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Top Ten Active Vehicle Barrier (AVB) Issues

In This Issue…

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Overview

Active vehicle barriers (AVBs) are a necessary part of securing an entry control facility (ECF). In the immediate reaction to the terrorist events of September 11, 2001, many installations lacked necessary security features and realized the security vulnerabilities. ECFs were rapidly constructed with the addition of AVBs with little consistency and guidance relative to security or traffic safety. It was soon realized that the barriers were too close to the gates and were not effective at stopping threat vehicles. Accidental deployments occurred and innocent motorists were harmed. As ECF standards developed, the need to provide AVBs for both installation security and safety for the innocent motorist was realized. TEA was at the forefront of advocating the need to provide both this balance of security and traffic safety. As standards developed, TEA developed different AVB safety schemes and coordinated with the Protective Design Center, Air Force Civil Engineering Center and Naval Engineering Systems Command to ensure security requirements were met as well as safety. While some of the initial AVB locations were often replaced, TEA still frequently observes many original barriers in place. Some have been locked down and deactivated, resulting in a lack of security. Others remain in operation, at distances too short to provide both threat vehicle containment and safety for innocent motorists.

This bulletin will focus on the list of the top ten AVB issues that TEA commonly observes. The intent is to bring attention to commonly occurring issues, in hopes that installations become aware, and that designers and contractors can implement the recommendations. TEA has developed several AVB safety schemes (see *Bulletin 20-01, Active Vehicle Barrier (AVB) Safety Schemes*). One of these safety schemes must be used at every location where an AVB is installed. The schemes are available on TEA's website, or you can download them here. The top ten items of the most common AVB issues are:

1. AVBs located too close to the ID Check Area
2. AVBs using Incorrect Signals
3. Incorrect Signing and Markings
4. Barriers with Gaps
5. AVBs Located too Close to Intersections
6. Incorrect Detection Loop Placement
7. Barriers not on the DOD Anti-Ram List
8. Overspeed Detection too Low
9. Speed Limits through AVBs Higher Than 25 mph
10. Improper AVB Maintenance

AVBs Located too Close to the ID Check Area

A very frequent problem that TEA observes is that barriers are located too close to the ID check area. This could be a result of trying to fit the barriers in with a limited amount of space available, inappropriate assumptions used while calculating the AVB location, or removing speed limiting infrastructure that were initially installed as part of the original AVB safety scheme requirements.

Barriers located too close to the gate may not provide the required safety for innocent motorists. They do not provide the appropriate time for barriers to activate, and therefore do not contain the threat.

Many legacy ECFs were built with very minimal length for the entire gate area. Security needs were minimal, so these ECFs functioned acceptably for the needs of the time. As a result, many installations have buildings and essential functions located close to the ECFs. Accesses to these buildings are often at intersections located very close to the ECF. Sometimes, AVBs were located at too short of a distance simply to save money on passive barrier, and other materials connecting the AVB to the gatehouse.

Another cause for improperly placed ABVs happens when all the threat scenarios are not properly evaluated. When evaluating the threat analysis, the designer must consider the threat vehicle accessing the installation in both the inbound and outbound lanes. The designer must also evaluate all four threat scenarios as defined in the UFC 4-022-01.

There are engineering solutions that can mitigate closely spaced intersections and access points. These can include closing the access and providing access farther away and building a parallel road to the ECF corridor. It could also include locating AVBs on multiple legs after an intersection. It may include relocating the ECF. TEA also has multiple AVB safety schemes that are designed for different time requirements, which can reduce the amount of time and distance needed in the response zone.

Active vehicle barriers that are located too close to the ID Check and do not currently meet threat containment time requirements can often be mitigated with roadway infrastructure improvements. This can be accomplished by installing curves or a traffic circle in the roadway to physically force vehicles to slow down. Lower speeds can significantly reduce the distance that AVBs need to be from the ID check area. Other methods are also available, such as using overspeed detection, installing in-roadway chicanes or introducing a different TEA AVB Safety Scheme with a lower threat containment time requirement.

AVBs Using Incorrect Signals

The detailed safety scheme drawings TEA developed mentioned above include signal requirements. Depending on the specific scheme, the signal could be a hybrid beacon or typical red-yellow-green traffic signal head with 12-inch indications mounted overhead on a mast arm. The 12-inch indications are more visible than the smaller 8-inch indications, and the overhead mounting provides more visibility in an expected location.

