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February 9, 2015

Gregory G. Nadeau
Acting Administrator
Federal Highway Administration
1200 New Jersey Ave., SE
Washington, DC 20590

RE: Notice; Request for Information, ET-Plus Guardrail End Terminal, Docket No. FHWA-2014-0039

Dear Administrator Nadeau:

The Safety Institute is a nonprofit organization dedicated to supporting evidence-based research and interventions aimed at reducing injuries and improving product safety. As you know, our organization was the sponsor of a recent study of the energy absorbing guardrail end terminals.

The following is our submission to Docket 2014-0039 in response to the FHWA's December 24, 2014, Federal Register notice requesting "data and information regarding the ET-Plus guardrail end terminal manufactured by Trinity Industries, Inc., before determining whether the product should continue to remain eligible for Federal-aid highway funding." We are submitting the comments and a data spreadsheet electronically, with supporting documents to follow via FedEx

We commend the agency for recognizing the need to obtain more data and information regarding the ET-Plus guardrail end terminal. We are also encouraged to learn that the agency is reviewing its process for assessing the safety of roadside safety hardware. The Safety Institute shares the FHWA's stated goal: to ensure that roadside safety hardware, and specifically in this case, guardrail end terminals, perform as intended, protecting the millions of people on the roads who depend on them every day. When there are doubts about the safety of a guardrail end terminal, it is imperative that all available data and tools are used to determine whether these products should remain in use.

Available Data on ET-Plus Crashes

In response to your request for data and information concerning crashes that involve the ET-Plus, we have compiled an index of 39 incidents in which a vehicle struck an end terminal, often resulting in severe injuries or deaths.[1] Where possible, the index includes the victims' names, the crash date and a summary of the crash, the vehicle information, the end terminal type, a case caption and attorney if applicable, and any supporting documents. The incidents detailed in the spreadsheet are part of an ongoing process to investigate crashes and do not represent a comprehensive accounting. We have excluded incidents that occurred in Ohio and Missouri, as those are addressed in the study discussed below.

Because neither the federal government nor the state departments of transportation (DOTs) have a reliable mechanism for tracking crashes involving roadside safety hardware, it is impossible to obtain comprehensive data. As discussed further below, when the FHWA requested that states provide information on the number of ET-Plus end terminals in their states and any crashes involving an ET-Plus, many states were unable to supply the information and others scrambled to conduct "windshield surveys" and manual file searches. Thus, the FHWA needs to consider this undercount as it analyzes the data that are available. The crash data that are available do provide insight into the field performance of the ET-Plus and can and should be used to help in identifying what appear to be performance concerns with this hardware.

The following are descriptions of five of the incidents provided. These incidents involved severe or fatal crashes with an ET-Plus end terminal that would likely have resulted in far less severe consequences had the energy-absorbing end terminal performed as intended.

- Rebecca Dryer, 26, was driving her 2003 Pontiac Vibe on a Pennsylvania highway on May 24, 2009, when she swerved to avoid a motorcycle and crashed into an ET-Plus end terminal. The guardrail sliced through the driver's side door, amputating Dryer's right leg and crushing her lower extremities. She was pinned to her seat until emergency personnel could extricate her.[2]

- On the morning of December 17, 2008, Sabrena Carrier was driving her 2006 Honda Ridgeline on a highway in Tennessee when she became dizzy and her vision blurred. She missed a curve in the road and instead struck a guardrail with an ET-Plus end terminal. The guardrail impaled her torso, causing massive internal organ damage and multiple fractures. Carrier, who was 38, died five hours later.[3]

- Bradley Abeln, 31, and Joshua Thomas, 32, were traveling on a Missouri interstate in a 1987 Ford Bronco II on January 17, 2014, when a vehicle sideswiped them. Abeln, who was driving, swerved to the right and struck an ET-Plus guardrail. The guardrail locked up in the ET-Plus and gated outward, severely deforming the driver's side door, spearing it, and causing the vehicle to rollover. Abeln and Thomas were both ejected, killing Abeln and seriously injuring Thomas.[4]

- On June 7, 2014, Cynthia Martin, 40, was driving a 2014 Subaru on a New Hampshire interstate with Richard Marklund, 41, as her passenger. Martin looked briefly at her radio and lost control

[1] Index of ET-Plus End Terminal Crashes

[2] Complaint, *Dryer v. Trinity Indus., Inc.*, No. 10843 (Pa., Beaver Co. Com. Pleas).

[3] Complaint, *Est. of Carrier v. Tenn. Guardrail, Inc.*, No. C13727 (M) (Tenn., Sullivan Co. Cir.).

[4] Petition, *Abeln v. Trinity Indus., Inc.*, No. 14CY-CV05518 (Miss., Clay Co. Cir.).

of the vehicle, striking the ET-Plus end terminal on a guardrail. Portions of the guardrail impaled the vehicle, causing serious injuries to Martin and Markland's lower extremities.[5]

- Diabetic LisaMarie Antonicelli was driving her 2011 Nissan Versa on a Texas highway on September 1, 2012, when her blood sugar dropped. She lost control of the vehicle and veered left into a guardrail with an ET-Plus end terminal. The guardrail intruded into the right floorboard and continued into the passenger compartment, impaling Antonicelli. She is now a paraplegic.[6]

Other Important Considerations

Importantly, lack of data about the ET-Plus highlights the need for monitoring and tracking of roadside safety hardware, which is why we have also included a discussion about the larger issues that should be considered: assuring the products are safe once they are installed on the roads and taking every possible measure to confirm their effectiveness when it is in doubt.

The agency has asserted that it has no legal authority to force states to monitor roadside equipment and that its legal responsibility for ensuring that roadside hardware is safe concludes when it deems the device eligible for federal funding after successful crash tests. While that is true from a legal standpoint, the agency has long acknowledged that the system is broken, leaving potentially dangerous hardware unchecked. The FHWA and other federal and state agencies have known for years that states are not performing in-service performance evaluations (ISPEs) due to lack of funding and resources, as well as a fear that they will be fully responsible for correcting any safety issues revealed through the ISPE.

We recognize the FHWA's authority is limited, and it does not have the authority to recall dangerous hardware or force the states to perform ISPEs. Nonetheless, the FHWA does have several tools it could use more effectively. The agency should take a more active role in the monitoring of roadside hardware after crash testing is completed, such as following up with states after the products have been in use for some time, encouraging them to perform ISPEs and helping to provide them with resources. The FHWA should also create a federal monitoring system that allows states to electronically track how many of each roadside safety device they have in use and where the hardware is located. States could use this system to log crashes that involve roadside hardware, including details about which make and model of hardware was impacted and the condition of the hardware after the accident. These measures of reform would allow the FHWA and the states to continually monitor for any emerging safety issues and timely investigate any concerns.

ET-Plus History

The FHWA has been reluctant to thoroughly investigate Trinity or the ET-Plus, choosing to overlook mounting concerns about its safety and opting not to participate in a qui tam lawsuit asserting Trinity defrauded the government.[7] But the verdict against Trinity in the qui tam lawsuit, information discovered during the course of litigation, and recent crash tests of the ET-Plus at the Southwest Research Institute –

[5] New Hampshire Police Accident Report, Accident involving Cynthia Martin and Richard Marklund, June 7, 2014.
[6] Complaint, *Antonicelli v. Trinity Indus., Inc.*, No. DC13-05900 (Tex., Dallas Co. 298th Jud. Dist.).
[7] *U.S. ex rel. Harman v. Trinity Indus., Inc.*, No. 2:12-cv-00089 (E.D. Tex. verdict Oct. 20, 2014).

in which the guardrail locked up in the extruder head and gated outward, protruding into the driver's side door in at least one test – have shown that the ET-Plus demonstrates performance issues that should concern the agency and the states that use them.

As you know, the FHWA approved Trinity's ET-Plus end terminal in 2000 after Trinity submitted a report certifying that it had successfully passed test 3-31, in which a pickup truck crashed into the terminal head-on at 62 mph. Trinity was not required to conduct any other crash tests because the FHWA determined that tests conducted on the ET-2000, which weighed almost 100 pounds more than the ET-Plus and had significantly different design specifications, would not be altered by the modified terminal anchor design in the ET-Plus.[8] The approved head had a feeder channel width of 5 inches, an exit gate of 1.3 to 1.5 inches, a feeder chute assembly length of 37 inches and exterior feeder chute assembly heights of 15 3/8 inches.

In September 2005, Trinity requested approval of a modified version of the ET-Plus, known as the ET-Plus 31, which was changed to comply with the Midwest Guardrail System's requirement that the height be 31 inches. Trinity submitted two tests – rather than the seven full-scale crash tests recommended by NCHRP Report 350 – conducted by the Texas Transportation Institute (TTI) purporting to demonstrate that the modified ET-Plus 31 safely directs the guardrail away from vehicles that strike it. Although Trinity detailed seven new modifications to the ET-Plus, it did not report that (1) the feeder channel width was reduced to 4 inches; (2) the exit gate was reduced to 1 inch; (3) the feeder chute assembly length was shortened to 36 1/4 inches; and (4) the exterior feeder chute assembly height was reduced to 14 7/8 inches.[9] Trinity also did not submit a schematic or design drawing that detailed the new ET-Plus's dimensions, as required.

