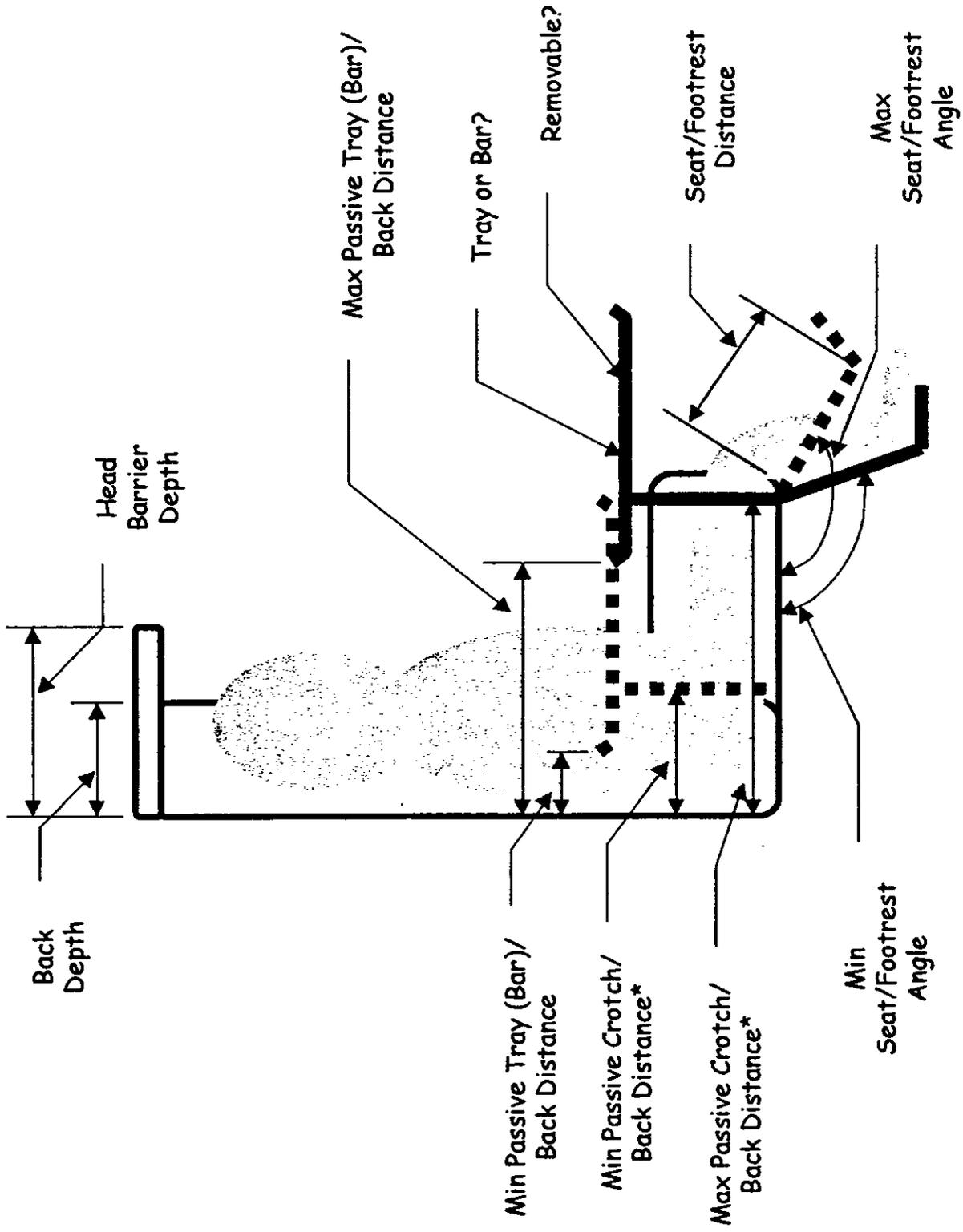


* - Seat/Back Angle (I.e., seat to back angle measure) can be deduced from captured measures.

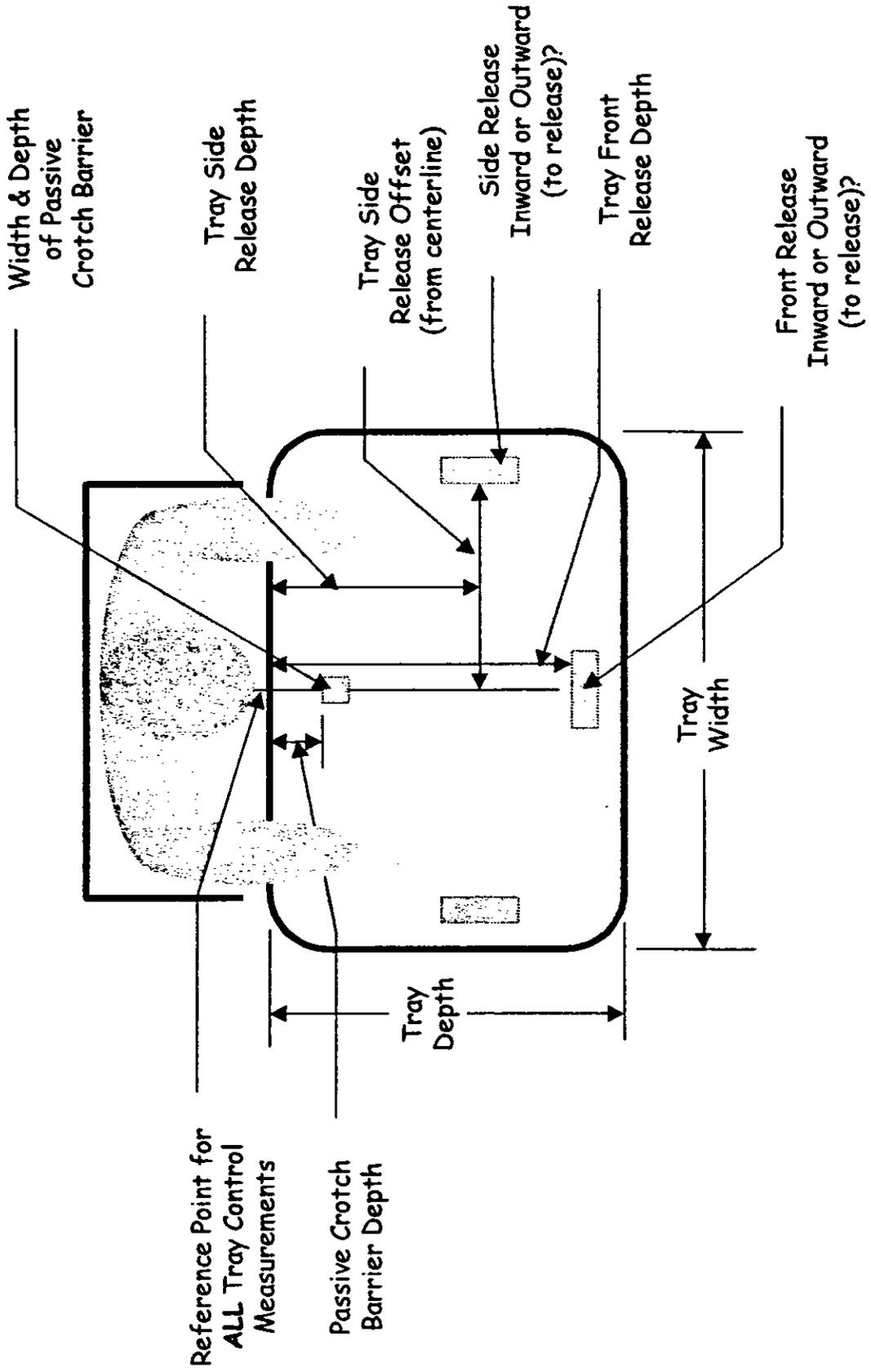


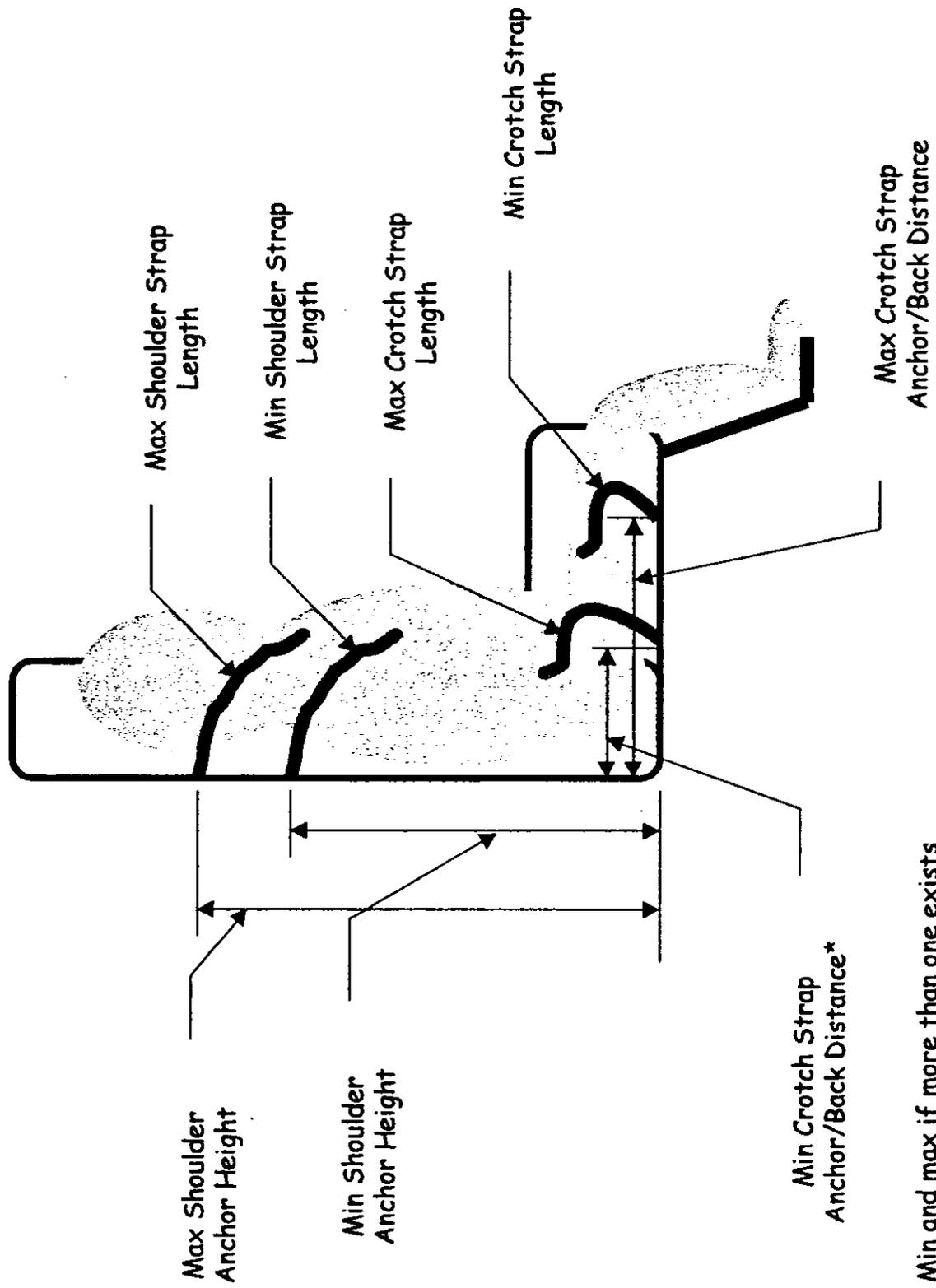
Back Barrier
Cantilever
Extension*

* - Positive if it extends only between wheels.
Negative if it extends beyond the wheels.

