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Commissioner Charles Kilpatrick
Department of Transportation
Commonwealth of Virginia
1401 E. Broad Street
Richmond, VA 23219

Dear Commissioner Kilpatrick:

Now that Virginia's Department of Transportation and Office of the Attorney General have chosen to pre-judge and comment on VDOT's recent non-standard and arbitrary crash testing of the ET Plus® end-terminal system (ET Plus), a number of scientifically informed observations are in order. These observations reveal that despite VDOT's best efforts to produce a spectacular penetration failure to aid the State of Virginia in litigation, the ET Plus performed within expectations.

None of the six tests run on the ET Plus complied with the standard National Cooperative Highway Research Program (NCHRP) Report 350 testing criteria that the ET Plus and other guardrail end-terminal systems of its kind were designed to meet. All these tests, which were run at the KARCO facility in the California desert, were poorly conducted, and two were made-up tests that used impact conditions outside of NCHRP Report 350 test criteria and to which no other guardrail end-terminal systems have been tested.

Before each test was run, an expert from the Texas A&M Transportation Institute (TTI) made an on-site inspection and identified crucial deviations from standard testing protocols. What did VDOT do when apprised of these problems? It ignored most of the recommendations and ran the tests anyway. It is difficult to encapsulate in a letter all the failings of the testing, but among the most egregious violations of the nationally accepted NCHRP Report 350 testing protocols are the following:

- For litigation purposes, VDOT invented two new tests that are not part of any testing protocols. The accepted national standard, NCHRP Report 350, to which the ET Plus (and others of its class) was designed, does not require shallow-angle tests. That the ET Plus alone was subjected to VDOT's "made-up" standards belies any assertion that "public safety" concerns prompted these tests. Were this so, all roadside safety products in this category would be similarly evaluated.
- VDOT set up all six test installations in soft, non-standard soil. NCHRP Report 350 clearly and unequivocally mandates both the type of soil and the required placement conditions of the soil when a safety feature is evaluated through crash testing. The soil must meet the American Association of State Highway and Transportation Officials (AASHTO)

Standard Specification M 147-65 Materials for Aggregate and Soil Aggregate Subbase, Base and Surface Courses, and the placement and compaction should be in accordance with the AASHTO Guide Specifications for Highway Construction. The VDOT tests achieved neither of these requirements.

NCHRP Report 350 states that soft soil conditions can cause or contribute to unsuccessful performance of a safety feature. Unsurprisingly, post-test observations found excessive post movement during the tests, a result directly attributable to non-standard soil conditions.

- All three pickup truck test vehicles were extensively modified from stock. Under NCHRP Report 350, test vehicles must be in good condition, which at a minimum means free of major body damage and not missing structural parts. NCHRP Report 350 further states that bumpers should be unmodified for the test and that the test weight of the vehicle should not vary significantly from the initial curb weight. Every one of the three pickups that VDOT used had extensive parts removed, including tailgates, rear bumpers, mufflers, spare tires, fuel tanks, catalytic converters and the entire exhaust system. This caused the trucks to ride high and substantially changed the weight distribution, balance and stability of the vehicles.
- VDOT did not properly instrument the test vehicles. Accelerometers capture important vehicle data during a crash test. Accordingly, NCHRP Report 350 holds that accelerometers should be mounted on a major structural element of the test vehicle. In the VDOT tests, the accelerometers were mounted on a very small plate that was attached directly to the sheet metal on the floor of the vehicle, which is a practice known to produce erroneous readings due to vibrations and localized deformations.
- VDOT attempted to use a wrecked test vehicle for one of the non-standard, shallow-angle tests. As already noted, NCHRP Report 350 states that test vehicles must be in good condition and free of major body damage. In one of its two non-standard, designed-to-produce-failure tests, VDOT actually attempted to use a car that had obvious prior front-end collision damage. The damage was readily apparent and was easily confirmed through a Carfax report. VDOT already had a replacement vehicle on site at KARCO, but never explained why it originally selected the previously damaged car for the test rather than the replacement vehicle, which was not damaged.

Despite Virginia's best efforts to engineer a "spearing" or other "catastrophic" testing result, none happened, even while handicapped by non-standard tests, shoddy installations, and heavily modified vehicles. The following are observations regarding each of the six tests based on presently available information:

- Test 1 (Pickup truck, end on, centerline aligned with face of post 1, 0 degrees). The observed test results were unremarkable. The system extruded over 25 feet of rail, including a rail splice, and the vehicle came to rest in contact with the ET Plus head. The vehicle remained stable throughout the impact sequence to its final rest. There was no occupant compartment deformation, intrusion or penetration.
- Test 2 (Small car, end-on with passenger front quarter point aligned with face of post 1, 0 degrees). The observed test results were unremarkable. The rail extruded as designed and—because of the offset impact—the vehicle rotated as expected and came to rest adjacent to

guardrail. There was no occupant compartment penetration and possibly only minor occupant compartment deformation (less than 2 inches), if any, which would not cause serious injury.

