



## How We Know It Works: Federal Testing Criteria for Roadside Safety Devices

Mostly we take them for granted, but the sign supports, guardrails and other devices installed alongside the nation's roads have played a central role in the overall reduction in highway traffic fatalities over the past four decades.

Known collectively as **roadside safety devices**, these roadway fixtures are the product of years of detailed research and careful engineering. The devices vary in form and function, but each shares a common goal: to minimize loss of life in the event a vehicle leaves the roadway.

Fifty years ago, guardrails were installed on the nation's roadways without protection on the end. It was observed over time, that an errant vehicle might be speared by striking the blunt end of those guardrails. This impact behavior led some highway designers to begin to turn the guardrail end down and anchor it at ground level. This solved the problem of vehicles being speared by a blunt end, but the turned-down guardrail end, when impacted, was observed in some instances to cause a vehicle to roll over. The Federal Highway Administration (FHWA) and state departments of transportation developed many guardrail end-terminal variants as they attempted to solve the guardrail end-impact problem. Each guardrail terminal design had both advantages and performance limitations.

In the late 1980s, Texas A&M Transportation Institute (TTI) engineers, responding to a call for innovation from highway agency officials, designed and began developing a guardrail end terminal known as the ET-2000. ET stands for end terminal. The ET-2000 is known as a *gating, energy-absorbing W-beam guardrail terminal*. It was designed in part to help mitigate the consequences of a vehicle striking the end of a guardrail. Simply put, it helps absorb the energy of a crash. When hit end-on, within specific federal criteria, it allows the guardrail to flatten and deflect away from the impacting vehicle, slowing the vehicle in the process.

The ET technology has evolved in response to feedback from highway authorities. The evolution occurred for many reasons, including changes in the vehicle fleet and its characteristics; reports of nuisance impacts of systems by snow plows, mowers, and other equipment; and observation of vehicle impact. The latest product in the extruding end terminal family is known as the ET Plus® and has a history of successful performance. Like all roadside safety devices, the ET Plus® must meet standards adopted by the federal government to ensure the device functions as intended.

For 16 years (1993 – 2009), those standards were known as National Cooperative Highway Research Program (*NCHRP Report 350*), the measure by which the FHWA evaluated the design and performance of roadside safety devices. Crash performance of a safety device is evaluated in *NCHRP Report 350* based on the device's

- Structural adequacy to meet the expected performance standard,
- Risk to vehicle occupants based on its design, and
- Post-impact vehicle trajectory after striking the device.

The ET Plus® is subject to a matrix of tests involving different types and weights of vehicles, different angles of collision, and different speeds at impact. FHWA engineers determine which of these tests are required before accepting a product for federal reimbursement and use on the National Highway System. Measurements and data are recorded during full-scale crash tests. The ET Plus® met the performance requirements of *NCHRP Report 350* and the review of those data by FHWA.

In layman's terms, a test of the ET Plus® passes *NCHRP Report 350* criteria if

- the test vehicle remains upright,
- the guardrail doesn't penetrate the passenger compartment, and
- occupants of a vehicle are not subjected to excessive and potentially fatal deceleration.

Highway products that are used in projects where federal reimbursement is sought are subject to the standards in place at the time the device was accepted by the FHWA. The ET Plus® has been successfully tested in accordance with *NCHRP Report 350* standards and deemed eligible for federal reimbursement by FHWA on guardrails installed at both the older guardrail height of 27 ¾ inches and the more recent 31-inch installation height. FHWA has requested that the ET Plus® be subjected to additional testing.

The four tests to be conducted at each of those heights in the most recent request by FHWA are

- An 1,800-lb passenger car hitting the terminal end-on (0 degree) at 62 mph,
- A 4,400-lb pickup truck hitting the terminal end-on (0 degree) at 62 mph,
- An 1,800-lb passenger car hitting the terminal end-on at 15-degrees at 62 mph, and
- A 4,400-lb pickup truck hitting the terminal end-on at 15-degrees at 62 mph.

The results, as noted above, will be evaluated based on structural adequacy, occupant risk, and post-impact vehicle trajectory.

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