

Helmet Information For Circuit and Offshore Report

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Addition of Appendices 2, 3



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Disclaimer: A driver has the ultimate responsibility for his or her safety. The UIM does not recommend a particular brand or model of safety equipment and presents the data in this report as information only.

INTRODUCTION

One of the most important pieces of a driver's personal safety gear is the helmet. The purpose of this document is to provide information and references regarding racing helmets used for UIM Circuit and Offshore racing.

The report begins describing helmet construction and moves on to the somewhat complex subject of helmet standards. The text provides information to summarize the differences between the standards and the exact wording of the standards can be found through the use of the references. A number of important helmet subjects are addressed in the "Other Considerations" section and the report concludes with a checklist that provides a guide when selecting a helmet.

The material included has been developed from reviews, test results, and analysis from many sources and experiences. Considerable thanks and appreciation is given to the racing safety equipment manufacturers for information and artwork, the UIM Cominsafe and Cockpit Commission's personnel, the helmet testing laboratory personnel, and fellow members of the International Council of Motorsport Sciences (ICMS). Special thanks to Ed Becker and Dr. Steve Olvey for their contribution to modern helmet design.

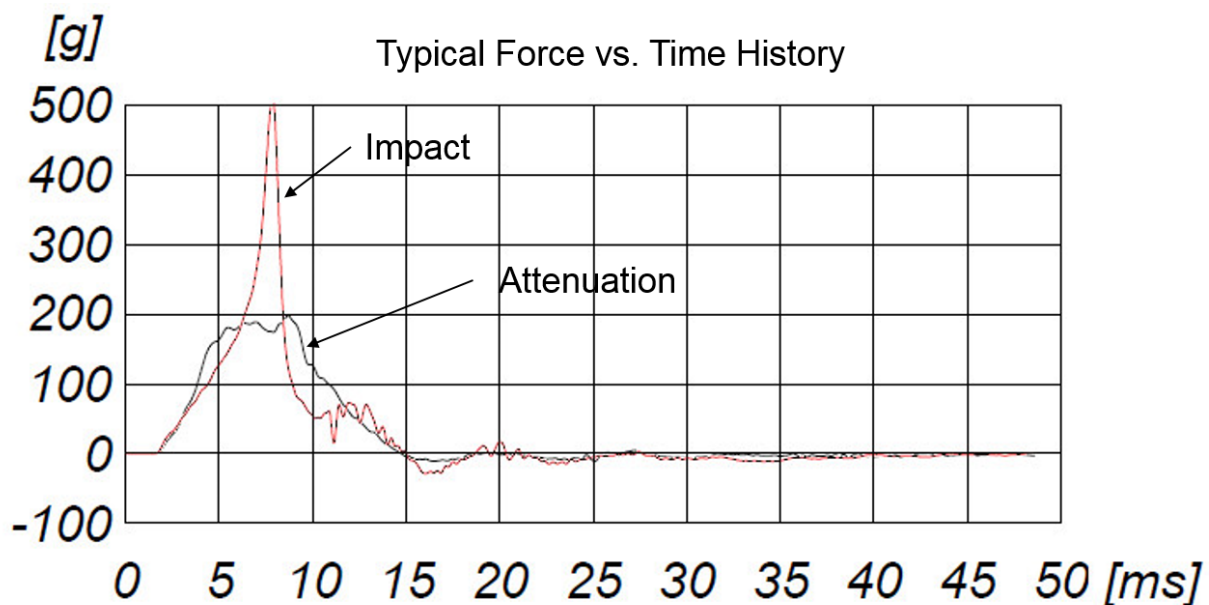
Helmet Construction

The primary purpose of the helmet is to reduce the likelihood of injury to the head during an impact to the head. There are two types of impact event scenarios considered by helmet standard developers and helmet manufacturers. One scenario relates to the helmet being penetrated and the other relates to the amount of energy being delivered to the head during an impact. Helmet construction is designed to reduce or mitigate the effects of these two characteristics of impact penetration and energy transmission.

The penetration requirement requires the outer shell of the helmet to resist and or prevent penetration from an impacting object when the race participants head is struck by or strikes an object.

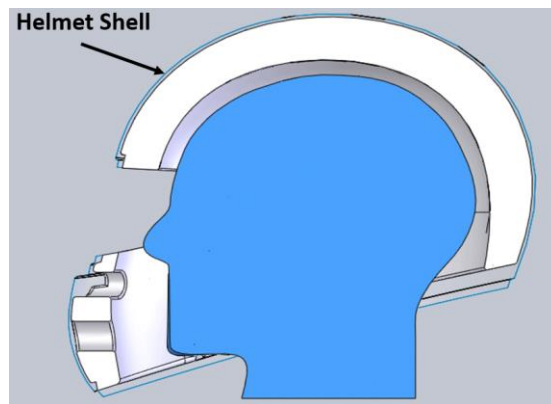
The energy management requirement desires to reduce the energy of the impact occurring on the shell of the helmet by attenuating the energy, essentially dissipating the energy by possible distortion and flexure of the shell, along with crushing and deformation of the inner liner(s) and padding within the shell, thus reducing the impact energy that ultimately is transmitted to the head.

To further illustrate the characteristics of an impact, the following figure is offered. The essential quantities used to describe the impact are units of Force and Time. There is a magnitude or “size” of the Force defined and a finite duration of time that the Force is applied. Generally, the impact event, using Force and Time to describe it, takes the shape of “pulse” where there is a rise in the Force to its maximum level and then decline occurring over a very “short” time.



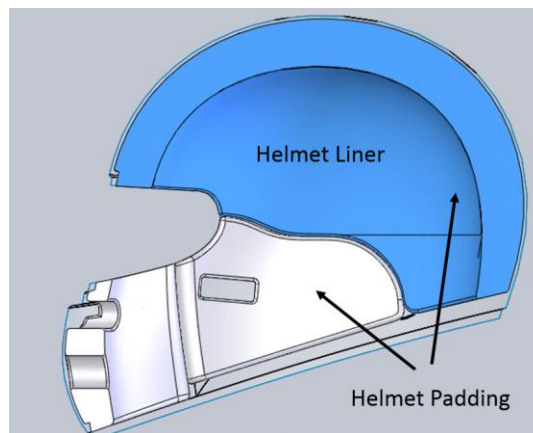
Helmet Materials

The outer shell of the helmet may be composed of Fiberglass, Fiberglass Reinforced Plastics (FRP), Carbon fiber, or combinations of these or other composite materials. The shell construction methods may be hand lay-up, vacuum bagged, thermal cured, as different processes are used by different manufacturers. The shell is one of the major components contributing to the total weight of the helmet. The manufacturer trades the cost of materials against the weight and penetration performance to arrive at the design configuration of the lay-up for the shell.



Drawing courtesy of Stand 21

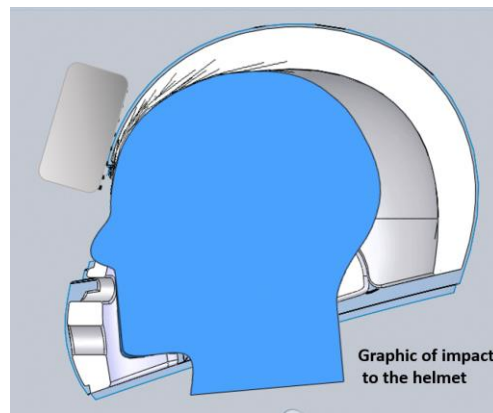
The helmet liner (and padding) is the major energy management component of the helmet. The liner is most likely made of Polystyrene or Polypropylene. The material is formed into a shell liner of closed cell foam. The Polypropylene will generally have more linear compressive properties, handle a higher initial impact loading, and have a better rebound performance than the Polystyrene.



The padding inside the liner and between portions of the shell and the face may consist of a variety of closed cell foams often covered with nylon or a soft felt. Nomex fabric is often used in helmets that may be used in environments where the helmet might be exposed to fire.

Helmet construction also has to consider the environment the helmet will be exposed to such as fresh and salt water, human sweat on the interior, grease and oils, sunlight (UV), and chemical environments imposed by painting/cleaning the shell of the helmet to name a few of the major considerations.

Consider the following graphic of how the helmet works under impact.



The helmet shell provides penetration protection and some rigidity for the inner liner as it absorbs energy of impact. The compression of the inner liner and the padding reduces the amount of energy applied to the head.

