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INTERNATIONAL CRASH TEST STANDARDS FOR ROADSIDE SAFETY FEATURES

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FOREWORD

The material in this publication was compiled from presentations made during a session entitled International Crash Test Standards for Roadside Safety Features, held at the 1993 TRB Annual Meeting. Mr. Harry W. Taylor, Federal Highway Administration, was the moderator for the session and prepared this circular.

The session focused on existing and proposed European and U.S. crash test acceptance procedures for roadside safety appurtenances, such as guardrails, safety fences, bridge rails, and crash cushions: what they are; how they have been developed; their similarities and differences; and how different standards will be implemented. People attending this session included highway safety researchers, highway agency technical experts, and industry representatives, indicating the high interest in this topic.

Crash testing is used by the highway safety community to evaluate and certify that roadside safety appurtenances are safe enough to be used on roads and streets. To be able to compare results of crash tests, the crash tests should be performed by a common method. Different countries that have developed their own method are now seeking to reconcile differences in these test methods. This is called harmonization. It is believed that harmonization of crash test standards will lead to increased safety by reducing acceptance time for improved roadside safety features, meeting individual conditions of each country, while providing the necessary safety.

This conference session continued the international dialog that began in September 1989 at a session initiated by Mr. Tom Turbell at the Conference on the Strategic Highway Research Program and Traffic Safety on Two Continents, in Göteborg, Sweden. In 1991 this was followed up by a workshop held at TRB entitled International Harmonization of Testing and Evaluation Procedures for Roadside Safety Features. TRB Circular 396 presents results of this workshop.

The 1993 TRB Annual Meeting was an opportune time for a conference session since (*a*) the basic test procedures for crash testing being developed in the United States and in Europe were nearly complete and (*b*) others outside the United States and Europe had asked to be kept informed of the development of these procedures. During the development of both the United States and the European Economic Community test procedures, there has been considerable interchange with representatives from both the United States and Europe attending meetings of the respective groups that are developing these separate test procedures and standards.

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OVERVIEW OF EUROPEAN STANDARDIZATION FOR ROAD RESTRAINT SYSTEMS

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The European Committee for Normalization (CEN) decided in 1990 to initiate a standardization program in the field of road equipment. For this purpose, a technical committee was created — TC 226. On the occasion of its first meeting in April 1990, TC 226 entrusted Working Group 1 (WG1) with the standardization of safety barriers, crash cushions, and, in a general way, of road restraint systems.

European Objectives

Road Safety and the Internal Market in 1993

Accidental exits from the carriageway is one of the major factors of road accidents: 25 to 40 percent of all accidents, according to the type of road. The solution to this safety problem consists in removing dangerous obstacles when possible and in implementing road vehicle restraint systems between the carriageway and the obstacle, or of the change of level.

Because of the complex aspects of road accidents, most of the European national road administrations have long since carried out their own safety studies. This has led authorities to require safety devices well designed for their specific road conditions. As a consequence, the devices and their manufacture differ from one country to another. Different prohibitions are therefore provided in the diverse European national regulations. Figure 1 displays the variety of test conditions for safety barriers and crash cushions in various countries.

In the opinion of the European Economic Community (EEC), such nonuniform regulations provide technical hindrances to trade that should now be removed in order to achieve the European internal market. For this purpose, the CEN could be mandated to harmonize the technical specifications that shall eventually become compulsory national regulations.

Concerning the roadways system market, the framework for all this action is established in a European directive, the so-called Construction Products Directive, adopted in 1988. The directive states that the harmonization of the European regulations should maintain in the different member states of EEC the present level of such restriction of the safety essential requirement for roadway users.

The Role of CEN

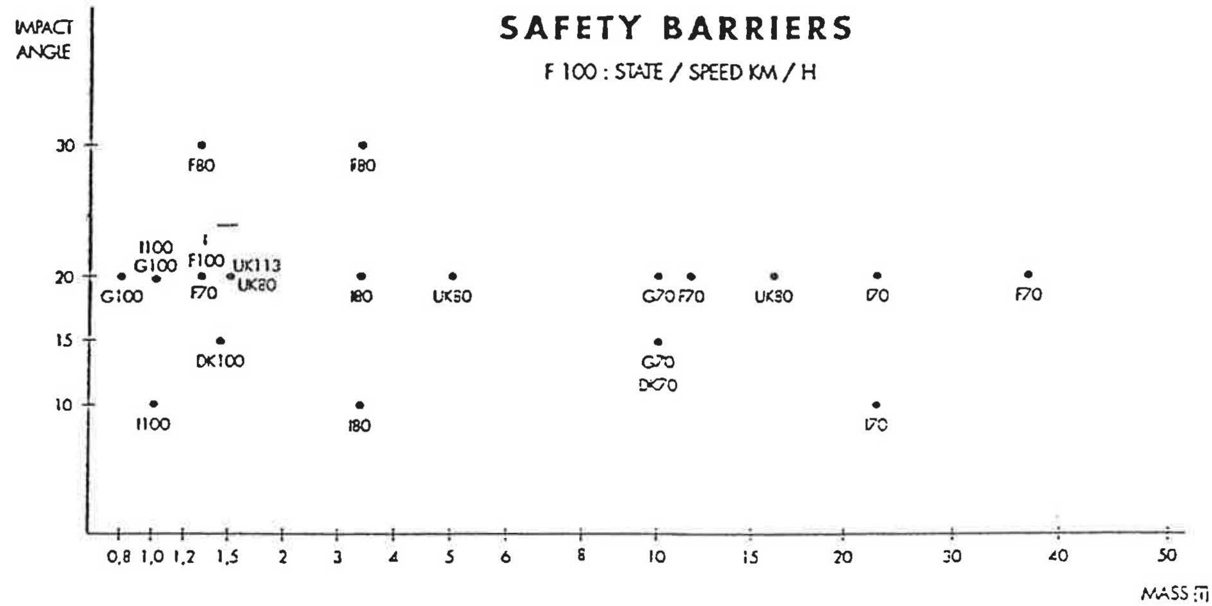
Technical specifications ensuring compatibility between products, appropriate levels for their safety, quality of efficiency, and the test methods needed to establish conformity to these specifications have so far been set by national standards bodies, sometimes very differently from one country to another, sometimes in an equivalent manner thanks to international cooperation, notably within the framework of the International Organization for Standardization (ISO).

However, a major part of these national documents is gradually being replaced by a single set of several thousand European standards forming a coherent technical background for the internal market, to the benefit of all involved in the European economic area.

CEN is the European organization responsible for the planning, drafting, and adoption of these standards (with the exception of those pertaining to the two sectors of electrotechnology and telecommunications, which are entrusted respectively to CENELEC, the European Committee for Electrotechnical Standardization, and ETSI, the European Telecommunications Standards Institute) through procedures that guarantee respect for the following principles:

- Openness and transparency: All interested concerns take part in the work program.
- Consensus: European standards are developed on the basis of voluntary agreement between the interested parties.
- National commitment: Formal adoption of European standards is decided by a majority vote of CEN national members, which is binding on all of them.
- Technical coherence at the European and national level: Standards form a collection, which ensures its own continuity for the benefit of users, both at the European and national level through compulsory national implementation of European standards and withdrawal of conflicting national standards.

The CEN has the advantage of grouping together not only the 12 states of the EEC but also the 6 states of the EFTA — European Free Trade Association:



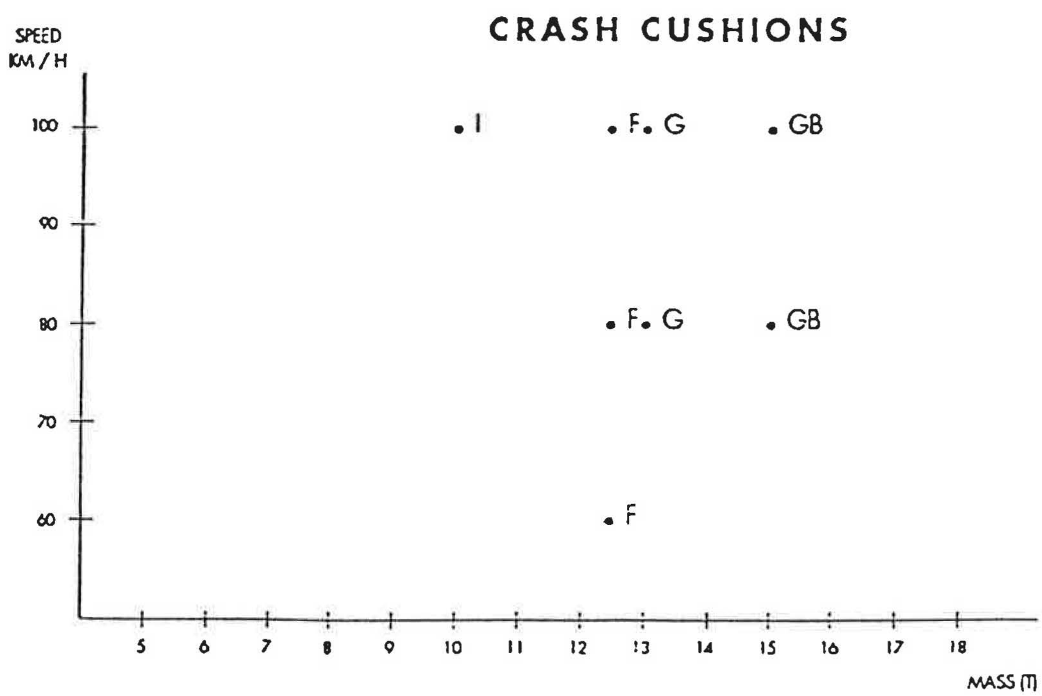


FIGURE 1 Test conditions in Europe 1990, situation testing characteristics.

Austria	Greece	Norway
Belgium	Iceland	Portugal
Denmark	Italy	Spain
Finland	Ireland	Sweden
France	Luxembourg	Switzerland
Germany	United Kingdom	Netherlands

Since 1991, seven countries from Eastern Europe have been affiliated with CEN:

Bulgaria	Hungary	Romania
Cyprus	Poland	Turkey
Czechoslovakia		

As a consequence, industries, administrations, and research laboratories of these 18 states have already begun the standardization process in the framework of the CEN. The first aim of this international activity consists in achieving the objectives on which the completion of a single European market depends.

To provide a technical force to establish all the standards, 270 technical committees inside the CEN are charged with establishment of the standards. Due to the action toward harmonization within the EEC, in 4 years the number of technical committees have doubled.

In CEN standard organizations, as it is in all European standardization processes, all interested concerns take part in one program. Industries, administrations, and research laboratories may participate in a committee or working group.

