7. Are there underground utilities in the area where barrier will be installed?

Before barrier layout is finalized, all underground utilities must be located and marked, especially in areas where there are street lights, traffic signals, and electrical/gas lines to residences. The location of any such utilities may require modifications to barrier placement or design, such as lateral placement or post location adjustments. If modifications are necessary, it is critical that the barrier effectively shield the hazard and still function as intended.

8. Is an appropriate terminal type specified?

Although the turned down terminal is no longer used by most DOTs, existing installations remain in place. Such terminals should be delineated, as in **Photograph J**, until they can be upgraded. This terminal in **Photograph K** would not prevent an errant motorist from striking the bridge pier or intruding into opposing traffic. Locations where impacts could result in severe crashes should be identified and systematically upgraded.

9**. Are the approaches to the terminal essentially flat?**

A terminal struck by a stable vehicle, i.e., a vehicle that has its suspension neither compressed nor extended and has minimal roll, pitch, and yaw angles, will result in the best terminal performance possible. The roadway approaches to virtually all terminals should be as flat and traversable as practical, as shown in **Photograph L**.

10. Is there a minimal runout area behind and beyond the terminal?

Impacting a terminal, even when it is installed on flat ground, induces some instability in most vehicles. When the area immediately behind a terminal is steep or non-traversable, a vehicle can overturn after breaking through the terminal. A minimal traversable runout area behind the terminal is an essential part of good barrier design. A field check to determine if a minimal runout area exists is to see if a passenger-type vehicle can be safely driven and parked behind the terminal, parallel to the barrier. If so, one may assume that a minimal runout area is available. Another check is to observe whether or not the area behind the terminal is at least as clear and unobstructed as the unshielded area immediately upstream of the terminal. If not, extending the barrier a greater distance may be warranted. In **Photograph M**, the area beyond the terminal is too steep and the barrier LON is too short. Any vehicle impacting the terminal at an angle would likely reach the river below.

J

K

L

M

Roadway Departure Technical Brief No. 4

Roadside Safety Systems Pre-Installation Field Review Check List

CATEGORY: Design

ISSUE: When roadside safety systems such as traffic barriers (e.g., metal beam guardrail and high tension cable barrier) and terminals are installed exactly as shown on project plans or replaced in-kind after a crash, the end result can be an installation that may not effectively shield the primary hazard, may not shield obvious "secondary" hazards in its immediate vicinity, or may not be needed at all.

OBJECTIVE: Provide guidelines to enable a pre-installation review team to recognize and make needed adjustments to the design to guarantee an optimal installation.

METHODOLOGY: The pre-installation review team should conduct a field review of each planned installation and consider, at a minimum, the issues and factors described below. After these issues and factors have been considered, the review team should document any findings, including justification for any recommended modifications to the design, and process them through agency procedures. For additional information please see the FHWA website at http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/ and AASHTO's Task Force 13 website at www.aashtotf13.org.

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EXPECTED RESULTS:

Barrier installations that are warranted, effectively shield all potential hazards and have terminals selected and located to minimize occupant injuries if impacted.

The pre-installation review team should ask the following questions when performing a field review:

1. Is the proposed barrier warranted?

Installing and maintaining roadside barriers can be costly and, if installed incorrectly, they can become an additional hazard in a serious crash, as shown in **Photograph A**. If running off the roadway at a specific location is clearly less hazardous than striking a guardrail, or if the hazardous feature can be removed, relocated, or redesigned, barrier should not be used. Be certain there is a clear and justifiable barrier warrant before installing guardrail.

The clear zone distances for low and high volume roadways used by most DOTs to determine if a hazard warrants shielding are minimum distances based on relatively limited data. While there are hazards adjacent to virtually every roadway, special attention should be given to man-made fixed objects such as bridge piers, culverts, and large sign or light supports. Such fixed objects may be considered for shielding if there is a reasonable expectation that an errant motorist may strike them even if they are outside the design clear zone. While the barrier in **Photograph B** does shield the end of the bridge, the steep median slope leaves the massive truss support in a vulnerable location - especially on a high speed freeway. Extending the metal beam guardrail to shield the support would be desirable.

2. Is the proposed length adequate?

To check the barrier length of need (LON) in the field, one need only pace off the appropriate runout distance (starting on the shoulder opposite the upstream edge of the hazard), then turn and look at the back of the hazard. If the barrier intersects this line of sight the LON is probably adequate. The barrier shown in **Photograph C** is too short to prevent a vehicle from reaching the steep slope/retaining walls directly behind the terminal.

3. Are there secondary hazards that should be shielded?

When verifying the correct LON required to shield a primary hazard, one must note other significant hazards immediately in the vicinity of the barrier terminal that could be effectively shielded by extending the barrier. While such secondary hazards (such as the concrete culvert in **Photograph D**) may not normally warrant shielding on their own, it is best to avoid a situation where a motorist runs off the road in advance of the metal beam guardrail and is then seriously injured in a collision with a secondary hazard that could easily have been shielded. Judgment must be used where these secondary hazards (such as a solid line of trees, which would not normally be shielded) extend a significant distance upstream from the primary hazard.

A

B

C

D

4. Is the barrier properly located on a slope or behind a curb?

State DOT policy is typically to design each barrier installation based on the lateral distance to the back of the identified hazard and the appropriate length of roadside travel based on traffic volume and design speed. This procedure, however, assumes a relatively flat and traversable area from the point where a vehicle leaves the roadway to the back side of the hazard. As shown in **Photograph E**, if the area behind the metal beam guardrail is sloped, the vehicle can travel a greater distance and be directed into the hazardous area.

For best performance when struck, an impacting vehicle must be stable at the moment of impact. When barrier is placed down a slope, a vehicle leaving the roadway at a high speed will become partially airborne and may strike the barrier too high. Rather than be redirected by the metal beam guardrail, the vehicle may override it and strike whatever object the barrier was intended to shield. For these reasons, AASHTO guidelines recommend placing metal beam guardrail on slopes no steeper than 1V:10H. high-tension cable barrier may be placed on steeper slopes, but then location on the slope is critical and must be in accordance with the manufacturers' guidelines.

Installing barrier behind curbs creates a concern similar to installing barrier on a slope. Because curbs do not have significant redirection capabilities, tire impact with a curb tends to raise a vehicle's bumper height, again resulting in a higher-than-normal impact into a metal beam guardrail. If the barrier is installed with its face directly above the curb and is stiffened to limit its deflection when struck, a curb/barrier combination poses only a slight risk of an override. However, installing a W-beam metal beam guardrail slightly beyond a 6-inch concrete curb, as shown in **Photograph F**, is an invitation to an override.

5. Is existing barrier warranted?

As noted above, barrier is also a fixed object and should be used only when it is able to result in a less severe crash that would occur if it were not present. The "need" for barrier in **Photograph G** is questionable.

6. Are there additional features that warrant shielding?

Photograph H shows a metal beam guardrail shielding the steel post in one direction of traffic but the supports on the near side of the curve remain unshielded. Similarly, the bridge piers in **Photograph I**, while beyond the 30-ft clear zone, are in a very vulnerable location on the outside of the curve along this high-speed, high volume freeway.

E

F

G

H

I