

## **NOTED PROBLEMS**

### **A. STANDARD SECTIONS:**

1. Too short to provide adequate LON
2. Insufficient deflection offset
3. Rail too low on overlay projects
4. Rail installed too high
5. Rotated blockouts due to lack of toe nailing
6. Improper use in conjunction with curbing
7. Improper transitions to stronger sections
8. No offset in front of the slope break for strong post soil backing
9. Poor alignment of rail and plumbness of posts
10. Hardware and fasteners left off
11. Fasteners not tight
12. Rectangular washers installed where not required
13. Rectangular washers not installed on last 50' of trailing stand-up end of strong post W-beam guardrail
14. Wood blockouts with dimensions of 6" x 6" instead of 6" x 8" as required by standard plans
15. W-beam rail and terminal connectors lapping in wrong direction

### **B. TERMINALS:**

1. Poor site preparation with steel foundation tubes protruding, strut too high or soil plates exposed
2. Anchorage cable not taut
3. Impact heads not parallel to top of rail
4. Exposed ends of W-beam on buried in back slope terminals

5. Improper flare or improper offset on flared terminals
6. End of terminal too high
7. Improper drilled breakaway hole height
8. Two abutting terminals side-by-side in gore and median areas
9. Inadequate length of buried terminal in cut slope
10. Height of buried terminal not consistent across ditchline
11. Buried terminals not graded and seeded properly
12. Terminal located too close to curb
13. No terminal anchorage installed on run-off end of weak post W-beam trailing end
14. W-beam guardrail not bottomed out in impact head

**C. TERMINAL REPAIRS:**

1. Substandard terminal replaced in kind

**D. FIXED OBJECT ATTACHMENTS:**

1. Improper post spacing
2. Plates not installed behind parapet walls
3. Use of threaded rods for connection projecting in front of rail
4. No FOA's or improper FOA's at guardrail approaches to temporary barriers in work zones

**E. DELINEATION:**

1. Delineators missing on guardrail runs
2. Missing delineation on flared terminals

## List Of Acronyms

<b>3R</b>	Restoration, Rehabilitation and Resurfacing
<b>AASHTO</b>	American Association of State Highway and Transportation Officials
<b>ADT</b>	Average Daily Traffic
<b>BCT</b>	Breakaway Cable Terminal
<b>BEST</b>	Beam-Eating Steel Terminal
<b>CAT</b>	Crash-cushion Attenuating Terminal
<b>CIA</b>	Critical Impact Angle
<b>CIP</b>	Critical Impact Point
<b>CRT</b>	Controlled Releasing Terminal
<b>CZ</b>	Clear Zone
<b>ELC</b>	Eccentrically Loaded Terminal
<b>ET</b>	Extruder Terminal
<b>FHWA</b>	Federal Highway Administration
<b>FOA</b>	Fixed Object Attachment
<b>FLEAT</b>	Flared Energy Absorbing Terminal
<b>ISRT</b>	Improved Slotted Rail Terminal
<b>LON</b>	Length of Need
<b>LR</b>	Length of Runout
<b>MELT</b>	Modified Eccentric Loader Terminal

<b>NCHRP</b>	National Cooperative Highway Research Program
<b>NHS</b>	National Highway System
<b>REGENT</b>	Redirecting Gating End Terminal
<b>ROR</b>	Run-off the Road
<b>SKT</b>	Sequentially Kinking Terminal
<b>SRT</b>	Slotted Rail Terminal
<b>TL</b>	Test Level

## Glossary

**Average Daily Traffic (ADT):** The average 24-hour volume of traffic calculated as the total volume during a stated period divided by the number of days in that period.

**Area of Concern:** An object or roadside condition that may warrant safety treatment.

**Attenuator:** A device that lessens, weakens, or reduces the severity of an impact.

**Back Plate:** A steel plate used under the nuts of bolts through a concrete parapet or wall to keep the bolts from pulling out. (Standardized hardware nomenclature FPB02)

**Backslope:** The cross-section slope beyond the ditchline.

**Back-up Plate:** A 1' section of W-beam rail used with steel post/steel blockout barrier systems to prevent the guardrail from shearing on the blockout. (Standardized hardware nomenclature RWB01a-b)

**Barricade:** A device which provides a visual indicator of a hazardous location or the desired path a motorist should take. Its function is not to contain or redirect an errant vehicle.

**Barrier:** A device which provides a physical limitation through which a vehicle would not normally pass. It is intended to contain or redirect an errant vehicle.

