American Association of State Highway and Transportation | 235

# Test Vehicle Selection Procedures

H

his appendix provides a description of the procedures used to select the small car and light truck test vehicles recommended herein. As automobile manufacturers revise vehicle designs more

T

frequently and with the potential for high gasoline prices affecting the demand for large passenger cars and light trucks, it is possible that vehicle sizes and/or major characteristics may change signifi cantly over a very short time. In that event, it is recommended that the procedures described below be utilized to select new test vehicles on an interim basis, without a complete updating of the impact performance evaluation guidelines. Some limited full-scale testing of any new test vehicles may be needed to accu- rately identify the relevance of changes in test vehicle sizes.

The process of selecting the appropriate vehicle types and sizes for use as a surrogate for the entire vehicle fleet begins with an analysis of the curb weight distributions of all vehicles sold in the na- tion for a given year. Note that for some vehicles, especially SUVs, curb weight can vary signifi cantly depending upon variations in the basic vehicle design, such as four-wheel drive or extended cabs on pickups. Tabulated curb weight and sales data should correctly identify the proportion of each vehicle

model that incorporated these important optional features. Also note that other optional features, such as engine size and wheel diameter can modestly affect vehicle weight. When possible, the mass associated with the most popular variations of these less important vehicle options should be used in data tabula- tion. Detailed vehicle sales data can be obtained from the *Automotive Yearbook*, published by Wards Communications, Inc., (147) or the *Market Data Book*, published by the *Automotive News* magazine (37). Tabulations of vehicle weights from the *2002 Automotive Yearbook* are shown in Tables H-1 and H-2. Tables such as these can be used to determine the tails of the vehicle weight distribution. Table H-1 lists the lightest vehicles sold in 2002 and Table H-2 lists the heaviest vehicles sold. Vehicles in Table

H-1 are in mass order beginning with the lightest vehicle sold and extending upward. Table H-2 lists the upper end of the vehicle spectrum and vehicles are presented in order of descending mass. The last column in both tables represents the percentage of vehicles sold with a mass equal to or less than the listed model. Note that these tables exclude specialty vehicles with sales volumes of less than 4,000 units. In 2002, there were a total of 16.8 million vehicles sold in the United States, and a vehicle model with only 4,000 units sold would represent only 0.02 percent of total vehicle sales.

It is recommended that, under normal circumstances, the 5th and 95th percentile heaviest weights be selected as the target weight for the small and large test vehicles, respectively. In recognition of the fact that vehicle weights have increased dramatically in the last ten years, the 2nd and 90th percentile

236 | Manual for Assessing Safety Hardware

vehicle weights were chosen for the test vehicles in this document. As shown in Table H-1, the 4-door Honda Civic, weighing 2,421 lb (1,099 kg), represents the 2nd percentile lightest vehicle sold in 2002. Vehicles within ±55 lb (25 kg) of the Civic fall within this weight category and include more than 400,000 cars, or 2.4 percent of all vehicles sold. Test agencies have reported that an adequate supply of used test vehicles can normally be obtained whenever more than 50,000 vehicles are sold nationally for any given model. Nevertheless, it is recommended that no test vehicle be selected unless there are at least 100,000 units sold each year in the target weight range.

As shown in Table H-2, the 95th percentile heaviest passenger vehicle sold in 2002 weighed approxi- mately 5,420 lb (2,460 kg) while a 5,000-lb (2,270-kg) vehicle was near the 90th percentile. Note that these vehicle weights represent a dramatic increase since the early 1990s when the 95th percen- tile heaviest vehicle was approximately 4,400 lb (2,000 kg). In recognition of the rapid increase in vehicle weights over the last 15 years and the expectation that the recent rise in gasoline prices may begin to push vehicle weights down, the 90th percentile vehicle weight was selected as the appropri- ate size for the light truck test vehicle. Initially, a 3/4-ton, two-wheel drive, regular cab pickup truck, such as the Chevrolet Silverado 2500, was selected as the candidate test vehicle. This was the same

vehicle recommended by NCHRP Report 350 (119), and it had the correct curb weight. By retaining the same test vehicle used in the prior document and merely increasing the target vehicle weight, the new performance evaluation guidelines would maintain the maximum possible connection with the prior procedures. In this situation, testing agencies’ and hardware designers’ experience with the Report 350 vehicle would carry forward to the new procedures.