Trinity and the FHWA have painted this as a simple oversight, but internal Trinity emails show that it never intended to disclose the modifications. In a November 9, 2004, email stream discussing the change, Trinity's then-president Steve Brown noted that it would save $2 per end terminal, which amounted to $50,000 per year. He went on to say, "If TTI agrees, I'm feeling that we could make this change with no announcement. We did pretty good with the TRACC changes."[10] TRACC is a guardrail cushion that Trinity previously modified without informing the FHWA.

The FHWA approved the ET-Plus modifications after evaluating two tests – test 3-30, in which a car strikes the end terminal head on, and test 3-35, in which a pickup truck strikes the guardrail at post 3 at a 20-degree angle – that TTI conducted on the ET-Plus 31. The agency said:

> "The NCHRP Report 350 requires up to seven crash tests to determine the adequacy of a traffic barrier terminal at TL-3. However, since the original designs for attachment to standard W-beam guardrail have proven to be crashworthy, only those tests that are likely to be affect by the design changes noted above are considered necessary. … The modifications described above are

[8] Ltr. from Dwight Home, Dir., Fed. Hwy. Admin. Off. of Hwy. Safety Infrastructure, to Hayes Ross, Tex. Transp. Instit., Refer to: HMHS-CC12G, Jan. 18, 2000.
[9] Amended Compl., *U.S. ex rel. Harman v. Trinity Indus., Inc.*, No. 2:12-cv-00089 (E.D. Tex. May 16, 2013).
[10] Email from Steve Brown to Rodney Boyd and Brian Smith, Nov. 9, 2004.

> acceptable and the ET-Plus 31 may be considered a TL-3 design that can be used on the National Highway System (NHS) when connected to the MGS barrier."[11]

Thus, the ET-Plus 31 was approved on the basis of its similarities to the original ET-Plus, which was largely approved on the basis of tests conducted on the ET-2000, even though all three models were substantially different from one another and Trinity had not submitted all information required for approval of modifications. Further, The Safety Institute has reason to believe that many of the ET-Plus end terminals have inconsistent measurements that are not in compliance with the specifications the FHWA has approved. For instance, the specifications call for a 1-inch exit gap on the ET-Plus. Dr. Roger Bligh, an engineer with TTI who also co-owns a patent on the ET-Plus, testified during the qui tam trial that the exit gap on the ET-Plus has "been 1 inch during my entire career at TTI, dating all the way back to the ET-2000."[12] He continued to insist the exit gap was only 1 inch even after plaintiff counsel dropped a 1 ½ inch bolt through the gap.[13] However, five out of eight ET-Plus end terminals that Trinity procured from Caltrans's inventory for the latest crash tests had an exit gap of more than 1 inch, including four with an exit gap as large at 1.25 inches.[14]

Reportedly, the eighth and final test conducted on January 27, 2015 – the test that experts have said was a failed test – involved an end terminal with 1-inch exit gap struck at a 0-degree offset, which is the most representative of serious injury and fatal ran-off-the-road crashes that occur in the real world. Although we are still in the process of documenting dimensional anomalies of these terminals, it is imperative that the agency focus on the fact that the exit gap dimensions, in combination with the other secret dimensional changes, may be contributing to field performance failures.

In either 2005 or 2006, Trinity also conducted five tests on a flared guardrail with the 4-inch ET-Plus extruder head. In all five tests, the ET-Plus failed to absorb the energy from impact; in two cases, the vehicle rolled over and in one, the guardrail impaled the vehicle. Trinity did not provide these reports to the FHWA.[15] Trinity has contended that is because the flare was experimental and never released on the market.[16] What Trinity does not say is that the test involved a head-on impact with the guardrail at a 0-degree angle, which is equivalent to a 4.5-degree, low angle test of the ET-Plus on a non-flared guardrail.[17] Two of these tests were reportedly conducted before Trinity sought approval of the modified ET-Plus 31. Thus, Trinity did not disclose to the FHWA that the ET-Plus repeatedly failed one of the tests that is required in full-scale crash testing of new products.

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[11] Ltr. from Dwight Home, Dir., Fed. Hwy. Admin. Off. of Hwy. Safety Infrastructure, to Hayes Ross, Tex. Transp. Instit., Refer to: HMHS-CC12G, Sept. 2, 2005.

[12] Testimony of Roger Bligh, *U.S. ex rel. Harman v. Trinity Indus., Inc.*, No. 2:12-cv-00089 (E.D. Tex.), Oct. 14, 2014, transcript at 187.

[13] Id. at 187-188.

[14] Declaration of Brian A. Coon, *U.S. ex rel. Harman v. Trinity Indus., Inc.*, No. 2:12-cv-00089 (E.D. Tex. filed Feb. 6, 2015), Attachment A.

[15] Testimony of Brian Smith, *U.S. ex rel. Harman v. Trinity Indus., Inc.*, No. 2:12-cv-00089 (E.D. Tex.), Oct. 14, 2014, transcript at 61.

[16] Id. at 64.

[17] Ltr. from Dean Sicking, Univ. of Ala., to Gregory Nadeau, Acting Administrator, Fed. Hwy. Admin., Oct. 22, 2014.

FHWA Learns of Modifications

As you know, the agency learned of the undisclosed modifications in early 2012 after a Trinity competitor, Joshua Harman, discovered the smaller dimensions in the process of developing a competing end terminal and reported it to the FHWA, along with evidence that the modified ET-Plus appeared to be involved in more crashes leading to injuries and deaths than its predecessors. Trinity sued Harman for patent infringement and claimed to the FHWA that Harman was merely a competitor seeking to discredit the ET-Plus.

According to the FHWA's Federal-Aid Reimbursement Eligibility Process, any modifications to hardware that has already been approved for federal aid must be reported to the agency. If the modification is non-significant but the effect is uncertain, the manufacturer must conduct a finite element analysis that shows it will perform in a similar manner to the original crash testing and a validation and verification analysis comparing both the original model and the model of the non-significant change to the baseline crash test.[18]

Even if the modification is non-significant and the effect is positive or inconsequential, the manufacturer must – at the time of modification – submit a certification by a registered professional engineer that the modification does not affect the hardware's structure. The certification must "show the changes have no adverse effect on the crash test performance of the hardware" and support it with an engineering analysis of the crash testing of the original hardware and the expected effects of the modification. If these documents do not adequately demonstrate the modification is non-significant, the FHWA should require either a finite element analysis or full crash testing. [19]

A structural change is significant if it could be expected to adversely affect the crash test performance of hardware that was previously approved under either NCHRP 350 or the more current and stringent MASH (Manual for Assessing Safety Hardware) provisions. The FHWA states:

> "Each crash test that is required for the hardware in order to establish that it meets MASH provisions should be listed, and the petitioner should provide a summary of each test actually conducted and its results. The petitioner should submit all documentation necessary to demonstrate that the hardware satisfies MASH."[20]

Regardless of what it believed the significance of the modifications was at the time, Trinity violated this policy when it failed to disclose them, and by the time the FHWA learned of the modifications, there was enough evidence – including mounting crash reports – to call into question its claims that the modifications were insignificant and had little to no impact on performance. Under the FHWA's own policy, the agency should have required that Trinity submit documentation that the modified ET-Plus could satisfy MASH criteria, or, at the very least, required a finite element analysis. Instead, it allowed Trinity to simply submit the two previous crash tests that did not test the angles at which the failures appear to occur.

The FHWA itself acknowledged in communications with other agencies shortly after it learned of the modifications that it was concerned that the ET-Plus was unsafe. In a February 2, 2012, email, Nicholas

[18] Fed. Hwy. Admin., Federal-Aid Reimbursement Eligibility Process, http://safety fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/acceptprocess/.
[19] Id.
[20] Id.

Artimovich, the FHWA engineer in charge of barrier terminals, requested more information, saying "I think it provides some pretty good documentation that there are extruder heads out there that do not conform to the crash-tested designs. Let me know what you think."[21] After Artimovich met with Trinity executives on February 14, he said in an internal email that even though the 2005 tests may have been conducted with the 4-inch feeder chute, "there does seem to be a valid question over the field performance of the current ET-Plus compared to earlier versions."[22] Further, the FHWA drafted a letter to Brian Smith at Trinity, saying:

> "[E]ven though it appears the ET-PLUS terminal can still meet crash testing requirements, anecdotal reports on the number of highway crashes with fatal injuries involving the ET-Plus terminals indicate they may not be performing as intended and do not match the excellent history of the original ET-2000 terminal. … Finally, we believe it is in the best interest of all parties for Trinity to conduct or sponsor an in-service performance evaluation of the current Trinity extruder terminals to determine their performance. Please include an investigation into the crashes documented by Mr. Joshua Harman."[23]

In March 2012, Dr. Dean Sicking, a co-inventor of the ET-2000, emailed Artimovich, asking "Is the claim about making changes without testing or gaining FHWA acceptance true?" Artimovich responded that he had seen additional crash tests of the modified version "that performed as expected," but said "it's hard to ignore the fatal results."[24]

Also in March, Monique Burns with the Connecticut DOT contacted Artimovich after hearing about Harman's allegations, asking if Trinity changed the dimensions and saying, "Scary to think the system is no longer working as it was originally designed."[25] Artimovich responded that, "We've heard of problems, too, with recent ET-Plus heads. … We are still looking into it and may ask Trinity to conduct an in-service performance evaluation."[26] He later told her, "We need to know how these terminals are performing across the entire range of real-world crashes."[27]