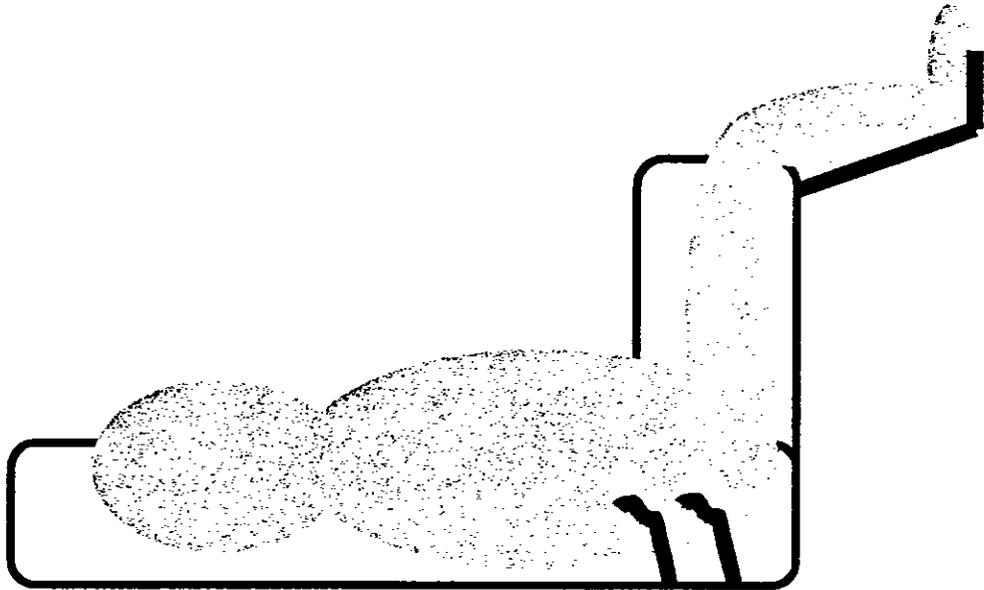


* - measured ~2" above seat



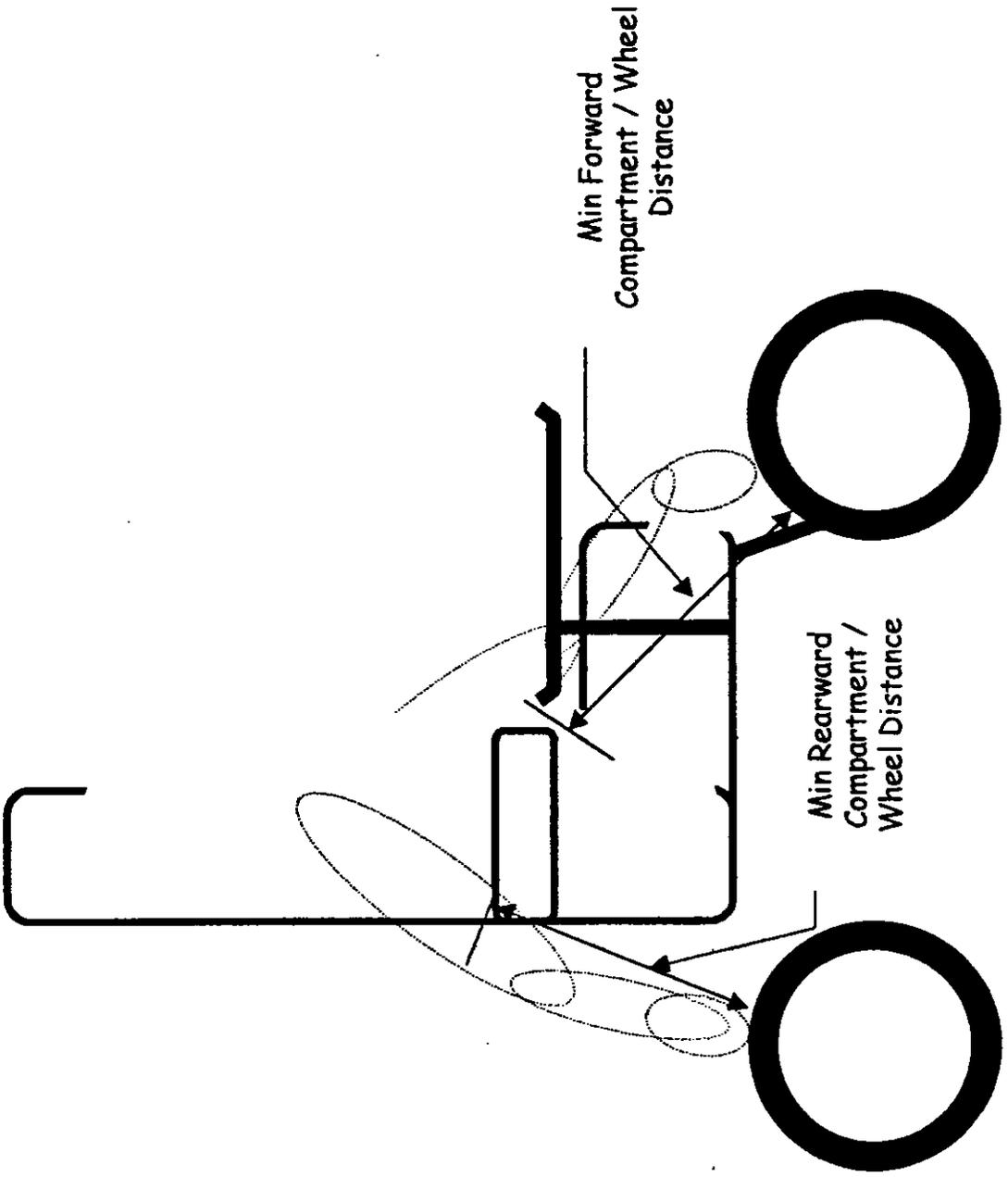


* - Min and max if more than one exists



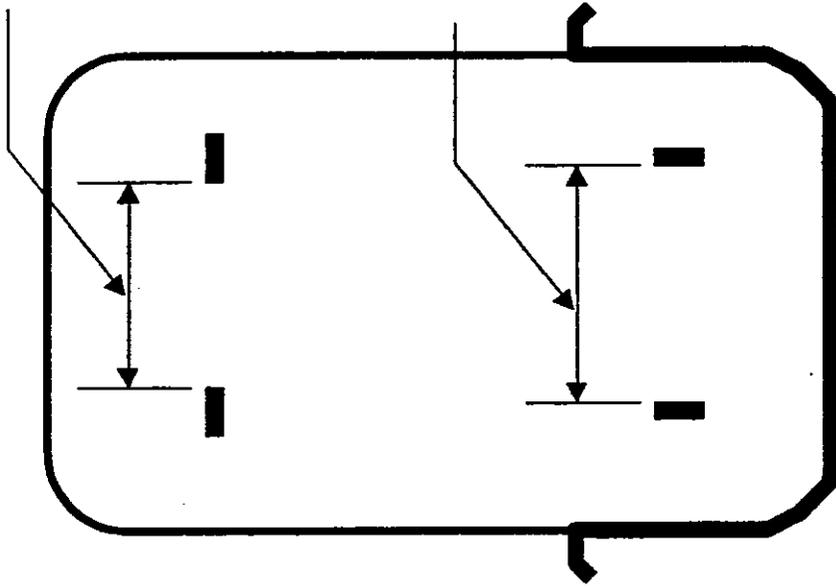
Max Waist Belt
Anchor Height

Min Waist Belt
Anchor Height

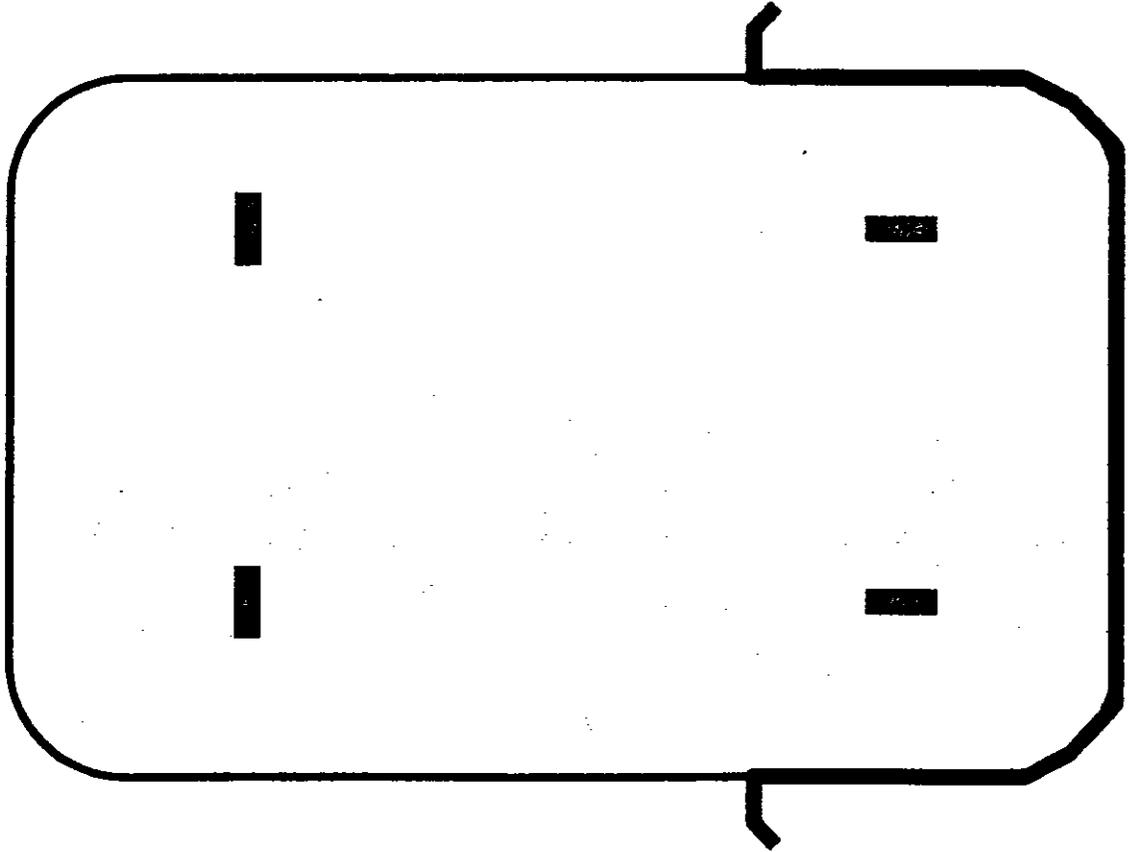


Shoulder Strap Anchor
Separation

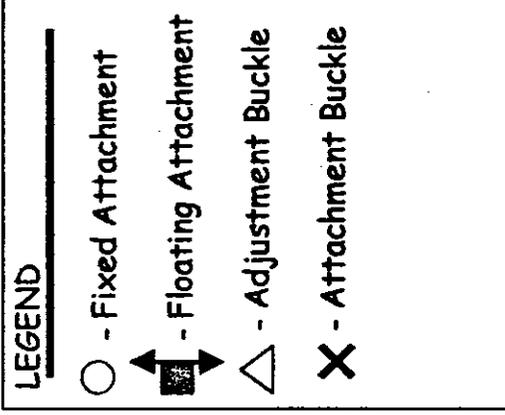
Waist Belt Anchor
Separation



Belt Characterization (shape)

