MEMORANDUM FOR RECORD

SUBJECT: Approval for the January 2009 Revision of the Army Access Control Points (ACPs) Standard Design/Criteria

1. The 2009 revised Access Control Points Standard Design Criteria (Encl 1) is approved. This 2009 version supersedes the 14 December 2004 document in its entirety.

2. The Army Standard for ACPs, approved by the Army Facility Standardization Committee also on 14 December 2004, remains in effect. No changes are required to the Army Standard for ACPs based on this revision of the Army ACPs Standard Design/Criteria.

3. Revisions in the ACP Standard Design/Criteria include:
   a. Incorporation of lessons learned.
   b. More detailed layouts and equipment information.
   c. Revised roadway geometry to improve traffic flow.
   d. Addition of alternative roadway layouts to improve threat detection.
   e. Revised floor plans and site plans to accommodate the future Automated Installation Entry (AIE) system.

4. We request the widest dissemination of the revised criteria. The USACE Center of Standardization (COS) POC for ACPs is Brian Erickson, at 402-995-2394.

FOR THE COMMANDER:

[Signature]

JEFFREY J. DORKO
Major General, USA
Deputy Commanding General
for Military and International Operations
1 INTRODUCTION

1.1 DEFINITIVE DESIGN
This Standard Design/Criteria supersedes all versions for this facility type. It shall be used for construction of all new ACP projects and renovations to existing ACP projects. It is intended for use anywhere in the continental United States or overseas locations. The design procedures and drawings included in this Standard Design/Criteria provide flexibility to Army ACP designers in meeting the Army’s baseline physical security requirements and the full range of Force Protection Conditions on Army Installations. This Standard Design/Criteria meets the Army Standard for Access Control Points approved by the Army Facilities Standardization Committee and the ACP Criteria established by the Office of the Provost Marshal General (OPMG), who is the Army’s proponent for Access Control Points. It also meets Architectural and Engineering design criteria established by the Headquarters U.S. Army Corps of Engineers (HQUSACE). The Chief of Engineering and Construction Division at HQUSACE must approve all changes, deviations, or waivers to the Standard Design/Criteria.

1.2 ACP DEFINITION
An Access Control Point is a corridor at an Installation entrance through which all vehicles and pedestrians must pass when entering or exiting the Installation. The perimeter of the ACP consists of both passive and active barriers arranged to form a contiguous barrier to pedestrians and vehicles. ACP guards control the active barriers to deny or permit entry into the Installation.

1.3 ACP PERFORMANCE REQUIREMENTS
ACP’s shall be designed to prevent an unauthorized vehicle or pedestrian from entering the Installation, to ensure safety of innocent ACP users, and to maximize throughput of vehicular and pedestrian traffic. In order to meet these diverse and sometimes conflicting requirements, Army ACP designers must consider local site constraints and then use creativity and innovation to develop design solutions that meet all of the ACP performance requirements. There are no cookie-cutter design
solutions. Each design is unique. Designers must carefully consider all of the criteria and then select and design protective measures that will be most effective for the given site.

2 ACP DESIGN CRITERIA

2.1 THE ARMY STANDARD FOR ACPs
The Army Facilities Standardization Committee established the Army Standard for Access Control Points on 14 December 2004. The standard lists mandatory requirements for all Army ACPs. The standard is included in Appendix A. The Army Facilities Standardization Committee must approve changes, deviations, or waivers from this standard.

2.2 OFFICE OF PROVOST MARSHAL GENERAL (OMPG) DESIGN CRITERIA
OPMG, as the Army’s proponent for Access Control Points, provided their criteria for ACP’s in a document titled “ACP Criteria from OMPG” dated 19 November 2004, which was subsequently updated in July 2008 and approved by OMPG on 10 December 2008. The OMPG Criteria consist of mandatory requirements and non-mandatory recommendations. Mandatory requirements in the criteria are designated by the words “shall”, “will”, or “must”, whereas non-mandatory recommendations are designated by the words “should”, “can”, or “may”. The current OMPG Criteria have been made a part of this Standard Design/Criteria. The OMPG Criteria is included in Appendix B.

2.3 STANDARD DESIGN/CRITERIA DRAWINGS
The Protective Design Center (PDC) of the U.S. Army Corps of Engineers (USACE), as the Center of Standardization (COS) for Army Access Control Points, developed Standard Design/Criteria drawings for ACP’s. These drawings incorporate the Army Standard for ACPs, the OMPG Criteria for ACPs, and other applicable criteria. They also provide mandatory requirements and recommendations to Army ACP designers and Installation Security Specialists for designing Army ACPs. The drawings have been made a part of this Standard Design/Criteria and are included in Appendix C.

2.4 OTHER CRITERIA
ACP designers are responsible to identify additional criteria such as applicable design codes, security (anti-terrorism), sustainability, energy conservation, environmental stewardship, and the Installation Design Guide
for each ACP project developed from this Standard Design/Criteria at the
time project design work is authorized.

3 DESIGN PROCEDURE
The Designer must evaluate the criteria in paragraph 2 above and select ACP
features that detect possible threats and ACP features that will delay the
threats for the delay times required in the criteria. Detection features include
vehicle speed detectors, vehicle wrong-way detectors, vehicle presence
detectors, and detection by security guards. Delay features for vehicles
include straight roadways, curved roadways, and roadways with chicanes or
turns. Based on the opportunities and constraints of the site, the designer
must determine appropriate detection and delay features and perform
calculations to assure that the selected features provide the delays required
for each Threat Scenario listed in the criteria. The design engineer must
prepare a Design Analysis including descriptions of selected ACP features,
layouts of detection and delay features, and calculations verifying delay
times. Step-by-step procedures along with examples are included in
Appendix D.

4 CONTROL OF ACTIVE VEHICLE BARRIERS (AVBs)
Active vehicle barriers are an essential element in preventing unauthorized
motorists from entering Army Installations. However, an active vehicle
barrier capable of stopping large, moving vehicles can cause significant
damage to vehicles and can cause injury or even death to vehicle occupants.
Through Army policy and design criteria, ACP designs must include
adequate safety features to ensure the safety of motorists entering and
exiting the ACP. The active vehicle barrier controls are an essential element
of the ACP safety features. Active vehicle barrier controls must provide
sufficient information to ACP guards to help them decide when to deploy
the barriers. Active vehicle barrier controls must also close the active
barriers upon command of the guards in order to stop a threat vehicle.
Finally, the active vehicle barrier controls must provide sufficient warning to
non-threat vehicles to allow them to either clear the barrier or stop safely in
front of it before it is closed.

4.1 SENSORS
Barrier controls include sensors that may be required to detect a vehicle
going the wrong way in the ACP, a vehicle speeding through the ACP, and a
vehicle’s presence at a specific location in the ACP. Sensor systems for
over-speed, wrong-way, and vehicle presence shall utilize proven sensor
technology and equipment.
4.1.1 Wrong Way Detection
Wrong way sensors, when required, are usually deployed in all outbound lanes at the ACP entrance and after each Turn-around from the inbound lanes. Wrong way detectors can utilize induction loops, video motion cameras, microwave, laser, or other appropriate sensor technology. Location of sensors is a function of the protective system design and the type(s) of sensors used.

4.1.2 Point Over-Speed Detection
Point over-speed sensors, when required, are used to detect speeding vehicles at calculated distances in front of the ACP Check Point. At each calculated distance, sensors must detect speeding vehicles in all inbound and, if required, all outbound lanes. Point over-speed detectors can utilize induction loops, video motion cameras, microwave, laser, or other appropriate sensor technology. Location of sensors is a function of the protective system design and the type(s) of sensors used.

4.1.3 Continuous Over-Speed Detection
Continuous over-speed sensors may be deployed in the Approach and Access Control Zones to defeat Threat Scenario #2 (see description of Threat Scenarios in Appendices B and D). Continuous over-speed detectors can utilize video motion cameras, forward/backward looking microwave or laser sensors, or other appropriate sensor technology. Induction loops and side fired microwave and laser sensors are not suitable for continuous over-speed detection. Location of sensors is a function of the protective system design and the type(s) of sensors used.

4.1.4 Vehicle Presence Detection
Vehicle Presence Detectors (VPDs) shall be deployed at all active vehicle barriers to detect a vehicle immediately in front of or behind the barrier. Detection of a vehicle traveling through the zone of these VPDs will suppress a barrier “close” command. VPDs shall also be deployed in the “Vehicle Presence Detection” safety system to detect vehicles that are stopped at a Stop Signal ahead of the barrier. VPDs can utilize induction loops, video motion cameras, microwave, break beam, or other appropriate sensor technology.

4.2 PROCUREMENT
The supplier of the active vehicle barriers at a given ACP shall be required to provide all barrier controls in accordance with UFGS 34 41 26.00 10 “Access Control Points Control System”. Controls shall include all required over-speed, wrong-way, and vehicle presence sensors; traffic warning signs
and signals; traffic control signals near the barrier; gate arms at the barrier (when applicable); barrier control panels including switches and indicating lights; Annunciator panels for gate guards; and traffic controller units (TCUs) to control the barriers and the warning and traffic signals associated with the barriers.

4.3 INSTALLATION

The active vehicle barrier supplier shall be required to provide on-site direction to the installation contractor (if different than the supplier) during installation of all barrier control elements and connecting wiring per UFGS 34 41 26.00 10 “Access Control Points Control System”.

4.4 COMMISSIONING

The barrier supplier shall be required to conduct all barrier control system commissioning activities per UFGS 34 41 26.00 10 “Access Control Points Control System” including, training, performance verification testing, and endurance testing. The active vehicle barrier supplier shall be required to submit for approval complete schematics and logic diagrams of the barrier control system along with complete test procedures for all commissioning tests. Commissioning tests must verify barrier performance for all modes of operation including the full range of operation of all sensors utilized in the barrier control system.

5 COSTS

All ACPs are different depending on traffic volume, internal and external roadway configurations, and site opportunities and constraints. Appendix E includes a cost estimate of an ACP with specifically defined parameters. However, the costs of the various ACP components can be extracted from this estimate and applied to a wide variety of ACP configurations to obtain programming level costs.

6 OTHER DESIGN CONSIDERATIONS

6.1 PASSIVE BARRIERS

6.1.1 Stopping Capacity

The OPMG Criteria in Appendix B require that passive barriers along the ACP corridor be capable of stopping a 15,000 pound vehicle traveling at the maximum velocity and approach angle that it can attain before impacting the barrier. The capacity in kinetic energy (KE) of a passive barrier that is
required to stop a vehicle with a mass of M impacting the barrier at an angle of $\theta^\circ$ and traveling at a velocity of V is:

$$KE = \frac{1}{2} M (\sin(\theta) V)^2$$

The $\sin(\theta) V$ term is the component of the threat vehicle’s velocity that is perpendicular to the barrier. The capacity of a passive barrier that is required to stop a 15,000 pound threat vehicle impacting the barrier at 90$^\circ$ and traveling at 30 miles per hour (mph) is 451,000 foot-pounds (ft-lbs). The capacity of a passive barrier required to stop a 15,000 pound threat vehicle impacting the barrier at 25$^\circ$ and traveling at 30 mph is 80,540 ft-lbs, which is a significant reduction from the kinetic energy in the 90$^\circ$ impact case. Reducing the impact angle of the threat vehicle through ACP corridor design can significantly reduce the energy stopping requirement for passive barriers. See Appendix D for a procedure for determining approach angles, velocities, and resulting energy stopping requirements for passive barriers along ACP corridors.

**6.1.2 Acceptable Passive Barriers**

The vehicle stopping capability of a passive barrier can be determined through crash testing or by engineering analysis. The following are acceptable passive barriers for use at Army ACPs:

1. Included on the list of U.S. Department of State Certified Anti-Ram Vehicle Barriers,
2. Included on the list of DOD Certified Anti-Ram Vehicle Barriers maintained by the Protective Design Center, or
3. Verified by calculations performed and/or checked by a registered Professional Structural Engineer with experience in the design and application of passive barrier systems. Stamped and signed copies of the calculations shall be obtained and maintained on file by the barrier purchasing agency and by the using Army Installation.

**6.2 ELECTRICAL LOADS**

Electrical loads include Utility loads, Emergency Generator loads, and Uninterruptible Power Supply (UPS) loads. The OPMG Criteria in Appendix B describes requirements for the Emergency Generator and UPS loads. Drawing E1.02 in Appendix C shows an overall summary of all three types of loads for a typical large ACP. A detailed listing of the loads for a typical large ACP is included in Appendix F. Electrical loads for a specific ACP must be determined on a case by case basis.
6.3 BARRIER SAFETY SYSTEMS

As described in the OMPG Criteria in Appendix B, there are three active barrier safety systems that have been approved by the Surface Development and Distribution Command (SDDC) for use at Army ACPs. One of these safety systems must be used whenever an active vehicle barrier is installed at an Army ACP. These safety systems are:

6.3.1 Signs and Signals

This system employs warning signs and signals to alert non-threat vehicles of impending vehicle barrier deployment. Barrier deployment is delayed for four seconds from the time the guard initiates an Emergency Fast Operate (EFO) command to allow warning signals to sequence. See drawing C9.10 in Appendix C.

6.3.2 Vehicle Presence Detection

This system consists of a Stop Line in front of each barrier, a lane control type traffic signal at the Stop Line, and Vehicle Presence Detectors before the Stop Line and before and after each barrier. The traffic signal will normally indicate “red” requiring all motorists to stop at the Stop Line in front of the barrier. The VPD in front of the Stop Line will sense the vehicle’s presence and change the lane control signal from “red” to “green” allowing the motorist to proceed over the barrier. If a guard initiates an Emergency Fast Operate command when the signal is “red” and there are no vehicles detected on the VPDs ahead of or behind the barrier, the barrier will close immediately thus eliminating the four second delay required in the Signs and Signals Safety System described above. This system is shown on drawings C3.17, 18, and 19 in Appendix C. Also, see Appendix G and drawings E1.03, E1.05, and E1.06 in Appendix C for information on logic control of the sensors, lane control signals, and barriers.

6.3.3 Normally Closed Operation

This safety system requires that two sets of barriers be installed to create an “entrapment area” in each inbound and outbound lane. One of the two barriers in each entrapment area must be closed. This system can be utilized when real estate for the ACP is limited. The distance between the two sets of barriers must be large enough to accommodate the largest vehicle served by the ACP, or it could be made larger to provide space for platooning multiple vehicles. Drawing C3.08 in Appendix C shows this safety system with the minimum space between barrier sets, and drawing C3.16 in Appendix C shows this safety system for a platooning operation.
APPENDIX A

THE ARMY STANDARD
FOR
ACCESS CONTROL POINTS
# APPENDIX A

## THE ARMY STANDARD FOR ACPs

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  APPROVAL LETTER

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APPENDIX A – REFERENCES 6
MEMORANDUM FOR RECORD

SUBJECT: The Army Standard for Access Control Points

1. The Army Standard for Access Control Points is approved for implementation. This Standard establishes mandatory features for Army Access Control Points (ACPs). It applies to all active Army installations and reserve components prime installations. Only the Army Facilities Standardization Committee has the authority to approve exceptions to this Standard. Waivers from the Army Standard must be approved through the installation management chain of command in accordance with AR 415-15.

2. The Army Standard for Access Control Points is mandatory for operations and maintenance projects starting FY2006 and beyond. For programming purposes requiring the use of Military Construction, Army/Army Reserve/National Guard appropriations, all projects from FY2008 and after must apply the Army Standard.

3. The proponent of this Standard is the Army Facilities Standardization Committee. Supplementation of this Standard is prohibited without prior approval from the Committee. The Army Standard for Access Control Points will be periodically reviewed and as needed, updated. The Army Standard for ACPs will be posted to the Army Installation Design Standards. Recommended changes with supporting rationale should be sent through the chain of command directly to the Assistant Chief of Staff for Installation Management, ATTN: Access Control Points Facilities Design Team (DAIM-MD), 600 Army Pentagon, Washington, DC 20310-0600.

JAMES A. CHEATHAM
Major General, USA
Acting Director for Military Programs
Army Facilities
Standardization Committee
30 Nov 2004
(Date)

RONALD L. JOHNSON
Major General, USA
Director, Installation Management Agency
Army Facilities
Standardization Committee
12/14/04
(Date)

LARRY J. LUST
Major General, GS
Assistant Chief of Staff for Installation Management
Chairman, Army Facilities Standardization Committee
13/14/04
(Date)
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The Assistant Chief of Staff for Installation Management, HQDA (Preparing Agent)

The United States Army Corps of Engineers

The Installation Management Agency

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This Army Standard supersedes the HQDA memorandum, 26 February 2004, subject: Interim Army Standards for Canopies at Army Installation Access Control Points
FORWARD

This printing publishes the Army Standard for Access Control Points (ACPs). The Army Facilities Standard process is explained in AR 415-15. This Army Standard establishes mandatory features for Army ACPs. It applies to all active Army installations and reserve components prime installations.

The proponent of this Standard is the Army Facilities Standardization Committee. Supplementation of this Standard is prohibited without prior approval from the Committee. Technical advice concerning the Army Standard is the responsibility of the Center of Standardization – the United States Army Corps of Engineers Omaha District. Users are invited to contact the Center of Standardization for document interpretation.

The Army Standard for Access Control Points is mandatory for operations and maintenance projects starting FY2006 and beyond. For programming purposes requiring the use of Military Construction, Army/Army Reserve/National Guard appropriations, all projects from FY2008 and after must apply the Army Standard.

Only the Army Facilities Standardization Committee has the authority to approve exceptions to this standard. Waivers from the Army Standard must be approved through the installation management chain of command in accordance with AR 415-15.

The Army Standard for Access Control Points will be periodically reviewed and as needed, updated, and made available to users as part of the Army’s responsibility for providing technical criteria for military construction. The Army Standard for ACPs will be posted to the Army Installation Design Standards. Recommended changes with supporting rationale should be sent through the chain of command directly to the Assistant Chief of Staff for Installation Management, ATTN: Access Control Points Facilities Design Team (DAIM-MD), 600 Army Pentagon, Washington, DC 20310-0600.
INTRODUCTION

1-1 PURPOSE AND SCOPE. This document provides standards for Army access control points (ACPs). The Army Facilities Standardization Committee (AFSC) under the Department of the Army Facilities Standardization Program publishes the Army Standard. The AFSC is composed of the Headquarters, Department of the Army, Assistant Chief of Staff for Installation Management (ACSIM); The Director for Military Programs, Headquarters, US Army Corps of Engineers (USACE); and the Director, Installation Management Agency (IMA). Publication of the Army Standard for Access Control Points is by electronic media on the Internet at the ACSIM Installation Design Standards website.

1-2 APPLICABILITY. This Army Standard applies to all Army active installations and reserve components prime installations where government or contractors plan for, construct, and maintain Army access control points.

1-3 REFERENCES. Appendix A.

REQUIREMENTS

2-1 ACP FUNCTION CLASSIFICATION. Army physical security policy requires all Army installations to restrict access. Access Control Points are the physical assets along with manpower and operational procedures that commanders employ to control access to Army installations. Army ACPs shall be categorized as follows:

Table 2-1 ACP Use Classifications

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<th>Operational Hours</th>
<th>Preferred Operation</th>
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<tr>
<td>Primary</td>
<td>24/7 Open continuously</td>
<td>Vehicle registration/visitor pass capacity. Could also be designated as truck and delivery gate.</td>
</tr>
<tr>
<td>Secondary</td>
<td>Less than 24/7 with regular operating hours</td>
<td>Regular operations, visitors with authorization. Could also be designated as truck and delivery gate.</td>
</tr>
<tr>
<td>Limited Use</td>
<td>Only opened for special purposes or special events</td>
<td>Tactical vehicles, HAZMAT, special events.</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>Varies</td>
<td>Personnel only. Could be located near installation housing areas, near schools, or as part of a Primary or Secondary ACP.</td>
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</table>
2-2 PRIMARY AND SECONDARY ACP REQUIREMENTS. The following requirements apply to all Primary and Secondary ACPs except as noted:

2-2.1 Performance Standard. ACPs must be designed to defeat the vehicle and pedestrian threats prescribed in the ACP Criteria from the Office of the Provost Marshal General (Appendix B in the Standard Designs for ACPs), and to ensure safety of motorists, pedestrians, and guards.

2-2.2 ACP Corridor. ACPs must have both passive and active vehicle barriers forming a contiguous perimeter around the ACP.

2-2.2.1 Passive Barriers. Passive barriers must be capable of preventing penetration of a threat vehicle.

2-2.2.2 Active Vehicle Barriers. Active vehicle barriers, controlled by ACP guards, must be utilized in each inbound and outbound lane to permit or deny vehicle access.

2-2.2.3 Active Vehicle Barrier Safety. An active vehicle barrier safety regime must be utilized that conforms to one of the Surface Deployment and Distribution Command – Transportation and Engineering Agency (SDDC-TEA) approved safety protocols.

2-2.3 Control. ACPs must have zones established to control the flow of vehicular and pedestrian traffic in order to detect, assess, and respond to prescribed threats.

2-2.4 Entry Gate. ACPs must have an entry gate capable of securing the ACP. The entry gate must provide the same level of protection as the adjoining perimeter, and should appear to resemble the adjoining perimeter fence and / or barriers

2-2.5 Identity Check Area. ACPs must have an identity check area within the access control zone where guards or automated equipment verify pedestrians, vehicles, and vehicular occupants identifications; perform limited searches; and validate authorizations to enter the installation. The identity check area must include:

2-2.5.1 Identity Check Area Canopy. Identity check area must be covered with a canopy over all inbound lanes.

2-2.5.2 Entry Lanes. ACPs must have at least two lanes in the identity check area.

2-2.5.3 Traffic Islands. ACPs must have raised, curbed islands to separate all inbound lanes in the identity check area.

2-2.5.4 Guard Booths. ACPs must have a guard booth building for each lane of incoming traffic for use by guards performing vehicle/patient identity checks.
2-2.5.5 **Lighting.** Identity check area must provide adequate lighting for visual inspection of identification cards and documents.

2-2.6 **Turn-around Lanes.** ACPs must have at least two turn-around lanes, one before and one immediately after the identity check or vehicle search area.

2-2.7 **Gatehouse.** ACPs must have a gatehouse with the primary controls for the final active vehicle barriers. The gatehouse must be sized to accommodate ACP guards and their activities.

2-2.8 **Search Area.** ACPs must have a covered area separated from and easily accessible to the identity check area and obscured from casual observation from the identity check area. The size of the search area must be determined from a traffic engineering study. However, for search areas that allow trucks, the area must be sized to accommodate a minimum of one WB-62 tractor-trailer. For areas that do not allow trucks, the search area must be sized to accommodate a minimum of two passenger-sized vehicles.

2-2.8.1 **Search Area Building.** Search areas must have an adjacent or nearby building to shelter vehicle occupants from inclement weather. The building will facilitate guards’ observation of vehicle occupants.

2-2.8.2 **Consolidated Search Area Building.** For ACPs with both truck and passenger search areas, one consolidated search area building is sufficient if the search areas are near each other.

2-2.9 **Overwatch Position.** ACPs must have a strategically located area suitable for an overwatch position that includes controls for the final active vehicle barriers.

2-2.10 **Visitors Control Center (VCC).** Installations must have a building for processing visitors. The building must be sized for the effective throughput of the expected number of visitors.

2-3 **LIMITED USE ACPs.** The following requirement applies to all Limited Use ACPs:

2-3.1 **Performance Standard.** Limited Use ACPs shall provide means to defeat the vehicle and pedestrian threats prescribed in the ACP Criteria from the Office of the Provost Marshal General (Appendix B in the Standard Designs for ACPs), and to ensure safety of motorists, pedestrians, and guards. Portable facilities including passive and active barriers, guard booths, and lights shall be used and configured to meet the requirements of limited use.
2-3.2 **Control.** Limited Use ACPs must have zones established to control the flow of vehicular and pedestrian traffic in order to detect, assess, and respond to prescribed threats.

2-3.3 **Entry Gate.** Limited Use ACPs must have an entry gate capable of securing the ACP. The entry gate must provide the same level of protection as the adjoining perimeter, and should appear to resemble the adjoining perimeter fence and / or barriers.

2-3.4 **Identity Check Area.** Limited Use ACPs must have an identity check area where guards can verify pedestrians, vehicles, and vehicular occupants identifications; perform limited searches; and validate authorizations to enter the installation. The identity check area shall be configured to accept portable facilities to include passive and active barriers, guard booths, and lights.

2-3.5 **Turn-around Lanes.** Limited Use ACPs shall provide means for turn-around of vehicles. Where operational procedures are not adequate for control, a turn-around lane is required and shall be located before the identity check area.

2-4 **PEDESTRIAN ACPs.** The following requirements apply to all Pedestrian ACPs.

2-4.1 **Performance Standard.** Pedestrian ACP’s must be designed to defeat the pedestrian threats prescribed in the ACP Criteria from the Office of the Provost Marshal General (Appendix B in the Standard Design for ACPs), and to ensure the safety of pedestrians and guards.

2-4.2 **Pedestrian Corridor.** Pedestrian ACPs must have both passive and active barriers forming a contiguous perimeter around the ACP.

2-4.2.1 **Passive Barriers.** Passive barriers must be capable of preventing easy circumvention or penetration by a pedestrian.

2-4.2.2 **Active Pedestrian Barriers.** Pedestrian ACPs must include active pedestrian barriers controlled by the ACP guards to permit or deny pedestrian access.

2-4.3 **Control.** ACP must have zones established to control the flow of pedestrian traffic in order to detect, assess, and respond to prescribed threats.

2-4.4 **Entry Gate.** Pedestrian ACPs must have an entry gate at the ACP entrance capable of closing off the ACP. The entry gate must provide equivalent security and equivalent appearance as the adjoining perimeter fence/barrier. If the active pedestrian barrier is located at the installation perimeter, a separate entry gate is not required.
2-4.5 **Identity Check Area.** Pedestrian ACPs must have an identity check area within the access control zone where guards or automated equipment verify pedestrians’ identifications, perform limited searches, and validate authorizations to enter the installation. The identity check area must include:

2-4.5.1 **Guard Booths.** Pedestrian ACPs must have a guard booth for use by guards performing pedestrian identity checks.

2-4.5.2 **Lighting.** Identity check area must provide adequate lighting for visual inspection of identification documents.
REFERENCES

GOVERNMENT PUBLICATIONS:

1. Department of Defense
   DefenseLink Publications Internet site http://www.defense.gov/pubs/
   DoD Directive 5200.8, Security of DoD Installations and Resources
   DoD 5200.8-R, DoD Physical Security Program
   DoD Instruction 2000.16, DoD Antiterrorism Standards
   Unified Facilities Criteria (UFC) Index http://65.204.17.188/report/doc_ufc.html

2. Department of the Army
   Army Electronic Publications Internet site http://www.army.mil/usapa/
   AR 190-13, The Army Physical Security Program
   AR 415-15, Army Military construction Program Development and Execution
   Army IDS web site http://www.mantech-mec.com/army_ids
   Army Installation Design Standards
   Army Standard Design for ACPs
   SDDC-TEA web site http://www.tea.army.mil/cdrom/readmes/allsections.htm#gates
   HQDA memorandum, Interim Army Standards for Canopies at Army Installation Access Control Points

3. Department of Transportation
   Federal Highway Administration web site http://mutcd.fhwa.dot.gov
   Manual on Uniform Traffic Control Devices and Standard Highway Signs
# APPENDIX B

## ACP CRITERIA FROM OPMG

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ACP CRITERIA FROM OPMG

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MEMORANDUM THRU ARMY CHIEF OF STAFF FOR INSTALLATION MANAGEMENT (ACSIM), 600 ARMY PENTAGON, WASHINGTON, DC 20310-0600

FOR UNITED STATES ARMY CORPS OF ENGINEERS, PROTECTIVE DESIGN CENTER (CENWO-ED-S), 1616 CAPITOL AVENUE, SUITE 9000, OMAHA, NE 68102-4901

SUBJECT: Review of Proposed Changes to Access Control Point (ACP) Physical Security Criteria from the Office of the Provost Marshal General (OPMG), November 2004

1. References:

2. The OPMG has reviewed and concurs with the United States Army Corps of Engineers (USACE) Protective Design Center (PDC) recommended changes to the November 2004 ACP Physical Security Criteria from the OPMG (Encl).

3. Request OPMG review and concur prior to any future supplementation or modification of the physical security requirements contained within the standard.

4. I sincerely appreciate the professional efforts of the USACE PDC working hand-in-hand with the OPMG staff; reevaluating and incorporating the necessary physical criteria into the Army Standard for ACPs to ensure our Soldiers, civilians and family members living and working on Army installations remain safe.

5. My point of contact for this action is Mr. Richard Patrick, COMM (703) 614-2597.

Encl

RODNEY L. JOHNSON
Brigadier General, USA
Provost Marshal General
A. The following four types of ACP shall be considered when designing an ACP:
   1. Primary - operates 24 hours per day 7 days a week – 24/7.
   2. Secondary - operates during regular hours but less than 24/7.
   3. Limited Use - open only for special purposes or special events.
   4. Pedestrian - is designated for pedestrians and bicyclers only.

B. ACP Functions. ACPs shall be designed for the following functions:
   1. Vehicle Screening. All vehicles shall be screened for authorization to enter the installation.
   2. Personnel Identification Validation. The identification of all personnel entering the installation shall be verified along with their authorization to enter the installation.
   3. Personnel and vehicles shall be checked and/or searched per prevailing Force Protection Conditions and local procedures.

C. Traffic Engineering Study. A traffic engineering study shall be conducted prior to the modification of an existing ACP; prior to the implementation of active vehicle barriers and automated technologies; and prior to the design of a new ACP. The traffic engineering study shall include scaled CADD drawings with bar scales and north arrows. Traffic engineering studies are subject to the review and approval of the Surface Deployment and Distribution Command – Transportation Engineering Agency (SDDCTEA) as well as the Army Corps of Engineers’ Protective Design Center (PDC). The traffic engineering study shall consist of the following:
   1. Perform an assessment of compliance of existing/proposed facilities with Unified Facilities Criteria (UFC) 4-022-01, Security Engineering: Entry Control Facilities/Access Control Points; Department of the Army, Army Access Control Points Standard Design/Criteria; and SDDCTEA Pamphlet 55-15, Traffic and Safety Engineering for Better Entry Control Facilities.
   2. Conduct a safety review and evaluate available crash data to identify improvements required to mitigate guard, pedestrian, and driver safety concerns.
   3. Calculate existing and future lane requirements (per SDDCTEA Pamphlet 55-15, Traffic and Safety Engineering for Better Entry Control Facilities) with consideration of growth (BRAC, Grow the Army, etc.), as well as single or tandem lane processing and automation (AIE, etc.).
   4. Utilize the ACP/ECF SMART Decision Evaluator© (or other methods to accomplish the same results) to evaluate the existing, short-term and long-term impact of security, manpower, automation, and roads and traffic.
   5. Identify short-term recommendations.
   6. Identify long-term recommendations.
   7. Calculate threat requirements including AVB strategy per Department of the Army, Army Access Control Points Standard Design/Criteria.
   8. Identify traffic control requirements per SDDCTEA Pamphlet 55-15, Traffic and Safety Engineering for Better Entry Control Facilities.
   9. Consider conducting a comprehensive review of overall ACP needs (number of ACPs, optimum ACP locations, total lanes, roadway infrastructure requirements, origins/destinations) on the entire installation if improvements for multiple ACPs are being considered or if an existing ACP cannot be upgraded to meet requirements without technically infeasible infrastructure modifications.

D. Siting. The ACP should be sited at a distance inside the installation to facilitate the queuing of vehicles without creating an off-post traffic problem, but spatially separated from inhabited buildings.
E. Traffic Types. ACPs shall be capable of handling one or more of the following traffic types: trucks up to WB62, visitor POVs, DOD personnel POVs, official Army vehicles, pedestrians, and bicycles.

F. Operation.
1. To minimize problems associated with mixing of traffic types, a separate ACP should be identified as a Commercial Vehicle Only ACP.
2. ACPs that must handle both commercial and passenger vehicles should provide separate commercial vehicle and passenger vehicle ID Check areas and separate search areas.
3. ACPs that handle pedestrian traffic and vehicular traffic shall keep these traffic types physically separate.

G. Future Enhancements. Designers shall consider future technology enhancements and possible expansion of the ACP. Automated systems to validate the identity of incoming personnel and vehicles are anticipated for use at Primary, Secondary, and Pedestrian ACPs. Designers shall provide spare conduits for communications, power, and computer upgrades.

H. Coordination.
1. Before designing an ACP, the designer shall coordinate with state and local authorities concerning impacts to public roadways, signage, and other requirements.
2. Designers should coordinate with the Surface Deployment and Distribution Command (SDDC) for assistance on issues involving public highways.
3. For OCONUS Installations, the designer should coordinate with the host nation government agencies or their appropriate Status of Forces Agreement (SOFA) subcommittee.

I. The following requirements apply to Primary and Secondary ACPs except as noted: (Note, additional requirements for pedestrian access at Primary and Secondary ACPs are listed below in paragraph K below.)

1. Performance Requirement. ACP’s shall be designed to defeat all threats described below, to ensure safety of innocent users, and to maximize throughput.
2. ACP Layout.
   a. Corridor. The Access Control Point shall consist of a corridor at the installation boundary through which all vehicles and pedestrians must pass when entering or exiting the installation.
   b. The perimeter of the ACP, except at its entrance, shall include both passive and active vehicle barriers arranged to form a contiguous barrier to vehicles. Active vehicle barriers, that can be opened and closed, shall be deployed at the end of the ACP (i.e., at the entrance to the Installation).
   c. ACP guards will control the active vehicle barriers to deny or permit entry into the Installation.
   d. Zones. The ACP corridor shall be divided into an Approach Zone, an Access Control Zone, and a Response Zone.
      1) The Approach Zone shall run from the ACP entrance to the beginning of the Access Control Zone. It shall provide an area for incoming vehicles to be sorted and queued for ID authentication.
      2) The Access Control Zone shall run between the Approach and Response Zones. Vehicle and occupant ID checks shall be performed within this zone at a covered ID Check Area or a covered Search Area.
3) The Response Zone shall run from the end of the Access Control Zone to the entrance to the Installation/Cantonment Area and includes the final active vehicle barriers.

3. Design Objective. The primary objective of the ACP design shall be to prevent an unauthorized vehicle or pedestrian from entering the installation. The ACP design shall include construction features supporting the effective and efficient use of equipment, manpower, and procedures to accomplish this primary objective.

4. Design Strategy. The overall design strategy to meet the objective above for vehicle threats shall be to detect the threat vehicle as early in its attack as possible and to delay it a sufficient amount of time to allow ACP guards time to deploy the active vehicle barriers before the threat vehicle can enter the Installation.

5. Design Criteria.
   a. Vehicle Threat Scenarios. ACPs shall be designed to defeat the following four minimum vehicle threat scenarios. Additional vehicle threat scenarios may be considered if supported by a local threat assessment.
      1) Vehicle Threat Scenario #1. Threat vehicle enters the ACP in the inbound or outbound lane(s) at the maximum speed attainable at the ACP entrance and then immediately accelerates at its maximum acceleration rate through the ACP. Army policy sets the maximum acceleration rate of a threat vehicle at 11.3 f/s/s.
      2) Vehicle Threat Scenario #2. Threat vehicle enters the ACP in the inbound or outbound lane(s) at or under the posted ACP Speed Limit and then, later at some point further in the Approach Zone, accelerates at its maximum acceleration rate through the rest of the ACP.
      3) Vehicle Threat Scenario #3. Threat vehicle attempts to covertly enter the ACP, but is detected and denied entry by guards at the ID Check Area. Vehicle driver then defies guards and accelerates through the rest of the ACP at the vehicle’s maximum acceleration rate.
      4) Vehicle Threat Scenario #4. Similar to Threat Scenario 3 above, except the driver of the denied vehicle drives toward the Turn-around or Search Area at the ACP Speed Limit (25mph) as if complying with guard instructions, but then fails to turn and instead accelerates at its maximum acceleration rate through the rest of the ACP.
   b. Delay Time. Once a threat vehicle is detected, the ACP design shall delay it a sufficient time to allow ACP security guards time to deploy the active barriers before the threat vehicle reaches the entrance to the Installation. Delay time begins at the instant the attack is detected either by sensors or by security guards. The delay shall include the following:
      1) Guard reaction time shall be no less than 3 seconds for Threat Scenarios #1 through #3 and 1 second for Threat Scenario #4,
      2) Barrier traffic signal sequence time shall be no less than 4 seconds (unless other ACP features provide an equivalent amount of safety for innocent vehicles).
      3) Barrier operating time should not be more than 2 seconds.
      4) The ACP design, therefore, shall provide a minimum of 9 seconds delay for Threat Scenarios #1 through #3 and 7 seconds delay for Threat Scenario #4.
6. Entry Gate. The ACP entrance shall include an entry gate to close off the ACP at the installation perimeter. The entry gate shall provide the same level of security and same aesthetics as the adjoining perimeter barrier/fence.