Despite the awareness that the modified ET-Plus may be linked to injuries and deaths and the acknowledgment that more information than simply the prior crash tests was necessary before declaring it safe, including in-service evaluations by the states, the FHWA did not send the drafted letter to Trinity, nor did it request that states begin performing ISPEs on the ET-Plus. In fact, in July 2012, when Kyle Berry at the South Carolina DOT asked the FHWA if the smaller dimension had been approved, saying "My biggest concern is the Department's liability should one of these end treatments fail and it is determined that the manufacturer made changes to the structural dimensions that have not been tested or approved,"[28] Artimovich responded that "Due to pending lawsuits I am asking our Chief Counsel's office

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[21] Email from Nicholas Artimovich to Brian Smith, Re: ET-Plus Head Changes Alleged by SPIG, Feb. 13, 2012.
[22] Email from Nicholas Artimovich to Frank Julian and Daniel Hinton, Fed. Hwy. Admin., Feb. 27, 2012.
[23] Unsigned and undelivered ltr to Brian Smith, Trinity Industries, Fed. Hwy. Admin., 2012.
[24] Email stream between Nicholas Artimovich and Dean Sicking, Re: ET-Plus Allegations!!!!, Mar. 14, 2012.
[25] Email from Monique Burns, Transp. Engineer, Conn. Dept. of Transp., to Nicholas Artimovich, Fed. Hwy. Admin., Mar. 14, 2012.
[26] Email from Nicholas Artimovich to Monique Burns, Mar. 14, 2012.
[27] Id.
[28] Email from Kyle Berry, S.C. Dept. of Transp., to Alice Travis, Fed. Hwy. Admin., Aug. 7, 2012.

to review my response to you. They're currently wordsmithing the language…"[29] The FHWA subsequently confirmed that the ET-Plus remained on the approval list without encouraging the state DOT to perform an ISPE. The agency waited until October 2012 to develop an official statement that:

> "…On February 14, 2012, the company reported the reduction in the width of the guide channels from 5 inches (in the year 2000) to 4 inches (in 2005) was a design detail omitted from the documentation submitted to the Agency on August 10, 2005. On March 15, 2012, Trinity submitted a letter to the FHWA dated March 14, 2011 (sic), which stated its ET-Plus with the 4-inch guide channels was crash tested at TTI in May 2005. The Trinity ET-Plus end terminal with the 4-inch guide channels is eligible for reimbursement under the Federal-Aid Highway Program under FHWA letter CC-94 of September 2, 2005."[30]

That statement was issued in response to an inquiry from Keith Cota who worked at the New Hampshire Department of Transportation and was the Chairman of the AASHTO Technical Committee on Roadside Safety (TCRS). He asked:

> "The question I do have is, 'for the terminal units we are installing in NH, should it be providing a 5 inch feed channel or not?' We have many, many of these terminal units on our high speed facilities and this certainly causes me some strong concern for crash worthiness of the ET-Plus and ET-2000 that we have and are installing each year. I am not sure if I want to wait until the court case is decided and all the appeals have been completed to take action (20 years from now) or be ready to answer the next set of bigger questions as to 1) the need to retrofit the devices installed along our highway system and 2) who pays? I understand this has been going around for some time and I am just now becoming aware of the issues through the complainant in the lawsuit. I will be looking toward Nick to give some guidance as to how NH and other States should proceed. Should I be worried? Should I send this out to the full slot of TCRS State members? Or worst yet, should I brief my Chief Engineer? I don't like the box this puts me in!"[31]

Artimovich's statement did not completely assure Cota, who asked for more information, including high resolution photographs of the 2005 test installation and "supportive documentation for the change in guide plate fabrication and its use in the crash test that is covered by FHWA's CC-94 acceptance letter."[32] Eventually, he accepted the FHWA response, prompting an email to other FHWA employees in which Artimovich once again stressed the importance of states performing ISPEs, saying that "the question has brought the added benefit that New Hampshire will now look more closely at the actual performance of their hardware."[33] Nevertheless, the FHWA did not tell other states to perform their own reviews.

In December 2012, AASHTO contacted the FHWA after conducting a survey of the TCRS, in which three of 21 state DOTs reported that guardrail end terminals were involved in severe crashes that resulted

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[29] Email from Nicholas Artimovich, Fed. Hwy. Admin., to Daniel Hinton, Fed. Hwy. Admin. S.C., July 19, 2012.

[30] Email from Nicholas Artimovich, Fed. Hwy. Admin., to Keith Cota, N.H. Dept. of Transp. & Chairman, AASHTO Technical Comm. on Roadside Safety, Oct. 11, 2012.

[31] Email stream between Keith Cota, N.H. Dept. of Transp. & Chairman, AASHTO Technical Comm. on Roadside Safety, and Nicholas Artimovich, Fed. Hwy. Admin., Oct. 1, 2012.

[32] Id.

[33] Id.

in serious injuries or deaths. [34] Although the FHWA continues to tout that none of the states specifically referenced the ET-Plus, the fact that any states reported problems with end terminals, combined with the doubts the FHWA earlier expressed about the ET-Plus, should have caused the agency to question its stance. Utah said "This is a conditional response, we have had a failure at the terminal end but are not sure why the failure occurred with the terminal."[35] Montana reported that "we have had some anomalous crashes that were severe," included one in which "the angle was just right for the engine block to cause a kink which resulted in the rail spearing through the passenger side of the vehicle."[36] Missouri reported that, "It is very likely that [injury and death] crashes have occurred as the result or poor end terminal performance."[37] AASHTO said:

> "In light of these findings AASHTO is recommending that the Federal Highway Administration re-review the crash acceptance of the ET-Plus end terminal and that it fully documents the modified barrier system for crash worthiness under the NCHRP 350 crash criteria. The issue also brings to light a larger question of crash worthiness testing and whether a single crash test is good for a product's entire life-cycle. The 'single test' concept may make sense in terms of limiting the cost to manufacturers and the industry, however there appears to be a supporting need to validate the crashworthiness of barrier systems, perhaps through comprehensive and coordinated field assessments, and to revalidate minor and major structural changes made to a product through computer analysis and, if need be, full scale crash testing."[38]

The FHWA's Associate Administrator in the Office of Safety, Tony Furst, responded that:

> "As a preliminary matter, we have no reliable data indicating that the ET-Plus end terminals are not performing as they were intended to perform. If we receive reliable data indicating the ET-Plus end terminal or any other safety devices are creating a safety hazard to the public, we will work with AASHTO, the States, and the industry to quickly address those safety concerns."[39]

Furst also noted that AASHTO considered a research proposal in 2011 that "would have addressed many of the issues you raised," and chose not to fund the project. Furst stated that "FHWA would fully support the technical committee's reconsideration of this research proposal in 2013. If this proposed research is funded, it is imperative that highway agencies and hardware manufacturers' work together to use the results of the research to improve hardware design as well as installation and maintenance practices."[40] As discussed further below, when the FHWA had a chance to consider the proposed research in 2013, however, it decided to rank the project a low priority and tell states the ET-Plus was safe.

The FHWA has consistently adhered to its October 2012 statement that the ET-Plus has been properly tested and was approved for federal-aid eligibility. It was not until Oct. 21, 2014, the day after the jury

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[34] Ltr. from John Horsley, Exec. Dir., AASHTO, to Tony Furst, Assoc. Administrator Off. of Safety, Fed. Hwy. Admin., Dec. 14, 2012.
[35] AASHTO Survey Results, Dec. 14, 2012, at 7.
[36] Id. at 8.
[37] Id. at 6.
[38] Ltr. from John Horsley, Exec. Dir., AASHTO, to Tony Furst, Assoc. Administrator Off. of Safety, Fed. Hwy. Admin., Dec. 14, 2012.
[39] Ltr. from Tony Furst, Assoc. Administrator Off. of Safety, Fed. Hwy. Admin., to John Horsley, Exec. Dir., AASHTO, Jan. 10, 2013.
[40] Id.

returned a $175 million verdict against Trinity in Harman's qui tam lawsuit – in which the five failed flared ET-Plus tests and Trinity's email regarding not announcing the modifications came to light – that the FHWA decided to retest the ET-Plus. By that time, three states, Nevada, Missouri, and Massachusetts, had removed the ET-Plus from their approval lists. In a letter to Trinity, the FHWA stated that, "In light of these events and to support FHWA's ongoing evaluation of the ET-Plus, FHWA has concluded that Trinity perform testing" and provide the product schematics for the system and extruder head, depicting all dimensions – which the FHWA had not previously asked for – and all information and data Trinity had collected on crash testing or field performance of the ET-Plus.[41] More than 40 states have since removed the ET-Plus from their approved-products lists.

In a Notice of Confirmation of Crashworthiness of the ET-Plus System – filed shortly after the ET-Plus failed one of the crash tests, but not referencing that crash test – Trinity asserted that even if the FHWA determines the ET-Plus is unsafe following its crash tests, "any new eligibility decision based on this testing would be prospective only."[42] Trinity bases this assertion on the FHWA's statement in a FAQs page on its website that, "The future use of the end terminal on U.S. roads will be determined by whether or not the device meets the applicable crash-test criteria …"[43] Trinity is ignoring, however, that future "use" is not the same as future installation. According to Merriam-Webster's dictionary, "use" is defined as the "fact or state of being used."[44] The ET-Plus end terminals currently on the roads are being used and thus should be removed if the FHWA determines they are unsafe based on all of the information it gathers. Further, the FHWA has the authority to make such determination, revoke the eligibility standing of the ET-Plus end terminals for "use" and in "use" on the nation's highways, and prove to the motoring public that its mission to save lives is alive and well.