Appendix H—Test Vehicle Selection Procedures | 237

TABLE H-1. Small Car Weights and Sales Volumes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Make/Model** | **Curb Weight, lb (kg)** | **2002 Sales, No. of Units** | **Market Share,****%** | **Cumulative Market Share,****%** |
| Toyota Echo | 2,035 (924) | 31,918 | 0.19 | 0.21 |
| Toyota MR2 Spydera | 2,195 (997) | 5,109 | 0.03 | 0.24 |
| Hyundai Accent | 2,280 (1,035) | 75,691 | 0.45 | 0.69 |
| Mini Coopera | 2,316 (1,051) | 15,761 | 0.09 | 0.78 |
| Mazda Miataa | 2,365 (1,074) | 15,956 | 0.09 | 0.87 |
| Kia Rio | 2,403 (1,091) | 51,881 | 0.31 | 1.18 |
| Honda Civic (2DR) | 2,405 (1,092) | 108,563 | 0.65 | 1.83 |
| Honda Civic (4DR) | 2,421 (1,099) | 181,462 | 1.08 | 2.91 |
| Toyota Celica GTa | 2,425 (1,101) | 24,861 | 0.15 | 3.06 |
| Ford Focus ZX2 | 2,478 (1,125) | 65,729 | 0.39 | 3.45 |
| Toyota Corolla | 2,502 (1,136) | 253,808 | 1.51 | 4.96 |
| Dodge Neon | 2,581 (1,172) | 119,542 | 0.71 | 5.67 |
| Ford Focus Sedanb | 2,586 (1,174) | 195,867 | 1.16 | 6.83 |
| Chevrolet Cavalierc | 2,617 (1,188) | 174,974 | 1.04 | 7.87 |

