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U. S. Consumer Product Safety Commission
c/o Scott Heh
Project Manager
Directorate for Engineering Sciences
Washington, D. C. 20207

Dear Sirs and Modoms,

We are very happy that the "Safety Standard for Bicycle Helmets" Is ready to be finalized and approved, It has been a long and difficult process. Scot Heh and his staff should be congratulated for the effort they applied along the way. We also thank the commission for providing a process that Involved industry and consumer advocate groups. Moreover, the ASTM bicycle helmet task group, which I chair, has been allowed to be influential in this process. The ASTM group is comprised of Industry, Independent test lab people, medical people, consumer advocates, a lawyer and, of course, Scott Heh. We hope that this new standard Is implemented as quickly as possible.

However, there is one change In this last draft standard that we strongly oppose: The change of test headform mass to 5 kg for infants/toddlers. I hove been a strong advocate of lower headform mass for years and feel #hat I have more information than is indicated in tab D of the briefing package. Moreover, the ASTM standard for Infants and toddlers that I drafted would have been In effect at least one year ago if not for administrative over sight at ASTM. It is now approved and going forward with a mass of 3.2 kg for the A size headform and 4.0 kg for the E size headform. We have no field experience with helmets designed to these weights under the ASTM standard because of this delay.

We do have other field experience. The Department of Transportation, DOT, safety standard for motorcycle helmets, F.M.V.S.S. 218, has used 3.5 kg for the small headform for adults and children, for many years Every study of the effectiveness of this standard has corroborated tt. In no' instance has evidence been raised that the small headform causes helmets that ore too soft. The liners In motorcycle helmets are typically in the 2.4 to 3.0 pound per cubic feet density ra e whereas liners for bicycle helmets, adult or infant, are typically 5?! and up-

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Another source of field experience is our experience with damaged helmets returned to customer service. We pioneered infant/toddler bicycle helmets beginning in the early '80's. We developed the first Lil Belt Shell in the absence of bicycle helmet standards, We followed our intuition, experience and test data. We pushed ourselves up to 4# density just to make the helmets sturdier and more dent resistant in handling. We didn't think that was too high, Since then we have sold hundreds of thousands of infant/toddler helmets At times standards and design details have forced us as high as 5.75#. We now run at 5# for ail infant model helmets. In ail this time, with all these models, we have never seen on infant toddler helmet that was anywhere near bottoming out. Moreover, I collected damaged infant/toddler helmets for several months in 1995. Not only did I not see bottomed out helmets, I didn't see any helmet showing signs of crushing on the inside. This poses the question of whether the helmets are stiffer than infant heads or do infants just not hit that hard, The evidence is that most of the time infants don't hit all that hard. But the evidence also indicates that bottoming out is not a risk for infant helmets.

Now i want to offer some common sense and basic physics. first, energy management is often discussed regarding helmet standards. This is a false concept. No helmet standard in the world even measures energy management of absorption nor have a pass/fail criteria for energy management. A helmet can absorb zero energy and still pass any helmet standard in the world. Energy absorption k a function of input velocity minus rebound velocity. No standard requires a laboratory to even measure rebound velocity never mind dictating that the coefficient of restitution be less than 0.5 or something, A helmet can rebound with the full input velocity and pass quite well. Moreover, it can be imagined that any number of liner materials could absorb energy better than contemporary helmet liners but in fact produce a very poor helmet, A couple of good energy managers ore soft lead sheet and modeling clay. impacting either of these produces negligible rebound velocity. In other words, they absorb virtually ail of the impact energy. None of us are advocating these materials for helmet liners because energy absorption is not very important for helmets. i think that any discussion of helmet test criteria that Includes the word "energy" is suspect and might be misleading.

Acceleration management is what helmets are about. All helmet standards measure acceleration and enforce a pass/fail criteria that includes a maximum acceleration rate. Some standards measure other aspects of the acceleration/time event. This acceleration/time event is caused by an initial velocity between a head/helmet and an anti!. The higher the initial velocity the more distance, thickness of liner, is required to control the acceleration/time curve to a given set of parameters. The mass of a test headform has no effect upon this thickness.

The mass of the headform does determine the stiffness, usually the density, of the helmet liner in accordance with f=ma. In the case of the small A size headform weighing the same as the medium adult headform, the helmet liner will need to be 30% stiffer In the infant helmet simply because the contact area of the small headform is only 77% of the area of the medium headform[1]. Thus with all else equal this makes an Infant helmet liner stiffer than an adult helmet liner.

The average newborn baby weighs about 7 lb.s and cannot have on 11 lb. head. It is obvious that small baby heads weigh less than their heads will weigh as adults. So let's suppose that A size Infant heads actually weigh the 3.2 kg that I recommend. Now let's Impact this head moss with the helmet designed for the 5 kg A size headform which is already 30% stiffer than an adult helmet. Substituting 3.2 for 5 in f=ma, with all else equal, indicates that the observed acceleration with the real Infant headform weight Is 56% higher than in the case with the falsely heavy 5 kg headform. The 5 kg headform that produces say 250 g's In a laboratory test would produce nearly 400 g's In an identical Impact In the real world given the weight of real baby's heads. Substituting In f=ma a liner resistance in kN:

12.3 kN = [illegible] kg • 250 g * 9.80665 m/s^-2/g

12.3 kN = 3.2 kg • 391 g • 9.80665 m/s^-2/g

7.8 kN = 3.2 kg * 250 g • 9.80665 m/s^-2/g

Clearly the helmet developed around a 3.2 kg headform will produce lower acceleration rates for real world accidents, Any valid argument in favor of 5 kg headforms would be even more valid for 10 or 20 kg headforms. If real infants have 3 kg beads but we should test with 5 kg headforms, should we test adult helmets for 5 kg aduit heads with 8 kg headforms. In fact, a 50 kg headform for testing would lead helmet designers to develop helmets that could 'absorb far more energy before bottoming out.'

123 kN = 50 kg * 250 g * 9.80665 m/s^-2/g

123 kN = 3.2 [illegible] • 3906 g * 9.80665 m/s^-2/g

This gross over simplification ignores the fact that the light headform wouid not crush the liner to a point that far into the spring rate. But It is obvious that such a helmet would provide unsuitable acceleration mtes for real children. Actual tests that we have done and math models that we and others have tried show a small and reasonable change over the small and reasonable ranges that we tested.

I propose that test headforms should be as close as possible to the average weight of real human heads so that we can properly control and estimate acceleration rates in the real world and not just in the laboratory.

We thank you for your consideration of this mutter.

Sincerely,

Jim G. Sundahl
Senior Engineer

p.s.: Paragraph 1203.5, Construction Requirements - projections. The last sentence mentlons "fixture,' an undefined term. Please clarify this in the final draft.

'The A,E,J,M & O test headforms are "photographically" scaled. Their relative geometry is as Wows:

	Size A	Size E	Size J	Size M	Size O
circumference	50	54	57	60	62
rel. area	0.77	0.9	-e-b	1.11	1.18
rel. volume	0.68	0.85	1	1.17	1.29,