Many existing signals are mounted too low (3-4 feet) and utilize the two-section traffic signal head instead of a three-section. Signals that are side mounted signals should be placed on overhead mast arms. These undersized signals, combined with the low mounting height, do not conform to the Manual on Uniform Traffic Control Devices (MUTCD) or the DoD Supplement to the MUTCD, and do not provide the correct signal visibility.

Signal visibility is a concern on multi-lane approaches where vehicles in adjacent lanes block the line of sight to a signal. Signal visibility is exceptionally important at AVBs to properly warn drivers in advance of the deploying AVB. When AVB signals are located on sharp curves, consideration should also be given to the signal orientation so that they are directed in the line of sight of the approaching driver. Without proper placement and orientation, the driver will not have adequate sight distance to properly react and stop in time.

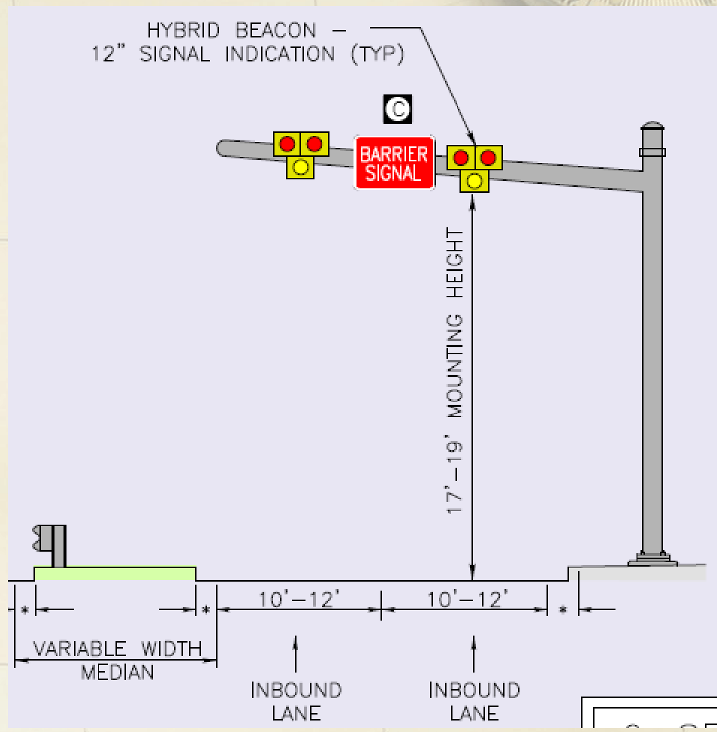
The following photos are examples of incorrectly installed side posts and signal heads. In both cases, the signals are mounted too low and utilize a two-section traffic signal head instead of a three-section signal head. These side mounted signals should have also been placed on an overhead mast arm.

Non-Compliant AVB Signal Examples

The following figure shows the hybrid beacon indication used for the 9-Second and 7-Second AVB Hybrid Beacon Safety Schemes. Both hybrid beacon signals are mounted above the roadway and centered over the lanes.

See TEA's AVB Safety Scheme drawings for more information.

Hybrid Beacon Signal Indication Example



Incorrect Signing and Markings

Incorrect signing and pavement markings are a common problem at AVB locations. TEA's AVB safety scheme drawings show required signing and pavement markings that must be in place at all AVB locations. Common problems with signing include lack of required signs, too many signs, irrelevant signs near the barriers, faded signs, and non-compliant signs. Common problems with pavement markings include lack of markings, incorrect colors, incorrect hatching, faded markings, and lack of retroreflectivity.