1. sports car
2. includes hatchback model
3. includes equivalent sister brand

238 | Manual for Assessing Safety Hardware

TABLE H-2. Light Truck and SUV Weights and Sales Volumes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Make/Model** | **Curb Weight, lb (kg)** | **2002 Sales, No. of Units** | **Market Share, %** | **Cumulative Market Share, %** |
| Ford Excursion (4WD) | 7,087 (3,215) | 21,883 | 0.13 | 100.00 |
| Ford Excursion (2WD) | 6,650 (3,019) | 9,877 | 0.06 | 99.87 |
| Dodge Ram 3500 Quad Cab (4WD) | 6,638 (3,014) | 11,683 | 0.07 | 99.81 |
| Hummer H2 Wagon | 6,400 (2,906) | 7,422 | 0.04 | 99.74 |
| Chevrolet Avalanche 2500 (4WD)a | 6,353 (2,884) | 4,702 | 0.03 | 99.70 |
| Ford F-250 Crew Cab (4WD)b | 6,271 (2,847) | 43,049 | 0.26 | 99.67 |
| Chevrolet Silverado 3500 Ext. Cabc,d,e | 6,231 (2,829) | 25,527 | 0.15 | 99.41 |
| Dodge Ram 3500 Quad Cab (2WD)f | 6,216 (2,822) | 12,251 | 0.07 | 99.26 |
| Ford F-250 Supercab (4WD)b | 6,005 (2,729) | 155,120 | 0.92 | 99.19 |
| Chevrolet Silverado 2500 Crew Cab (4WD)a,e | 5,892 (2,675) | 37,866 | 0.23 | 98.27 |
| Chevrolet Silverado 3500 Reg. Cab (4WD)e | 5,870 (2,665) | 8,397 | 0.05 | 98.04 |
| Ford F-250 Crew Cab (2WD)b | 5,841 (2,652) | 18,449 | 0.11 | 97.99 |
| Ford F-250 Reg. Cab (4WD)b | 5,837 (2,650) | 42,326 | 0.25 | 97.88 |
| Lincoln Navigator (4WD) | 5,774 (2,621) | 14,178 | 0.08 | 97.63 |
| Dodge Ram 2500 Quadcab (4WD) | 5,769 (2,619) | 38,860 | 0.23 | 97.55 |
| Chevrolet Silverado 1500 Crew Cab (4WD)e | 5,763 (2,616) | 45,529 | 0.27 | 97.32 |
| Chevrolet Suburban 2500 (4WD)d | 5,760 (2,615) | 7,175 | 0.04 | 97.05 |
| Chevrolet Avalanche 1500 (4WD)a | 5,652 (2,566) | 95,429 | 0.57 | 97.01 |
| Ford F-250 Supercab (2WD)b | 5,601 (2,543) | 66,480 | 0.40 | 96.44 |
| Cadillac Escalade (4WD)c | 5,554 (2,522) | 48,001 | 0.29 | 96.04 |
| Dodge Ram 2500 Regular Cab (4WD) | 5,501 (2,497) | 12,609 | 0.07 | 95.75 |
| Dodge Ram 2500 Quad Cab (2WD) | 5,464 (2,481) | 12,272 | 0.07 | 95.68 |
| Chevrolet Silverado 1500 Crew Cab (2WD)e | 5,461 (2,479) | 48,357 | 0.29 | 95.61 |
| Lincoln Navigator (2WD) | 5,424 (2,462) | 15,607 | 0.09 | 95.32 |
| Chevrolet Silverado 2500 Reg. Cab (4WD)e | 5,424 (2,462) | 159,943 | 0.95 | 95.23 |
| Chevrolet Silverado 2500 Ext. Cab (2WD)e | 5,393 (2,448) | 35,688 | 0.21 | 94.28 |
| Toyota Land Cruisere | 5,390 (2,447) | 15,172 | 0.09 | 94.07 |
| Ford F-250 Regular Cab (2WD) | 5,356 (2,432) | 16,280 | 0.09 | 93.98 |
| Ford Expedition (4WD) | 5,297 (2,405) | 55,714 | 0.33 | 93.89 |
| Toyota Sequoia (4WD) | 5,270 (2,393) | 33,883 | 0.20 | 93.56 |
| Chevrolet Suburban 1500 (4WD)e | 5,219 (2,369) | 127,427 | 0.75 | 93.36 |
| Dodge Ram 1500 Quad Cab (4WD) | 5,184 (2,354) | 87,263 | 0.52 | 92.61 |
| Ford E-150 Econoline Wagon (2WD) | 5,101 (2,316) | 22,147 | 0.13 | 92.09 |
| Toyota Sequoia (2WD) | 5,070 (2,302) | 36,414 | 0.21 | 91.96 |
| Chevrolet Tahoe (4WD)e | 5,050 (2,293) | 159,914 | 0.95 | 91.75 |
| Dodge Ram 1500 Quad Cab (2WD) | 5,035 (2,286) | 136,488 | 0.81 | 90.80 |
| Ford F-150 Crew Cab (4WD) | 5,006 (2,273) | 36,552 | 0.22 | 89.99 |
| Chevrolet Silverado 2500 Reg. Cab (2WD)e | 4,995 (2,268) | 16,060 | 0.09 | 89.77 |
| Ford Expedition (2WD) | 4,909 (2,229) | 101,266 | 0.60 | 89.68 |

a Includes both 2WD and 4WD models b Includes both 1-ton and 3/4-ton models c Includes both 2WD and 4WD models

d Includes extended cab and crew cab models e Includes equivalent models in multiple brands

f Includes both 2WD-quad cab and 4WD-regular cab models

Appendix H—Test Vehicle Selection Procedures | 239

However, commonly available 3/4-ton pickup trucks were found to have a center-of-gravity (c. g.) height signifi cantly below that of the large SUV class that the light truck test vehicle is supposed to represent. As shown in Table H-3, most large SUVs have c. g. heights in the range of 28 in. (710 mm) to 29.5 in. (750 mm) while those for 3/4-ton, regular cab pickup trucks are closer to 27 in. (685 mm). In order to as- sure that the c. g. heights of the test vehicles are more closely matched with those of large SUVs, a

1/2-ton, two-wheel drive, four-door pickup truck was chosen to replace the current test vehicle.