University of Alabama-Birmingham Study

As the FHWA, state DOTs, and industry-funded experts admit, there is a dearth of studies on the real-world performance of end terminals. Although a letter Malcolm Ray, a frequent engineering expert for Trinity, wrote to the FHWA in December 2014 asserts that states have conducted seven ISPEs on end terminals since 1996, only three of those were conducted after the ET-Plus was secretly modified and one of those three specifically focused on the ET-2000, rather than its successor.[45]

The unwillingness of government agencies to conduct studies has placed a burden on outside organizations to fund and conduct scientifically sound studies. After The Safety Institute learned that the ET-Plus may have been modified in a way that makes it more likely to injure people when vehicles strike the terminal directly, we felt it was imperative to gather more information across the same class of

[41] Ltr. from Gregory Nadeau, Acting Administrator, Fed. Hwy. Admin., to Gregory Mitchell, Pres., Trinity Highway Products, LLC, Oct. 21, 2014.
[42] Defendants' Notice of Confirmation of Crashworthiness of the ET-Plus System, *U.S. ex rel. Harman v. Trinity Indus., Inc.*, No. 2:12-cv-00089 (E.D. Tex. filed Feb. 8, 2015)
[43] Fed. Hwy. Admin., Guardrail Safety: Trinity ET-Plus Re-Testing/Guardrail End Terminal Safety – FAQ, available at www fhwa.dot.gov/guardrailsafety/faq.cfm.
[44] Definition of "use," Merriam-Webster Online Dictionary, available at http://www.merriam-webster.com/dictionary/use.
[45] Ltr. from Malcolm Ray, Roadsafe LLC, to Gregory Nadeau, Acting Administrator, Fed. Hwy. Admin., Re: October 22, 2014 Letter of Dr. D. L. Sicking, Dec. 6, 2014.

roadside safety equipment. We thus sponsored a study in conjunction with the Missouri Highways and Transportation Commission to compare death and injury rates linked to the ET-Plus with death and injury rates linked to other end terminals in Missouri and Ohio.[46] The study, conducted by Dr. Kevin Schrum with the University of Alabama-Birmingham School of Engineering (UAB), took hundreds of hours to develop and execute because the states did not have a comprehensive electronic database, requiring that researchers do a manual review of all crashes that involved a guardrail end terminal.

The study found that in Missouri, the ET-Plus was involved in nearly two-thirds (93 of 156) of the crashes that resulted in death or serious injury between January 2005 and March 2014. It accounted for almost three-fourths of the deaths (17 of 23).[47] In Ohio, the ET-Plus was involved in only 43.3 percent of the total death and serious injury crashes between 2006 and 2013, less than the 46.7 percent for the ET-2000. However, 4 of the 5 fatalities involved the ET-Plus.[48] The study concluded that the ET-Plus was 1.36 to 1.95 times more likely to produce an injury and 2.86 to 3.95 times more likely to produce a fatality than the ET-2000 end terminal design.[49]

The study had limitations because crashes had to be excluded if the state did not collect enough information. If there were no photographs of the end terminal before a crash occurred, the crash was excluded, and crashes with only minor injuries were also excluded because the crash reports did not include diagrams, photographs, and reconstruction descriptions necessary to definitively determine whether a terminal was struck. Further, it would have been cost and time prohibitive to gather detailed information about the location of each crash, including posted speed limit, traffic volume, and width of the road. However, it is believed that accounting for traffic volume would further bolster the severity of injuries and deaths related to the ET-Plus in at least one of the states studied.

The FHWA commissioned four anonymous reviewers, including three in other countries, to evaluate the study and later released a report focused on their criticism of the case-control methodology used.[50] However, the case-control design is an accepted methodology long used in the highway safety field to determine relative risk. In fact, the FHWA itself has acknowledged the usefulness of case-control studies, saying, "[c]ase-control studies assess whether exposure to a potential treatment is disproportionately distributed between the cases and controls, thereby indicating the likelihood of an actual benefit from the treatment."[51]

But more importantly, the UAB study never presented itself as a "perfect" study that represented definitive conclusions about the safety of the ET-Plus. The belief was that if there was an indication that one end terminal presented a greater danger than others, the FHWA and state DOTs – which are better equipped to undertake the endeavor than small nonprofit organizations – would be motivated to conduct their own comprehensive, unbiased studies to see if the findings are a national trend or are more localized. Researchers would be free to choose their own method and factors, as long as they were scientifically sound and the researchers were free from influence by any self-interested parties. Instead of learning from

[46] Kevin Schrum, "Relative Comparison of NCHRP 350 Accepted Guardrail Terminals," Univ. Ala. Sch. of Engineering, Oct. 28, 2014.
[47] Id. at 12.
[48] Id. at 16.
[49] Id. at 21.
[50] Fed. Hwy. Admin., "Peer Review of Report: 'Relative Comparison of NCHRP 350 Accepted Guardrail Terminals,'" Jan. 9, 2015.
[51] Fed. Hwy. Admin., "A Guide to Developing Quality Crash Modification Factors," 2010, at 30.

the study, which clearly uses a widely accepted methodology and offers important insight, or conducting its own study, the FHWA chose to focus its attention and resources on discrediting the UAB study by dismissing a methodology the agency itself has previously validated.

Recommendations for Testing

The FHWA determined that the ET-Plus should be tested using NCHRP 350 criteria, rather than the more current MASH requirements, because that is the criteria in effect when the modifications were made in 2005. According to AASHTO policy, the FHWA said, hardware only has to be tested to MASH criteria if it was developed after Jan. 1, 2011, or underwent significant changes on or after that date.

However, Senators Richard Blumenthal and Charles Schumer expressed concerns with that plan, arguing that because Trinity was deceitful and there are doubts about the safety of the ET-Plus, it should be tested under the rigorous MASH standards. As Schumer explained in a letter to the FHWA:

> "In order to ensure the safety of the traveling public, FHWA must require Trinity to test the guardrails using the toughest and most up to date possible standard, in this situation that is MASH. Grandfathering Trinity into the older NCHRP standard, which was replaced in 2011 by MASH, leaves significant gaps and concerns with the safety of the Trinity ET-Plus end terminal. While I understand that the ET-Plus end terminal was developed prior to the 2011 standard, given Trinity's track record and the significant and documented concerns with the ET-Plus end terminal, FHWA should be exhaustive in efforts to determine the performance of the ET-Plus."[52]

Moreover, as previously mentioned, the FHWA's Federal-Aid Reimbursement Process says that if a structural change is significant – which the ET-Plus modifications have proven to be:

> "Each crash test that is required for the hardware in order to establish that it meets MASH provisions should be listed, and the petitioner should provide a summary of each test actually conducted and its results. The petitioner should submit all documentation necessary to demonstrate that the hardware satisfies MASH."[53]

The tests performed were the 3-30, 3-31, 3-32 and 3-33 at a 27.5 inch guardrail height, as requested by the state of Virginia, and the same tests at the 31-inch height. All of the tests were conducted head-on, at a 0-degree angle.

Dr. Dean Sicking, who testified in the qui tam trial, wrote to the FHWA urging it to test the guardrails at the 4.5-degree angle with an offset one-fourth of the width of the vehicle to replicate the angle at which the ET-Plus failed in the flared-guardrail tests. He said:

> "Because there was no deformation of the guardrail anywhere outside of the flared region, these tests were equivalent to testing the straight ET-Plus in an end-on, offset configuration at an angle

[52] Ltr. from Sen. Charles Schumer to Gregory Nadeau, Acting Administrator, Fed. Hwy. Admin., included in press release, Nov. 13, 2014.
[53] Id.

> of approximately 4.5 degrees. These are the conditions that appear to be causing the catastrophic failures that have been widely reported in the press."[54]

Senators Blumenthal and Charles Schumer again expressed concern in January 2015. In a joint letter, they said:

> "In light of the lack of clear information from FHWA, we find it difficult to maintain confidence that your agency is taking proper action to ensure that the device meets the highest safety standards. In order to rest assured that ET-Plus guardrail end terminals are safe, we strongly urge FHWA to ensure that testing – which is now underway in Texas – use the most up-to-date methodology, be conducted on the products as they actually exist and perform on our roads, and be fully open and transparent. The testing now underway fails on all of these fronts, so we are writing to reiterate our concerns about apparent flaws in the process and ask you to rectify them immediately."[55]

Although there are doubts that the tests chosen by the FHWA are comprehensive enough to confirm that the ET-Plus is safe, the ET-Plus has proven dangerous even in those tests. On the final day of testing in January 2015, a 1998 Geo Metro was driven head-on into the ET-Plus end terminal at 62 mph. The Geo spun around, and it appears from photographs that the guardrail initially began to ribbon through the ET-Plus but then gated outward into a V-shape that struck the driver's side door. The door was pushed inward toward the test dummy. [56] While the data has not been released by the FHWA, it is apparent that the ET-Plus did not perform as intended.