7. ID Check Area. ACPs shall have an ID Check Area within the Access Control Zone where guards or automated means perform vehicle and passenger ID checks, grant vehicles authorization to enter the installation, or direct vehicles to other areas of the ACP.

8. ID Check Area Canopy. The ID Check Area shall be covered with a canopy over all inbound lanes to provide some protection from the weather for ID Check Area guards. The canopy shall meet the following requirements:
   a. The canopy shall consist of a roof structure supported by columns.
   b. Architectural treatment must reflect the architectural themes on the Installation and must also be consistent with architectural treatment of other facilities in the ACP, especially the gatehouse.
   c. Canopy columns shall be sized to preclude the requirement for cross bracing below the roofline.
   d. Columns shall be sized and located so as not to obstruct guard lines of site.
   e. Roof underside shall be capable of supporting lighting fixtures and security equipment (e.g., CCTV cameras) anywhere on the underside of the roof and shall be treated with a reflective surface to help achieve required lighting levels and CCTV camera coverage.
   f. Vertical clearance must be a minimum of 15 feet unless a large number of over height vehicles is expected, then 17 feet. Canopies at Truck/Commercial Vehicle only ACPs must have a minimum clearance of 17 feet.
   g. Width shall be sufficient to cover all inbound lanes and all current and known future requirements for guard booths and the ID Check Area footprint.
   h. Length shall be sufficient to cover single or tandem vehicle processing stations. New ACPs and existing ACPs with peak hourly demands greater than 300 vehicles per hour require tandem processing stations on each traffic island.

   a. The number of inbound and outbound lanes shall be determined from the Traffic Engineering Study.
   b. ACPs shall have a minimum of 2 lanes in the ID Check Area.

10. Primary Traffic Islands. ACPs shall have raised, curbed islands to separate all inbound lanes in the ID Check Area.

   a. ACPs may also have raised, curbed islands at the end of the Approach Zone for installing over speed detectors or optional over height detectors.
   b. When used, secondary islands should be the same width as primary islands.

12. Turn-around Lanes.
   a. ACPs shall have at least two Turn-around Lanes, one before and one immediately after the ID Check Area.
   b. If secondary islands are used, a Turn-around should be included between the secondary and primary islands.
13. **Gatehouse.** ACPs shall have a Gatehouse sized to accommodate ID Check Area guards and their activities. For new construction, the Gatehouse building shall be located on a raised island immediately after the last Turn-around to give the Gatehouse guard clear views of operations in the ID Check Area, of vehicles directed to the last Turn-around, and of vehicles entering and exiting the Search Area. At ACPs with existing Gatehouses, the Gatehouse building may be located within the ID Check Area. All Gatehouses shall have the following:

a. Construction to provide a minimum ballistics protection of UL 752 (latest edition) Level 3 with a higher level of protection authorized if warranted by a local threat assessment.
b. Heating and/or Air Conditioning appropriate for the geographic location,
c. Water Cooler.
d. Unisex Latrine with sink.
e. Interior storage for cleaning materials and special equipment.
f. Exterior storage for traffic cones, signs, etc.
g. Heavy-duty exterior power outlets sufficient to run temporary floodlights, etc.
h. Interior power outlets sufficient for radio chargers, computers, etc.
i. Active vehicle barrier control console with enunciator, computer workstation, and communications equipment including LAN, telephone, and Internet connections.
j. Sufficient counter space for report writing and storage of reference material.
k. Passive barriers to provide crash protection from vehicles.
l. Windows to provide 180 degree field of view toward incoming traffic and mirrors or other visual aids to complete the field of view.
m. Electrical/communications room at least 10’ by 10’.

14. **Guard Booths.** ACPs shall have a Guard Booth building for each lane of incoming traffic (except for the lane with a Gatehouse) for use by guards performing vehicle/passenger ID checks. Guard Booths shall be located on the primary, raised traffic islands or between raised traffic island sections in the ID Check Area. Guard Booths shall also have:

a. Construction that provides a minimum ballistics protection of UL 752 (latest edition) Level 3 with a higher level of protection authorized if warranted by a local threat assessment.
b. Heating and/or Air Conditioning appropriate for the geographic location.
c. Exterior power outlet sufficient to power hand-held searchlights, bug zappers etc.
d. Interior power outlet sufficient for radio chargers, computers, etc.
e. Active vehicle barrier control console with enunciator, computer workstation, and communications equipment including Local Area Network (LAN), telephone, and Internet connections.
f. Anti-fatigue floor mat.
g. Sufficient counter space for report writing and storage of reference material.
h. Passive barriers to provide crash protection from vehicles.
i. Windows to provide 360-degree field of view.

15. **Passenger Vehicle Search Area.** ACPs will have a Passenger Vehicle Search Area:

a. Covered with a canopy.
b. Easily assessable from the ID Check Area.
c. Shielded from casual observation from the ID Check Area.
d. Sized to accommodate the search of a minimum of 2 passenger vehicles.
16. Truck Search Area. ACPs that allow truck traffic will have a Truck Search Area:
   a. Separate from the Passenger Vehicle Search Area.
   b. Covered with a canopy (unless prohibited by the cargo search equipment
      system in use).
   c. Obscured from casual observation.
   d. Sized to accommodate the search of one WB-62 tractor-trailer and the search
      equipment to be used, e.g., Mobil Vehicle Inspection System (MVIS).
   e. If there is only one Search Area for both trucks and passenger vehicles, the
      Search Area shall be easily assessable from the ID Check Area.

17. Search Offices. The ACP shall include a Search Office building located adjacent
   to both the Passenger Vehicle and Truck Search Areas to support Search Area
   guards and their activities. If Truck and Passenger Vehicle Search Areas are far
   apart, provide a Search Office for each. The size of the Search Office building
   shall be based on the volume of traffic expected through the ACP. As a
   minimum, the Search Office shall provide shelter for vehicle occupants during
   searches and storage of Search Area equipment. For ACPs with significant
   traffic volumes, each Search Area building will have:
   a. Heating and Air Conditioning appropriate for the geographic location.
   b. Water cooler.
   c. Unisex Latrine with sink.
   d. Internal storage for security equipment, supplies, and spare parts.
   e. External storage for traffic control devices, vehicle inspection equipment, etc.
   f. Locker storage for weapons, personal gear, and pre-positioning of protective
      equipment.
   g. Break room for 4 security personnel with refrigerator, microwave, water
      cooler, and sink.
   h. Space and power for Computer servers for future automated systems.
   i. Interior power outlets sufficient for radio chargers, computers, etc.
   j. Control console with enunciator controls for gate arms, aids to search guards
      (e.g., CCTV monitors), and communications equipment including LAN and
      Internet connections.
   k. Secure and Non-secure areas for vehicle drivers and passengers separated
      by a space suitable for a walk-through metal detector and x-ray package
      scanner if used.
   l. Space for a future Computer Kiosk for self-registration of drivers/passengers
      located in the non-secure area.
   m. One or two (depending on anticipated requirement) truck driver/passenger
      processing stations each with sufficient workspace for a computer, ID Badge
      making machine, and camera for taking ID Photos.
   n. Requirements for support of package and personnel screening devices, such
      as x-ray machines and magnetometers, if used.

18. Overwatch Position. ACPs shall have a strategically placed Overwatch Position
   located near the final active vehicle barriers but within sight of the ID Check Area.
   The Overwatch Position shall include a permanent facility or a paved pad to
   accommodate a security force vehicle or temporary facility during increased
   FPCONS. The position shall be equipped with controls for the active vehicle
   barriers.
   a. Permanent Building. If a permanent building is provided, it shall provide a
      fighting position for one guard and shall include the following:
1) Construction to provide a minimum ballistics protection of UL 752 (latest edition) Level 3 with a higher level of protection authorized if warranted by a local threat assessment.
2) Heating and/or Air Conditioning appropriate for the geographic location.
3) Interior power outlet sufficient for radio chargers, computers, etc.
4) Active vehicle barrier control console with enunciator, computer workstation, and communications equipment including Local Area Network (LAN), telephone, and Internet connections.
5) Windows to provide 360-degree field of view.

b. Paved Pad. If the Overwatch position is established as a paved pad for a temporary facility, a lockable junction box shall be imbedded in the pad with quick connections to communications, power, and barrier controls.

19. Passive Barriers. Passive vehicle barriers shall be capable of stopping a 15,000-pound vehicle traveling at the maximum speed and approach angle it can attain immediately prior to impacting the barrier. Where possible, the roadway shall be designed to limit the maximum approach angle to no more than 25 degrees. However, for other points on the perimeter, e.g., opposite to a Turn-around, the maximum approach angle could be as high as 90 degrees. Barriers at these points shall be sized accordingly.

20. Active Barriers.
   a. Number. Active barriers shall be installed in all inbound and outbound lanes at the end of the Response Zone.
   b. Vehicle Crash Resistance Capability. Active vehicle barriers shall be capable of stopping a 15,000-pound vehicle traveling at the maximum speed it can attain before impacting the barrier, but in no case shall the speed be less than 30 mph. The maximum vehicle speed must be determined by an evaluation of the threat vehicle speed and acceleration characteristics and the design of the roadway approaching the barrier. The allowable length of vehicle penetration beyond the barrier shall be determined by a local vulnerability assessment of buildings and facilities adjacent to the barrier that would be subjected to the detonation of the threat vehicle explosive charge. Active barriers shall have both an impact condition rating (weight of vehicle and impact speed) and a penetration rating (distance vehicle penetrates past the barrier). Active barriers shall have an impact condition rating for a 15,000-pound vehicle impacting the barrier at the speed determined above (but no less than 30 miles per hour) and a penetration rating equal to or greater than the allowable length of vehicle load penetration determined above. A larger vehicle weight may be used if warranted by a local threat/vulnerability assessment.
   c. Certification/Rating. Active vehicle barriers shall be:
      1) Included on the list of U.S. Department of State Certified Anti-Ram Vehicle Barriers, or
      2) Included on the list of DOD Certified Anti-Ram Vehicle Barriers maintained by the Protective Design Center.
      Both the DOS and DOD certified anti-ram vehicle barrier lists are available on the PDC website https://pdc.usace.army.mil/library/BarrierCertification.
   d. Operating Modes: Active vehicle barriers shall be capable of either or both of the following modes of operation:
      1) Normally Open Mode. In the Normally Open mode, the barrier is open to normal traffic flow. Security guards will close the barriers only when they detect a threat vehicle. The design of the ACP for this mode of operation...
shall provide a sufficient delay after the threat vehicle is detected to allow the guards to close the barrier before the threat vehicle reaches it.

2) Normally Closed Mode. In the Normally Closed mode, the barrier is closed to normal traffic flow. Security guards will open it for each authorized vehicle and then immediately close it once that vehicle has passed over the barrier. This mode of operation adds time to process vehicles and creates additional wear and tear on the barriers. However, it significantly reduces the real estate required for the ACP by eliminating the requirement to delay the threat vehicle.

e. Emergency Fast Operating Time. Active vehicle barriers deployed in the Normally Open operating mode shall have an Emergency Fast Operating (EFO) control capability. The EFO control shall be capable of closing the barrier in two (2) seconds or less when actuated.

f. Barrier Safety. Active vehicle barrier safety features shall ensure safety of innocent (non-threat) vehicles using the ACP in the event that the barrier is activated. One of the following Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA) approved safety regimes shall be implemented:

1) Option 1 – Signs and Signals Safety System. Active barriers shall be deployed in the Normally Open mode. ACP guards will activate all barriers simultaneously when a threat vehicle is detected. A traffic signal(s) shall be installed at the active vehicle barriers. During normal operation, the traffic signal shall indicate solid green or flashing yellow. When the guards initiate the barrier EFO command, the traffic signal shall change to solid yellow for a minimum of 3 seconds and then change to red. After a minimum of another 1 second, the barrier “close” circuit shall then be energized. The total delay of 4 seconds will give innocent vehicles approaching the barrier time to either clear the barrier or stop safely in front of it.

2) Option 2 – Presence Detection Safety System. Active barriers shall be deployed in the Normally Open mode. ACP guards will activate all barriers simultaneously with the EFO command when a threat vehicle is detected. A traffic signal and stop line shall be installed in front of each active barrier. Vehicle presence detectors (VPDs) shall also be installed ahead of the stop line, between the stop line and the active barrier, and behind the active barrier. The traffic signal shall normally be red, requiring all vehicles to stop at the stop line. When the VPDs ahead of the stop line sense a vehicle for more than 1 second, the traffic signal shall change to green allowing the vehicle to proceed over the barrier. If the barrier EFO command is activated while a vehicle is in the zone of one of the VPDs between the stop line and the barrier or the VPDs behind the barrier, the barrier “close” circuit for that barrier shall be suppressed until the vehicle clears the zone. The other barriers shall not be affected and shall close instantaneously, unless a vehicle is also in their presence detector’s zone. This safety system will allow the elimination of the 4-second safety time delay described in Option 1 above. This safety system also requires passive barriers between all lanes (both inbound and outbound), which shall extend from the VPD’s in front each barrier to the VPD’s behind each barrier to prevent the threat vehicle from changing lanes from a closed barrier to an open barrier.

3) Option 3 – Barrier Normally Closed Safety System. Active barriers shall be deployed in the Normally Closed mode. One set of Active Vehicle Barriers shall be installed in each inbound and outbound lane. Each set of barriers shall consist of an initial and final barrier separated by a selected
distance to form an entrapment area. Either the initial barrier or final barrier shall always be closed. Initial and final barriers are alternately opened and closed by guards to admit one or more authorized vehicles into the entrapment area and then to release them into the Installation (or vice-versa). VPDs immediately ahead of and behind each barrier shall suppress barrier closure until both VPDs are clear. Since there is always a closed barrier in the path of a threat vehicle, features to delay the threat vehicle are not required.

4) Other systems approved by SDDCTEA that provide an equivalent level of safety.

4. Other systems approved by SDDCTEA that provide an equivalent level of safety.


1) Only guards in the Gatehouse, Guard Booths, Overwatch Position, and possibly the Search Area shall have emergency fast operate (EFO) control of the active barriers. An EFO button shall be provided on a barrier Master Control Panel located in the Gatehouse. An EFO button shall also be located on a Control Panel in each Guard Booth, the Overwatch Position, and the Search Area (if required). Actuation of any EFO button shall close all active barriers in all inbound and outbound lanes.

2) The barrier Master Control Panel, each Guard Booth Control Panel, and the Search Area Control Panel (if required) shall include an enunciator providing audible and visual indication of alarms including over speed and wrong way alarms.

3) Switches and indicating lights shall be provided on the barrier Master Control Panel to allow the Gatehouse guard to enable or disable the individual EFO buttons in the Guard Booths, Overwatch Position, and Search Area (if required).

4) Indicating lights shall be provided on the Guard Booth, Overwatch Position, and Search Area (if required) control panels showing whether the EFO switch on the control panel is enabled or disabled. A separate indicating light on these control panels shall also indicate if the EFO has been actuated. Indicating lights may also be provided on these control panels that indicate the OPEN and CLOSE positions of each barrier.

5) The Master Control Panel shall include a key operated LOCAL-EFO-TEST mode selector switch, OPEN and CLOSE control switches, and OPEN and CLOSE status indication for each barrier. The mode selector switch will allow the lead ACP guard to switch to LOCAL mode (open and normal close control only at the barrier), TEST mode (open and normal close control only from the Master Control Panel), and EFO mode (emergency fast closure control from any of the EFO switches).

6) The Master Control Panel shall also include a key operated EFO RESET switch to reset EFO after it has been initiated.

7) Under normal operations, keys for each barrier’s mode selector switch and the EFO Reset switch shall be removed from the switches and controlled by the lead ACP guard.

h. Barrier Controls – Barrier Normally Closed Safety System.

1) Guards shall control barriers from either the Gatehouse or Guard Booths.

2) A Gatehouse Master Control Panel shall be located in the Gatehouse and shall include the following:

   1. Key operated LOCAL-AUTO-MANUAL mode selector switch for each barrier set (initial and final barriers).
   2. FILL and RELEASE control switches for each barrier set for operation in the AUTO mode.
3. OPEN and CLOSE switches for each individual barrier for operation in the MANUAL mode.
4. OPEN and CLOSE status indicating lights for each individual barrier.

3) A Guard Booth Control Panel shall be provided for each Guard Booth and shall include the following:
   1. FILL and RELEASE control switches for each barrier set for operation in the AUTO mode.
   2. OPEN and CLOSE status indicating lights for each individual barrier.

4) Strict key control must be maintained to prevent ACP guards from operating barriers in the LOCAL or MANUAL modes unless supervised by the head of the ACP guards.

21. Visitors Control Center (VCC). For ACPs that handle visitors, the ACP shall have a Visitors Control Center building for processing visitors wishing to enter the installation. The VCC should be sized for effective throughput of the number of expected visitors considering that a single processor can process 12-20 visitors per hour. The Visitors Control function for ACPs with minimal visitors can be performed from a Guard Booth; a separate VCC building is not required. The VCC should include the following:
   a. Waiting Area.
   b. Parking.
   c. Service Counter.
   d. Self-registering kiosks.
   e. Administration Office.
   f. Break Room.
   g. Water cooler.
   h. Restrooms.

22. Lighting. ACP lighting will meet the following criteria:
   a. Approach and Response Zones and Search Area Parking and Roadways – 3 Foot Candles (FC) average with average to minimum ratio not to exceed 4:1.
   b. Access Control Zone and Search Areas – 5 FC average with average to minimum ratio not to exceed 3:1. In the location where ID checks or searches are made, illumination shall be 10 FC or twice the illumination in the immediate surrounding area (whichever is greater). The vertical illumination shall be at least 25% of the horizontal illumination.
   c. Lighting at the ID Check and Search Areas shall have a color rendition index (CRI) of not less than 65. All other light sources shall have a CRI of not less than 50.

23. Surveillance. ACPs will have a CCTV system with the following:
   a. Overwatch Cameras. CCTV cameras shall overlook the Approach Zone, ID Check Area, Search Area, and Active Vehicle Barrier areas.
   b. ID Check Area. CCTV cameras shall be positioned to view driver, ID Check guard, and the vehicle in the ID check lane.
   c. Search Areas. CCTV cameras shall be positioned to view drivers, Search guards, and the vehicle being searched.
   d. Rear License Plates. Conduit shall be installed in the islands at the ID Check Area and Search Areas to accommodate future cameras to view rear license plates.
   e. Monitors. Monitors for CCTV shall be at the Gatehouse and the Central Security Monitoring Station.
Digital Video Recording. The CCTV system shall include digital video recording for all ACP video cameras. The video recording shall operate 24 hours per day, 7 days a week and shall retain all imagery for a minimum of 7 days.

Communications. Guards at the Gatehouse, Guard Booths, Search Areas, Overwatch Position, and Visitors Control Center shall have a minimum of 2 means of communications with each other and with the Central Security Monitoring Station.

Information Access. ACPs shall have computers capable of accessing and displaying pertinent law enforcement information and Installation access data.

Electronic Security.
   a. Duress Alarms. Guards at the ID Check Area, Search Areas, Overwatch Position, and VCC will have duress alarm capability that will annunciate at both the Gatehouse and the Central Security Monitoring Station.
   b. Intrusion Detection. The entry doors to the Gatehouse, Guard Booths, Overwatch Building, Search Office, and Visitors Control Center shall be equipped with Balanced Magnetic Switches (BMS) for intrusion detection.
   c. Tamper Switches.
      1) Electronic control cabinets for communications, security, and barrier controls shall be equipped with tamper switches.
      2) The junction box at the Overwatch Position pad (if provided) shall be equipped with a tamper switch.

Back-up Power. The ACP will have a back-up emergency generator or equivalent with the following:
   a. Automatic start-up within 10 seconds after the normal source of electrical power fails.
   b. Sufficient on-site fuel to maintain full-load operation for a minimum of 12 hours.
   c. Status monitored at Gatehouse including alarms for loss of normal power, emergency generator malfunction, and low fuel.
   d. The following loads shall be on Back-up Power:
      1) Interior lighting for the Gatehouse, Guard Booths, Overwatch position, and Inspection Offices.
      2) Canopy lighting in the ID Check Area and the Search Areas.
      3) External lighting in the Access Control Area.
      4) External lighting in the Search Areas.
      5) Approach Zone and Response Zone lighting within 100 feet of the Access Control Zone.
      6) External lighting 150 feet on both sides of the final vehicle barriers.
      7) Uninterruptible Power Supplies (UPS).

Uninterruptible Power Supply (UPS). The ACP shall have one or more Uninterruptible Power Supplies to power critical security and safety loads. The UPS(S) shall be sized to carry its required load(s) for a minimum of 10 minutes when the normal source of electrical power fails. The following loads shall be on UPS:
   a. Primary communications system
   b. Duress alarm system.
   c. Computers.
d. CCTV systems.
e. Intrusion Detection Systems (IDS).
f. Lighting:
   1) One luminaire for each ID Check Lane located near the guard position.
   2) One luminaire for each CCTV camera required at the Active Vehicle Barrier.
g. Access Control Equipment including:
   1) Active vehicle barrier controls,
   2) Active barrier activation system for one complete operation cycle (open to close and close to open).
   3) Traffic arms.
   4) Traffic sensors (wrong way, over speed, and presence detectors).
   5) Traffic signals and warning lights.

29. Traffic Control Devices.
   a. ACPs shall utilize traffic control devices including signs, markings, signals, and traffic arms to direct traffic, to provide information, and to safeguard both drivers and guards.
   b. Traffic control devices shall be in accordance with the Manual on Uniform Traffic Control Devices (MUTCD), the National Standard IAW Title 23 U.S. Code, and applicable State and Host-Nation laws.
   c. The Surface Deployment and Distribution Command, Transportation Engineering Agency (SDDCTEA) is available to assist in defining traffic control requirements when standards are not available.
   d. An Overheight Vehicle Detection and Warning System should be deployed ahead of the ID Check Area to detect and warn drivers of Overheight vehicles before proceeding to the canopy.

30. Automation: Personnel identification systems for automated access control shall be compatible with approved DOD identification credentials.

J. The following requirements apply to Limited Use ACPs:
   1. Entry Gate. The ACP entrance shall include an entry gate to close off the ACP at the Installation perimeter.
   2. The entry gate shall provide the same level of security and same aesthetics as the adjoining perimeter barrier/fence.

K. The following requirements apply to Pedestrian ACPs. These requirements apply to Pedestrian ACPs that stand-alone or Pedestrian ACP facilities that are a part of a Primary or Secondary ACP. The term pedestrian used here includes both pedestrian and bicycle traffic.

   1. Performance Standard. Pedestrian ACPs shall be designed to prevent unauthorized entry, to ensure safety, and to maximize throughput of pedestrians.
   2. Design Criteria. Pedestrian Threat Scenarios. ACPs shall be designed to defeat the following two minimum pedestrian threat scenarios. Additional threat scenarios may be considered if supported by a local threat assessment:
      a. Pedestrian Threat Scenario #1. Pedestrian attempts to forcibly enter the Installation by breaching or circumventing ACP barriers using limited hand tools.
      b. Pedestrian Threat Scenario #2. Pedestrian attempts to covertly enter the Installation by using false credentials.
3. Entry Gate. Pedestrian ACPs will have an Entry Gate at the ACP entrance capable of closing off the ACP. The Entry Gate shall provide equivalent security and equivalent aesthetics as the adjoining perimeter fence/barrier.

4. Guard Booths. Pedestrian ACPs will have one or more Guard Booth buildings for use by guards performing pedestrian ID checks. Guard Booths will have the following:
   a. Construction that provides a minimum ballistics protection of UL 752 (latest edition) Level 3 with a higher level of protection authorized if warranted by a local threat assessment.
   b. Heating and/or Air Conditioning appropriate for the geographic location.
   c. Exterior power outlet sufficient to power hand-held searchlights, bug zappers, etc.
   d. Interior power outlets sufficient for radio chargers, computers, etc.,
   e. Anti-fatigue floor mat.
   f. Sufficient counter space for report writing and storage of reference material.
   g. Windows to provide a 360-degree field of view.

5. Perimeter Barriers. Pedestrian ACPs shall have passive barriers along each side of the ACP corridor capable of preventing easy penetration by a pedestrian. These barriers must tie into the Entry Gate at the ACP entrance as well as the Active Pedestrian Barrier(s) to form a contiguous personnel barrier from the ACP entrance through the Active Pedestrian Barrier(s).

6. Active Pedestrian Barriers. Pedestrian ACPs shall include active pedestrian barriers (e.g., turnstiles, portals, etc.) controlled by the ACP guards to regulate pedestrian traffic.

7. Communications.
   a. ACP guards shall have a minimum of two means to communicate with each other and with guards at the Gatehouse (if the pedestrian access is part of a Primary or Secondary ACP) or guards at the Central Security Monitoring Station (if the Pedestrian ACP is Stand-alone).
   b. ACP guards will have wireless duress alarms that annunciate at the Gatehouse (if the pedestrian access is part of a Primary or Secondary ACP) or the Central Security Monitoring Station if the Pedestrian ACP is stand-alone.

8. Lighting. Lighting in the Pedestrian ACP shall maintain a minimum of 2-foot candles illumination.

9. Surveillance Equipment. Pedestrian ACPs shall be equipped with a Closed Circuit Television (CCTV) system with the following requirements:
   a. Overwatch Cameras. CCTV cameras shall over watch the approach to the Guard Booth from the Entry Gate to the area around the active pedestrian barrier including the Guard Booth.
   b. Monitors. Monitors for CCTV shall be at the Pedestrian Guard Booth. Monitors shall also be at the Gatehouse if the Pedestrian ACP is part of a Primary or Secondary ACP or at the Central Security Monitoring Station if the Pedestrian ACP is stand-alone.
   c. Digital Video Recording. The CCTV system shall include digital video recording for all ACP cameras. The video recording shall operate 24 hours per day, 7 days a week and shall retain all imagery for a minimum of 7 days.
10. Information Access. Pedestrian ACPs shall have a computer capable of accessing and displaying pertinent law enforcement information and Installation access data.

11. Signs. Pedestrian ACPs shall include signs to direct pedestrians, provide security information, and provide adequate safeguards to both guards and pedestrians.
APPENDIX C

DRAWINGS
REFERENCE CRITERIA

1. UNITED FACILITIES CRITERIA (UFC) 3-200-02, SITE PLANNING AND DESIGN, 15 JANUARY 2004
2. UNITED FACILITIES CRITERIA (UFC) 3-200-02, FIBER OPTIC SYSTEMS FOR MILITARY FACILITIES, 15 JANUARY 2004
3. UNITED FACILITIES CRITERIA (UFC) 3-200-02, GENERAL DESIGN AND CONSTRUCTION DESIGN FOR MILITARY FACILITIES, 15 JANUARY 2004
4. UNITED FACILITIES CRITERIA (UFC) 3-200-02, GENERAL DESIGN AND CONSTRUCTION DESIGN FOR MILITARY FACILITIES, 15 JANUARY 2004
5. UNITED FACILITIES CRITERIA (UFC) 3-200-02, GENERAL DESIGN AND CONSTRUCTION DESIGN FOR MILITARY FACILITIES, 15 JANUARY 2004

ARCHITECTURAL

1. CSA, CANADIAN STANDARD, Z245.5-89,徑, UNIFORM ACCESSIBILITY STANDARDS
2. CSA, CANADIAN STANDARD, Z245.5-89,徑, UNIFORM ACCESSIBILITY STANDARDS
3. CSA, CANADIAN STANDARD, Z245.5-89,徑, UNIFORM ACCESSIBILITY STANDARDS
4. CSA, CANADIAN STANDARD, Z245.5-89,徑, UNIFORM ACCESSIBILITY STANDARDS
5. CSA, CANADIAN STANDARD, Z245.5-89,徑, UNIFORM ACCESSIBILITY STANDARDS

STRUCTURAL

1. FOR A STRUCTURAL REFERENCE, SEE UFC 1-200-01 "DESIGN: ARCHITECTURAL DESIGN CRITERIA FOR BUILDINGS, 01 SEPTEMBER 1999
2. FOR A STRUCTURAL REFERENCE, SEE UFC 1-200-01 "DESIGN: ARCHITECTURAL DESIGN CRITERIA FOR BUILDINGS, 01 SEPTEMBER 1999
3. FOR A STRUCTURAL REFERENCE, SEE UFC 1-200-01 "DESIGN: ARCHITECTURAL DESIGN CRITERIA FOR BUILDINGS, 01 SEPTEMBER 1999
4. FOR A STRUCTURAL REFERENCE, SEE UFC 1-200-01 "DESIGN: ARCHITECTURAL DESIGN CRITERIA FOR BUILDINGS, 01 SEPTEMBER 1999
5. FOR A STRUCTURAL REFERENCE, SEE UFC 1-200-01 "DESIGN: ARCHITECTURAL DESIGN CRITERIA FOR BUILDINGS, 01 SEPTEMBER 1999

CIVIL ENGINEERING

1. UNITED FACILITIES CRITERIA (UFC) 3-200-02, SITE PLANNING AND DESIGN, 15 JANUARY 2004
2. UNITED FACILITIES CRITERIA (UFC) 3-200-02, SITE PLANNING AND DESIGN, 15 JANUARY 2004
3. UNITED FACILITIES CRITERIA (UFC) 3-200-02, SITE PLANNING AND DESIGN, 15 JANUARY 2004
4. UNITED FACILITIES CRITERIA (UFC) 3-200-02, SITE PLANNING AND DESIGN, 15 JANUARY 2004
5. UNITED FACILITIES CRITERIA (UFC) 3-200-02, SITE PLANNING AND DESIGN, 15 JANUARY 2004

ELECTRICAL DESIGN REQUIREMENTS

1. ELECTRICAL ENGINEERING SOCIETY, NORTH AMERICAN electrical wiring standards for security systems standards for security systems standards for security systems
2. ELECTRICAL ENGINEERING SOCIETY, NORTH AMERICAN electrical wiring standards for security systems standards for security systems standards for security systems
3. ELECTRICAL ENGINEERING SOCIETY, NORTH AMERICAN electrical wiring standards for security systems standards for security systems standards for security systems
4. ELECTRICAL ENGINEERING SOCIETY, NORTH AMERICAN electrical wiring standards for security systems standards for security systems standards for security systems
5. ELECTRICAL ENGINEERING SOCIETY, NORTH AMERICAN electrical wiring standards for security systems standards for security systems standards for security systems

MECHANICAL DESIGN REQUIREMENTS

1. APPLIANCE INSTALLATION CODE, INSTALLATION CODE, INSTALLATION CODE
2. APPLIANCE INSTALLATION CODE, INSTALLATION CODE, INSTALLATION CODE
3. APPLIANCE INSTALLATION CODE, INSTALLATION CODE, INSTALLATION CODE
4. APPLIANCE INSTALLATION CODE, INSTALLATION CODE, INSTALLATION CODE
5. APPLIANCE INSTALLATION CODE, INSTALLATION CODE, INSTALLATION CODE

PLUMBING DESIGN REQUIREMENTS

1. NATIONAL PLUMBING CODE, INSTALLATION CODE, INSTALLATION CODE
2. NATIONAL PLUMBING CODE, INSTALLATION CODE, INSTALLATION CODE
3. NATIONAL PLUMBING CODE, INSTALLATION CODE, INSTALLATION CODE
4. NATIONAL PLUMBING CODE, INSTALLATION CODE, INSTALLATION CODE
5. NATIONAL PLUMBING CODE, INSTALLATION CODE, INSTALLATION CODE

REFERENCES

1. UNIFIED FACILITIES CRITERIA (UFC) 3-250-01FA, PAVEMENT DESIGN FOR ROADS, STREETS, WALKS, AND OPEN STORAGE AREAS, 16 JANUARY 2004
2. UNIFIED FACILITIES CRITERIA (UFC) 3-250-18FA, GENERAL PROVISIONS AND GEOMETRIC DESIGN FOR ROADS, STREETS, WALKS, AND OPEN STORAGE AREAS, 16 JANUARY 2004
3. UNIFIED FACILITIES CRITERIA (UFC) 3-210-06A, SITE PLANNING AND DESIGN, 16 JANUARY 2004
4. UNIFIED FACILITIES CRITERIA (UFC) 3-200-02, SITE PLANNING AND DESIGN, 15 JANUARY 2004
5. UNIFIED FACILITIES CRITERIA (UFC) 3-200-02, SITE PLANNING AND DESIGN, 15 JANUARY 2004
NOTES:

2. SITE ALL PERMANENT FACILITIES SUCH THAT THEY ARE NOT IN THE DIRECTION OF TRAVEL. PROVIDE NO CANOPY OVER THE INSPECTION AREA PLANNED OR DEDICATED FOR USE TO INCREASE THROUGHPUT A LONGER INSPECTION LANE CAN BE PROVIDED FOR B. CAPACITY FOR POSSIBLE ADDITION OF A FIXED VEHICLE INSPECTION SYSTEM. CAN EMPLOY. REFER TO ACTUAL EQUIPMENT TO BE USED FOR SPECIFIC EXCLUSION ZONES SHOULD ALSO CONSIDER OBLIQUE SCAN ANGLES, WHICH SOME INSPECTION SYSTEMS

3. A 305mm (12") WIDE X 2.4m (8') HIGH (MIN) CONCRETE SHIELDING WALL IS PROVIDED BETWEEN THE FACILITY IS AT LEAST 90.0m (300'). THE INTENT IS TO ENSURE THAT THE 100mR/YEAR RADIATION DOSE LIMIT IS NOT EXCEEDED FOR PERSONNEL WHO MAY BE IN THE DIRECTION OF THE RADIATION BEAM UNLESS THE DISTANCE BETWEEN THE INSPECTION VEHICLE AND VEHICLES. THIS WILL ALLOW THE SYSTEM TO SCAN SEVERAL VEHICLES AT ONE TIME.

4. THE LENGTH IS SUFFICIENT TO ALLOW THE INSPECTION SYSTEM TO SCAN A LARGE STATIONARY VEHICLE AND MANEUVER.

5. SEE SHEET C9.01 FOR LANE DETAILS AND TYPICAL LAYOUT. SEE SHEET C9.14 FOR PAVEMENT DETAILS OF THE PASSIVE AND ACTIVE VEHICLE BARRIER INTERFACES. SEE DWG. C9.10 AND FENCE CAN BE MAINTAINED AND THE PASSIVE BARRIER CANNOT BE USED TO AID FROM THE PASSIVE BARRIER SUCH THAT THE AREA BETWEEN THE PASSIVE BARRIER BARRIERS, e.g., CABLE BARRIER SYSTEMS (SEE DRAWING C9.08). IF FENCE IS NOT INHABITED BUILDING WITHIN AN UNCONTROLLED PERIMETER. PER DOD MINIMUM 4. IF 11 OR MORE PEOPLE INHABIT THE VCC ON A ROUTINE BASIS, THAN THE VCC IS AN ANTI-TERRORISM STANDARDS FOR BUILDINGS (UFC 4-010-01), REQUIRED STANDOFF DISTANCE WITH VCC AND COMMERCIAL VEHICLE CHASE PASSenger OFFICE AREA TRUCK SEARCH

TEXAS NATIONAL GUARD

EQUIPMENT USED)

REFERENCES

SOLICITATION NO.: W912HN-07-D-6204

APPENDIX D FOR METHOD TO DETERMINE DETECTION AND DELAY REQUIREMENTS NOT TO SCALE

PLOT SCALE:

NOTES:

GATE CONTROLLED BY R=42.0m (140')

NOTE 1

NOTE 2A

NOTE 2B

NOTE 2C

NOTE 3

NOTE 4

REFERENCE SHEET OF 60 SHEET 4
NOTES:

1. SEE APPENDIX D FOR METHODS TO DETERMINE DETECTION AND DELAY REQUIREMENTS INCLUDING THE LENGTH OF THE RESPONSE ZONE. SEE DETAILS FOR PASSIVE AND ACTIVE VEHICLE BARRIERS INTERFACES. SEE DRAWING FOR DETAIL, SIZE AND LOCATION REQUIRED FOR THE ACTIVE VEHICLE BARRIERS. SEE DRAWING FOR DETAIL AND TYPICAL LAYOUT. SEE DRAWING FOR DETAIL OF THE PASSIVE AND ACTIVE VEHICLE BARRIER INTERFACES. SEE DRAWING FOR DETAIL AND TYPICAL LAYOUT. SEE DRAWING FOR DETAIL OF THE PASSIVE AND ACTIVE VEHICLE BARRIER INTERFACES.

2. SLIDING GATE TO CLOSE SEARCH AREA DURING NON-MANNED HOURS.

3. IF 11 OR MORE PEOPLE INHABIT THE VCC ON A ROUTINE BASIS, THEN THE VCC IS AN INHABITED BUILDING WITHIN AN UNCONTROLLED PERIMETER. SEE DETAIL AND TYPICAL LAYOUT. SEE DRAWING (NOT FOR COMMERCIAL VEHICLES).