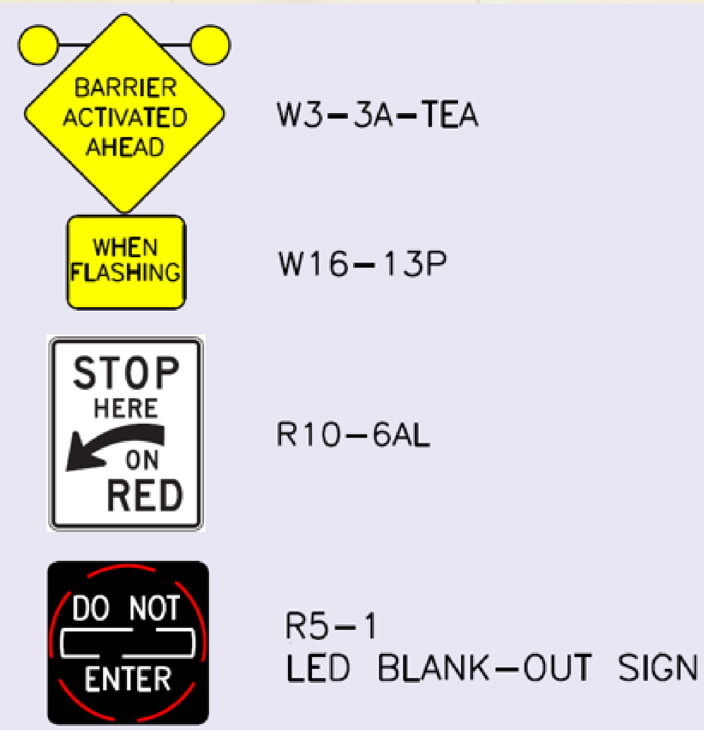
Incorrect signing approaching AVBs on both the inbound and outbound approaches fail to provide the appropriate information to motorists. This could include lack of necessary warning information, or irrelevant information unrelated to the AVBs and can often distract from the important and necessary signs. The signing and marking requirements will vary slightly depending on which AVB Safety Scheme is used. Signs and markings commonly used can include:

- ☑ BARRIER ACTIVATED AHEAD (W3-3A-TEA) sign, mounted with a WHEN FLASHING (W16-

13P) plaque located a minimum of 100 feet in advance of the stop bar.

- ☑ A STOP HERE ON RED (R10-6A) sign should be installed at the stop line.
- ☑ LED blank-out DO NOT ENTER (R5-1) sign located between the stop bar and the barrier.

Common AVB Signs



Earlier versions of the safety schemes required more signs, but all were related to the barrier. If signs comply with earlier versions of TEA's safety schemes, they are considered grandfathered in for the duration of their service life.

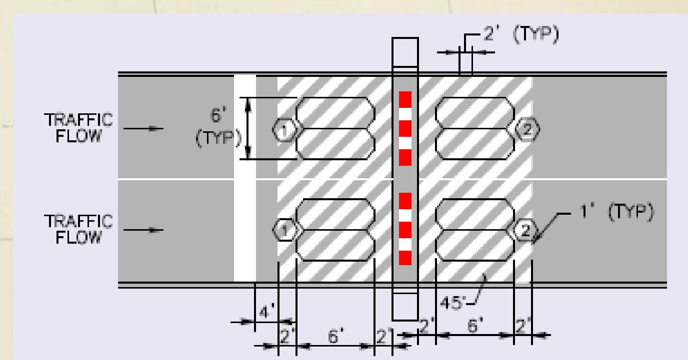
TEA commonly observes sign clutter in the response zone. Sign clutter may consist of installation regulation signs, guide signs, or common and appropriate roadway signs such as speed limit signs. Installation regulation signs should not be installed in the gate area, especially in the response zone. Installation regulation signs are not traffic-related, and if used, should be located farther from the edge of the roadway to not detract from important signs. To avoid sign clutter within the AVB safety scheme, it is recommended to place guide and installation regulatory signs after the AVBs. This would also apply to marquis signing. The lights and changing messages for marquis signing can be distracting if it is in the response zone leading to the barriers. Traffic control signs used within the response zone should be placed an appropriate distance in advance of the AVBs.

Example of Irrelevant Signing Approaching AVBs

Signing for the outbound direction is similar; signing should not conflict or obstruct the AVB safety scheme signing.

Pavement markings should also follow TEA standards. Current AVB Safety Scheme standards require a stop line at the point where traffic is required to stop and crosshatching within the zone between the stop line and the barrier. While older versions of TEA's safety scheme requirements are grandfathered in, signing and markings should be updated to meet current AVB safety schemes when signs are replaced, or markings are restriped since there is little to no infrastructure improvements required to do this.

Barrier Pavement Markings



Barriers with Gaps

The entire ECF area makes a corridor that can be made impenetrable into the rest of the installation by closing the AVBs. When a threat vehicle is detected and the barriers are activated, the threat vehicle is trapped from entering the installation. Therefore, the ECF corridor must have a continuous passive barrier connecting to the AVBs. Any gap is a vulnerability in security. Depending on the barrier configuration, some locations incorrectly leave gaps that can be penetrated by a threat vehicle. Gaps are acceptable, but they can be no larger than three feet in width. Gaps could occur if any of the following are constructed incorrectly:

- ☑ A connection between the active barrier and the passive barrier
- ☑ A connection between the active barrier and a median barrier.
- ☑ A multi-lane road with single lane active vehicle barriers with large gaps between barriers.