Engineer Brian Coon, who was retained by Harman, recently filed a declaration in the qui tam suit, noted this is a "failed" test under NCHRP 350, which requires that "the test article not penetrate the occupant compartment and that there be no deformations of or intrusions into the occupant compartment that could cause a disabling injury."[57] Coon said:

> "The deformation of the driver's side door in the January 27 crash test not only could have caused disabling injuries, but showed a propensity to penetrate the vehicle and cause devastating injuries. This was a clear failure under NCHRP Report 350 guidelines."[58]

In the agency's request for information about the ET-Plus end terminal, you stated that you are collecting information "to assess whether the ET-Plus has vulnerabilities outside of the NCHRP 350 testing now being conducted. The review of this information will help FHWA determine whether to require additional testing of the ET-Plus or other devices in the same class." Given that Trinity has proven to be deceitful

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[54] Ltr. from Dean Sicking, Univ. of Ala., to Gregory Nadeau, Acting Administrator, Fed. Hwy. Admin., Oct. 22, 2014.

[55] Ltr. from Sens. Richard Blumenthal and Charles Schumer, to Gregory Nadeau, Acting Administrator, Fed. Hwy. Admin., included in press release, Jan. 17, 2015.

[56] Danielle Ivory and Aaron M. Kessler, "Assessment of Guardrails May Hinge on Final Crash Test," N.Y. Times, Jan. 30, 2015.

[57] NCHRP 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features," at 51, section 4.4.

[58] Declaration of Brian A. Coon, *U.S. ex rel. Harman v. Trinity Indus., Inc.*, No. 2:12-cv-00089 (E.D. Tex. filed Feb. 6, 2015).

several times since 2005, that dozens of injuries and deaths have been linked to the ET-Plus, that states have reported incidents involving the ET-Plus and removed it from their approved-products lists and that the ET-Plus has now failed one of the tests it was predicted to pass, it is time for the FHWA to require all of the tests it has in its arsenal, following the MASH criteria. The FHWA should use every tool it possesses to ensure the ET-Plus end terminals that are currently on the nation's roadways do not reduce safety for motorists.

Post-Approval Monitoring

Unfortunately, the scant data on the safety of the modified ET-Plus is common with roadside safety hardware because there is no nationally coordinated or mandated system for monitoring the performance of roadside equipment, nor do most states collect information about motor vehicle accidents involving the equipment.

The agency has frequently agreed that full-scale crash tests are not the most important factor in proving roadside equipment is safe—their proven ability to protect vehicle occupants when accidents occur in the real world is the true test. When the agency first began regulating roadside hardware, it established a system in which a device that passed all of the full-scale crash tests would be approved on an "experimental" basis, with the recommendation that states conduct post-installation ISPEs. After the hardware demonstrated satisfactory field service, the agency would upgrade its status to "operational," meaning it was safe.

But states often did not comply and in 1993, the agency eliminated the "experimental" stage and ended the ISPE requirement.[59] That year, AASHTO released NCHRP Report 350, with guidelines for crash testing roadside safety features. The report urged states to conduct ISPEs, noting that "These normalized test conditions have a significant effect on a feature's importance but are of secondary importance when comparing results of two or more systems."[60]

In a 2005 memorandum to state DOTs, John Baxter, director of the Office of Safety Design, noted that states were not performing ISPEs on roadside safety features and again urged them to do so:

> "Because the crash tests by which safety features are deemed acceptable for use on the NHS are conducted under ideal conditions, are limited in number, and use only two vehicle types, this testing may not reveal longer term operation, maintenance, or repair problems that do not become apparent under short-term certification testing. Actual field experience must be monitored to assure that a safety device is working as intended."[61]

The agency has acknowledged in internal emails that the states do not have the resources or motivation to conduct ISPEs even though they are a key component of keeping the public safe. In 2008, several employees in the FHWA, DOT, state DOTs, a guardrail manufacturer and two people who helped develop the National Cooperative Highway Research Program's (NCHRP) recommendations for ISPEs,

[59] Natl. Cooperative Hwy. Research Program, "Report 490: In-Service Performance of Traffic Barriers," 2003.
[60] Natl. Cooperative Hwy. Research Program, "Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features," 1993.
[61] Memo. from John R. Baxter, Dir. Off. of Safety Design, to Safety Field, "INFORMATION: In-service Performance Evaluation and Continuous Monitoring of Roadside Safety Features," Nov. 17, 2005.

found in Report 490, discussed ideas for how to get states to conduct the evaluations on a continuous basis. Many participants felt they should introduce (for a third year) a Problem Statement to the AASHTO TCRS seeking to study the issue. Some of them recognized that the federal government would need to take the reins because states would not do ISPEs on their own accord. FHWA safety engineer Frank Julian suggested a poolfund that all states would contribute to and then select the products to be evaluated. [62] FHWA highway research engineer Kenneth Opiela suggested a federal mandate that might, for instance, require that an acceptance letter expire after a fixed period of time unless the state submits a certain number of ISPEs, saying:

> "It is critical to remind everyone that crash testing only serves to provide a uniform means to compare various types of hardware for a small set of impact conditions. Deployment of roadside hardware opens the possibility for hundreds of other setting and impact condition for which we can't be assured there will be effective crash performance."[63]

Malcolm Ray, who co-wrote Report 490, said states could "calculate pretty coarse rates based on police reported crashes" and record them in state DOT traffic records sections. Then the states would be required to perform ISPEs when the rates indicate "an emerging problem." Ray noted,

> "An ISPE-based decision is based on the most common crash scenarios whereas the crash testing is based on more extreme crash test scenarios. We like to think if we cover the more extreme scenarios we will get the common ones by default but I think we all realize that isn't really true."[64]

Incidentally, Report 490 also stated that there needs to be a procedure for efficiently gathering data on a regular basis and compiling, maintaining and sharing the data.[65]

A Problem Statement entitled "In Service Evaluation of End Terminals" was submitted to the AASHTO TCRS in 2011, but the technical committee decided not to fund the research.

In 2013, the FHWA again considered a Problem Statement that had been submitted to AASHTO regarding ISPEs for guardrail end terminals. By this time, the qui tam lawsuit was underway and some states were reporting injuries and deaths in accidents involving the ET-Plus. The AASHTO Subcommittee on Design, in collaboration with the TCRS and the TRB Roadside Safety Design Committee, proposed to (1) work with selected states to conduct an ISPE on the most common barrier end terminals in service; (2) develop a list of factors that could affect performance; and (3) evaluate comparative crash performance in terms of injury severity, secondary crash involvement, repair costs, and routine maintenance needs.[66] The proposal stated that:

> "While ensuring that new devices can be expected to perform acceptably in real world crashes is by itself sufficient reason to pursue in-service performance evaluation, another issue adds to its importance. Barrier end terminals currently in service on the nation's highway system include a

[62] Frank Julian email, Email Stream Aug. 28, 2008 to Sept. 5, 2008, Re: NCHRP Project Statement on ISE, at 1.
[63] Kenneth Opiela email, Email Stream Aug. 28, 2008 to Sept. 5, 2008, Re: NCHRP Project Statement on ISE, at 2.
[64] Malcolm Ray email, Email Stream Aug. 28, 2008 to Sept. 5, 2008, Re: NCHRP Project Statement on ISE, at 3-4.
[65] Natl. Cooperative Hwy. Research Program, "Report 490: In-Service Performance of Traffic Barriers," 2003, at Foreward.
[66] Proposed NCHRP Research Problem Statement, "In Service Evaluation of End Terminals," No. 2014-C-23, Submitted Sept. 15, 2011, reviewed by AASHTO Feb. 26, 2013.

> wide range of devices with a wide range of wood and steel post design options. . . . The need to fully understand the actual real world performance of new terminals, as well as the comparative performance of the wide range of terminals currently in service, make it urgently important to evaluate the actual in service performance of the full range of barrier end terminals currently in service on the nation's highway system."[67]

The FHWA was asked to rate the need for the research project from 0 (no need) to 5 (absolute need), and FHWA employees varying opinions. Safety engineer Dick Albin said that, "The need for in-service performance evaluations has been a priority for a long time. However, AASHTO has been reluctant to fund this in the past. This is probably a very opportune time to get the ball rolling. While I might look at this as a '4' for impact, I think that the timing bumps it up to a '5.'"[68] Albin later said in the email stream that "for individual states, it is unlikely that there will be enough data to make a useful conclusion," arguing that the best way to prompt more ISPEs would be to get National Highway Traffic Safety Administration data collectors to routinely collect roadside information.[69] Frank Julian agreed with the priority assessment, noting that obtaining ISPEs on end terminals was "a high priority this year due to some current events."[70]

Monique Evans, director of the Office of Safety Research and Development, had a different opinion—she felt that the issue was not appropriate for an AASHTO research project because the proposal was to enforce a process that had already been developed but was not being used, not to solve a technical problem. She offered an extensive discussion about the reasons states are not performing ISPEs. In addition to the time and money it takes to collect and analyze data, states are reluctant to perform them on hardware that has been successfully crash tested because they are not required to do so and they do not want to be forced to correct problems that are discovered. [71] Evans concluded:

> "Due to all of the uncontrollable variables, any in-service performance evaluation may be informative but it won't be definitive. Comparisons of these evaluations done by different states can't be any more definitive than the individual evaluations themselves. Relative to other safety priorities, the value of this proposal in my opinion is low."[72]

Nicholas Artimovich disagreed, noting that IPSEs are necessary and are not being conducted: "And since the vast majority of end terminals are proprietary, it is not likely that any state or pooled fund group will study them without 'massive government intervention.' Thus my continued support for the subject

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[67] Id.