REFERENCE:

ACCP CONSTRUCTION DETAIL

NOTE 1

OPERATION POSITIONS OR EXTВ applications for Temporary Facility

NOTE 2

XXXXX

NOTE 3

XXXXX

NOTE 4

XXXXX

NOTE 5

XXXXX

NOTE 6

XXXXX

NOTE 7

XXXXX

NOTE 8

XXXXX
NOTES:

1. SUPPLEMENTAL BARRIERS REQUIRED TO STOP VEHICLES APPROACHING AT GREATER THAN 25 DEGREES.

Provide a paved area for storage of Portable Vehicle Barriers and/or Security Forces Vehicles.

BEGIN TRANSITION TO EXISTING ROADWAY CROSS SECTION

SUPPLEMENTAL PASSIVE BARRIER (SEE NOTE 1)

APPROPRIATE LOCATION FOR PORTABLE VEHICLE BARRIERS

BEGIN TRANSITION TO EXISTING ROADWAY CROSS SECTION

LIMITED USE ACP

NOT TO SCALE

LEGEND

= TRAFFIC FLOW PATTERN
Y/YD = 14" PAVEMENT STYLE/ WIDTH
BY = DOUBLE YELLOW LINE
YM = SOLID WHITE LINE
YM = P Y M A R K
AY = ACTIVE VEHICLE BARRIER
PB = PASSIVE VEHICLE BARRIER
ander = ORNAMENTAL FENCE
B = BOLLARDS
C = CANOPY
B = BARRIER WALL
D = DOUBLE FACE GUARD RAIL
S = SINGLE FACE GUARD RAIL
G = GUARD BOOTH
E = GENERATOR PAD MISEA R K
R = CURB RAMP
NOTES:


2. Provide a 4.8m (16') wide x 6.0m (20') high (min) concrete shielding wall between the site and the facility to be secured. The determination of exclusion distance can be reduced to 23.0m (75.5') if a site-wide security force is provided.

3. Provide a 10.7m (35') wide x 33.5m (110') long paved inspection area for use by the cargo and vehicle inspection system.

4. Gatehouse doubles as overwatch.

5. Number of spaces determined by personnel requirements.

COMMERCIAL VEHICLE ACP
BARRELS NORMALLY CLOSED DEPLOYED OPERATION

[Diagram of a site plan showing various elements such as barriers, fencing, and access control points.]
Pavement Marking Details.

Interfaces. See DWG.C9.13 for Sign Details and Typical Layout. See DWG C9.14 for
SEE DWGS. C9.02 AND C9.03 FOR DETAILS OF THE PASSIVE AND ACTIVE VEHICLE BARRIER
SEEN ONLY FROM APPROPRIATE LANE.

Tilt Traffic Signals Inward Such That They Can Be
Mounted Traffic Signals on Both Sides of Barriers.

Restricted Real Estate ACP

With Barrier Normally Closed (Deployed) Operation

Low Volume Applications Only (Not Suitable for > 400 Vehicles Per Hour)

1. See drains, curb and grass for details of the passive and active vehicle barrier.
2. Barriers are normally closed. See figure for typical layout. See Figure 1 for
   pavement marking details.
3. Inactive traffic signals are shown that they can be
   seen only from appropriate lane.

Legend:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Notes</th>
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<tr>
<td></td>
<td>Paint Flow Pattern</td>
<td>Low Volume Applications Only 400 Vehicles Per Hour</td>
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<tr>
<td></td>
<td>Part Line Style/Width</td>
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<tr>
<td></td>
<td>Double Yellow Line</td>
<td></td>
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<tr>
<td></td>
<td>Solid White Line</td>
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<td></td>
<td>Traffic Arm</td>
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<td></td>
<td>Active Vehicle Barrier</td>
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<td>Passive Vehicle Barrier</td>
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<td>Double Face Guard Rail</td>
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<td></td>
<td>Single Face Guard Rail</td>
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<td></td>
<td>Guard Riser</td>
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<td></td>
<td>Exterior Pad/Windscreen</td>
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<tr>
<td></td>
<td>Curb Ramp</td>
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<tr>
<td></td>
<td>Traffic Signal Detail</td>
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</table>
ALTERNATE ID CHECK AREA CONFIGURATION

NOTES:
1. CURVED ID CHECK POINT ISLANDS SHOWN PROVIDE A LIMITING SPEED OF 113 KPH (70MPH) FOR PASSENGER VEHICLES. CURVED ID CHECK POINT ISLANDS ARE NOT SUITABLE FOR TRACTOR/TRAILERS.

REFERENCES:
- FACILITIES STANDARDS PROGRAM
- ACCESS CONTROL POINTS FOR U.S. ARMY INSTALLATIONS

SHEET OF 60

U.S. ARMY CORPS
OF ENGINEERS
OMAHA DISTRICT

SHEET NUMBER:

CATEGORICAL CODE:

LEGEND:
- Y/100mm (4") PAINT STRIPE STYLE/WIDTH
- TRAFFIC FLOW PATTERN
- ACTIVE VEHICLE BARRIER
- PASSIVE VEHICLE BARRIER
- BOLLARDS
- CANOPY
- BARRIER WALL
- DOUBLE FACE GUARD RAIL
- SINGLE FACE GUARD RAIL
- GUARD BOOTH
- GENERATOR PAD W/SIDEWALK
- CURB RAMP
- DOUBLE YELLOW LINE
- ORNAMENTAL FENCE
- SOLID WHITE LINE
- FENCE
- CONCEPT
- GUARDED WALL
- CURB RAMP
- CURB GAP
NOTES:
1. BARRIERS IN TRUCK ONLY LANES ARE OPERATED IN THE NORMALLY CLOSED (DEPLOYED) SAFETY SYSTEM.
2. BARRIERS IN PASSENGER VEHICLE ONLY LANES ARE NORMALLY OPEN WITH SIGNS AND SIGNALS SAFETY SYSTEM.

SCALE: 1:5

LEGEND:
- TRAFFIC FLOW PATTERN
- Y/100mm (1/4") PAVEMENT STRIPE STYLE/WIDTH
- TRAFFIC ARM
- DOUBLE YELLOW LINE
- TRAFFIC LANE
- PASSIVE VEHICLE BARRIER
- ACTIVE VEHICLE BARRIER
- ORNAMENTAL FENCE
- CANOPY
- BARRIER WALL
- DOUBLE FACE GUARD RAIL
- SINGLE FACE GUARD RAIL
- GUARD BOOTH
- GENERATOR PAD/RESERVOIR
- CURB RAMPS
- TRAFFIC SIGNAL DETAIL

SHEET: 60

REFERENCE SHEET

SITE PLAN
RESTRICTED REAL ESTATE ACP
WITH PASSENGER AND COMMERCIAL VEHICLE ACCESS

ACP CORRIDOR FENCE
MINIMUM FE6-84
SEE NOTE 5 ON DWG C3.01.

NCHRP/AASHTO
COMPLIANT END TREATMENT
(RECOMMENDED)
ENTRY GATE

NOTES:


2. RESPONSE ZONE LENGTH IS REDUCED IN THIS EXAMPLE BY APPLYING 2 HALF CIRCLES. HALF CIRCLES ARE SIMILAR TO TRAFFIC TURNAROUNDS OR ROUND-ABOUTS THAT ARE USED IN URBAN RESIDENTIAL AREAS.

LIMITED REAL ESTATE ACP WITH HALF CIRCLES
NOT FOR COMMERCIAL VEHICLES

NOT TO SCALE
1. The conventional ACP has straight roadways through the ACP corridor. The protective system for a conventional ACP consists of overspeed and wrong-way detectors to detect the threat vehicle as early as possible in its attack. The length of the roadway segment in the ACP corridor to delay the threat vehicle is calculated in Section D for overspeed and wrong-way sensor locations, ranges, and settings. The required length of the roadway segment is determined in Section D for overspeed and wrong-way safety systems and the presence detection safety system.

2. See Section 4.1 of the standard design/criteria for definitions of point and continuous overspeed detection and wrong-way detection.

3. See DWG C9.02 and C9.03 for details of the passive and active barriers interfaces, see DWG C3.17 for signs and signals required for the signs and signals safety system and DWG. C9.13 for signs and signals required for the presence detection safety system. See DWG C9.14 for pavement marking details.

Notes:
- **NOTE 1**: See DWG C9.02 and C9.03 for details of the passive and active barriers interfaces.
- **NOTE 2**: The zone of continuous overspeed detection is shown. See DWG C9.13 for sign details and typical layout.
- **NOTE 3**: See DWG C9.14 for pavement marking details.
CHICANE: 95KPH (59 MPH) MAXIMUM SPEED

<table>
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<tr>
<th>DESIGN PARAMETERS</th>
<th>MAX THREAT SPEED</th>
<th>PROS</th>
<th>CONS</th>
<th>APPLICABILITY/CONSIDERATIONS</th>
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<tbody>
<tr>
<td>NOTE 1</td>
<td></td>
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</tbody>
</table>

**MAX THREAT SPEED**

40 KPH (25 MPH) DESIGN SPEED

**ANGLE OF DEFLECTION**

50°

**AS RADIUS (NOTE 1)**

R = 61.5 m (205')

**NOTE 1**

ADDITIONAL REQUIRED SIGNING NOT SHOWN

**NOTE 2**


2. CONTACT THE PROTECTIVE DESIGN CENTER (PDC) FOR CHICANES WITH SMALLER RADII TURNS.

**NOTE 1**

ACTIVE VEHICLE BARRIERS

**NOTE 2**

PASSIVE VEHICLE BARRIER

**NOTE 3**

ORNAMENTAL FENCE

**NOTE 4**

BARRED WALL

**NOTE 5**

DOUBLE FACE GUARD RAIL

**NOTE 6**

SINGLE FACE GUARD RAIL

**NOTE 7**

GUARD BOOTH

**NOTE 8**

GENERATOR PAD/WEIGHPILOT

**NOTE 9**

CURB RAMP

**NOTE 10**

NOT TO SCALE
C3.14

LEGEND

PAINT STRIPE STYLE/WIDTH
Y/100mm (4"

TRAFFIC FLOW PATTERN

TRAFFIC ARM
ACTIVE VEHICLE BARRIER
PASSIVE VEHICLE BARRIER
BOLLARDS
CANOPY
BARRIER WALL
DOUBLE FACE GUARD RAIL
SINGLE FACE GUARD RAIL
GUARD BOOTH
GENERATOR PAD/WINDHWALK
CURB RAMP

NOTE 1

DOUBLE YELLOW LINE
DY
ORNAMENTAL FENCE
SW
SOLID WHITE LINE
FENCE

PROTECTIVE SYSTEMS

TURN - 58 KPH (36 MPH) MAXIMUM SPEED

NORMAL CONDITIONS DESIGN SPEED:
24 KPH (15 MPH) DESIGN SPEED

MAX THREAT SPEED

APPROACH AND RESPONSE DISTANCE

CONS

PHYSICALLY LIMITS NORMAL AND THREAT SPEEDS
REQUIRES ADDITIONAL R/W AND ROADWAY CONSTRUCTION
MAY CAUSE SOME MINOR REDUCTION IN CAPACITY
CONSISTS OF 4 TURNS AS DEFINED BY MUTCD

PROS

CAN HELP ACHIEVE NEEDED APPROACH AND RESPONSE DISTANCE

APPLICABILITY/CONSIDERATIONS

MAY CAUSE SOME MINOR REDUCTION IN CAPACITY
CONSISTS OF 4 TURNS AS DEFINED BY MUTCD

VALUE TO SEE PARAGRAPH F AND TABLE 4 OF APPENDIX D FOR METHODOLOGY

MINOR CRASHES MAY INCREASE W/O LANE SEPARATION
ID CHECK TO BARRIER

NOTE 1


LOOP - 58 KPH (36 MPH) MAXIMUM SPEED

NOTES:

MAX SPEED

YIELD

SEE APPENDIX D FOR METHOD TO DETERMINE DETECTION AND DELAY REQUIREMENTS

Percent vehicle visible in zone of attack
20%

R = 19.5m (65') (TYP)

Response zone

ACCESS CONTROL ZONE
NO REQUIREMENTS FOR DELAY

Approach zone

NO REQUIREMENTS FOR DELAY

Response zone

DELAYED directs vehicle to barrier

ACTIVE VEHICLE BARRIER

PASSIVE VEHICLE BARRIER

ORNAMENTAL FENCE

BOLLARDS

CANOPY

BARRIER WALL

DOUBLE FACE GUARD RAIL

SINGLE FACE GUARD RAIL

GUARD BOOTH

GENERATOR PAD/WINDHWALK

CURB RAMP

NOT TO SCALE

24 KPH (15 MPH) DESIGN SPEED

NOT FOR COMMERCIAL USE

ADDITIONAL REQUIRED SIGNING NOT SHOWN

NOTES:

1. See Appendix D for method to determine detection and delay requirements.

NORMAL CONDITIONS DESIGN SPEED = 24 KPH (15 MPH)

ANGLE OF DEFLECTION = 80°

SOLID WHITE LINE

R = 19.5m (65') (TYP)

NORMAL CONDITIONS DESIGN SPEED = 24 KPH (15 MPH)

SEE PARAGRAPH F AND TABLE 4 OF APPENDIX D FOR METHODOLOGY

MINOR CRASHES MAY INCREASE W/O LANE SEPARATION
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MINOR CRASHES MAY INCREASE W/O LANE SEPARATION
ID CHECK TO BARRIER

NOTE 1


LOOP - 58 KPH (36 MPH) MAXIMUM SPEED

NOTE TO SCALE

24 KPH (15 MPH) DESIGN SPEED

NOT FOR COMMERCIAL USE

ADDITIONAL REQUIRED SIGNING NOT SHOWN

NOTES:

1. See Appendix D for method to determine detection and delay requirements.
VEHICLE PLATOONING

NOT TO SCALE

** typical operations **

1. **Processing**
   - Car is stopped at the initial barrier, and identification is checked.
   - Barrier is retracted after identification is verified.
   - Traffic is resumed.

2. **Change**
   - Vehicle moves through a change point and repositions itself.
   - Barrier is retracted after change is complete.
   - Traffic is resumed.

3. **Platoon Clear**
   - Vehicle moves through a clear point and repositions itself.
   - Barrier is retracted after clear is complete.
   - Traffic is resumed.

4. **Hotel/Safety**
   - Vehicle moves through a safety area and repositions itself.
   - Barrier is retracted after safety is complete.
   - Traffic is resumed.

**Legend**

- **PAINT STRIPE STYLE/WIDTH**
  - Y/100mm (4")

- **TRAFFIC FLOW PATTERN**
  - **DY**: Double Yellow Line
  - **SW**: Solid White Line

- **TRAFFIC ARM**
- **ACTIVE VEHICLE BARRIER**
- **PASSIVE VEHICLE BARRIER**
- **BOLLARDS**
- **CANOPY**
- **BARRIER WALL**
- **DOUBLE FACE GUARD RAIL**
- **SINGLE FACE GUARD RAIL**
- **GUARD BOOTH**
- **GENERATOR PAD W/SIDEWALK**
- **CURB RAMP**
- **ORNAMENTAL FENCE**
- **DOUBLE YELLOW LINE**

**Vehicle Platooning**

- **Response Zone Length**
  - Varies with the number and type of vehicles to be queued and available real estate.
  - Adjust signs and sign spacing as necessary, but in accordance with the MUTCD.

**Design Parameters**

- **Normal Conditions Design Speed**: N/A
- **Annual Superimposed Design Lane**: N/A
- **Design Volume**: N/A

**Pros**

- **Decreases Traffic Processing by 38% for Single Processing and 46% for Tandem Processing**

**Cons**

- **Higher Cost Due to More Bollards and Increased Usage**

**Application/Considerations**

- **Vehicle Platoon Application**: N/A
- **Anticipated Volume**: N/A

**Table**

<table>
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<tr>
<th>Design Parameters</th>
<th>Response Zone Length</th>
<th>Pros</th>
<th>Cons</th>
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<td><strong>Vehicle Platoon Application</strong>: N/A</td>
</tr>
</tbody>
</table>
WHEN GATE ARM IS ACTIVATED, AN 80db AUDIBLE ALARM SHALL SOUND FOR 10 SECONDS.

THE GATE ARM IS IN THE DOWN (CLOSED) POSITION.

“BARRIER ACTIVATED” MAY BE PROVIDED. THE MESSAGE WOULD APPEAR WHENEVER ALTERNATIVE TO THE SIGN SHOWN HERE A BLANK OUT SIGN WITH THE MESSAGE PIGMENTED CONCRETE PAVEMENT.

PAVEMENT DEFINED BY THE “DO NOT STOP IN RED ZONE” SIGN SHALL CONSIST OF RED APPENDIX G FOR REQUIRED CONTROL SEQUENCES.

DETECTORS (LOOP 4) AS SHOWN ON THE DRAWINGS.  SEE DRAWING E1.06 AND WHEN QUEUE PREEMPTION IS REQUIRED, PROVIDE ADVANCED VEHICLE PRESENCE DETECTORS (LOOP 4) AS SHOWN ON THE DRAWINGS.  SEE DRAWING E1.06 AND APPENDIX G.

WITH UFGS 34 41 26.00 10 “ACCESS CONTROL POINT CONTROL SYSTEM”; BARRIERS SHALL BE CONTROLLED BY A TRAFFIC CONTROLLER UNIT IN ACCORDANCE AND ALL SIGNS.  DIMENSIONS AND MOUNTING HEIGHTS SHOWN ON THE DRAWINGS ARE ISLAND, OTHER TRAFFIC CONTROL DEVICES, LANDSCAPING, ROADSIDE FEATURES, ETC.

SIGN PLACEMENT MUST BE BASED ON MUTCD, LOCAL CONDITIONS, GEOMETRY, TRAFFIC FROM CHANGING FROM A LANE WITH A CLOSED BARRIER TO ONE WITH AN OPEN BARRIER. ADJACENT LANES AT THE BARRIER ARE REQUIRED TO PREVENT THE THREAT VEHICLE FOR PLACEMENT OF SIGNS, SIGNALS AND BEAM SENSORS.  PASSIVE BARRIERS BETWEEN ISLANDS BETWEEN INBOUND AND OUTBOUND LAMES AT THE BARRIER ARE REQUIRED FOR SIGN DETAILS AND TYPICAL LAYOUT.  SEE DWG. C9.14 FOR PAVEMENT MARKING DETAILS.

DETAILS OF THE PASSIVE AND ACTIVE VEHICLE BARRIER INTERFACES.  SEE DWG C9.13 INCLUDING THE LENGTH OF THE RESPONSE ZONE (LENGTH SHOWN IS FOR ONE ZONE OF.

SEE APPENDIX D FOR METHOD TO DETERMINE DETECTION AND DELAY REQUIREMENTS.
PRESENCE DETECTION LAYOUT DETAILS

NOT TO SCALE

NOTES:


2. LOOP DETECTORS SHALL NOT BE INSTALLED ACROSS THE TRANSITION IN PAVING MATERIALS WITHOUT APPROPRIATE PROTECTION.

MAXIMUM OF 3' (0.91M) BETWEEN BOLLARDS

SEE DETAIL C
SHEET C3.17

SEE DETAIL B
SHEET C3.17

PASSIVE BARRIER

MAXIMUM OF 6' (1.83M)

ACTIVE BARRIER

NCHRP/AASHTO COMPLIANT END TREATMENT
(RECOMMENDED)
NOTES:
2. LOOP DETECTORS SHALL NOT BE INSTALLED ACROSS THE TRANSITION IN PAVING MATERIALS WITHOUT APPROPRIATE PROTECTION (AS DETERMINED BY PROJECT ENGINEER).
3. SEE SHEET C3.17 FOR DETAILS OF OUTBOUND QUEUE DETECTION IF REQUIRED.
ACCESS CONTROL ZONE -
MEDIAN GATEHOUSE LANE DETAILS

NOTES:
1. LANE WIDTHS OF 3.6m (12') ARE REQUIRED TO ACCOMMODATE 90% OF TRAFFIC.
2. PROVIDE A MINIMUM OF 4.2m (14') FOR GATEHOUSE ACCESS.

ACCESS CONTROL ZONE -
RIGHT SHOULDER GATEHOUSE LANE DETAILS

OUTBOUND TRAFFIC
INBOUND TRAFFIC
GUARDRAIL (TYP)
ID CHECK AREA
CHASE VEHICLE
CANOPY ROOF LINE
ADVANCE SECONDARY ISLANDS FOR FUTURE TECHNOLOGY (OPTIONAL)

NOTES:
1. LANE WIDTHS OF 3.6m (12') ARE REQUIRED TO ACCOMMODATE 90% OF TRAFFIC.
2. PROVIDE A MINIMUM OF 4.2m (14') FOR GATEHOUSE ACCESS.

ADVANCE SECONDARY ISLANDS FOR FUTURE TECHNOLOGY (OPTIONAL)
GUARDRAIL (TYP)
ID CHECK AREA
CHASE VEHICLE
CANOPY ROOF LINE

NOTES:
1. LANE WIDTHS OF 3.6m (12') ARE REQUIRED TO ACCOMMODATE 90% OF TRAFFIC.
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GUARDRAIL (TYP)
ID CHECK AREA
CHASE VEHICLE
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GUARDRAIL (TYP)
ID CHECK AREA
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GUARDRAIL (TYP)
ID CHECK AREA
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NOTES:
1. LANE WIDTHS OF 3.6m (12') ARE REQUIRED TO ACCOMMODATE 90% OF TRAFFIC.
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ADVANCE SECONDARY ISLANDS FOR FUTURE TECHNOL
NOT TO SCALE

**ACTIVE VEHICLE BARRIER TYPICAL SECTION**

- **NOT TO SCALE**

**PASSIVE BARRIER (SEE NOTE 3)**

- **0.45m (1'-6") MIN**
- **0.9m (3'-0") MAX**

**ACTIVE VEHICLE BARRIER**

- **0.9m (3'-0") MAX**

- **DISTANCE BETWEEN ACTIVE BARRIER AND PASSIVE BARRIER CANNOT EXCEED 0.9m (3'-0")**

**NOTES:**

1. PROVIDE 1.5m (5') BIKEWAY IF APPROPRIATE.
2. NUMBER OF PASSIVE BARRIERS IS DETERMINED BY WIDTH OF MEDIAN AND DISTANCE BETWEEN THE BARRIERS NOT EXCEEDING 0.9m (3'-0").
3. TYPE AND SIZE OF PASSIVE BARRIERS TO BE DETERMINED IN FINAL DESIGN. PASSIVE BARRIERS MUST PROVIDE VEHICLE PENETRATION RESISTANCE. PASSIVE BARRIERS IN THE CLEAR ZONE MUST BE OF THE TYPE THAT REDIRECT VEHICLES BACK ON THE ROADWAY FOR A SIDE SWIPE IMPACT. SEE ASSHTO ROADSIDE DESIGN GUIDE.
TRANSPORTABLE ACTIVE VEHICLE BARRIER

NOT TO SCALE

BARRIER RATING: K4, K8, K12
OPERATION: TRANSPORTABLE VEHICLE BARRIER, MANUAL OR HYDRAULIC OPERATION

SHALLOW FOUNDATION AND SURFACE MOUNT BARRIERS

NOT TO SCALE

BARRIER RATING: K4, K8, K12
OPERATION: Deployed Barrier from a recess in the roadway

REFERENCE MATERIAL:
- UFC 4-020-01/UFC 4-020-02 SECURITY ENGINEERING PLANNING AND DESIGN MANUALS
- UFC 4-022-01 ENTRY CONTROL FACILITIES/ACCESS CONTROL POINTS
- UFGS 34-71-13-19 ACTIVE BARRIERS SPECIFICATIONS
- UFGS 34-41-26.00 10 2 ACCESS CONTROL POINT CONTROL SYSTEM.
- AMERICAN SOCIETY OF TESTING MATERIALS (ASTM) F2656-07 STANDARD TEST METHOD FOR VEHICLE CRASH TESTING OF PERIMETER BARRIERS.

ACTIVE VEHICLE BARRIERS:
CAUTION: THE FORCE OF IMPACT CONDITIONS BASED ON A RANGE OF ANY VEHICLE RAMMING THESE BARRIERS AT SPEEDS ABOVE 20 MPH MAY BE LETHAL TO THE OCCUPANTS OF THAT VEHICLE. CERTAIN CIRCUMSTANCES MAY RESULT IN FATALITIES AT SPEEDS SIGNIFICANTLY LOWER THAT 20 MPH. THEREFORE, EXTREME CAUTION MUST BE EXERCISED TO ENSURE THAT THEY ARE NOT ACTIVATED AT THE WRONG TIME.
The standard drawings shown here are in the form of active and passive barriers, with a focus on vehicle barrier selection. The selection of barriers is based on the specific needs of the area, the type of threat, and the potential impact of different vehicles. For instance, the selection may be influenced by factors such as the speed of the vehicle, the condition of the road, and the type of impact expected. The barriers are designed to stop or significantly limit the movement of vehicles, ensuring the safety of personnel and facilities.

**Notes:**

1. **Impact Kinetic Energy**
   
   - Impact kinetic energy in Ft-Lbs = \[ KE = \frac{1}{2} \times \text{Mass} \times (\text{Velocity})^2 \]
   
   Where Mass = Weight (Lbs)/32.2 feet/(second)
   
   Velocity = Speed (feet/second) * Sin(\(\theta\))

   For the vehicle weight (W) given in Lbs and the vehicle speed (S) given in miles per hour, the kinetic energy in Ft-Lbs is:

   \[ KE = 0.03344 \times W \times (S \times \sin(\theta)) \]

   For active barriers deployed in the roadway at the end of the ACP corridor, the vehicle impact angle is 90\(^\circ\). For passive barriers along the perimeter of the ACP corridor, the maximum impact angle must be determined by evaluating the vehicle's speed, the roadway alignment, and the clear roadway width. Maximum vehicle impact angles and speeds will vary along ACP corridors with speed management features such as curves and turns.

   Passive barrier systems must be capable of stopping the threat vehicle anywhere along the ACP corridor. See Draft UFC 4-022-02 "Selection and Application of Vehicle Barriers" and Appendix D for information on determining impact angles.

2. Examples of both active and passive barriers are shown on these drawings. Some of the examples show actual barriers supplied by barrier manufacturers. For additional information on any barrier shown or other barriers not shown, contact the Protective Design Center at the USACE, Omaha District.

**State Department Ratings**

- **K4** - 15,000 pound vehicle traveling at 48 kmh (30 mph)
- **K8** - 15,000 pound vehicle traveling at 64 kmh (40 mph)
- **K12** - 15,000 pound vehicle traveling at 80 kmh (50 mph)
**Vehicle Barriers**

Passive barriers are designed to stop or control vehicle traffic without moving parts. These barriers rely on their bulk and position to be effective. Passive barriers include:

- **Concrete Bollards**: Made of reinforced concrete, these are often used to deter vehicle penetration.
- **W-beam guardrails**: A type of guardrail designed to withstand impact from vehicles.
- **Ornamental fences**: These are decorative barriers that can be effective in preventing direct vehicle penetration.

**Selection of Passive Barriers**

The selection of a passive barrier is based on the site, security requirements, and the environment. Factors to consider include:

- Type of vehicle to be stopped
- Penetration force of the vehicle
- Site conditions
- Budget constraints
- Maintenance costs
- Aesthetic considerations

**Notes**

1. Concrete bollards are specified for vehicle crash testing to ensure safety and functionality.
2. W-beam guardrails are designed to withstand impact forces from vehicles.
3. Ornamental fences can be effective in deterring vehicles, especially in high-profile areas.
4. Passive barriers require regular maintenance to ensure their effectiveness.

**Related Drawings**

- Sidehill cut ditch
- Sidehill cut as-tested
- Concrete deadman
- Deadman detail
- Pull post
- Cable: 3-19mm (3/4") dia.
- U-bolt at cable pull
- Ornamental fence
- Security fence
- Reinforced chain link fence
- Reinforced steel fence

**Reference Material**

1. UFC 4-022-01 Entry Control Facilities/Access Control Points
2. UFC 4-020-02 Security Engineering: Design Manual
3. Corps of Engineers
4. Contractors

**Specifications**

- Material: Portland cement
- Size: 6" dia. x 30" high
- Style: flat top
- Note: Not to scale

**Comment**

- Not designed to prevent head-on penetration. Designed to deflect impact.
- Rated less than K4.
1. All traffic signal faces shall have the following signal indications:
   - RED = 12" DIAMETER
   - YELLOW = 12" DIAMETER
   - FLAShING YELLOW OR GREEN = 12" DIAMETER

2. For multi-lane roadways on multiple inbound or outbound lanes, use detail A with a signal face over each lane.

3. For the lane roadways with one inbound lane and one outbound lane, the preferred traffic signalization is one post and mast structure with signal faces on both the mast and the post. Detail B for each lane. An alternative for roadways with one inbound and one outbound lane that are separated by a median island of at least 5-foot wide, use post mounted signal faces (Detail C) with one post mounted on the right shoulder (median island) for each lane. This alternative requires a total of 4 posts with signal faces.

4. Barriers shall be controlled by a traffic controller unit in accordance with U.S. Army Corps of Engineers' Design Drawings D103 and D104.
NOTES:

9. Signal to run 'normal' phasing plan when AVB is not activated.
10. Upon AVB preemption, all 'normal' phases will immediately cease the green phase and transition to
    «normal» phasing operation.
11. All 'WALK' indications will immediately transition to 'FLASHING DONT WALK' (FDW). Normal FDW
12. After reset, all devices to remain in operational sequence 10 until the system is reset. Normal operations to reset
    will be provided and may be completed beyond operational sequence 10.
13. All signals and signs shall be in conformance with the MUTCD and state DOT guidelines.
14. Non-conflicting movements can continue as directed
15. Pedestrian crossings are permitted on all approaches except the approach with the AVBs itself.
16. Final design and operational analyses in accordance with the MUTCD and to be performed by a qualified
17. Use optically programmed signal indications for Pole B.
18. For single lane approaches, signs are needed on the right side only.
19. All devices to remain in operational sequence 10 until the system is reset. Normal operations to reset
20. Final yellow and red clearance intervals to be calculated in accordance with the MUTCD. Final yellow
21. Normal Mode to AVB Preemption
22. Signals and Signs

General

• All signals and signs shall be in conformance with the MUTCD and state DOT guidelines.
• Use officially programmed signal indications for Pole B.
• Normal Mode to AVB Preemption
• Signals to run 'normal' phasing plan when AVB is not activated.
• All 'WALK' indications will immediately transition to 'FLASHING DONT WALK' (FDW). Normal FDW
• All devices to remain in operational sequence 10 until the system is reset. Normal operations to reset
• Final design and operational analyses in accordance with the MUTCD and to be performed by a qualified
• Use optically programmed signal indications for Pole B.
• For single lane approaches, signs are needed on the right side only.
• All devices to remain in operational sequence 10 until the system is reset. Normal operations to reset
• Final yellow and red clearance intervals to be calculated in accordance with the MUTCD. Final yellow
• Normal Mode to AVB Preemption
• Signals to run 'normal' phasing plan when AVB is not activated.
• All 'WALK' indications will immediately transition to 'FLASHING DONT WALK' (FDW). Normal FDW
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• Final design and operational analyses in accordance with the MUTCD and to be performed by a qualified
• Use optically programmed signal indications for Pole B.
• For single lane approaches, signs are needed on the right side only.
• All devices to remain in operational sequence 10 until the system is reset. Normal operations to reset
• Final yellow and red clearance intervals to be calculated in accordance with the MUTCD. Final yellow
1. See BIM drawings for construction details. BIM drawings for Access Control Points are maintained by the Center of Standardization for Access Control Points (COS for ACPs) located in the Omaha District.

2. The VCC is the only building at the ACP that must meet the requirements of UFC 4-010-01 "DOD Minimum Antiterrorist Standards for Buildings". VCCs that are projected to have 11 or more people in them on a routine basis are considered to be Inhabited Buildings within an uncontrolled perimeter for the purposes of UFC 4-010-01. The COS for ACPs maintains designs for the following two types of VCC (note the following standoff distances apply only if the VCC will be routinely inhabited by 11 or more people):
   a. VCC using conventional construction, which requires a standoff distance of 82 feet from parking areas and roadways.
   b. VCC using hardened construction, which requires a standoff distance of 50 feet from parking areas and roadways.

3. The VCC shown on the drawing includes spaces for 3 visitor processing stations. The COS for ACPs maintains VCC designs for 6 and 9 processing stations also. VCC dimensions are as follows:
   a. VCC with 3 visitor processing stations - 62' x 40'
   b. VCC with 6 visitor processing stations - 74' x 40'
   c. VCC with 9 visitor processing stations - 86' x 40'

4. The VCC must be Americans with Disabilities Act (ADA) compliant.

5. Exterior masonry patterning and coursing to be determined during design.

6. Luminaire and diffuser types and locations to be determined during design.

7. All windows should be tinted.
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7. All windows should be tinted.
1. See BIM drawings for construction details. BIM drawings for Access Control Points are maintained by the Center of Standardization for Access Control Points (COS for ACPs) located in the Omaha District.

2. The building, doors, windows, and frames around the guard areas shall meet Level 3 Ballistics Standard UL-752 as a minimum.

3. Exterior masonry patterning and coursing to be determined during design.

4. Luminaire and diffuser types and locations to be determined during design.

5. All windows should be tinted. Interior surfaces in the Gatehouse should be dark in color.
GENERAL NOTES

1. Linear dimension references are based on the recognized building: 1/8" = 4'.

2. Locate interior door opening 4" from the outer face of the door frame to the nearest inside wall corner unless noted otherwise.

3. Elevators and stairwells are not shown on the reflected ceiling plan. Quantity and locations to be determined during design.

4. Exterior masonry patterning and coursing to be determined during design.

5. The design office will include a control console with CCTV monitors, an annunciation panel, and communications to the installation's central security monitoring station.

6. Size waiting area for expected number of searched vehicles.

LOCATE INTERIOR DOOR FRAMES 4" FROM THE OUTSIDE FACE OF THE DOOR FRAME TO THE NEAREST INSIDE WALL CORNER UNLESS NOTED OTHERWISE.

LIGHTS AND DIFFUSERS ARE NOT SHOWN ON THE REFLECTED CEILING PLAN. QUANTITY AND LOCATIONS TO BE DETERMINED DURING DESIGN.

EXTERIOR MASONRY PATTERNING AND COURSING TO BE DETERMINED DURING DESIGN.

THE SEARCH OFFICE WILL INCLUDE A CONTROL CONSOLE WITH CCTV MONITORS, AN ANNUNCIATION PANEL, AND COMMUNICATIONS TO THE INSTALLATION'S CENTRAL SECURITY MONITORING STATION.

SIZE WAITING AREA FOR EXPECTED NUMBER OF SEARCHED VEHICLES.
GENERAL NOTES

1. EXTERIOR MASONRY PATTERNING AND COURSING TO BE DETERMINED DURING DESIGN.
2. LUMINARE AND DIFFUSER TYPES AND LOCATIONS TO BE DETERMINED DURING DESIGN.
3. SIZE WAITING ROOM FOR EXPECTED NUMBER OF VEHICLES TO BE SEARCHED.
4. FOR ACP's NOT REQUIRING A SEARCH OFFICE, A SEARCH AREA SHELTER MUST BE PROVIDED NEAR THE SEARCH LANE(S) TO SHELTER VEHICLE OCCUPANTS WHILE THEIR VEHICLE IS BEING SEARCHED. THE SHELTER MAY BE SIMILAR TO BUS TYPE SHELTERS WITH SEE-THROUGH WALLS TO ALLOW SECURITY PERSONNEL TO OBSERVE VEHICLE OCCUPANTS DURING THE SEARCH.
GENERAL NOTES

1. LIGHTS AND DIFFUSERS ARE NOT SHOWN ON GENERAL NOTES.
2. EXTERIOR FINISH MATCHING INSTALLATION DESIGN OR PROCUREMENT.
3. EXTERIOR MASONRY PATTERNING AND STANDARDS LL-752 AS A MINIMUM.
4. EXTERIOR MASONRY PATTERNING AND STANDARDS LL-752 AS A MINIMUM.
5. ALL WINDOWS SHOULD BE TINTED, INTERIOR COURSING TO BE DETERMINED DURING DESIGN.
6. RECOMMEND ANTI-FATIGUE MATS BE SURFACES SHOULD BE DARK IN COLOR.

SCALE: 1/4” = 1’-0”
1. LIGHTS AND DIFFUSERS ARE NOT SHOWN ON THE SOFFIT PLAN. QUANTITY AND LOCATIONS TO BE DETERMINED DURING DESIGN.

2. CANOPIES MUST PROVIDE 15'-0" VERTICAL CLEARANCE ABOVE FINISHED ROADWAY SURFACE. IF A LARGE NUMBER OF OVERHEIGHT VEHICLES ARE EXPECTED, PROVIDE 17'-0" VERTICAL CLEARANCE ABOVE ROADWAY SURFACE.