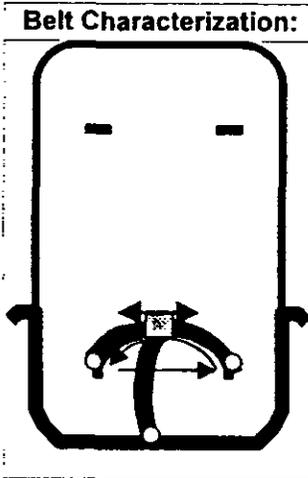


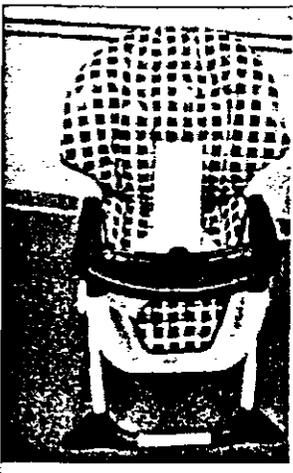
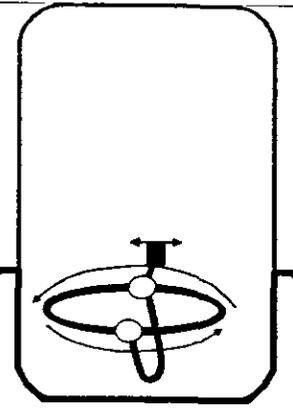
- Max Waist Belt Circumference (combine strap length plus anchor separation)
- Min Waist Belt Circumference (combine strap length plus anchor separation)

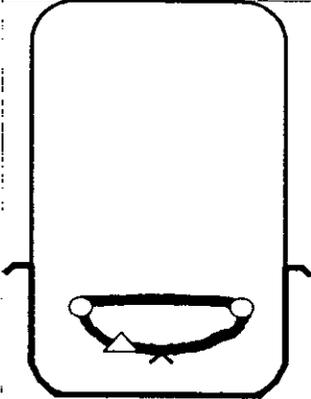


APPENDIX C:

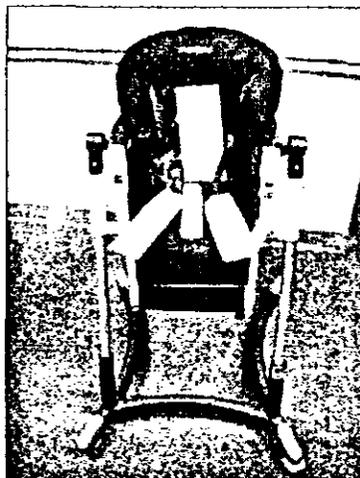
**DATABASE OF SAMPLE PRODUCT DIMENSIONS
AND RESTRAINT CONFIGURATIONS**

| | | | | | |
|--|-------------------------------------|--|-----------------------------------|---|-------|
| Stroller | 1 |  | | Belt Characterization: | |
| Sample ID: | 01-830-4526 | | |  | |
| Make: | | | | | |
| Model: | | | | | |
| Back Depth | 10 | | | | |
| Seat Back Width | 13 (inside) | | | | |
| Seat Back Height | 17 | | | | |
| Seat Width | 13.25 | | | | |
| Seat Pan Height | 11 | | | | |
| Arm Rest Height | 7 | | | | |
| Seat Side Opening | | | | | |
| Leg Opening (Vertical / Horizontal) | 7 / | Head Barrier Depth: | 5 | | |
| | | Cantilever Extension: | -5.5 | | |
| Seat/Back Angle (Min / Max) | 150 / 130 (between 90 and 180 deg.) | Seat Incline (Min / Max) | 20 / 20 (between 0 and 90 deg.) | | |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | 65 / 65 (between 90 and 180 deg.) | | |
| Back Length: | 29.75 | Seat Footrest Distance: | 7 | | |
| Back Depth: | 12 | | | | |
| Removable? <input checked="" type="checkbox"/> | | Crotch Barrier: | | Shoulder Strap | |
| Distance to Back (Min / Max) | 12 / 13.5 | Distance to Back (Min / Max) | | Length (Min / Max) | |
| Angle (Min / Max) | 70 / 70 | Depth from Tray Back: | | Anchor Height (Min / Max) | |
| Width: | 16 | Size of Bar (Depth / Width): | | Anchor Separation (Min / Max) | |
| Depth | 4.75 | | | | |
| Side Release? | | Crotch Strap | | Waist Belt | |
| Depth: | 4 | Length (Min / Max) | 8.5 / 8.5 | Anchor Height (Min / Max) | 0 / 0 |
| Offset: | | Anchor to Back (Min / Max) | 4 / 4 | Anchor Separation: | 8.5 |
| Front Release? no | | | | Circumference (Min / Max) | |
| Depth: | | | | | |
| Minimum Rearward Compartment/Wheel Distance: | 18 | | | | |
| Minimum Forward compartment/Wheel Distance: | 17.75 | | | | |
| Stroller Side Release? | -7 | | | | |

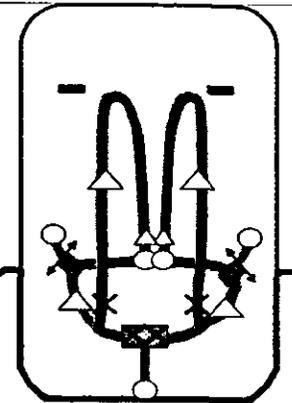
| | | | |
|--|--|--|--|
| High Chair | 2 |  | Belt Characterization:  |
| Sample ID: | 01-830-4435 | | |
| Make: | | | |
| Model: | | | |
| Back Depth | 0 | | |
| Seat Back Width | 12.5 (inside) | | |
| Seat Back Height | 19 | | |
| Seat Width | 10.5 | | |
| Seat Pan Height | 6 | | |
| Arm Rest Height | 6 | | |
| Seat Side Opening | | | |
| Leg Opening (Vertical / Horizontal) | 5 / 5 | Head Barrier Depth: | |
| | | Cantilever Extension: | |
| Seat/Back Angle (Min / Max) | 110 / 135 (between 90 and 180 deg.) | Seat Incline (Min / Max) | 10 / 33 (between 0 and 90 deg.) |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | 80 / 80 (between 90 and 180 deg.) |
| Back Length: | | Seat Footrest Distance: | 5.25 |
| Back Depth: | 4 | | |
| Snack Tray | Removable? <input checked="" type="checkbox"/> | Crotch Barrier: | Shoulder Strap |
| Distance to Back (Min / Max) | 6.75 / 12.5 | Distance to Back (Min / Max) | 8.5 / 8.5 |
| Angle (Min / Max) | 3 / 28 | Depth from Tray Back: | 4.5 |
| Width: | 25 | Size of Bar (Depth / Width): | 1 / 1.5 |
| Depth | 12.5 | Crotch Strap | Length (Min / Max) |
| Side Release? yes | | Length (Min / Max) | 13 / |
| Depth: | 2.5 | Anchor to Back (Min / Max) | 0 / 0 |
| Offset: | 10.5 | | |
| Front Release? inward | | Waist Belt | Anchor Height (Min / Max) |
| Depth: | 13 | | 3 / 3 |
| | | | Anchor Separation: |
| | | | 0 |
| | | | Circumference (Min / Max) |
| | | | 0 / 29 |
| Minimum Rearward Compartment/Wheel Distance: | | | |
| Minimum Forward compartment/Wheel Distance: | | | |
| Stroller Side Release? | 0 | | |

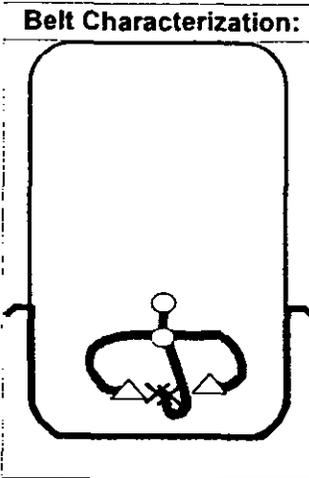
| | | | |
|---|---|--|--|
| Stroller | <input type="text" value="3"/> |  | Belt Characterization:  |
| Sample ID: | <input type="text" value="00-860-6140"/> | | |
| Make: | <input type="text" value=""/> | | |
| Model: | <input type="text" value=""/> | | |
| Back Depth | <input type="text" value="0"/> | | |
| Seat Back Width | <input type="text" value="12"/> (inside) | | |
| Seat Back Height | <input type="text" value="20.25"/> | | |
| Seat Width | <input type="text" value="14.25"/> | | |
| Seat Pan Height | <input type="text" value=""/> | | |
| Arm Rest Height | <input type="text" value="6.5"/> | | |
| Seat Side Opening | <input type="text" value=""/> | | |
| Leg Opening (Vertical / Horizontal) | <input type="text" value="7.75"/> / <input type="text" value="5"/> | Head Barrier Depth: | <input type="text" value="8"/> |
| | | Cantilever Extension: | <input type="text" value="-3"/> |
| Seat/Back Angle (Min / Max) | <input type="text" value="111"/> / <input type="text" value="160"/> (between 90 and 180 deg.) | Seat Incline (Min / Max) | <input type="text" value="7"/> / <input type="text" value="7"/> (between 0 and 90 deg.) |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | <input type="text" value="97"/> / <input type="text" value="180"/> (between 90 and 180 deg.) |
| Back Length: | <input type="text" value="22.5"/> | Seat Footrest Distance: | <input type="text" value="6.75"/> |
| Back Depth: | <input type="text" value="6.5"/> | | |
| Bar | <input type="checkbox"/> Removable? | Crotch Barrier: | Shoulder Strap |
| Distance to Back (Min / Max) | <input type="text" value="17"/> / <input type="text" value="20.5"/> | Distance to Back (Min / Max) | Length (Min / Max) |
| Angle (Min / Max) | <input type="text" value="0"/> / <input type="text" value="0"/> | Depth from Tray Back: | <input type="text" value="0"/> / <input type="text" value="0"/> |
| Width: | <input type="text" value="0"/> | Size of Bar (Depth / Width): | <input type="text" value="0.25"/> / <input type="text" value="3"/> |
| Depth | <input type="text" value="0"/> | Crotch Strap | Anchor Separation (Min / Max) |
| Side Release? | <input type="checkbox"/> | Length (Min / Max) | <input type="text" value="0"/> / <input type="text" value="0"/> |
| Depth: | <input type="text" value="0"/> | Anchor to Back (Min / Max) | <input type="text" value="0"/> / <input type="text" value="0"/> |
| Offset: | <input type="text" value="0"/> | | |
| Front Release? | <input type="checkbox"/> | | Waist Belt |
| Depth: | <input type="text" value="0"/> | | Anchor Height (Min / Max) |
| | | | <input type="text" value="0"/> / <input type="text" value="0"/> |
| | | | Anchor Separation: |
| | | | <input type="text" value="4.5"/> |
| | | | Circumference (Min / Max) |
| Minimum Rearward Compartment/Wheel Distance: | <input type="text" value="17.5"/> | | <input type="text" value="11.5"/> / <input type="text" value="29.5"/> |
| Minimum Forward compartment/Wheel Distance: | <input type="text" value="17"/> | | |
| Stroller Side Release? | <input type="text" value="no"/> | | |