The following photos show gaps in barrier. Large rocks are not considered acceptable as a passive barrier due to size, shape, weight, and composition variation. That aside, the gaps between the AVB and boulders is greater than 3 feet and can be breached by certain vehicles. The second photo also shows a gap next to the barrier. The low height wall extending from the barrier is not a compliant passive barrier, and it does not extend to the fence, resulting is a wide gap. The rocks in the foreground of the photo can be traveled over by the right vehicle.

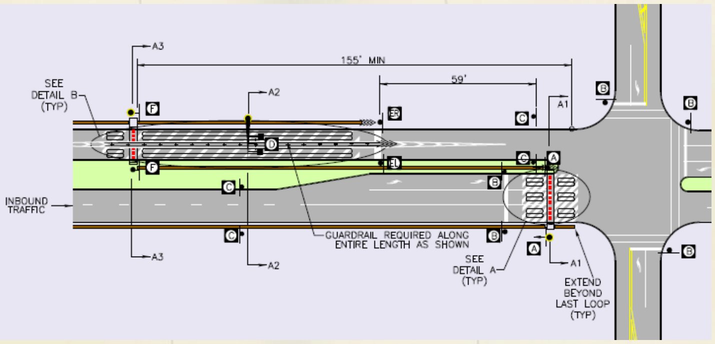
Gaps between the AVB and Passive Barrier Examples

AVBs Located Too Close to Intersections

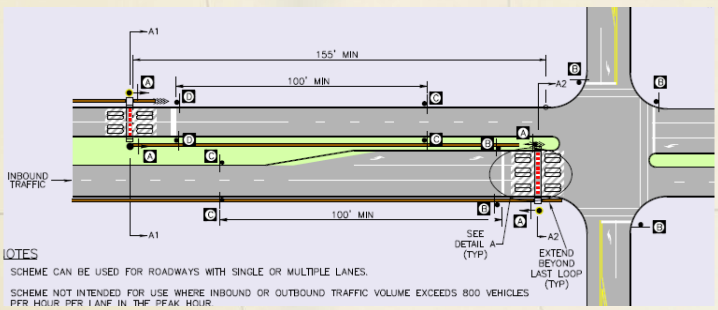
Approaching barriers and intersections are both critical tasks that often require the driver's attention. They both have different traffic control requirements, different devices that the driver sees, and different requirements for the driver to act at as part of driving through it. As a result, they must have sufficient distance between them. On the outbound side, length is required approaching the barrier to allow for required signing, and to provide proper distance to for visibility and reaction to the barrier signals for a potential barrier activation by traffic traveling through or turning at the intersection and approaching the barriers.

Per the TEA Safety Schemes, the following are minimum requirements:

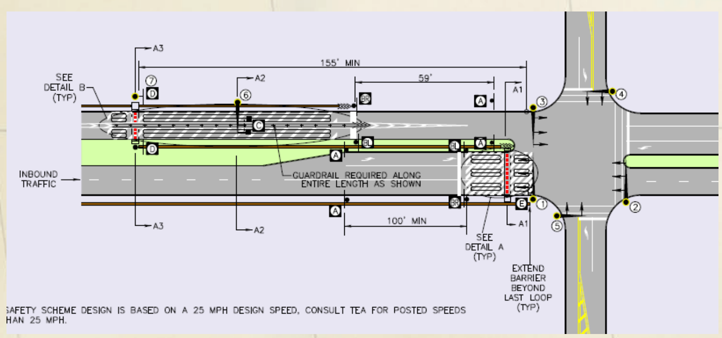
Outbound: Provide a minimum 155 feet between the barrier and the intersection. This is based on providing a sufficient distance approaching the barrier for all required signing and signals.



Inbound: If the barrier is within 200 feet of an intersection, and the midblock Stop Control Safety Scheme was intended, relocate the barrier on the inbound side to the intersection. It is not necessary that the inbound and outbound barriers be adjacent; they can be staggered if there is a median barrier with passive barrier between them.



Inbound: If the barrier is within 300 feet of an intersection and a Hybrid Beacon Safety Scheme was intended, relocate the barrier on the inbound side to the intersection and use the Intersection Combination 9-Sec Traffic Signal/7 Sec Hybrid Beacon Safety Scheme.