3. BOLLARDS OR OTHER COLUMN PROTECTION MEASURES SHOULD BE PLACED AS REQUIRED.

4. CANOPY COLUMNS TO BE PLACED 5'-0" FROM THE EDGE OF THE CURB.

5. CANOPY WIDTH DETERMINED BY ADDING THE Lanes, COLUMN SETBACKS, AND CANOPY OVERHANG.

6. CANOPIES WILL BE CONSTRUCTED SO COLUMNS DO NOT OBSTRUCT GUARD'S LINE OF SIGHT.
1. PROVIDE DELINEATION OF ISLANDS TO ONCOMING VEHICLES.
2. CURB RAMPS ARE REQUIRED FROM THE ISLAND AND SIDEWALKS OR CENTERED IN THE ISLAND.
3. BOLLARDS OR OTHER COLUMN PROTECTION MEASURES SHOULD BE PLACED 2'-6" FROM THE EDGE OF CURB ABOVE FINISHED ROAD SURFACE.
4. CANOPY COLUMNS TO BE PLACED 2'-6" FROM THE EDGE OF CURB.
5. PANELS OF LOUVERED SCREENS HAVE BEEN IDENTIFIED. UNDOUBTEDLY THERE ARE OTHERS. THESE FOLLOWING MANUFACTURERS OF LOUVERED SCREENS HAVE BEEN IDENTIFIED. UNDOUBTEDLY THERE ARE OTHERS. THESE FOLLOWING MANUFACTURERS OF LOUVERED SCREENS HAVE BEEN IDENTIFIED. UNDOUBTEDLY THERE ARE OTHERS. THESE FOLLOWING MANUFACTURERS OF LOUVERED SCREENS HAVE BEEN IDENTIFIED. UNDOUBTEDLY THERE ARE OTHERS. THESE FOLLOWING MANUFACTURERS OF LOUVERED SCREENS HAVE BEEN IDENTIFIED. UNDOUBTEDLY THERE ARE OTHERS. THESE FOLLOWING MANUFACTURERS OF LOUVERED SCREENS HAVE BEEN IDENTIFIED. UNDOUBTEDLY THERE ARE OTHERS. THESE FOLLOWING MANUFACTURERS OF LOUVERED SCREENS HAVE BEEN IDENTIFIED. UNDOUBTEDLY THERE ARE OTHERS. THESE FOLLOWING MANUFACTURERS OF LOUVERED SCREENS HAVE BEEN IDENTIFIED. UNDOUBTEDLY THERE ARE OTHERS. THESE FOLLOWING MANUFACTURERS OF LOUVERED SCREENS HAVE BEEN IDENTIFIED. UNDOUBTEDLY THERE ARE OTHERS. THESE FOLLOWING MANUFACTURERS OF LOUVERED SCREENS HAVE BEEN IDENTIFIED. UNDOUBTEDLY THERE ARE OTHERS. 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1. See design criteria for limiting level requirements.

2. See design criteria for descriptions of requirements for communications devices alarms, intrusion detection sensors, speed detections, micro-switches, and vehicle presence detectors, and active vehicle barrier controls.

3. See continuity to adjoin main line conductors.

4. Provide the required number of conduits plus 2 spare conduits for each duct bank. Spares should be a maximum of 2" in diameter.

5. Conductor runs should not exceed 150.0 ft (500 ft) in total length.

6. See conductors for maximum voltage drop and maximum amperes.

7. Specify direct burial cable to be installed in direct burial conduit for lighting conductors. Minimum size conductor to be used for maximum 5% voltage drop and maximum amperes.

8. Size conductor to 40% fill maximum per conduit.

9. Concealed conduit runs should not exceed 150.0 ft (500 ft) in total length.

10. Provide emergency generator back-up power and luminaires with time delay automatically switched.

11. Provide additional separate quartz luminaries with time delay automatically switched.

12. Provide automatic switching for all luminaires with power and normal lighting systems.

13. Provide emergency generator back-up power and luminaires with time delay automatically switched.

14. Provide emergency generator back-up power and luminaires with time delay automatically switched.

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STANDARDS DEVELOPED UTILIZING COMMON ENGINEERING AND ARCHITECTURAL RESOURCES.
ENGINEERING JUDGEMENT APPLIED WHERE APPROPRIATE.  ALL FEATURES AND DIMENSIONS
SHOULD BE VALIDATED AND ADJUSTED AS APPROPRIATE AS PART OF THE DESIGN PROCESS.

NOT TO SCALE

CONDUIT PLAN
TRAFFIC ISLAND W/O AUTOMATION
GUARD BOOTH NOT ON ISLAND

NOTES:
1. A CURB CUTOUT FOR THE TANDEM GUARD IS OPTIONAL.
   IF PROVIDED, CUTOUT SHALL BE 3' DEEP BY 6' WIDE AS SHOWN AND SHALL HAVE VERTICAL FACES.
2. DESIGN MAY VARY TO FIT EXISTING CONDITIONS.

CONDUITS:
- 2-102mm (4") CONDUITS TO GATEHOUSE
- 2-25mm (1") CONDUITS
- 1.5m (5') BARREI WALL
- 1.8m (6') CONCRETE CURB (TYP)
- 3.7m (12') BARRIER WALL
- 2.4m (8') CONCRETE CURB (TYP)
- 2-102mm (4") CONDUITS TO NEXT TRAFFIC ISLAND
- 22.9m (75') TRAFFIC ISLAND

SEE NOTE 1
- CANOPY EDGE (ABOVE) 0.15m (6"
- CANOPY EDGE (ABOVE) 0.9m (3')
- 0.45m (18") BOLLARD
- 19.5m (64') WALL
NOTES:

1. DEVICE LOCATIONS SHOWN ARE ADVISORY, EXCEPT THE DISTANCE BETWEEN THE GATE ARM AND THE DRIVER INTERFACE PEDESTAL SHOULD BE 27' AS SHOWN, FOR BOOTH ARM WITH SHORTER TRAFFIC ISLANDS, THIS DISTANCE SHALL BE A MINIMUM OF 16 FEET.

2. FOR EXISTING ACPs WITH TRAFFIC ISLANDS SHORTER THAN 75 FEET, EVALUATE EXISTING CONDITIONS TO DETERMINE THE OPTIMAL LOCATION OF THE REAR TAG CAMERA TO ENSURE PROPER COVERAGE.

3. A CURB CUTOUT FOR THE TANDEM GUARD IS OPTIONAL, IF PROVIDED, CURB SHALL BE 3' DEEP BY 6' WIDE AS SHOWN AND SHALL HAVE VERTICAL FACES.

4. DESIGN MAY VARY TO FIT EXISTING CONDITIONS.
STANDARDS DEVELOPED UTILIZING COMMON ENGINEERING AND ARCHITECTURAL RESOURCES.
ENGINEERING JUDGEMENT APPLIED WHERE APPROPRIATE. ALL FEATURES AND DIMENSIONS
SHOULD BE VALIDATED AND ADJUSTED AS APPROPRIATE AS PART OF THE DESIGN PROCESS.

CONDUIT PLAN
TRAFFIC ISLAND W/O AUTOMATION
GUARD BOOTH ON ISLAND

NOT TO SCALE

X X X
X X X
X X X

SOLICITATION NO.: 
FILE NAME: 
DESIGN BY: 
C HD BY: 
P L O T S C A L E : 
P L O T DA TE : 
DES CRIPTION DA TE : 
CONTRACT NO.: 

US ARMY CORPS 
OF ENGINEERS 
OMAHA DISTRICT 

W912HN-07-X-6204

SHEET REFERENCE NUMBER
SHEET OF 60

FACILITIES STANDARDS PROGRAM
ACCESS CONTROL POINTS FOR U.S. ARMY INSTALLATIONS

CATEGORY CODE:

NOTES:
1. A CURB CUTOUT FOR THE TANDEM GUARD IS OPTIONAL.
   IF PROVIDED, CUTOUT SHALL BE 3' DEEP BY 6' WIDE AS
   SHOWN AND SHALL HAVE VERTICAL FACES.
2. NOTE: DESIGN MAY VARY TO FIT EXISTING CONDITIONS

NOTES:
1. SEE NOTE 1
2. SEE NOTE 1
3. SEE NOTE 1
4. NOTE DESIGN MAY VARY TO FIT EXISTING CONDITIONS

1.0m (4') BARRIER WALL
2.4m (8') CONCRETE CURB (TYP)
2.4m (8') TRAFFIC ARM
2-102mm (4") CONDUITS

0.5m (1.5') 0.5m (1.5')
5.2m (17')
3.05m (10')
19.5m (64')
0.9m (3')
0.61m (2')
1.52m (5')
0.3m (1')
1.8m (6')
2.7m (9')
2.4m (8')
3.05m (10')

ERECT CIRCA EDGE (ABOVE)

2-102mm (4") CONDUITS TO NEXT TRAFFIC ISLAND
2-25mm (1") CONDUITS TO GATEHOUSE
2-102mm (4") CONDUITS TO NEXT TRAFFIC ISLAND

CANOPY EDGE (ABOVE)
GUARD BOOTH 1.22m x 2.44m (4' x 8')
NOT TO SCALE

CONDUIT PLAN

TRAFFIC ISLAND WITH AUTOMATION

GUARD BOOTH ON ISLAND

NOTES:

1. DEVICE LOCATIONS SHOWN ARE ADVISORY, EXCEPT THE DISTANCE BETWEEN THE GATE ARM AND THE DRIVER INTERFACE PEDESTAL SHOULD BE 27 AS SHOWN. FOR EXISTING ACPs WITH SHORTER TRAFFIC ISLANDS, THIS DISTANCE SHALL BE A MINIMUM OF 15 FEET.

2. FOR EXISTING ACPs WITH TRAFFIC ISLANDS SHORTER THAN 75 FEET, EVALUATE EXISTING CONDITIONS TO DETERMINE THE OPTIMAL LOCATION OF THE REAR TAG CAMERA TO ENSURE PROPER COVERAGE.

3. A CURB CUTOUT FOR THE TANDEM GUARD IS OPTIONAL. IF PROVIDED, CUTOUT SHALL BE 3' DEEP BY 6' WIDE AS SHOWN AND SHALL HAVE VERTICAL FACES.

4. NOTE DESIGN MAY VARY TO FIT EXISTING CONDITIONS.
### Zone/Facility

<table>
<thead>
<tr>
<th>Zone/Facility</th>
<th>Number</th>
<th>Description</th>
<th>View</th>
<th>Camera Location</th>
<th>Location Note</th>
<th>Number of Cameras</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach Zone</td>
<td>①</td>
<td>Approach Zone Operation</td>
<td>New Approaching Traffic</td>
<td>Pole of Canopy Roof</td>
<td>Gatehouse</td>
<td>External</td>
<td>1</td>
</tr>
<tr>
<td>E. Check Area</td>
<td>②</td>
<td>Lane Operations</td>
<td>Driver, Vehicle, and E Check Guards</td>
<td>Underside of Canopy</td>
<td>Gatehouse</td>
<td>Covered</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>③</td>
<td>New License Plate - Future</td>
<td>New License Plate Using Special Boarding</td>
<td>Underside of Canopy</td>
<td>Gatehouse</td>
<td>Covered</td>
<td>1</td>
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<tr>
<td></td>
<td>④</td>
<td>Pedestrian E Check Operations</td>
<td>Pedestrian Guard Booth and Pedestrian Active Barriers</td>
<td>Underside of Canopy</td>
<td>Gatehouse</td>
<td>Covered</td>
<td>1</td>
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<tr>
<td></td>
<td>⑤</td>
<td>E Check Area Operation</td>
<td>E Check Area Subarea and Search Area Design Subarea</td>
<td>Pole or Gatehouse Roof</td>
<td>Gatehouse</td>
<td>Covered</td>
<td>1</td>
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<tr>
<td>Response Zone</td>
<td>⑥</td>
<td>Threat Detection Operation</td>
<td>Pole</td>
<td>Pole</td>
<td>Gatehouse</td>
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<td></td>
<td>⑦</td>
<td>Passenger Vehicle Search Area</td>
<td>Search Operations</td>
<td>Truck</td>
<td>Gatehouse</td>
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<tr>
<td></td>
<td>⑧</td>
<td>Search Operations</td>
<td>Driver, Vehicle, and Search Area Guard</td>
<td>Underside of Canopy</td>
<td>Gatehouse</td>
<td>Covered</td>
<td>1</td>
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<tr>
<td></td>
<td>⑨</td>
<td>Search Area Guards - Optional</td>
<td>Top of Vehicle Using Special Boarding</td>
<td>Underside of Canopy</td>
<td>Search Area</td>
<td>Covered</td>
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<tr>
<td>Search Area</td>
<td>⑩</td>
<td>Search Area Operation</td>
<td>Search Area</td>
<td>Pole</td>
<td>Gatehouse</td>
<td>External</td>
<td>1</td>
</tr>
</tbody>
</table>

**Notes:**
- An additional camera may be required to view the Approach Zone for pedestrians.
- Provide conduit only for future cameras and lights.
- An additional camera to view the Search Area guards.
- It is possible to view the Search Area Guard using one camera.
- Site design criteria are for general description of CCTV requirements.
- Camera Plan Intended to Provide Initial Guidance Per Policy Requirements. Locations are approximate. Actual locations and number of cameras to be determined based on site conditions and level of need.
### Power Requirements

**NOT TO SCALE**

**Notations:**
- Power requirements per ACP criteria requirements and standard drawings.
- See Appendix F for detailed list of electrical loads.
- Physical location(s) and size of UPS(s) shall be determined by the electrical designer.

**Table: Power Requirements**

<table>
<thead>
<tr>
<th>Area</th>
<th>VA Connected</th>
<th>VA Demand</th>
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<tbody>
<tr>
<td>Access Control Zone</td>
<td>24000.0</td>
<td>16079.2</td>
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<tr>
<td>Advanced Secondary Islands</td>
<td>2400.0</td>
<td>5980.0</td>
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<tr>
<td>Search Area and Office</td>
<td>100000.0</td>
<td>78360.0</td>
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<td>Cargo and Vehicle Inspection System Area</td>
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<td>26994.0</td>
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<tr>
<td>Area Total</td>
<td>300000.0</td>
<td>260000.0</td>
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</tbody>
</table>

**Notes:**
- Backup power & UPS requirements per ACP criteria requirements.
- Generator, Island, and UPS requirements shall be determined by the electrical designer.
GATEHOUSE MASTER CONTROL PANEL

Notes:
1. The control panel layout may be depicted as a 2D drawing, not necessarily to scale.
2. The control panel layout may be depicted as a 3D drawing, not necessarily to scale.
3. The control panel layout may be depicted as a 4D drawing, not necessarily to scale.
4. The control panel layout may be depicted as a 5D drawing, not necessarily to scale.
5. The control panel layout may be depicted as a 6D drawing, not necessarily to scale.
6. The control panel layout may be depicted as a 7D drawing, not necessarily to scale.
7. The control panel layout may be depicted as a 8D drawing, not necessarily to scale.
8. The control panel layout may be depicted as a 9D drawing, not necessarily to scale.
9. The control panel layout may be depicted as a 10D drawing, not necessarily to scale.

Notes (Cont.):
10. The control panel layout may be depicted as a 11D drawing, not necessarily to scale.
11. The control panel layout may be depicted as a 12D drawing, not necessarily to scale.
12. The control panel layout may be depicted as a 13D drawing, not necessarily to scale.
13. The control panel layout may be depicted as a 14D drawing, not necessarily to scale.
14. The control panel layout may be depicted as a 15D drawing, not necessarily to scale.
15. The control panel layout may be depicted as a 16D drawing, not necessarily to scale.
16. The control panel layout may be depicted as a 17D drawing, not necessarily to scale.
17. The control panel layout may be depicted as a 18D drawing, not necessarily to scale.
18. The control panel layout may be depicted as a 19D drawing, not necessarily to scale.
19. The control panel layout may be depicted as a 20D drawing, not necessarily to scale.

Legend:
- Green indicating light
- Red indicating light
- Amber indicating light
Standards developed utilizing common engineering and architectural resources. Engineering judgement applied where appropriate. All features and dimensions should be validated and adjusted as appropriate as part of the design process.

Electric Plan

Barrier Normally Closed Safety System

Gatehouse Master Control Panel

Guard Booth Control Panel

(BARRIER NORMALLY CLOSED SAFETY SYSTEM)

Legend:
- Green Indicating Light
- Red Indicating Light
- Amber Indicating Light
- Control Switches
- Selector Switch
- Key Operated Control Switch

By

1. The control panel layouts depict an ACP with a gatehouse, 2 guard booths, and 4 active vehicle barriers. (2 for inbound entrapment area and 2 for outbound entrapment area).

2. See UFGS 34 41 26.00 10 "Access Control Point Control System" Appendix A "Barrier Normally Closed Safety System" for description of required barrier and traffic control sequences.

NOT TO SCALE

Lamp Test (See Note 7 SHT. E1.03)
STANDARDS DEVELOPED UTILIZING COMMON ENGINEERING AND ARCHITECTURAL RESOURCES. ENGINEERING JUDGEMENT APPLIED WHERE APPROPRIATE. ALL FEATURES AND DIMENSIONS SHOULD BE VALIDATED AND ADJUSTED AS PART OF THE DESIGN PROCESS.

ACTIVE VEHICLE BARRIER CONTROL SYSTEM (AVBCS) CONFIGURATION

1:1

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SOLICITATION NO.: 
FILE NAME: 
CONSIGNED BY: 
DATE: 
SIZE: 
SUBMITTED BY: 
PLOT SCALE: 
PLOT DATE: 
DESCRIPTION: 

CONTRACT NO.: 

US ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
W912HN-07-X-6204

FACILITIES STANDARDS PROGRAM
ACCESS CONTROL POINTS FOR U.S. ARMY INSTALLATIONS

CATEGORY CODE: 

US ARMY CORPS
OF ENGINEERS
OMAHA DISTRICT

TRAFFIC ARM(S)
(PRESENCE DETECTION SAFETY SYSTEM ONLY)
CLOSE COMMAND
OPEN COMMAND
CLOSE STATUS
OPEN STATUS

WIG-WAG WARNING SIGNAL

TRAFFIC SIGNALS
RED
YELLOW
GREEN

AVB's
CLOSE ACTIVATOR
OPEN ACTIVATOR
EFO ACTIVATOR
CLOSE STATUS
OPEN STATUS
AVB LIGHTS
AVB MODE SW
AVB CLOSE SW
AVB OPEN SW
INDICATING LIGHTS

AVB TROUBLE/MALFUNCTION
LOCAL CONTROL PANEL

CCTV MONITOR 1
CCTV MONITOR 2

GATEHOUSE CONTROL CONSOLE

LOCAL INTERFACE PANEL AT ACP FOR THE AUTOMATED VEHICLE CONTROL MONITORING SYSTEM

TRAFFIC CONTROLLER AND CLOSED SUBSYSTEM

GATEWAY CONTROL PANEL

LOCAL INTERFACE PANEL AT ACP FOR THE AUTOMATED VEHICLE BARRIER CONTROL SYSTEM

NOTE:
1. ADJUSTABLE AUDIBLE ALARM AND BACKLIT VISUAL ALARM.
2. OVERWATCH POSITION ONLY.
3. DURESS ALARM SHALL NOT BE AUDIBLE OUTSIDE OF GATEHOUSE.
APPENDIX D

DESIGN PROCEDURE
Appendix D
Design Procedure

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A. General.

1. Designers shall use the following design procedure to determine ACP features that can be used to defeat the four Threat Scenarios defined in the Design Criteria (Appendix B). If additional Threat Scenarios are defined in the project specific criteria, designers can use the equations and methodologies in this Design Procedure to help determine appropriate ACP features against these scenarios as well. The designer shall assemble all selected ACP features into a Protective System.

2. The Designer must select ACP features that enable detection of possible threat vehicles and ACP features that delay the threat vehicle for the times described in the Design Criteria. Detection features include vehicle speed detectors, vehicle wrong-way detectors, and vehicle presence detectors along with detection by security guards. Delay features include straight roadways and roadways with speed management features such as chicanes, loops, serpentines, or turns.

3. Based on the opportunities and constraints of the site, the designer must determine appropriate detection and delay features and perform calculations to assure that the selected features provide the delays required for the given Threat Scenarios.

4. The designer must prepare a Design Analysis showing the Protective System including descriptions of selected ACP features, layouts of detection and delay features, and calculations verifying delay times for each threat scenario listed in the Design Criteria (Appendix B). Calculations must verify that a threat vehicle is detected and delayed a sufficient time to allow guards to deploy the final barriers before the threat vehicle reaches them. For each Threat Scenario, the calculation procedure must identify the following:
   a. Point of detection. This is the point in or before the ACP corridor that the Threat Vehicle is detected.
   b. The speed of the Threat Vehicle at the point of detection ($V_d$).
   c. The time ($T$) it takes the threat vehicle to reach the barrier starting from the point of detection and traveling at an initial speed of $V_d$ at that point. Note, time $T$ is dependent on the maximum acceleration and deceleration rates of the threat vehicle and the roadway features between the point of detection and the barrier, e.g., straight roadway, curved roadway, passive barriers in the roadway (serpentines), and turns in the roadway.
   d. Time $T$ must be equal to or greater than the time delay required in the Design Criteria (Appendix B).
B. Criteria.

1. Threat Scenarios: Show calculations to defeat the following Threat Scenarios:
   a. Threat Scenario #1 – High Speed. In this threat scenario, Threat Vehicle enters the ACP at the highest speed it can attain considering roadway features before and in the ACP corridor. Threat Vehicle disregards any overspeed detection systems if used. The Threat Vehicle’s speed is limited only by the acceleration capability of the threat vehicle and the characteristics of the roadway before and in the ACP corridor.
   b. Threat Scenario #2 – High Speed. This threat scenario applies only when the Protective System includes overspeed detection. In this threat scenario, the Threat Vehicle enters the ACP at a speed that it is just under the setting of one or more of the overspeed detectors in order to avoid detection. Immediately after passing the range(s) of the overspeed detector(s), the Threat Vehicle begins to accelerate. After passing the range(s) of the overspeed detector(s), the Threat Vehicle’s speed will be limited only by the acceleration capability of the threat vehicle and the characteristics of the roadway in the ACP corridor.
   c. Threat Scenario #3 – Covert Entry at the ID Check Point. In this threat scenario, the Threat Vehicle attempts to gain entry through the ACP using false credentials. When the guard rejects the false credentials and denies access, the Threat Vehicle bolts from the ID Check Point and accelerates toward the final barriers. The Threat Vehicle’s speed will be limited only by the acceleration capability of the threat vehicle and the characteristics of the roadway in the ACP corridor.
   d. Threat Scenario #4 – Covert Entry at the end of the last Turn-around. In this threat scenario, the Threat Vehicle attempts to gain entry through the ACP by using false credentials. When guards at the ID Check Point or Search Area direct the Threat Vehicle to the ACP rejection lane or when guards at the ID Check Point direct the Threat Vehicle to the Search Area, the Threat Vehicle feigns compliance and starts at a low speed (under the 25 mph ACP speed limit) toward the rejection lane or Search Area. Once at the point of the turn, the Threat Vehicle bolts toward the final barriers instead of making the turn. The Threat Vehicle’s speed will be limited only by the acceleration capability of the threat vehicle and the characteristics of the roadway in the ACP corridor.

2. Barrier Safety Systems: One of the following active vehicle barrier safety systems must be incorporated in the ACP design:
a. Signs and Signals Safety System: This safety system consists of a normally open active barrier in each inbound and outbound lane, vehicle presence detectors (VPDs) on both sides of each barrier, warning signs, a traffic signal for each barrier, and controls. Upon actuation of the barrier Close (deployment) command by ACP guards, actual barrier deployment is delayed for 4 seconds while traffic signals at the barrier go through a predefined sequence to warn innocent vehicles who may be approaching the barrier. Also, barrier deployment is suppressed when a vehicle is detected by either VPD.

b. Presence Detection Safety System: This safety system consists of a normally open active barrier in each inbound and outbound lane, VPDs immediately before and after each barrier, warning signs, a traffic signal for each inbound and outbound barrier, a Stop line in front of each barrier, VPDs in front of each Stop line, and controls. Each barrier’s traffic signal is normally Red, which will require an innocent vehicle to stop at the Stop Line. The VPDs in front of the Stop Line will sense the vehicle. If there has not been an active barrier deployment command by ACP guards, the Traffic Signal will change to Green, allowing the vehicle to pass. If there has been a barrier deployment command, the traffic signal will stay Red, holding the vehicle at the Stop Line. If there are no vehicles detected by the VPDs immediately in front of and behind the barrier when a deployment command is initiated by guards, the barrier will immediately close (deploy). If either of the VPDs immediately before or after the barrier detects a vehicle when the barrier deployment command is initiated by guards, barrier deployment will be suppressed until the vehicle clears both of these VPDs. There is no time delay required for safety warning signals for this safety system.

c. Barrier Normally Closed Safety System: This safety system consists of normally closed active barriers, (VPDs) on both sides of each barrier, warning signs, a traffic signal for each barrier, and controls. In this safety system, two active barriers are arranged to form an entrapment area in each inbound and outbound lane. Barrier controls prevent both barriers in a lane to be open at the same time. Guards ensure that only cleared vehicles are allowed into the entrapment area before closing the initial entrapment barrier and opening the final entrapment barrier. Upon actuation of a barrier Close (deployment) command by ACP guards, actual barrier deployment is delayed for 4 seconds while traffic signals at the barrier go through a predefined sequence to warn innocent vehicles in front of the barrier. Also, barrier deployment is suppressed when a vehicle is detected by either of its VPDs. Since there is always at least one closed barrier in the entrapment area, there is no need to
delay the Threat Vehicle. Calculations to defeat the Threat Scenarios are not required for this safety system.

3. Delay Times:
   a. Per OPMG Criteria (Appendix B), the following delay times must be considered for the Signs and Signals Safety System and the Presence Detection Safety System:
      i. Guard Reaction Time: Guard reaction time per the OPMG Criteria (Appendix B) is 3 seconds for Threat Scenarios 1, 2, and 3 and 1 second for Threat Scenario #4.
      ii. Warning Signal Sequence Time: Warning signals sequence time is 4 seconds for the Signs and Signals Safety System and 0 seconds for the Presence Detection Safety System.
      iii. Barrier Deployment Time. Per the OPMG Criteria (Appendix B), active barriers utilized in the normally open mode (Signs and Signals Safety System and Presence Detection Safety System) must have an Emergency Fast Operate (EFO) mode that provides complete barrier closure (deployment) in less than 2 seconds from the time the barrier close control is energized.
   b. Total Delay Times: The following total delay times will be used in the calculations to defeat the required Threat Scenarios:
      i. Signs and Signals Safety System:
         1. Nine (9) seconds for Threat Scenarios 1, 2, and 3.
         2. Seven (7) seconds for Threat Scenario 4.
      ii. Presence Detection Safety System:
         1. Five (5) seconds for Threat Scenarios 1, 2, and 3.
         2. Three (3) seconds for Threat Scenario 4.

C. Protective System: The Protective System for the ACP must consist of features that detect the Threat Vehicle and features that delay the Threat Vehicle.
   1. Detection Features. The Threat Vehicle can be detected by guards at the ID Check Point, wrong-way detectors located in outbound lanes, and overspeed detectors located at some distance in front of the ID Check Point.
      a. Guards.
         i. Threat Scenario #1. In the absence of advanced overspeed detection, the ID Check Point guard is the means of Threat Vehicle detection. In the worst case, the ID Check Point guard will detect the Threat Vehicle, but not until it speeds by the ID Check Point.
ii. Threat Scenario #2. In this threat scenario, the Threat Vehicle stays under the setting(s) of the overspeed detector(s) so as not to be detected by them. Guards will detect the Threat Vehicle as it passes by the ID Check Point.

iii. Threat Scenario #3. Guards detect the Threat Vehicle when it bolts out of the ID Check Point.

iv. Threat Scenario #4. Guards detect the Threat Vehicle at the last turn-around when it bolts toward the AVB instead of making the turn to the exit or search lanes.

b. Wrong-way Detectors. Wrong-way detectors are located in the outbound lanes to detect a Threat Vehicle attempting to enter the ACP in the outbound lanes.

c. Overspeed Detectors. There are two types of overspeed detectors that can be utilized at an ACP.

i. Point Overspeed Detection. A point overspeed detector will detect the speed of a vehicle at a particular point on the roadway. Typical point overspeed sensors are paired magnetic loops embedded in the roadway, radar and lidar sensors applied across (transverse to) the roadway, and video motion sensors. Point overspeed detectors located at an ACP measure the speed of vehicles as they cross a point in the roadway, which is a specified distance from the ID Check Point.

ii. Continuous Overspeed Detection. A continuous overspeed detector will detect vehicle speed over a range of the roadway. Typical continuous overspeed sensors are Doppler radar sensors looking up (parallel to) the roadway and video motion sensors. Continuous overspeed detectors located at an ACP measure the speed of vehicles in a range starting at a point that is some distance in front of the ID Check Point and ending at a point either at the ID Check Point or a shorter distance in front of the ID Check Point than the starting point. The range of continuous overspeed detectors should usually be no more than 400 feet.

2. Delay Features. The ACP must include features that will delay the Threat Vehicle a sufficient time to allow guards to deploy the Active Vehicle Barrier (AVB). Delay features include straight roadways and roadways with speed management features, e.g., curves, turns, chicanes, loops, or serpentine barriers that require all vehicles including the Threat Vehicle to slow down. A Threat Vehicle driving through such a speed management feature faster than the feature’s spin-out speed will spin out and thus lose time in its race to the AVB before it deploys.

3. Examples. The following sections provide procedures and examples for calculating delay times for ACPs with various detection and delay features. All examples are on Excel Spreadsheets. These spreadsheets can be used by the designer to input alternative parameters and fine tune a design. However, care
should be used in selecting parameters to ensure results are consistent with the assumptions made in developing the spreadsheets. Results should always be verified by hand calculations. If results are suspect, contact the USACE Protective Design Center (PDC) for verification of method and assumptions. Procedures and examples in the paragraphs below are divided into the following roadway types:

a. Straight Roadways,
b. Roadways with a Curve or Turn,
c. Roadways with a Chicane or Loop, and
d. Roadways with Serpentine Barriers.

D. Straight Roadway.

1. General:
   a. For ACPs with a straight roadway, the Protective System will usually require advanced overspeed detection to detect the Threat Vehicle early in its attack. The distance between the ID Check Point and AVB (Dib) required to delay the Threat Vehicle is a function of the settings of the overspeed detectors. The higher the settings of the overspeed detectors are, the longer the distance Dib must be. Overspeed detectors must be set at speeds that are high enough to avoid excessive nuisance alarms. Therefore, maximizing the distance Dib, whether for a new ACP or upgrading an existing ACP, is a primary design objective.
   b. Distance Dib must be selected to defeat all four Threat Scenarios. In most cases, the worst case (longest) Dib will be the one required to contain high speed Threat Scenarios #1 or #2. Paragraphs 3 and 4 below describe calculation methods for defeating the high speed threats. Paragraph 5 below describes calculation methods for the covert entry threats.

2. ACP Corridor: The following two conditions must be considered when calculating delay for the high speed threat scenarios at an ACP with a straight roadway corridor.
   a. Limited Entry Speed. The first condition is when the speed of the Threat Vehicle entering the ACP corridor is limited by a speed management feature such as a curve, turn, or other permanent roadway feature for which the Threat Vehicle must slow down. The Threat Vehicle’s speed in the speed management feature must not exceed the spin-out speed of the feature or else it will spin out and lose the race to the AVB.
   b. Unlimited Entry Speed. The second condition is when the speed of the Threat Vehicle entering the ACP corridor is unlimited by any roadway features outside of the ACP corridor. For this type of ACP, the Threat Vehicle can attain an extremely high speed. Its speed approaching the ACP will be limited
only by restrictions in the ID Check Point area. The ID Check Point’s raised islands provide sufficient restrictions to limit the Threat Vehicle’s speed to 100 mph as it goes through the ID Check Point. Similar restrictions may be required in the outbound lanes for a Threat Vehicle attempting to enter the Installation through the outbound lanes. For protective systems requiring a maximum speed of 100 mph in the outbound lanes adjacent to the ID Check Point, install raised islands between adjacent lanes that are a minimum of 6” high with vertical curb faces similar to the traffic islands in the ID Check area.

3. High Speed Attack - Limited Entry Speed.
   a. No Advanced Overspeed Detection. Note, without advanced overspeed detection, there is no Threat Scenario #2. See examples at Attachment 2 for the Signs and Signals Safety System and Attachment 8 for the Presence Detection Safety System. Without advanced overspeed detection, the Threat Vehicle is not detected until it passes the ID Check Point (worst case), where it is traveling at a high rate of speed.
      i. Determine the spin-out speed \( V_s \) of the speed management feature near the ACP entrance. See Section E below for the method to calculate the spin-out speed of a speed management feature.
      ii. Determine the distance \( D_{si} \) between the end of the speed management feature and the ID Check Point.
      iii. Assuming the Threat Vehicle uses Threat Scenario #1 to attack, determine the Threat Vehicle’s speed \( V_i \) at the point of detection (ID Check Point). This speed is a function of \( V_s \), \( D_{si} \), and the acceleration rate of the Threat Vehicle. Note, this speed cannot be greater than 100 mph because of restrictions in the ID Check area (see paragraph D2b above).
      iv. Calculate the distance \( D_{ib} \) that the Threat Vehicle can travel in the required delay time from the point of detection (ID Check Point) at an initial speed of \( V_i \) and accelerating toward the AVB.
      v. Locate the AVB at a distance \( D_{ib} \) or greater beyond the ID Check Point to defeat Threat Scenario #1.

b. Advanced Overspeed Detection. Without advanced overspeed detection, the required distance \( D_{ib} \) between the ID Check Point and the barrier is very large (up to 1778 feet for the Signs and Signal Safety System). Most ACP corridors are not long enough to place the AVB this far from the ID Check Point. Distance \( D_{ib} \) is a function of the point where the Threat Vehicle is detected (ID Check Point in the example above) and the Threat Vehicle’s speed at the point of detection. In order to reduce the required distance \( D_{ib} \), the Threat Vehicle’s speed at the point of detection must be reduced or the point of detection must be moved ahead of the ID Check Point. The following calculation method shows how to select overspeed detection features that have
the effect of either reducing the Threat Vehicle’s speed at the point of
detection or moving the point of detection ahead of the ID Check Point.

i. One Zone of Continuous Overspeed Detection. Select a continuous
overspeed detector to cover a zone in the ACP corridor from the ID Check
Point to a certain distance ahead of the ID Check Point. The Threat Vehicle
has two options in attacking an ACP with a continuous overspeed detector.
The first option is Threat Scenario #1, where the Threat Vehicle ignores
the detectors and speeds through the ACP as fast as it can. The second
option is Threat Scenario #2, where the Threat Vehicle attempts to stay
under the setting of the detector. If the Threat Vehicle exceeds the set
point of the detector anywhere within the detector’s zone, overspeed
alarms notify the guards and the threat vehicle is detected. However, if the
Threat Vehicle’s speed stays just under the detector setting, the Threat
Vehicle will not be detected until it reaches the ID Check Point. At that
point, the ID Check Point guards will detect the vehicle and it will be
traveling (in the worst case) very close to the overspeed setting of the
detector. Therefore, the required distance Dib between the ID Check Point
and the AVB is a function of the speed setting of this continuous overspeed
detector.

1. Select the desirable or available distance Dib between the ID Check
Point and the AVB. Maximize this distance as described below.
2. Using the selected distance Dib between the ID Check Point and the
AVB, determine the setting of the continuous overspeed detector
required to achieve distance Dib. The setting of the continuous
overspeed detector should be set at as high a speed as possible to
reduce nuisance alarms. If nuisance alarms are excessive, guards will
either ignore the alarms or even turn them off. Without advanced
overspeed detection, the ACP will not defeat the high speed threats.
3. In order to maximize the detector’s alarm point setting, the distance
between the ID Check Point and the AVB (Dib) must be maximized.
Where possible, set the distance between the ID Check Point and the
AVB at 1118 feet for the Signs and Signals Safety System and 508 feet
for the Presence Detection Safety System. These distances require that
the continuous overspeed detector be set at 50 mph.
4. For ACPs with limited real estate, the minimum distances between the
ID Check Point and the AVB should be 853 feet for the Signs and
Signals Safety System and 361 feet for the Presence Detection Safety
System. These distances require that the continuous overspeed
detectors be set at 30 mph. For ACPs where these minimum distances
cannot be achieved, contact the PDC for guidance.
5. For ACPs with available distances Dib between 853 feet and 986 feet, install a second set of continuous overspeed detectors as described in paragraph ii below to help reduce nuisance alarms.