| | | | |
|--|---|---|---|
| High Chair | <input type="text" value="4"/> | | |
| Sample ID: | <input type="text" value="01-830-4119"/> | | |
| Make: | <input type="text" value=""/> | | |
| Model: | <input type="text" value=""/> | | |
| Back Depth | <input type="text" value="0"/> | | |
| Seat Back Width | <input type="text" value="16.25"/> | (inside) | |
| Seat Back Height | <input type="text" value="16.5"/> | | |
| Seat Width | <input type="text" value="11.5"/> | | |
| Seat Pan Height | <input type="text" value=""/> | | |
| Arm Rest Height | <input type="text" value="7.5"/> | | |
| Seat Side Opening | <input type="text" value=""/> | | |
| Leg Opening (Vertical / Horizontal) | <input type="text" value="6"/> / <input type="text" value="5"/> | Head Barrier Depth: | <input type="text" value=""/> |
| | | Cantilever Extension: | <input type="text" value=""/> |
| Seat/Back Angle (Min / Max) | <input type="text" value="100"/> / <input type="text" value="130"/> | (between 90 and 180 deg.) | Seat Incline (Min / Max) |
| | | | <input type="text" value="10"/> / <input type="text" value="35"/> |
| | | | (between 0 and 90 deg.) |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | |
| Back Length: | <input type="text" value=""/> | <input type="text" value="100"/> / <input type="text" value="100"/> | (between 90 and 180 deg.) |
| Back Depth: | <input type="text" value=""/> | Seat Footrest Distance: | <input type="text" value="7"/> |
| Tray | Removable? <input checked="" type="checkbox"/> | Crotch Barrier: | Shoulder Strap |
| Distance to Back (Min / Max) | <input type="text" value="8"/> / <input type="text" value="11"/> | Distance to Back (Min / Max) | Length (Min / Max) |
| | | <input type="text" value="8"/> / <input type="text" value=""/> | <input type="text" value="9.25"/> / <input type="text" value="17.5"/> |
| Angle (Min / Max) | <input type="text" value="0"/> / <input type="text" value="120"/> | Depth from Tray Back: | Anchor Height (Min / Max) |
| | | <input type="text" value="2.75"/> | <input type="text" value="1"/> / <input type="text" value="1"/> |
| Width: | <input type="text" value="23"/> | Size of Bar (Depth / Width): | Anchor Separation (Min / Max) |
| Depth | <input type="text" value="15.5"/> | <input type="text" value="1.5"/> / <input type="text" value="1.75"/> | <input type="text" value="10"/> / <input type="text" value="10"/> |
| Side Release? <input type="checkbox"/> no | | Crotch Strap | |
| Depth: | <input type="text" value=""/> | Length (Min / Max) | Waist Belt |
| Offset: | <input type="text" value=""/> | <input type="text" value="6.75"/> / <input type="text" value="6.75"/> | Anchor Height (Min / Max) |
| Front Release? <input type="checkbox"/> Outward | | Anchor to Back (Min / Max) | <input type="text" value=""/> / <input type="text" value="0"/> |
| Depth: | <input type="text" value="10.5"/> | <input type="text" value="6"/> / <input type="text" value=""/> | Anchor Separation: |
| | | | <input type="text" value="9.5"/> |
| Minimum Rearward Compartment/Wheel Distance: | <input type="text" value=""/> | Circumference (Min / Max) | <input type="text" value="23.5"/> / <input type="text" value="32.5"/> |
| Minimum Forward compartment/Wheel Distance: | <input type="text" value=""/> | | |
| Stroller Side Release? | <input type="text" value=""/> | | |



Belt Characterization:

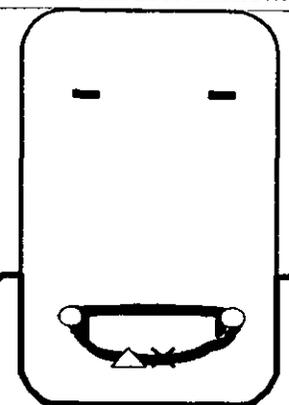


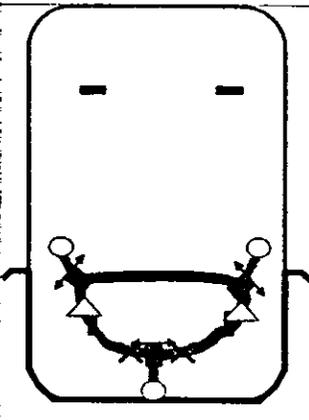
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|--|--|--|---|--|
| High Chair | 5 |  | Belt Characterization: | |
| Sample ID: | 99-830-3431 | |  | |
| Make: | | | | |
| Model: | | | | |
| Back Depth | 0 | | | |
| Seat Back Width | 16.75 (inside) | | | |
| Seat Back Height | 19 | | | |
| Seat Width | 12.5 | | | |
| Seat Pan Height | | | | |
| Arm Rest Height | 5.5 | | | |
| Seat Side Opening | 1.25 | | | |
| Leg Opening (Vertical / Horizontal) | | Head Barrier Depth: | | |
| | / | Cantilever Extension: | | |
| Seat/Back Angle (Min / Max) | | Seat Incline (Min / Max) | | |
| 100 / 100 (between 90 and 180 deg.) | | 5 / 5 (between 0 and 90 deg.) | | |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | | |
| Back Length: | | 90 / 90 (between 90 and 180 deg.) | | |
| Back Depth: | | Seat Footrest Distance: | 6 | |
| Tray | Removable? <input checked="" type="checkbox"/> | Crotch Barrier: | Shoulder Strap | |
| Distance to Back (Min / Max) | | Distance to Back (Min / Max) | Length (Min / Max) | |
| 7 / 9 | | | | |
| Angle (Min / Max) | | Depth from Tray Back: | Anchor Height (Min / Max) | |
| 0 / 0 | | | | |
| Width: | 23.5 | Size of Bar (Depth / Width): | Anchor Separation (Min / Max) | |
| Depth | 12.5 | | | |
| Side Release? | | Crotch Strap | Waist Belt | |
| Depth: | 4 | Length (Min / Max) | Anchor Height (Min / Max) | |
| Offset: | 9.75 | 12 / 12 | | |
| Front Release? Outward | | Anchor to Back (Min / Max) | Anchor Separation: 0 | |
| Depth: | | | Circumference (Min / Max) | |
| Minimum Rearward Compartment/Wheel Distance: | | | 8 / 28 | |
| Minimum Forward compartment/Wheel Distance: | | | | |
| Stroller Side Release? | | | | |

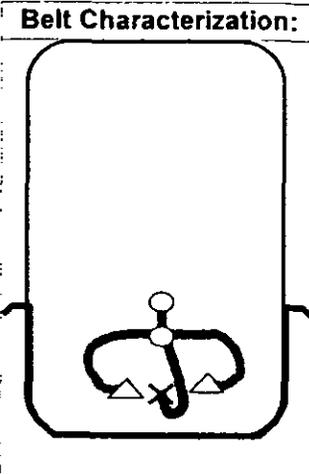
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|---|--|--------------------------------------|
| Stroller | 6 | |
| Sample ID: | 00-800-2347 | |
| Make: | [REDACTED] | |
| Model: | [REDACTED] | |
| Back Depth | 0 | |
| Seat Back Width | 11.5 (inside) | |
| Seat Back Height | 20.5 | |
| Seat Width | 13 | |
| Seat Pan Height | [REDACTED] | |
| Arm Rest Height | 5.5 | |
| Seat Side Opening | [REDACTED] | |
| Leg Opening (Vertical / Horizontal) | 7.5 / 5 | Head Barrier Depth: 8 |
| | | Cantilever Extension: -7 |
| Seat/Back Angle (Min / Max) | 120 / 165 (between 90 and 180 deg.) | Seat Incline (Min / Max) |
| | | 10 / 10 (between 0 and 90 deg.) |
| @ Maximum Recline | Seat/Footrest Angle (Min / Max) | |
| Back Length: 21 | 150 / 110 (between 90 and 180 deg.) | |
| Back Depth: 7 | Seat Footrest Distance: 6.5 | |
| Bar <input type="checkbox"/> Removable? | Crotch Barrier: | Shoulder Strap |
| Distance to Back (Min / Max) | Distance to Back (Min / Max) | Length (Min / Max) |
| 17.25 / 22.25 | 16 / 19.5 | [REDACTED] / [REDACTED] |
| Angle (Min / Max) | Depth from Tray Back: | Anchor Height (Min / Max) |
| [REDACTED] / [REDACTED] | [REDACTED] | [REDACTED] / [REDACTED] |
| Width: | Size of Bar (Depth / Width): | Anchor Separation (Min / Max) |
| [REDACTED] | [REDACTED] / [REDACTED] | [REDACTED] / [REDACTED] |
| Depth | Crotch Strap | |
| Side Release? | Length (Min / Max) | Waist Belt |
| <input type="checkbox"/> | 7.5 / 7.5 | Anchor Height (Min / Max) |
| Depth: | Anchor to Back (Min / Max) | [REDACTED] / 1 |
| Offset: | 12.5 / 12.5 | Anchor Separation: 4.5 |
| Front Release? | | Circumference (Min / Max) |
| <input type="checkbox"/> | | 12.5 / 27.5 |
| Depth: | | |
| Minimum Rearward Compartment/Wheel Distance: | 14 | |
| Minimum Forward compartment/Wheel Distance: | 15 | |
| Stroller Side Release? | no | |

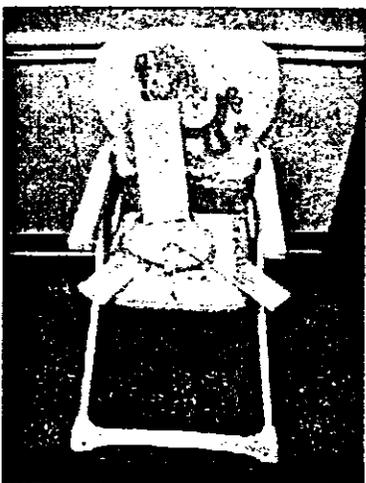
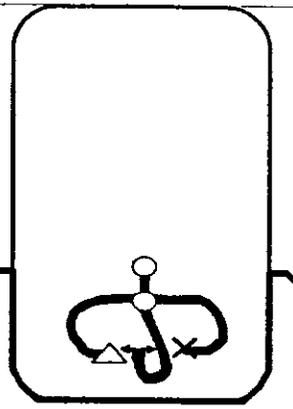


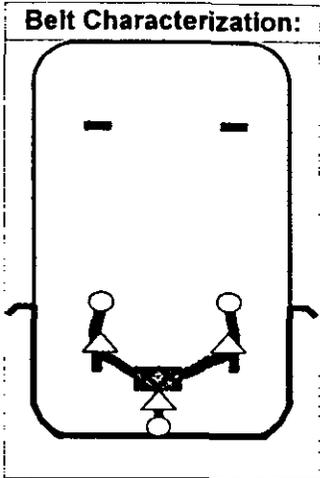
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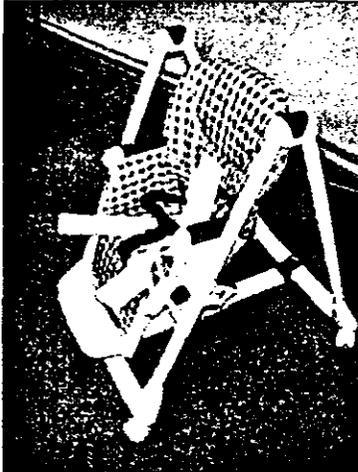
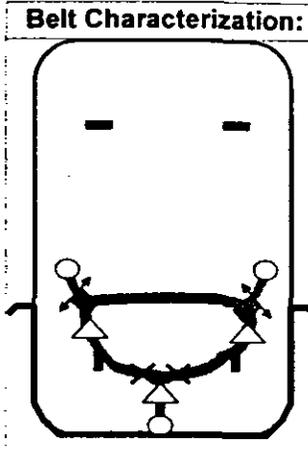