Manufacturers have many material and design options to use in construction and these options combined with the economics of different markets shaping the pricing means that there are a wide range of helmet models available. It should also be mentioned that the larger manufacturers manufacture the shell of their helmets and also the inner parts for their helmets while smaller manufacturer's may buy some or all of the parts for the helmet from various suppliers and then assemble the helmet at their build site. The wide variety of available helmets is so great it is possible to find helmets that are "less" or "more" suitable to their intended use in motorsport. Helmets are not all created "equal". So, how would a purchaser know which helmet would best suit his/her needs? We next explore the criteria that can be used to determine the helmet choice and the first area we will discuss is helmet standards.

Helmet Standards

The purpose of helmet standards is to set some criteria for the helmet performance and capability so that the buyer can be assured of the minimum helmet capability. This criteria does

not mean that a given helmet which satisfies a certain criteria will withstand all loadings and prevent injury all the time, but, rather that the helmet has been manufactured and tested to certain criteria. The standards generally discuss two subjects, the performance of the helmet under a variety of tests and inspections and a process for verifying that the helmet that is purchased is a replica of the one tested. The most stringent verification process consists of the independent testing agency buying random samples of helmets throughout a time period, usually one or two years, and then testing the samples to see that they match the originally built and tested helmet.

Standard History and Relevance

The standards that are used today are the result of a tremendous amount of work by numerous agencies over more than 60 years. This was driven, in part, by the need for a consistent level of protection as the ability to mass produce helmets grew along with the increased demand for motorcycle helmets. Some states mandated the wearing of helmets on motorcycles and the medical profession strongly urged this practice. The SNELL standards were published in 1959 and the FIA's more formal standards were also published in the late 1950's. During this time the medical disciplines were also working to understand the physiology of brain injuries. (See References 1 and 2) As more was known about brain injuries this knowledge was able to aid and influence the standards development. The DOT (United States Department of Transportation's Federal Motor Vehicle Standard 218 (FMVSS218)) (Reference 3), ANSI Z 90, British Standards Institute (BSI), the ECE 22.05 (set by the UNECE Inland Transport Committee's Working Group on Passive Safety) (Reference 4), and some national standards unique to a particular country were established along with military standards for flight helmets. The standards also progressed with improved testing methods being developed and the introduction of different shaped impact surfaces all with the desire to more accurately replicate the impact environment the helmet would be exposed to.

Since the existing standards account for linear direction in the impact, there is more work to be done in the future to be able to take into account the angular rotation that happens in most impacts. Both the work to understand the brains tolerance capability to angular motion and the modeling and development of the test techniques will occupy helmet standard research for the foreseeable future.

Comparison of Helmet Standards

There is a saying in the helmet testing and standard development world that if you could tell helmet designers exactly what your crash will be, they could come up with the perfect helmet for that impact...the challenge is having an impact, if you have one, that would exactly match the design impact. Therefore, the process of designing a helmet is the process of trade-offs

between competing variables using the standards as they are developed as criteria for performance.

The DOT standard is required of helmets worn on motorcycles driven on public streets in the US. The ECE standard is required of helmets used on public roads in the EU. These two standards apply to the majority of the helmets produced for the commercial public road use market. The SNELL (Reference 5) and FAI standards have their roots in the racing world and are the standards that are considered by competitive motorsports organizations to be applied to helmets used in their activities.

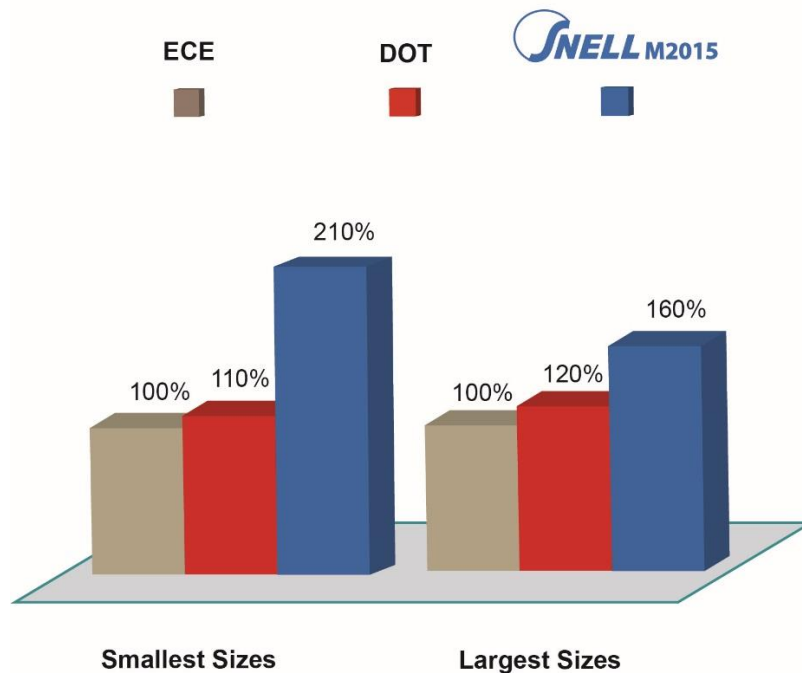
The motorsports racing sanctioning bodies undertake the mandate to specify the standards for the helmets to be used in their activities. To be more specific, the FIM currently requires a helmet with a minimum of the ECE standard. The FIM is discussing changing their requirement for competition to the SNELL M2015 standard in possibly two years. I would predict, at this writing, that this might happen in 2018. The FIA events require helmets which meet the current FIA standards (FIA 8860, Advanced Helmet, FIA 8859-2015, Premium Helmet) (References 6 and 7).

The UIM has specified the use of SNELL and FIA standards, however not all racing categories have adopted these standards and some racing categories are using ECE 22.05 as a minimum standard and the internal discussion continues.

Some boat racing categories are specifying the use of SNELL or FIA standards. The American Power Boat Association (APBA) requires the SNELL or FIA standard helmets for use. There are also a few Military Standard helmets, MIL-DTL-87174 tested to ANSI Z90.1 protocols, permitted at this time in APBA racing.

One of the primary functions of having standards is to develop helmets which manage the impact energy. A comparison between the energy management requirements of the standards is given below. Note that the detailed report is found in Reference 8.

Helmet Protective Capability Comparison *



*Impact Energy Management as a percentage of ECE demands

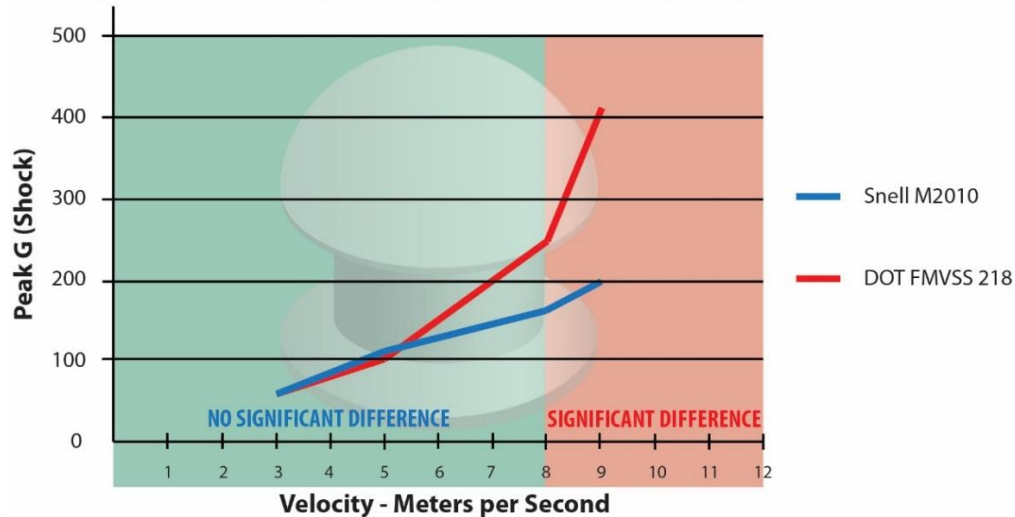
A helmet satisfying the SNELL standard M2015 would have more energy management capability across all the sizes than helmets meeting the other standards. The SNELL M2010 standard is essentially equivalent to the M2015. The other difference between the 2010 standard and the 2015 standard is that SNELL has added some requirements to test for lower level impacts. SNELL believes that lower level impacts may occur more often and with the increased awareness of concussions, desires that the helmet be more capable in the low level impact environment.

