

The Snell board of directors has voted to proceed with the proposed E2016 Standard. This standard introduces a change in the way helmets will be tested. Instead of the 5.0 kg test head form masses called out in E2001, E2016 will use much the same test gear as in Snell's M2015 and SA2015 programs.

This change in test gear means that E2001 and E2016 are incompatible: some E2001 qualified helmets will not meet E2016 and some helmets meeting E2016 will not meet E2001. It is expected that current makers of E2001 certified helmets will need to make changes to switch production over to E2016. Therefore, the Foundation proposes a two year transition time between E2001 and E2016.

E2016 Introduction

- Certification Testing starts..... Immediately
- E2016 Labels Available..... April 1, 2016 (depending on the printer)
- First E2016 Helmets Available for Sale..... October 1, 2016

E2001 Termination

- Certification Testing ends..... June 30, 2017
- E2001 Labels last available..... June 30, 2017
- E2001 Production ends..... March 31, 2018

Important Differences

- Significant changes to impact testing - see below
- Labeling - helmets must be marked with the largest and smallest appropriate head circumferences in centimeters.
- Numbers of Samples - depending on the helmet's intended size range; eight samples may be required for certification testing.

Impact Test Differences

The differences between E2001 and E2016 all stem from a reevaluation of impact test head forms. E2001 required impact testing on head forms with an effective mass of 5.00 kg regardless of head form circumference. E2016 calls for impact testing on head forms for which the effective mass depends on head form size. E2001 invoked head forms meeting the mass and geometries specified in ISO Draft International Standard 6220, the same as those in the British Standards Institute 6658-1985 standard. E2016 calls out head forms matching the mass specifications in many current European Norms as well as a number of ASTM helmet standards..

This reevaluation of head form mass is supported by a study conducted at the University of Washington by Dr. Randal Ching. Dr. Ching performed measurements on 15 cadaver heads and found a strong correlation between head mass and circumference. This correlation approximates a cubic mass versus circumference relationship and suggests that the ECE 22-05 mass specification would enable a more precise fit between the properties of Snell certified helmets and the needs of their wearers across a broad range of different head sizes.

Imposing this new mass specification on Snell standards requires a host of changes to the testing and to the test criteria as shown in the following table. The table shows date for six head forms. Five of these should be familiar but the C head form is new. It has been added to fill the gap between the A and E head forms. Since, for E2001, the drop mass had been the same for all head forms, the 4 cm jump in head circumference between A and E had not been a problem. If a helmet had met E2001 requirements on a larger head form, the same helmet would obtain comparable results on smaller

head forms. But for E2016, there is a 1.0 kg difference between the masses of the A and the E head forms; the corresponding difference in test results will be pronounced. For this reason, the C head form has been selected to fill that gap and mass properties have been assigned by interpolation across the ECE 22-05 values.

Nominal Impact Velocity Table (m/sec)						
		Head Form				
		A	C	E	J	M
	Test Criteria Pk G	275	275	275	275	264
	Head Form Mass	3.1 kg	3.6 kg	4.1 kg	4.7 kg	5.6 kg
	Head form Circ.	50 cm	52 cm	54 cm	57 cm	60 cm
Test Type	Anvil	Impact Velocity (m/sec)				
Certification	Flat	6.06	6.06	6.06	6.06	5.93
	Hemi	5.42	5.42	5.42	5.42	5.31
	Horse Shoe	5.07	5.07	5.07	5.07	4.96
Deviation	Flat	5.75	5.75	5.75	5.75	5.63
	Hemi	5.15	5.15	5.15	5.15	5.04
	Horse Shoe	4.81	4.81	4.81	4.81	4.71
						4.52

The impact test criteria have been set to 275 G for the A through J head forms mostly for better compatibility with some European Norms. But this 275 G value, combined with the head form mass changes, would allow larger helmets to transmit more shock than allowed by E2001 and previous Snell standards. So, for the M and O head forms, the largest sizes, the peak G levels have been reduced even further to assure that E2016 never allows any more shock than the Foundation allowed previously.

The certification velocities replace the impact energy requirements specifications set in E2001. E2001 had effectively demanded flat impact velocities of approximately 6.3 m/sec, hemispherical impact velocities of 5.65 m/sec and horse shoe impact velocities of 5.3 m/sec. The E2016 impact velocities given in the table are based upon estimates of the capabilities of helmets of comparable size and weight to current E2001 headgear criteria but with liner densities selected to satisfy the new peak G criteria. In general, I expect that liner densities will be reduced progressively as helmet sizes go from medium to smaller but that liner densities will remain much as they are for E2001 for helmets sized 60 cm and up.