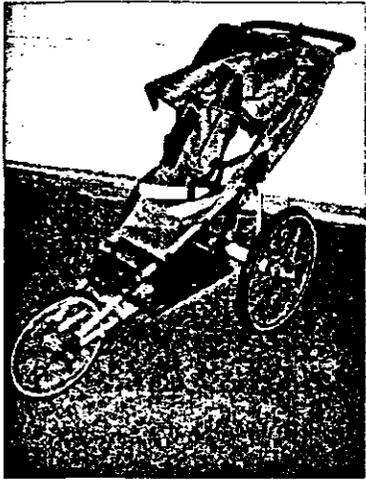
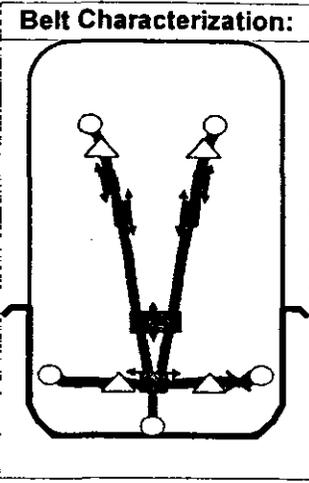
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|--|---|--|--|
| Stroller | <input type="text" value="7"/> |  | Belt Characterization:  |
| Sample ID: | <input type="text" value="00-860-6189"/> | | |
| Make: | <input type="text" value=""/> | | |
| Model: | <input type="text" value=""/> | | |
| Back Depth | <input type="text" value="5"/> | | |
| Seat Back Width | <input type="text" value="12"/> (inside) | | |
| Seat Back Height | <input type="text" value="17.5"/> | | |
| Seat Width | <input type="text" value="14"/> | | |
| Seat Pan Height | <input type="text" value=""/> | | |
| Arm Rest Height | <input type="text" value="7.25"/> | | |
| Seat Side Opening | <input type="text" value=""/> | | |
| Leg Opening (Vertical / Horizontal) | <input type="text" value="7.25"/> / <input type="text" value=""/> | Head Barrier Depth: | <input type="text" value="3.5"/> |
| | | Cantilever Extension: | <input type="text" value="-8"/> |
| Seat/Back Angle (Min / Max) | <input type="text" value="125"/> / <input type="text" value="160"/> (between 90 and 180 deg.) | Seat Incline (Min / Max) | <input type="text" value="15"/> / <input type="text" value="15"/> (between 0 and 90 deg.) |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | <input type="text" value="90"/> / <input type="text" value="90"/> (between 90 and 180 deg.) |
| Back Length: | <input type="text" value="32"/> | Seat Footrest Distance: | <input type="text" value="7.5"/> |
| Back Depth: | <input type="text" value="5"/> | | |
| Bar | Removable? <input checked="" type="checkbox"/> | Crotch Barrier: | Shoulder Strap |
| Distance to Back (Min / Max) | <input type="text" value="12.75"/> / <input type="text" value="16.5"/> | Distance to Back (Min / Max) | Length (Min / Max) |
| Angle (Min / Max) | <input type="text" value="20"/> / <input type="text" value="20"/> | Depth from Tray Back: | Anchor Height (Min / Max) |
| Width: | <input type="text" value="13.5"/> | Size of Bar (Depth / Width): | <input type="text" value=""/> / <input type="text" value=""/> |
| Depth | <input type="text" value="2"/> | Crotch Strap | Anchor Separation (Min / Max) |
| Side Release? <input checked="" type="checkbox"/> yes | | Length (Min / Max) | <input type="text" value=""/> / <input type="text" value=""/> |
| Depth: | <input type="text" value=""/> | <input type="text" value="4"/> / <input type="text" value="4"/> | Waist Belt |
| Offset: | <input type="text" value="8"/> | Anchor to Back (Min / Max) | Anchor Height (Min / Max) |
| Front Release? <input type="checkbox"/> no | | <input type="text" value="7"/> / <input type="text" value="7"/> | <input type="text" value="4.5"/> / <input type="text" value="4.5"/> |
| Depth: | <input type="text" value=""/> | | Anchor Separation: <input type="text" value="12"/> |
| Minimum Rearward Compartment/Wheel Distance: | <input type="text" value="19"/> | | Circumference (Min / Max) |
| Minimum Forward compartment/Wheel Distance: | <input type="text" value="15"/> | | <input type="text" value="18"/> / <input type="text" value="25.5"/> |
| Stroller Side Release? | <input type="text" value=""/> | | |

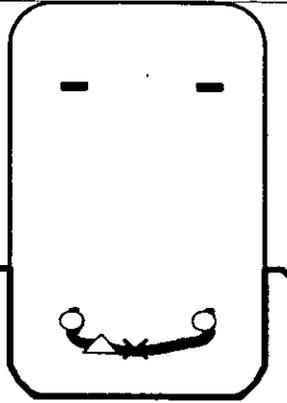
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|--|--|--|--|
| High Chair | 8 |  | Belt Characterization:  |
| Sample ID: | 01-810-3302 | | |
| Make: | | | |
| Model: | | | |
| Back Depth | 4 | | |
| Seat Back Width | 10 (Inside) | | |
| Seat Back Height | 16.5 | | |
| Seat Width | 11.5 | | |
| Seat Pan Height | | | |
| Arm Rest Height | 5 | | |
| Seat Side Opening | | | |
| Leg Opening (Vertical / Horizontal) | 6 / 6 | Head Barrier Depth: | 0 |
| | | Cantilever Extension: | |
| Seat/Back Angle (Min / Max) | 110 / 110 (between 90 and 180 deg.) | Seat Incline (Min / Max) | 0 / 0 (between 0 and 90 deg.) |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | 90 / 90 (between 90 and 180 deg.) |
| Back Length: | | Seat Footrest Distance: | 6 |
| Back Depth: | | | |
| Tray | Removable? <input checked="" type="checkbox"/> | Crotch Barrier: | Shoulder Strap |
| Distance to Back (Min / Max) | 6 / 9 | Distance to Back (Min / Max) | 4 / 7 |
| Angle (Min / Max) | 355 / 355 | Depth from Tray Back: | 2.5 |
| Width: | 25 | Size of Bar (Depth / Width): | 2 / 2.25 |
| Depth | 13 | Crotch Strap | Length (Min / Max) |
| Side Release? Outward | | Length (Min / Max) | 14 / 14 |
| Depth: | 3.75 | Anchor to Back (Min / Max) | 0 / 0 |
| Offset: | 9.25 | | |
| Front Release? no | | | |
| Depth: | | | |
| Minimum Rearward Compartment/Wheel Distance: | | Waist Belt | Anchor Height (Min / Max) |
| Minimum Forward compartment/Wheel Distance: | | | 1.5 / 1.5 |
| Stroller Side Release? | | | Anchor Separation: |
| | | | 0 |
| | | | Circumference (Min / Max) |
| | | | 2 / 28 |

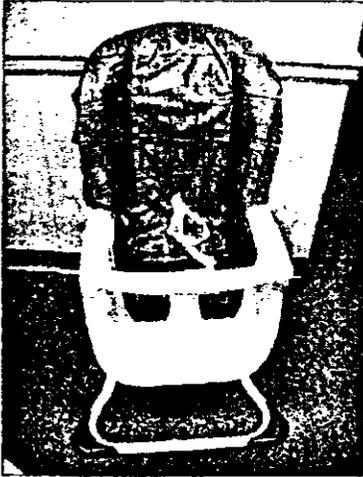
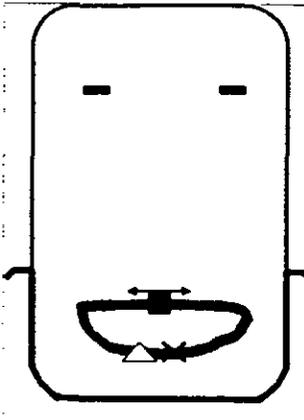
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|--|---|--|--|
| High Chair | <input type="text" value="9"/> |  | Belt Characterization:  |
| Sample ID: | <input type="text" value="01-830-4120"/> | | |
| Make: | <input type="text" value=""/> | | |
| Model: | <input type="text" value=""/> | | |
| Back Depth | <input type="text" value="0"/> | | |
| Seat Back Width | <input type="text" value="15.75"/> (inside) | | |
| Seat Back Height | <input type="text" value="15"/> | | |
| Seat Width | <input type="text" value="12.5"/> | | |
| Seat Pan Height | <input type="text" value="0"/> | | |
| Arm Rest Height | <input type="text" value="6"/> | | |
| Seat Side Opening | <input type="text" value="5"/> | | |
| Leg Opening (Vertical / Horizontal) | <input type="text" value="5.5"/> / <input type="text" value=""/> | Head Barrier Depth: | <input type="text" value="0"/> |
| | | Cantilever Extension: | <input type="text" value=""/> |
| Seat/Back Angle (Min / Max) | <input type="text" value="98"/> / <input type="text" value="98"/> (between 90 and 180 deg.) | Seat Incline (Min / Max) | <input type="text" value="2"/> / <input type="text" value="2"/> (between 0 and 90 deg.) |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | <input type="text" value=""/> / <input type="text" value=""/> (between 90 and 180 deg.) |
| Back Length: | <input type="text" value=""/> | Seat Footrest Distance: | <input type="text" value=""/> |
| Back Depth: | <input type="text" value=""/> | | |
| Tray | Removable? <input checked="" type="checkbox"/> | Crotch Barrier: | Shoulder Strap |
| Distance to Back (Min / Max) | <input type="text" value="5"/> / <input type="text" value="10"/> | Distance to Back (Min / Max) | <input type="text" value=""/> / <input type="text" value=""/> |
| Angle (Min / Max) | <input type="text" value="0"/> / <input type="text" value="0"/> | Depth from Tray Back: | <input type="text" value=""/> / <input type="text" value=""/> |
| Width: | <input type="text" value="25"/> | Size of Bar (Depth / Width): | <input type="text" value=""/> / <input type="text" value=""/> |
| Depth | <input type="text" value="11.75"/> | | |
| Side Release? Outward | <input type="text" value="7.5"/> | Crotch Strap | Waist Belt |
| Depth: | <input type="text" value="7.5"/> | Length (Min / Max) | <input type="text" value="10.5"/> / <input type="text" value="10.5"/> |
| Offset: | <input type="text" value="12"/> | Anchor to Back (Min / Max) | <input type="text" value="3"/> / <input type="text" value="3"/> |
| Front Release? Inward | <input type="text" value="12"/> | | |
| Depth: | <input type="text" value="12"/> | | |
| Minimum Rearward Compartment/Wheel Distance: | <input type="text" value=""/> | | <input type="text" value=""/> / <input type="text" value="18"/> |
| Minimum Forward compartment/Wheel Distance: | <input type="text" value=""/> | | |
| Stroller Side Release? | <input type="text" value=""/> | | |