- Test 3 (Small car, end-on, centerline aligned with face of post 1, 15 degrees). The observed test results were unremarkable. The rail extruded as designed and—because of the angled impact—the vehicle gated through the system as expected. The vehicle then traveled behind the system to the perimeter of the KARCO facility and impacted a soil berm. There was minor occupant compartment deformation; there was, however, no intrusion or penetration.
- Test 4 (Pickup truck, end-on, centerline aligned with face of post 1, 15 degrees). It was observed that the rail extruded and—because of the angled impact—the vehicle gated through as expected. As the ET Plus head rotated behind the guardrail system, the impact face dug into the soft soil. This soil interaction stopped the movement of the head and caused the guide channels on the rear of the impact head to pitch upwards towards the gating pickup truck. This resulted in a glancing contact with the lower side, rear corner of the cab of the pickup that removed some external sheet metal in that location. The adjacent interior sheet metal was not compromised. There was no penetration or deformation into the occupant compartment. There was subsequent contact between the system and bed of the pickup. It is believed that the damage to the bed was aggravated because the tailgate was removed prior to the test.
- Test 5 (non-standard) (Pickup truck, end-on, centerline of pickup aligned with face of post 1, 5 degrees). It was observed that after a small amount of rail extrusion, the vehicle successfully gated through the system. There was no occupant compartment deformation, intrusion or penetration associated with this initial impact.

After the pickup truck traveled beyond the ET Plus (more than 100 feet downstream of the initial point of impact), a second collision occurred, this time between the pickup truck and the back side of the guardrail installation. The back side of a guardrail is not crashworthy, and the interaction of the pickup truck with the back side of the guardrail caused further damage to the vehicle and directly altered its trajectory and stability. The second impact between the front driver's side of the pickup and the back side of the guardrail stopped the forward motion of the pickup truck and caused an abrupt counter-clockwise rotation that ultimately resulted in a rollover. It was the interaction with the back side of the downstream guardrail—not the impact with the ET Plus system—that caused the truck to roll over.

The second impact with the back side of the guardrail was a unique and separate collision event from the first impact with the ET Plus system. It is the first impact with the ET Plus system that is being evaluated in the test. Subsequent collisions with non-crashworthy features are not part of the test evaluation process. For example, some test facilities may not have sufficient runout distance to stop vehicles that have gated through a system at high speed prior to a second impact with a tree, berm, or protective barrier at the perimeter of the test facility. To the extent possible, vehicle damage and other results arising directly from the second impact are separated from the first impact through the use of video, photos, etc. Similarly, the vehicle damage and vehicle instability that were a direct result of the second collision between the pickup truck and the non-crashworthy, back side of a guardrail system should be separated and excluded from the process of evaluation of the ET Plus.

In sum, Virginia's recent statement that this test "failed miserably" is erroneous and not supported by the scientific evidence.

- Test 6 (non-standard) (Small Car, end-on, centerline aligned with face of post 1, 5 degrees). The observed test results were unremarkable. Rail extruded, and the vehicle gated through the system. After gating, the vehicle rotated to final rest adjacent to guardrail. There was no occupant compartment deformation, intrusion, or penetration.

Virginia's testing approach undermines the credibility of the tests and reinforces suspicions about the real motive for the testing. Quite simply, when a device is tested under conditions outside the national standard, NCHRP Report 350, that these types of guardrail end-terminal systems were designed to meet, the testing outcome is meaningless. Standards exist for a reason. Without them, there is no objective mechanism for evaluating the design, effectiveness and performance of any roadside safety device.

In September, after months of reviewing real-world crash data from around the country, a joint task force of federal and state transportation safety experts found no reason for further testing of the ET Plus or other NCHRP Report 350-compliant extruding w-beam guardrail end-terminal systems. The task force was comprised of individuals from the Federal Highway Administration (FHWA), various state departments of transportation, the American Association of State Highway and Transportation Officials (AASHTO), and three independent experts. FHWA called the task force's efforts "the most thorough evaluation ever conducted of this particular roadside safety hardware."

The ET Plus has undergone the most rigorous testing ever applied to any guardrail end-terminal system and has an unbroken chain of eligibility for federal-aid reimbursement from the FHWA. It has repeatedly passed NCHRP Report 350 test criteria. This, plus 15 years of roadside experience, completely reinforce our confidence in the ET Plus.

Very truly yours,



Dennis L. Christiansen, P.E.
Agency Director

cc: Aubrey Layne, Jr., Secretary of Transportation, Commonwealth of Virginia
Greg Nadeau, Administrator, Federal Highway Administration