Basis for Standardization

Focusing on roadside devices, it has been unanimously agreed that satisfactory behavior under impact tests will be the basis for the standard. Within the short time fixed by the CEN, this appears to be the criterion on which a consensus may be reasonably reached. By harmonizing the performances with several levels, the standards could possibly foster innovation. The industries are thus free to design products as far as they meet the conditions of standard performance, while using various materials such as metal, concrete, plastic or wood. But the standards also remain open to include other devices with complementary functions, such as noise protection, pedestrian restraint, or aesthetic aspects.

Work of TC 226/WG1

The beginning of standardization came from the question of the technical committee dealing with all road equipment. This technical committee was created in 1988-89. During its first meeting in April 1990, the technical committee charged Working Group 1 with the standards in the field of roadway systems.

The scope of the Working Group 1 is divided into road restraint systems and pedestrian way systems. The object of the CEN/TC226/WG1 consists in dealing with all the restraint systems used on central reserves of motorways and on verges of roads, including bridge and retaining wall structures for permanent and temporary use, with priority being given to the road vehicle restraint systems that are the most used devices. Focus will be on crash cushions and safety barriers and connections between barriers, terminals, and pedestrian barriers.

Participating within the TC226, WG1 has about 40 experts from 14 different national organizations, plus two U.S. observers, Mr. Harry Taylor and Dr. Hayes Ross.

It has been unanimously agreed to raise the harmonization of the performance levels on crash tests, which appears to be the criteria from which a consensus may be reasonably reached in the short term. Initially, standards have to define impact test conditions and acceptance criteria.

The work that began 2 years ago consisted first of gathering the test conditions as applied in the research laboratories or provided in national regulations. In the area of safety barriers, there have been 2 years of work. To determine current European standards, attention was focused on the necessity of being clear about the development of the types of vehicles in the future without going too far from the present conditions. The maturity of existing systems will find their place eventually.

Documents concerning terminology on safety barriers, performance classes accident criteria, and test results are now ready for inquiry. As work progresses, crash cushions will be well advanced, but terminals will require a bit more time.

Choice of Performances

Future systems to be agreed on in the market should meet the various and complex needs of the road design.

In a general way, the choice of a suitable safety barrier depends on the risk to be covered, and the risk is a function of the road and traffic characteristics as well as the nature of the obstacles in the vicinity.

WG1 has chosen a classification based on restraint capacity. The normal level of restraint capacity concerns the containment of light vehicles, the high level concerns the containment of current lorries and buses, and the very high level concerns the containment of the heaviest authorized lorries (i.e., approaching 40 t).

The tests for all the containment levels are specified in terms of impact speed and angle as well as mass and dimensions of the colliding vehicle.

Acceptance Criteria

The principal acceptance criteria for these tests are as follows:

1. Behavior of the vehicle:
   - The vehicle shall not breach the barrier, and
   - The vehicle shall be redirected.
2. Behavior of the barrier:
   - No major part of the barrier shall fracture and become detached.
3. Severity index:
   - Both the acceleration severity index (ASI) and the theoretical head impact velocity (THIV) will be used before reaching any agreement on a single index.
4. Vehicle deformation:
   - The deformation of the vehicle interior shall be evaluated by completing the vehicle compartment deformation index (VCDI) form.

Generally, these criteria may not be evaluated on only one representative test. They may not be critical under the same impact conditions. In particular, a high containment level system that can meet the conditions of restraint for lorries might not meet the correct performance for the impact severity required for a light vehicle.

It has therefore been decided to carry out two impact tests for each specified performance class:

- One test for checking the maximum containment level, and
- An additional test on a small passenger car for checking the behavior of the vehicle and the impact severity for the safety of the occupants.

Drafted test methods are not yet ready. To determine them, attention was focused on the necessity of being coherent with the development of the types of vehicles of the future, without going too far from the previous conditions. A majority of existing barrier systems should easily find their place in the new scheme.

Conclusion

Work yet to be defined concerns all necessary prohibitions to achieve the harmonization. The European Construction Products Directive asks for labeling, so-called the "seal" or "mark," of all devices that are based on the conformity to harmonize European standards. What remains is to define all prohibitions of evaluation of conformity and an attestation procedure that will permit industries to put the seal on their products. The standards for the pedestrian barrier system will also be started.

European harmonization must obviously go further, particularly concerning performance standards for safety barriers, crash cushions, and pedestrian guardrails. Standardization in this field might be more difficult and require more time than expected. The current objective is to create a document and have it approved.

PERFORMANCE CLASSES AND IMPACT TEST CRITERIA FOR SAFETY BARRIERS AND CRASH CUSHIONS

Colin Wilson
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The first meeting of Working Group 1 took place in September 1990, when about 40 people from about 14 member countries met to produce harmonized standards for safety barriers and other systems. Representatives at the meeting included civil servants, scientists, manufacturers, and experts from research laboratories and universities. There were many problems: different languages, national standards, procedures, and regulations and perhaps a degree of national protectionism. It was soon discovered that there were different names for systems and components, and the first priority was to sort out the terminology to be used.

Safety Barriers

The following represent draft proposals. These proposals are nearing completion but are still subject to all necessary CEN voting procedures.

The idea of having performance classes for safety barriers is that a product will be able to be tested and assessed against a set of established performance criteria. Once these criteria have been complied with, a product can then be approved and registered against a particular performance class. It will be up to each member nation of the EEC and EFTA to decide what level of performance it requires on its roads. A product, therefore, does not have to comply with all the performance classes listed in the standard.

When Working Group 1 started, all participating nations entered their national performance standards on a large board. There was a great disparity of vehicle

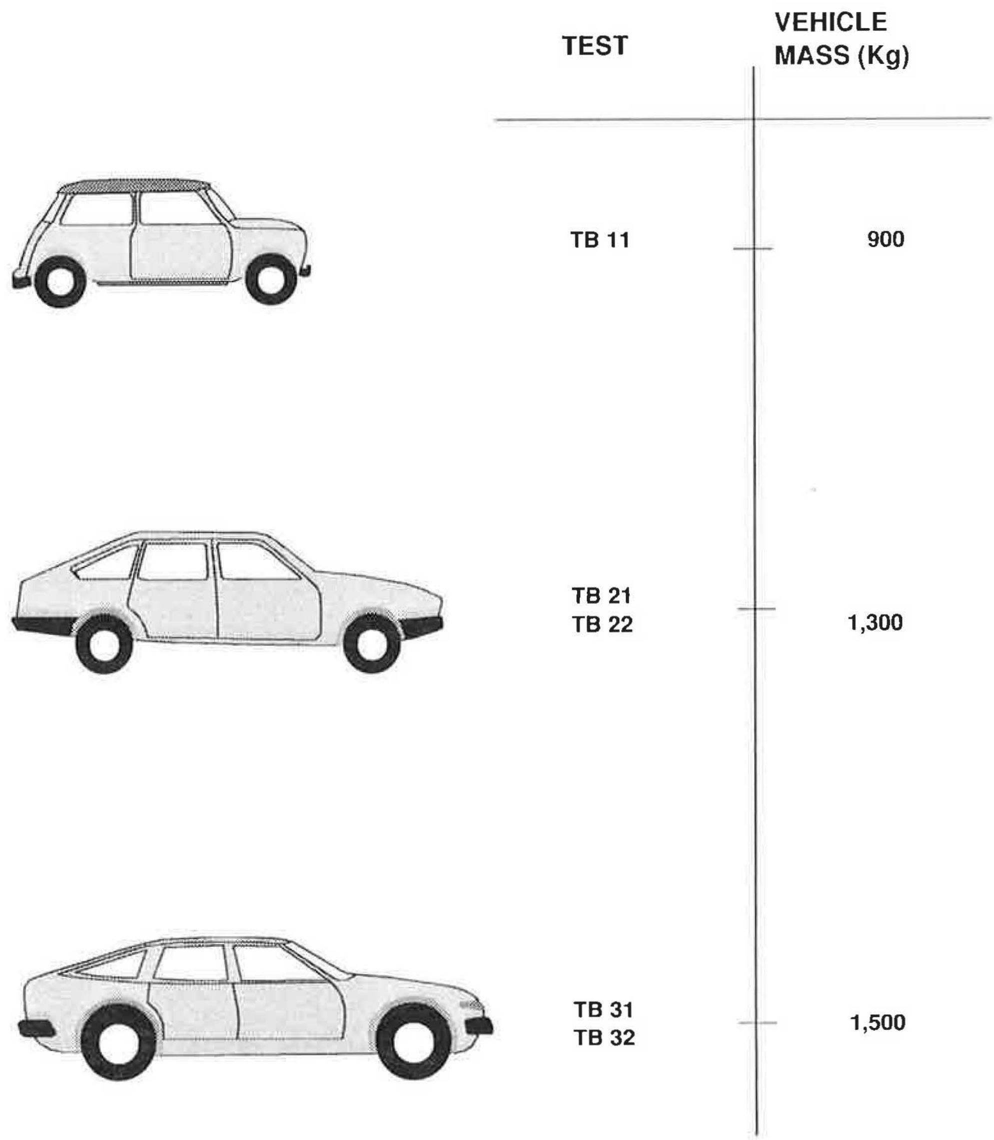


FIGURE 2 Three different weight categories of test cars.

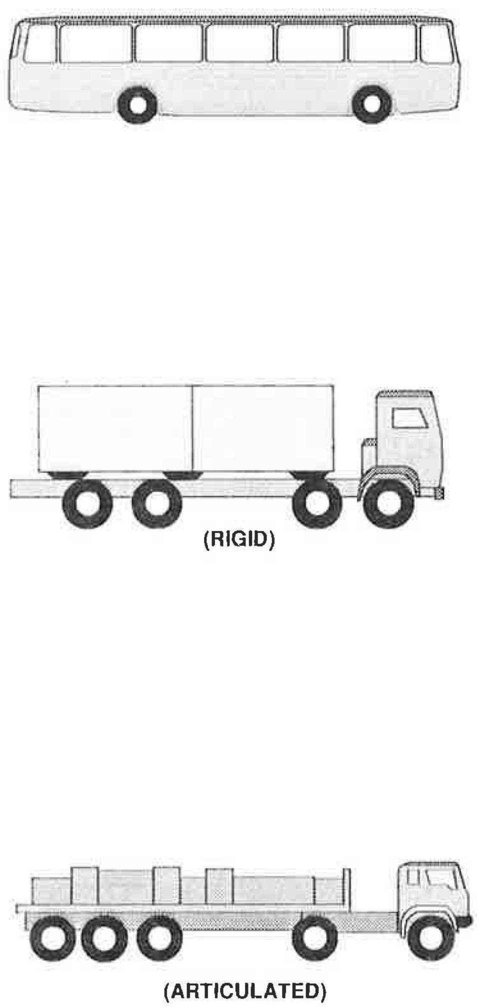
sizes, shapes, masses, and impact speeds, and a table of agreed-on vehicle types, masses, and impact speeds was drawn up. The standard test for the permanent vehicle restraint system will be the 1,500-kg car (see Figure 2).