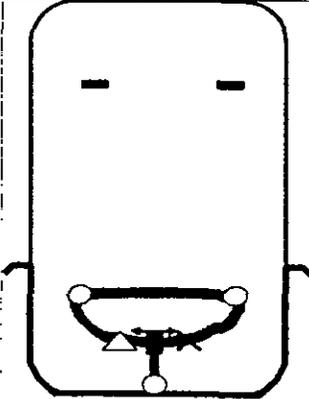
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|---|-------------|--|--|
| Stroller | 10 |  | Belt Characterization:  |
| Sample ID: | 00-860-6012 | | |
| Make: | | | |
| Model: | | | |
| Back Depth | 3 | | |
| Seat Back Width | 16 (inside) | | |
| Seat Back Height | 18 | | |
| Seat Width | 14 | | |
| Seat Pan Height | 1 | | |
| Arm Rest Height | | | |
| Seat Side Opening | | | |
| Leg Opening (Vertical / Horizontal) | | Head Barrier Depth: | 2 |
| | / | Cantilever Extension: | -5 |
| Seat/Back Angle (Min / Max) | | Seat Incline (Min / Max) | |
| 120 / 165 (between 90 and 180 deg.) | | 15 / 15 (between 0 and 90 deg.) | |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | |
| Back Length: | 27 | 102 / 102 (between 90 and 180 deg.) | |
| Back Depth: | 9 | Seat Footrest Distance: | 7.5 |
| Removable? <input type="checkbox"/> | | Crotch Barrier: | |
| Distance to Back (Min / Max) | | Distance to Back (Min / Max) | |
| | / | | |
| Angle (Min / Max) | | Depth from Tray Back: | |
| | / | Size of Bar (Depth / Width): | |
| Width: | | | |
| Depth | | Crotch Strap | |
| Side Release? <input type="checkbox"/> | | Length (Min / Max) | |
| Depth: | | 5 / 8 | |
| Offset: | | Anchor to Back (Min / Max) | |
| Front Release? <input type="checkbox"/> | | 3.5 / 3.5 | |
| Depth: | | Waist Belt | |
| Minimum Rearward Compartment/Wheel Distance: | 19.5 | Anchor Height (Min / Max) | 4.25 / 4.25 |
| Minimum Forward compartment/Wheel Distance: | 17.5 | Anchor Separation: | 4.5 |
| Stroller Side Release? <input type="checkbox"/> | yes | Circumference (Min / Max) | 6.5 / 26.5 |

| | | | |
|--|--|--|--|
| High Chair | 11 |  | Belt Characterization:  |
| Sample ID: | 00-830-5353 | | |
| Make: | | | |
| Model: | | | |
| Back Depth | 2 | | |
| Seat Back Width | 16.5 (inside) | | |
| Seat Back Height | 17 | | |
| Seat Width | 12 | | |
| Seat Pan Height | 0 | | |
| Arm Rest Height | 7.5 | | |
| Seat Side Opening | | | |
| Leg Opening (Vertical / Horizontal) | 7 / | Head Barrier Depth: | 0 |
| | | Cantilever Extension: | |
| Seat/Back Angle (Min / Max) | 100 / 130 (between 90 and 180 deg.) | Seat Incline (Min / Max) | 5 / 35 (between 0 and 90 deg.) |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | 98 / 98 (between 90 and 180 deg.) |
| Back Length: | 17 | Seat Footrest Distance: | 6.5 |
| Back Depth: | 2 | | |
| Tray | Removable? <input checked="" type="checkbox"/> | Crotch Barrier: | Shoulder Strap |
| Distance to Back (Min / Max) | 8 / 15 | Distance to Back (Min / Max) | Length (Min / Max) |
| Angle (Min / Max) | 357 / 0 | Depth from Tray Back: | Anchor Height (Min / Max) |
| Width: | 23.5 | Size of Bar (Depth / Width): | Anchor Separation (Min / Max) |
| Depth | 13.5 | | |
| Side Release? | | Crotch Strap | Waist Belt |
| Depth: | | Length (Min / Max) | Anchor Height (Min / Max) |
| Offset: | | 4 / 6 | 3.5 / 3.5 |
| Front Release? Outward | | Anchor to Back (Min / Max) | Anchor Separation: |
| Depth: | 11 | 8 / 8 | 9.5 |
| Minimum Rearward Compartment/Wheel Distance: | | | Circumference (Min / Max) |
| Minimum Forward compartment/Wheel Distance: | | | 16 / 22 |
| Stroller Side Release? | | | |

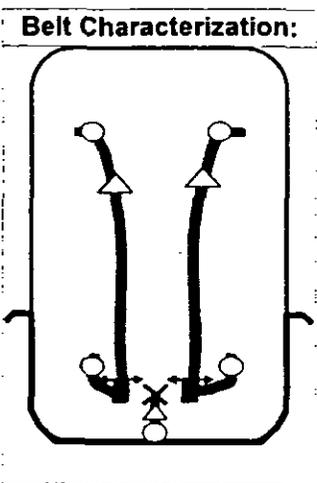
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| Stroller | 12 |  | Belt Characterization:  |
| Sample ID: | 01-810-3651 | | |
| Make: | | | |
| Model: | | | |
| Back Depth | 6 | | |
| Seat Back Width | 15 (inside) | | |
| Seat Back Height | 21.5 | | |
| Seat Width | 11 | | |
| Seat Pan Height | 5 | | |
| Arm Rest Height | | | |
| Seat Side Opening | | | |
| Leg Opening (Vertical / Horizontal) | | Head Barrier Depth: | 0 |
| / | | Cantilever Extension: | -17 |
| Seat/Back Angle (Min / Max) | | Seat Incline (Min / Max) | |
| 120 / 150 (between 90 and 180 deg.) | | 20 / 20 (between 0 and 90 deg.) | |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | |
| Back Length: | 30 | 129 / 129 (between 90 and 180 deg.) | |
| Back Depth: | 9 | Seat Footrest Distance: | 14 |
| Removable? <input type="checkbox"/> | Crotch Barrier: | Shoulder Strap | |
| Distance to Back (Min / Max) | Distance to Back (Min / Max) | Length (Min / Max) | 3 / 11 |
| / | / | Anchor Height (Min / Max) | 17.5 / 17.5 |
| Angle (Min / Max) | Depth from Tray Back: | Anchor Separation (Min / Max) | 3 / 3 |
| / | Size of Bar (Depth / Width): | | |
| Width: | / | Crotch Strap | |
| Depth | Length (Min / Max) | Waist Belt | |
| Side Release? <input type="checkbox"/> | 8 / 8 | Anchor Height (Min / Max) | 2 / 2 |
| Depth: | Anchor to Back (Min / Max) | Anchor Separation: | 12 |
| Offset: | 8 / 8 | Circumference (Min / Max) | 16 / 32 |
| Front Release? <input type="checkbox"/> | | | |
| Depth: | | | |
| Minimum Rearward Compartment/Wheel Distance: | 8 | | |
| Minimum Forward compartment/Wheel Distance: | 18 | | |
| Stroller Side Release? | yes- (pins) | | |

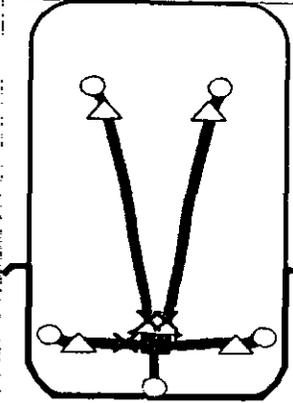
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|---|--|--|--|
| Stroller | 13 |  | Belt Characterization:  |
| Sample ID: | 00-830-3852 | | |
| Make: | [REDACTED] | | |
| Model: | [REDACTED] | | |
| Back Depth | 0 | | |
| Seat Back Width | 13 (inside) | | |
| Seat Back Height | 17 | | |
| Seat Width | 15 | | |
| Seat Pan Height | 0 | | |
| Arm Rest Height | 7 | | |
| Seat Side Opening | | | |
| Leg Opening (Vertical / Horizontal) | 7 / 6 | Head Barrier Depth: | 0 |
| | | Cantilever Extension: | 4 |
| Seat/Back Angle (Min / Max) | 115 / 145 (between 90 and 180 deg.) | Seat Incline (Min / Max) | 3 / 3 (between 0 and 90 deg.) |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | 110 / 180 (between 90 and 180 deg.) |
| Back Length: | 26 | Seat Footrest Distance: | 8 |
| Back Depth: | 0 | | |
| Bar | Removable? <input type="checkbox"/> | Crotch Barrier: | Shoulder Strap |
| Distance to Back (Min / Max) | 10.5 / 17 | Distance to Back (Min / Max) | 10.5 / 16.25 |
| Angle (Min / Max) | 10 / 10 | Depth from Tray Back: | |
| Width: | | Size of Bar (Depth / Width): | 2 / 12.5 |
| Depth | | Crotch Strap | Anchor Height (Min / Max) |
| Side Release? | | Length (Min / Max) | |
| Depth: | | Anchor to Back (Min / Max) | |
| Offset: | | | |
| Front Release? | | | Waist Belt |
| Depth: | | | Anchor Height (Min / Max) |
| | | | 2.5 / 2.5 |
| | | | Anchor Separation: 13 |
| Minimum Rearward Compartment/Wheel Distance: | 20 | | Circumference (Min / Max) |
| Minimum Forward compartment/Wheel Distance: | 14 | | 25 / 39 |
| Stroller Side Release? | no | | |

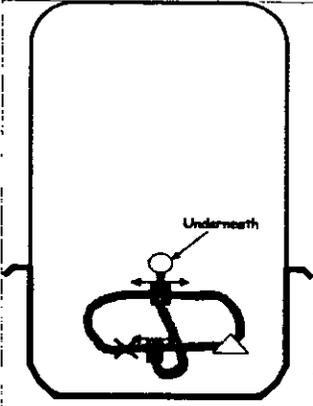
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|--|-------------------------------------|--|--|
| High Chair | 14 |  | Belt Characterization:  |
| Sample ID: | 00 800 2913 | | |
| Make: | | | |
| Model: | | | |
| Back Depth | 4 | | |
| Seat Back Width | 10 (inside) | | |
| Seat Back Height | 21.5 | | |
| Seat Width | 12 | | |
| Seat Pan Height | | | |
| Arm Rest Height | 5 | | |
| Seat Side Opening | | | |
| Leg Opening (Vertical / Horizontal) | 4.5 / 5 | Head Barrier Depth: | 0 |
| | | Cantilever Extension: | |
| Seat/Back Angle (Min / Max) | 100 / 115 (between 90 and 180 deg.) | Seat Incline (Min / Max) | 5 / 20 (between 0 and 90 deg.) |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | 88 / 88 (between 90 and 180 deg.) |
| Back Length: | | Seat Footrest Distance: | 8 |
| Back Depth: | | | |
| Bar | Removable? <input type="checkbox"/> | Crotch Barrier: | Shoulder Strap |
| Distance to Back (Min / Max) | 8 / 13.5 | Distance to Back (Min / Max) | 8.5 / 8.5 |
| Angle (Min / Max) | 0 / 15 | Depth from Tray Back: | |
| Width: | 25.5 | Size of Bar (Depth / Width): | 1.5 / 1.5 |
| Depth | 12.5 | Crotch Strap | Length (Min / Max) |
| Side Release? Outward | Length (Min / Max) | | Anchor Height (Min / Max) |
| Depth: 3.5 | | | Anchor Separation (Min / Max) |
| Offset: 8.5 | Anchor to Back (Min / Max) | | |
| Front Release? Inward | | | Waist Belt |
| Depth: 12.5 | | | Anchor Height (Min / Max) |
| | | | 3 / 3 |
| | | | Anchor Separation: 0 |
| | | | Circumference (Min / Max) |
| | | | 0 / 26 |
| Minimum Rearward Compartment/Wheel Distance: | | | |
| Minimum Forward compartment/Wheel Distance: | | | |
| Stroller Side Release? | | | |