The FIA 8860-2010 may exceed the SNELL standard in some areas and this will be shown later on in this report. The FIA 8859-2015 standard is essentially the same as the SNELL M2015 standard except for larger helmets (greater than 60 cm cir.) where it requires less energy management. This FIA standard also references the SNELL standard in a number of its paragraphs. The helmet standards organizations are beginning to converge on a more common standard consistent with the design and materials capabilities of the helmet manufacturer's. It should be noted that the FIA 8859-2015 is replacing the FIA 8859-2010 and all helmets produced for FIA certification after March 31, 2016 must be labeled FIA 8859-2015 to be used in most FIA events.

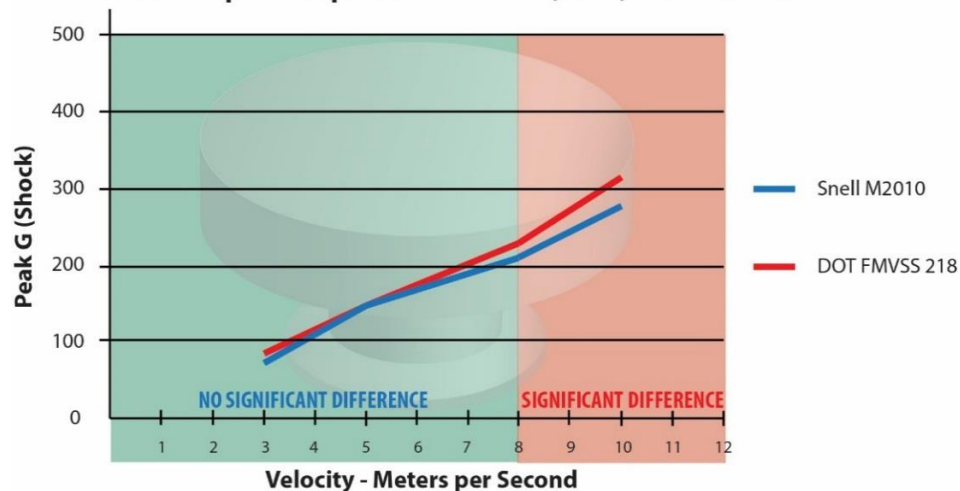
The following graphs look at a range of impacts with a certain size range of helmets to compare the energy management between the DOT standard and the SNELL M2010 standard. There are two different impact shapes used in the testing, the flat shape and the hemispherical shape. The

question to be answered was, “Is there an appreciable difference between the standards at low to moderate impacts?” and “Where does separation between the standards occur?” The detailed discussion is presented in Reference 9.

Hemispherical Anvil Impact Response - 57-59 cm (ISO J) Sized Helmets

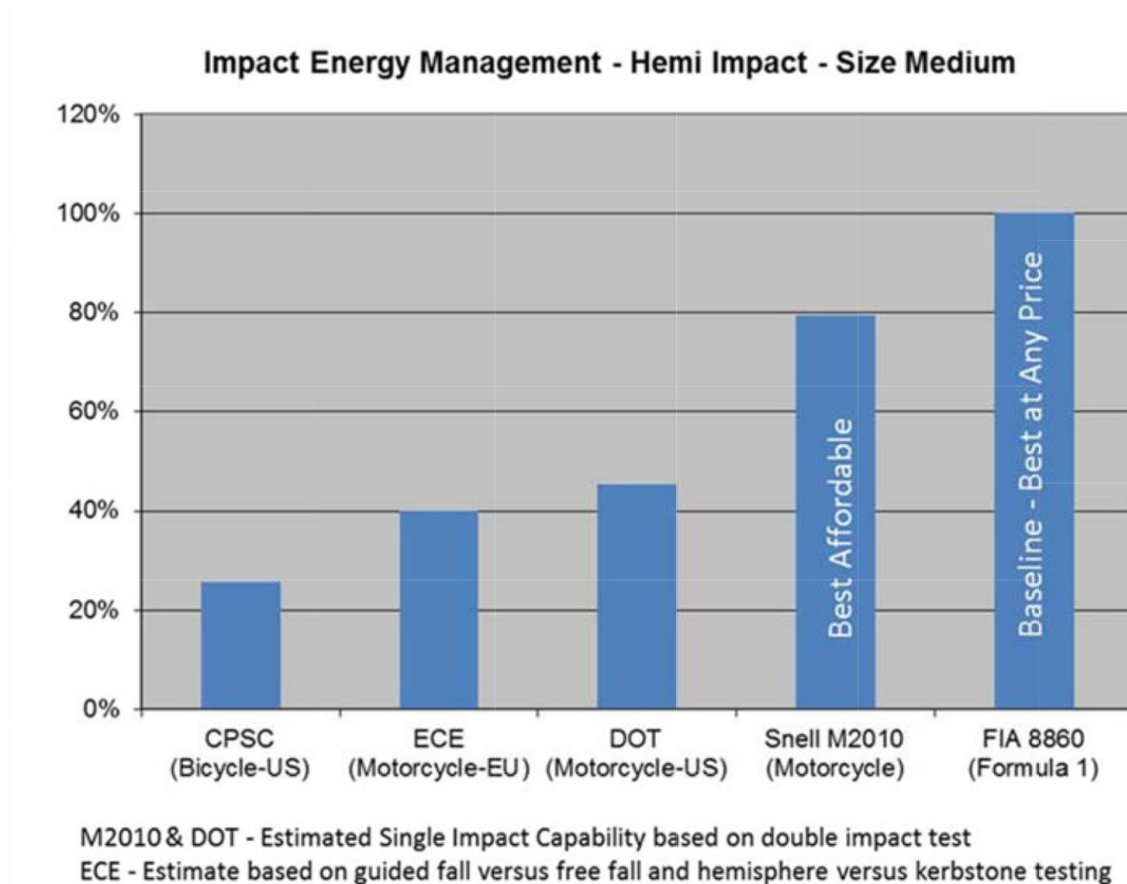


Flat Anvil Impact Response - 57-59 cm (ISO J) Sized Helmets



The results indicate that there is very little difference between the energy management of the helmets built to the DOT standard and the SNELL M2010 standard at the low impact velocities, however, there is a dramatic difference as the impact velocity increases. This would suggest that the helmets that satisfy the SNELL standard have some premium performance with respect to energy management at the higher energy impacts over the protection implied by the DOT certified helmets.

The following compares the CPSC, DOT, ECE, SNELL M2010 and FAI 8860 Advanced Helmet standards using the FAI standard as the baseline at 100%. (Reference 9)



In summary, the largest SNELL helmets must manage about 60% more impact energy than the DOT requires and the smaller SNELL sizes must manage almost 100% more. Moreover the DOT helmets are required to manage about 10% more energy than what is required by the ECE standard.

There are a number of factors that explain the difference between the SNELL energy management and the ECE energy management. Although each of the standards may specify a similar value for a maximum peak g level not to be exceeded, the energy management capability is quite different between the standards. This variation in capability results from variations in the test equipment, the shape of the impact surfaces, headform characteristics, test procedures, and other differences in the fine details spelled out in each standard. For further information on the details between the standards which lead to the different energy amounts that are being managed, the reader is referred to *Motorcycle Helmet Standards Comparison- SNELL, DOT, and ECE* included in the Appendix of this report.

Youth Standards

One of the important ways to maintain and grow the sport of boat racing is via the introduction and retention of young drivers. Considerable attention has been paid to the subject of helmets for youthful drivers and resulted in two standards in use in motorports at the present time.

They are the SNELL CMS/CMR 2007 and the SFI 24.1 standards (Reference 10).

The SNELL CMS/CMR standard specifies a maximum weight of the helmet in addition to its other requirements, such as energy management. It is the only standard to do so. The SFI does not. What this means is that the SFI helmet might use any shell that meets the energy regulation and other requirements and in some cases, an adult shell, which might have more weight than a SNELL rated helmet. The SNELL requirements on weight, then, are taking into account an emphasis on protecting the neck. The SFI standard, by not specifying a maximum weight for a helmet size and managing energy a little less than the SNELL permits a lower cost helmet to be produced, in general. It also allows the more liberal use of certain adult size shells, etc. For some junior necks, there is the possibility that an adult shell could touch the shoulders under some conditions.

The energy management capability of each standard depends on helmet size (head size). The youth sizes range from less than 49 cm head circumference to 59 cm head circumference. Interestingly some smaller adult heads are in the size ranges of the larger youth head diameters.

Summarizing a review of all the numbers and comparison tables...again there is some variation by head size...I would draw these conclusions.

The SNELL/FIA CMR/CMS 2007 standards generally requires better energy management (less shock to the head) than the requirements of SFI 24.1. The test impacts are larger forces for the SNELL testing than the SFI and they are both required to attenuate the shock loading to about the same level.