Incorrect Detection Loop Placement

Detection loops are an important safety component to AVB operation. A detection loop is required to verify that the barrier is free of traffic traveling over it, and if so, allows the barrier to activate. If a vehicle is present on the loop, it will delay activation until the vehicle passes over the barrier. A loop is required both before and after the barrier to allow a buffer between the barrier activation and an innocent driver to clear the AVB. Detection loop widths are 6 feet, and the lengths will range from 6 feet to 76 feet, dependent on which AVB Safety Scheme is utilized. Loops installed by the barrier manufacturer are often too short, often 3 to 4 feet at the barrier, are not placed at the correct location from the AVB or do not have an exiting detection loop (after the AVB).

Loops Used at AVB

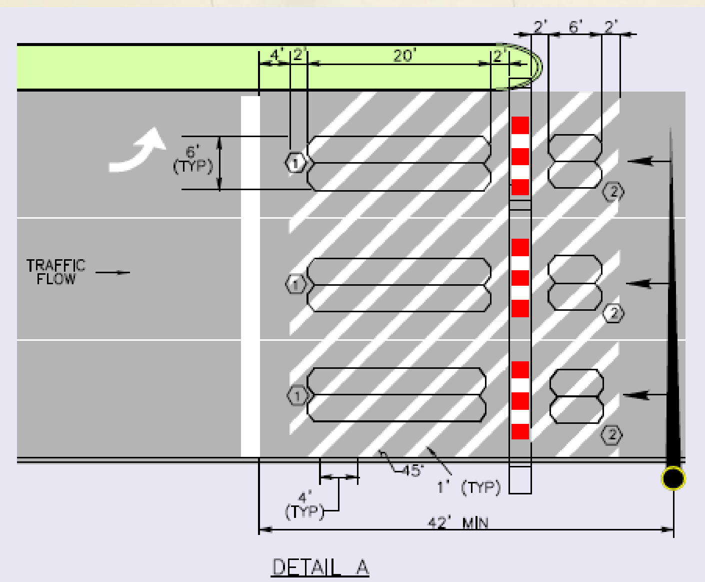
TEA safety schemes recommend the following loop configurations:

- ☑ 0-Second Full Containment Safety Scheme: 10-foot loop at the stop line; 6-foot loop before and after the barrier.
- ☑ 5-Second Stop Control Safety Scheme: 6-foot loop before and after the barrier.
- ☑ 7-Second Hybrid Beacon Safety Scheme: 76-foot loop in advance of the barrier and 6-foot loop after the barrier.
- ☑ 7-Second High Efficiency Presence Detection Safety Scheme: 8-foot loop in advance of the stop bar, 34-foot loop approaching the barrier, and 6-foot loop after the barrier.
- ☑ 9-Second Hybrid Beacon Safety Scheme: 20-foot loop in advance of the barrier and 6-foot loop after the barrier.

An example loop configuration (9-Second Hybrid Beacon Safety Scheme) is shown on the following page. For other safety schemes, see TEA's AVB Safety Scheme document.

The detection required can be accomplished by traditional inductive loops embedded in the pavement, by video, or by radar. Loops can fail. When they do, they must be replaced for proper functionality. A failed loop sends a constant call, as if a vehicle is always present. In these instances, a failed loop would prevent the activation of the barrier. Video detectors must be cleaned annually. Road dirt can cover the lens, and even spiders can nest in the camera housing, interfering with the lens.

Loop Requirements for 9-Second Hybrid Beacon Safety Scheme



Barriers not on the DoD Anti-Ram List

Many early passive and active barrier systems were installed in reaction to early security needs realized after 9-11. This was before many systems were tested to verify their actual threat vehicle stopping capabilities. Testing has been performed over time, resulting in some barriers used commonly early on to be eliminated. The U.S. Army Corps of Engineers Protective Design Center maintains a list of approved barriers for use at gates. These are approved based on proper performance for stopping a threat vehicle and considers the deflection of the barrier (vehicle penetration) if hit. The list covers both active and passive barriers.

Designers and contractors should be aware of the list, and the barriers that are included and excluded. Cost savings should not be used as a reason to use a barrier not on the list. The list can be accessed here: [DoD anti-ram vehicle barrier list - Booklets, Manuals, and Guides - USACE Digital Library (oclc.org)].