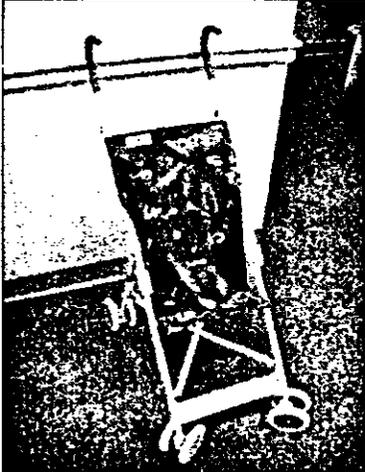
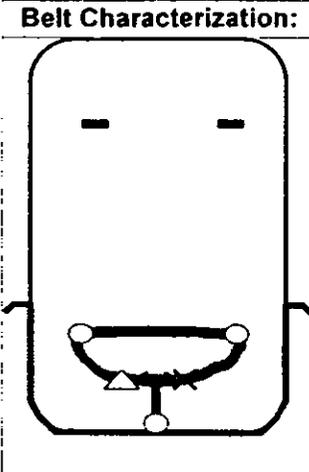
| | | | |
|---|---|--|--|
| Stroller | <input type="text" value="15"/> |  | Belt Characterization:  |
| Sample ID: | <input type="text" value="01-830-5076"/> | | |
| Make: | <input type="text" value=""/> | | |
| Model: | <input type="text" value=""/> | | |
| Back Depth | <input type="text" value="4"/> | | |
| Seat Back Width | <input type="text" value="13"/> (inside) | | |
| Seat Back Height | <input type="text" value="16.5"/> | | |
| Seat Width | <input type="text" value="13"/> | | |
| Seat Pan Height | <input type="text" value="7"/> | | |
| Arm Rest Height | <input type="text" value="9"/> | | |
| Seat Side Opening | <input type="text" value=""/> | | |
| Leg Opening (Vertical / Horizontal) | <input type="text" value=""/> | Head Barrier Depth: | <input type="text" value="6"/> |
| <input type="text" value=""/> | <input type="text" value=""/> | Cantilever Extension: | <input type="text" value="-5"/> |
| Seat/Back Angle (Min / Max) | <input type="text" value="125"/> / <input type="text" value="155"/> (between 90 and 180 deg.) | Seat Incline (Min / Max) | <input type="text" value="20"/> / <input type="text" value="20"/> (between 0 and 90 deg.) |
| @ Maximum Recline | <input type="text" value=""/> | Seat/Footrest Angle (Min / Max) | <input type="text" value="72"/> / <input type="text" value="72"/> (between 90 and 180 deg.) |
| Back Length: | <input type="text" value="27"/> | Seat Footrest Distance: | <input type="text" value="6.5"/> |
| Back Depth: | <input type="text" value="10"/> | | |
| Removable? <input type="checkbox"/> | Crotch Barrier: | Shoulder Strap | |
| Distance to Back (Min / Max) | <input type="text" value=""/> | Length (Min / Max) | |
| <input type="text" value=""/> | <input type="text" value=""/> | <input type="text" value=""/> | |
| Angle (Min / Max) | Depth from Tray Back: | Anchor Height (Min / Max) | |
| <input type="text" value=""/> | <input type="text" value=""/> | <input type="text" value=""/> | |
| Width: | Size of Bar (Depth / Width): | Anchor Separation (Min / Max) | |
| <input type="text" value=""/> | <input type="text" value=""/> | <input type="text" value=""/> | |
| Depth | Crotch Strap | Waist Belt | |
| <input type="text" value=""/> | Length (Min / Max) | Anchor Height (Min / Max) | |
| Side Release? <input type="checkbox"/> | <input type="text" value="6"/> / <input type="text" value="6"/> | <input type="text" value="5"/> / <input type="text" value="5"/> | |
| Depth: | Anchor to Back (Min / Max) | Anchor Separation: | |
| <input type="text" value=""/> | <input type="text" value="6"/> / <input type="text" value="6"/> | <input type="text" value="2.5"/> | |
| Front Release? <input type="checkbox"/> | | Circumference (Min / Max) | |
| Depth: | | <input type="text" value="10.5"/> / <input type="text" value="28.5"/> | |
| Minimum Rearward Compartment/Wheel Distance: | <input type="text" value="22"/> | | |
| Minimum Forward compartment/Wheel Distance: | <input type="text" value="15"/> | | |
| Stroller Side Release? | <input type="text" value="yes"/> | | |

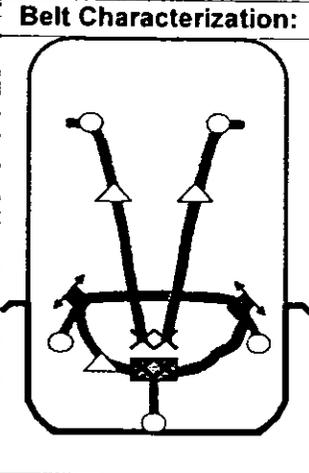
| | | | |
|--|--|---------------------------------|-----------------------------------|
| High Chair | 16 | | |
| Sample ID: | N/A | | |
| Make: | | | |
| Model: | | | |
| Back Depth | 4 | | |
| Seat Back Width | 13 (inside) | | |
| Seat Back Height | 19.25 | | |
| Seat Width | 11.5 | | |
| Seat Pan Height | 4 | | |
| Arm Rest Height | 6 | | |
| Seat Side Opening | | | |
| Leg Opening (Vertical / Horizontal) | 5 / 5.5 | Head Barrier Depth: | |
| | | Cantilever Extension: | |
| Seat/Back Angle (Min / Max) | 115 / 135 (between 90 and 180 deg.) | Seat Incline (Min / Max) | 7 / 33 (between 0 and 90 deg.) |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | 90 / 90 (between 90 and 180 deg.) |
| Back Length: | | Seat Footrest Distance: | 6 |
| Back Depth: | | | |
| Tray & Bar | Removable? <input checked="" type="checkbox"/> | Crotch Barrier: | Shoulder Strap |
| Distance to Back (Min / Max) | 7.5 / 12 | Distance to Back (Min / Max) | 7.5 / 7.5 |
| Angle (Min / Max) | 0 / 26 | Depth from Tray Back: | 4.5 |
| Width: | 25.25 | Size of Bar (Depth / Width): | 1.5 / 1.5 |
| Depth | 12.5 | Crotch Strap | |
| Side Release? Outward | Depth: 2.75 | Length (Min / Max) | 0 / 14.5 |
| | Offset: 9 | Anchor to Back (Min / Max) | 3 / 3 |
| Front Release? Inward | Depth: 13 | Waist Belt | |
| | | Anchor Height (Min / Max) | 3 / 3 |
| | | Anchor Separation: | 5.75 |
| | | Circumference (Min / Max) | |
| Minimum Rearward Compartment/Wheel Distance: | | | |
| Minimum Forward compartment/Wheel Distance: | | | |
| Stroller Side Release? | | | |



| | | | | |
|---|---|--|---|--|
| Stroller <input type="text" value="17"/> | |  | Belt Characterization: | |
| Sample ID: <input type="text" value="01-840-6672"/> | | |  | |
| Make: <input type="text" value=""/> | | | | |
| Model: <input type="text" value=""/> | | | | |
| Back Depth | <input type="text" value="6"/> | | | |
| Seat Back Width | <input type="text" value="13.5 (inside)"/> | | | |
| Seat Back Height | <input type="text" value="17.5"/> | | | |
| Seat Width | <input type="text" value="14"/> | | | |
| Seat Pan Height | <input type="text" value="6"/> | | | |
| Arm Rest Height | <input type="text" value="6"/> | | | |
| Seat Side Opening | <input type="text" value=""/> | | | |
| Leg Opening (Vertical / Horizontal) | <input type="text" value=""/> | Head Barrier Depth: | <input type="text" value="9"/> | |
| <input type="text" value=""/> / <input type="text" value=""/> | | Cantilever Extension: | <input type="text" value="-10"/> | |
| Seat/Back Angle (Min / Max) | <input type="text" value="135"/> / <input type="text" value="160 (between 90 and 180 deg.)"/> | Seat Incline (Min / Max) | <input type="text" value="10"/> / <input type="text" value="10 (between 0 and 90 deg.)"/> | |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | <input type="text" value="90"/> / <input type="text" value="90 (between 90 and 180 deg.)"/> | |
| Back Length: | <input type="text" value="28"/> | Seat Footrest Distance: | <input type="text" value="7"/> | |
| Back Depth: | <input type="text" value="9"/> | | | |
| Removable? <input type="checkbox"/> | Crotch Barrier: | Shoulder Strap | | |
| Distance to Back (Min / Max) | <input type="text" value=""/> / <input type="text" value=""/> | Distance to Back (Min / Max) | <input type="text" value=""/> / <input type="text" value=""/> | Length (Min / Max) |
| <input type="text" value=""/> / <input type="text" value=""/> | | Depth from Tray Back: | <input type="text" value=""/> | <input type="text" value="9.25"/> / <input type="text" value="17.75"/> |
| Angle (Min / Max) | <input type="text" value=""/> / <input type="text" value=""/> | Size of Bar (Depth / Width): | <input type="text" value=""/> / <input type="text" value=""/> | Anchor Height (Min / Max) |
| <input type="text" value=""/> / <input type="text" value=""/> | | <input type="text" value=""/> / <input type="text" value=""/> | | <input type="text" value="9.5"/> / <input type="text" value="9.5"/> |
| Width: | <input type="text" value=""/> | Crotch Strap | | Anchor Separation (Min / Max) |
| Depth | <input type="text" value=""/> | Length (Min / Max) | <input type="text" value=""/> / <input type="text" value=""/> | <input type="text" value="5.5"/> / <input type="text" value="5.5"/> |
| Side Release? <input type="checkbox"/> | | Anchor to Back (Min / Max) | <input type="text" value=""/> / <input type="text" value=""/> | Waist Belt |
| Depth: | <input type="text" value=""/> | <input type="text" value="5.75"/> / <input type="text" value="5.75"/> | | Anchor Height (Min / Max) |
| Offset: | <input type="text" value=""/> | | | <input type="text" value="3.5"/> / <input type="text" value="3.5"/> |
| Front Release? <input type="checkbox"/> | | | | Anchor Separation: |
| Depth: | <input type="text" value=""/> | | | <input type="text" value="12"/> |
| Minimum Rearward Compartment/Wheel Distance: | <input type="text" value="10"/> | | | Circumference (Min / Max) |
| Minimum Forward compartment/Wheel Distance: | <input type="text" value="21"/> | | | <input type="text" value="24"/> / <input type="text" value="41"/> |
| Stroller Side Release? <input type="checkbox"/> yes | | | | |