The SNELL CMR/CMS 2007 has a maximum helmet weight per head size requirement.

What you should also know is that the adult standards have more energy management required than the youth helmets...therefore, I would have a small adult head in a small adult helmet, if I could get the correct fit, which is critical. The SNELL CMR/CMS energy management approaches the adult levels, but is less than. The SNELL engineers believe this is not to much of a concern because the youth head mass is typically less than an adult and this factors into the forces being exchanged and mitigated. So SNELL standards have taken into account, youth head mass, size, helmet and weight of the helmet into consideration. SFI standards energy management exceeds the DOT capability (so that they could be used on the road, motorcycles), but would be lower in capability than SNELL.

The SNELL standard requires that a number of helmets be selected and tested randomly, each year. The SNELL foundation selects the helmets from distribution sources, randomly, and tests a quantity that varies by the number of helmets produced of a given type. If a helmet fails the Random Selection Test (RST), another three helmets are selected and tested, if a failure, then additional procedures are accomplished which, if failing, the certification is lifted.

The SFI has a self-certification process where the manufacturer has a test done every two years and submits the test report and an affidavit of test to SFI.

One more point that is important is that the helmet fit, which can change as the youth becomes older, needs to be monitored. Also, the percentage of the head shapes that are not round in the population need to be accounted for. At the moment only ARAI build helmets for three different head shapes. Arai builds SNELL CMR/CMS helmets. More on this in the next section.

Other Helmet Considerations

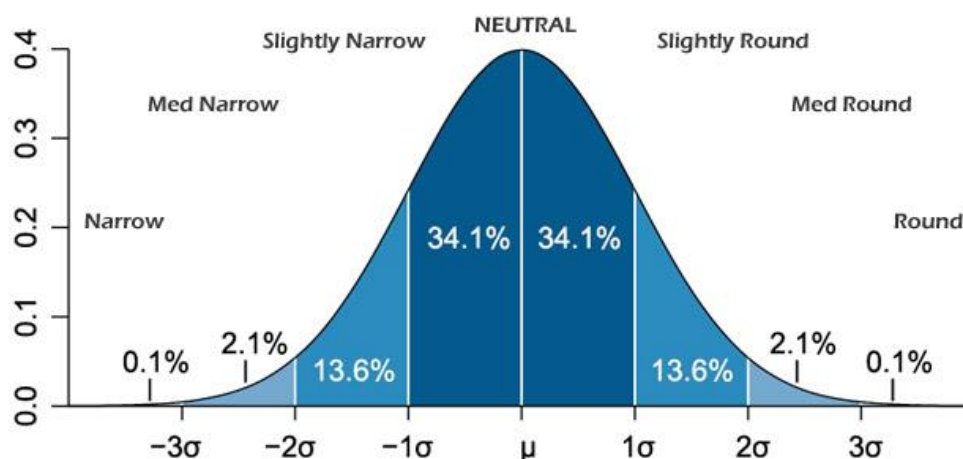
Other considerations are very important to safety and comfort. Paying attention to these items will not only enhance your performance, but that of the helmet as well.

Helmet Fit

Helmet fit is a critical element in achieving the impact performance of the helmet and also affects comfort and hearing ability. If the helmet is loose on the head or only bearing on a couple of points on the skull, the full measure of the liners capabilities may not be realized during an impact. For the unrestrained boat racing driver that may be thrown into the water, having a good fit minimizes the effects of “bucketing” where water tries to forcibly enter the helmet between the helmet and the head.

The challenge in obtaining a fit is that heads come in all shapes and sizes and your particular head is looking for a great match with helmets that vary considerably in interior size and shape. Over the years, there has been analysis to determine groupings of head shapes and profiles for adult riders and for youth. One of the more extensive head shape/fitting studies has been done by webBikeWorld.com, <http://www.webbikeworld.com> (Reference 11).

A postulated distribution of adult head sizes is shown below.



WebBikeWorld defined various head shapes and applied a Gaussian Distribution Function to estimate the percentage of adult head shapes that would occur in a specific shape. Image courtesy Wikipedia. Edited by webBikeWorld.

My personal experience and conversations with many helmet wearers is consistent with the findings of webBikeWorld. I happen to have a head shape that does not fall into the middle 64% of the distribution. Mine falls into the “medium narrow” to narrow “range” of the distribution which means that I have tried on a lot of helmets, especially when I was beginning racing, in order to find a reasonable fit. Since the bulk of the population is in the centroid of the distribution, a majority of helmets will be built to those shapes and then sizing applied as Small, Medium, Large, and from X Large to XXXL sizes. I have found that Arai is the only manufacturer to advertise and produce three distinctly different head shapes and it is curious to me why other manufacturers have not also produced multiple head shape helmets. In fact, though, there are differences between head shapes of helmets in different models from a single manufacturer. Sometimes these differences in internal shapes are subtle and may be as small as a few mm in one dimension or another, but the feel and fit of the helmet is completely different with a small change.

The goal is to have the helmet fit you, not try to have you fit the helmet. Perhaps you are not sure what a good helmet feels like, then it is imperative to get some help from a helmet fitter, someone that has experience in fitting helmets. Most larger retailers of helmets have what is known as a “fitter” on their staff. Not only will they take circumference measurements, they may have gauges or wire frames that are used for measuring the shape of the head. When they get close to knowing what shape might work, then the more detailed fitting can be tried. Many of the manufacturers supply different sizes of cheek pads and other internal padding to aid in obtaining a better fit. People with hard-to-fit heads, go to people who know what a good fit on your head looks like. Then adjust to fit internally. Sorry, there is no substitute for trying it on in person and having people with lots of helmet fitting experience help you. Another way to help

with your understanding of the helmet fitting process is to view a number of the available videos done by professional helmet fitters and available on the internet.

Another important piece of information for the hard to fit head of a driver, often a very large head shape/circumference but can be applied to more normal heads also, is that some manufacturer's will profile your head with a laser measuring device and then make a liner that fits the head contour. This process has been successfully used with drivers that have spent years in less than perfect fitting helmets to obtain a great fit.

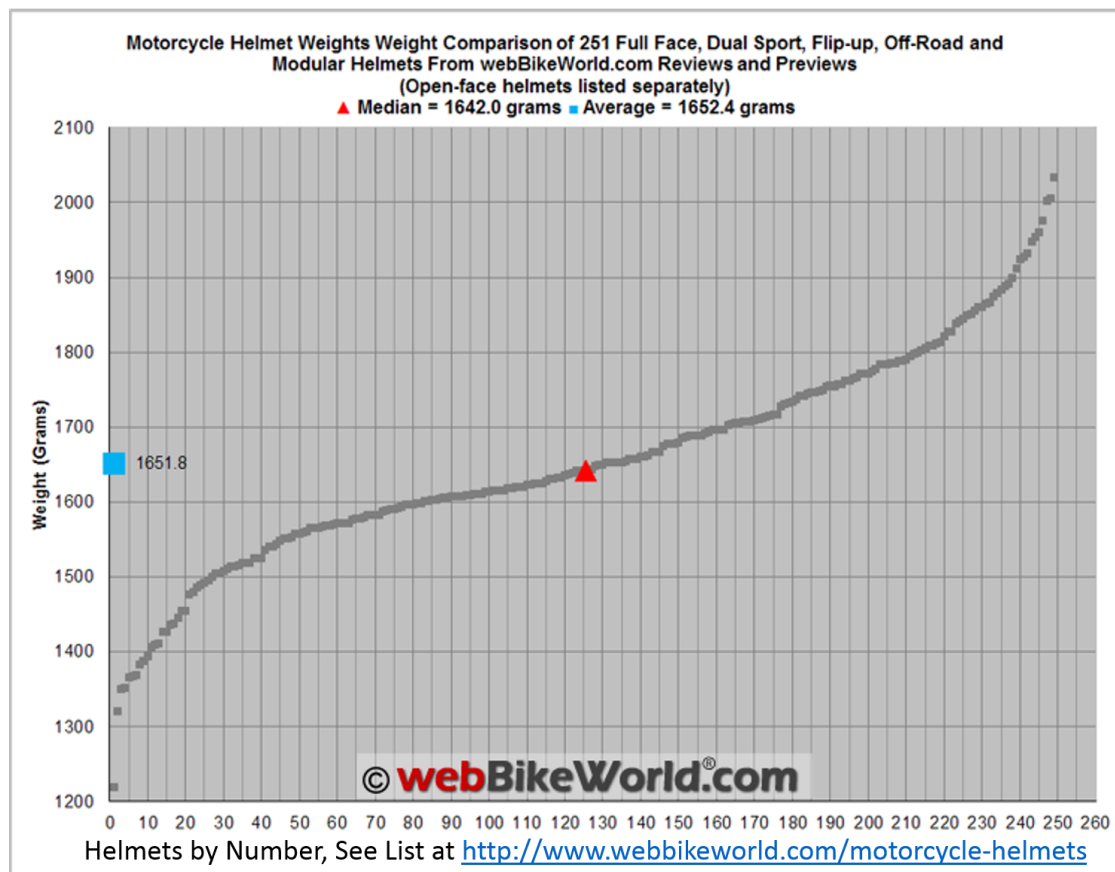
The steps for helmet fitting are 1), Determine your head shape, 2), Know your head measurement, 3), Try on helmets. Remember that a new helmet should fit snugly because as the helmet conforms to your head it will loosen just a bit and a "too loose" needs to be avoided. Also, with the correct fit, there should not be "pressure points" being felt on the skull, but more of a uniform pressure.