When we started looking at what each nation used in heavy goods vehicle testing, a whole host of different vehicle masses, types, impact angles, and speeds was found. Barrier test (TB) 41 and TB 42 relate to a 10-tonne vehicle, and TB 61 relates to a 16-tonne vehicle. These different classes of vehicles are used in various countries. The 38-tonne articulated vehicle is used in France, the 30-tonne tanker is used in the United Kingdom, and the 13-tonne bus is used in Germany. In the United Kingdom the 16-tonne two-axle lorry also is used. It was necessary to rationalize the number of different heavy goods vehicles in the performance criteria list (see Figure 3).

Vehicle Impact Test Criteria for Cars

As indicated in Tables 1 and 2, the three basic elements are impact speed, impact angle, and total vehicle static mass. TB 11, TB 21, and TB 22 will basically be used for temporary restraint situations. TB 11 will cover both temporary and permanent vehicle restraint systems.

In vehicle impact testing for heavy goods vehicles and buses, one system will, if it is suitable for TB 71, probably be compliant with a TB 41 containment restraint system. There is a multitude of containment



TEST	VEHICLE MASS (Kg)
TB 51	13,000
TB 71	30,000
TB 81	38,000

FIGURE 3 Weight distinctions in three different heavy goods test vehicles.

levels from which to choose. Performance classes for safety barriers are determined by the following.

1. Containment Levels (see Table 3)

There are four categories, the first being for temporary safety barriers for use at road works, the second for normal containment, and the third and fourth being the higher and very high containment categories, which are used at hazardous locations. For the normal containment level, we use TB 32 (a 1.5-t car traveling at 110 km/h at 20 degrees) to check the structural stability of the restraint system. The small vehicle test, TB 11 (a 900-kg car impacting at 100 km/h at 20 degrees), will give an indication of the harshness and severity of the impact.

Clearly, when you get into the higher containment types of safety barriers, the need to carry out the smaller vehicle tests as well could be a major factor because one should never introduce a restraint system that not only will contain and redirect very heavy goods vehicles but also will create problems for smaller vehicles. In the United Kingdom, cars represent about 70 to 80 percent of all vehicles on the road.

TABLE 1 CAR IMPACT TEST CRITERIA

Test	Impact Speed (km/h)	Impact Angle (degrees)	Total Vehicle Static Mass (kg)
Cars			
TB 11	100	20	900
TB 21	80	8	1,300
TB 22	80	15	1,300
TB 31	80	20	1,500
TB 32	110	20	1,500

TABLE 2 HEAVY GOODS VEHICLES IMPACT TEST CRITERIA

Test	Impact Speed (km/h)	Impact Angle (degrees)	Total Vehicle Static Mass (kg)
Heavy Goods Vehicles			
TB 41	70	8	10,000
TB 42	70	15	10,000
TB 51	70	20	13,000
TB 61	80	20	16,000
TB 71	65	20	30,000
TB 81	65	20	38,000

2. Impact Severity Levels (see Table 4)

There are different procedures that are being adopted throughout the EEC. To some extent, what is happening in Europe is that some are using the acceleration severity index (ASI). In the United Kingdom the theoretical head impact velocity (THIV) and post head impact deceleration (PHID) is used. We therefore have impact severity level criteria but there is also an option: Where containment is going to be the prime requirement for the restraint system, say at a very hazardous location such as near fuel storage tanks, the main consideration is to stop the errant vehicle getting

TABLE 3 CONTAINMENT LEVELS

	Containment levels	Acceptance test
Containment for temporary safety barriers only	T1 T2 T3	TB 21 TB 22 TB 41 + TB 21
Normal containment	N1 N2	TB 31 TB 32 + TB 11
Higher containment	H1 H2 H3	TB 42 + TB 11 TB 51 + TB 11 TB 61 + TB 11
Very high containment	H4a H4b	TB 71 + TB 11 TB 81 + TB 11

TABLE 4 IMPACT SEVERITY LEVELS

Impact Severity Index	Index Value		Index Value
A	ASI £ 1.0	PLUS	THIV £ 9
B	ASI £ 1.4		PHD £ 20g

beyond the restraint system. In such cases, it may be that impact severity is not specified.

3. Deformation of the Restraint Systems (see Tables 5 and 6)

The third performance criterion is the question of how much the restraint system deflects under impact, which has been defined as the dynamic deflection and working width (see Figures 4 and 5). There are many vehicle restraint systems, all operating differently. There is the weak post design that collapses to the ground, the design where the beam and post bend over, and the wire rope type of system. The draft CEN standard states that the working width is "the distance between the initial traffic face of the vehicle restraint system and the maximum dynamic lateral position of any part of the system under the impact."

This type of information is clearly needed for designers where there are obstructions and hazards that are going to be located behind the restraint system. One can imagine bridge piers, columns, signs, and all the

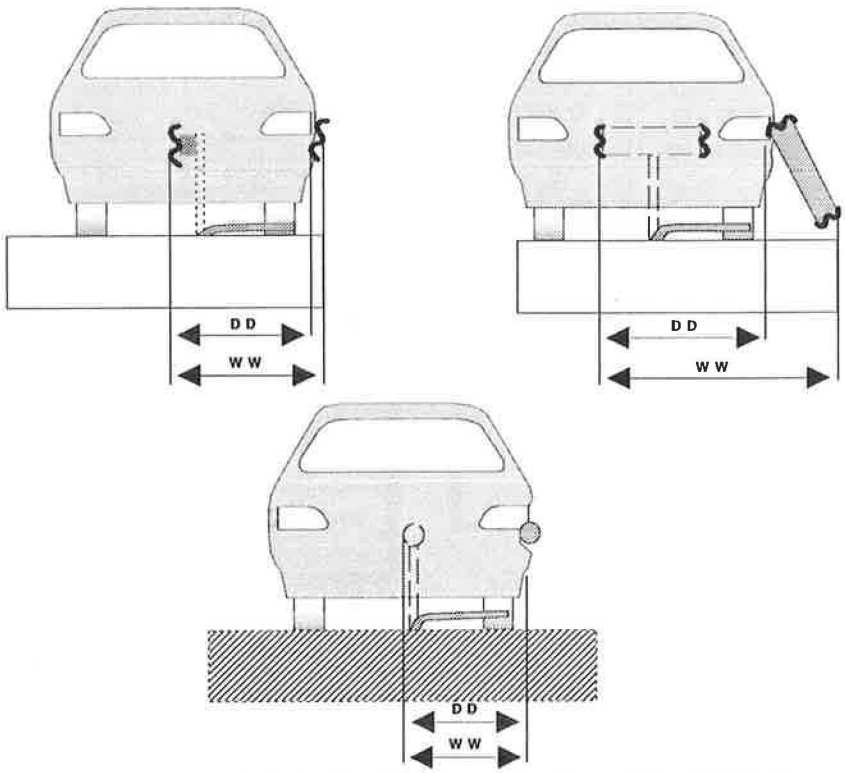


FIGURE 4 Dynamic deflection (D D) and working width (W W) for cars.

TABLE 5 DEFORMATION OF THE RESTRAINT SYSTEM FOR CARS

Containments levels CARS	PARAMETERS			
	Safety barrier and vehicle behavior	Impact severity level (ASI - THIV (PHD))	Vehicle deformation (VCDI)	Safety barrier deformation
T1	TB 21	TB 21	TB 21	TB 21
T2	TB 22	TB 22	TB 22	TB 22
T3	TB 41 + TB 21	TB 21	TB 21	TB 41
N1	TB 31	TB 31	TB 31	TB 31
N2	TB 32 + TB 11	TB 32 + TB 11	TB 32 + TB 11	TB 32

other road equipment and furniture that are within our highways.

The working width concept has also been extended into the higher containment criteria for heavy goods vehicles and buses, but most who have been involved in research of this type of device have found that there are a few other problems coming into the equation. Because of the higher center of gravities, it is likely that some

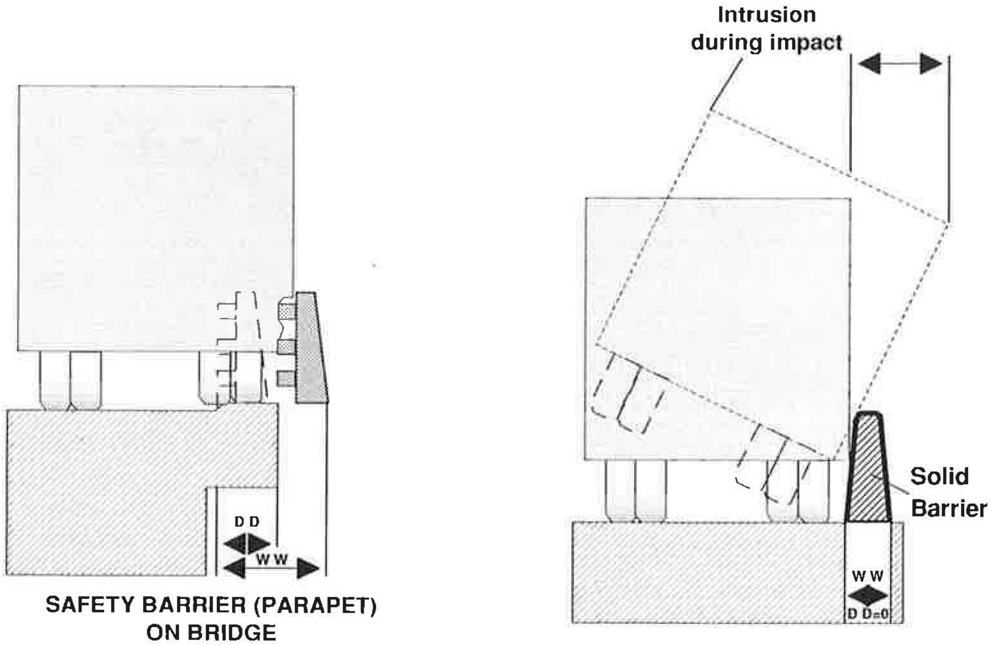


FIGURE 5 Dynamic deflection (D D) and working width (W W) for heavy goods vehicles.