- **Rigid Barrier** - A longitudinal barrier which does not deflect upon impact and dissipates a negligible amount of the vehicle's impact energy.
- **Semi-Rigid Barrier** - A longitudinal barrier ranging from practically rigid to quite flexible, which will dissipate some of the impact energy through yielding of the rail and post elements and in some cases, the soil.
- **Flexible Barrier** - A longitudinal barrier that deflects a considerable distance, dissipating much of the energy, and smoothly redirects a vehicle through the tension in the longitudinal element.

**Bearing Plate:** A plate used on the first post of a breakaway cable anchorage through which the cable passes to provide bearing. (Standardized hardware nomenclature FPB01)

**Breakaway:** A design feature which allows a device such as a sign, luminaire, or traffic signal support to yield or separate upon impact. The release mechanism may be slip plane, plastic hinges, fracture elements, or a combination of these.

**Breakaway Cable Anchorage:** A device designed to develop the tension in a W-beam barrier system using a cable attached to the W-beam rail and passing through a hole in a wood post near ground level and anchored with a bearing plate on the upstream side of the wood post. For downstream impacts on the barrier system, the wood post transfers the tension from the cable to the ground resistance; for end on impacts, the wood post breaks away releasing the cable, allowing the vehicle to continue moving without significant decelerations. Soil resistance is developed by steel foundation tube(s) into which the wood post is inserted.

**Bridge Pier:** Intermediate support structure for a bridge.

**Bridge Railing:** A longitudinal barrier whose primary function is to prevent an errant vehicle from going over the side of the bridge structure.

**Buffered End Section:** The curved end section used on the beginning end of breakaway cable terminal. (Standardized hardware nomenclature RWE04a)

**Cable Anchor Bracket:** A steel bracket or assembly used to attach a breakaway cable to a W-beam rail. (Standardized hardware nomenclature FPA01)

**Center of Mass (c.m.):** Point within a test vehicle at which its total mass can be assumed to be concentrated.

**Clearance:** Lateral distance from edge of traveled way to a roadside object or feature.

**Clear Run-out Area:** The area at the toe of a non-recoverable slope available for safe use by an errant vehicle.

**Clear Zone (CZ):** The total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a non-recoverable slope and/or a clear run-out area. The “minimum design” width is dependent upon the traffic volumes and speeds, and on the roadside geometry. The desired width is the maximum, cost-effective attainable.

**Controlled Release Terminal (CRT) Post:** A drilled wood guardrail post used in breakaway terminals. (Standardized hardware nomenclature PDE09)

**Cost-Effective:** An item or action taken which is economical in terms of tangible benefits produced by money spent.

**Crash Cushion:** An impact attenuator device that prevents an errant vehicle from impacting fixed object hazards by gradually decelerating the vehicle to a safe stop or by redirecting the vehicle away from the hazard.

- **Non-redirective Crash Cushion** - An impact attenuator that does not control an angle impact on its side and allows pocketing or penetration of the system. The vehicle can reach the hazard.
- **Redirective Crash Cushion** - An impact attenuator that smoothly controls an angle impact on its side without pocketing or penetrating the system. The vehicle does not reach the hazard.

**Crash Tests:** Vehicular impact tests by which the structural and safety performance of roadside barriers and other highway appurtenances may be determined. Three evaluation criteria are considered, namely (1) structural adequacy, (2) impact severity, and (3) vehicular post-impact trajectory.

**Crash Worthy:** A device that has met the evaluation criteria when subjected to the applicable crash tests.

**Critical Impact Angle (CIA):** For a given test and the attendant range of vehicular impact angles, the CIA is the angle within this range judged to have the greatest potential for causing a failure when the test is assessed by the recommended evaluation criteria. For most tests, impact angles can range from 0 up to 25 degrees.

**Critical Impact Point (CIP):** For a given test, the CIP is the initial point(s) of vehicular contact along the longitudinal dimension of a feature judged to have the greatest potential for causing a failure when the test is assessed by the recommended evaluation criteria.

**Curb Mass:** Mass of test vehicle with standard equipment, maximum capacity of engine fuel, oil and coolant, and, if so equipped, air conditioning and additional optional mass engine. It does not include occupants or cargo.

**Design Speed:** The speed selected and used for correlation of the physical features of a highway that influence vehicle operation. It is the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern.

**Device:** Refers to a design or a specific part thereof, such as a breakaway device. Note that the terms "device" and "feature" are often synonymous.