| | | | |
|--|--|--|--|
| High Chair | 18 |  | Belt Characterization:  |
| Sample ID: | 01-840-6272 | | |
| Make: | | | |
| Model: | | | |
| Back Depth | 0 | | |
| Seat Back Width | 15 (inside) | | |
| Seat Back Height | 17.25 | | |
| Seat Width | 13 | | |
| Seat Pan Height | 0 | | |
| Arm Rest Height | 7.25 | | |
| Seat Side Opening | 5.5 | | |
| Leg Opening (Vertical / Horizontal) | 7 / | Head Barrier Depth: | 0 |
| | | Cantilever Extension: | |
| Seat/Back Angle (Min / Max) | 100 / 100 (between 90 and 180 deg.) | Seat Incline (Min / Max) | 0 / 0 (between 0 and 90 deg.) |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | 105 / 105 (between 90 and 180 deg.) |
| Back Length: | | Seat Footrest Distance: | 6 |
| Back Depth: | | | |
| Tray | Removable? <input checked="" type="checkbox"/> | Crotch Barrier: | Shoulder Strap |
| Distance to Back (Min / Max) | 8.5 / 10.5 | Distance to Back (Min / Max) | Length (Min / Max) |
| Angle (Min / Max) | 0 / 0 | Depth from Tray Back: | Anchor Height (Min / Max) |
| Width: | 18.75 | Size of Bar (Depth / Width): | Anchor Separation (Min / Max) |
| Depth | 9.75 | Crotch Strap | |
| Side Release? push cla | | Length (Min / Max) | Waist Belt |
| Depth: | 2 | 13 / 13 | Anchor Height (Min / Max) |
| Offset: | 7.5 | Anchor to Back (Min / Max) | 0 / 3 |
| Front Release? no | | 13 / 13 | Anchor Separation: |
| Depth: | | | 0 |
| Minimum Rearward Compartment/Wheel Distance: | | | Circumference (Min / Max) |
| Minimum Forward compartment/Wheel Distance: | | | 1 / 24 |
| Stroller Side Release? | | | |

| | | | | | | |
|--|-------------------------------------|----|--|-------------------------------------|-------------|---|
| Stroller | | 19 |  | Belt Characterization: | |  |
| Sample ID: | N/A | | | | | |
| Make: | [REDACTED] | | | | | |
| Model: | [REDACTED] | | | | | |
| Back Depth | 3 | | | | | |
| Seat Back Width | 13 (inside) | | | | | |
| Seat Back Height | 18.25 | | | | | |
| Seat Width | 11 | | | | | |
| Seat Pan Height | 0 | | | | | |
| Arm Rest Height | | | | | | |
| Seat Side Opening | 1.5 | | | | | |
| Leg Opening (Vertical / Horizontal) | | | Head Barrier Depth: | 0 | | |
| | / | | Cantilever Extension: | | | |
| Seat/Back Angle (Min / Max) | 115 / 115 (between 90 and 180 deg.) | | Seat Incline (Min / Max) | 18 / 18 (between 0 and 90 deg.) | | |
| @ Maximum Recline | | | Seat/Footrest Angle (Min / Max) | 100 / 100 (between 90 and 180 deg.) | | |
| Back Length: | | | Seat Footrest Distance: | 9.5 | | |
| Back Depth: | | | | | | |
| Removable? <input type="checkbox"/> | Crotch Barrier: | | Shoulder Strap | | | |
| Distance to Back (Min / Max) | Distance to Back (Min / Max) | | Length (Min / Max) | | | |
| | / | | / | | | |
| Angle (Min / Max) | Depth from Tray Back: | | Anchor Height (Min / Max) | | | |
| | / | | / | | | |
| Width: | Size of Bar (Depth / Width): | | Anchor Separation (Min / Max) | | | |
| Depth | / | | / | | | |
| Side Release? | Crotch Strap | | Waist Belt | | | |
| Depth: | Length (Min / Max) | | Anchor Height (Min / Max) | | | |
| Offset: | 8.5 / 8.5 | | 4 / 4 | | | |
| Front Release? | Anchor to Back (Min / Max) | | Anchor Separation: | | 3.5 | |
| Depth: | 7.5 / | | Circumference (Min / Max) | | 13.5 / 27.5 | |
| Minimum Rearward Compartment/Wheel Distance: | 13 | | | | | |
| Minimum Forward compartment/Wheel Distance: | 12 | | | | | |
| Stroller Side Release? | no | | | | | |

| | | | |
|--|--|--|--|
| High Chair | 20 |  | Belt Characterization:  |
| Sample ID: | N/A | | |
| Make: | [REDACTED] | | |
| Model: | [REDACTED] | | |
| Back Depth | 4 | | |
| Seat Back Width | 17.5 (Inside) | | |
| Seat Back Height | 19 | | |
| Seat Width | 12 | | |
| Seat Pan Height | 8 | | |
| Arm Rest Height | 9 | | |
| Seat Side Opening | | | |
| Leg Opening (Vertical / Horizontal) | 8 / | Head Barrier Depth: | |
| | | Cantilever Extension: | |
| Seat/Back Angle (Min / Max) | 100 / 126 (between 90 and 180 deg.) | Seat Incline (Min / Max) | 0 / 26 (between 0 and 90 deg.) |
| @ Maximum Recline | | Seat/Footrest Angle (Min / Max) | 100 / 100 (between 90 and 180 deg.) |
| Back Length: | | Seat Footrest Distance: | 7 |
| Back Depth: | | | |
| Tray | Removable? <input checked="" type="checkbox"/> | Crotch Barrier: | Shoulder Strap |
| Distance to Back (Min / Max) | 10 / 12 | Distance to Back (Min / Max) | Length (Min / Max) |
| | | | 8.5 / 16.75 |
| Angle (Min / Max) | 0 / 0 | Depth from Tray Back: | Anchor Height (Min / Max) |
| | | | 8.75 / 11.5 |
| Width: | 22.5 | Size of Bar (Depth / Width): | Anchor Separation (Min / Max) |
| | | | 4.5 / 4.5 |
| Depth | 13 | Crotch Strap | Waist Belt |
| Side Release? | | Length (Min / Max) | Anchor Height (Min / Max) |
| Depth: | | 4.75 / 4.75 | 0.5 / 0.5 |
| Offset: | | Anchor to Back (Min / Max) | Anchor Separation: |
| | | 8.5 / 8.5 | 10 |
| Front Release? Outward | | | Circumference (Min / Max) |
| Depth: | 8.75 | | 27.5 / 37.5 |
| Minimum Rearward Compartment/Wheel Distance: | | | |
| Minimum Forward compartment/Wheel Distance: | | | |
| Stroller Side Release? | | | |

APPENDIX D:

**ADULT CAREGIVER FACTORS RELATED TO NONUSE OR
MISADJUSTMENT OF RESTRAINT SYSTEM FEATURES**

Adult Caregiver Factors Related to Nonuse or Misadjustment of Restraint System Features

(Taken from Product Profile Report, Lerner, Huey, & Kotwal, 2001)

Adult caregivers do not always use or properly adjust restraint systems. There appears to be a high level of restraint non-use, although it was not possible to quantify this. Adult caregivers have a range of perceptions about the necessity of using the restraint or about the primary purpose of the restraint system. There seems to be more focus on the need to retain the child in the seat during difficult dynamic situations (e.g., going down steps), rather than as a means to keep the child from falling or escaping. The comfort of the child appears to be a major concern of adult caregivers when using restraint systems. Many are concerned about the restraints being too confining or the straps pinching or cutting into the child.

A wide variety of factors was identified for adult nonuse or misadjustment of restraint system features. These include the following:

User Factors Related to Non-Use of Restraint System Features

- Lack of perceived need to use restraints
 1. Users perceive the risk as being low because the hazard does not seem very likely or severe.
 2. Users perceive the risk as being low because the previous behavior of the child suggests that the child is unlikely to engage in any behavior that might result in a fall or serious injury.
 3. There is not a need to use certain components of the restraint system (e.g., straps) because other passive components (e.g., high chair passive crotch restraint, stroller restraint bar) or other active elements (e.g., waist belt, high chair tray) provide adequate protection.
 4. The adult caretaker is confident of providing adequate close supervision so that any emerging incidents are noticed and stopped.
- Nuisance for adult
 1. The restraint system interferes with lifting the child in and out of the product and with accessing the child for other needs (e.g., adjusting clothing, cleaning).
 2. It is difficult to operate elements of the restraint system (e.g., buckles, strap adjustments). Operation may be non-intuitive or may require hand strength or fine motor movements that some users find difficult.
 3. It is difficult to get access to some component of the restraint system, especially if the child is already seated. For example, waist straps may lay across the seat, unless they are intentionally laid out to the sides in advance.
 4. Straps tend to get tangled and twisted.
 5. It is awkward to cope with some restraint system component while holding the child. Examples include adjusting belt length when placing a child in a stroller or removing a high chair tray after lifting out the child.
 6. It is a nuisance to clean components that tend to get dirty and are hard to clean. Woven straps tend to get encrusted with food and do not wipe clean easily. Shoulder straps tend to get food spilled on them frequently. Straps typically are not easy to remove and replace for cleaning. Unfortunately, the solution to this problem is, at times, to remove the straps completely, rendering the restraint system less effective or nonexistent.

- Negative effect on child
 1. Some children get upset when confined in a restraint.
 2. Restraints may cause pain or discomfort (e.g., straps cut into skin, pinch points, tightness).
 3. The restraint system interferes with the child's freedom of movement and the utility of the product. For example, it may be difficult for a child to eat in a high chair if he or she is unable to lean forward.
- Difficulty in strap attachment
 1. Once straps are removed from the product (e.g., for cleaning or to allow removal of a seat cushion) it may be difficult to reattach them.
- Non-use of restraints to accomplish temporary functional acts.
 1. Restraints are removed to lift a child from the seat.
 2. The tray from a high chair is removed to clean it.
 3. Restraints are removed to accomplish some child-tending task, such as putting a jacket on the child.

User Factors Related to Misadjustment of Restraint System Features

- Child actions
 1. If the child arches the back or puffs the belly during adjustment there may be too much slack once the child relaxes his or her posture.
 2. If the child squirms it is difficult to make adjustments and determine how adequate they are.
- Clothing rides up after adjustment
Belts tightened sufficiently around a child wearing outerwear may come to fit loosely if the outerwear rides up and the belt becomes positioned underneath the outerwear.
- Poor user feedback
 1. It is difficult to determine if interlocking components are properly engaged (e.g., buckles, trays).
 2. It is difficult to tell how much slack is in the straps.
- Need to provide child comfort and utility
 1. Restraint components are kept loose to give the child comfort and freedom of movement
 2. Restraint components are kept loose to allow the child to accomplish functional acts (e.g., eating, playing, or watching TV).
- Difficulty of adjustment
 1. The means of adjustment is not intuitive and is unclear to the adult caretaker.
 2. It is difficult to make adjustments to an adjustable feature (e.g., awkwardness of threading straps through small slots, finger strength requirements).
 3. Straps tangle and twist.
 4. It is difficult or impossible to make adjustments after the child is seated. For example, the adjustable component may be blocked by a passive restraint bar or be behind the child.

5. It is awkward to make adjustments while holding the child prior to placing the child in the seat.
 6. There is a need for re-adjustment of the restraint system every time there is a change in the seat adjustment. Seats may adjust in horizontal and vertical dimensions and in incline.
- Child growth
 1. As the child grows, compensating adjustments to the restraint system fail to be made.