[68] Dick Albin email, Email Stream from Feb. 27, 2013 to Mar. 1, 2013, Re: Due March 4 – NCHRP 2014 Ballot – AASHTO committee late entry, at 23.

[69] Dick Albin email, Email Stream from Feb. 27, 2013 to Mar. 1, 2013, Re: Due March 4 – NCHRP 2014 Ballot – AASHTO committee late entry.

[70] Frank Julian email, Email Stream from Feb. 27, 2013 to Mar. 1, 2013, Re: Due March 4 – NCHRP 2014 Ballot – AASHTO committee late entry, at 23.

[71] Monique Evans email, Email Stream from Feb. 27, 2013 to Mar. 1, 2013, Re: Due March 4 – NCHRP 2014 Ballot – AASHTO committee late entry, at 21-22.

[72] Id.

NCHRP study."[73] In her response, Evans again emphasized that if massive government intervention is needed, it will have to be in the form of a mandate or program, not a Problem Statement. She stated that:

> "Unless a state suspects that it has a safety problem with a device or unless they are being told to no longer use a device that they think is working well or if they are told to remove devices that think [sic] are safe then the potential liability and cost associated with doing these types of evaluations will likely keep them from doing them. The desire to have a better understanding of the performance is not generally a strong motivator to incur these costs in a fiscally constrained environment where there are other competing needs."[74]

Despite knowledge that the ET-Plus may reduce motorist safety, states were not conducting ISPEs to monitor the ET-Plus, the FHWA ranked the Problem Statement a priority level 2. It was eventually approved, but the language quoted above about the urgent need to study the varying end terminals was removed. The statement did note that:

> "Although the roadside safety community has agreed about the importance of in-service evaluations and procedures in existence, few in-service performance evaluations have been completed. Simply relying on full-scale crash tests to assess the long-term performance of end terminals may overlook important aspects of crash safety as well as other aspects of device performance."[75]

Unfortunately, the FHWA allegedly awarded the project to researchers with known ties to Trinity. As you know, the study has been stayed and is expected to be "reallocated to a potential special study." In a November 2014 letter to the FHWA, Malcolm Ray expressed his anger that the project had been stopped:

> "ISPEs have been called for over and over again by the roadside safety community because investigation of real crash events is needed to improve crash testing procedures and determine how effective our roadside designs actually are when installed on the nation's highways. A comprehensive study of real-world crashes would allow testing guidelines to evolve such that tests more accurately mirror impact conditions observed in the field rather than using guesses and assumptions. … The time has truly come to do a comprehensive fair and unbiased in-service performance evaluation (ISPE) of <u>all</u> w-beam terminals. In fact, such a study is long overdue. Even after decades of use the roadside safety and highway design communities have little understanding of how <u>any</u> of these units function in the field."[76]

We agree with Ray's argument that comprehensive studies are urgently needed to determine the safety of all end terminals. But efforts to compare the safety records of various end terminals and to analyze the obligation to conduct ISPEs regarding end terminals can be successful only if the studies are unbiased and transparent. To ensure that studies are accurate and not influenced by the industry, the FHWA should

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[73] Monique Evans email, Email Stream from Feb. 27, 2013 to Mar. 1, 2013, Re: Due March 4 – NCHRP 2014 Ballot – AASHTO committee late entry, at 21.

[74] Monique Evans email, Email Stream from Feb. 27, 2013 to Mar. 1, 2013, Re: Due March 4 – NCHRP 2014 Ballot – AASHTO committee late entry, at 25.

[75] NCHRP 22-30, "In-Service Performance Evaluation of W-beam End Terminals," Posted Nov. 20, 2013.

[76] Ltr. from Malcolm Ray, Roadsafe LLC, to Gregory Nadeau, Acting Administrator, Fed. Hwy. Admin., Re: In-Service Performance of the ET-PLUS, Nov. 4, 2014 (emphasis in original).

choose researchers who are free of conflicts which includes appointing those that have not worked with any manufacturers to conduct a transparent, comprehensive, and scientifically sound review.

States Have No Monitoring Mechanism

Because most states do not have electronic systems for monitoring the performance of equipment on their highways, many have had a difficult time determining how many ET-Plus end terminals they have and how many of those have been involved in serious crashes. The FHWA itself has acknowledged this: After requesting on October 10, 2014, that states provide information regarding how many ET-Plus terminals they used, the agency said in a follow-up email, "We realize that not all states' record systems can facilitate such data compilation."[77]

For instance, after meeting with attorneys representing victims harmed by ET-Plus end terminals in December 2012, the South Carolina Attorney General asked the state DOT how many of the terminals were in use in the state, whether any had been involved in an accident, and whether an assessment had been performed. David Cook, the state maintenance engineer, reported:

> "I haven't heard back from anyone yet, but I don't think the crash performance is something that we are evaluating at all. I don't think we'll be able to verify whether or not these terminals have always functioned as designed. We replace them after they are hit, but no one is analyzing the type of impact and the response of the terminal and verifying that it is proper."[78]

Later that day, his colleague reported to the state legal department that, "We are unaware of any problems with the terminal end sections that are currently in use on our right-of-ways."[79]

The Washington state DOT found that information in its Materials Tracking Program was often incomplete and vague: "It doesn't appear that the lab has a system that would data mine fully the information needed on these Trinity terminals much more than any of the other systems being tried at both construction and design offices. This is looking more like a manpower quest than a data mine to get the information."[80]

The Kansas DOT decided to estimate the number of ET-Plus terminals in the state by looking at quarterly bid averages since 2008, reporting that "We do not have any KDOT Bid averages prior to 2008 and are not sure just when KDOT started installing the ET-Plus terminals."[81] Oddly, there were 83 ET-Plus bids in 2011, but only 5 in 2012 and none in 2013, while 54 were already slated through the third quarter of 2014.[82]

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[77] Email from Mike Griffith, Fed. Hwy. Admin., to state depts. of transp., Re: ET-Plus end terminal: Follow-up to October 10th memo, Oct. 24, 2014.

[78] Email from David Cook, S.C. Dept of Transp., to Jim Feda, S.C. Dept. of Transp., Jan. 9, 2013.

[79] Id.

[80] Email from Mark Grigware, Wash. Dept. of Transp. Documentation Engineer, to Mark Sujka, Wash. Dept. of Transp., Oct. 22, 2014.

[81] Email from David LaRoche, Fed. Hwy. Admin. Kan., to James Brewer and Scott King, Kan. Dept. of Transp. Div. Engineering & Design, Oct. 27, 2014.

[82] Id.

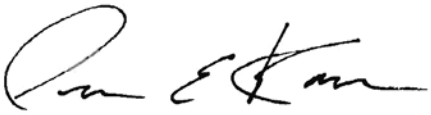
Connecticut said that "Due to the requested turnaround of this info, we had the inventory assessed based on 'windshield surveys' by our supervisors, so additional investigation will be needed if the exact number of Trinity ET-plus units currently installed is required."[83] Connecticut DOT employees also had an internal email discussion in September 2014 after Massachusetts suspended approval of the ET-Plus, when one employee suggested they confirm how many ET-Pluses were in use and maybe update them. Another employee said the state had been discussing the issue with the Rhode Island DOT "for several months" but noted his belief that:

> "The jury is out, it could be a bad product, but I would be cautious in jumping to conclusions. Where possible, specify end treatments as 'energy absorbing end terminals,' or 'non-energy absorbing end terminal.' That will leave the approved fabricators and products in the hands of the DOT, and the liable [libel – sic] and slander can be someone else's problem."[84]

The questions surrounding the safety of the ET-Plus and the extent of Trinity's deception require more extensive action than another round of crash tests that do not include angles that have proven to be the vulnerable spots for the ET-Plus. Further, the unavailability of reliable data have made it clear that there is a need for extensive reforms in roadside safety hardware monitoring – including for those devices that pass the initial tests. Leadership in this area should start with a federal system for monitoring and electronically tracking hardware inventory and any accidents involving them, and states should be given the tools they need to perform ISPEs before vehicle occupants die or are severely injured by the hardware that was intended to save them.

Sincerely,

Jamie Schafer-Wilson
Executive Director



Sean E. Kane
President of the Board of Directors

[83] Email from Bartholomew Sweeney, Transp. Maintenance Dir., Conn. Dept. of Transp., to Thomas Harley, Conn. Dept. of Transp., Oct. 17, 2014.
[84] Id.