**Drainage Features:** Roadside items whose primary purpose is to provide adequate roadway drainage such as curbs, culverts, culvert end treatments, ditches, and drop inlets.

**Downstream:** The leave side of a feature or trailing end relative to traffic. This term is synonymous with “run-off.”

**Dynamic Deflection Distance:** This is the distance a guardrail system deflects when crash tested by a 4400-pound pickup truck at 62 mph and 25° measured from the back of the guardrail post.

**End Section:** A short section of metal hardware used to terminal a run of guardrail. (Standardized hardware nomenclature RWE01a-b)

**End Treatment:** The designed modification of a roadside or median barrier at its end.

**Evaluation Criteria:** Criteria used to assess the results of a crash test or to assess the in service performance of a feature.

**Experimental Barrier:** One that has performed satisfactorily in full-scale crash tests and promises, but not yet demonstrated satisfactory in-service performance.

**Feature:** Refers to a specific element of a highway. It may be a hardware item and its associated foundation, such as a sign or barrier installation, or it may be a geometric element, such as a side slope or a ditch cross section.

**Fixed Object Attachment:** The design used to strengthen and attach a run of strong post guardrail to a immovable fixed object.

**Flare:** the variable offset distance of a barrier to move it farther from the traveled way.

**Flared Terminal:** A guardrail terminal that is flared away from the roadway.

**Flare Rate:** The ratio expressing the flare as the relation of the longitudinal length to the offset distance.

**Foundation Tube:** A metal tube installed in the soil for the installation of a breakaway wood post used in guardrail terminals. (Standardized hardware nomenclature PTE05)

**Frangible:** A structure readily or easily broken upon impact.

**Frontslope:** The slope between the shoulder break and the ditchline.

**Gating Device (Feature):** A device designed to allow penetration of a vehicle when impacted upstream of the beginning of its redirection capability point. Note: there is some distance between the end of a gating device and the beginning of its redirecting capability.



**Geometric Feature:** A roadside cross section element such as a ditch section, an embankment, a driveway or a median crossover, or a curb.

**Glare Screen:** A device used to shield a driver's eye from the headlights of an oncoming vehicle.

**Gore:** The location where one or more lanes of the road diverge away or converge from the previous direction of travel.

**Ground Strut and Yoke Assembly:** A metal channel section installed flush with ground at the beginning of breakaway terminals between the first two posts. (Standardized hardware nomenclature PFP01)

**High Speed Roadway:** Roadway with a design speed of 45 mph or more.

**Hinge Point:** The point where the roadside cross-section changes from one cross-slope to another, such as from the shoulder cross-slope to the frontslope.

**Impact Angle:** For a longitudinal barrier, it is the angle between a tangent to the face of the barrier and a tangent to the vehicle's path at impact. For a crash cushion/terminal, it is the angle between the axis of symmetry of the crash cushion/terminal and a tangent to the vehicle's path at impact.

**Impact Attenuator:** See Crash Cushion.

**Impact Head:** The metal unit that is attached to the end of guardrail terminals which moves down the guardrail when hit dissipating energy through various methods.

**Impact Point:** The initial point on a test article contacted by the impacting test vehicle.

**Lapping:** The placement of one section of w-beam over the next downstream section so that the connection will not snag a vehicle.

**Length of Need (LON):** That length of longitudinal barrier required upstream of an area of concern necessary to appropriately shield the area, containing and redirecting an impacting vehicle.

**Length of Runout (LR):** The theoretical distance needed for a vehicle that has left the roadway to come to a stop.

**Longitudinal Barrier:** A device whose primary functions are to prevent vehicular penetration and to safely redirect an errant vehicle away from a roadside or median hazard. The three types of longitudinal barriers are roadside barriers, median barriers, and bridge rails.

**Low Speed Roadway:** Roadway with a design speed of 45 mph or less.

**Median:** The portion of a divided highway separating the traveled ways for traffic in opposite directions, measured from edge of traveled way to edge of traveled way.

**Median Barrier:** A longitudinal barrier used to prevent an errant vehicle from crossing the highway median.

**Michigan Shoe:** Standardized metal hardware transitioning from a W-beam section to a flat section used to connect W-beam rail to a rigid object. (Standardized hardware nomenclature RWE02)

**National Highway System (NHS):** All Interstate highways and other major arterial highways nominated by the states and designated under the National Highway System Act of 1995.

**Nesting:** The doubling of W-beam guardrail to reduce deflection.

**Non-gating Device:** A device with redirection capabilities along its entire length. Note that the end of a non-gating device is essentially the beginning of its redirecting capability.