Overspeed Detection Too Low

Overspeed detection is sometimes used to detect threat vehicles sooner. If the response zone is not long enough with certain geometric features, the barrier cannot be located without the use of overspeed detection for certain barrier safety schemes. When this occurs, the overspeed detection provides the guards a warning that a vehicle is travelling at a high rate of speed, thereby allowing them to react to a high-speed threat before the vehicle reaches the ID checkpoint.

The primary disadvantage of overspeed detection is the likelihood for false positive calls, or specifically that a vehicle is travelling above the posted speed that triggers the detection alarm, but still stops for the ID check. The closer the speed detection setting is to the speed limit, the more likely the false call will occur. With too many false calls, there is a likelihood that the guards will view this as a nuisance and deactivate it.

Overspeed detection should generally be set to about 20 miles per hour above the speed limit before any lower speed limit used because of the gate. For example, if the roadway is posted at 40 mph leading to the gate, the speed setting should be set to 60 mph, even if the speed limit for the gate is set to a slower limit of 25 mph.

The use of overspeed detection should be a last resort. Consider the use of any of the following:

- ☑ Curvature leading into the ID check and in the response zone.
- ☑ Another safety scheme, possibly one with a lower time requirement.
- ☑ Relocating the desired barrier location farther in the base. This could involve the closure of an internal intersection or changing internal traffic flow.

When overspeed detection is used, consider the following:

- ☑ Keep the detector setting at least 20 mph above the posted speed limit before reductions leading to the gate.
- ☑ Detection length should not be more than 400 feet ahead of the ID check.
- ☑ Detection should use non-invasive hardware, specifically video or radar detectors. An advantage to using these detectors is that they can detect vehicles on public roadways not owned by the installation when the equipment is installed on the installation property.

Speed Limits Through AVBs Higher Than 25 mph

The recommended speed limit through ECF areas is 25 mph. Lower speed limits are not recommended since lower speed limits are in most states not enforceable. Higher speed limits through ECFs are also not recommended since higher speeds can pose a risk to guards and reduce the amount of time a driver must pay attention to traffic control devices within the area of the ECF. Therefore, 25 mph is the optimal speed limit through the ECF area. The specific area that the 25-mph speed limit should be applied extends from just before the ID check (approach zone) through the AVBs (response zone).

TEA designs the AVB safety schemes for a 25-mph operating speed. Therefore, it is not appropriate to use an operating speed different from this, whether it be lower or higher. The speed affects the following safety scheme features:

- ☑ Clearance intervals (yellow and red)
- ☑ Sign placement
- ☑ Required distance for signal visibility
- ☑ Loop length
- ☑ Tapers and lane shifts
- ☑ Clear zone width requirements
- ☑ Required distance between barriers and adjacent intersections

Drivers tend to increase speeds after the ID checkpoint since there is no perceived need to stop again until the next intersection. Speed limit signing and alignment curvature should be used in this area to reinforce the need to continue to travel at lower speeds. Also, consideration should be given for non-threat drivers and accidental collisions with the AVB. The kinetic energy of the vehicle impacting the AVB doubles when the vehicle speed changes from just 25 mph to 35 mph.

Improper AVB Maintenance

Barriers require regular maintenance to function properly. Many barrier types are in the ground, so it is important to ensure that submerged parts drain continuously. Hydraulics need to operate properly. Ensure that gaps between the roadway and the actual barrier do not allow dirt or silt to fall into the barrier housing, these require regular cleaning.

With numerous types of active barriers available, the specific maintenance requirements differ by barrier. Follow manufacturer instructions on barrier maintenance.

In addition to maintenance of the barriers, ensure that the traffic control is properly maintained. This includes:

- ☑ Signal functionality
- ☑ Loop operation
- ☑ Sign retroreflectivity
- ☑ Paint on the barrier surface.

The following photos show examples of maintenance issues.

Wedge Barriers with Faded Paint.

Without visible paint, the barrier is not visible to outbound vehicles if activated

Active Barrier Signing with Missing Bolt and Damaged Signal Indication

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Reference List

- ☑ TEA Home
- ☑ SDDCTEA Pamphlet 55-15: *Traffic and Safety Engineering for Better Entry Control Facilities*
- ☑ *TEA Safety Schemes*, 05 Jan 2022.
- ☑ Federal Highway Administration: *Manual on Uniform Traffic Control Devices*, 2009 Edition with Revision Numbers 1 and 2 incorporated, dated May 2012.
- ☑ *DoD Supplement to the MUTCD*, TEA, 2015
- ☑ Bulletin 20-01 – Active Vehicle Barrier (AVB) Safety Schemes, May 2020.