ET-Plus Incidents

Name	Case Venue	Case No.	Plaintiffs' Attorney(s)	Vehicle Information	Guardrail / Barrier Information	Date of Incident	State	Facts	Injury Information	Supporting Doc #1	Supporting Doc #2	Supporting Doc #3	Supporting Doc #4	Supporting Doc #5
Elisa E. Gonzales	44th Judicial District Court, Dallas, TX	DC13-08063			Trinity ET-Plus	20110000	FL	Driver fell asleep The car struck the ET-Plus guardrail, which sliced through the car directly to the passenger side, amputating Gonzales' leg.	Leg amputation	News Article	Legal Document			
Timothy Benson v. Trinity Industries, Inc.	US Northern District Court, Dallas, TX	3:14-cv-00746	The Lawrence Law Firm 700 Lavaca Street Suite 1400 Austin, Texas 78701	2002 Pontiac Grand Prix	Trinity ET-Plus	20130609	IL	Car rotated, and five feet of guardrail went through driver side door, piercing the compartment until it reached from the driver's door to the door on the passenger's side, essentially cutting the driver in two.	Lower leg and abdominal injuries	Complaint	News Article	News Article		
Scott Bass				2001 Chevrolet Tahoe	Trinity ET-Plus 5"	20140329	IN	Chevy Tahoe left the road and struck a guardrail. Vehicle spun around 180 degrees, according to officials, shoving the guardrail into the vehicle before the SUV came to rest.	Severed Legs	Accident Report	News Article	News Article	Photos	
Dianna Allen	Suffolk County Superior	14-2473	Richard J. Sullivan Sullivan & Sullivan, LLP 83 Walnut Street Wellesley, Massachusetts 02481	2008 Cadillac ETS	Trinity ET-Plus	20110804	MA	Driver was cut off by an unknown driver, exited the roadway to avoid a collision, lost control of the ability to steer her vehicle and impacted an ET-Plus end terminal system. She hit the guardrail and as a result she lost her right leg below the knee.	Leg amputation	Complaint	Civil Action	News Article		
Brandt v. Trinity	Circuit Court of Lafayette County, MO	05LF-CV-01066	R. Denise Henning Stephen R. Bough 1044 Main, Suite 500 Kansas City, MO 64105 Kent Emison Langdon & Emison 911 Main St. Lexington, MO 64067	1996 Chevrolet Tahoe	ET- 2000 Plus	20030607	MO	The vehicle left the roadway on the right side and collided with the end terminal of a metal guardrail. The guardrail penetrated the vehicle and as a result caused the deaths of Carl and David Brandt.	Fatalities	Complaint				
Charity Adams			Kent Emison Langdon & Emison 911 Main St. Lexington, MO 64067	1992 Ford Taurus	Trinity ET-Plus	20121213	MO	Accident occurred as driver lost control on ice covered roadway. Car went off the right side, struck a guardrail and overturned off the roadway. Victim was pronounced dead at the scene.	16 year old passenger was killed.	Accident Report	News Article	Accident Report	Photos	
Bradley Abeln v. Trinity Industries, Inc.	Circuit Court Clay County, MS	14CY-CV05518	Kent Emison Langdon & Emison 911 Main St. Lexington, MO 64067	1987 Ford Bronco II	Trinity ET-Plus	20140117	MO	Two-vehicle accident occurred at 6:49 AM in Lake County at mile marker 19.8 on Interstate 35 (in Clay County near Liberty). Vehicles driven by 45-year old Pamela Wilson of Gallatin and 31-year old Bradley Abeln of Polo were both southbound. The Wilson vehicle was in the passing lane and swerved to the right, striking the Abeln truck. The truck began to skid, struck the guardrail and overturned, ejecting both Abeln and his passenger, Joshua Thomas, from the vehicle.	One fatality (driver), one serious injury (passenger)	News Article	Accident Report	Accident Report Supplement	Petition	
Jay Traylor	14th Judicial District Court, Dallas County, Texas	DC-14-01965	The Lawrence Law Firm 700 Lavaca Street Suite 1400 Austin, Texas 78701	SUV	Trinity ET-Plus	20140126	NC	Jay Traylor was on his way home from Raleigh on Jan. 26 when he fell asleep at the wheel, and his SUV veered off I-40 near Hillsborough and slammed into a guardrail. The guardrail sliced through the vehicle, came through his floorboard between the accelerator and the brake, barely missed his torso and continued through the back seat, stopping short of the back door of the vehicle. His right leg was severed, and surgeons at Duke University Hospital had to amputate his mangled left leg.	Bilateral leg amputations	News Article	News Article	Complaint	Trinity's Response	Accident Report
Darius Jemal Williams				2011 Nissan Sentra	Trinity ET-Plus	20140223	NC	Vehicle ran off the left side of the roadway into the grass median and collided with the guardrail. The left side door area struck the guardrail causing it to go through the vehicle. The driver was pinned in the backseat on the right side.		Accident Report				

ET-Plus Incidents

Name	Case Venue	Case No.	Plaintiffs' Attorney(s)	Vehicle Information	Guardrail / Barrier Information	Date of Incident	State	Facts	Injury Information	Supporting Doc #1	Supporting Doc #2	Supporting Doc #3	Supporting Doc #4	Supporting Doc #5
Cynthia Martin / Richard Markland			David Kwass Saltz, Mongeluzzi, Barrett & Bendesky 1650 Market Street One Liberty Place, 52nd Floor Philadelphia, PA 19103	2014 Subaru	Trinity ET-Plus	20140607	NH	Driver was momentarily distracted, struck the beginning of the guardrail head on. Portions of the guardrail impaled the vehicle.	Lower extremity injuries to both driver and passenger.	Accident Report	Photos			
Kristen Sweeney	Superior Court of New Jersey Law Division	BER-L-7170-06	Bruce Nagel and Andrew O'Connor		Trinity ET-Plus		NJ	Husband was a passenger in a limo that struck a guardrail and he was killed.	Fatality	News Article	Legal Document			
Bradley Howell				2010 GMC Yukon	Trinity ET-Plus	20140403	NY	SUV veered off the road and struck the front of an elevated guardrail. A section of the railing entered the vehicle near the driver's side front headlight, passed through the interior of the Chevrolet Yukon and exited near the passenger's side taillight. The sport-utility vehicle was towed with part of the guardrail still in it.	Right leg amputation	News Article	Accident Report			
Anthony Butterbaugh			Phillip Kuri Elk & Elk Co., Ltd. 6105 Parkland Boulevard Mayfield Heights, OH 44124	1999 Toyota RAV4	Trinity ET-Plus	20140330	OH	Intoxicated driver drove vehicle off the right side of the road and struck a guardrail.	Driver - Left and right leg contusions. Right ankle was severed.	Accident Report	Photos			
Rebecca Dryer v. PDOT , et al.	Court Of Common Pleas Of Beaver County, Pennsylvania	10843	David Kwass Saltz, Mongeluzzi, Barrett & Bendesky 1650 Market Street One Liberty Place, 52nd Floor Philadelphia, PA 19103	2003 Pontiac Vibe	Trinity ET-Plus	20090524	PA	Lost control attempting a lane change causing vehicle to travel off the roadway and strike the end of the West berm guardrail with Its front. Vehicle continued to travel along guardrail for approximately 25 feet and came to final rest facing Southwest against West berm guardrail. Driver couldn't move due to the guardrail piercing driver side compartment and trapping her legs.	Leg injury resulting in amputation	Complaint	Accident Report	Photos		
Marzena Mulawka v. Commonwealth of PA, et al.	District Court, Western District of PA	11-1651	Pro Se Plaintiff	2005 Ford Freestyle	ET-2000/ET-2000 PLUS/ SRT-350	20100103	PA	While travelling eastbound on I-80, plaintiff was hit in the rear by a tractor-trailer, and was pushed into the rear-end of another tractor-trailer travelling in front of Plaintiff's vehicle. After the second impact, Plaintiff's driver's side door came into contact with the terminal end of the guardrail, which penetrated the driver's side door and severed Plaintiff's right leg as well as causing numerous other injuries.	Right leg amputation	Complaint	Trinity Highway Products, Llc's Answer To Plaintiff's Complaint	News Video		
				Nissan Altima	Trinity ET-Plus	20130530	SC	According to Irmo Police, the driver was traveling on Dutch Fork road in a Nissan Altima when his tire blew out in front of the Irmo Wal-Mart. The car then ran off the right side of the road and hit a guardrail. Irmo Police Chief Brian Buck says approximately 14 feet of guardrail went through the car, narrowly missing the driver.	Minor injuries to driver	News Article				