**Non-Recoverable Slope:** A slope which is considered traversable but on which the errant vehicle will continue on to the bottom. Embankment slopes steeper than 4:1 but no steeper than 3:1 may be considered traversable but non-recoverable if they are smooth and free of fixed object hazards.

**Occupant Impact Velocity:** Velocity at which a hypothetical “point mass” occupant impacts a surface of a hypothetical occupant compartment of a vehicle.

**Offset:** Distance between the traveled way and a roadside barrier or other obstacle.

**Operating Speed:** The highest speed at which reasonable prudent drivers can be expected to operate vehicles on a section of highway under low traffic densities and good weather. This speed may be higher or lower than posted or legislated speed limits or nominal design speeds where alignment, surface, roadside development, or other features affect vehicle operations.

**Operational Barrier:** One that has performed satisfactorily in full scale tests and has demonstrated satisfactory in-service performance.

**Parallel Terminal:** A guardrail terminal that basically is parallel to the roadway with no more than a two-foot flare.

**Penetration:** Action of a vehicle passing into or through an appurtenance by overcoming its' redirective resistance.

**Pocketing:** Action of a vehicle creating excessive lateral movement of an appurtenance which can result in an abrupt redirection back into the traffic stream.

**Recoverable Slope:** A slope on which a motorist may, to a greater or lesser extent, retain or regain control of a vehicle. Slopes equal to or flatter than 4:1 are generally considered recoverable.

**Recovery Area:** Generally synonymous with clear zone.

**Ride down Acceleration:** Acceleration by a hypothetical "point mass" occupant subsequent to impact with a hypothetical occupant compartment of a vehicle.

**Roadside:** That area between the outside shoulder edge and the right-of-way limits.

**Roadside Barrier:** A longitudinal barrier used to shield roadside obstacles or non-traversable terrain features. It may occasionally be used to protect pedestrians or "bystanders" from vehicle traffic.

**Roadway:** The portion of a highway, including shoulders, for vehicular use.

**Run-off End:** The downstream end or trailing end of a guardrail system.

**Run-off the Road Accident:** A accident that occurs beyond the edge of pavement striking and obstacle.

**Run-on End:** The upstream end or beginning end of a guardrail system.

**Shielding:** The introduction of a barrier or crash cushion, between the vehicle and an obstacle or area of concern to reduce the severity of impacts of errant vehicles.

**Shy Distance:** The distance from the edge of the traveled way beyond which a roadside object will not be perceived as an immediate hazard by the typical driver, to the extent that he will not change his vehicle's placement or speed.

**Slip Base:** A structural element at or near the bottom of a post or pole which will allow release of the post from its base upon impact while resisting wind loads.

**Slope:** The relative steepness of the terrain expressed as a ratio or percentage. Slopes may be categorized as positive (backslopes) or negative (foreslopes), and as parallel or cross slopes in relation to the direction of traffic.

**Slope Break:** The point at which a shoulder slope and fill meet.

**Snagging:** When a portion of a test vehicle, such as a wheel, engages a vertical element in a redirective device, such as a post, snagging is said to have occurred. The degree of snagging depends on the degree of engagement. Snagging may cause large and unacceptable vehicular decelerations.

**Soil Plate:** A rectangular steel plate attached to a guardrail post or soil tube to resist horizontal movement in the ground. (Standardized hardware nomenclature PLS03)

**Taut:** This term is used when referring to a cable anchor. A taut anchor should be no more than 1" lift from its free hanging position.

**Terminal:** A device designed to treat the end of a longitudinal barrier. An upstream terminal may function by (a) decelerating a vehicle to a safe stop within a relatively short distance; (b) permitting controlled penetration of the vehicle behind the device; (c) containing and redirecting the vehicle; or (d) a combination of a., b., and c. A downstream terminal develops the tension required for the barrier system to perform properly.

**Terminal Connector:** A W-beam guardrail connector used to attach the rail to a concrete parapet, wall or deadman. (Standardized hardware nomenclature RWE02)

**Test Article (Test Feature):** All components of a system, including the foundation as relevant being evaluated in a crash test. Note that the system may be a geometric feature such as a ditch or driveway slope.

**Test Inertial Mass:** Mass of test vehicle and all items rigidly attached to vehicle's structure, including ballast and instrumentation. Mass of surrogate occupant(s), if used, is not included in test inertial mass.