Helmet Weight

The next consideration to take into account is helmet weight. The object of this report's information is to aid the driver in choosing the greatest protection, the best fit, and the lightest weight helmet. Existing helmet weight vary within a range for a common type of helmet like open face or full face due to the materials used, the size (small versus large), size of view port opening, and the standard that the helmet is designed to meet. The lower the weight the less strain on the neck during the wearing of the helmet and the distinct advantage in a crash situation of having less force applied to the neck and spine as a result of the g loading X the helmet weight. It should also be noted that a lighter helmet can sometimes feel heavier depending on where the center of gravity is placed. How would the center of gravity be different? Well it can vary by the difference in shape, i.e. mass distribution between two helmets, and it may vary due to the standard it meets. For example, SNELL requirements may test the helmet in a number of locations and ECE 22.05 requires impact testing in very specific areas. This can lead to different amounts of material being used (i.e. mass) in various locations on the helmet, to satisfy a given standard. To obtain "balance", there may be some material that has to be added to balance a helmet considering its c.g. location and the aerodynamic forces imposed so as to lessen the fatigue loading on the neck when wearing for sustained periods.

WebBikeWorld has weighed 251 helmets that they have reviewed in their most recent report, (Reference 12). The listing covers Open Face, Full Face, Modular, Off Road, and Flip-Up types.

Considering the total range of all the types of helmets, the weights range from 1115 grams (2pounds, 7.4 oz.) to 2054 grams, (4 pounds, 7.75 oz.). A graphical representation for the distribution of helmet weights, except Open Face, is shown below.



Once a helmet weight is heavier than the median weight, the weight begins to be noticeable. To some degree the helmets which meet the lower energy management standards may be a little bit lighter than the ones that meet the greater energy management standards, however, the helmets that meet the higher or greater energy management standards can be seen to be a very light weight in some models and this is due to the materials used in the helmet. The lighter materials, such as carbon, and carbon hybrids will raise the cost of the helmet over the cost of a more basic helmet. The interplay between protection, advanced materials, and cost for a mass produced helmet provides a lot of variability to take into account by the manufacturer in order to build a popular and successful helmet.

Helmet Shape

The majority of helmet shapes were essentially a spherical shape with a smooth exterior surface until about 20 years ago when the possibilities for lessening the wind resistance on motorcycle helmets with different exterior shapes became practical because of the capabilities to manufacture the shapes at lower cost. Not only were the shapes less drag in some cases, but, the ability to add additional venting ports that protruded from the basic spherical shell could direct airflow better through the helmet and help decrease the internal heat build up and more

importantly help with the problem of the fogging of the helmet visor in full face helmets. Shell shapes have also been modified from the spherical to enable the housing of better acoustic speakers for audio transmission.

This has an effect on the driver's choice for a helmet to be worn for boat racing. If the driver is restrained by belts in an enclosed cockpit, the external head shape will not matter as much because in a crash there is a lower likelihood that the helmet will be in contact with a high-speed stream of water, like the un-restrained driver. However, the restrained driver is reminded that it is important to have a helmet with a smooth external surface. It can help to have a thin teflon coating added to the exterior of the helmet to help reduce the friction and promote slip between the exterior of the helmet and the interior cockpit surfaces. Large communication connectors added to the external side of the helmet may also catch on the interior of the cockpit during a crash and are to be avoided.

The unrestrained driver, when tossed or thrown from a boat may enter the water from almost any angle and a number of factors can come into play. The first factor is the relative size of the helmet. The larger the helmet, the larger the drag force due to the increased cross sectional area and this force is applied to the neck and spine. When choosing a helmet and comparing helmets it is a good idea to use a tape measure to measure the height of the helmet from the base, the width of the helmet and other sizing dimensions. Two helmets that may look approximately the same size may have different external measurements. The addition of vents, duckbill fins and other non-spherical shapes increase the drag on the helmet when entering the water. It is often the case where the vents have been stripped off the helmet by the force of the water during an accident, so we know from examination of the helmets that the water's forces are at work during a high speed entry.

The UIM and APBA have banned the use of photographic equipment that is mounted on the helmets. Not only is the mass of the helmet increased, the drag from these devices when entering the water is considerable and add more risk of neck injury. Analysis was performed in 2013 to determine the forces that would be applied to the helmet/head from a helmet with camera entering the water at 80 km/h (50 mph) and the loading from the typical camera ranged from 592 Nt. (133 pounds) to 787 Nt. (177 pounds). Some argue that the mount of the camera breaks off and therefore the load is not imparted to the helmet. Our analysis indicates that there is a load applied to the helmet in any case, especially since the camera mount is not designed to come off easily and the loads are certainly in excess of the capabilities of the neck if certain angles are achieved upon entry.

The use of the helmets with the protruding visor commonly known as the "motocross style" also present a large surface (visor) protruding from the basic hemispherical shape of the helmet. This configuration provides another large surface that may catch in the water upon impact and exert additional loads upon the neck. A driver that would choose this type of helmet would be responsible for increasing the possibility of injury to themselves.

The emphasis of this section is to raise awareness that the shape of the helmet does influence the neck and spinal loading, especially for the unrestrained drivers, and to choose the helmet with the smaller crosssectional area and least differences in outer shell shape from a spherical configuration.

Head and Neck Restraint (HNR)

The HNR devices have proven to lower the risk of spinal injury in crashes. There are two specifications which refer to HNR's, the SFI 38.1 (Reference 13) and the FIA 8858 (Reference 14).

The helmets which are used with a HNR have attach points for the HNR tethers that restrain the helmet/head motion in a crash. The location of the tether points is defined in the specifications and also in the HNR instructions supplied with the HNR device. A number of helmets are being produced with the mounting hardware for the tethers already located on the helmet. The FIA 8859-2015 helmet standard also refers to the FIA 8858 HNR standard so that helmets that meet this helmet standard are required to satisfy the HNR requirements. These specifications refer to the restrained driver where the driver and the HNR are restrained by the restraint belts in the cockpit (Reference 15) .

For the unrestrained driver there are some HNR devices manufactured that are of two basic types. One type restricts the motion of the helmet by interfacing the lower edge of the helmet with the device worn over the shoulders (similar to a "collar") and has been developed for motorcycle riders. These types do not require modification of the helmet. The other type of device consists of tethers that are attached to the helmet and then attach to the driver via belts under the armpits and/or to the lifejacket. The instructions for modifying the helmets to attach the tethers are included with the devices. These types of device are undergoing evaluation in the motorcycle racing community and within the unrestrained boat racing driver communities as to their efficacy and to determine potential changes in design.

Vision Protection

Eye protection is accomplished in a couple of ways depending on the style of helmet. For the Open Face style, there are visors and more commonly, goggles. For the Full Face style, the more common style in boat racing, eye protection is accomplished by a visor. The vision challenge is fogging of the visor due to the high humidity and moisture conditions that are often present in boat racing. The protection of the eyes from debris in a crash and from the effects of forceful water in the eyes and face is of high importance. The visor adds another optical surface between the eye and viewed object so the optical clarity in addition to having sufficient strength to withstand impact forces is important. In the past couple of years, the helmet manufacturer's have thickened the visor material to improve its impact strength and designed with optical clarity in mind. It is well worth the time to compare visors and having selected a

helmet, ask if there are any optional visors available that may have extra features over and above the standard visor. There are some categories of boat racing where the drivers assume that since they are in a safety cockpit, they do not need the eye protection. That is a very poor assumption, the eyes need to be protected at all times.