ET-Plus Incidents

Name	Case Venue	Case No.	Plaintiffs' Attorney(s)	Vehicle Information	Guardrail / Barrier Information	Date of Incident	State	Facts	Injury Information	Supporting Doc #1	Supporting Doc #2	Supporting Doc #3	Supporting Doc #4	Supporting Doc #5
Sandra Lester (for Estate Of Decedent Sabrena Carrier) v. Tennessee Guardrail, Inc., et al.	Circuit Court For Sullivan County At Bristol, TN	C13737 (M)	Ritchie, Dillard, Davies & Johnson, P.C. Suite 300, 606 W. Main Street Post Office Box 1126 Knoxville, TN 37901-1126 Leopold Law, P.A. 2925 PGA Boulevard, Suite 200 Palm Beach Gardens, FL 33410 Law Offices of Wayne Culbertson 119 W. Market S tree! Kingsport, TN 37660	2006 Honda Ridgeline	Trinity ET-Plus	20081217	TN	While traveling westbound along Highway 394, plaintiff began to experience dizziness and blurred vision on account of a medical condition, preventing her to make a curve in the road. The vehicle continued straight and directly into the end of the guardrail terminal, or which a portion penetrated the passenger compartment, striking Ms. Carrier's torso and causing her to suffer serious and fatal injuries.	Fatality	Amended Complaint	Trinity Highway Products, LLC Answer To Second Amended Complaint	Accident Report	Photos	
Brian Elsevier (surviving spouse of Elizabeth Elsevier) v. Trinity Industries, Inc., et al.	Circuit Court For Campbell County, Tennessee	15614	Gary L. Adkins Bill Hotz & Associates Attorney for Plaintiffs 6004 Walden Drive Knoxville, TN 37919	Toyota 4Runner	Trinity ET-Plus	20130113	TN	Decedent Elizabeth Elsevier lost control of her vehicle which impacted with the ET-Pius end terminal at issue. The impact resulted in the failure of the ET -Plus end terminal to properly extrude and, rather than performing properly, caused the guardrail to lock inside the end terminal and fail to dissipate the energy of the vehicle in a safe manner and bring it to safe stop.	Fatality	Complaint (Circuit Court)	Complaint (Claims Commission)	News Article		
Connie Spink (Decedent) / Lilyanna Escobedo					Trinity ET-Plus	20110712	TX	Vehicle drifted off the road and struck the guardrail seconds later. The rail cut through the vehicle.	Driver fatality, injury to 2 YO child	Complaint to AG	News Article	Photos		
Gerardo and Rosa Munoz v. Trinity Industries, Inc. and Trinity Highway Products, LLC	71st Judicial District Court, Harrison County, TX	130812	Josh B. Maness PO Box 1785 Marshall, TX 75671 Joe Black P.O. Box 1982 Marshall, Texas 75671		Trinity ET-Plus	20111029	TX	Decedent was driving eastbound on US Highway 80 when it appeared that he fell asleep at the wheel. Vehicle veered across the westbound lane, then struck a section of guardrail and impact head, which penetrated the vehicle through the center grill area. This penetration caused the vehicle to flip end over end, then going airborne to cross a thirty-foot concrete drain.	Fatality	Complaint				
Isaac Puente					Trinity ET-Plus	20120723	TX	Driver fell asleep and hit guardrail. The rail went through the engine block and cab and out the back.		News Article	News Video	News Article		
Lisa Antonicelli v. Trinity Industries, Inc.	298th Judicial District Court, Dallas, TX	DC13-05900	Simpson, Boyd & Powers P.O. Box 957 105 North State Street, Suite B Decatur, Texas Kilgore & Kilgore, PLLC 3109 Carlisle Dallas, TX 75204-2471	2011 Nissan Versa	Trinity ET-Plus	20120901	TX	While driving eastbound on US Highway 80, plaintiff (a diabetic) experienced a sudden drop in blood sugar. In response, Plaintiff attempted to disengage her cruise control mechanism so that she could slow her vehicle and pull over. However, before she could do so, Plaintiff lost the ability to control her vehicle, which veered suddenly to the left and into a guardrail located on the left side of the highway. The guardrail penetrated the vehicle through the right floorboard area. This penetration continued into the passenger compartment and impaled Plaintiff, causing massive injuries.	Paraplegia	Complaint	Defendant, Trinity Highway Products, LLC's Answer and Special Exceptions To Plaintiff's Original Petition			
Melton Tucker (Decedent)				2012 Chevrolet Cruze	Trinity ET-Plus	20120917	TX	Vehicle struck the End Guardrail head on. The head stayed together and just broke off and flew away from the scene and about 30 ft. of guardrail went through the car. It went through the engine, through the front windshield, hit driver in the head (instantly killing him) and continued out through the back window.	Fatality	Complaint to AG	Accident Report	Photos		

ET-Plus Incidents

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Shawnie Williams				1997 Ford F-150	Trinity ET-Plus	20130814	TX	Driver fell asleep and her pickup veered 10 the left and slammed head-on into a guardrail. Shawnie Williams was pinned in her truck after the guardrail impaled her pickup through the floor pinning her leg.	Leg Injuries	News Article				
Brittany Robinson	Circuit Court Of Pulaski County, Virginia		The Lawrence Law Firm 700 Lavaca Street Suite 1400 Austin, Texas 78701	2001 Buick LeSabre	Trinity ET-Plus	20120213	VA	Vehicle drifted to the right off road, hitting rumble strips. Driver overcorrected back to the left and lost control, crossing back across traffic lanes. Vehicle then ran off road on the left, striking guard rail, which punctured the vehicle through the rear wheel well, and pushed through the back seat, pinning a 3 year old child in his car seat and injuring him. Brittany had severe arm injuries.	Pelvic fractures, head trauma	Accident Report	News Stories	Photos	Complaint	Complaint to AG
Patricia Jean Yonker				2010 Ford Escape	Trinity ET-Plus	20140422	VA	Vehicle left the roadway and entered the shoulder area and struck a guardrail. The guard detached and a second portion of the guardrail impacted the passengers side door area. The guardrail entered the vehicle's cabin area and struck the front seat passenger and driver.	Passenger lost both legs.	Accident Report	Photos	Medical Records		
Aaron Rausche	`		Rogge Dunn Clouse Dunn LLP 1201 Elm Street Suite 5200 Dallas, Texas 75270	Lexus	Trinity ET-Plus	20120800		Driver fell asleep and drifted off the road and into a guardrail.		News Article	News Video			
Jackie Ford			Chad Newman Erskine McMahon L.L.P. 426 N. Center St. Longview, TX 75606	2012 Mazda 6	Trinity ET-Plus	20121215	TX	Vehicle lost control in rainy conditions and entered the east barditch. It then overcorrected and began to skid to the left. Struck a guardrail with Its left side and came to rest across both lanes of street. The terminal penetrated into the passenger compartment and crushed or impaled driver causing massive injuries.	Sustained injuries that render her permanently disabled.	Petition	Crash Report	Photos		
Alexandra Walsh / Thomas MacPhee				2009 Chevrolet 1500	Trinity ET-Plus	20141229	MA	Vehicle ran off the left side of the road and struck the end cap of a guardrail. Evidence from the scene suggests the truck struck several sections of guardrail and was redirected back across the left travel lane, rolling over across the center lane and coming to rest on its wheels in the center and right lanes. Police determined that the Chevrolet's fuel tank was damaged, which caused the fire that engulfed the truck.	Driver and front passenger fatal.	News Article	News Article			
Danielle Washington V. Trinity	U.S. District Court for the Eastern Districk of Texas Marshall Division	2:14-cv-01041-JRG-RSP	The Clark Firm Colleen Clark 2911 Turtle Creek, Suite 1400 Dallas, Texas 75219		Trinity ET-Plus	20131129	NC	Plaintiff was driving to work when she fell asleep and collided with an extruder-type guardrail end terminal fitted on the blunt end of a line of guardrail.	Plaintiff suffered severe damage including, but not limited to, hip socket injuries, a ruptured bladder, and a lower lumbar fracture.	Complaint				
Christopher B. Fonner			Theodore J. Leopold Cohen Milstein Sellers & Toll 2925 PGA Boulevard, Suite 200 Palm Beach Gardens, FL 33410	2007 Infiniti G35	Trinity ET-Plus	20131116	FL	Vehicle for unknown reasons lost control of car hit another vehicle and hit guardrail.		Accident Report	Photos			
Mark Joseph Hranek			David Kwass Saltz, Mongeluzzi, Barrett & Bendesky 1650 Market Street One Liberty Place, 52nd Floor Philadelphia, PA 19103	2000 Chevrolet Express CU	Trinity ET-Plus 5"	20140402	AZ	Newspaper delivery truck went off the road, driver may have fallen asleep, struck and sheared off 140 feet of guardrail, which intruded into the box truck. Guardrail first penetrated from under drivers floor mat, went through the seatback, and severed one of the driver's legs. Driver died later at the hospital after surgery.	Fatality	News Article	News Video	Photos	Accident Report	

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John and John Sellem, III	Contra County California Superior Court	CIV-MSC-1101705		2005 Toyota Sienna	Trinity ET-Plus	20100628	CA	Hit guardrail and another vehicle struck him setting his car on fire.		News Article	Legal Document	News Article		
Vijay Guntur					Trinity ET-Plus	20110900	CA	A metal guardrail had pierced his family's SUV through and through. The long, twisted piece of metal had also sliced through his wife's leg.		News Article				
	Birmingham, AL				Trinity ET-Plus	20140212	AL	Shoot and part of the squeezer section came apart part. Local deformation of the top and bottom of the WB show that there was a high force on the inside of the feeder shoot which probably led to the failure		Photos				
				SUV	Trinity ET-Plus	20100905	TX	Vehicle flipped over at least once and hit the guardrail. As he hit the guardrail the end of it punctured his floor board coming up through it and severing his leg. The guardrail continued to enter and collapse in the front seat.	Leg amputation	News Article	Photos	Video		
Rebecca Wilson / Bryan Albright	Kendall County, TX		Robert P Wilson		Trinity ET-Plus	20130107	TX	Vehicle impacted guardrail and it penetrated drivers door and into the back seat.		News Article				
Goforth v. Trinity	St Louis, MO		Kent Emison Langdon & Emison 911 Main St. Lexington, MO 64067	2000 Toyota Camry	Trinity ET-Plus	20140316	MO	Vehicle drifted off the right side of the roadway. Driver attempted to steer the vehicle back onto the roadway and the right center of the vehicle struck the end of the guardrail. The right rear door opened due to the impact ejecting one occupant		Accident Report	Photos			
Melnick/Makepeace			David Kwass Saltz, Mongeluzzi, Barrett & Bendesky 1650 Market Street One Liberty Place, 52nd Floor Philadelphia, PA 19103	2001 Ford 2DSD	Trinity ET-Plus	20120715	NY	According to news reports, Alicia Makepeace and David Melnick of Maine and New Hampshire, the vehicle Alicia was driving allegedly drifted from the roadway and struck an end terminal which penetrated the vehicle, spearing through her body and killing her. David Melnick was also severly injured in the crash. The product involved in the accident is believed to be an ET-Plus.	Driver Fatality, Front passenger leg injuries	Accident Report	News Article			