TABLE 6 DEFORMATION OF THE RESTRAINT SYSTEM FOR HGVs and PSVs

Contain-ments levels HGV's and PSV's	PARAMETERS			
	Safety barrier and vehicle behavior	Impact severity level (ASI - THIV (PHD))	Vehicle deformation (VCDI)	Safety barrier deformation
H1	TB 42 + TB 11	TB 11	TB 11	TB 42
H2	TB 51 + TB 11	TB 11	TB 11	TB 51
H3	TB 61 + TB 11	TB 11	TB 11	TB 61
H4a	TB 71 + TB 11	TB 11	TB 11	TB 71
H4b	TB 81 + TB 11	TB 11	TB 11	TB 81

vehicle intrusion behind the barrier will result. The vehicle will be contained, but it may pitch and roll. This information may be very important for designers who are widening or refurbishing a road if there is a weakbridge column. For instance, can the amount of overhang observed in the impact test be allowed?

Another feature we observed in the United Kingdom when testing 30-tonne tankers on higher containment concrete safety barriers (1.2-m high) and parapets (1.5-m high) is that the rear of the vehicle can rise up to 1.25, 1.3, or even 1.4 m.

So while there may not only be a problem transversely, there could be one of available height at an overhead structure. What has been said in the draft standard is that while you cannot legislate for this in any performance standard, information on such intrusions should be recorded on the impact test report so that designers are aware of what potential systems can be used at different locations.

The classes of working width are to be split into different levels of deformation. At the lower levels of deformation, the classes will be in 0.2-m steps, but this increases up to 1.0 m where the deformation of the restraint system is very large.

The designer, when deciding which performance class of safety barrier to use, will be able to consider any approved systems that have the requisite containment level (i.e., vehicle mass and impact angle and speed), the impact severity level, and the appropriate working width.

There are various performance parameters for the different containment levels and the tests that will need to be undertaken for each parameter. The vehicle deformation parameter VCDI (vehicle compartment damage index) will be measured but will not be a mandatory performance criterion. This is, however, an indication of how much of the cockpit of the vehicle is damaged in the impact test.

Equivalent parameters and tests for the various containment levels for heavy goods vehicles and buses range from 10 tonnes (TB 42) to 38 tonnes (TB 81). While one can have very high containment safety barriers, the additional test with the 900-kg car (TB 11) will give values for the impact severity and vehicle deformation levels. However, there are many occasions in which the restraint of the errant heavy goods vehicle or bus is of paramount importance and the impact severity level will not be specified, although its test value will be recorded. Both ASI (acceleration severity index) and THIV/PHID will be recorded because both systems are currently used in the different member states. The proposal is that both measurements shall be established in impact test data for the next few years, and then the position will be reviewed to ascertain whether one or the other or neither of the indices will be adopted in the CEN standard.

Crash Cushions

Crash cushions have been part of road restraint system equipment used in several EEC countries but they have not been deployed to any great extent in the United Kingdom. They have, however, been extensively used in America for a long time, and U.S. knowledge and experience with them has helped Working Group 1 overcome some pitfalls in preparing the CEN draft standard. We have been looking very closely at what the United States has been doing in its update of NCHRP 230 (i.e., NCHRP 350).

Performance Classes for Crash Cushions

The current proposed criteria are generally similar to the NCHRP 350 matrix of test criteria, but we have tried to reduce the size of the matrix to that in NCHRP 350. As shown in Table 7, we have chosen three velocity classes: 50, 80, and 100/110 km/h.

Two different types of crash cushions, nonredirective and redirective, have been adopted. We have not included the gated and nongated definitions used in NCHRP 350 because discussions with Harry Taylor and Hayes Ross indicated that these two definitions are mainly associated with terminals and crash cushions. Working Group 1 intends to prepare a separate standard dealing with terminals.

To identify the type of tests that are required for the various parameters for crash cushions, we have devised a test notation that indicates the vehicle approach path, the test vehicle static mass, and the vehicle impact speed (see Figure 6).

Proposed Crash Cushion Impact Test Criteria

These include the "head-on center" impact, with both the 900-kg and 1500-kg vehicles with three different speeds. With the "head-on 1/4 vehicle offset" test, only the 900-kg vehicle will be tested but at the three specified impact speeds. The two side-impact tests will only involve the 1500-kg vehicle at 80 and 110 km/h impact speeds.

Proposed Performance Classes Test Matrix

Three velocities — 50 km/h, 80 km/h, and 100/110 km/h, were chosen. Certain tests will not be required where side impacts are not possible on the actual crash cushion (e.g., crash cushions installed in front of multiple toll booths). A matrix is shown in Table 8.

Impact Severity Levels for Crash Cushions

From the limited research and testing of crash cushions in the United Kingdom and the other EEC and EFTA

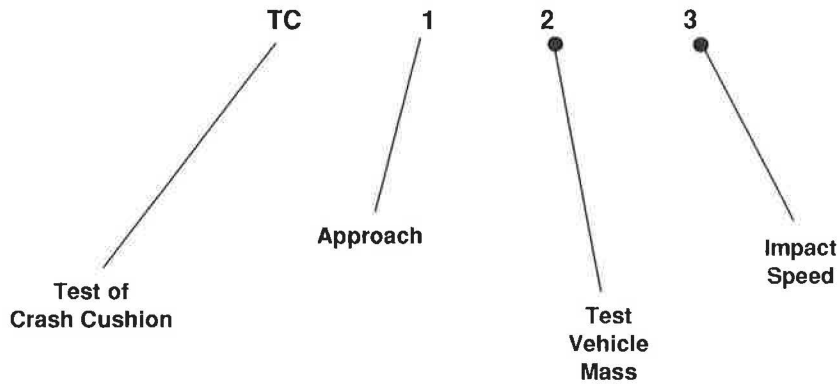


FIGURE 6 Test notation indicating vehicle approach path.

TABLE 7 CRASH CUSHIONS VEHICLE IMPACT TEST CRITERIA

TEST (*)	APPROACH	TEST VEHICLE STATIC MASS (kg)	VELOCITY (km.h)
TC1.1.1	Head-on, center	900	50
TC1.1.2			80
TC1.1.3			100
TC1.2.1	Head-on, center	1500	50
TC1.2.2			80
TC1.2.4			110
TC2.1.1	Head-on, 1/4 vehicle offset	900	50
TC2.1.2			80
TC2.1.3			100
TC3.1.2	Nose, at 15°	825	80
TC3.2.4		1500	110
TC4.2.2	Side impact at 20°	1500	80
TC4.2.4		1500	110
TC5.2.2	Side impact at 160°	1500	80
TC5.2.4		1500	110

countries, definitive impact severity levels must still be established. In the United Kingdom, THIV/PHID levels of below 12 m/s and 20 g, respectively, appear acceptable.

Conclusion

There are other acceptance criteria in the draft safety barrier and crash cushion standards. These include

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

Thomas Turbell
Swedish Road and Traffic Research Institute

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.

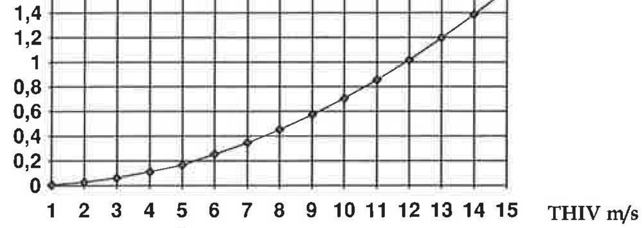


FIGURE 7 THIV (OIV) versus ASI.

U.S. TEST AND EVALUATION PROCEDURES

OVERVIEW

Kenneth Opiela
National Cooperative Highway Research Program

Development of Updated Procedures for the Safety Performance Evaluation of Highway Features

The National Cooperative Highway Research Program (NCHRP) was initiated in 1962 as a means for the states to address common research needs. One of the very first research projects initiated was an effort that led to Highway Research Circular 482, which recommended specific vehicular masses, impact speeds, and approach angles as the basis for full-scale crash testing to validate the performance of roadside safety features. This one-page circular reflected the knowledge of safety performance evaluation when it was published in 1962.

In 1973 NCHRP initiated Project 22-2, Traffic Barrier Performance and Design. The Southwest Research Institute was selected to undertake this project, with Mr. Maurice Bronstad and Mr. Jarvis Michie heading the research team. This project investigated issues related to safety performance evaluation and developed an expanded set of procedures, recognizing that there was not a sufficient understanding of safety performance to develop procedures for all aspects and roadside features. Their efforts led to the publication of NCHRP Report 153, *Recommended Procedures for Vehicle Crash Testing of Highway Appurtenances,* which recommended a set of testing procedures to promote greater uniformity. This report was 19 pages in length.

Report 153 quickly was found to have some limitations, and in 1976 Transportation Research Board (TRB) Committee on Roadside Safety Features (A2A04) accepted the responsibility to monitor the needs for the updating of these procedures. They initiated an effort in 1978 that led to TRB Research Circular 191, which recommended some minor changes in procedures and provided the basis for broadening the scope of the testing procedures themselves.

In 1978, recognizing that something better was again needed, the NCHRP initiated Project 22-2(4), Procedures for Testing Highway Appurtenances, to consolidate Report 153 and Research Circular 191 into a single document and incorporate the things that had been learned over that era. Since there had been a considerable amount of crash testing during the 1970s, there was a new wealth of both experience and understanding of safety performance of roadside features that was incorporated into the procedures. The procedures were described in a report authored by Jarvis Michie, which became the venerable NCHRP Report 230, *Recommended Procedures for the Safety Performance Evaluation of Highway Safety Appurtenances.* This report was 42 pages in length, more than doubling the length of the previous report, indicating greater detail and breadth in the procedures.

NCHRP Report 230 was the only document that was specifically referenced (other than U.S. laws) in the 300-page legislation for the Intermodal Surface Transportation Efficiency Act (ISTEA), which was enacted into law by Congress in 1991. ISTEA set the stage for further investigations in this country to validate the safety performance of barriers and other safety features relative to vans, minivans, pickup trucks, and four-wheel-drive vehicles. This "light truck" of truck class of vehicles has grown to represent about one-quarter of the current fleet of vehicles in use in this country.

Again in 1988, recognizing that things had changed over time, the American Association of State Highway and Transportation Officials (AASHTO) authorized NCHRP Project 22-7, Update of Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances. In 1989 NCHRP initiated a contract with the Texas Transportation Institute to undertake Project 22-7. The research team was headed by principal investigators Dr. Hayes Ross and Jarvis Michie, who were charged with taking a critical look at existing crash testing procedures and developing an appropriate update.

It was a long and arduous process that Dr. Ross and Mr. Michie undertook to develop the update. It started with the project panel identifying those issues that were considered critical to the update. Dr. Ross and his research team investigated these issues and generated white papers on the subjects. Ultimately, eight white papers were produced, covering the topics of future characteristics of the vehicle fleet, form of the test matrices, feasibility of using surrogate testing and simulation modeling, in-service evaluation procedures, the instrumentation of test articles, the purpose of the document, and conversions to standard international (SI) units of measurement.