Another related subject to be aware of is the size of the eye port. On most motorcycle helmets the eye port will be larger than the eye port of the helmets made for car racing. This is a feature to check out when comparing helmets and for the different dimensional requirements for the various eye ports, they can be seen in the SNELL standards.

Glasses can be considered as some sort of eye protection although not as capable as the helmet visor itself, so should be used with a helmet visor. A note to remember is that it can be easier to get the glasses on in a full face helmet if the glasses rims are trimmed smaller. This may take an optician, but well worth the effort for putting on the helmet and taking it off cleanly.

Helmet Life

Common agreement among manufacturer's regarding helmet life is that the helmet should be replaced at least every five years. After an impact, the helmet should be sent to the factory to determine if the inner liner has been crushed. If the liner has been crushed, the helmet will probably be turned into souvenir as some of the energy management capability is gone. The more expensive helmet have better materials and the interiors will not be as susceptible to the elements, solar radiation, human sweat and hair oils as the lower cost helmets. If the helmet has not been damaged or impacted, the liner will usually begin to wear out as soon as 3 years, in some cases.

MIL-SPEC Helmets (Revised March, 2020, also see Appendix 2)

Mil-Spec helmets are the flight qualified helmets that satisfy military standards for energy management and require the helmets to satisfy flight environment conditions including air blast to the visor in the case of ejection from a high speed aircraft. These helmets usually have very good acoustic properties in the earpieces and microphones to enable communication in a high noise level environment. The flight helmets also are designed to retain an air mask for the pilot, while most boat racing helmets, adapted from motorsport, have to be modified by a boat racing supplier to add the air mask. The modifications for the motorsport helmets for the addition of the air system are understood by the manufacturer's and are in an evolutionary stages as new ideas are developed and tried.

The flight helmets generally satisfy MIL- DTL-87174 and ANSI Z90.1 protocols. The loading, test procedure, and permissible transmitted g's to the head requirements are different than the SNELL or FIA requirements and the helmets provide less energy management than the

motoracing standards. The two brands that were being used are the Gentex CGF and the MSA Gallet helmets. The MSA Gallet helmet was tested to the SNELL standards in June 2019 and failed to satisfy the energy management criteria. The test result curves are shown in Appendix 2.

The test report states that the helmet is not recommended for motor racing use. These helmets are not permitted in UIM racing.

Misrepresented Helmets

During the past year or so a couple of incidents have occurred where helmet certification has been misrepresented. The first type of incident is where the certification label, such as SNELL, has been counterfitted and applied to a helmet which had not gone through the certification process. There is something usually wrong with the actual label, or the label is affixed in a different place in the helmet than usual, or an actual label is removed and placed on another helmet. The objective seems to be to lower the cost of a certified helmet by affixing the certification label to a less costly helmet.

The second type of misrepresentation occurs on the internet. A helmet make and model will be listed as certified, for example SNELL, and when the helmet arrives at the buyers, there is no SNELL sticker apparently in the helmet. This seems to happen mostly in Europe, where a person can buy both SNELL certified helmets and ECE 22.05 helmets. It appears that the dealers that run the internet ad's do have both types of certified helmets in stock but may choose to sell a certain standard, (such as substituting an ECE approved helmet for a SNELL approved one) into a given geographical area, in this case Europe. It has been inconclusive as to how the misrepresentation happens, but the manufacturer's that have been contacted have instructed dealers that are selling their helmets to be very careful to sell and deliver the helmet type that is ordered.

These situations indicate that care must be taken to ensure that when you are buying a helmet it is examined to make sure that it is certified/labeled correctly for your sanctioning body's requirements.

The Checklist

The following is provided in order to help sort through the information and help when you are choosing a helmet.

- ❑ Check your sanctioning body's requirements in order to understand what standards are required for the helmet.
- ❑ Determine the use of the helmet, is it for closed cockpit restrained driver with HNR, aircsystem, is it for an unrestrained driver, is it for a youth? Do you want a narrow viewport or wider viewport? Check the thickness of the visor and how it is attached to the helmet considering whether the helmet is being used in a cockpit or in an open boat.
- ❑ Determine your head size and shape. Get experienced help, if needed.
- ❑ Try on helmets to obtain a proper fit, Get experienced help, if needed. This may require effort on your part, effort to travel, to find a large enough selection. This effort is well worth it when you find a comfortable well fit helmet with the protection you desire.
- ❑ Compare helmet weights among helmets that fit well and consider the lightest having satisfied the criteria above.
- ❑ Compare the external dimensions of helmets, especially if you are driving an unrestrained cockpit boat. Choose the relatively "smaller" of the helmets.
- ❑ Check to see that the helmet does not have pronounced protrusions such as venting, duck bill shapes that might catch on the interior of the cockpit or catch when entering the water.
- ❑ Check to see that the external surface of the helmet is smooth and low friction.
- ❑ Check to see if the provisions for a HNR device are provided or whether you might have to do the installation if you want an HNR.
- ❑ Is the certification labeling in place appear legitimate?
- ❑ If the helmet that gives a great fit and is light weight, and satisfies your other criteria is "too expensive" in your eyes, consider the cost of health care should you have an injury. Do not cut corners here.
- ❑ If your helmet is more than five years old, start the process of looking for another helmet. Helmets change markedly in five years and there may be some significant improvements. Start back at the top of this checklist and work your way through it.

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Appendix

1) Motorcycle Helmet Standards Comparison – Snell, DOT and ECE, Ed Becker

Street motorcycle helmets for sale in the United States must meet United States Department of Transportation's Federal Motor Vehicle Standard 218 (FMVSS218) commonly known as the DOT helmet standard. Street motorcycle helmets used in Europe must meet ECE 22-05 which is set by the UNECE Inland Transport Committee's Working Group on Passive Safety. These standards represent mandatory minimums but better, more protective helmets are available to those motorcyclists who choose to wear them. These helmets will have Snell certification in addition to the DOT or ECE 22-05 qualification demanded by local authorities.

Snell standards are set by the Snell Memorial Foundation, a private not-for-profit organization setting voluntary standards for motorcycle helmets, bicycle helmets and auto racing helmets as well as other kinds of protective headgear. Snell's mission is to promote the development, production and use of superior protective headgear. Snell looks for helmets which can manage impacts much more severe than the minimums satisfying either DOT or ECE 22-05. A tabular comparison of the impact test demands of the standards follows below.

Impact Test Comparison Table			
Standard	Snell M2010 & M2015	USA DOT (FMVSS 218)	Europe ECE 22-05
Flat Surface Impact			
Size	Double Impact	Double Impact	Single Impact
50 cm – 54 cm	7.75 m/s – 7.09 m/s	6.0 m/s – 6.0 m/s	7.5 m/s

Impact Test Comparison Table			
Standard	Snell M2010 & M2015	USA DOT (FMVSS 218)	Europe ECE 22-05
Flat Surface Impact			
Size	Double Impact	Double Impact	Single Impact
50 cm – 54 cm	7.75 m/s – 7.09 m/s	6.0 m/s – 6.0 m/s	7.5 m/s
57 cm – 59 cm	7.75 m/s – 6.78 m/s		
60 cm – 61 cm	7.75 m/s – 5.73 m/s		
62 cm and up	7.75 m/s – 5.02 m/s		
Load Concentrating Impact			
Size	Hemispherical Surface Double Impact		Kerbstone Single Impact
50 cm – 54 cm	7.75 m/s – 7.09 m/s	5.2 m/s – 5.2 m/s	7.5 m/s
57 cm – 59 cm	7.75 m/s – 6.78 m/s		
60 cm – 61 cm	7.75 m/s – 5.73 m/s		
62 cm and up	7.75 m/s – 5.02 m/s		
Criteria			
Size	Peak G	Peak G and Time Duration	Peak G and HIC
50 cm – 59 cm	275 G	400 G	275 G HIC 2400
60 cm – 61 cm	264 G	2 msec over 200 G	
62 cm and up	243 G	4 msec over 150 G	
Test Gear			
Rig Type	Guided Fall Twin Wire	Guided Fall Monorail	Free Drop
Headforms	ISO A 50 cm/3.1 kg ISO C 52 cm/3.6 kg ISO E 54 cm/4.1 kg ISO J 57 cm/4.7 kg ISO M 60 cm/5.6 kg ISO O 62 cm/6.1 kg	Small 50 cm/3.1 kg Med 54 cm/5.0 kg Large 60 cm 6.1 kg	ISO A 50 cm/3.1 kg ISO E 54 cm/4.1 kg ISO J 57 cm/4.7 kg ISO M 60 cm/5.6 kg ISO O 62 cm/6.1 kg

This tabular comparison summarizes the details in each of the standards, but the implications require further consideration. The double impacts in Snell and DOT versus the single impact in ECE, for example, are important mostly in load concentrating impacts. Since the helmets recover somewhat between impacts, the effect of two impacts is approximately the same as a single impact at a velocity equal to the square root of the sum of half the square of the first velocity plus the square of the second velocity. The double impacts are less important in flat surface tests although tests in the brow area of many helmets yield slightly higher G's for the second of two successive impacts.