6. Calculate the range of the continuous overspeed detector. See examples at Attachment 3 for the Signs and Signals Safety System and Attachment 9 for the Presence Detection Safety System. Assume the Threat Vehicle begins its attack in Threat Scenario #1 at the end of the speed management feature traveling at the speed management feature’s spin-out speed and is accelerating. Determine the point where the Threat Vehicle must be detected in order to delay it for the required delay time before reaching the AVB. This point is the beginning of the zone of the continuous overspeed detector.

7. If the range of the overspeed detector calculated above is beyond the range of available detectors or will cause excessive nuisance alarms, add a point overspeed detector or an additional continuous overspeed zone at the point determined above and recalculate the overspeed detector range.

ii. Two Zones of Continuous Overspeed Detection. If a second zone of continuous overspeed detection is required, see examples at Attachment 4 for the Signs and Signals Safety System and Attachment 10 for the Presence Detection Safety System for the calculation method. Adding a second zone of continuous overspeed detection shrinks the required range of the overspeed zone closest to the ID Check Point (Zone 2), where innocent vehicles must be slowing down anyway to have their ID’s checked.

1. Set the zone closest to the ID Check Point (Zone 2) at the speed required to achieve the selected Dib.
2. Set the zone furthest from the ID Check Point (Zone 1) at 15 mph over the setting of the closer zone (Zone 2). This setting will provide a range of 198 feet for Zone 2.
3. Calculate the range of the outer continuous overspeed zone (Zone 1) using Threat Scenario #1 and the method described in paragraph D3bi6 above.
4. If the range of the Zone 1 overspeed detector calculated above is beyond the range of available detectors or will cause excessive nuisance alarms, add a point overspeed detector at the point determined above and recalculate the Zone 1 overspeed detector range.

iii. Overspeed Zones. Whenever speed zones are used in the ACP’s protective system, post speed limit signs at 15 mph at least 250 feet in front of the ID Check Point. Education of ACP users and diligent speed
enforcement by the Installation will be necessary to minimize nuisance overspeed alarms.

4. High Speed Attack - Unlimited Entry Speed ACP.
      i. The practical maximum speed of the Threat Vehicle at the point of detection (ID Check Point) is $V_{\text{max}}=100$ mph.
      ii. Calculate the distance $D_{ib}$ that the Threat Vehicle can travel in the required delay time at an initial speed of $V_{\text{max}}$ and accelerating toward the AVB. For $V_{\text{max}}=100$ mph, this distance is 1778 feet for the Signs and Signals Safety system and 875 feet for the Presence Detection Safety System.
      iii. Locate the AVB a distance $D_{ib}$ or greater beyond the ID Check Point to defeat Threat Scenario #1.
   b. Advanced Overspeed Detection.
      i. One Zone of Continuous Overspeed Detection. See examples at Attachment 6 for the Signs and Signals Safety System and Attachment 12 for the Presence Detection Safety System.
         1. Select the desirable or available distance $D_{ib}$ between the ID Check Point and the AVB. Maximize this distance as described above for the case of the limited entry speed ACP.
         2. Using Threat Scenario #2, determine the setting of the continuous overspeed detector required to achieve the $D_{ib}$ selected above.
         3. Using Threat Scenario #1, calculate the time $T_{ib}$ for the Threat Vehicle to travel distance $D_{ib}$ at an initial speed of $V_{\text{max}}=100$ mph.
         4. Subtract $T_{ib}$ from the required delay time to determine the remaining time the Threat Vehicle must be delayed. This time is designated $T_{di}$ and is the time the Threat Vehicle must take to go from the point of detection to the ID Check Point, which is designated as distance $D_{di}$.
         5. The least time that the Threat Vehicle can go distance $D_{di}$ is by starting at the point of detection at a high initial speed and decelerating at the Threat Vehicle’s maximum deceleration rate to $V_{\text{max}}$ by the time it gets to the ID Check Point. Calculate $D_{di}$ as a function of $V_{\text{max}}$, $T_{di}$, and the maximum deceleration rate of the Threat Vehicle.
         6. Locate a point overspeed detector at distance $D_{di}$ in front of the ID Check Point.
         7. Calculate the range of the continuous overspeed detector by assuming the Threat Vehicle will pass the point overspeed detector at just under its setting and then begin to accelerate. The point of detection will then be the beginning of the range of the continuous overspeed detector.
8. If the range of the overspeed detector calculated above is beyond the range of available detectors or will cause excessive nuisance alarms, add a point overspeed detector or an additional continuous overspeed zone at the point determined above and recalculate the overspeed detector range.

ii. Two Zones of Continuous Overspeed Detection. If a second zone of continuous overspeed detection is required, see examples at Attachment 7 for the Signs and Signals Safety System and Attachment 13 for the Presence Detection Safety System for the calculation method. Adding a second zone of continuous overspeed detection shrinks the required range of the overspeed zone closest to the ID Check Point (Zone 2), where innocent vehicles must be slowing down anyway to have their ID’s checked.

1. Set the zone closest to the ID Check Point (Zone 2) at the speed required to achieve the selected Dib.
2. Set the zone furthest from the ID Check Point (Zone 1) at 15 mph over the setting of the closer zone (Zone 2). This setting will provide a range of 198 feet for Zone 2.
3. Calculate the range of the outer continuous overspeed zone (Zone 1) using Threat Scenario #1 and the method described in paragraph D4bi7 above.
4. If the range of the Zone 1 overspeed detector calculated above is beyond the range of available detectors or will cause excessive nuisance alarms, add a point overspeed detector at the point determined above and recalculate the Zone 1 overspeed detector range.

iii. Overspeed Zones. Whenever speed zones are used in the ACP’s protective system, post speed limit signs at 15 mph at least 250 feet in front of the ID Check Point. Education of ACP users and diligent speed enforcement by the Installation will be necessary to minimize nuisance overspeed alarms.

5. Covert Entry Attack.
   a. Threat Scenario #3. Threat Scenario #3 begins at the ID Check Point with the Threat Vehicle stopped. The Threat Vehicle’s speed at the point of detection is then $V_d=0$ mph. Threat Scenarios #1 or #2 are always a worse case than Threat Scenario #3.
   b. Threat Scenario #4. Threat Scenario #4 begins at the end of the last turn-around with the Threat Vehicle traveling at the ACP speed limit. The Threat Vehicle’s speed at the point of detection is then $V_d=25$ mph. Threat Scenario #4 may be a worse case than Threat Scenario’s #1 and #2, especially if the last turn-around is far from the ID Check Point.
i. Determine the distance $D_{tb}$ the Threat Vehicle can travel from the point of
detection in the required time delay (7 seconds for Signs and Signals
Safety System and 3 seconds for the Presence Detection Safety System)
assuming it reaches the end of the last turn-around at a speed of 25 mph
and begins to accelerate.

ii. Add the distance $D_{it}$ from the ID Check Point to the end of the last turn-around
to distance $D_{tb}$ calculated above to find distance $D_{ib}$.

iii. Compare distance $D_{ib}$ calculated above to the $D_{ib}$ selected for the
high speed threat scenarios. If the $D_{ib}$ calculated for Threat Scenario #4 is
greater, move the last turn-around closer to the ID Check Point if possible.
If not possible, use the $D_{ib}$ calculated for Threat Scenario #4 and adjust as
necessary the settings and locations of any overspeed detectors required for
the high speed threats.

   a. Although speed zones reduce the required length of the Response Zone, they
      add a level of complexity to the protective system for both guard force
      operations and equipment maintenance. They should be utilized only when
      real estate for the ACP is limited and speed management features are not
      possible. If speed zones are to be utilized, care must be taken when selecting
      an over-speed detection system. Select system components including sensors,
      software, and head end equipment that have been proven for similar
      applications.
   b. Where possible, maximize the distance between the ID Check Point and the
      barrier. The locations and settings of the overspeed detectors are a function of
      this distance. The larger this distance is, the higher the settings of the sensors
      can be. Higher sensor settings will result in fewer nuisance overspeed alarms,
      which will improve the efficiency of the guards in identifying potential Threat
      Vehicles.
   c. Table 1 “Signs and Signals” lists the required distances between the ID Check
      Point and the AVB for various settings of the continuous overspeed detector
      for the Signs and Signals Safety System. Table 2 “Presence Detection” lists
      the same information for the Presence Detection Safety System.

E. Speed Management.
   1. General. Speed Management features such as curves, chicanes, turns, and
      serpentine barriers can be utilized to slow down the Threat Vehicle and,
      therefore, provide required delay times in less distance than straight roadways.
      Speed management features (SMF) provide delay by forcing vehicles to slow
      down to the spinout speed of the SMF. If a Threat Vehicle exceeds this speed, it
      will spin out. Even if it recovers, time lost will cause it to lose the race to the
final barrier. The Response Zone is the most effective location for an SMF, as an SMF here will delay the Threat Vehicle in all of the Threat Scenarios.

2. SMF Selection. To select an appropriate SMF, the first step is to evaluate its effect on defeating the given Threat Scenarios. The following is an evaluation of the four Threat Scenarios given in the Design Criteria considering an SMF is deployed in the Response Zone:

a. High Speed Threat Scenario #1. In high speed Threat Scenario #1, the Threat Vehicle speeds through the ID Check Area at the maximum speed it can attain. However, in order to keep from spinning out when it reaches the SMF, it must decelerate at some point before the SMF entrance so its speed when it reaches the SMF is at or below the SMF’s spinout speed. If the SMF is selected carefully, advance overspeed detection is not necessary. Select an SMF based on the following and considering that the point of detection is the ID Check Point, i.e., there is no advanced overspeed detection:
   i. Determine the quickest path through the SMF.
   ii. Determine the spinout speed or speeds if there is more than one SMF.
   iii. Determine the time a threat vehicle will take in getting through the SMF considering the path through the SMF and the SMF spinout speed.
   iv. Using the spinout speed at the SMF entrance, the distance between the SMF entrance and the ID Check Point, and the threat vehicle’s deceleration rate; determine the time it takes the threat vehicle to go from the ID Check Point to the SMF entrance assuming it is decelerating at its maximum rate over the entire distance.
   v. Subtract the time that the threat vehicle takes to go from the ID Check Point to the SMF entrance plus the time it takes it to go through the SMF from the required delay time to determine if additional delay is required for Threat Scenario #1. If additional delay is required, determine the straight line length of roadway between the end of the SMF and the barrier to get the required delay.

b. Threat Scenario #2. With no advanced overspeed detection, there is no Threat Scenario #2.

c. Threat Scenario #3. Threat Scenario #3 begins and is detected at the ID Check Point. However, the Threat Vehicle’s speed when it is detected is zero. The Threat Vehicle in Threat Scenario #1 above is also detected at the ID Check position, but it is traveling much faster. Therefore, Threat Scenario #1 is a worse case than Threat Scenario #3.
d. Threat Scenario #4. Threat Scenario #4 begins and is detected at the end of the last Turn-around. The last turn-around is the turn to the rejection lane or the turn in to the Search Area, whichever is closer to the barrier.

i. Using the threat vehicle’s speed at the end of the last turn around (25 mph), the spinout speed at the SMF entrance, the distance between the SMF entrance and the end of the last Turn-around, and the threat vehicle’s acceleration and deceleration rates; determine the time \( T_{ts} \) that it takes the threat vehicle to go from the end of the last Turn-around to the SMF entrance.

ii. Add the time \( T_{ts} \) to the time it takes the Threat Vehicle to go through the SMF (\( T_s \)). Subtract this time from the required delay time to determine if additional delay is required for Threat Scenario #4. If additional delay is required, determine the straight line length of roadway between the end of the SMF and the AVB to get the required delay. Remember, the required time delay for TS#4 is 2 seconds less than for TS #'s 1, 2, and 3 because of the reduced guard reaction time from 3 to 1 second.

F. Curves and Turns: A curve or turn in the Response Zone can be used to slow the threat vehicle and reduce the Response Zone distance required for delay. The threat vehicle in the high speed attack will have to decelerate to the spinout speed of the turn as it enters the turn. Therefore, design the turn and Response Zone such that advanced overspeed detection is not necessary. Without advanced overspeed detection, there is no Threat Scenario #2. The ID Check Point is the point of detection for Threat Scenario #'s 1 and 3 and the end of the last Turn-around is the point of detection for Threat Scenario #4.

1. Design Procedure:
   a. From the Traffic Study, determine the required roadway width and minimum inside radius of the turn.
   b. Select an angle of deflection or Turn angle (CA) for the curve/turn based on the desired delay. Turn angle is the angle between the curve’s entrance and exit. The larger the Turn angle, the longer the curve is.
   c. Determine the quickest path through the curve. The quickest path through a curve is a function of the Turn angle, the unobstructed roadway width, and the inside radius of the curve. See Figure 1 below– Path of Threat Vehicle in a Curve/Turn for the calculation method for determining the spinout speed \( \left( V_s \right) \) of a curve/turn.
d. Based on the spinout speed \( (V_s) \) calculated above, the distance between the ID Check Point (point of detection) and the beginning of the curve (\( D_{ic} \)), and the deceleration rate of the threat vehicle (\( a_d \)), determine the time the threat vehicle takes to go from the ID Check Point to the beginning of the curve:
   i. \( T_{ic} = \frac{(-V_s + (V_s^2 + 2a_dD_{ic})^{\frac{1}{2}})}{a_d} \).

e. Determine the time to go through the curve:
   i. \( T_c = \frac{CA}{360} \times 2\pi \times R/V_s \), where \( R \) is computed from the method shown in Figure 7 – Path of Threat Vehicle in a Curve/Turn.

f. Calculate the delay time remaining (\( T_r \)):
   i. \( T_r = T_d - T_{ic} - T_c \), where \( T_d \) is the delay time required for Threat Scenario #1.

g. Determine the required straight line distance between the end of the turn to the final barrier (\( D_{cb} \)):
   i. \( D_{cb} = V_s \times T_r + \frac{1}{2}a \times T_r^2 \).

h. Perform similar procedure for TS#4, only determine the time the Threat Vehicle travels between the end of the last turn around to the beginning of the curve/turn (\( T_{ce} \)). \( T_{ce} + T_c + T_r \) must be equal to or greater than the required delay time for Threat Scenario #1 (\( T_d \)). If \( T_{ce} + T_c + T_r \) is greater than \( T_d \), increase \( T_r \) by moving the final barrier further away until \( T_{ce} + T_c + T_r \) is equal or greater than \( T_d \).

2. Examples:
   a. See Attachment 14 for an example of a curve in the Response Zone utilizing the Signs and Signals Safety System and no advanced overspeed detection.
   b. See Attachment 15 for an example of a curve in the Response Zone utilizing the Signs and Signals Safety System with a point overspeed detector and one zone of continuous overspeed detection.
   c. See Attachment 16 for an example of a curve in the Response Zone utilizing the Presence Detection Safety System and no advanced overspeed detection.
   d. See Attachment 17 for an example of a curve in the Approach Zone utilizing the Signs and Signals Safety System and no advanced overspeed detection.

G. Chicanes and Loops.

1. Parameters of Chicanes and loops. Chicanes and loops are a series of turns whose exit is in the same alignment as its entrance. An example of a loop is shown on Drawing C3.14. Examples of chicanes are shown on Drawings C3.13 and C3.15. In order to determine delay times provided by chicanes and loops, the parameters of the chicane/loop must be defined. Parameters include inside turning radius, unobstructed roadway width, and angle of deflection or turn angle.
a. Turning radius determines how fast the threat vehicle can turn without spinning out. The spinout speed of a passenger vehicle can be calculated from the following equation (see page 119 of “A Policy on Geometric Design of Highways and Streets 1990” from AASHTO):

i. Eq. 1) \( V_s = ((f+e) * g * R)^{1/2} \), Where:
   1. \( f = \) friction factor (assume 0.75 for good tires and dry pavement)
   2. \( e = \) super elevation rate (usually between 0.00 and 0.04)
   3. \( g = \) acceleration of gravity (32.2 feet/second\(^2\))
   4. \( R = \) radius of turn in feet.

ii. Note, the radius (\( R \)) of the turn is not the same radius as the Inside Radius of the curve. The \( R \) used to calculate \( V_s \) is the radius of the quickest path or path segments through the chicane/loop. The quickest path can have several turns and straight sections. The radius of each turn was computed geometrically and checked graphically to determine each turn’s spinout speed. The various spinout speeds, curve distances, and straight line distances were used to calculate the chicane/loop traverse times.

b. The unobstructed roadway width is the width of the roadway between curbs. It includes the width of each lane plus the width of any shoulders or gutters. In order to minimize the unobstructed roadway width, roadways through chicanes and loops should be curbed on both sides. For one, two, and three-lane roadways, the unobstructed widths would normally be 14, 26, and 38 feet respectively, that is the 12-foot wide lanes plus one 2-foot gutter.

c. For a chicane or loop that ends in the same direction and alignment as it started (see Drawings C3.13, 14, and 15), the chicane/loop is a series of four turns; one right turn, two consecutive left turns, and one final right turn or vice versa. The turn angle is the angle that each turn makes between its entrance and exit. The turn angle determines the total distance traveled. The larger the turn angle is, the longer the turn distance is and, therefore, the longer the delay time is. To provide sufficient delay, turn angles normally vary between 50 and 90 degrees. Care must be taken in selecting turn angles. For wide roadway widths, larger turn angles are required to provide required delay, because the threat vehicle will use the wide roadway to switch between lanes and achieve a large radius path or paths through the chicane/loop. Use the following equations to calculate the total travel distance in the chicane/loop and the length and width of the chicane/loop given the inside radius, the turn angle, the roadway width, and the median width.
i. For Chicanes:

1. Eq. 2) CLR (Chicane Centerline Radius) = IR+W+M/2
2. Eq. 3) CD (Centerline Distance) = 4*CLR*Theta
3. Eq. 4) CL (Chicane Length) = 4*CLR*Sin(Theta)
4. Eq. 5) CW (Chicane Width) = 2*CLR*(1-Cos(Theta)) + 2*W+M,
   Where:
   a. IR is the inside radius of chicane;
   b. Theta is the turn angle;
   c. W is the roadway width, and
   d. M is the median width.

ii. For Loops:

1. Eq. 2a) CLR (Loop Centerline Radius) = IR+W/2
2. Eq. 3a) CD (Centerline Distance) = 4*CLR*Theta
3. Eq. 4a) CL (Loop Length) = 4*CLR*Sin (Theta)
4. Eq. 5a) CW (Loop Width) = 2*(2*CLR*(1-Cos (Theta)) + W)+M,
   Where:
   a. IR is the inside radius of curve;
   b. Theta is the turn angle;
   c. W is the roadway width, and
   d. M is the median width.

2. Time Delay through Chicanes and loops.

a. The ideal minimum time required to traverse a chicane/loop can be calculated using the chicane/loop centerline distance (Eq. 3 or 3a) divided by the maximum speed in the chicane/loop (Eq. 1). However, the ideal time assumes the threat vehicle will follow the centerline radius through the chicane/loop. In reality, the threat vehicle will use the entire width of the roadway to maximize the turning radii and thus maximize its spinout speeds. The practical traverse time can be calculated by analyzing the chicane/loop and determining the quickest path through it. This path will consist of several segments. Once the segments of the path are determined, calculate the radius, distance, maximum speed, and time to traverse each segment and add these times together to obtain the total traverse time.
b. The fastest path through a chicane/loop depends on the turn angle, the clear roadway width, and physical features at the entrance and exit. Two different paths were analyzed in this design procedure as follows:

i. Tangent Method – This path consists of 3 curved sections and 2 straight sections. Considering the chicane/loop consists of 4 Turns as described above, the path through the chicane/loop follows:

1. Approach Turn #1 from the left most ID Check Lane and gradually turn on a circular path toward the right hand curb of Turn #1. For a 6-foot wide vehicle, the centerline of the vehicle would travel toward a curve with a radius of 3 feet longer than the inside radius of Turn #1. Travel speed is limited by the radius of the curve.

2. Follow this curve a certain distance through Turn #1 and then turn straight toward the left curb of Turn #2. The straight section is a line tangent to the two circles defined by Turn #1 and Turn #2. These circles are separated by a distance s=RW-6, where RW is the unobstructed roadway width and the 6 feet is the width of the threat vehicle. Travel speed in the straight section is limited by how fast the vehicle can accelerate after exiting the first curve and how fast it must decelerate before entering the second curve.

3. The vehicle would then follow the left curb of the rest of Turn #2 and part of Turn #3 and then turn straight again toward the right curb of Turn #4.

4. The vehicle would finally travel along the right curb of Turn #4 and exit along a curve with the maximum radius attainable through the active vehicle barriers at the end of the curve.

ii. Three Curve Method – This path consists of three circle segments, one segment entering the Chicane/loop, one segment through the middle section of the Chicane/loop, and one segment exiting the Chicane/Turn. The middle circle segment is tangent to both the entrance and exit circle segments. Travel speeds are limited by the radius of each circle segment.

c. Chicanes and loops with various inside radii and roadway widths were evaluated to determine the quickest paths through them. Tables 3 and 4 below show parameters of these chicanes and loops respectively. For a given roadway width (number of lanes) and inside roadway radius, the tables show the required turn angle to achieve the 9 or 7 seconds of delay required for the Signs and Signals Safety System. The tables also list the distance through the Chicane/Loop (CD), Chicane/Loop Length (CL), Roadway Corridor Width (CW), Chicane/loop Traverse Time (Trz), and the time to traverse the distance between the ID Check Point and the active barriers (T_{ib}). Times Trz and Tib
listed in the tables are the best (least) traverse times between the two paths described above. Generally, for low turn angles, the Three Curve method is fastest, whereas, for higher turn angles, the Tangent method is fastest. Tables 5 and 6 below show the same information for chicanes and loops using the Presence Detection Safety System.

d. In Tables 3 through 6, the computed chicane and loop parameters assume that the ID Check Point is 90 feet in front of the chicane/loop and that inbound lanes are separated by raised islands. Also, the computed parameters assume that the active vehicle barriers are just beyond the end of the chicane/loop. These assumptions affect the radii of both entrance and exit curves and, therefore, the threat vehicle’s entry and exit speeds. If conditions at the entrance or exit to the chicane/loop are different than described above, calculations using the actual conditions must be performed.

3. Design Procedure for a Chicane or Loop:
   a. For a Chicane or Loop deployed in the Response Zone and meeting the requirements listed above, perform the following:
      i. Step 1 – Consider traffic volumes and types based on the Traffic Engineering Study and select appropriate parameters for the roadway width and the chicane/loop’s inside radius.
      ii. Step 2 - Select the AVB safety system, either Signs and Signals or Presence Detection.
      iii. Step 3 – Select the appropriate Table 3, 4, 5, or 6 based on the type feature (chicane or loop) and the AVB Safety System (Signs and Signals or Presence Detection).
      iv. Step 4 - For the appropriate roadway width and roadway inside radius, find the required chicane/loop parameters from the Table.
   b. For chicanes or loops that do not meet the requirements listed above, determine the fastest path through the chicane/loop and perform calculations to determine traverse times, or consult the PDC.

H. Serpentine Barriers:

1. General:
   a. Passive barriers arranged in a serpentine and placed in the Response Zone can be used to slow the threat vehicle and reduce Response Zone distances required for delay. Passive barriers must be substantial enough to stop or at least significantly slow down a vehicle upon impact. Concrete Jersey Barriers
or other equivalent passive barriers are suitable for serpentine application. See Figure 2 for layout.

b. Similar to the case for curves and turns, the threat vehicle in the high speed attack will have to decelerate to the spinout speed of the serpentine as it enters the serpentine. Therefore, design the serpentine and Response Zone such that advanced overspeed detection is not necessary. Without advanced overspeed detection, there is no Threat Scenario #2. The ID Check Point is the point of detection for Threat Scenario #’s 1 and 3. The end of the last turn-around is the point of detection for Threat Scenario #4.

2. Design Procedure:
   a. Refer to Figure 3 Serpentine Spinout Speeds to determine the spinout speed (Vₛ) of the serpentine. Note, the spinout speed is a function of the spacing between passive barriers.
   b. Based on the spinout speed (Vₛ) determined above, the distance between the ID Check Point (point of detection) and the beginning of the serpentine (Dᵣₛ), and the deceleration rate of the threat vehicle (aᵣ); determine the time the threat vehicle takes to go from the ID Check Point to the beginning of the serpentine:
      i. Tᵢₛ = (-Vₛ+(Vₛ²+2*aᵣ*Dᵣₛ)½)/aᵣ.
   c. Determine the time to go through the serpentine:
      i. Tₛ = 2*s/Vₛ, Where s=barrier spacing.
      ii. Note: the actual distance through the serpentine is slightly larger than 2*s, but only slightly, so use 2*s.
   d. Calculate the delay time remaining (Tᵣ):
      i. Tᵣ = T_d-Tᵢₛ-Tₛ, Where T_d is the delay time required for Threat Scenarios 1 and 3.
   e. Determine the required straight line distance between the end of the serpentine and the AVB (Dₛₐₚ).
      i. Dₛₐₚ=Vₛ*Tᵣ+½*a*Tᵣ²
   f. Perform similar procedure for TS#4; only determine the time the Threat Vehicle travels between the end of the last Turn-around to the beginning of the serpentine (Tₑₛ). Tₑₛ+Tₛ+Tᵣ must be equal to or greater than the required delay time for Threat Scenario #4.

3. Example: See Attachments 18 and 19 for examples for computing delay for serpentines in the Response Zone. Note, use of serpentine barriers reduces the effective roadway width. For a typical 2 lane roadway, the serpentine barriers
reduce the roadway to 1 lane. Serpentine barriers should only be used when traffic volumes can be handled by the reduced roadway widths.

I. Vehicle Barrier Sizing:

1. General: Per the OPMG Criteria (Appendix B) there are two types of threat vehicle, the high performance threat vehicle capable of accelerating at 11.3 f/s/s, and the 15,000-pound truck threat vehicle. The high performance threat vehicle is used to determine the barrier location to meet delay requirements. The 15,000-pound threat vehicle is used to determine the required stopping capacity of active and passive vehicle barriers. The stopping capacity of vehicle barriers is measured in kinetic energy. The barrier’s stopping capacity must be greater than the threat vehicle’s kinetic energy at the point of impact with the barrier. The threat vehicle’s kinetic energy at the point of impact with the barrier is determined by the following formula:
   a. KE=$\frac{1}{2}M(V\sin(\theta))^2$, where
      1. KE=Kinetic Energy,
      2. M=Mass of Threat Vehicle,
      3. V=Velocity of Threat Vehicle, and
      4. $\theta$=Angle of impact between the barrier and the Threat Vehicle.

2. Active Barriers: Per the OPMG Criteria (Appendix B), active vehicle barriers shall be capable of stopping a 15,000-pound vehicle traveling at the maximum speed it can attain before impacting the barrier, but in no case shall the speed be less than 30 mph. The 15,000-pound threat vehicle’s speed when it reaches the barrier depends on several factors, including initial speed, maximum acceleration rate(s), distance to barrier, and the alignment and grade of the roadway approaching the barrier. To determine the required vehicle stopping energy of the active vehicle barrier, use the following procedure:
   a. Determine the distance from the ID Check Point to the barrier (Dib) by evaluating the high speed Threat Vehicle (see Paragraphs D through H above).
   b. Determine roadway alignment in front of and through the ACP corridor including any speed management features that will limit the Threat Vehicle’s speed.
   c. Determine the grade of the ACP corridor.
   d. Determine the acceleration characteristics of the Threat Vehicle.
      Traditionally, trucks with a gross vehicle weight rating (GVWR) of 15,000 pounds are large single unit (SU) trucks. Acceleration characteristics at various grades for a large SU truck with a GVWR of 12,000-pounds are shown in Figure 4. Acceleration rates for a 15,000 pound SU will be similar.
Recently, heavy duty pick-up trucks are becoming available with GVWR approaching 15,000 lbs. Figure 5 shows the acceleration characteristics at various grades for the Ford F450, which has a GVWR of 14,500 pounds. Note for both vehicles, the acceleration rate is fairly constant up to about 15 mph, but then continually decreases as speed increases. However, the acceleration rates for the F450 are significantly higher than the SU truck.

e. Calculate the 15,000-pound threat vehicle’s velocity and energy at the barrier under each Threat Scenario. Threat vehicle kinetic energy is found from the equation in paragraph 1a above. Note, the impact angle $\theta$ is 90° for active barriers deployed in the roadway.

f. Select a barrier whose kinetic energy stopping capacity is greater than the highest threat vehicle kinetic energy determine above.

3. Active Barrier Example. Assume the evaluation of the high speed threat vehicle resulted in an ACP with a straight and level corridor, no speed management features, one zone of continuous overspeed detection set at 50 mph, and a $Dib=1118$ feet.

a. Threat Scenario #1: In Threat Scenario #1, the threat vehicle enters the ACP as fast as it can go considering any speed management features (SMF) or other features in the ACP corridor that would cause it to slow down. In this example, there are no SMFs, however the threat vehicle’s speed will be limited by restrictions in the ID Check Point area. For the high speed Threat Vehicle, the maximum speed through the ID Check Point area was limited to 100 mph (see paragraph D2b above). A practical limit for the SU truck would be 40 mph and for the F450 would be 60 mph. Per Figure 4, at an initial speed of 40 mph, a 15,000-pound SU truck will accelerate to about 50 mph after traveling 1118 feet. The threat vehicle’s kinetic energy would be 1,253,000 foot-pounds, which would require a K12 rated barrier. Per Figure 5, at an initial speed of 60 mph, the F450 will accelerate to about 70 mph after traveling 1118 feet. The threat vehicle’s kinetic energy would be 2,373,000 foot-pounds, which would exceed the capacity of a K12 rated barrier.

b. Threat Scenario #2: In Threat Scenario #2, the Threat Vehicle is detected at the ID Check Point when it is traveling at or below a speed equal to the setting of the continuous overspeed detector nearest to the ID Check Point. For this example, the continuous overspeed detector is set at 50 mph, which is higher than the maximum practical speed of the 15,000-pound SU truck at the ID Check Point but lower than the maximum speed of the F450. Therefore, the threat vehicle’s speed and energy at the barrier will be less than the speed and energy for Threat Scenario #1 determined above.
c. Threat Scenario #3: In Threat Scenario #3, the Threat Vehicle is detected at the ID Check Point and is stopped. Per Figure 4, at an initial speed of 0 mph, the 15,000-pound SU truck will accelerate to about 43 mph after traveling 1118 feet. The threat vehicle’s kinetic energy would be 926,000 foot-pounds, which is less than that determined for Threat Scenario #1 above. Per Figure 5, the F450 starting at 0 mph and traveling 1118 feet will accelerate to about 57 feet when it reaches the barrier. The F450’s kinetic energy will be 1,574,000 foot-pounds, which is less than that determined for Threat Scenario #1 above.

d. Threat Scenario #4: In Threat Scenario #4, the Threat Vehicle is detected at the end of the last turn-around, which is 90 feet beyond the ID Check Point and is traveling at 25 mph. Per Figure 4, at an initial speed of 25 mph, the 15,000-pound SU Truck will accelerate to about 43 mph after traveling (1118-90=) 1028 feet. The threat vehicle’s kinetic energy would be 926,000 foot-pounds, which is less than that determined for Threat Scenario #1 above. Per Figure 5, at an initial speed of 25 mph, the F450 will accelerate to about 57 mph after traveling (1118-90=) 1028 feet. The threat vehicle’s kinetic energy would be 1,574,000 foot-pounds, which is less than that determined for Threat Scenario #1 above.

e. Select Threat Scenario #1 as the worst case. Note, the F450’s kinetic energy at the barrier of 2,373,000 foot-pounds exceeds the rating of a K12 barrier (1,253,000 foot-pounds). However, at speeds over 50 mph, most K12 rated active vehicle barriers will disable if not destroy a 15,000 pound SU or a F450 type heavy duty pick-up. Therefore, based on engineering judgment, a K12 rated active vehicle barrier would be sufficient to defeat the Threat Vehicle in this example.

4. Passive Barriers: Per the OPMG Criteria (Appendix B), passive barriers are required to stop a 15,000 pound threat vehicle anywhere along the ACP corridor traveling at whatever speed and impact angle it can attain upon barrier impact. The 15,000-pound threat vehicle’s energy when it impacts the barrier depends on its speed and impact angle per the equation in paragraph 11 above. To determine the required vehicle stopping energy of passive vehicle barriers, use the following procedure:

a. Evaluate the entire ACP corridor. Determine each curve, turn, and straight segment in the ACP corridor.

b. For each corridor segment, determine the maximum speed and impact angle attainable by the 15,000 pound threat vehicle. Note, corridor segments with curves or turns may allow larger impact angles (which may require higher energy capacity barriers) than straight segments.
i. The threat vehicle’s kinetic energy increases with increasing impact angles and increasing velocities per the equation in paragraph 11 above.

ii. The impact angle for the threat vehicle is a function of the vehicle’s velocity and the clear roadway width, i.e., the width of the roadway between the passive barriers.

iii. Figure 6 shows the relationship between the clear roadway width and the threat vehicle’s impact angle for a straight roadway segment. From Figure 6, as the threat vehicle’s speed increases, the radius of its turn into the passive barrier must also increase to keep from spinning out. As the threat vehicle’s turn radius increases, its impact angle into the barrier decreases. Increasing threat vehicle speed increases kinetic energy, however, because of the resultant decrease in impact angles, speeds above 50 mph result in only small increases in kinetic energy. Table 7 shows the threat vehicle’s kinetic energy for various clear roadway widths for a 15,000 pound threat vehicle traveling at 50 mph upon impact.

iv. Figure 7 shows the relationship between the clear roadway width and the threat vehicle’s impact angle for a roadway segment with a curve.

c. Determine the maximum threat vehicle speed for each passive barrier segment in the corridor and the resultant impact angles from the method shown in Figure 6 for straight corridor segments and Figure 7 for corridor segments with curves.

d. Using the equation in paragraph 11 above, determine the maximum kinetic energy of the threat vehicle for each corridor segment.

e. Select a passive barrier with stopping capability equal to or greater than the threat vehicle’s kinetic energy for each corridor segment.

5. Passive Barrier Example. Assume the evaluation of the high speed threat vehicle resulted in an ACP with a 50’ wide clear roadway width and a right hand 130’ radius 90° turn that is 225’ beyond the ID Check Point. Using Attachment 14 “Example - Curve in Response Zone, Signs and Signals Safety System”, there must be 249’ of straight roadway beyond the end of the threat vehicle’s path in the turn to the barrier.

a. Determine the passive barrier capacity for barriers along the curve and for barriers in the straight roadway sections before and after the curve.

b. Barriers along the curve.

i. For a turn to the right, the Threat Vehicle can impact the left side passive barrier without having to slow down for the curve. The impact angle is a function of the curve radius and the clear roadway width between the passive barriers – see Figure 7 – Threat Vehicle Impact Angle in a Curve. From Figure 7 with an inside radius of IR=130 feet and a clear roadway...
width of RW=50 feet (4 lane roadway), the Threat Vehicle’s impact angle is \( \theta = 90^\circ - \arcsin\left(\frac{R-RW+Dpb}{R}\right) \); where R=IR+RW=180’, RW=50’, and Dpb=4’. For this example, \( \theta = 41.9^\circ \).

ii. From Attachment 14, the maximum speed in the curve is 57 mph and the maximum speed at the ID Check Point to keep from spinning out in the curve is 77 mph. The maximum speed of the 14,500 pound F450 through the ID Check Point, per paragraph I3a above, is 60 mph. The distance between the ID Check Point and the point of impact with the left side passive barrier is 225’ + R*Sin(\( \theta \)) = 345’ (see figure 7). The Threat Vehicle will pass the ID Check Point at 60 mph and then start to accelerate through the 345’ to the barrier. From Figure 5, the Threat Vehicle’s speed at the point of impact with the barrier is about 63 mph. The Threat Vehicle’s kinetic energy at the point of impact is

\[
KE = \frac{1}{2} \times \frac{14,500}{32.2} \times (63 \times 5280/3600 \times \sin(41.9^\circ))^2 = 857,000 \text{ foot-pounds.}
\]

c. Barriers along the straight sections.

i. For straight sections of the roadway, the Threat Vehicle’s impact angle with the barrier is a function of the Threat Vehicle’s speed and the clear roadway width between the passive barriers along the roadway – see Figure 6.

ii. Straight Section after the curve. From paragraph 5bii above, the Threat Vehicle’s maximum speed through the curve is 57 mph. The active barrier is 249’ from the end of the threat vehicle’s path in the curve. From Figure 5, the Threat Vehicle can attain a speed of about 60 mph before impacting the active barrier. To attain its maximum speed upon impact, the Threat Vehicle would attempt to impact the passive barrier just ahead of the active barrier. Using the method shown on Figure 6 at a speed of 60 mph, the radius of the Threat Vehicle’s turn into the barrier must be no greater than 341’ and its impact angle into the barrier can be no greater than \( \theta = 30^\circ \). Maximum Threat Vehicle kinetic energy is then

\[
KE = \frac{1}{2} \times \frac{14,500}{32.2} \times (60 \times 5820/3600 \times \sin(30^\circ))^2 = 436,000 \text{ foot-pounds.}
\]

iii. Straight Section before the curve. The Threat Vehicle’s maximum speed through the ID Check Point is 60 mph. In order maximize its impact speed, the Threat Vehicle would attempt to impact the straight section of the passive barrier just ahead of the curve. This point is 225’ from the ID Check Point. Per Figure 5, the Threat Vehicle’s speed at the point of impact would be about 62 mph. Using the method shown on Figure 6 at a speed of 62 mph, the radius of the Threat Vehicle’s turn into the barrier must be no greater than 342’ and its impact angle into the barrier can be no greater than \( \theta = 30^\circ \). Maximum Threat Vehicle kinetic energy is then

\[
KE = \frac{1}{2} \times \frac{14,500}{32.2} \times (62 \times 5820/3600 \times \sin(30^\circ))^2 = 465,000 \text{ foot-pounds.}
\]
d. Conclusion. The required kinetic energy capacity of the passive barriers along the first straight roadway section is 465,000 foot-pounds, which is slightly higher than the stopping capacity required for the straight section after the curve, which is 436,000 foot-pounds. Use passive barriers with a stopping capacity of 465,000 foot-pounds for both straight roadway sections and the right side of the curve section. Use passive barriers with a stopping capacity of 824,000 foot-pounds for the left side of the curve section, which is slightly higher than the 802,000 foot-pound capacity of a K8 rated barrier.