The panel reviewed each of these white papers and met in mid-1990 to review the issues and the recommendations that the research team had made. After detailed discussions, the panel reached consensus on both the research approach and content of the update. The panel's consensus was reflected in a first draft of the report that was produced in late 1990. The panel again took a very close look at all aspects of the proposed update to the procedures for safety performance evaluation in the context of the many new features and concepts that had emerged both in the United States and abroad.

After a thorough review of the first draft, the panel convened for a second time with the research team to go over each issue and establish a consensus to set the foundation for a second draft report. The second draft report was issued in the early 1991. It was initially reviewed by the project panel to ascertain that an effective set of safety performance evaluation procedures was evolving. The second draft report was then sent out for further review by about 100 additional individuals, including about 30 foreign representatives.

The comments of these reviewers were compiled in their entirety and transmitted to the research team. The set of returned comments, when typed single-spaced, were 75 pages long and represented more text than there was in the second draft of the report. Dr. Ross and Mr. Michie waded through all the comments and responded to all the major criticisms that were made. They then recommended a series of revisions to the procedures and met with the panel to weigh the validity of and the need for these revisions.

In early 1992 the third draft of the report was produced. After another panel review, final revisions were made, technical editing was completed, and the revised document — NCHRP Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features* — became available from TRB in March 1993. It was a long and arduous process that involved a lot of individuals. There were a lot of comments reviewed and pros and cons debated, and the various perspectives — manufacturers', state DOTs', and federal agencies' — were considered in the process of producing this consensus document.

Dr. Ross and Mr. Michie worked hard with the project panel to produce a viable set safety evaluation procedures that cover a broad range of roadside features and provide a basis for tailoring performance to roadway and traffic conditions. The project panel that served on a voluntary basis reviewed all materials, met on numerous occasions, and hammered out an updated set of procedures for the United States. The panel, under the guidance of Chairman Roger Stoughton, included Mr. James Bryden, Dr. Charles Dougan, Mr. Dennis Hanson, Mr. James Hatton, Mr. Walter Jestings, Mr. James Roberts, Mr. Florio Taminini, Mr. Tom Turbell, Mr. Harry Taylor, and the late Dr. Edward Post. In addition, Mr. Marty Hargrave and Mr. Leonard Meczkowski from the Federal Highway Administration were very instrumental in the review of the document.

UPDATE TO NCHRP REPORT 230

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National Cooperative Highway Research Program (NCHRP) Project 22-7 developed an update to NCHRP Report 230. The project was a team effort. Input was provided by a large number of people in various disciplines, not only nationally but internationally. The document, published as NCHRP Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features,* is a consensus document. The NCHRP advisory panel, chaired by Roger Stoughton of the California Department of Transportation, and staffed by Kenneth Opiela, NCHRP senior project officer, provided comments and reviewed the drafts.

The project, which began in June 1989 and was completed in August 1992, was conducted at the Texas Transportation Institute. Jarvis Michie of Dynatech Engineering Inc. was a consultant/subcontractor on the project. Jarvis was a key member of the research team because he wrote Report 230 and guidelines that preceded Report 230.

One major change incorporated in Report 350 includes the adoption of the International System of Units (SI). To the extent possible, a "hard conversion" procedure was used, in which English units are converted to the equivalent SI unit and then rounded. By so doing, it increased the requirements of some tests and it diminished the requirements of others, but in all cases the changes were not major. For example, a 60 mph test speed, which has been a standard value for high-speed tests, converts to 96.6 km/h. The decision was made to round to 100 km/h, which is 62.1 mph.

The critical test speed for many breakaway features is at the lower end of the spectrum rather than the high end. The test speed on the low end has been 20 mph. In Report 350 the speed was set at 35 km/h, or 21.7 mph. It was initially decided to round to 30 km/h, which is 18.6 mph. However, those who design and use breakaway hardware stated that such a conversion would create an unnecessarily conservative test requirement since the 20 mph requirements of Report 230 were believed to be very conservative. Not only are these features required to break away at low speeds, they also are required to do this for vehicles at the low end of the weight spectrum. Furthermore, the acceptable vehicular velocity change (and hence occupant risk measures) for breakaway features is much lower than for other features such as crash cushions, end treatments, and so on.

Other major changes include test vehicles, more specific features, the contents and number of the test matrices, modifications to the evaluation criteria, and guidelines on selection of the impact point for redirection-type tests. In addition, Report 350 contains guidelines, as opposed to absolute standards, for testing and evaluating safety features. Adoption of the guidelines, in whole or in part, as a standard is at the discretion of federal and state transportation agencies.

Report 350 contains no selection criteria, or warrants, for features addressed therein. Features tested and evaluated according to the guidelines will have specific applications, but identification of these applications remains to be determined by the user agency or perhaps by the American Association of State Highway and Transportation Officials (AASHTO) or the Federal Highway Administration (FHWA).

The basic test vehicles, which are passenger-type vehicles, include the 820C, a small car with a mass of 820 kg, which is essentially the same small car test vehicle used in Report 230. A major change was made in the adoption of the 2000P, which is a 3/4-ton pickup truck with a curb weight or mass of approximately 2000 kg, or 4,400 lb. The primary reason for selecting the 2000P vehicle was that it is believed to be a reasonable representative of the light-truck population. Light trucks, which include pickups, vans, and sport/utility vehicles, now make up a significant portion of the total passenger vehicle population in the United States, and indications are that sales and use of light trucks will continue to increase for the foreseeable future. It was also selected since its mass approximated that of the 4,500 lb car so widely used in the past.

Supplementary vehicles that can be used in the design and evaluation of a feature include the 700C test vehicle, which is a very small car with a mass of approximately 700 kg, or about 1,500 lb. Use of this vehicle is optional. If a developer or manufacturer of a safety feature is confident that the feature can meet test requirements using the 700C vehicle, the option is available. Tests with the 820C vehicle are not necessary if tests with the 700C are acceptable. A manufacturer may have an advantage over the competition if its feature is the only one that satisfies test requirements with the 700C vehicle.

The 8000S vehicle is a 8000-kg (about 17,600-lb) single unit truck. This vehicle has been used in recent years in the United States for the development and evaluation of bridge railings, in accordance with the AASHTO guide specifications published in 1989. Then there are two very heavy vehicles: the 36000V, a tractor van trailer with a mass of 36,000-kg (about 79,300 lb), and the 36000T, a tractor tanker-type trailer vehicle with a mass of 36,000 kg that can be used in the testing. These vehicles are to be used in the development of high performance, or high containment, barriers.

The 2000P pickup truck is only about 100 lb, or 40 kg, lighter than the 4,500-lb car. So there is not a lot of difference in the mass but there are differences in some of the other properties. Center of mass height of the 2000P vehicle is about 70 cm, whereas the 4,500 lb car had a height of about 60 cm. With regard to the fore-aft mass distribution, the 4,500-lb car typically has about 55 percent on the front axle and 45 percent on the rear axle, whereas the pickup truck typically has about 58 percent on the front and 42 percent on the rear. The wheel base of the car is about 305 cm, whereas the wheel base of the pickup is somewhat longer. The front overhang is shorter on the pickup truck--80 cm for the pickup versus 110 cm for the car.

With regard to the effect these changes will have on performance, a higher center of mass probably means the 2000P vehicle will be less stable and more prone to overturn. The shorter front overhang of the 2000P vehicle means the tire nearest the impact point will tend to impact a redirective feature, such as a guardrail, sooner than would have occurred on the 4,500-lb car. Further, the tire/wheel radius of the 2000P vehicle is larger. These changes may result in a greater tendency for the 2000P vehicle to climb up and over the face of the feature. Bumper height is another parameter of concern. The bumper height of the 2000P vehicle will typically be about 55 cm, whereas the car's was about 45 cm. All other factors being the same, performance is expected to degrade for many features as the bumper height increases.

Other factors that will potentially influence performance include crush stiffness and body design of the 2000P vehicle. It has a stiffer front end, and it has two distinct body shells. For energy-absorbing devices such as a crash cushion, the pickup will not absorb as much energy as the 4,500-lb car did. Thus, an energy-absorbing device whose performance is near recommended limits may not pass the pickup truck test. Tests have shown that the body design of the 2000P vehicle tends to reduce the impact loads slightly on a redirective feature.

There are up to six test levels in Report 350, depending on the feature being evaluated. All six test levels apply to longitudinal barriers; test levels 2 and 3 apply to breakaway features; and test levels 1, 2, and 3 apply to crash cushions and end treatments.

Although selection guidelines or warrants do not presently exist, it is assumed that devices developed for test level 1 would be used for very low service level conditions, such as in a work zone in an urban area where speeds are 50 km/h or less. Test levels 2 and 3 are the more basic test levels, and devices developed, therefore, would have application on high-speed facilities. Of these, level 3 is considered to be the basic level, but perhaps level 2 will also be widely used. Levels

4, 5, and 6 are for special, higher service level longitudinal barrier requirements.

The features for which test and evaluation criteria are given in Report 350 include longitudinal barriers (roadside barriers, median barriers, and bridge railings); these types of barriers are referred to as safety barriers in Europe. There are three distinct parts of a longitudinal barrier of concern: the length-of-need section, the transition region in which the barrier may be connected to a longitudinal barrier of different lateral stiffness, and the end of the barrier. The first two are addressed within the longitudinal barrier test series, and the latter is addressed within the terminal and crash cushion series.

The next category includes longitudinal barrier terminals and crash cushions. The first three test levels apply to this category. That category is further subdivided into (*a*) terminals and redirective crash cushions and (*b*) nonredirective crash cushions. There was considerable discussion among the advisory panel and others about required test conditions for crash cushions and terminals. Some believed that the tests should be selected so as to require all crash cushions to have redirective capabilities. However, the consensus was that the updated test procedures for crash cushions should not be selected so as to eliminate future use of nonredirective systems. As a general rule the nonredirective sand-tub crash cushion has proven to be a reliable, cost-effective system and is widely used throughout the United States.

Also addressed are test and evaluation procedures for support structures, work zone traffic control devices, and breakaway utility poles. Included under the support structure category are sign and luminaire supports, emergency call boxes, and mailbox supports. Included under the work zone traffic control devices are plastic drums, barricades, cones, chevron panels and their supports, and delineator posts and lights that may be attached to drums or barricades. Features within these categories can be designed and evaluated to test levels 2 or 3. It was concluded that it would not be cost-effective to develop one of these features for test level 1. In other words, it is believed that a feature developed for levels 2 or 3 would also be cost-effective for test level 1.

Specific test guidelines for truck-mounted attenuators (TMAs) can be developed to test levels 2 or 3; however, most of the current designs were developed for level 2 conditions.

There are very general guidelines for testing geometric features such as side slopes, ditches, and median crossovers; however, there are no specific test levels for features of this type.