Vehicles with curb weights near the two selected target weight categories were then compared to identify their basic characteristics such as body style, wheelbase, track width, c. g. height, front overhang, rear overhang, weight distribution, overall height, overall length, and overall width. Other characteristics, such as engine location, suspension type, and drive wheels were also identifi ed. Specialty vehicles, such as hybrids or sports cars, are generally excluded from use as test vehicles due to the fact that these vehicles are not representative of most vehicles in the fl eet. Table H-4 presents a summary of characteristics of small sedans weighing near 2,209 lb (1,100 kg). As shown in this table, all of the vehicles have similar dimensional and mechanical characteristics. Therefore, there was

no reason to exclude any of these vehicles. A similar approach should be taken when selecting the light truck test vehicle. Note that vehicle c. g. height becomes a very important factor when select- ing a light truck test vehicle. Provided large SUVs continue to maintain a signifi cant market share in the future, the light truck test vehicle c. g. height should be selected to be representative of this vehicle class.

As mentioned previously, a four-door, 1/2-ton pickup was selected as the light truck test vehicle because it was found to have a c. g. height generally in the same range as most large SUVs and used prices for this vehicle appear to be somewhat lower than most vehicles falling into the large SUV cat- egory. However, the c. g. height of pickup trucks has been shown to vary signifi cantly, depending upon suspension options and brand name of the vehicle. Therefore, vehicle documentation guidelines have been revised to require that testing agencies measure the vehicle center of gravity height. The measured height, after completion of vehicle preparation should be no less than 28 in. (711 mm). Although a sus- pension method is recommended for measuring vehicle c. g. height, alternative methods are acceptable, provided height measurement accuracy can be maintained to within 0.25 in. (6 mm).

A midsize test vehicle, designated 1500A, has been added to the test matrix in order to evaluate stag- ing of energy absorbing terminals, crash cushions, and truck-mounted attenuators. This vehicle will be used to determine if staging in an attenuation system is designed properly to safely accommodate high-speed, head-on impacts with mid-sized vehicles. In this situation, the mass of the mid-sized vehicle will carry it beyond the point where the 1100C vehicle is brought to a stop and likely enter into the high energy dissipation ranges of an attenuator where deceleration forces may become exces- sive for mid-sized cars. Hence, the primary concern is that this test will cause excessive ridedown accelerations. Because activation of attenuation systems is primarily related to vehicle mass and the test is a head-on impact, where spin-out and rollover are not a factor, total mass is the only important vehicle parameter for the 1500A. The 3,307-lb (1,500-kg) vehicle mass was chosen after evaluating the potential for excessive occupant ridedown acceleration in recently tested energy absorbing termi- nals and crash cushions. This analysis showed that test vehicles weighing between 2,872 and 3,755 lb (1,300 and 1,700 kg) would be most likely to cause excessive ride-down accelerations. The 1500A test vehicle was therefore set to the middle of this range.

