TABLE 8 PROPOSED PERFORMANCE CLASSES

Performance Class		Acceptance Test (TC x.x.x.)
Vclocity Class	Typc	
A	NR	1.1.1, 1.2.1, 2.1.1
A	R	1.1.1, 1.2.1, 2.1.1
B	NR	1.1.2, 1.2.2, 2.1.2, 3.1.2, 4.2.2
B	R	1.1.2, 1.2.2, 2.1.2, 3.1.2, 4.2.2, 5.2.2
C	NR	1.1.3, 1.2.4, 2.1.3, 3.2.4, 4.2.4
C	R	1.1.3, 1.2.4, 2.1.3, 3.2.4, 4.2.4, 5.2.4*

redirection of the test vehicle and the requirement that no significant parts of the restraint system shall become detached and that there shall be no penetration of the test vehicle by the components of the restraint system. The test vehicle shall remain upright throughout the test, although a certain amount of rolling, pitching, and yawing will be acceptable. The test vehicle shall not underride or completely override the safety barrier or crash cushion. In addition, the ground anchorages and fixings of the restraint system shall be demonstrated to perform to the design specification. While most of these requirements have been agreed on for safety barriers, those for crash cushions are still being developed. Although work is far from complete, CEN Working Group 1 has made good progress with these matters.

TEST METHODS

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As part of the CEN regulation, there are eight technical annexes that describe the test specifications a little further. This includes how-to methods of measuring the acceleration severity index (ASI), theoretical head impact velocity (THIV), post-impact head deceleration (PHD), and vehicle compartment deformation index (VCDI). They include how to compensate for instrumentation displaced from a vehicle's center of gravity and a test report from an International Standardization Organization (ISO) proposal that is very detailed. Also included is how to measure kinetic energy and average force, some measurement techniques for compensating for different locations of axle loads on the vehicles, and so on.

There are some problems with the test vehicles. Colin Wilson called his smallest one 900 kg, but this is including the 75-kg dummy, which is mandatory when testing with the small car. CEN allows for maximums for vehicle specifications, which will mean that different local cars will be used in Europe in these tests. They need not be the 1300-kg car or the 1500-kg car; they actually could be the same vehicle but with different amounts of ballast. We would like to tighten this up so that a fewer number of different cars in European testing are allowed.

There are some dimensions that should be measured inside the vehicle before performing the crash test. And then CEN looks at the relative change in these dimensions and sets an index for it. There are no requirements yet, but it should be recorded in all tests.

The impact velocity measurement is almost the same as the American model, the impact velocity of an unrestrained occupant located 0.6 m from the front and 0.3 m from the side of the passenger compartment. The main difference between the CEN and the American model is that CEN is a two-dimensional model (THIV) and the American model, occupant impact velocity (OIV), is two times one-dimensional so that one direction at a time is looked at. This is much easier to measure and calculate, and there is no need for a lot of instrumentation. But in principle they are the same.

The other index is the ASI. This is the resultant acceleration that is weighted in the different directions. For frontal impact and constant speed, with a 0.6 m flail space, ASI may be estimated at

$$ASI = \frac{(THIV)^2}{141.4}$$

This index has been used for many years in Europe in several different ways in different crash test laboratories. The filtering and averaging have been different; some laboratories have taken the maximum of each of these components and added them. So this situation is a bit mixed up. It is very difficult to compare values that do not always match the definitions.

Then there is the problem of having two different ways of calculating impact severity. There is the ASI and the THIV method, and there are the three different limits.

$$ASI = \max \sqrt{\left(\frac{\overline{a}_x}{12g}\right)^2 + \left(\frac{\overline{a}_y}{9g}\right)^2 + \left(\frac{\overline{a}_z}{10g}\right)^2}$$

$$\overline{a}_x, \overline{a}_y, \overline{a}_z = 50 \; ms \; moving \; average$$

For certain cases there is a correlation between these same accelerations. If the accelerations on impact, where there is a constant force, are looked at, and where there is a 0.6-m flail space, there is a correlation between ASI and THIV (see Figure 7). But that is just for these special cases. For other acceleration curves, other similar correlations will exist.

There are problems in working with two limits. The ASI = 1 and the ASI = 1.4 can never be reached. So the THIV value of 9 is actually the limiting factor. If it were up to THIV = 12, that corresponds in this case with ASI = 1 because ASI = 1.4 cannot be reached as long as the THIV is kept at 12. This situation will have to be accepted for a couple of years to see what will emerge.

Looking at the definition of THIV, there are connected regulations. Regulation 21 for the interior of the car (the instrument panel, back of the seat, and so on), where there is an impact speed of 70 m/sec, which is the design requirement for the interior of the car. If hit at or below that speed, an acceleration of no more than 80 g will result, which would give a severe head injury to less than 50 percent of the population. If that is looked at strictly, the THIV value should be altered down to 7.

There are some draft regulations for cars hitting a rigid barrier at 50 km/hr. There would be a THIV value of about 14 m/sec, and there would be an ASI of about 2, meaning that there would be about a 24 g mean acceleration. That is what is proposed for the frontal impact performance of cars.

There are also some investigations stating that the risk of injuries in percent is 30 times the ASI standard. So an ASI = 1 would mean a 30 percent risk of injury.

If the THIV value for a rigid barrier is less than 9, and in all types of barriers it is less than 9, do we really need all these measurements for the barriers? I see as the worst case the concrete wall. One can never hit anything harder than that. And if these numbers are correct, the THIV value is still below 9. The major thing is to concentrate on looking at the trajectory and vehicle behavior and so on, which is more important.

A European test house used an interesting propulsion system with a hot water rocket. The test house could get up to 100 km/hr in a very short distance. But it was only one small vehicle. There also was a very sophisticated measuring system with on-board recording of all data into a computer.

About the harmonization between the CEN and the United States, there is a metric system now in the NCHRP 350 report in the United States. The small car is the same. The test procedures for the crash cushions will be almost the same. There is the flail space and the THIV, which are almost the same. There is the vehicle compartment deformation index, which is also in NCHRP 350 now. There also will be equal measuring procedures. CEN uses the same standard for the instrumentation. We have come quite a long way in the harmonization process.

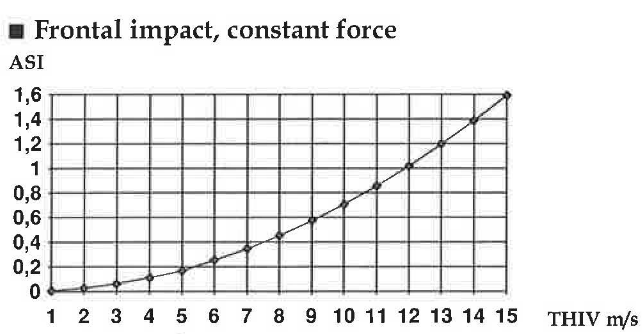

FIGURE 7 THIV (OIV) versus ASI.