Specific tests are designed to evaluate the strength or containment capabilities of longitudinal barriers. The first three test levels are conducted with the 2000P vehicle, at impact speeds of 50 km/h, 70 km/h, and 100 km/h and an impact angle of 25 degrees. Requirements of level 3 do not vary significantly from the basic requirements of Report 230 in terms of impact speed and angle and vehicular mass. For levels 4, 5, and 6, test vehicles range from the 8000S up to the 36000T. All three tests are conducted at 80 km/h, which is about 50 mph, and at a 15-degree impact angle.

There are key changes in criteria used to evaluate a given test. There are no major changes in the structural adequacy requirements of Report 230. With regard to occupant risk criteria, it was decided to retain the flail space model. In this model the occupant is represented by a lumped mass that is allowed to move within a specified space until it impacts a surface. At initial contact, the impact velocity normal to the surface is computed and is referred to as the occupant impact velocity (OIV). Following impact the mass is assumed to remain in contact with the surface and to experience the "ridedown" acceleration (RA) of the vehicle.

Recommended limits of OIV and RA are given in two categories, "preferred" and "maximum." For all features except support structures and work zone traffic control devices, the preferred and maximum OIV are 9 m/s and 12 m/s, respectively. For all features the preferred and maximum RA are 15 g and 20 g, respectively. Similar limits were given in Report 230. In addition, the lateral and longitudinal components of the OIV have the same limits in Report 350, whereas in Report 230 the lateral limit was approximately 30 percent less than the longitudinal limit. Based on a review of the literature and on discussions with experts, it was concluded that limits in the lateral and longitudinal directions should be equal. The OIV limits for support structures and work zone traffic control devices are essentially the same as those in Report 230, 3 m/s preferred and 5 m/s maximum.

Some changes were made with regard to the post-impact trajectory criteria. The 15 mph (24.2 km/h) vehicular velocity change limit for redirective features was increased to 12 m/s (43.2 km/h).

Finally, Report 350 contains guidelines for identifying the critical impact point for a redirective feature. That is the point along the feature judged to have the greatest potential for causing snagging or pocketing of the vehicle with the barrier or for causing structural failure of the feature.

It is expected that Report 350 will foster uniform test and evaluation procedures for highway safety features throughout the United States and other countries. More important, it is expected that use of the document will result in the design and implementation of improved safety features, thereby reducing the severity of accidents.

IMPLEMENTATION AND INTERACTION BETWEEN CEN STANDARDS AND U.S. PROCEDURES

VALIDATION OF CEN TEST STANDARDS

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The work of achieving an agreement based on consensus of the different European countries has been quite a difficult one because each country had its own experiences and its own testing procedures. The result is a kind of blend of the different testing procedures and a kind of envelope of what has been done already.

Nevertheless, it is in many respects something new. Maybe not everything is new for everyone, but in general all testing procedures are rather new for everyone. It is believed that some assessment and validation of the testing procedures and of the acceptance as a rule is needed. And at the same time, an evaluation of a lot of this is needed, and when this standard is implemented, it must be together with at least a laboratory that can be authorized to do the testing.

Concerning the physical vehicular standard, there is some doubt about the required tolerances. In some respects, they are too large and will allow two different tests. On the other hand, they may be too narrow and difficult to meet.

But there is still another reason for CEN test calibration procedures; that is, to check to see if the result from different laboratories on normally equivalent tests are comparable, which is not granted from the beginning. And finally, another reason is to check if normally equivalent tests—tests made with normally equivalent data, which can be quite different and may be interpreted—could really lead to the same result, and at the same time, if tests with parameters that are the same are within the tolerances. Everyone has accepted the proposal of running an interlaboratory test program.

Another point is that Working Group 1 has discussed how to mandate this program and has related to Task Group I the mandate to prepare, supervise, and assess problems. Task Group I has been established by Working Group 1 and had a mandate to prepare part of the technical part of the proposal.

So at the beginning, one of the most critical issues of this would be the choice of the candidate laboratories and how that can be done. I believe that at the beginning the initial laboratories would donate funds to participate in the test program. And looking at preliminary answers, an initial number of these from six to eight may be forecast, which is probably too much for a test program like that. But the number of the initial laboratories could contribute to the program some additional funds to the European Economic Community funding.

On the other hand, at the end of the project, this will demonstrate ability to produce a homogenous result, which will be very important. Only such laboratories will be at the end of this program and will be certified to be homogenous to each other and able to produce some results that are comparable. And possibly before starting the program, some preliminary check about the systems and the data acquisition, systems, and procedures of the laboratories should be assessed so as to start with a homogenous set of equipment and procedures.

Some standard testing and calibration procedures of the data acquisition system are needed. Maybe what the Federal Highway Administration has developed, a kind of black box used to calibrate the data ignition system. I believe that it is a good idea to start with this kind of problem already solved so that it will be known that all the laboratories are taking results that are comparable. The rest of the tests will be much easier and it will be known that money is not being wasted on running tests in which the end results are not comparable.

Procedures could be established to run a single test that would be exactly the same in all the laboratories--same vehicle, same barrier--and then the result could be checked to see if it is comparable. If not, the reason would be understood and corrective actions would be taken, and possibly some of the tests would be rerun.

After that, a number of wheeling tests could be performed in different labs. In this case, a particular vehicle could be chosen, and possibly this test could be performed near a different limit of the tolerance so that an evaluation could be made of what is the limit and what is the consequence, the consequences of the tolerance. This possibly could be the main program. It will be enough to make it with private vehicles; to make this with heavy vehicles is not needed. So the cost of using just the small cars and one or two types of barriers could be predicted. But this will be an object of discussion.

IMPLEMENTATION OF CEN PROCEDURES: THE CONSTRUCTION PRODUCTS DIRECTIVE

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Outline

In 1985 the European Economic Community (EEC) European Council decided, among others, a further step on completing the internal market. Following the so-called "New Approach," the Construction Products Directive was developed, which includes requirements relating not only to building safety but also to health, durability, energy economy, protection of the environment, aspects of economy, and other aspects important in the public interest.

These essential requirements provide the basis for the preparation of harmonized standards at the European level for construction products. For that purpose, mandates will be given by the European Council to CEN/CENELEC. It will be explained how the planned cooperation procedure between the European communities and the CEN/CENELEC should be managed for issuing standards.

In the future, a product will be presumed fit for use if it conforms to a harmonized standard, a European technical approval, or a nonharmonized technical specification recognized at the community level.

Finally, there is some information about the required three types of harmonized European standards and the expected mandates in relation to road equipment.

Introduction

For more than 20 years the European states have tried to cooperate with each other. So now we have two alliances: (*a*) since 1958, EEC with the member states Ireland, Great Britain, Denmark, Netherlands, Belgium, Luxembourg, Germany, France, Spain, Portugal, Italy, and Greece; and (*b*) since 1960, the European Federal Free Trade Association (EFTA), now only with the member states Iceland, Norway, Sweden, Finland, Switzerland, and Austria.

In 1985 the EEC European Council decided, among others, a further step on completing the internal market. It states that, within the general policy, particular emphasis will be placed on certain sectors, including construction. That means the removal of technical barriers in the construction field, to the extent that they cannot be removed by mutual recognition of equivalence among all member states. This action should follow the New Approach set out in a council resolution in 1985, which calls for the definition of essential requirements on safety and other aspects that are important for the general well-being.

Construction Products Directive

But up until now, the member states have been responsible for ensuring that building and civil engineering works in their territory are designed and executed in a way that does not endanger the safety of persons, domestic animals, and property, while respecting other essential requirements in the interest of general well-being. Having regarded that situation and the idea of the New Approach, the council directive of 21 December 1988, on the approximation of the laws, regulations, and administrative provisions of the member states relating to construction products (89/106/EEC), abridged Construction Products Directive, was adopted by the 12 EEC member states in the first instance. Meanwhile, the EFTA member states have taken over this directive unchanged.

The basic idea of the Construction Products Directive (CPD) is explained in the following citations from the introduction of that directive:

"Member States have provisions, including requirements, relating not only to building safety but also to health, durability, energy economy, protection of the environment, aspects of economy, and other aspects important in the public interest.

. . . These requirements, which are often the subject of national provisions laid down by laws, regulations, or administrative actions, have a direct influence on the nature of construction product standards, technical approvals, and other technical specifications and provisions which, by their disparity, hinder trade within the Community.

. . . The removal of technical barriers in the construction field calls for the definition of essential requirements . . ." Therefore, the CPD provides the following six essential requirements explained in detail in Interpretative Documents:

- Mechanical resistance and stability
- Safety in case of fire
- Hygiene, health, and the environment
- Safety in use
- Protection against noise
- Energy economy and heat retention

These essential requirements constitute both the general and specific criteria with which the construction works must comply. They are to be understood as required that the said works conform with an appropriate degree of reliability with one, some, or all of these requirements when and where this is laid down in regulations.

Harmonized Standards

The essential requirements provide the basis for the preparation of harmonized standards at the European level for construction products. In that sense, harmonized standards will be established as far as, and as quickly as, possible with the following aims:

- To achieve the greatest possible advantage for a single internal market;
- To afford access to that market for as many manufacturers as possible;
- To ensure the greatest possible degree of market transparency; and
- To create the conditions for a harmonized system of general rules in the construction industry.

In general the European standards are drawn up by the European Committee for Normalization (CEN) and the European Committee for Electrotechnical Standardization (CENELEC), which are recognized as the competent bodies. In principle these standards remain nonmandatory texts. But based on special guidelines for cooperation between EEC and CEN/CENELEC, it is assigned to develop harmonized standards for the purpose of the Construction Products Directive upon a mandate given by the European Council.

Using construction as a basis for harmonized standards and other technical specifications at the European level, and for drawing up or grading European technical approval, requires that interpretative documents be established to give concrete form to the essential requirements at a technical level.

Within that, harmonized standards terms of product performance should be expressed as far as possible. Performance requirements to be fulfilled by products in the future of the member states shall be laid down and shall take account of different levels of essential requirements for certain works and different conditions prevailing in the member states.

Harmonized standards should include classifications that allow construction products that meet the essential requirements and that are produced and used lawfully in accordance with technical traditions warranted by local climatological and other conditions to continue to be placed on the market. These standards may not reduce the existing and justified level of protection in the member states.

A product is presumed fit for use if it conforms to a harmonized standard, a European technical approval, or a nonharmonized technical specification recognized at the community level. Products thus considered fit for use are easily recognizable by the EC mark; there must be allowed free movement and free use for their intended purpose throughout the community.

In the case of products where European standards cannot be produced or foreseen within a reasonable period of time or of products that deviate substantially from a standard, the fitness for use of such products may be proved by recourse to European technical approvals on the basis of common guidelines. The common guidelines for the granting of European technical approvals will be adopted on the basis of the interpretative documents, too.