240 | Manual for Assessing Safety Hardware

TABLE H-3. Center-of-Gravity Heights of Sport Utility Vehicles and Pickups

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Make** | **Model** | **Mass, lb (kg)** | **c. g. Height, in. (mm)** |
| 2001 | Ford | Expedition (2WD) | 5,267 (2,391) | 29.2 (742) |
| 2001 | Chevrolet | Tahoe (2WD) | 5,050 (2,292) | 29.2 (742) |
| 2002 | Chevrolet | Avalanche | 5,503 (2,507) | 29.2 (742) |
| 2001 | Dodge | Ram Van/Wagon | 4,820 (2,188) | 29.2 (742) |
| 2001 | Ford | Expedition (4WD) | 5,548 (2,519) | 29.1 (739) |
| 2002 | Toyota | Sequoia (2WD) | 5,000 (2,270) | 28.9 (734) |
| 2001 | Chevrolet | Suburban (2WD) | 5,504 (2,498) | 28.9 (734) |
| 2002 | Land Rover | Discovery | 4,752 (2,158) | 28.8 (731) |
| 2002 | Toyota | Sequoia (4WD) | 5,222 (2,372) | 28.7 (728) |
| 2001 | Chevrolet | Tahoe (4WD) | 5,417 (2,459) | 28.6 (726) |
| 2001 | Chevrolet | Suburban (4WD) | 5,673 (2,575) | 28.6 (726) |
| 2002 | Dodge | Ram 1500 Quadcab | 5,098 (2,314) | 28.3 (720) |
| 2002 | Chevrolet | Silverado 1500 HD Crew Cab | 5,544 (2,517) | 28.2 (716) |
| 2001 | Mitsubishi | Montero (4WD) | 4,788 (2,170) | 27.4 (696) |
| 2002 | Ford | F-250 Regular Cab | 5,518 (2,505) | 27.4 (696) |
| 2002 | Ford | F-150 Supercrew | 4,836 (2,195) | 27.3 (693) |
| 2002 | GMC | Sierra C2500 Regular Cab | 5,024 (2,281) | 27.0 (686) |

Appendix H—Test Vehicle Selection Procedures | 241

TABLE H-4. Candidate Test Vehicle Dimensions

|  |  |  |  |
| --- | --- | --- | --- |
| **Vehicle Parameter** | **2002 Kia Rio Dimension, in. (mm)** | **2002 Saturn SL-1 Dimension,****in. (mm)** | **2002 Toyota Celica Dimension,****in. (mm)** |
| Overall Width | 64.4 (1,635) | 63.8 (1,619) | 67.0 (1,702) |
| Overall Height | 55.3 (1,403) | 53.5 (1,359) | 51.3 (1,302) |
| Overall Length | 166.3 (4,223) | 175.3 (4,451) | 171.0 (4,343) |
| Rear Overhang | 38.0 (965) | 35.8 (908) | 31.8 (807) |
| Wheelbase | 95.5 (2,426) | 102.3 (2,597) | 102.4 (2,600) |
| Front Overhang | 32.8 (832) | 37.3 (946) | 36.9 (937) |
| Distance c. g. aft Front Wheel | 38.5 (978) | N/A | N/A |
| Front Bumper Ht. (Bottom) | 8.5 (216) | 8.5 (216) | 8.0 (203) |
| Front Bumper Height (Top) | 20.5 (521) | 20.0 (508) | 20.0 (508) |
| Rear Bumper Height (Bottom) | 10.1 (257) | 13.3 (337) | 17.5 (445) |
| Rear Bumper Height (Top) | 20.5 (521) | 23.0 (584) | 27.5 (699) |
| Front Track Width | 55.6 (1,413) | 56.3 (1,429) | 58.0 (1,473) |
| Rear Track Width | 56.9 (1,445) | 55.3 (1,403) | 57.4 (1,457) |
| Hood Height (Front) | 22.0 (559) | 25.3 (641) | 27.0 (686) |
| Tire Diameter (Front) | 22.3 (565) | 23.6 (600) | 24.5 (622) |
| Wheel Diameter (Front) | 15.4 (391) | 15.5 (394) | 18.6 (473) |
| Ground Clearance | 11.3 (286) | 8.8 (222) | 9.0 (229) |
| Wheel Center Height (Front) | 10.6 (270) | 10.6 (270) | 11.8 (299) |

444 N Capitol St. NW Ste. 249 Washington, DC 20001

[www.transportation.org](http://www.transportation.org/)