J. Summary: Using properly designed Speed Management Features in the Response Zone can effectively delay the Threat Vehicle in all 4 of the Threat Scenarios defined in the criteria. When SMF’s cannot be utilized, large distances in the Response Zones are required to defeat the Threat Scenarios defined in the criteria, especially Threat Scenario #2. Over-speed detection systems can be utilized to reduce Response Zone lengths, but these systems add complexity in ACP operations and equipment maintenance and are not as effective as Speed Management Features.
### Signs & Signals

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### Presence Detection

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### Table 3 - Chicanes - Signs and Signals

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TABLE 4 - LOOPS - SIGNS AND SIGNALS

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CA = Curve Angle of Turn
IR = Inside Radius of Turn
RW = Width of Unobstructed Roadway
R = Radius of Path of Threat Vehicle

\[ R_1 = IR + 3 \]
\[ S = RW - 6 \]
\[ TH = \frac{CA}{6} \]
\[ COS(TH) = \frac{Y}{R_2} \]
\[ Y = R_2 \cdot COS(TH) \]
\[ R = Y + R_1 + S \]
\[ R = R_1 + R_2 \]
\[ Y + R_1 + S = R_1 + R_2 \]
\[ S = R_2 - Y \]
\[ S = R_2 - R_2 \cdot COS(TH) \]
\[ R_2 = \frac{S}{1 - COS(TH)} \]
\[ R = R_1 + \frac{S}{1 - COS(TH)} \]
\[ V_s = \sqrt{R \cdot g \cdot (f + e)} \]
\[ X = \frac{S \cdot SIN(TH)}{1 - COS(TH)} \]

Figure 1
Path of Threat Vehicle in a Curve/Turn
Figure 2 – Serpentine Barriers Layout

Figure 3 – Serpentine Spinout Speeds
Figure 4 – Acceleration Characteristics of a 12,000 Pound Truck
Figure 5 – Acceleration Characteristics of a Ford F450 with a 14,500 Pound Gross Vehicle Weight Rating (GVWR)
RW = Clear width of the roadway between passive barriers [feet]
TW = Width of Threat Vehicle = 8 feet
a = RW - \( \frac{1}{2} \) * TW = RW - 4 [feet]
V = Speed of Threat Vehicle on turn into the passive barrier [feet/second]
f = coefficient of friction for dry pavement and good tires = 0.75
\( g \) = acceleration of gravity = 32.2 feet/second/second
R = Minimum radius of Threat Vehicle's turn into the barrier to avoid spinning out at a speed of V [feet]
\[
R = \frac{V^2}{f \cdot g}
\]
b = R - a [feet]
\( \theta \) = Impact angle of Threat Vehicle with barrier = ACos(b/R)
W = Weight of Threat Vehicle = 15,000 pounds
M = Mass of Threat Vehicle = W/g = 15,000/32.2 = 466 Slugs
KE = Component of the Threat Vehicle's kinetic energy that is perpendicular to the barrier upon impact. This energy is the required stopping capacity of the passive barrier.
\[
KE = \frac{1}{2} \cdot M \cdot (V \cdot \text{Sin}(\theta))^2 \text{ [foot-pounds]}
\]

**FIGURE 6**

**THREAT VEHICLE IMPACT ANGLE ON A STRAIGHT ROADWAY**
\[ \theta = 90^\circ - \phi = \text{Impact Angle} \]
\[ \sin(\phi) = \frac{R - RW + Dpb}{R} \]

**FIGURE 7**

**THREAT VEHICLE IMPACT ANGLE IN A CURVE**

**Legend:**
- \( R \) = Outside Radius of Curve
- \( RW \) = Clear Roadway width between Passive Barriers
- \( Dpb \) = Distance between right side Passive Barrier and the Centerline of the Threat Vehicle. Assume Threat Vehicle is 8' wide.
A. Equations of Motion. Calculations showing that the threat scenarios will be defeated are based on the equations of motion, the most common of which are shown below:

1. \( V = V_o + a \times T \)
2. \( D = V_o \times T + \frac{1}{2} \times a \times T^2 \)
3. \( V^2 = V_o^2 + 2 \times a \times D \)
4. \( D = \frac{(V^2 - V_o^2)}{2 \times a} \)
5. \( T = \frac{(-V_o + (V_o^2 + 2 \times a \times D)^{1/2})}{a} \)

- **a.** \( V \) = final speed (feet per second)
- **b.** \( V_o \) = initial speed (feet per second)
- **c.** \( D \) = distance (feet)
- **d.** \( T \) = time (seconds).
- **e.** \( a \) = acceleration or deceleration (feet/second\(^2\))

   i. Acceleration: The Design Criteria (Appendix B) sets the maximum acceleration of the threat vehicle at \( a = 11.3 \) feet/second\(^2\).

   ii. Deceleration: The maximum deceleration rate of the threat vehicle \( (a_d) \) is calculated from the relationship \( a_d = f \times g \), where \( g \) is the acceleration of gravity (32.2 feet/second\(^2\)) and \( f \) is the friction factor. From page 122, Figure III-IA in “A Policy on Geometric Design of Highways and Streets 1990” from the American Association of State Highway and Transportation Officials (AASHTO), \( f = 0.75 \) for dry pavement and good tires. Therefore, \( a_d = 24.1 \) feet/second\(^2\).

B. Spin-out Speed. The spin-out speed \( V_s \) of a vehicle in a curve is:

1. \( V_s = \sqrt{R \times g \times (f + e)} \), where
   - **a.** \( R \) is radius of the curve in feet,
   - **b.** \( g \) is the acceleration of gravity (32.2 feet/second\(^2\))
   - **c.** \( f \) is the friction factor (0.75),
   - **d.** \( e \) is the super elevation of the roadway (from 0 to 0.04).

C. Accelerate and then Decelerate over Known Distance. To find the time for a vehicle to travel over a known distance \( D \) starting at a known initial speed \( V_i \) and ending at a known final speed \( V_f \), use the following calculation method:
1. Calculate distances d₁ (which is the distance the vehicle will travel from the beginning of D to the point where it reaches a maximum speed) and d₂ (which is the distance vehicle will travel from the point of maximum speed to the end of D).
   a. \[ d₁ = \frac{(V_f^2 - V_i^2 + 2*a_d*D)}{(2*a + 2*a_d)} \]
   b. \[ d₂ = D - d₁ \]

2. Calculate the maximum speed \( V_m \) that the vehicle will reach before starting to decelerate. Recommend calculating \( V_m \) using both of the equations below to verify accuracy of previous calculations:
   a. \[ V_m = \sqrt{(V_i^2 + 2*a*d₁)} \]
   b. \[ V_m = \sqrt{(V_f^2 + 2*a_d*d₂)} \]

3. Calculate \( T_1 \), \( T_2 \), and \( T \); which are the times to go distances \( d₁ \), \( d₂ \), and \( D \) respectively.
   a. \[ T_1 = \frac{(V_m - V_i)}{a} \]
   b. \[ T_2 = \frac{(V_m - V_f)}{a_d} \]
   c. \[ T = T_1 + T_2 \]

D. Range of Continuous Overspeed Detector. To find the required range of a continuous overspeed detector given the location and setting of the point overspeed detector immediately in front of it, use the following calculation method:

1. Solve the following 3 simultaneous equations assuming the vehicle will pass the point overspeed detector at just under its setting and then start to accelerate toward the range of the continuous overspeed detector:
   a. \[ V_c = \sqrt{(V_p^2 + 2*a*D_{pc})} \], Where:
      i. \( V_p \) is the setting of the point overspeed detector.
      ii. \( V_c \) is the speed the vehicle will attain when it reaches the beginning of the continuous overspeed detector’s range.
      iii. \( D_{pc} \) is the distance between the point overspeed detector and the beginning of the range of the continuous overspeed detector.
   b. \[ D_{cb} = V_c*t + \frac{1}{2}*a*t^2 \], Where:
      i. \( D_{cb} \) is the distance between the beginning of the range of the continuous overspeed detector and the final barrier and
      ii. \( t \) is the required delay time (5 seconds for the Presence Detection Safety System and 9 seconds for the Signs and Signals Safety System).
c. \( D_{pb} = D_{pc} + D_{cb} \), Where: \( D_{pb} \) is the known distance from the point overspeed detector to the final barrier.

2. Solving these 3 equations for \( D_{cb} \) results in a quadratic equation with the following parameters:
   a. \( A = 1/t^2 \)
   b. \( B = a \)
   c. \( C = a^2 \cdot t^2 / 4 - V_p^2 - 2a \cdot D_{pb} \)
   d. \( D_{cb} = (-B + (B^2 - 4A \cdot C)^1/2) / (2A) \)
   e. \( D_{ci} = D_{cb} - D_{ib} \), Where:
      i. \( D_{ib} \) is the know distance between the ID Check Point and the final barrier.
      ii. \( D_{ci} \) is the required distance between the beginning of the range of the continuous overspeed detector and the ID Check Point. \( D_{ci} \) is then the required range of the continuous overspeed detector.
APPENDIX D

ATTACHMENTS 2 THRU 19

(The actual Excel Spreadsheets are in a Separate File Folder)
### No Overspeed Detection

#### Assumptions

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assume that the ACP corridor is straight, but that there is a required</td>
<td></td>
</tr>
<tr>
<td>turn or turns to get into the corridor, which limit vehicle speed to $V_e$</td>
<td></td>
</tr>
<tr>
<td>at the ACP entrance.</td>
<td>$V_e$ 60 mph 88.0 f/s</td>
</tr>
<tr>
<td>Also assume that the end of the turn is $D_{a_d}$ feet in front of the ID</td>
<td></td>
</tr>
<tr>
<td>Check Point.</td>
<td>$D_{a_d}$ 400 feet</td>
</tr>
<tr>
<td>Delay time for S&amp;S Safety System is $t$</td>
<td>$t$ 9 sec</td>
</tr>
<tr>
<td>Threat Vehicle acceleration rate is $a$</td>
<td>$a$ 11.3 f/s/s</td>
</tr>
<tr>
<td>TV deceleration is $a_d$</td>
<td>$a_d$ 24.1 f/s/s</td>
</tr>
</tbody>
</table>

#### A Threat Scenarios #1

Since there is no overspeed detection, there is no Threat Scenario #2.

With no advanced overspeed detection, the Threat Vehicle enters the ACP at the spin-out speed of the turn and begins to accelerate. By the time it reaches the ID Check Point, it is traveling at

$$V_i = \sqrt{(V_e^2 + 2 \cdot a \cdot D_{a_d})^{1/2}}$$

If $V_i$ is greater than 100 mph, use $V_i = 100$ as the criteria limits the Threat Vehicle's speed through the ID Check Point to no more than 100 mph.

In the worst case, ACP guards will not detect the Threat Vehicle until it passes the ID Check Point. The point of detection is then the ID Check Point with the Threat Vehicle traveling at an initial speed of $V_i$.

The required distance $D_h$ from the ID Check Point to the Barrier must be

$$D_h = V_i \cdot t + \frac{1}{2} \cdot a \cdot t^2$$

$$D_h = 1624 \text{ feet}$$

#### B Threat Scenario #3

Threat Scenario 3 begins at the ID Check Point with the Threat Vehicle traveling at an initial speed of 0 mph. In the required delay time, Threat Vehicle will travel

$$D_h = \frac{1}{2} \cdot a \cdot t^2$$

$$D_h = 458 \text{ feet}$$

#### C Threat Scenario #4

Threat Scenario #4 begins at the end of the last turnaround with the Threat Vehicle traveling at an initial velocity of $V_t = 25$ mph.

The required delay for Threat Scenario #4 is $t$

$$t = 7.0 \text{ sec}$$

In the required delay time of 7 seconds, Threat Vehicle will travel

$$D_h = V_t \cdot t + \frac{1}{2} \cdot a \cdot t^2$$

The distance between the ID Check Point and the end of the last turnaround is $D_{a_d}$

$$D_{a_d} = 90.0 \text{ feet}$$

The required distance between the ID Check Point and barrier is

$$D_{ib} = D_{a_d} + D_h$$

$$D_{ib} = 624 \text{ feet}$$

#### D Recommendations

Distances required for Threat Scenarios #3 & #4 are much less than for Threat Scenario #1. Place the barriers at least $D_{ib}$ feet (for Threat Scenario #1) from the ID Check Point.

$$D_{ib} = 1624 \text{ feet}$$
Assumptions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assume that the ACP corridor is straight, but that there is a required</td>
<td>V_e 60 mph 88.0 f/s</td>
</tr>
<tr>
<td>turn or turns to get into the corridor, which limit vehicle speed to V_e at</td>
<td></td>
</tr>
<tr>
<td>the ACP entrance. Enter V_e.</td>
<td></td>
</tr>
<tr>
<td>Also assume that the ACP entrance is D_{ei} feet in front of the ID Check</td>
<td>D_{ei} 500 feet</td>
</tr>
<tr>
<td>Point. Enter D_{ei}.</td>
<td></td>
</tr>
<tr>
<td>Delay time for S&amp;S Safety System is t</td>
<td>t 9 sec</td>
</tr>
<tr>
<td>Threat Vehicle acceleration rate is a</td>
<td>a 11.3 f/s/s</td>
</tr>
<tr>
<td>TV deceleration is a_d</td>
<td>a_d 24.1 f/s/s</td>
</tr>
</tbody>
</table>

A Threat Scenario #2

Assume there is sufficient distance in the Response Zone to place the barrier at Dib feet beyond the ID Check Point. Install one zone of continuous overspeed detection immediately in front of the ID Check point. Set the alarm point at a speed V_{cs} to achieve the desired Dib.

In order to avoid early detection, the Threat Vehicle will stay just under V_{cs} until it reaches the ID Check Point and then it will start to accelerate. Point of detection is the ID Check Point with the Threat Vehicle traveling at a speed of V_{cs}.

Enter the desireable distance D_{ib} from the ID Check point to the Barrier:  D_{ib} 1118 feet

In order to travel distance Dib in the required time delay of t seconds, the Threat Vehicle's speed at the ID Check Point must be no greater than \( V_{cs} = (Dib - \frac{1}{2}a_t^2)/t \)

The distance D_{eb} from the ACP entrance to the final barrier is

\[ D_{eb} = D_{cs} + D_{ib} \]

D_{eb} 1618 feet

B Threat Scenarios #1 & #2

To find the required range of the continuous overspeed detector, assume the TV starts to accelerate from an initial speed of V_e immediately after it enters the ACP.

The speed of the TV as it reaches the beginning of the continuous overspeed zone is \( V_z = (V_e^2 + 2a*D_{ez})^{1/2} \), where D_{ez} is the distance between the ACP entrance and the beginning of the range of the continuous overspeed detector.

The distance between the beginning of the range of the continuous overspeed detector and the barrier (D_{sh}) must provide t seconds of delay, so \( D_{sh} = V_z*t + 1/2*a*t^2 \).

The distance between the ACP entrance and the beginning of the range of the continuous overspeed detector is \( D_{ez} = D_{sh} - D_{eb} \).

Solving these 3 equations for D_{sh} gives the following quadratic parameters:
### D Threat Scenario #3

Threat Scenario 3 begins at the ID Check Point with the Threat Vehicle traveling at an initial speed of 0 mph. In the required delay time, Threat Vehicle will travel \( D_{ib(3)} = \frac{1}{2}a*t^2 \)

\( D_{ib(3)} \) 458 feet

### E Threat Scenario #4

Threat Scenario #4 begins at the end of the last turnaround with the Threat Vehicle traveling at an initial velocity of \( V_t = 25 \text{ mph} \).

\[ V_i = 25.0 \text{ mph} \quad 36.7 \text{ f/s} \]

The required delay for Threat Scenario #4 is \( t = 7.0 \text{ sec} \)

In the required delay time, Threat Vehicle could travel

\( D_{ib} = V_i * t + \frac{1}{2}a*t^2 \)

\( D_{ib} \) 534 feet

Assume the distance between the ID Check Point and the end of the last turnaround is \( D_{it} \)

\( D_{it} \) 90.0 feet

The required distance between the ID Check Point and barrier is

\( D_{ib(4)} = D_{it} + D_{tb} \)

\( D_{ib(4)} \) 624 feet

### F Recommendations

Distances \( D_{ib(3)} \) and \( D_{ib(4)} \) required for Threat Scenarios #3 & #4 respectively are less than the \( D_{ib} \) selected above. Place barrier a minimum distance of \( D_{ib} \) from the ID Check Point.

\( D_{ib} \) 1118 feet

Set continuous overspeed detector to reach from ID Check Point to a distance \( D_{zi} \) feet in front of ID Check Point.

\( D_{zi} \) 319 feet

Set continuous overspeed detector(s) at \( V_{cs} \) mph.

\( V_{cs} \) 50.0 mph

Note, if the range of the continuous overspeed zone needs to be reduced because of detector limitations or in order to reduce nuisance alarms (e.g., \( D_{zi} > 400' \)), place a point overspeed detector at \( D_{zi} \), set it at 10 mph over \( V_{cs} \), and recalculate \( D_{zi} \) using the above procedure.
## Example - Signs & Signals, Straight Roadway, Limited Entry Speed

### Two Zones of Continuous Overspeed Detection

#### Assumptions

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assume that the ACP corridor is straight, but that there is a required turn or turns to get into the corridor, which limit vehicle speed to $V_e$ at the ACP entrance.</td>
<td>$V_e$ 60 mph 88.0 f/s</td>
</tr>
<tr>
<td>Also assume that the ACP entrance is $D_{ei}$ feet in front of the ID Check Point.</td>
<td>$D_{ei}$ 500 feet</td>
</tr>
<tr>
<td>Delay time for S&amp;S Safety System is $t$</td>
<td>$t$ 9 sec</td>
</tr>
<tr>
<td>Threat Vehicle acceleration rate is $a$</td>
<td>$a$ 11.3 f/s/s</td>
</tr>
<tr>
<td>TV deceleration is $a_d$</td>
<td>$a_d$ 24.1 f/s/s</td>
</tr>
</tbody>
</table>

#### A Threat Scenario #2

Assume the available distance $D_{ib}$ beyond the ID Check Point to place the barrier is limited. Install two zones of continuous overspeed detection in front of the ID Check point. Set the alarm point of the zone immediately in front of the ID Check Point (Zone 2) to $Vc_2$ to achieve the available $Dib$. Set the alarm point of the outer zone (Zone 1) at $Vc_2$.

In order to avoid early detection, the Threat Vehicle will stay just under both $Vc_1$ and $Vc_2$ until it reaches the ID Check Point and then it will start to accelerate. Point of detection is the ID Check Point with the Threat Vehicle traveling at a speed of $Vc_2$.

- Energy the available distance $D_{ib}$ from the ID Check point to the Barrier: $D_{ib}$ 854 feet
- In order to travel distance $D_{ib}$ in the required time delay of $t$ seconds, the Threat Vehicle's speed at the ID Check Point must be no greater than $Vc_2=(D_{ib}-1/2*a*t^2)/t$ $Vc_2$ 30.0 mph 44.0 f/s
- Set the Zone 1 detector 15 mph higher than the setting of the Zone 2 detector. $Vc_1$ 45.0 mph 66.0 f/s
- The range of the Zone 2 detector is then $Dc2i=(Vc1-Vc2)*t$ $Dc2i$ 198 feet

- The distance $D_{eb}$ from the ACP entrance to the final barrier is $D_{eb}=D_{ei}+D_{ib}$ $D_{eb}$ 1354 feet

#### B Threat Scenarios #1 & #2

To find the required range of the Zone 1 continuous overspeed detector, assume the TV starts to accelerate from an initial speed of $V_e$ immediately after it enters the ACP.

The speed of the TV as it reaches the beginning of the Zone 1 continuous overspeed zone is $V_z=(V_e^2+2*a*D_{ez})^{1/2}$, where $D_{ez}$ is the distance between the ACP entrance and the beginning of the range of the Zone 2 continuous overspeed detector.

The distance between the beginning of the range of the Zone 1 continuous overspeed detector and the barrier ($D_{ab}$) must provide $t$ seconds of delay, so $D_{ab}=V_z*t+1/2*a*t^2$
The distance between the ACP entrance and the beginning of the range of the Zone 1 continuous overspeed detector is $D_{ez} = D_{eb} - D_{zb}$

Solving these 3 equations for $D_{zb}$ gives the following quadratic parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A$</td>
<td>$1/t^2$</td>
</tr>
<tr>
<td>$B$</td>
<td>$a$</td>
</tr>
<tr>
<td>$C$</td>
<td>$a^2<em>t^2/4 - V^2 - 2</em>a*D_{eb}$</td>
</tr>
</tbody>
</table>

Hence, $D_{zb} = \frac{-B + \sqrt{B^2 - 4*A*C}}{2*A}$

The distance between the beginning of the Zone 1 detectors range and ID Check Point is $D_{zi} = D_{zb} - D_{ib}$

**D Threat Scenario #3**

Threat Scenario 3 begins at the ID Check Point with the Threat Vehicle traveling at an initial speed of 0 mph. In the required delay time, Threat Vehicle will travel $D_{ib}(3) = \frac{1}{2}a*t^2$

**E Threat Scenario #4**

Threat Scenario #4 begins at the end of the last turnaround with the Threat Vehicle traveling at an initial velocity of $V_t = 25$ mph. The required delay for Threat Scenario #4 is $t = 7.0$ sec

In the required delay time, Threat Vehicle could travel $D_{ib} = V_t*t + \frac{1}{2}a*t^2$.

Assume the distance between the ID Check Point and the end of the last turnaround is $D_{it} = 90.0$ feet

The required distance between the ID Check Point and barrier is $D_{ib}(4) = D_{it} + D_{tb}$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_t$</td>
<td>25.0 mph</td>
</tr>
<tr>
<td>$V_z$</td>
<td>94 f/s</td>
</tr>
<tr>
<td>$D_{zb}$</td>
<td>1305 feet</td>
</tr>
<tr>
<td>$D_{ez}$</td>
<td>49 feet</td>
</tr>
<tr>
<td>$V_z=V^2_{e}+2<em>a</em>D_{ez}$</td>
<td></td>
</tr>
<tr>
<td>$D_{bi}(3)$</td>
<td>458 feet</td>
</tr>
<tr>
<td>$t$</td>
<td>7.0 sec</td>
</tr>
<tr>
<td>$D_{it}+D_{tb}$</td>
<td>624 feet</td>
</tr>
</tbody>
</table>
### Recommendations

Distances $D_{ib}(3)$ and $D_{ib}(4)$ required for Threat Scenarios #3 & #4 respectively are less than the $D_{ib}$ selected above. Place barrier a minimum distance of $D_{ib}$ from the ID Check Point.

| $D_{ib}$ | 854 feet |

Set the Zone 2 continuous overspeed detector at $V_{c2}$.

| $V_{c2}$ | 30.0 mph |

Set the Zone 2 continuous overspeed detector to reach from the ID Check Point to $D_{c2i}$ in front of the ID Check Point.

| $D_{c2i}$ | 198 feet |

Set the Zone 1 continuous overspeed detector to reach from the beginning of the range of the Zone 2 continuous overspeed detector out to a distance $D_{c12} = D_{zi} - D_{c2i}$.

| $D_{c12}$ | 253 feet |

The distance from the beginning of the Zone 1 detector's range to the ID Check Point is $D_{zi}$.

| $D_{zi}$ | 451 feet |

Set the Zone 1 continuous overspeed detector(s) at $V_{c1}$ mph.

| $V_{c1}$ | 45.0 mph |

If the Zone 1 detectors are located at the ID Check Point, they must have a range of $D_{zi}$. For this case, if $D_{zi}$ is less than 400 feet, point overspeed detectors are not required. However, if $D_{zi}$ is greater than 400 feet for this case, place a point overspeed detector at $D_{zi}$, set it at 10 mph over $V_{c1}$, and recalculate $D_{zi}$ using the above procedure.
**Example - Signs & Signals, Straight Roadway, Unlimited Entry Speed**

**No Overspeed Detection**

<table>
<thead>
<tr>
<th>Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Because of the long, straight roadway running up to this ACP, the TV can attain an extremely high speed. Its speed approaching the ACP is limited only by the narrow lanes and traffic islands at the ID Checkpoint. In order to successfully get through the ID Checkpoint without hitting ID Checkpoint features, the TV will limit its speed ( V_{\text{max}} ) at the ID Checkpoint to 100 mph.</td>
</tr>
<tr>
<td>( V_{\text{max}} )</td>
</tr>
<tr>
<td>Delay time for S&amp;S Safety System is ( t )</td>
</tr>
<tr>
<td>Threat Vehicle acceleration rate is ( a )</td>
</tr>
<tr>
<td>TV deceleration is ( a_d )</td>
</tr>
</tbody>
</table>

**A Threat Scenarios #1**

With no advanced overspeed detection, there is no Threat Scenario #2. In Threat Scenario #1, the Threat Vehicle begins its attack either inside or outside of the ACP at an initial high speed. However, the Threat Vehicle must slow down to a speed of \( V_{\text{max}} \) as it enters the ID Check Point islands.

In the worst case, ACP guards will not detect the Threat Vehicle until it passes the ID Check Point. The point of detection is then the ID Check Point with the Threat Vehicle traveling at an initial speed of \( V_{\text{max}} \).

The required distance \( D_{ib} \) from the ID Check Point to the Barrier must be:

\[
D_{ib} = V_{\text{max}} t + \frac{1}{2} a t^2
\]

\( D_{ib} = 1778 \text{ feet} \)

**B Threat Scenario #3**

Threat Scenario 3 begins at the ID Check Point with the Threat Vehicle traveling at an initial speed of 0 mph. In the required delay time, Threat Vehicle will travel:

\[
D_{ib} = \frac{1}{2} a t^2
\]

\( D_{ib} = 458 \text{ feet} \)

**C Threat Scenario #4**

Threat Scenario #4 begins at the end of the last turnaround with the Threat Vehicle traveling at an initial velocity of \( V_t = 25 \text{ mph} \).

\[ V_t = 25.0 \text{ mph} \quad 36.7 \text{ ft/s} \]

The required delay for Threat Scenario #4 is \( t = 7.0 \text{ sec} \)

In the required delay time of 7 seconds, Threat Vehicle will travel:

\[
D_{ib} = V_t t + \frac{1}{2} a t^2
\]

\( D_{ib} = 534 \text{ feet} \)

The distance between the ID Check Point and the end of the last turnaround is \( D_{it} = 90.0 \text{ feet} \)

The required distance between the ID Check Point and barrier is:

\[
D_{ib} = D_{it} + D_{ib}
\]

\( D_{ib} = 624 \text{ feet} \)
### Recommendations

Distances required for Threat Scenarios #3 & #4 are much less than for Threat Scenarios #1 & #2. Place the barriers at least 1778 feet (for Threat Scenarios #1 & #2) from the ID Check Point.

D<sub>in</sub> 1778 feet
Attachment 6
Example - Signs & Signals, Straight Roadway, Unlimited Entry Speed
Two Point and One Zone of Continuous Overspeed Detection

<table>
<thead>
<tr>
<th>Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Because of the long, straight roadway running up to this ACP, the Threat Vehicle (TV) can attain an extremely high speed. Its speed approaching the ACP is limited only by the narrow lanes and traffic islands at the ID Check point. In order to successfully get through the ID Check point without hitting ID Check point features, the TV must limit its speed at the ID Check point to ( V_{\text{imax}} ).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>( V_{\text{imax}} )</th>
<th>100 mph</th>
<th>146.7 ( \text{f/s} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay time for S&amp;S Safety System is ( t )</td>
<td>( t )</td>
<td>9 sec</td>
</tr>
<tr>
<td>Threat Vehicle acceleration rate is ( a )</td>
<td>( a )</td>
<td>11.3 ( \text{f/s/s} )</td>
</tr>
<tr>
<td>TV deceleration is ( a_d )</td>
<td>( a_d )</td>
<td>24.1 ( \text{f/s/s} )</td>
</tr>
</tbody>
</table>

A Threat Scenario #2
Assume there is sufficient distance in the Response Zone to place the barrier at \( D_{ib} \) feet beyond the ID Check Point. Install one zone of continuous overspeed detection immediately in front of the ID Check point. Set the alarm point at a speed \( V_{cs} \) to achieve the desired \( D_{ib} \).

In order to avoid early detection, the Threat Vehicle will stay just under \( V_{cs} \) until it reaches the ID Check Point and then it will start to accelerate. Point of detection is the ID Check Point with the Threat Vehicle traveling at a speed of \( V_{cs} \).

Enter the desireable distance \( D_{ib} \) from the ID Check point to the Barrier: \( D_{ib} \) 1118 feet

In order to travel distance \( D_{ib} \) in the required time delay of \( t \) seconds, the Threat Vehicle's speed at the ID Check Point must be no greater than \( V_{cs}=(D_{ib}-1/2*a*t^2)/t \)

\[ V_{cs} = 50.0 \text{ mph} \quad 73.4 \text{ f/s} \]

B Threat Scenario #1
In Threat Scenario #1, the Threat Vehicle can enter the ACP at an extremely high speed, but must decelerate at some point to a speed of \( V_{\text{imax}} \) as it enters the ID Check Point.

In order to contain the Threat Vehicle in Threat Scenario #1, the overspeed detector must detect the TV at a sufficient distance in front of the ID Check Point to achieve the required delay time.

The TV's speed at the barrier is \( V_b=(V_{\text{imax}}^2+2*a*D_{ib})^{1/2} \)

\[ V_b = 216.3 \text{ f/s} \quad 147.5 \text{ mph} \]

The time it takes the TV to go from the ID Check point to the barrier is \( t_{ib}=(V_b-V_{\text{imax}})/a \)

\[ t_{ib} = 6.16 \text{ sec} \]

The delay required from the point of detection to the ID Check point is \( t_{di}=t-t_{ib} \), where \( t \) is the required delay time.

\[ t_{di} = 2.84 \text{ sec} \]
The fastest way the Threat Vehicle can reach the ID Check Point is by attaining a maximum speed at the point of detection and then decelerating to Vimax as it enters the ID Check Point islands. The maximum speed at the point of detection is

\[ V_d = V_{max} + a_d t_{di} \]

\[ V_d = 215.1 \text{ f/s} \quad 146.7 \text{ mph} \]

The distance \( D_{pi} \) between the point of detection and the ID Check point must be

\[ D_{pi} = \frac{(V_d^2 - V_{max}^2)}{(2a_d)} \]

\[ D_{pi} = 514 \text{ feet} \]

Distance \( D_{pi} \) is greater than the effective range of the continuous overspeed detector required for Threat Scenario #2 above. So, in addition to the continuous overspeed detector, a point overspeed detector is required at distance \( D_{pi} \) from the ID Check Point.

Set the point overspeed detector at \( V_p \). Ensure that \( V_p \) is set at a high enough speed to limit the number of nuisance overspeed alarms. Enter \( V_p \).

\[ V_p = 60 \text{ mph} \quad 88.0 \text{ f/s} \]

The distance between the point overspeed detector and the barrier is

\[ D_{pb} = D_{pz} + D_{zb} \]

\[ D_{pb} = 1632 \text{ feet} \]

## Threat Scenario #2

To find the required range of the continuous overspeed detector, assume the TV passes the point overspeed detector at just under its setting so as not to be detected and then starts to accelerate.

The speed of the TV as it reaches the beginning of the continuous overspeed zone is

\[ V_z = \left( V_p^2 + 2aD_{pz} \right)^{1/2} \]

\[ D_{pz} = D_{pb} - D_{zb} \]

Solving these 3 equations for \( D_{zb} \) gives the following quadratic parameters:

\[ A = \frac{1}{t^2} \]

\[ B = a \]

\[ C = a^2 - 4V_p^2 - 2aD_{pb} \]

\[ D_{zb} = \frac{-B + \sqrt{B^2 - 4AC}}{2A} \]

\[ D_{pb} = 1443 \text{ feet} \]

\[ D_{pz} = 188 \text{ feet} \]

\[ V_z = (V_p^2 + 2aD_{pz})^{1/2} \]

\[ V_z = 110 \text{ f/s} \]

The range of the continuous overspeed detector is

\[ D_{zi} = D_{zb} - D_{ib} \]

\[ D_{zi} = 325 \text{ feet} \]
The effective range of continuous overspeed detectors vary from about 250 feet to 500 feet, depending on the type used. Also, a long \( D_{zi} \) may cause an excessive number of nuisance overspeed alarms.

If the required range \( (D_{zi}) \) needs to be reduced, locate a second point overspeed detector at a distance \( D_{zi} \) from the ID Check Point and set it at \( V_{p2} \). Recalculate the required range of the continuous overspeed detector by assuming the Threat Vehicle will pass the second point overspeed detector at just under its setting of \( V_{p2} \) and then start to accelerate.

The distance from the second point overspeed detector to the barrier is \( D_{p2b} = D_{zb} \) from above.

<table>
<thead>
<tr>
<th>Distance from the second point overspeed detector to the ID Check Point</th>
<th>( D_{p2i} )</th>
<th>( D_{p2b} = D_{zb} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( D_{p2b} )</td>
<td>1443 feet</td>
<td></td>
</tr>
<tr>
<td>We</td>
<td>( D_{p2i} )</td>
<td>325 feet</td>
</tr>
</tbody>
</table>

Set the second point overspeed detector at a setting \( V_{p2} \) that is high enough to limit the number of nuisance overspeed alarms. Enter \( V_p \).

<table>
<thead>
<tr>
<th>( V_{p2} )</th>
<th>55.0 mph</th>
<th>80.7 f/s</th>
</tr>
</thead>
</table>

The speed of the TV as it reaches the beginning of the continuous overspeed zone is now \( V_z = (V_{p2}^2 + 2aD_{p2z})^{1/2} \), where \( D_{p2z} \) is the distance between the second point overspeed detector and the beginning of the range of the continuous overspeed detector.

The distance between the beginning of the range of the continuous overspeed detector and the barrier \( (D_{zb}) \) must provide \( t \) seconds of delay, so \( D_{zb} = V_z \cdot t + 1/2a\cdot t^2 \)

The distance between the second point overspeed detector and the beginning of the range of the continuous overspeed detector is \( D_{p2z} = D_{p2b} - D_{zb} \)

Solving these 3 equations for \( D_{zb} \) gives the following quadratic parameters:

\[
A = 1/t^2
\]

\[
B = a
\]

\[
C = a^2t^2/4 - V_{p2}^2 - 2aD_{p2b}
\]

\[
D_{zb} = (-B + (B^2 - 4AC)^{1/2})/(2A)
\]

\[
D_{p2z} = D_{p2b} - D_{zb}
\]

\[
V_z = (V_{p2}^2 + 2aD_{p2z})^{1/2}
\]

The range of the continuous overspeed detector is then

\[
D_{zi} = D_{zb} - D_{zb}
\]

| Range of the continuous overspeed detector | \( D_{zi} \) | 205 feet |
D Threat Scenario #3

Threat Scenario 3 begins at the ID Check Point with the Threat Vehicle traveling at an initial speed of 0 mph. In the required delay time, Threat Vehicle will travel $D_{ib}(3)=\frac{1}{2}a*t^2$.

```
$D_{ib}(3) = 458$ feet
```

E Threat Scenario #4

Threat Scenario #4 begins at the end of the last turnaround with the Threat Vehicle traveling at an initial velocity of $V_t=25$ mph. The required delay for Threat Scenario #4 is $t = 7.0$ sec.