Developing Mandates

The following will explain how the planned cooperation procedure between the European communities and the CEN/CENELEC should be managed for issuing standards. The procedure follows.

First Stage

For each interpretative document, the European Council prepares some draft provisional mandates with the assistance of the Standing Committee, and the council sends the provisional mandates to CEN.

Second Stage

CEN and the relevant CEN technical committees study the provisional mandates, and propose (*a*) programs of work, including work items, and (*b*) target dates. CEN then sends these elements to the council. The council, assisted by the expert group, examines these proposals and sends back a definitive mandate to CEN.

Third Stage

Before publishing the references of the mandated standards, as harmonized standards in the sense of the

Construction Products Directive, the council will consider if they comply with the mandate.

Member state authorities responsible for national regulations should be able to participate through the national delegations to CEN/CENELEC and present their points of view adequately in all stages of the drafting process.

A European standard based on a mandate and adopted by the council is characterized as harmonized. These harmonized standards are obligatory for all member state authorities. Corresponding to that fact, member states have to choose levels and classes among those fixed at the European level within such standards.

Types of Standards

Finally, they should be given some information about the required three types of harmonized European standards. The types are defined as follows.

Category A

These are fundamental standards related to the design and execution of works and to the basic data of products and are closely linked to the relevant essential requirements; for instance, definition and determination of the acoustic insulation of a wall.

Category Bh

These are intermediate standards related to whole families of products and applied to common characteristics of these product families; for instance, definition and measurement of the impact severity of safety barriers.

Category B

These standards apply to more or less homogenous product families or products and, where applicable, differentiate for intended uses. The standards define the products and spell out their principal characteristics, specific requirements and/or performances related to the essential requirements, the interpretive documents, and, where applicable, the intended uses and related requirement performance levels. Where necessary the standards may include indications of their production process as well as their application.

Signification of Standard Types in Relation to Road Equipment

Relating to the directive mandates respectively, harmonized standards will be established for road equipment as far as this equipment may be characterized as construction products. This term refers to products that are produced for incorporation in a permanent manner in the construction works. This means (*a*) that its removal reduces the performance capabilities of the works or of parts of the works; and (*b*) that the dismantling and the replacement of the product are operations that refer to building and civil engineering activities.

Furthermore, it is sure that there will not be a Category A standard for road equipment. Therefore, it is expected that mandates for Category Bh and Category B will be given for the following:

- Permanent road vehicle restraint systems;
- Road marking materials for permanent and temporary horizontal road signs as far as they are fixed on a road surface;
- Permanent road vertical signs but none for equivalent temporary products;
- Permanently installed traffic control devices;
- Noise protection walls; and
- Other permanent road equipment such as antiglare screens and emergency telephone posts.

IMPLEMENTATION OF U.S. PROCEDURES

Harry W. Taylor
Federal Highway Administration

U.S. Procedures

U.S. acceptance procedures encompass regulatory requirements along with actual practices. Existing U.S. barrier acceptance procedures have slowly evolved in a step-by-step fashion. Like a European castle or palace built over a period of time that has evolved wing by wing, with major overhauls when necessary, the U.S. procedures have developed requirement by requirement in response to a need or problems, becoming more and more formalized as the conditions and the public interest has required it. Since they were not developed at one time, they are based on regulations along with practice. Specific details of this evolution are addressed in TRB Circular 396, May 1992.

U.S. acceptance procedures reflect the intergovernmental relationships between the highway agencies; that is, the states and local jurisdictions own most of the roads, while the Federal Highway Administration (FHWA) is basically a funding and oversight agency. The following will focus on federal and state highway acceptance procedures for the federal-aid system, with the understanding that most other highway agencies, including toll road authorities, accept the results of this acceptance process. The U.S. procedures also reflect the fact that most of the crash testing is done by third-party testing laboratories, not by the responsible highway agencies.

Test and Evaluation Procedures

1. Standards and guidelines developed by the American Association of State Highway and Transportation Officials (AASHTO)
    a. 1985 AASHTO standard specifications for structural supports for highway signs, luminaires, and traffic signals
    b. AASHTO guide specifications for bridge railings
2. NCHRP 230, *Recommended Procedures for the Safety Performance Evaluation of Highway Safety Appurtenances*
3. Regulations and guidance contained in the *Code of Federal Regulations,* 23 CFR part 625, Design Standards for Highways

The U.S. roadside safety appurtenance acceptance system is based in part on consensus-based test and evaluation procedures. It is based on performance criteria. It does not include product standards.

In the United States, only the threshold of crashworthiness of a barrier is quantified for acceptance, not the amount of safety. Other critical items in the selection of a roadside device, such as costs, ease of repair, durability, deflection distance, and required site conditions, may be measured and reported but do not serve as a basis for rejection. But as such the U.S. results are subject to interpretation by the user, in this case the highway agency, of the safety device. It is the user agency that is the guarantor of the safety of the installations.

According to federal policy, in the federal-aid road system, each state highway agency is responsible for accepting a roadside safety device. Officially FHWA has said that roadside safety appurtenances other than those covered by letters of acceptance could be acceptable for use on federal-aid highway projects. It is not a requirement of FHWA that such a letter be issued for each appurtenance to be used in a federal-aid project. If for a particular appurtenance it can be demonstrated to the satisfaction of the highway agency and the FHWA division office that a system has been tested in accordance with recognized procedures and the results are satisfactory, then that support system could be accepted for use in a federal-aid project in the division.

However, in actual practice the highway agencies generally rely on FHWA to certify the safety of devices. The manufacturer or the highway agency that developed the device submits the crash test report to FHWA. FHWA then issues a letter of acceptance stating that the device has met crashworthiness criteria included in NCHRP 230. This acts as a certificate and is accepted as such. In the case of proprietary devices, it is a letter to the developer of the device with copies to the FHWA regions. With devices developed by FHWA, it is by memorandum to the regional administrator.

Items Covered in the Letter

This acceptance letter:

1. Provides a brief description of the device tested;
2. Summarizes the test conditions and results;
3. Limits the approval to the crashworthy characteristics of the devices, with the manufacturer expected to provide information to the highway agency on structural design and installation requirements;
4. States that the state highway agency will expect a manufacturer to certify that the hardware furnished has the same physical and crashworthy properties as demonstrated in the test; and
5. Encourages in-service evaluation or field testing of new roadside safety hardware, even though it is not required by FHWA.

Let's Turn to the Future

What will be the future direction of our acceptance procedures? With the advent of NCHRP 350, with the increased emphasis on quality assurance, and with the desire to interface with CEN standards and procedures, it is likely that U.S. procedures will become more formalized and detailed.

What will happen in the near future, since the new procedures are expected to become available in February as a published research report and FHWA proposes to formally adopt the report? We propose to incorporate it into the *Code of Federal Regulations,* a codification of general and permanent rules by the executive departments and agencies of the federal government. It will be incorporated in the Guides and Reference section of 23 CFR part 625, Design Standards for Highways, for guidance on the acceptability of roadside barriers and other safety appurtenances for use on federal-aid projects.

The guides and references include information and general controls that are valuable in attaining good design and in promoting uniformity. They are intended to provide general program direction. Though it is called a guide, in practice NCHRP 350 will serve as a regulation.

It is likely that both the AASHTO guide specification for bridge railings and the *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* will still be available for use and the results will be accepted by FHWA.

Besides performance criteria established by crash testing, will the United States develop other formalized criteria to be used for third-party testing? Answer: FHWA does not have generic criteria for a third-party certification program under which a supplier is authorized by a third party to use the programs's mark (certification mark) or a certificate of conformity to indicate that a product is in compliance with applicable standards or specifications. We are proposing to develop such a system.

Will we incorporate more surveillance; that is, the initial and continuing observation of the product supplier to ensure that the products comply with the criteria contained in the standards and/or specifications for the product? Answer: Any increased surveillance probably will be the responsibility of state highway agencies.

Will there be requirements for a third-party certification body? Answer: FHWA does not have any specific requirements for an internal quality system and audit procedure.

Will FHWA institute requirements for crash lab certification? Answer: We also do not have any formal requirements for competence of calibration and testing laboratories. In the United States, the National Highway Traffic Safety Administration (NHTSA) has taken the lead in the qualification of crash test laboratories as part of its car crash test program. FHWA will probably follow NHTSA's lead and use some of the procedures. FHWA is considering having a contact in which it will prequalify labs for an FHWA contract. We would expect that any labs that prequalify for our research testing would be qualified for acceptance testing.

Conclusion

Our procedures continue to evolve, especially toward the desire to harmonize acceptance of roadside safety hardware with the rest of the world.

IMPLEMENTATION OF CEN AND U.S. PROCEDURES ON A GLOBAL BASIS

Andrew Naylor
Bridon Ropes Limited, United Kingdom

As a manufacturer of a barrier system, it is a fairly daunting prospect to look around the world and consider the amount of privately funded money that goes into testing products to gain individual country approval. It is quite vast. My company has been fortunate because countries where the Bridon wire rope safety fence is installed did accept the U.K. Department of Transport's approval system, which approved the product. Nevertheless, there are many countries throughout the world that require my company to test under their different conditions.

This situation even occurs within Europe. My company recently completed some testing in France to gain French approval. The reason behind that was that not knowing when CEN was going to come forward, we wanted to increase our market share in certain parts of the world. To do that, we needed an order of approval. So, again, within Europe there are different approval systems set up.

From that my company sees that the pending CEN performance standard for our rope barriers actually would be very much welcomed by all European manufacturers of whatever type of barrier system they are marketing.

This is the first time I have actually been involved with TRB, but it is a tremendous international step forward to establishing links between Europe and the United States. Despite the expansive body of water between us, it has been recognized that working together can only benefit the road user worldwide.

By comparing some of the test parameters for the United Kingdom, France, and in particular, the proposed CEN standards and the U.S. NCHRP Report 230 and the updated Report 350, what became fairly apparent was that on the larger car testing, the European values, that is, CEN, the United Kingdom, and France, about 80 km, are all of a similar order. This surprise came when looking at what the United States is doing, probably around 130 to 140 km. So there is a significant magnitude of difference there. So perhaps, just on that one aspect, there is a need to close that gap, perhaps bridge the gap between water, and bridge it between the other testing parameters.

On the lighter vehicle testing, both Europe and the United States seem to achieve a great degree of compatibility. From my company's point of view, this means that we could gain acceptance throughout Europe but would still have to carry out significant test work for U.S. approval. If successful, this would in essence close the circle worldwide as far as we are concerned for the approval of not only the wire rope safety fence system, but also other barrier systems.

Harmonization can only lead to freer and greater competitive nonconditions for all manufacturers. There is going to be a significant reduction in my company's testing costs, and we will not have to direct our testing toward a specific market, if there is going to be common work throughout and if previous work will be accepted.