The differences between the two guided fall rigs are slight but tests at similar velocities on the ECE free drop device are notably less severe. Much of the severity of a free drop test appears to be dissipated in rotation so that only about 80% of the energy must be managed by the helmet itself.

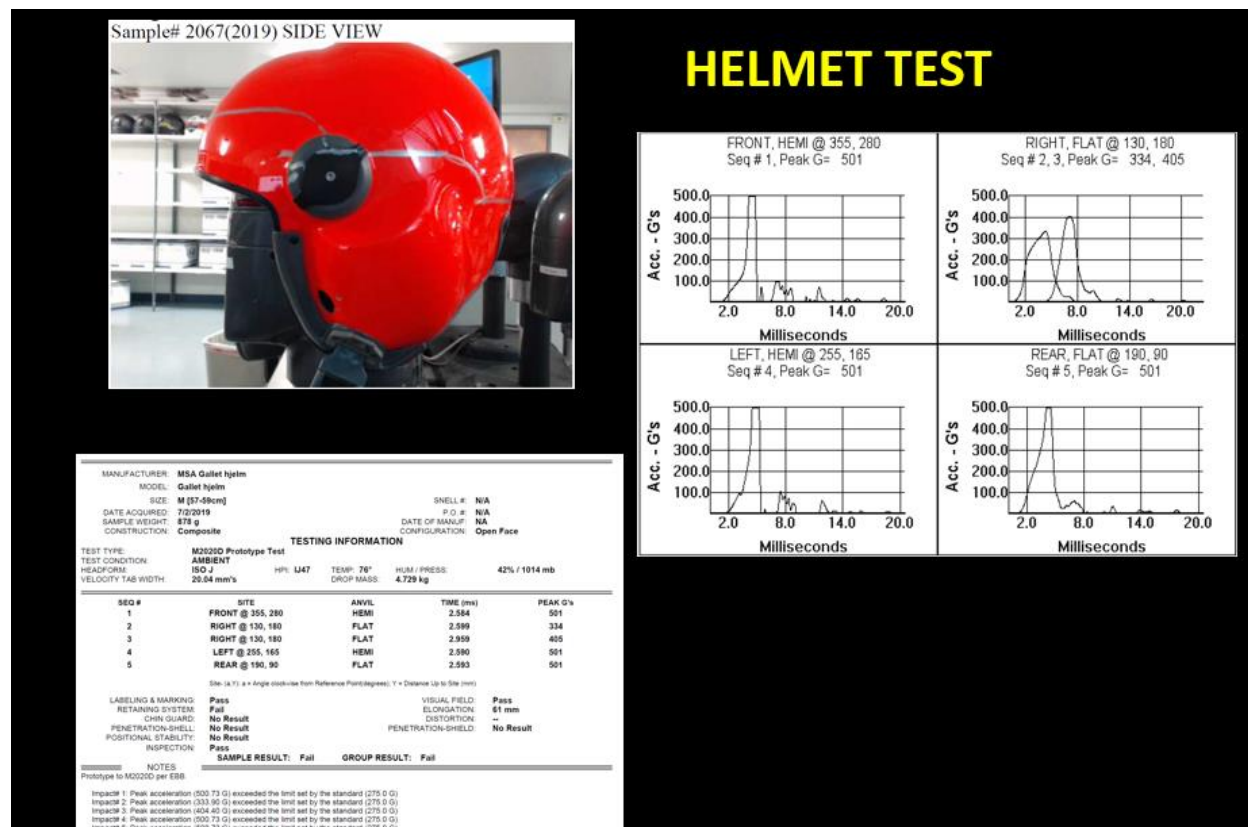
The difference between the load concentrating impact surfaces, that is, the hemisphere used in Snell and DOT tests versus the kerbstone surface used in ECE testing is that the kerbstone is less aggressive. The load concentrating surfaces generally work a limited area of the helmet's shell and impact liner. The forces exerted on the test head form are generally lower but the local compressions to the impact liner are greater. Rather than compressing a broad area of the helmet wall as in flat impact, these load concentrating surfaces appear to punch through it. If the local compression collapses the liner completely, any remaining impact velocity is transferred directly to the head form. Comparison testing on a guided fall rig indicates that liner compressions for the kerbstone are only about 80% of those for the hemisphere.

The differences in test criteria between the three standards largely bear only on the flat impact testing. Snell M2010 establishes peak G criteria but DOT imposes time duration criteria and ECE imposes a Head Injury Criterion (HIC) as well as peak G criteria. The effect of the DOT time duration criteria and, possibly, the ECE HIC criterion is that the peak G requirements set in the standard have no real importance. If the peak G exceeds about 250 G, a DOT helmet will almost certainly fail because the G pulse in flat impact will exceed 200 G for more than 2 milliseconds. The HIC criterion in the ECE standard is based on a complicated calculation performed over the entire G pulse. It too will almost certainly exceed the 2400 limit set in the standard if the peak G exceeds much more than 250 G. The peak G requirements in Snell standards are superseded for the smaller sized headgear by the requirements of the mandatory DOT and ECE 22-05. Even though Snell permits peaks as much as 25 G's greater, Snell certified motorcycle helmets are also subject to DOT in the US and to ECE 22-05 in Europe. It is only for the largest helmet sizes that the Snell peak G criteria is even more stringent than the US and European demands. This is because Snell demands also seek to limit the peak force transmitted through the helmet. Previous Snell standards had called out head form masses of 5.0 kg regardless of size. The effect was that Snell's peak G criterion amounted to a peak force limit of about 14715 Newton's. For Snell M2010 and M2015, the peak G criteria for the smaller head forms was set to 275 G for better compatibility with the current mandatory requirements but for the largest head forms 275 G would have exceeded the force limits set in Snell's earlier standards. So M2010 and M2015 call out even lower peak G criteria for these sizes to keep the peak force within these earlier limits.

The combined effect of these differences is that the largest Snell helmets must manage about 60% more impact energy than DOT requires and the smaller Snell sizes must manage almost 100% more. However, DOT appears to demand about 10% more energy management than does ECE 22-05. However, a wrinkle in the ECE 22-05 procedures raises one more consideration: impact testing is narrowly restricted to certain sites on the helmet shell rather than to broad test areas as in Snell and DOT. At least a few current ECE helmets appear to game the system by compromising the helmet structure in areas away from these specific sites. The result is that the helmets are a little lighter and more appealing but there may be holes in the protection at which the protective capabilities of the helmet are less than the 90% of DOT demands implied above.

2) Flight Standard Helmet Test Information

The MSA Gallet helmet was tested in a helmet test laboratory during June, 2019. The SNELL 2015 loadings were applied. The test report recommended that the helmet not be used for motor sport due to the high g loadings that were transmitted to the head form. The SNELL standard requires limiting the g loading transmitted to the head form to a maximum of 275 g's for the applied load. The transmitted g's exceeded 500 g's as shown in the test data below. The transmitted g values also exceeded the MIL-Std limits for the helmet. Consultation with helmet designers indicated that the helmet was not designed for a motor racing environment and the manufacturer's literature indicated that the helmet was intended for flight use.



There was an MSA helmet failure during a GN Hydroplane crash at Cambridge, Maryland, USA during the 2019 season. The Gentex flight helmet is of similar construction. The allowable transmission of g loadings transmitted to the head form was considered proprietary by the company, however, the assumption can be made by examining the construction that this helmet is not intended for motor racing use.

3) Additional Helmet Standard Comparison and Update

The following e-mail exchange resulted in additional standard comparison and is added here to update information regarding the SNELL 2020 standard.

The information is contained in the e-mail below, prompted by the question asked in the e-mail at the beginning of the e-mail string regarding ECE 2020 R.

E-mail from Bob Wartinger to Robert McCarthy, Fred Hauenstein, Thomas Kurth, and Chris Fairchild, February 12, 2020.

Hi Bob,

I appreciate the question regarding the ECE R 22-05 helmet standard.