In the required delay time of 7 seconds, Threat Vehicle will travel $D_{ib}=V_t*t+\frac{1}{2}a*t^2$.

```
$D_{ib} = 534$ feet
```

The distance between the ID Check Point and the end of the last turnaround is $D_{it} = 90.0$ feet.

The required distance between the ID Check Point and barrier is $D_{ib}(4)=D_{it}+D_{ib}$.

```
$D_{ib}(4) = 624$ feet
```

F Recommendations

Distances $D_{ib}(3)$ and $D_{ib}(4)$ required for Threat Scenarios #3 & #4 respectively are less than the $D_{ib}$ selected above. Place barrier a minimum distance of $D_{ib}$ from the ID Check Point.

```
$D_{ib} = 1118$ feet
```

Locate the the first point overspeed detector(s) at $D_{pi}$ feet in front of the ID Check point.

```
$D_{pi} = 514$ feet
```

Set the first point overspeed detector at $V_{p1}$.

```
$V_{p1} = 60$ mph
```

Locate the second overspeed detector at $D_{p2i}$ feet in front of the ID Check Point.

```
$D_{p2i} = 325$ feet
```

Set the second point overspeed detector at $V_{p2}$.

```
$V_{p2} = 55$ mph
```

Set continuous overspeed detector to reach from ID Check Point to a distance $D_{zi}$ feet in front of ID Check Point.

```
$D_{zi} = 205$ feet
```

Set continuous overspeed detector(s) at $V_{cs}$ mph.

```
$V_{cs} = 50.0$ mph
```

Check that $D_{zi}$ is within the range of the selected continuous overspeed detectors.

Notes:

1. If the range of the continuous overspeed zone needs to be reduced because of detector limitations or in order to reduce nuisance alarms (e.g., $D_{zi}>400'$), install a second continuous overspeed detector. See Attachment 7 for calculation method.
2. If $D_{zi}$ is less than 200', eliminate the second point overspeed detector and recalculate $D_{zi}$. 
Example - Signs & Signals, Straight Roadway, Unlimited Entry Speed
Two Point and Two Zones of Continuous Overspeed Detection

Assumptions
Because of the long, straight roadway running up to this ACP, the TV can attain an extremely high speed. Its speed approaching the ACP is limited only by the narrow lanes and traffic islands at the ID Check point. In order to successfully get through the ID Check point without hitting ID Check point features, the TV will limit its speed ($V_{\text{max}}$) at the ID Check point to 100 mph.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{\text{max}}$</td>
<td>100 mph</td>
</tr>
<tr>
<td>$\text{f/s}$</td>
<td>146.7</td>
</tr>
</tbody>
</table>

Delay time for S&S Safety System is $t = 9$ sec
Threat Vehicle acceleration rate is $a = 11.3$ f/s/s
TV deceleration is $a_d = 24.1$ f/s/s

In order to defeat the high speed threat scenarios, provide 2 continuous zones of overspeed detection and point overspeed detection at two points.

A Threat Scenario #2
Assume the available distance $D_{ib}$ beyond the ID Check Point to place the barrier is limited. Install two zones of continuous overspeed detection in front of the ID Check point. Set the alarm point of the zone immediately in front of the ID Check Point (Zone 2) to $V_{c2}$ to achieve the available $D_{ib}$. Set the alarm point of the outer zone (Zone 1) at $V_{c2}$.

In order to avoid early detection, the Threat Vehicle will stay just under both $V_{c1}$ and $V_{c2}$ until it reaches the ID Check Point and then it will start to accelerate. Point of detection is the ID Check Point with the Threat Vehicle traveling at a speed of $V_{c2}$.

Ener the available distance $D_{ib}$ from the ID Check point to the Barrier:

$$D_{ib} = 854 \text{ feet}$$

In order to travel distance $D_{ib}$ in the required time delay of $t$ seconds, the Threat Vehicle's speed at the ID Check Point must be no greater than $V_{c2} = (D_{ib} - 1/2a*t^2)/t$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{c2}$</td>
<td>30.0 mph</td>
</tr>
<tr>
<td>$\text{f/s}$</td>
<td>44.0</td>
</tr>
</tbody>
</table>

Set the Zone 1 detector 15 mph higher than the setting of the Zone 2 detector.

$$V_{c1} = 45.0 \text{ mph}$$

$$V_{c1} = 66.0 \text{ f/s}$$

B Threat Scenario #1
In Threat Scenario #1, the Threat Vehicle can enter the ACP at an extremely high speed, but must decelerate at some point to a speed of $V_{\text{max}}$ as it enters the ID Check Point.

In order to contain the Threat Vehicle in Threat Scenario #1, the overspeed detector must detect it at a sufficient distance in front of the ID Check Point to achieve the required delay time.

The TV's speed at the barrier is $V_{b} = (V_{\text{max}}^2 + 2aD_{ib})^{1/2}$

$$V_{b} = 202.0 \text{ f/s}$$

$$V_{b} = 137.7 \text{ mph}$$

The time it takes the TV to go from the ID Check point to the barrier is $t_{ib} = (V_{c2} - V_{\text{max}})/a$

$$t_{ib} = 4.90 \text{ sec}$$
The delay required from the point of detection to the ID Check point is then \( t_{di} = t - t_{ib} \), where \( t \) is the required delay time. \( t_{di} \) 4.10 sec

The fastest way the Threat Vehicle can reach the ID Check Point is by attaining a maximum speed at the point of detection and then decelerating to \( V_{imax} \) as it enters the ID Check Point islands. The maximum speed at the point detector is then

\[
V_d = V_{max} + a_d * t_{di}
\]

\( V_d \) 245.5 f/s 167.4 mph

The minimum distance \( D_{pi} \) between the point of detection and the ID Check point must be

\[
D_{pi} = \frac{(V_d^2 - V_{max}^2)}{2*a_d}
\]

\( D_{pi} \) 804 feet

Locate the point overspeed detector at \( D_{pi} \) feet in front of the ID Check Point and set it at \( V_p \). Enter \( V_p \). \( V_p \) 60 mph 88.0 f/s

The distance between the point overspeed detector and the barrier is \( D_{pb} = D_{pi} + D_{ib} \)

\( D_{pb} \) 1658 feet

C Threat Scenario #2

The required range for the Zone 2 continuous overspeed detector is

\[
D_{z2i} = (V_1 - V_2)^*t
\]

\( D_{z2i} \) 198 feet

To find the required range of the Zone 1 continuous overspeed detector, assume the TV passes the point overspeed detector at just under its setting so as not to be detected and then starts to accelerate.

The speed of the TV as it reaches the beginning of the range of the Zone 1 detector is

\[
V_{z1} = (V_p^2 + 2*a*D_{pz1})^{1/2}, \text{ where } D_{pz1} \text{ is the distance between the point overspeed detector and the beginning of the range of the Zone 1 detector.}
\]

The distance between the beginning of the range of the Zone 1 detector and the barrier \( D_{z1b} \) must provide \( t \) seconds of delay, so

\[
D_{z1b} = V_{z1}*t + 1/2*a*t^2
\]

The distance between the point overspeed detector and the beginning of the range of the Zone 1 detector is \( D_{pz1} = D_{pb} - D_{z1b} \)

Solving these 3 equations for \( D_{z1b} \) gives the following quadratic parameters:

\[
A = \frac{1}{t^2}
\]

\( A \) 0.012

\[
B = a
\]

\( B \) 11.300

\[
C = a^2*t^2/4-V_p^2+2*a*D_{pb}
\]

\( C \) -42636

\[
D_{z1b} = (-B + (B^2 - 4*A*C)^{1/2})/(2*A)
\]

\( D_{z1b} \) 1456 feet

\[
D_{pz1} = D_{pb} - D_{z1b}
\]

\( D_{pz1} \) 202 feet

\[
V_{z1} = (V_p^2 + 2*a*D_{pz1})^{1/2}
\]

\( V_{z1} \) 111 f/s

The distance between the beginning of the range of the Zone 1 continuous overspeed detector and the ID Check Point is

\[
D_{z1i} = D_{z1b} - D_{pb}
\]

\( D_{z1i} \) 602 feet

The range of the Zone 1 continuous overspeed detector is

\[
D_{z12} = D_{z1i} + D_{z2i}
\]

\( D_{z12} \) 404 feet
Setting the range of the Zone 1 continuous overspeed detector out to \( D_{zh} \) may cause an excessive number of nuisance alarms. Instead, locate a second point overspeed detector at \( D_{zh} \) and set it at a higher speed \( V_{p2} \) to reduce nuisance alarms.

Recalculate the required range of the Zone 1 continuous overspeed detector by assuming the Threat Vehicle will pass the second point overspeed detector at just under \( V_{p2} \) before it starts to accelerate.

The distance between the second point overspeed detector and the barrier is \( D_{p2b} = D_{zh} \)

\[
D_{p2b} = 1456 \text{ feet}
\]

The distance between the second point overspeed detector and the ID Check Point is \( D_{p2i} = D_{p2b} - D_{ib} \)

\[
D_{p2i} = 602 \text{ feet}
\]

Set second point overspeed detector at \( V_{p2} \). Enter \( V_{p2} \).

\[
V_{p2} = 50.0 \text{ mph, } 73.3 \text{ f/s}
\]

The speed of the TV as it reaches the beginning of the Zone 1 continuous overspeed zone becomes \( V_z = (V_{p2}^2 + 2aD_{p2z})^{1/2} \), where \( D_{p2z} \) is the distance between the second point overspeed detector and the beginning of the range of the Zone 1 continuous overspeed detector.

The distance between the beginning of the range of the Zone 1 continuous overspeed detector and the barrier \( (D_{zh}) \) must provide \( t \) seconds of delay, so \( D_{zh} = V_zt + 1/2at^2 \)

The distance between the second point overspeed detector and the beginning of the range of the Zone 1 continuous overspeed detector is \( D_{p2z} = D_{p2b} - D_{zh} \)

Solving these 3 equations for \( D_{zh} \) gives the following quadratic parameters:

\[
\begin{align*}
A &= 1/t^2 & A &= 0.012 \\
B &= a & B &= 11.300 \\
C &= a^2t^2/4 - V_{p2}^2 - 2aD_{p2b} & C &= -35703 \\
D_{zh} &= (B + \sqrt{B^2 - 4AC}) / (2A) & D_{zh} &= 1303 \text{ feet} \\
D_{p2z} &= D_{p2b} - D_{zh} & D_{p2z} &= 153 \text{ feet} \\
V_z &= (V_{p2}^2 + 2aD_{p2z})^{1/2} & V_z &= 94.0 \text{ f/s} \\
D_{zh} &= (D_{zh} - D_{ib} - D_{p2i}) & D_{zh} &= 251 \text{ feet} \\
D_{zh} &= (D_{zh} - D_{ib} - D_{p2i}) & D_{zh} &= 449 \text{ feet}
\end{align*}
\]

### D  Threat Scenario #3

Threat Scenario 3 begins at the ID Check Point with the Threat Vehicle traveling at an initial speed of 0 mph. In the required delay time, Threat Vehicle will travel \( D_{b}(3) = 1/2at^2 \)

\[
D_{b}(3) = 458 \text{ feet}
\]

### E  Threat Scenario #4
Threat Scenario #4 begins at the end of the last turn-around with the Threat Vehicle traveling at an initial velocity of \( V_t = 25 \text{ mph} \). The required delay for Threat Scenario #4 is \( t = 7 \text{ sec} \). In the required delay, Threat Vehicle could travel

\[
D_{tb} = V_t \cdot t + \frac{1}{2} a \cdot t^2
\]

Assume the distance between the ID Check Point and the end of the last turn-around is \( D_{lt} = 90 \text{ feet} \). The required distance between the ID Check Point and barrier is \( D_{ab(4)} = D_{lt} + D_{tb} = 534 + 90 = 624 \text{ feet} \).

F Recommendations

Distances \( D_{ib(3)} \) and \( D_{ib(4)} \) required for Threat Scenarios #3 & #4 respectively are less than the \( D_{ib} \) selected above. Place barrier a minimum distance of \( D_{ib} \) from the ID Check Point.

- Place the first point overspeed detector at \( D_{pi} = 854 \text{ feet} \) in front of the ID Check Point.
- Set the first overspeed detector at \( V_p = 60 \text{ mph} \).
- Locate the second overspeed detector at \( D_{p2i} = 804 \text{ feet} \) in front of the ID Check Point.
- Set the second point overspeed detector at \( V_{p2} = 50 \text{ mph} \).
- Set the range of the Zone 1 continuous overspeed detector to \( D_{z1z2} = 251 \text{ feet} \).
- Set the Zone 1 continuous overspeed detector at \( V_{c1} = 45.0 \text{ mph} \).
- Set the range of the Zone 2 continuous overspeed detector to \( D_{z2i} = 198 \text{ feet} \).
- Set the Zone 2 continuous overspeed detector at \( V_{c2} = 30.0 \text{ mph} \).

Note the distance between the beginning of the Zone 1 continuous overspeed detector and the ID Check Point is \( D_{z1i} = D_{z1b} - D_{ib} = 449 \text{ feet} \).

If the Zone 1 detector is located at the ID Check Point, the detector must have a range of \( D_{z1i} \). The locations and settings of the overspeed detectors described above are necessary to limit the required distance between the ID Check Point and the barrier to \( D_{ib} \). However, these detector locations and settings may cause nuisance alarms. To minimize nuisance alarms, recommend that the Installation initiate a program to educate ACP users on the necessity to abide by posted speed limits and an enforcement program to punish motorist who exceed speed limits. Speed calming means ahead of the ID Check Point such as rumble strips should also be considered along with proper signage including variable message signs that display motorists actual speed along with the posted speed limit.
## Example - Presence Detection, Straight Roadway, Limited Entry Speed
### No Overspeed Detection

#### Assumptions

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assume that the ACP corridor is straight, but that there is a required</td>
<td></td>
</tr>
<tr>
<td>turn or turns to get into the corridor, which limit vehicle speed to $V_e$</td>
<td>$V_e$ 60 mph 88.0 f/s</td>
</tr>
<tr>
<td>at the ACP entrance.</td>
<td></td>
</tr>
<tr>
<td>Also assume that the end of the turn is $D_{id}$ feet in front of the ID</td>
<td>$D_{id}$ 400 feet</td>
</tr>
<tr>
<td>Check Point.</td>
<td></td>
</tr>
<tr>
<td>Delay time for S&amp;S Safety System is $t$</td>
<td>$t$ 5 sec</td>
</tr>
<tr>
<td>Threat Vehicle acceleration rate is $a$</td>
<td>$a$ 11.3 f/s/s</td>
</tr>
<tr>
<td>TV deceleration is $a_d$</td>
<td>$a_d$ 24.1 f/s/s</td>
</tr>
</tbody>
</table>

#### A Threat Scenarios #1

Since there is no overspeed detection, there is no Threat Scenario #2.

With no advanced overspeed detection, the Threat Vehicle enters the ACP at the spin-out speed of the turn and begins to accelerate. By the time it reaches the ID Check Point, it is traveling at

$$V_i = \sqrt{(V_e^2 + 2aD_{id})^2}$$

If $V_i$ is greater than 100 mph, use $V_i=100$ as the criteria limits the Threat Vehicle's speed through the ID Check Point to no more than 100 mph.

In the worst case, ACP guards will not detect the Threat Vehicle until it passes the ID Check Point. The point of detection is then the ID Check Point with the Threat Vehicle traveling at an initial speed of $V_i$.

The required distance $D_{ib}$ from the ID Check Point to the Barrier must be

$$D_{ib} = V_i^2t + \frac{1}{2}at^2$$  

$$D_{ib} = 789 \text{ feet}$$

#### B Threat Scenario #3

Threat Scenario #3 begins at the ID Check Point with the Threat Vehicle traveling at an initial speed of 0 mph. In the required delay time, Threat Vehicle will travel

$$D_{ib} = \frac{1}{2}at^2$$  

$$D_{ib} = 141 \text{ feet}$$

#### C Threat Scenario #4

Threat Scenario #4 begins at the end of the last turnaround with the Threat Vehicle traveling at an initial velocity of $V_i=25$ mph.

The required delay for Threat Scenario #4 is $t$

$$t = 3.0 \text{ sec}$$

In the required delay time of 7 seconds, Threat Vehicle will travel

$$D_{ib} = V_i^2t + \frac{1}{2}at^2$$  

$$D_{ib} = 161 \text{ feet}$$

The distance between the ID Check Point and the end of the last turnaround is

$$D_{it} = 90.0 \text{ feet}$$

The required distance between the ID Check Point and barrier is

$$D_{ib} = D_{it} + D_{ib}$$  

$$D_{ib} = 251 \text{ feet}$$
### D Recommendations

Distances required for Threat Scenarios #3 & #4 are much less than for Threat Scenario #1. Place the barriers at least Dib feet (for Threat Scenario #1) from the ID Check Point. 

| $D_{ib}$ | 789 feet |
### Attachment 9

#### Example - Presence Detection, Straight Roadway, Limited Entry Speed

**One Zone of Continuous Overspeed Detection**

#### Assumptions

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assume that the ACP corridor is straight, but that there is a required turn or turns to get into the corridor, which limit vehicle speed to $V_e$ at the ACP entrance. Enter $V_e$.</td>
<td>$V_e$ 50 mph 73.3 f/s</td>
</tr>
<tr>
<td>Also assume that the ACP entrance is $D_{ei}$ feet in front of the ID Check Point. Enter $D_{ei}$.</td>
<td>$D_{ei}$ 600 feet</td>
</tr>
<tr>
<td>Delay time for S&amp;S Safety System is $t$</td>
<td>$t$ 5 sec</td>
</tr>
<tr>
<td>Threat Vehicle acceleration rate is $a$</td>
<td>$a$ 11.3 f/s/s</td>
</tr>
<tr>
<td>TV deceleration is $a_d$</td>
<td>$a_d$ 24.1 f/s/s</td>
</tr>
</tbody>
</table>

#### A Threat Scenario #2

Assume there is sufficient distance in the Response Zone to place the barrier at $D_{ib}$ feet beyond the ID Check Point. Install one zone of continuous overspeed detection immediately in front of the ID Check point. Set the alarm point at a speed $V_{cs}$ to achieve the desired $D_{ib}$. In order to avoid early detection, the Threat Vehicle will stay just under $V_{cs}$ until it reaches the ID Check Point and then it will start to accelerate. Point of detection is the ID Check Point with the Threat Vehicle traveling at a speed of $V_{cs}$.

Enter the desireable distance $D_{ib}$ from the ID Check point to the Barrier: $D_{ib}$ 508 feet

In order to travel distance $D_{ib}$ in the required time delay of $t$ seconds, the Threat Vehicle's speed at the ID Check Point must be no greater than $V_{cs}=(Dib-1/2*a*t^2)/t$ | $V_{cs}$ 50.0 mph 73.4 f/s |

The distance $D_{cs}$ from the ACP entrance to the final barrier is $D_{cb}=D_{cs}+D_{ib}$ | $D_{cb}$ 1108 feet |

#### B Threat Scenarios #1 & #2

To find the required range of the continuous overspeed detector, assume the TV starts to accelerate from an initial speed of $V_e$ immediately after it enters the ACP.

The speed of the TV as it reaches the beginning of the continuous overspeed zone is $V_z=(V_e^2+2*a*D_{ez})^{1/2}$, where $D_{ez}$ is the distance between the ACP entrance and the beginning of the range of the continuous overspeed detector.

The distance between the beginning of the range of the continuous overspeed detector and the barrier ($D_{cb}$) must provide $t$ seconds of delay, so $D_{cb}=V_z*t+1/2*a*t^2$

The distance between the ACP entrance and the beginning of the range of the continuous overspeed detector is $D_{ez}=D_{cb}-D_{eb}$

Solving these 3 equations for $D_{eb}$ gives the following quadratic parameters:
\[
\begin{align*}
A &= 1/t^2 & A &= 0.040 \\
B &= a & B &= 11.300 \\
C &= a^2t^2/4-V_e^2-2*a*D_{eb} & C &= -29621 \\
D_{zh} &= (-B+\sqrt{B^2-4*A*C})/(2*A) & D_{zh} &= 731 \text{ feet} \\
D_{ez} &= D_{eb}-D_{zh} & D_{ez} &= 377 \text{ feet} \\
V_z &= (V_e^2+2*a*D_{ez})^{1/2} & V_z &= 118 \text{ f/s} \\
\text{The range of the continuous overspeed detector is } D_{zi} &= D_{zh}-D_{ib} & D_{zi} &= 223 \text{ feet}
\end{align*}
\]

D Threat Scenario #3

Threat Scenario 3 begins at the ID Check Point with the Threat Vehicle traveling at an initial speed of 0 mph. In the required delay time, Threat Vehicle will travel \(D_{ib}(3)=1/2*a*t^2\) 

\[
D_{ib}(3) = 141 \text{ feet}
\]

E Threat Scenario #4

Threat Scenario #4 begins at the end of the last turnaround with the Threat Vehicle traveling at an initial velocity of \(V_t=25\text{ mph}\). 

\[
\begin{align*}
V_t &= 25.0 \text{ mph} & 36.7 \text{ f/s} \\
\text{The required delay for Threat Scenario #4 is } t &= 3.0 \text{ sec} \\
\text{In the required delay time, Threat Vehicle could travel } & \text{ } \\
D_{ib} &= V_t*t+1/2*a*t^2 & D_{ib} &= 161 \text{ feet} \\
\text{Assume the distance between the ID Check Point and the end of the last turnaround is } D_{it} &= 90.0 \text{ feet} \\
\text{The required distance between the ID Check Point and barrier is } D_{ib}(4) &= D_{it}+D_{tb} & D_{ib}(4) &= 251 \text{ feet}
\end{align*}
\]

F Recommendations

Distances \(D_{ib}(3)\) and \(D_{ib}(4)\) required for Threat Scenarios #3 & #4 respectively are less than the \(D_{ib}\) selected above. Place barrier a minimum distance of \(D_{ib}\) from the ID Check Point. 

\[
D_{ib} = 508 \text{ feet}
\]

Set continuous overspeed detector to reach from ID Check Point to a distance \(D_{zi}\) feet in front of ID Check Point. 

\[
D_{zi} = 223 \text{ feet}
\]

Set continuous overspeed detector(s) at \(V_{cs}\) mph. 

\[
V_{cs} = 50.0 \text{ mph}
\]

Note, if the range of the continuous overspeed zone needs to be reduced because of detector limitations or in order to reduce nuisance alarms (e.g., \(D_{zi}>400'\)), place a point overspeed detector at \(D_{zi}\), set it at 10 mph over \(V_{cs}\), and recalculate \(D_{zi}\) using the above procedure.
**Example - Presence Detection, Straight Roadway, Limited Entry Speed**

**Two Zones of Continuous Overspeed Detection**

<table>
<thead>
<tr>
<th>Assumptions</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Assume that the ACP corridor is straight, but that there is a required turn or turns to get into the corridor, which limit vehicle speed to ( V_e ) at the ACP entrance.</td>
<td>( V_e )</td>
<td>50 mph</td>
</tr>
<tr>
<td>Also assume that the ACP entrance is ( D_{ei} ) feet in front of the ID Check Point.</td>
<td>( D_{ei} )</td>
<td>600 feet</td>
</tr>
<tr>
<td>Delay time for S&amp;S Safety System is ( t )</td>
<td>( t )</td>
<td>5 sec</td>
</tr>
<tr>
<td>Threat Vehicle acceleration rate is ( a )</td>
<td>( a )</td>
<td>11.3 f/s/s</td>
</tr>
<tr>
<td>TV deceleration is ( a_d )</td>
<td>( a_d )</td>
<td>24.1 f/s/s</td>
</tr>
</tbody>
</table>

**A Threat Scenario #2**

Assume the available distance \( D_{ib} \) beyond the ID Check Point to place the barrier is limited. Install two zones of continuous overspeed detection in front of the ID Check point. Set the alarm point of the zone immediately in front of the ID Check Point (Zone 2) to \( V_{c2} \) to achieve the available \( D_{ib} \). Set the alarm point of the outer zone (Zone 1) at \( V_{c2} \).

In order to avoid early detection, the Threat Vehicle will stay just under both \( V_{c1} \) and \( V_{c2} \) until it reaches the ID Check Point and then it will start to accelerate. Point of detection is the ID Check Point with the Threat Vehicle traveling at a speed of \( V_{c2} \).

In order to travel distance \( D_{ib} \) in the required time delay of \( t \) seconds, the Threat Vehicle's speed at the ID Check Point must be no greater than:

\[
V_{c2} = \frac{D_{ib} - \frac{1}{2}a\times t^2}{t}
\]

Set the Zone 1 detector 15 mph higher than the setting of the Zone 2 detector.

\[
V_{c1} = \frac{D_{c2i} = (V_{c1} - V_{c2})\times t}{t}
\]

The distance \( D_{ch} \) from the ACP entrance to the final barrier is \( D_{ch} = D_{ei} + D_{ib} \)

\[
D_{ch} = 961 \text{ feet}
\]

**B Threat Scenarios #1 & #2**

To find the required range of the Zone 1 continuous overspeed detector, assume the TV starts to accelerate from an initial speed of \( V_e \) immediately after it enters the ACP.

The speed of the TV as it reaches the beginning of the Zone 1 continuous overspeed zone is \( V_z = (V_e^2 + 2\times a\times D_{oz})^{1/2} \), where \( D_{oz} \) is the distance between the ACP entrance and the beginning of the range of the Zone 2 continuous overspeed detector.

The distance between the beginning of the range of the Zone 1 continuous overspeed detector and the barrier (\( D_{ch} \)) must provide \( t \) seconds of delay, so

\[
D_{ch} = V_z \times t + \frac{1}{2}a\times t^2
\]
The distance between the ACP entrance and the beginning of the range of the Zone 1 continuous overspeed detector is $D_{ez} = D_{eb} - D_{zb}$

Solving these 3 equations for $D_{zb}$ gives the following quadratic parameters:

<table>
<thead>
<tr>
<th>A</th>
<th>0.040</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>11.300</td>
</tr>
<tr>
<td>C</td>
<td>-26298</td>
</tr>
</tbody>
</table>

$$D_{zb} = \frac{(-B + \sqrt{B^2 - 4AC})}{2A}$$

$$D_{ez} = D_{eb} - D_{zb}$$

$$V_z = (V_e^2 + 2aD_{ez})^{1/2}$$

The distance between the beginning of the Zone 1 detectors range and ID Check Point is $D_{zi} = D_{eb} - D_{ib}$

| D_{zi} | 321 feet |

**D Threat Scenario #3**

Threat Scenario 3 begins at the ID Check Point with the Threat Vehicle traveling at an initial speed of 0 mph. In the required delay time, Threat Vehicle will travel $D_{ib}(3) = \frac{1}{2}at^2$

$$D_{ib}(3) = 141 feet$$

**E Threat Scenario #4**

Threat Scenario #4 begins at the end of the last turnaround with the Threat Vehicle traveling at an initial velocity of $V_t = 25$ mph. The required delay for Threat Scenario #4 is $t = 3.0$ sec

$$D_{ib} = V_t^2 + \frac{2a}{t^2}$$

$$D_{ib} = 161 feet$$

The required distance between the ID Check Point and the end of the last turnaround is $D_{it}$

$$D_{it} = 90.0 feet$$

**F Recommendations**

Distances $D_{ib}(3)$ and $D_{ib}(4)$ required for Threat Scenarios #3 & #4 respectively are less than the $D_{ib}$ selected above. Place barrier a minimum distance of $D_{ib}$ from the ID Check Point.

Set the Zone 2 continuous overspeed detector at $V_{c2}$. $V_{c2} = 30.0$ mph

Set the Zone 2 continuous overspeed detector to reach from the ID Check Point to $Dc2i$ in front of the ID Check Point. $Dc2i = 110$ feet

The distance from the beginning of the Zone 1 detector's range to the ID Check Point is $Dzi$.

Set The Zone 1 continuous overspeed detector(s) at $V_{c1}$ mph. $V_{c1} = 45.0$ mph
Note, if Dzi is less than 400 feet, point overspeed detectors are not required. If Dzi is greater than 400 feet, place a point overspeed detector at Dzi, set it at 10 mph over Vcs, and recalculate Dzi using the above procedure.
### Assumptions

Because of the long, straight roadway running up to this ACP, the TV can attain an extremely high speed. Its speed approaching the ACP is limited only by the narrow lanes and traffic islands at the ID Check point. In order to successfully get through the ID Check point without hitting ID Check point features, the TV will limit its speed ($V_{\text{max}}$) at the ID Check point to 100 mph.  

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{\text{max}}$</td>
<td>100 mph</td>
<td>146.7 f/s</td>
</tr>
<tr>
<td>Delay time for S&amp;S Safety System is $t$</td>
<td>5 sec</td>
<td></td>
</tr>
<tr>
<td>Threat Vehicle acceleration rate is $a$</td>
<td>11.3 f/s²</td>
<td></td>
</tr>
<tr>
<td>TV deceleration is $a_d$</td>
<td>24.1 f/s²</td>
<td></td>
</tr>
</tbody>
</table>

### A Threat Scenarios #1

With no advanced overspeed detection, there is no Threat Scenario #2. In Threat Scenario #1, the Threat Vehicle begins its attack either inside or outside of the ACP at an initial high speed. However, the Threat Vehicle must slow down to a speed of $V_{\text{max}}$ as it enters the ID Check Point islands.

In the worst case, ACP guards will not detect the Threat Vehicle until it passes the ID Check Point. The point of detection is then the ID Check Point with the Threat Vehicle traveling at an initial speed of $V_{\text{max}}$.

The required distance $D_{ib}$ from the ID Check Point to the Barrier must be:

$$D_{ib} = V_{\text{max}}t + \frac{1}{2}at^2$$

**$D_{ib}$: 875 feet**

### B Threat Scenario #3

Threat Scenario 3 begins at the ID Check Point with the Threat Vehicle traveling at an initial speed of 0 mph. In the required delay time, Threat Vehicle will travel:

$$D_{ib} = \frac{1}{2}at^2$$

**$D_{ib}$: 141 feet**

### C Threat Scenario #4

Threat Scenario #4 begins at the end of the last turnaround with the Threat Vehicle traveling at an initial velocity of $V_i=25$ mph.

The required delay for Threat Scenario #4 is $t$:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_i$</td>
<td>25.0 mph</td>
<td>36.7 f/s</td>
</tr>
<tr>
<td>$t$</td>
<td>3.0 sec</td>
<td></td>
</tr>
</tbody>
</table>

In the required delay time of 7 seconds, Threat Vehicle will travel:

$$D_{ib} = V_i t + \frac{1}{2}a t^2$$

**$D_{ib}$: 161 feet**

The distance between the ID Check Point and the end of the last turnaround is $D_{it}$:

**$D_{it}$: 90.0 feet**

The required distance between the ID Check Point and barrier is:

$$D_{ib} = D_{it} + D_{ib}$$

**$D_{ib}$: 251 feet**
## Recommendations

Distances required for Threat Scenarios #3 & #4 are much less than for Threat Scenarios #1 & #2. Place the barriers at least Dib feet (for Threat Scenarios #1 & #2) from the ID Check Point.

| Dib       | 875 feet |
Attachment 12

Example - Presence Detection, Straight Roadway, Unlimited Entry Speed

One Zone of Continuous Overspeed Detection

### Assumptions

<table>
<thead>
<tr>
<th></th>
<th>( V_{\text{imax}} )</th>
<th>100 mph</th>
<th>146.7 f/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay time for S&amp;S Safety System is ( t )</td>
<td>( t )</td>
<td>5 sec</td>
<td></td>
</tr>
<tr>
<td>Threat Vehicle acceleration rate is ( a )</td>
<td>( a )</td>
<td>11.3 f/s/s</td>
<td></td>
</tr>
<tr>
<td>TV deceleration is ( a_d )</td>
<td>( a_d )</td>
<td>24.1 f/s/s</td>
<td></td>
</tr>
</tbody>
</table>

### Threat Scenario #2

Assume there is sufficient distance in the Response Zone to place the barrier at \( D_{\text{ib}} \) feet beyond the ID Check Point. Install one zone of continuous overspeed detection immediately in front of the ID Check point. Set the alarm point at a speed \( V_{\text{cs}} \) to achieve the desired \( D_{\text{ib}} \).

In order to avoid early detection, the Threat Vehicle will stay just under \( V_{\text{cs}} \) until it reaches the ID Check Point and then it will start to accelerate. Point of detection is the ID Check Point with the Threat Vehicle traveling at a speed of \( V_{\text{cs}} \).

Enter the desireable distance \( D_{\text{ib}} \) from the ID Check point to the Barrier: \( D_{\text{ib}} \) 508 feet

In order to travel distance \( D_{\text{ib}} \) in the required time delay of \( t \) seconds, the Threat Vehicle's speed at the ID Check Point must be no greater than \( V_{\text{cs}} = (D_{\text{ib}} - 1/2 * a * t^2)/t \)

<table>
<thead>
<tr>
<th></th>
<th>( V_{\text{cs}} )</th>
<th>50.0 mph</th>
<th>73.4 f/s</th>
</tr>
</thead>
</table>
### Threat Scenario #1

In Threat Scenario #1, the Threat Vehicle can enter the ACP at an extremely high speed, but must decelerate at some point to a speed of $V_{imax}$ as it enters the ID Check Point.

In order to contain the Threat Vehicle in Threat Scenario #1, the overspeed detector must detect the TV at a sufficient distance in front of the ID Check Point to achieve the required delay time.

The TV's speed at the barrier is $V_b=(V_{imax}^2+2*a*Dib)^{1/2}$

<table>
<thead>
<tr>
<th>$V_b$</th>
<th>181.6 f/s</th>
<th>123.8 mph</th>
</tr>
</thead>
</table>

The time it takes the TV to go from the ID Check point to the barrier is $t_{ib}=(V_b-V_{imax})/a$

<table>
<thead>
<tr>
<th>$t_{ib}$</th>
<th>3.09 sec</th>
</tr>
</thead>
</table>

The delay required from the point of detection to the ID Check point is $t_{di}=t-t_{ib}$, where $t$ is the required delay time.

<table>
<thead>
<tr>
<th>$t_{di}$</th>
<th>1.91 sec</th>
</tr>
</thead>
</table>

The fastest way the Threat Vehicle can reach the ID Check Point is by attaining a maximum speed at the point of detection and then decelerating to $V_{imax}$ as it enters the ID Check Point islands. The maximum speed at the point of detection is $V_d=V_{imax}+a_d*t_{di}$

<table>
<thead>
<tr>
<th>$V_d$</th>
<th>192.6 f/s</th>
<th>131.3 mph</th>
</tr>
</thead>
</table>

The distance $D_{pi}$ between the point of detection and the ID Check point must be $D_{pi}=(V_d^2-V_{imax}^2)/(2*a_d)$

<table>
<thead>
<tr>
<th>$D_{pi}$</th>
<th>323 feet</th>
</tr>
</thead>
</table>

The range of the continuous overspeed detector is then $D_{zi}=D_{pi}$

<table>
<thead>
<tr>
<th>$D_{zi}$</th>
<th>323 feet</th>
</tr>
</thead>
</table>

### Threat Scenario #3

Threat Scenario 3 begins at the ID Check Point with the Threat Vehicle traveling at an initial speed of 0 mph. In the required delay time, Threat Vehicle will travel $D_{ib}(3)=1/2*a*t^2$

<table>
<thead>
<tr>
<th>$D_{ib}(3)$</th>
<th>141 feet</th>
</tr>
</thead>
</table>

### Threat Scenario #4

Threat Scenario #4 begins at the end of the last turnaround with the Threat Vehicle traveling at an initial velocity of $V_t=25$ mph.

<table>
<thead>
<tr>
<th>$V_t$</th>
<th>25.0 mph</th>
<th>36.7 f/s</th>
</tr>
</thead>
</table>

The required delay for Threat Scenario #4 is $t$

<table>
<thead>
<tr>
<th>$t$</th>
<th>3.0 sec</th>
</tr>
</thead>
</table>

In the required delay time of 7 seconds, Threat Vehicle will travel $D_{ib}=V_t*t+1/2*a*t^2$

<table>
<thead>
<tr>
<th>$D_{ib}$</th>
<th>161 feet</th>
</tr>
</thead>
</table>

The distance between the ID Check Point and the end of the last turnaround is $D_{it}$

<table>
<thead>
<tr>
<th>$D_{it}$</th>
<th>90.0 feet</th>
</tr>
</thead>
</table>

The required distance between the ID Check Point and barrier is $Dib(4)=D_{it}+D_{ib}$

<table>
<thead>
<tr>
<th>$Dib(4)$</th>
<th>251 feet</th>
</tr>
</thead>
</table>
### Recommendations

Distances $D_{ib}(3)$ and $D_{ib}(4)$ required for Threat Scenarios #3 & #4 respectively are less than the $D_{ib}$ selected above. Place barrier a minimum distance of $D_{ib}$ from the ID Check Point.