The other thing is that it does enable my company to develop safer systems perhaps and things like containment systems, again trying to benefit both road user and people involved in highways.

So manufacturers, designers, and approval authorities probably all have one goal in common — and that is to save the world for the road user. And as far as my company is concerned as a manufacturer, we welcome all forms of harmonization.

IMPLEMENTATION OF CEN AND U.S. PROCEDURES ON A GLOBAL BASIS: THE UNITED STATES

Michael Drezenes
Energy Absorption, Inc.

Before you can understand the potential implications of the CEN TC226 WG1 harmonization efforts on U.S. highway safety product manufacturers, it is necessary to have an idea of the current status of these manufacturers overseas. I will use Energy Absorption Systems as an example, because knowing how the experiences of the past put U.S. highway safety product manufacturers in the position they are in today will allow us to better predict what will happen in the future after the CEN standards are officially approved.

Driving through any country in the world, one quickly realizes that many of the roadside hazards that are prevalent in one's own country are also routinely found in other countries. These black spots become more evident when kilometers of highways are built near large cities, thereby losing the luxury of geometries. This is a fact of life in every country in the world.

Many different approaches are taken to correct these black spots, and typically these corrections are handled on a country-by-country or even a state-by-state or county-by-county basis. Before the implementation of CEN TC226, little discussion between countries was ever held regarding the proper way to correct roadside hazards. Some practices were acceptable in one country, but ridiculed in another — a lot of "not invented here" was evident.

Energy Absorption Systems tried to introduce crash cushions overseas and had some limited success. In some countries, crash cushions, although recognized as safety features, were and still are illegal because of a lack of specifications and a misunderstanding of the concept. My company stopped trying to sell a product and started selling a concept: the concept of using properly tested and designed crash cushions to make roads safer. We explained the need for specifications, the evolution of NCHRP Report 230, and why the testing was so stringent. The same basic objections were always present whenever we presented NCHRP Report 230 or the American example:

- The speed overseas is different from the United States.
- The size of cars overseas is smaller compared with the United States.
- People overseas wear seat belts; in the United States we just talk about wearing them.
- The product liability issue is much greater in the United States compared with other countries.
- The "not invented here" syndrome is ever present.

Everyone made it very clear that their country was not the United States. Their conditions were different, and Energy needed to understand their needs and to design the right product. Product modifications were often required. We explained that although the conditions were different, the physics of a crash were very similar regardless of where you are in the world. A properly designed and tested crash cushion would make this crash less severe.

We explained that the size of the test vehicles or the speeds used for testing did not matter; a crash cushion needs to do certain things to be effective. These items were discussed in detail, and we came up with the following key functional requirements: (*a*) contain the vehicle with no penetration or vaulting; (*b*) redirect the vehicle; and (*c*) allow for tolerable impact forces.

This would normally get the attention of most of the highway officials, and we would look at each of these a little closer. Contain the vehicle means that no matter where the car impacts the crash cushion, the car must be stopped from getting to the hazard. Only by actually crash testing the crash cushion can one know exactly what a system will do when impacted by a vehicle. Energy Absorption Systems has run hundreds of crash tests at its facility in Rocklin, Calif., and we are confident of our ability to predict what our crash cushions will do during a design impact.

The second requirement for a crash cushion is to keep the car on the ground and not allow it to vault or roll after it hits the crash cushion. To achieve this, the center of gravity between the car and the center of applied force from the crash cushion must be maintained. Only through actual testing can one be sure that the car will stay on the ground during an impact.

Next, since many impacts in a crash cushion are angled impacts, the crash cushion must be able to safely redirect the car back into the original flow of traffic or bring the vehicle to a controlled stop. Only by testing the crash cushions with angle impacts can manufacturers and highway officials be assured that the crash cushions will properly redirect a vehicle during an actual angled impact.

Finally, and possibly most important, the crash cushion must reduce the level of deceleration to allow occupants of a vehicle to walk away from an impact that might have otherwise killed them.

It is clear that during a high-speed car impact three impacts are present. First the car hits something, and it stops. This is the first impact. However, for a short period of time the passengers in the car are still traveling at the original speed. During the second impact, these passengers will hit something--possibly the steering wheel or the windshield. If they are in the back seat, they may hit the front seat. It is hoped that they will hit the seat belt. Once the passengers come into contact with the car they start to experience the vehicle's decelerations. During the third impact the forces of deceleration drive our major organs into our chest cavities, causing the internal injuries or bleeding that can kill us. Crash cushions will reduce these levels of deceleration to allow us to survive these impacts.

Every highway agency we spoke to agreed that a system that will accomplish these functional requirements is an excellent safety addition for their highways. They needed to establish some criteria for specifications. Since they often had no specifications, they might use NCHRP Report 230, a modified NCHRP Report 230, the acceleration severity index (ASI), or a visual approval approach or accept a product on a trial basis based on its history. In fact, one European highway authority told me that if any other country in the world accepted a product then that country would accept it. Having over 15,000 crash cushions installed gave Energy instant credibility.

At times a government, after agreeing to accept the concept of a crash cushion and accepting a set of specifications, did require a few tests to be run in their own country. These can be expensive, but they had to be done. The markets outside the United States are much smaller than U.S. markets, and it is very difficult to amortize the costs of these tests on future sales.

The next step was to get specially priced trial units installed to allow local officials to gain confidence in their effectiveness. This is where Energy is today in 28 countries around the world. Our crash cushions are working and saving lives around the world.

That's today. What about tomorrow? It is clear that the CEN harmonization will affect U.S. manufacturers differently in Europe than in the rest of the world outside Europe.

For the future in Europe, having standardized European specifications that will presumably require one set of tests at a certified test area will cut down costs and clear up much of the ambiguity that highway safety product manufacturers are subjected to today. The specifications must be realistic, and the performance criteria must be based on fact, not just on "the way we always did it," with no substantiation.

Ideally the CEN standards will allow manufacturers to know that if they have a redirective, nongating crash cushion or a temporary barrier, they can test their product to the prescribed tests and have the approval of this product anywhere in Europe. The other European countries will recognize the qualified testing agency's test results. This is an excellent concept, and if implemented properly, it will benefit everyone.

It is very important to any manufacturer that the costs to run tests are kept to a minimum. This should also be very important to any highway authority since the costs of these tests will ultimately be passed on to the highway authorities. Having many testing agencies in Europe will help prevent a monopoly situation and keep the prices at a minimum. It would be even cheaper for a U.S. manufacturer if these tests could be run in the United States to the CEN specification and vice versa. If the United States and Europe form a mutual recognition agreement, the Europeans should insist on multiple crash test sites in the United States to prevent a monopoly situation and to keep their testing costs down. Multiple agencies in the United States and Europe do exist.

U.S. manufacturers must realize that having CEN/U.S. harmonization will have some negative side effects. It will open new markets in the United States for European highway safety products because the entry procedure will be clearer and better understood by manufacturers. This could become a problem, and this competitive threat must be taken into account by U.S. manufacturers.

It is also very probable that as testing specifications are clarified, allowing Europe to be considered a unified larger market, and the concept of highway safety becomes more popular, more local and foreign competitors will be present in Europe. The presence of local manufacturers will ultimately force foreign firms to enter into licensing arrangements or joint ventures if they want to compete. The freight and duty costs will make it far too expensive to export from the United States.

In general, the CEN specifications will be very good for Europe and for U.S. highway safety product manufacturers who are willing to make a total commitment to Europe. It will not come easy or cheap. U.S. manufacturers will have to relearn how to do business overseas. The tuition to learn may be high but at least the guidelines for success will be clear.

The CEN harmonization will affect U.S. manufacturers slightly differently in non-European countries. In non-European countries, the fact that a product meets both U.S. and European specifications will make highway officials more likely to accept its use in their country. They will more readily agree that the products will work in their road conditions and environment. This will cut down the number of tests and product adaptations that might otherwise be required for safety products, thus reducing the end price. It will be interesting to see if a non-European country that today requires no specifications will someday insist that a product meets not only the CEN specifications, but also the U.S. specifications.

In summary, the CEN harmonization has been, and will continue to be, an excellent opportunity to share experiences gained worldwide regarding the effectiveness of counter measures based on performance, field experience, and cost-effectiveness.

Some questions still need to be answered before the entire harmonization concept is successfully implemented. For example, once these guidelines are submitted to CEN for final approval, I understand that it could be as long as 1996 before they are actually formally approved. What happens between now and 1996? Why not start to use the agreed-on specifications today? In Berlin at the FERSI Conference, the buzz words were "We must start now." I believe this. We should not wait until 1996 to put our hard work to practice. We should not allow one more life to be lost on any road around the world because that country has no formal specifications for a highway safety product. We must put into practice what we have developed and obviously believe.

I am a little concerned about the future. For instance, one U.S. company that was planning to run a test on a crash cushion in Europe was told to run a test that had never been a part of the CEN test matrix. Why? Because the test was part of the old testing process previously used by this country. In addition, the country that was requiring the test could not determine what performance criteria would be acceptable. This does not make sense. Consistency is critical. Use the CEN guidelines. If you agreed to use them in a meeting room, then start to use them on the test track.

Why wait until 1996 before the test matrix and criteria for barriers and crash cushions are formally accepted? As manufacturers it is very frustrating and costly to run a test that will have no other use in Europe. Why has CEN TC226 WG1 been meeting? Where is the consistency? When will we stop hearing one country speaking and start hearing a unified continental voice?

In a second situation a barrier company was told that each European country can require supplemental tests in addition to the accepted CEN test matrix for a barrier or a crash cushion and that a country can decide that a temporary barrier must be tested as a permanent barrier, even if it is to be used only as a temporary barrier. Where is the consistency? This does not make sense either. Why make the classifications if no one will use them? Are the CEN specifications European specifications or simply guidelines for European countries to pick and choose from at their will?

Many people have put in a lot of time, work, and effort into this harmonization process. It has been very worthwhile, and people's lives will be saved because of this work. However, if this harmonization is to be totally effective, every country that signs that piece of paper must be totally committed to the process.

Highway officials in each country must be willing to give up some of their authority for the overall benefit. This is the only way that the separate entities in Europe can successfully act autonomously as a single body. Everyone must be ready to consistently follow the written rules regarding the acceptance of tests done at approved test sites and be willing to accept the approved service levels. This consistency is critical. If this does not occur completely, the resulting confusion and uncertainty will make marketing conditions for both U.S. and European safety product manufacturers very miserable.

Having a set of written rules that are not uniformly enforced will create an even worse situation resulting in higher cost products, a more difficult acceptance of the products, and an all-around unacceptable condition. Consistency is key and critical.

However, if the countries in Europe can work together as a single entity, and they can, the benefits to committed manufacturers from this harmonization process will be tremendous. We must start now.