I discussed the matter with the helmet engineers on the team and we put together the following material to help answer your questions.

You were asking about the "R" and whether ECE R 22-05 is a different animal than ECE 22-05. It is not. The R stands for Regulation. It is sometimes included in the standard designation because the standard is descended from a 1957 UNECE document promoting the harmonization of traffic regulations. The motorcycle helmet standard included in the original UNECE recommendation was known as Regulation 22. If I understand correctly, little was done with Regulation 22 until the formation of the ECU when it was the compromise motorcycle helmet standard that replaced all the national standards that had been in place before.

Looking at the two articles that you provided links for, it should be noted that there are at least a few misconceptions. The Bikes Republic article doesn't say much at all, but the helmet mass limit for ECE was new to us. I'm not sure if the original Regulation 22 limited helmet mass to 1000 grams, or the helmet shell mass is 1000 grams, but the current ECE R 22-05 doesn't seem to have any helmet mass restrictions these days. Good thing as more than a few current ECE R 22-05 helmets weigh considerably more than that.

The Silodrome article went a lot deeper, Mr. Branch did his homework, but there are still some misunderstandings. Pete Snell wasn't a famous race car driver. He was an amateur and a member of the Sports Car Club of America. However, he had more than a few friends in the Sacramento and San Francisco area. After his death in an incident in an amateur race in Arcata, California, his friends set up the Snell Foundation to memorialize Pete and to promote the development, manufacture and use of superior protective helmets.

Also, Snell motorcycle standards do not call out the kerbstone anvil. The hemi (48 mm radius hemisphere) and the flat represent the extremes of impact surfaces in Snell testing. If a helmet can withstand both of these, it will laugh at the kerbstone. There are also single impacts against a narrow 6.3 mm edge but this is more properly a test of shell toughness. Snell does do double impacts for flat and hemi but the second impacts are generally at slightly reduced velocities that are set according to our best estimates of what is reasonably the most a good helmet might withstand.

Neither of the articles discusses impact severity. This is too bad because this is the issue that sets Snell apart from both DOT, ECE R 22-05, FIM FRHPhe#01, and the upcoming ECE R 22-06. Snell hits helmets harder. There are two impacts instead of just one. Snell's impact gear, guided fall instead of ECE and FIM free drop gear, avoids losses to rotational dynamics. Some of the energy is dissipated due to the rotation of the helmet and the cabling system in the ECE testing and does not pass to the helmet.

One paper out of Sweden estimated that these losses amount to as much as 20% of impact severity. And Snell's hemi anvil is also much more severe than the kerbstone. In hemi and kerbstone impact, the helmet shell folds around the anvil surface so that, initially, the G loading is less than in a comparable flat impact. But the kerb and hemi anvils penetrate deeper into the helmet wall compressing the helmet liner much more completely than a comparable flat. If the impact severity is too great, the liner will collapse and a good chunk of the impact momentum will pass directly into the test head form or, potentially to a wearer's head. Managing the energy from these greater impacts to lower the energy transfer to the driver's head is the challenge for the helmet designer in meeting the SNELL standard. New head forms are expensive, but they are replaceable; not so driver's heads. The virtue of the hemi is that it penetrates significantly deeper into the helmet surface than the kerbstone for comparable impacts. As a result, taking the double hit, guided fall versus free fall and the hemi versus the kerbstone into account, Snell demands 60 to 100 percent more impact energy management than ECE. In fact, we think that even DOT demands more energy management than ECE R 22-05.

This energy management is a critical issue for Snell certification and Snell standards. From the first Snell standard published in 1959 till today, Snell has sought to maximize the energy management of motorcycle and auto racing helmets. Through the sixties and into the seventies, Snell standards called for greater and greater levels of energy management. However, after 1975, Snell energy management began to close in on natural limits. Snell looks for a balance between the energy management and a helmet that the riders and drivers might reasonably be expected to wear. If the helmet is too heavy or bulky for use, it won't do anyone any good.

Furthermore, the DOT standard came online in 1974 placing another limit on Snell standards. The US government essentially adopted a US consensus standard and reissued it as Federal Motor Vehicle Safety Standard (FMVSS) 218. From then on, Snell certified motorcycle helmets either had to meet DOT or they could not be distributed for sale in US. Too bad, but what's legally allowable trumps what's best every time. So, the helmet has to be able to satisfy the

different DOT testing protocol and test impact values and also meet the more severe SNELL standards all in one helmet package.

There are similar difficulties with ECE R 22-05. We remain convinced that Snell standards demand more effective protection than ECE 22-05 but ECE R 22-05 use requirements essentially locked Snell certified helmets out of European and other markets for the motorcycle and public road use. The tragedy is that ECE R 22-05 doesn't demand nearly as much impact energy management as current technology can provide. Riders and competition racers could benefit from this additional capability but, without a good standards program, no one can readily tell whether a particular helmet has the better energy management, except when the SNELL sticker is in place. Worse, since no one can tell how much energy management is in the design by just looking at it, helmet makers aren't likely to try to provide it, unless held to a standard. They will do the minimum. That's the basis of M2020R. This standard has been written to require all the impact energy management a helmet meeting current ECE and FIM demands might provide and more to meet the SNELL standard. This new SNELL standard will enable helmets that meet SNELL to also easily meet the ECE standard and possibly, eventually, the SNELL standard helmet will become more present in the EU.

FIM, for all the ballyhoo, really doesn't consider impact energy management at all. There are no hemi or kerbstone impacts set out in their testing.

Instead, FIM impact energy management depends on which of the three prerequisite standards, ECE, Snell or JIS, the helmet met before it was submitted for FIM testing. Right now, FIM impact energy management is essentially the same as demanded in ECE R 22-05.

SNELL 2020 intends to provide a helmet that will satisfy ECE R 22-05 as well as with FIM and the upcoming ECE R 22-06. But the helmet will be a long way from being identical to any of these. The point of Snell is to assure a higher level of protective performance; in fact, all the protective performance users might reasonably wear on their heads. For what we need in boat racing, we want the best energy management that we can get, that is why we need to stay with SNELL and FIA standards.

Let me know if there are more questions and we will do our best to answer them.

Bob
Bob Wartinger
206-409-8978
bobwartinger@comcast.net

-----Original Message-----

From: UIM <uim@uim.sport>

Sent: Wednesday, February 12, 2020 1:22 AM

To: Robert McCarthy <ocrda@btconnect.com>; 'WARTINGER BOB
(bobwartinger@comcast.net)' <bobwartinger@comcast.net>

Cc: UIM <uim@uim.sport>

Subject: RE: Helmet Standards

Robert,

This is to acknowledge receipt of your below e-mail enquiry on compliance of ECE R 22-05 certified helmets with the provisions of the pertinent UIM Regulations.

Your enquiry is herewith being forwarded to Bob Wartinger, UIM COMINSAFE Chairman, with the request for swift direct reply to you and guidance for the UIM Office in case an official communication concerning the matter you are raising needs to be issued by the UIM to all National Authorities and to the Powerboating community.

We remain at your disposal for any further clarification or assistance you may wish to receive.

Best wishes,

Thomas Kurth
Secretary General

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[\[cid:image015.png@01D47812.14C73110\]](#) <<https://twitter.com/uimpowerboating?lang=fr>>
[\[cid:image018.png@01D47812.14C73110\]](#) <<https://www.instagram.com/uimpowerboating/>>
[\[cid:image017.png@01D47812.14C73110\]](#) <<https://www.youtube.com/user/uimchannel>>

P Please consider the environment before printing this e-mail

From: Robert McCarthy [<mailto:ocrda@btconnect.com>]
Sent: mercredi 12 février 2020 10:10
To: Thomas Kurth UIM <tk@uim.sport>
Subject: Fw: Helmet Standards

Thomas

I have recently purchased a new Crash Helmet and happened to notice its standard is ECE R 22-05.

Whilst familiar with ECE 22-05 I had concerns with the "R". Concerned this maybe a cheap copy I did some investigating.

It seems that this is the next level of testing introduced last year and appears to exceed Snell Standards.

Please see attached links and documents.

I have always had concerns about the Snell approval although it seems they may now be working towards coming in line with ECE R.

I would request that we be authorized to accept ECE R along side Snell with immediate effect.

<https://silodrome.com/snell-vs-dot-vs-ece-r22-05-helmet-standards-throwdown/>
<https://www.bikesrepublic.com/featured/helmet-standards-ece-r22-05-un-r22-05>

Regards
Bob McCarthy