**Test Level (TL):** A set of conditions, defined in terms of vehicular type and mass, vehicular impact speed, and vehicular impact angle, that quantifies the impact severity of a matrix of tests.

**Test Vehicle:** A commercially available, production model vehicle or an approved surrogate vehicle used in a crash test to evaluate the impact performance of a test article.

**Three R (3R) Projects:** Highway construction projects for restoration, rehabilitation or resurfacing.

**Traffic Barrier:** A device used to prevent a vehicle from striking a more severe obstacle or feature located on the roadside or in the median, or to prevent crossover median accidents. As defined herein, there are four classes of traffic barriers, namely, roadside barriers, median barriers, bridge railings, and crash cushions.

**Trailing End Anchorage:** An W-beam anchorage system used on the downstream end of guardrail run to provide anchorage and tension in the rail.

**Transition:** A section of barrier between two different barriers or, more commonly, where a roadside barrier is connected to a bridge railing or to a rigid object such as a bridge pier; the upstream barrier system is less stiff than the downstream system. The transition should produce a gradual stiffening of the approach rail so vehicular pocketing, snagging, or penetration at the connection can be avoided.

**Traveled Way:** The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

**Traversable Slope:** A slope on which a vehicle will likely be steered back to the roadway, be able to retained control of, or continue safely to the bottom.

**Upstream:** The approach side of a feature relative to traffic. This term is synonymous with “run-on.”

**Vehicle:** A motorized unit for use in transporting passengers or freight, ranging from an 1800 lb automobile to an 80,000 lb tractor-trailer.

**Warrants:** The criteria by which the need for a safety treatment or improvement can be determined.

## GRIT COURSE EVALUATION

Class Date: \_\_\_\_\_ Class Location: \_\_\_\_\_

Rate your ability to perform guardrail inspections according to regulations and standards:

	<i>Low</i>		<i>Average</i>		<i>High</i>
Before the class	1	2	3	4	5
After the class	1	2	3	4	5

### Rate the Class

	<i>Not at all</i>		<i>Average</i>		<i>Very Well</i>
How well do you believe the class prepared you for the accreditation exam?	1	2	3	4	5
How helpful was the manual in your learning?	1	2	3	4	5
How clear and understandable was the manual?	1	2	3	4	5

Overall, what do you feel is your level of knowledge in these areas after finishing the course?

	<i>Low</i>		<i>Average</i>		<i>High</i>
I can state the reasons why this training is required	1	2	3	4	5
I can state the requirements for:					
the proper dimensions of cable systems	1	2	3	4	5
the proper dimensions of weak post systems	1	2	3	4	5
the proper dimensions of strong post systems	1	2	3	4	5
installing blockouts	1	2	3	4	5
attaching guardrail to fixed objects	1	2	3	4	5
guardrail transitions	1	2	3	4	5
site grading	1	2	3	4	5
guardrail placement	1	2	3	4	5

What additional training would you like to receive?

List at least one suggestion you have for improving this course.

**Rate the Instructor / Materials**

*Complete this part only if you used the CD-ROM materials.*

	<i>Disagree</i>		<i>No Opinion</i>		<i>Agree</i>
I found the instructions easy to follow.	1	2	3	4	5
I had no problems using the CD-ROM.	1	2	3	4	5
I found the CD-ROM format helped me to learn.	1	2	3	4	5
I found the CD-ROM easy to use.	1	2	3	4	5
The self-assessment questions helped me to determine my level of knowledge.	1	2	3	4	5

*Complete this part only if you were a participant in an instructor-led course.*

Please mark whether you agree or disagree that \_\_\_\_\_:

	Strongly Disagree	Disagree	Agree	Strongly Agree
a) Was prepared & organized				
b) Gave clear directions				
c) Presented information so that I could understand it				
d) Showed interest in me				
e) Knew the subject well				
f) Showed enthusiasm				
g) Answered my questions				
h) Listened to me				
i) Made me feel welcome				
j) Encouraged my participation				
k) Maintained my self-esteem				
l) Handled class disruptions well				

*Complete this part if you attended both a class and used the CD-ROM materials.*

Which version of the course – CD-ROM or instructor-led course – did you like the most?

In which version of the course – CD-ROM or instructor-led course – did you learn the most?

List at least one reason why you liked that version better.

**Tell us about yourself:**

I am a VDOT \_\_\_\_\_ or contract \_\_\_\_\_ employee. (check one)

I have worked \_\_\_\_\_ years for at my job.

I have \_\_\_\_\_ years experience in inspecting guardrail.

My job title is \_\_\_\_\_.