Helmet Sizing Concerns

Helmets must meet requirements over their entire range of head sizes. In previous Snell standards, if a helmet met impact requirements on the largest appropriate head form, it would also meet them reliably on smaller test head forms. But for E2016, helmets must be tested on the largest and smallest appropriate head forms if there is to be any confidence that helmets will meet requirements reliably throughout their intended size ranges. We have a procedure for determining the largest head form a helmet will fit but, unfortunately, I know of no good way to determine which might be the smallest head form. Instead, E2016 will require manufacturers to declare the intended size range of each helmet submitted for certification.

Helmet sizing information should be in terms of the smallest and largest head circumferences, in centimeters, for which the helmet is appropriate. Fractional values will be rounded down to the next whole centimeter but the largest size will be considered to include head circumferences up to but not

including the next whole centimeter value. Once a helmet is certified, all units produced and distributed must be labeled with the size range in terms of centimeters of head circumference. These labels may indicate size ranges narrower than the declaration made for certification but must not indicate any sizes outside the original declaration. If only a single value of circumference is given, it will be accepted as the both the smallest and largest appropriate values.

Test Head Forms as Determined by Size Specification (Head Circumference in cm)						
		Largest Size Specified				
		50 - 51	52 - 53	54 - 56	57 - 59	60 - 61
Smallest Size Specified	< 52	A	A-C	A-E	A-J	A-M
	52-53		C	C-E	C-J	C-M
	54-56			E	E-J	E-M
	57-59				J	J-M
	60-61					M
	≥ 62					O

If the helmet is sized so that only a single head form is appropriate for testing, E2016, like E2001, requires six samples fitted for the largest intended head size. But if the helmet's intended size range implies that two or more head forms are appropriate, E2016 demands two additional samples with the same shell and liner as the first six but which may be fitted with soft comfort padding appropriate for the smallest appropriate size. The table shows the head forms considered appropriate to head size ranges given in terms of centimeters of circumference. If a helmet's specified size range falls into one of the light gray cells along the table's principal diagonal, only a single head form is deemed appropriate and only six samples fitted to the largest intended size are necessary. Otherwise, two or more head forms are indicated and the manufacturer must provide two additional samples appropriate to the smallest intended head size.

E2001 and E2016

E2001 and E2016 are, effectively, incompatible. Newton's 2nd Law, force equals mass times acceleration, is at the root of it. Smaller sized helmets certified to E2001 will have trouble meeting E2016 requirements on lighter head forms and smaller sized helmets certified to E2016 will have trouble meeting E2001 on 5.00 kilogram head forms. Even so, the E2001 standard and the helmets certified to it will continue to have the full faith and support of the Foundation. The excellent safety record achieved by helmets certified to E2001 continues. However, in the future, the Foundation's E standards will seek superior head protection along a different path.

There is a compelling reason for this break with a successful tradition: Snell standards are voluntary but must coexist with applicable accepted requirements. E2016 adopts test head forms comparable to those in many European Norms as well as the most recent revisions of the ASTM equestrian helmet standard.

It is worth noting that E2001 called out test impacts more severe than those in ASTM F1163-04a, the previous 5.0 kg head form version of the ASTM equestrian helmet standard. But the difference between E2016 and ASTM F1163-15 is less pronounced for the medium and smaller sizes, practically non-existent for the M sized head form and the ASTM impacts for the largest O sized head form are distinctly more severe than those in E2016. The fact that the E2016 M and O head form sized helmets are expected to be much the same as those which met E2001 requirements makes this all the more remarkable. Somehow, the ASTM requirement which was pitched more than 5%

below Snell E2001 is now more than 5% more severe than Snell E2016 even though the Snell requirements for the O size have remained, effectively, pretty much the same.

The explanation is that Snell has avoided increasing the force transmission through these helmets and has structured the E2016 requirements to demand helmets of similar wall thickness and weight to those which were certified to E2001. The shift from the 5.0 kg mass head forms to those which vary with head form circumference brought about a 22% increase in O head form mass. If the O sized helmets were to remain the same, that mass increase had to be compensated by an 11% reduction in impact velocity.

Rather than make this compensation, ASTM F1163-15 continued to call out the same impact velocities specified in the earlier 5.0 kg head form F1163-04a revision. However, at least some of the O head form mass change might be compensated instead by an increased allowance for force transmission. And ASTM had also continued to call out the same peak G criteria which implied a 22% increase in the force an O sized helmet would be permitted to transmit to the test head form or to a wearer's head. The concern is whether such an increase in force transmission beyond what had been permitted earlier might lead to increased injury risk. Snell chose not to allow this increased force transmission for the O and M head forms and went instead with impact velocities calculated to demand O and M helmets comparable to those currently certified to E2001. It must be remembered that although we've changed head forms, riders' heads will remain pretty much the same as before. Until we know much more about human impact tolerance, any step which increases impact stress is a step in the wrong direction.