<table>
<thead>
<tr>
<th>$D_{ib}$</th>
<th>508 feet</th>
</tr>
</thead>
</table>

Set continuous overspeed detector to reach from ID Check Point to a distance $D_{zi}$ feet in front of ID Check Point.

<table>
<thead>
<tr>
<th>$D_{zi}$</th>
<th>323 feet</th>
</tr>
</thead>
</table>

Set continuous overspeed detector(s) at $V_{cs}$ mph.

<table>
<thead>
<tr>
<th>$V_{cs}$</th>
<th>50.0 mph</th>
</tr>
</thead>
</table>

$D_{zi}$ is within the range of most continuous overspeed detectors.

Note, if the range of the continuous overspeed zone needs to be reduced because of detector limitations or in order to reduce nuisance alarms (e.g., $D_{zi}>400'$), install a point or a second continuous overspeed detector. See Attachments 6 and 13 respectively for calculation method.
Attachment 13
Example - Presence Detection, Straight Roadway, Unlimited Entry Speed

One Point and Two Zones of Continuous Overspeed Detection

### Assumptions

Because of the long, straight roadway running up to this ACP, the TV can attain an extremely high speed. Its speed approaching the ACP is limited only by the narrow lanes and traffic islands at the ID Check point. In order to successfully get through the ID Check point without hitting ID Check point features, the TV will limit its speed ($V_{\text{max}}$) at the ID Check point to 100 mph. 

<table>
<thead>
<tr>
<th>Delay time for S&amp;S Safety System is $t$</th>
<th>$t$</th>
<th>5 sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threat Vehicle acceleration rate is $a$</td>
<td>$a$</td>
<td>11.3 f/s/s</td>
</tr>
<tr>
<td>TV deceleration is $a_d$</td>
<td>$a_d$</td>
<td>24.1 f/s/s</td>
</tr>
</tbody>
</table>

In order to defeat the high speed threat scenarios, provide 2 continuous zones of overspeed detection and point overspeed detection at one point.

### A Threat Scenario #2

Assume the available distance $D_{ib}$ beyond the ID Check Point to place the barrier is limited. Install two zones of continuous overspeed detection in front of the ID Check point. Set the alarm point of the zone immediately in front of the ID Check Point (Zone 2) to $V_{c2}$ to achieve the available $D_{ib}$. Set the alarm point of the outer zone (Zone 1) at $V_{c2}$.

In order to avoid early detection, the Threat Vehicle will stay just under both $V_{c1}$ and $V_{c2}$ until it reaches the ID Check Point and then it will start to accelerate. Point of detection is the ID Check Point with the Threat Vehicle traveling at a speed of $V_{c2}$.

<table>
<thead>
<tr>
<th>Ener the available distance $D_{ib}$ from the ID Check point to the Barrier:</th>
<th>$D_{ib}$</th>
<th>361 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>In order to travel distance $D_{ib}$ in the required time delay of $t$ seconds, the Threat Vehicle's speed at the ID Check Point must be no greater than $V_{c2}=\frac{(D_{ib}-1/2<em>a</em>t^2)}{t}$</td>
<td>$V_{c2}$</td>
<td>30.0 mph</td>
</tr>
<tr>
<td>Set the Zone 1 detector 15 mph higher than the setting of the Zone 2 detector.</td>
<td>$V_{c1}$</td>
<td>45.0 mph</td>
</tr>
</tbody>
</table>
B Threat Scenario #1

In Threat Scenario #1, the Threat Vehicle can enter the ACP at an extremely high speed, but must decelerate at some point to a speed of \( V_{\text{max}} \) as it enters the ID Check Point.

In order to contain the Threat Vehicle in Threat Scenario #1, the overspeed detector must detect it at a sufficient distance in front of the ID Check Point to achieve the required delay time.

The TV's speed at the barrier is \( V_b = (V_{\text{max}}^2 + 2*a*Dib) \)^{1/2}  
\[
V_b = 172.2 \text{ f/s} \quad 117.4 \text{ mph}
\]

The time it takes the TV to go from the ID Check point to the barrier is \( t_b = (V_b - V_{\text{max}})/a \)  
\[
t_b = 2.26 \text{ sec}
\]

The delay required from the point of detection to the ID Check point is then \( t_d = t - t_b \), where \( t \) is the required delay time.  
\[
t_d = 2.74 \text{ sec}
\]

The fastest way the Threat Vehicle can reach the ID Check Point is by attaining a maximum speed at the point of detection and then decelerating to \( V_{\text{max}} \) as it enters the ID Check Point islands.

The maximum speed at the point detector is then \( V_d = V_{\text{max}} + a* t_d \)  
\[
V_d = 212.6 \text{ f/s} \quad 145.0 \text{ mph}
\]

The minimum distance \( D_{pi} \) between the point of detection and the ID Check point must be \( D_{pi} = (V_d^2 - V_{\text{max}}^2)/(2*a) \)  
\[
D_{pi} = 491 \text{ feet}
\]

Locate the point overspeed detector at \( D_{pi} \) feet in front of the ID Check Point and set it at \( V_p \).  
\[
V_p = 60 \text{ mph} \quad 88.0 \text{ f/s}
\]

The distance between the point overspeed detector and the barrier is \( D_{pb} = D_{pi} + Dib \)  
\[
D_{pb} = 852 \text{ feet}
\]

C Threat Scenario #2

The required range for the Zone 2 continuous overspeed detector is \( D_{z2} = (V_1 - V_2)*t \)  
\[
D_{z2} = 110 \text{ feet}
\]

To find the required range of the Zone 1 continuous overspeed detector, assume the TV passes the point overspeed detector at just under its setting so as not to be detected and then starts to accelerate.

The speed of the TV as it reaches the beginning of the range of the Zone 1 detector is \( V_{z1} = (V_p^2 + 2*a*D_{pz1})^{1/2} \), where \( D_{pz1} \) is the distance between the point overspeed detector and the beginning of the range of the Zone 1 detector.

The distance between the beginning of the range of the Zone 1 detector and the barrier (\( D_{z1b} \)) must provide \( t \) seconds of delay, so \( D_{z1b} = V_{z1}*t + 1/2*a*t^2 \)

Solving these 3 equations for \( D_{z1b} \) gives the following quadratic parameters:

\[
A = 1/t^2 \quad A = 0.040
\]

\[
B = a \quad B = 11.300
\]

\[
C = a^2*t^4/4 - V_p^2 - 2*a*D_{pz} \quad C = -26212
\]

\[
D_{z1b} = (-B + (B^2 - 4*A*C)^{1/2})/(2*A) \quad D_{z1b} = 680 \text{ feet}
\]

\[
D_{pz} = D_{pb} - D_{z1b} \quad D_{pz} = 172 \text{ feet}
\]

\[
V_{z1} = (V_p^2 + 2*a*D_{pz})^{1/2} \quad V_{z1} = 108 \text{ f/s}
\]

The distance between the beginning of the range of the Zone 1 continuous overspeed detector and the ID Check Point is \( D_{z1} = D_{z1b} + Dib \)  
\[
D_{z1} = 319 \text{ feet}
\]
The range of the Zone 1 continuous overspeed detector is 
\[ D_{z1z2} = D_{z1i} - D_{z2i} \] 
\[ D_{z1z2} = 209 \text{ feet} \]

D Threat Scenario #3

 Threat Scenario 3 begins at the ID Check Point with the Threat Vehicle traveling at an intial speed of 0 mph. In the required delay time, Threat Vehicle will travel 
\[ D_{a(3)} = \frac{1}{2}a t^2 \] 
\[ D_{a(3)} = 141 \text{ feet} \]

E Threat Scenario #4

 Threat Scenario #4 begins at the end of the last turn-around with the Threat Vehicle traveling at an intial velocity of 
\[ V_t = 25 \text{ mph} \] 
\[ V_t = 36.7 \text{ f/s} \]
The required delay for Threat Scenario #4 is 
\[ t = 3.0 \text{ sec} \] 

In the required delay, Threat Vehicle could travel 
\[ D_{b} = V_t t + \frac{1}{2} a t^2 \] 
\[ D_{b} = 161 \text{ feet} \]

Assume the distance between the ID Check Point and the end of the last turn-around is 
\[ D_b = 90 \text{ feet} \]
The required distance between the ID Check Point and barrier is 
\[ D_{b(4)} = D_{b} + D_{a(4)} \] 
\[ D_{b(4)} = 251 \text{ feet} \]

F Recommendations

Distances 
\[ D_{b(3)} = D_{a} + D_{b} \] 
\[ D_{b(4)} = D_{b} + D_{a(4)} \]
required for Threat Scenarios #3 & #4 respectively are less than the 
\[ D_{b} = 361 \text{ feet} \] 
\[ D_{b} = 361 \text{ feet} \]
Place barrier a minimum distance of 
\[ D_{a} = 491 \text{ feet} \] 
\[ D_{a} = 491 \text{ feet} \]
Locate the point overspeed detector at 
\[ D_{p} = 60 \text{ mph} \] 
\[ V_p = 60 \text{ mph} \]
Set the point overspeed detector at 
\[ V_{c1} = 45.0 \text{ mph} \] 
\[ V_{c1} = 45.0 \text{ mph} \]
Set the range of the Zone 1 continuous overspeed detector to 
\[ D_{z1z2} = 209 \text{ feet} \] 
\[ D_{z1z2} = 209 \text{ feet} \]
Set the Zone 1 continuous overspeed detector at 
\[ V_{c2} = 30.0 \text{ mph} \] 
\[ V_{c2} = 30.0 \text{ mph} \]
Set the range of the Zone 2 continuous overspeed detector at 
\[ D_{z2i} = 110 \text{ feet} \] 
\[ D_{z2i} = 110 \text{ feet} \]
Set the Zone 2 continuous overspeed detector at 
\[ D_{z2i} = 319 \text{ feet} \] 
\[ D_{z2i} = 319 \text{ feet} \]
Note the distance between the beginning of the Zone 1 continuous overspeed detector and the ID Check Point is 
\[ D_{z1i} = 319 \text{ feet} \] 
\[ D_{z1i} = 319 \text{ feet} \]
If the Zone 1 detector is located at the ID Check Point, the detector must have a range of 

Notes

The locations and settings of the overspeed detectors described above are necessary to limit the required distance between the ID Check Point and the barrier to 
\[ D_{a} = 361 \text{ feet} \] 
\[ D_{a} = 361 \text{ feet} \]
However, these detector locations and settings may cause nuisance alarms. To minimize nuisance alarms, recommend that the Installation initiate a program to educate ACP users on the necessity to abide by posted speed limits and an enforcement program to punish motorist who exceed speed limits. Speed calming means ahead of the ID Check Point such as rumble strips should also be considered along with proper signage including variable message signs that display motorists actual speed along with the posted speed limit.
Attachment 14
Example - Curve in Response Zone, Signs and Signals Safety System
No Overspeed Detection

<table>
<thead>
<tr>
<th>Parameters of the ACP:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curve in the Response Zone with a inside radius</td>
</tr>
<tr>
<td>IR = 130 feet</td>
</tr>
<tr>
<td>Roadway Width is RW= 50 feet</td>
</tr>
<tr>
<td>Curve Angle in degrees: CA = 90 deg</td>
</tr>
<tr>
<td>Radius of threat vehicle path is (see Note 1)</td>
</tr>
<tr>
<td>R=(IR+3)+(RW-6)/(1-cos(CA/2))</td>
</tr>
<tr>
<td>Spinnout speed in curve = Vc=(R<em>g</em>(f+s))^0.5,</td>
</tr>
<tr>
<td>where g=32.2 f/s/s, f=0.75, and s=0.03.</td>
</tr>
<tr>
<td>Vc = 84.2 f/s 57.404 mph</td>
</tr>
<tr>
<td>Signs and Signals Safety System where required delay time = t 9 sec</td>
</tr>
<tr>
<td>Acceleration of Threat Vehicle: a = 11.3 f/s/s</td>
</tr>
<tr>
<td>Deceleration of Threat Vehicle: a_d = 24.1 f/s/s</td>
</tr>
<tr>
<td>Distance from ID Check Point to end of last Turn-around: D_t 90 feet</td>
</tr>
<tr>
<td>Distance from ID Check Point to curve: D_tv 225 feet</td>
</tr>
<tr>
<td>Distance from beginning of the TV's path in the turn to the beginning of the curve: X=(RW-6)*Sin(CA/2)/(1-Cos(CA/2)) X 106 feet</td>
</tr>
<tr>
<td>Distance from ID Check Point to beginning of TV's path in the curve: D tcb= D_tv-X (see Note 1) D tcb 119 feet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Threat Scenarios #1 and #2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>For the high speed threat scenarios (TS #1&amp;#2) with no advanced overspeed detection, the point of detection is the ID Check Point.</td>
</tr>
<tr>
<td>Path of the vehicle from the point of detection is as follows:</td>
</tr>
<tr>
<td>ID Check Point to beginning of TV's path in the curve: D tcb D tcb</td>
</tr>
<tr>
<td>Distance of TV's path through curve: D_e D_e</td>
</tr>
<tr>
<td>End of TV's path in the curve to final barriers: D cb D cb</td>
</tr>
<tr>
<td>Given D tcb and D e, determine required length of D cb to defeat threat.</td>
</tr>
</tbody>
</table>
Maximum speed of Threat Vehicle in the curve (Vc) from above
\[ V_i = \text{maximum speed of threat vehicle at the ID Check Point to be able to decelerate to } V_c \text{ at beginning of curve} = (V_c^2 + 2a_d * D_{ic})^{1/2} \]
\[ V_i = 77.2 \text{ mph} \quad 113.2 \text{ f/s} \]

Time for TV to travel from ID Check Point (point of detection) to the curve is
\[ T_{ic} = (V_i - V_c)/a_{d} \quad T_{ic} = 1.2 \text{ sec} \]
Distance thru curve:
\[ d_c = 2\pi R CA/360 \quad d_c = 443 \text{ feet} \]
Time to go thru curve:
\[ t_c = d_c/V_c \quad t_c = 5.3 \text{ sec} \]
Additional time required to delay Threat Vehicle for T_d seconds:
\[ t_r = t - T_{ic} - t_c \quad t_r = 2.5 \text{ sec} \]
Additional straight line distance required to delay Threat Vehicle for t_r seconds:
\[ D_{cb} = V_c * t_r + 1/2 * a * t_r^2 \quad D_{cb} = 249 \text{ feet} \]
Required distance between ID Check Area and the final barrier:
\[ D_{ib} = D_{ic} + d_c + D_{cb} \quad D_{ib} = 811 \text{ feet} \]

### Threat Scenario #3:
In this Threat Scenario, The threat vehicle's initial speed at the point of detection (ID Check point) is \( V_o = 0 \text{ mph} \), so this scenario is a less case than Threat Scenarios 1&2 above where \( V_i \) is much higher.

### Threat Scenario #4:
In this Threat Scenario, the threat vehicle is detected at the end of the last Turn-around traveling at the ACP speed limit (\( V_o = 25 \text{ mph} \)).
\[ V_o = 25 \text{ mph} \quad 36.7 \text{ f/s} \]
Since the guards have identified this vehicle as a possible threat, guard reaction time is reduced from 3 to 1 seconds and the overall delay time is reduced from 9 to 7 seconds.
\[ t = 7 \text{ sec} \]
The distance from the end of the last Turn-around to the beginning of TV's path in the Curve is
\[ D_{tc} = D_{ic} - D_{it} \quad D_{tc} = 29 \text{ feet} \]
The threat vehicle will start to accelerate at end of the Turn-around from a speed of $V_o$ to a maximum speed ($V_m$) and then decelerate to the curve's spinout speed $V_c$ at the entrance to the curve.  

$V_c = 84.2$ f/s

Distance from end of Turn-around to get to point where Threat Vehicle speed is $V_m$: $d_1$

Distance for Threat Vehicle to decelerate from the point where its speed is $V_m$ to the beginning of the curve: $d_2 = d_{ic} - d_1$

Time to travel $d_1$: $t_1$

Time to travel $d_2$: $t_2$

Distance thru curve: $d_c = 2\pi R CA/360$

Time to go thru curve: $t_c = d_c/V_c$

Additional time required to delay Threat Vehicle for $T_d$ seconds: $t_r = T_d - t_1 - t_2 - t_c$

Additional straight line distance to go in $t_r$ seconds: $D_{cb} = V_c t_r + 1/2 a t_r^2$

Solution Method:

$$V_m^2 = V_o^2 + 2 a d_1$$

$$V_m^2 = V_c^2 + 2 a d_2$$

$$V_o^2 + 2 a d_1 = V_c^2 + 2 a_d d_2$$

$$d_2 = D_{ic} - d_1$$

$$2 a d_1 - 2 a_d (D_{ic} - d_1) = V_c^2 - V_o^2 + 2 a_d d$$

$$d_1 = (V_c^2 - V_o^2 + 2 a_d D_{ic})/(2 a + 2 a_d) = d_1$$

$$d_2 = D_{ic} - d_1 = d_2$$

$$V_m = (V_o^2 + 2 a d_1)^{1/2} = V_m$$

$$V_m = (V_c^2 + 2 a_d d_2)^{1/2} = V_m$$

$$t_1 = (V_m - V_o)/a = t_1$$

$$t_2 = (V_m - V_c)/a_d = t_2$$

$$d_c = 2\pi R CA/360 = d_c$$

$$t_c = d_c/V_c = t_c$$

$$t_{ic} = t_c + t_1 + t_2 > t$$, so TS#4 is contained

$$t_{ic} = 6.35 \text{ sec}$$
### Summary

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance between ID Check Point and Curve, (D_{iv})</td>
<td>(D_{iv})</td>
<td>225 feet</td>
</tr>
<tr>
<td>Distance between the beginning of the TV's path in the curve and the beginning of the curve: (X)</td>
<td>(X)</td>
<td>106 feet</td>
</tr>
<tr>
<td>Distance through the TV's path in the Curve, (d_c)</td>
<td>(d_c)</td>
<td>443 feet</td>
</tr>
<tr>
<td>Distance between end of TV's path in the Curve and barrier, (D_{cb})</td>
<td>(D_{cb})</td>
<td>249 feet</td>
</tr>
<tr>
<td>Distance between ID Check Point and barrier, (D_{ib})</td>
<td>(D_{ib})</td>
<td>811 feet</td>
</tr>
</tbody>
</table>

### Notes:

1. See Figure 7 - Path of Threat Vehicle in a Curve/Turn
2. In order to reduce \(D_{cb}\), overspeed detection can be provided in front of the ID Check Point. See example in Attachment 8.
Parameters of the ACP

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value/Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D_{it}$ = Distance between ID Check Point and</td>
<td>400 feet</td>
</tr>
<tr>
<td>beginning of the turn.</td>
<td></td>
</tr>
<tr>
<td>$X$ = Distance between the beginning of the TV's path in the turn and beginning of the turn, $X=(RW-6)*\sin(\text{CA}/2)/(1-\cos(\text{CA}/2))$. (see Note 1)</td>
<td>63 feet</td>
</tr>
<tr>
<td>$D_{ic}$ = Distance between ID Check Point and</td>
<td>336.6 feet</td>
</tr>
<tr>
<td>beginning of the TV's path in the turn: $D_{ic}=D_{it}-X$</td>
<td></td>
</tr>
<tr>
<td>Inside radius of turn = IR</td>
<td>130 feet</td>
</tr>
<tr>
<td>Roadway width through turn = RW</td>
<td>26 feet</td>
</tr>
<tr>
<td>Turn Angle of turn = CA</td>
<td>70 deg</td>
</tr>
<tr>
<td>Radius of threat vehicle path is (see Note 1)</td>
<td>R = (IR+3)+(RW-6)/(1-cos(CA/2))</td>
</tr>
<tr>
<td>Spinout speed in turn = $V_c=(R \cdot g \cdot (f+s))^{0.5}$, where $g=32.2 \text{ ft/s/s}$, $f=0.75$, and $s=0.03$.</td>
<td>$V_c$ = 78.1 ft/s</td>
</tr>
<tr>
<td>$a=$TV acceleration rate = $a$ = 11.3 ft/s/s</td>
<td></td>
</tr>
<tr>
<td>$a_d=$TV deceleration rate = $a_d$ = 24.1 ft/s/s</td>
<td></td>
</tr>
<tr>
<td>$t=$required time delay = $t$ = 9 s</td>
<td></td>
</tr>
</tbody>
</table>

Threat Scenario #2

Do Threat Scenario #2 first to determine time for Threat Vehicle to go from ID Check Point to turn ($T_{sc}$).

In TS#2, TV will begin attack at the ID Check Point and start to accelerate to a maximum speed $V_m$ between the Check Point and the turn and then start to decelerate to $V_c$ as it enters the turn.

$V_i$ = TV speed at ID Check Point (point of detection), which is the setting of the continuous overspeed detector = $V_i$ = 35 mph = 51.3 ft/s

$V_m^2 = V_i^2 + 2 \cdot a \cdot d_1$, where $d_1$ is the distance between the ID Check Point and the point where the TV reaches $V_m$.  

$V_m^2 = V_c^2 + 2 \cdot a_d \cdot d_2$, where $d_2$ is the distance between the turn and the point where the TV reaches $V_m$.  

$d_{ic} = d_1 + d_2$

Combining the above three equations in terms of $d_1$:

$d_1 = (V_c^2 - V_i^2 + 2 \cdot a_d \cdot D_{ic})/(2 \cdot a + 2 \cdot a_d)$

$d_2 = D_{ic} - d_1$
Threat Scenario #1

Determine distance between point overspeed detector (which is the point of detection for TS#1) and the turn.

In TS#1, TV enters ACP at high speed, however, at some point it must start to decelerate to reach speed \( V_c \) at the beginning of the turn.

The point overspeed detector must be placed at a distance from the turn to be able to detect the TV in the same amount of time as the TV was detected in TS#2 from the point of detection to the beginning of the turn. This time is \( T_{ic} \) for TS#2 above.

In the worst case, the TV will be decelerating at this point, so its speed is \( V_p = V_c + a_d \cdot T_{ic} \). \( V_p \) 186.3 f/s 127.1 mph

Distance between the point overspeed detector and the turn is \( D_{pc} = V_p \cdot T_{ic} - \frac{1}{2} \cdot a_d \cdot T_{ic}^2 \). \( D_{pc} \) 594 feet

Distance between the point overspeed detector and the ID Check Point is \( D_{pi} = D_{pc} - D_{ic} \). \( D_{pi} \) 257 feet

Threat Scenario #2

Determine the range of the continuous overspeed detector (\( D_{zi} \))

The other attack option in TS#2 is that the TV will pass the point overspeed detector at just under its setting (\( V_p \)) and then begin to accelerate. The continuous OS detector will detect this attack at the beginning of its range of coverage. \( V_p \) 55 mph 80.7 f/s

From the point OS Detector, the TV will begin to accelerate from a speed of \( V_p \) to a speed of \( V_m \) and then start to decelerate in order to get to a speed of \( V_c \) at the entrance to the turn.

\[
V_m = \sqrt{V_p^2 + 2 \cdot a \cdot d_1}
\]

\[
V_m = \sqrt{V_c^2 + 2 \cdot a_d \cdot d_2}
\]

Also, \( D_{pc} = d_1 + d_2 \)
Combining the above 3 equations in terms of \( d_1 \):

\[
d_1 = \frac{(V_c^2 - V_p^2 + 2*a_d \cdot D_{pc})}{(2*a + 2*a_d)} \quad d_1 \quad 399 \text{ feet}
\]

\[
d_2 = D_{pc} - d_1 \quad d_2 \quad 195 \text{ feet}
\]

\[
V_m = (V_p^2 + 2*a \cdot d_1)^{1/2} \quad V_m \quad 125 \text{ f/s}
\]

\[
V_m = (V_c^2 + 2*a_d \cdot d_2)^{1/2} \quad V_m \quad 125 \text{ f/s}
\]

\[
t_1 = \frac{(V_m - V_p)}{a} \quad t_1 \quad 3.88 \text{ sec}
\]

\[
t_2 = \frac{(V_m - V_c)}{a_d} \quad t_2 \quad 1.93 \text{ sec}
\]

\[
T_{pc} = t_1 + t_2 \quad T_{pc} \quad 5.81 \text{ sec}
\]

The time it takes the TV to go from the beginning of the continuous OS detector (point of detection) to the turn must be no greater than \( T_{ic} \) calculated for TS#2 above.

The time it takes the TV to go from the point OS detector to the beginning of the continuous OS detector's zone is then \( T_{pz} = T_{pc} - T_{ic} \quad T_{pz} \quad 1.32 \text{ sec} \)

The speed of the TV at the beginning of the continuous OS detector's zone is then \( V_z = V_p + a \cdot T_{pz} \quad V_z \quad 95.6 \text{ f/s} \)

Distance between point OS detector and the beginning of the continuous OS detector's zone is

\[
D_{pz} = V_p \cdot T_{pz} + \frac{1}{2} \cdot a \cdot T_{pz}^2 \quad D_{pz} \quad 116 \text{ feet}
\]

Length of continuous OS detector's zone is \( D_{zi} = D_{pi} - D_{pz} \quad D_{zi} \quad 141 \text{ feet} \)

Distance in turn is \( D_c = 2\pi*R*CA/360 \quad D_c \quad 296 \text{ feet} \)

The time to get through the turn is \( T_c = D_c/V_c \quad T_c \quad 3.80 \text{ sec} \)

Remaining delay time required is \( T_r = t - T_{pc} - T_c \quad T_r \quad 0.71 \text{ sec} \)

Straight line distance required from the end of the TV's path in the turn to the barriers is

\[
D_{cb} = V_c \cdot T_r + \frac{1}{2} \cdot a \cdot T_r^2 \quad D_{cb} \quad 58 \text{ feet}
\]

Required distance between the ID Check Point and barrier is \( D_{ib} = D_c + D_z + D_{cb} \quad D_{ib} \quad 691 \text{ feet} \)

**Threat Scenario #3**

In TS#3, TV begins attack at ID Check Point at a speed of 0 mph. This is a much less case than TS#2, which also begins at the ID Check Point but at a much higher speed.

TS#3 can be ignored in this example.
### Threat Scenario #4

In Threat Scenario #4, the TV begins the attack at the end of the last Turn-around, which is a distance $D_{it}$ from the ID Check Point.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D_{it}$</td>
<td>90 feet</td>
</tr>
</tbody>
</table>

**Delay time** $T_S # 4$ is $t = 7$ sec

**Distance between the end of the last Turn-around, which is the point of detection, and the turn is**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D_{tc} = D_{tc} - D_{it}$</td>
<td>246.6 feet</td>
</tr>
</tbody>
</table>

At the end of the last Turn-around, TV will begin to accelerate from an initial speed of $V_t = 25$ mph to a maximum speed of $V_m$ and then start to decelerate to $V_c$ as it enters the turn.

- $V_m = V_t^2 + 2 \cdot a \cdot d_1$
- $V_m = V_c^2 + 2 \cdot a_d \cdot d_2$
- $D_{tc} = d_1 + d_2$

Combining the above 3 equations in terms of $d_1$:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$d_1 = (V_c^2 - V_t^2 + 2 \cdot a_d \cdot D_{tc}) / (2 \cdot a + 2 \cdot a_d)$</td>
<td>234.9 feet</td>
</tr>
<tr>
<td>$d_2 = D_{tc} - d_1$</td>
<td>11.64 feet</td>
</tr>
</tbody>
</table>

**$V_m = (V_t^2 + 2 \cdot a \cdot d_1)^{1/2}$**

**$V_m = (V_c^2 + 2 \cdot a_d \cdot d_2)^{1/2}$**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_1 = (V_m - V_t) / a$</td>
<td>3.974 sec</td>
</tr>
<tr>
<td>$t_2 = (V_m - V_c) / a_d$</td>
<td>0.146 sec</td>
</tr>
</tbody>
</table>

**$T_{tc} = t_1 + t_2$**

- Time for TV to go through turn is $T_c$ from above.
- $T_c = 3.80$ sec
- Time for TV to go from end of last Turn-around to end of turn is $T_{tec} = T_{tc} + T_c$

$T_{tec} = 7.92$ sec

Since $T_{tec}$ is greater than the required delay time $t$, TS#4 is contained.

### Summary

| Distance between ID Check Point and turn, $D_h$ | $D_{it}$ | 400 feet |
| Distance between the beginning of the TV's path in the turn and the beginning of the turn, $X$ | $X$ | 63 feet |
| Distance between end of turn and Barrier, $D_{ch}$ | $D_{ch}$ | 58 feet |

| Distance between ID Check Point and barrier, $D_{hb}$ | $D_{hb}$ | 691 feet |
| Distance between point overspeed detector and the ID Check Point, $D_{pi}$ | $D_{pi}$ | 257 feet |
| Setting of the point overspeed detector, $V_p$ | $V_p$ | 55 mph |
| Range of the continuous overspeed detector, $D_{ri}$ | $D_{ri}$ | 141 feet |
| Setting of the continuous overspeed detector, $V_i$ | $V_i$ | 35 mph |

### Notes:

1. See Figure 7 - Path of Threat Vehicle in a Curve/Turn.
### Parameters of the ACP:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curve in the Response Zone with a inside radius</td>
<td>IR 130 feet</td>
</tr>
<tr>
<td>Roadway Width is RR</td>
<td>RW 26 feet</td>
</tr>
<tr>
<td>Curve Angle in degrees: CA</td>
<td>CA 70 deg</td>
</tr>
<tr>
<td>Radius of threat vehicle path is (see Note 1)</td>
<td>R 243 feet</td>
</tr>
<tr>
<td>Spinout speed in curve = $V_c = (R \cdot g \cdot (f+s))^{0.5}$,</td>
<td>$V_c$ 78.1 f/s</td>
</tr>
<tr>
<td>where g=32.2 f/s/s, f=0.75, and s=0.03.</td>
<td></td>
</tr>
<tr>
<td>Length of Threat Vehicle path through the curve is $D_c = 2\pi R \cdot CA/360$</td>
<td>$D_c$ 296 feet</td>
</tr>
<tr>
<td>Time for Threat Vehicle to traverse the curve is $T_c = D_c/V_c$</td>
<td>$T_c$ 3.8 sec</td>
</tr>
<tr>
<td>Signs and Signals Safety System where required delay time =</td>
<td>$t$ 5 sec</td>
</tr>
<tr>
<td>Acceleration of Threat Vehicle: $a = a 11.3$ f/s/s</td>
<td></td>
</tr>
<tr>
<td>Deceleration of Threat Vehicle: $a_d = a_d 24.1$ f/s/s</td>
<td></td>
</tr>
<tr>
<td>Distance from ID Check Point to end of last Turn-around: $D_{it}$</td>
<td>$D_{it}$ 90 feet</td>
</tr>
<tr>
<td>Distance from ID Check Point to beginning of the curve: $D_{iv}$</td>
<td>$D_{iv}$ 100 feet</td>
</tr>
<tr>
<td>Distance from the beginning of the TV’s path in the curve and the beginning of the curve: $X = (RW-6) \cdot \sin(CA/2)/(1-\cos(CA/2))$ (Note 1)</td>
<td>$X$ 63 feet</td>
</tr>
<tr>
<td>Distance from ID Check Point to beginning of TV’s path in the curve: $D_{ic} = D_{iv} - X$</td>
<td>$D_{ic}$ 37 feet</td>
</tr>
</tbody>
</table>

### Threat Scenarios #1 and #2:

For the high speed threat scenarios (TS #1&#2) with no advanced overspeed detection, the point of detection is the ID Check Point.

Path of the vehicle from the point of detection is as follows:

- ID Check Point to beginning of curve: $D_{ic}$
- Distance through curve: $D_c$
End of curve to final barriers: $D_{cb}$

Given $D_{ic}$ and $D_c$, determine required length of $D_{cb}$ to defeat threat.

Maximum speed of Threat Vehicle in the curve ($V_c$) from above

$$V_i = \text{maximum speed of threat vehicle at the ID Check Point to be able to decelerate to } V_c \text{ at beginning of curve} = \left(\frac{V_c^2 + 2a_d D_{ic}}{2}\right)^{1/2}$$

$V_i$ 60.4 mph 88.6 f/s

Time for TV to travel from ID Check Point (point of detection) to the curve is $T_{ic} = \frac{V_i - V_c}{a_d}$

$T_{ic}$ 0.4 sec

Distance thru curve: $d_c = 2\pi R CA / 360$ $d_c$ 296.4 feet

Time to go thru curve = $\frac{d_c}{V_c}$ $t_c$ 3.797 sec

Additional time required to delay Threat Vehicle for $T_d$ seconds: $t_r = t - T_{ic} - t_c$ $t_r$ 0.8 sec

Additional straight line distance required to delay Threat Vehicle for $t_r$ seconds:

$$D_{cb} = V_c t_r + \frac{1}{2}a_d t_r^2$$ $D_{cb}$ 63 feet

Required distance between ID Check Area and the final barrier: $D_{ib} = D_{ic} + d_c + D_{cb}$ $D_{ib}$ 395.9 feet

Threat Scenario #3:

In this Threat Scenario, the threat vehicle's initial speed at the point of detection (ID Check point) is $V_o = 0$ mph, so this scenario is a less case than Threat Scenarios 1&2 above where $V_i$ is much higher.

Threat Scenario #4:

In this Threat Scenario, the threat vehicle is detected at the end of the last Turn-around traveling at the ACP speed limit ($V_o = 25$ mph). $V_o$ 25 mph 36.7 f/s

Since the guards have identified this vehicle as a possible threat, guard reaction time is reduced from 3 to 1 seconds and the overall delay time is reduced 2 seconds. $t$ 3 sec
Since the time delay in the curve \((t_c)\) is greater than the required time delay, Threat Scenario #4 will be defeated.

### Summary

<table>
<thead>
<tr>
<th>Distance</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance between ID Check Point and beginning of curve, (D_{ic})</td>
<td>(D_{ic}) 100 feet</td>
</tr>
<tr>
<td>Distance between beginning of TV's path in the curve and the beginning of the curve, (X)</td>
<td>(X) 63 feet</td>
</tr>
<tr>
<td>Distance between ID Check Point and Curve, (D_{ib})</td>
<td>(D_{ib}) 37 feet</td>
</tr>
<tr>
<td>Distance between end of Curve and Barrier, (D_{cb})</td>
<td>(D_{cb}) 63 feet</td>
</tr>
</tbody>
</table>

### Notes:

1. See Figure 7 - Path of Threat Vehicle in a Curve/Turn
2. For the Presence Detection Safety System, most of the required delay can be achieved in a properly selected curve. Advance speed detection should, therefore, not be necessary.
Attachment 17

Example - Curve in Approach Zone, Signs and Signals Safety System
No Speed Detection

<table>
<thead>
<tr>
<th>Parameters of the ACP:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The approach roadway to the ACP corridor has a turn into the ACP corridor with a radius of $R = 65$ feet</td>
</tr>
<tr>
<td>Roadway width is $RW = 26$ feet</td>
</tr>
<tr>
<td>Curve Angle of turn is $CA = 90$ deg</td>
</tr>
<tr>
<td>Radius of threat vehicle path is (see Note 1) $R = (IR + 3) + (RW - 6) / (1 - \cos(CA/2))$</td>
</tr>
<tr>
<td>Spinout speed in curve $V_c = (R \cdot g \cdot (f + s))^{0.5}$, where $g = 32.2 \text{f/s/s}$, $f = 0.75$, and $s = 0.03$. See Note 2.</td>
</tr>
<tr>
<td>$V_c = 58.5 \text{ f/s} 39.9 \text{ mph}$</td>
</tr>
<tr>
<td>Signs and Signals Safety System where required delay time is $t = 9$ sec</td>
</tr>
<tr>
<td>Acceleration of Threat Vehicle: $a = 11.3 \text{ f/s/s}$</td>
</tr>
<tr>
<td>Distance from the end of the turn to the ID Check Point: $D_{ti} = 50$ feet</td>
</tr>
<tr>
<td>No advanced speed detection.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Threat Scenarios 1&amp;2 - High Speed Attacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>The maximum speed in the turn is $V_t = (See Notes 2 &amp; 3) V_t = 58.5 \text{ f/s} 39.9 \text{ mph}$</td>
</tr>
<tr>
<td>The Threat Vehicle will start to accelerate from the end of the turn and will continue to accelerate to the barrier.</td>
</tr>
<tr>
<td>The worst case point of detection is the ID Check Point at which point the TV will be traveling at $V_d = (V_t^2 + 2 \cdot a \cdot D_{ti})^{1/2}$</td>
</tr>
<tr>
<td>$V_d = 67.5 \text{ f/s}$</td>
</tr>
<tr>
<td>The required distance between the ID Check Point and the barrier is $D_{ib} = V_d \cdot t + 1/2 \cdot a \cdot t^2$</td>
</tr>
<tr>
<td>$D_{ib} = 1065$ feet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Threat Scenario #3 - Covert at ID Check point.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV begins attack at ID Check Point, where it is immediately detected by the ID Check guard.</td>
</tr>
<tr>
<td>TV's speed at the point of detection is $V_d = 0 \text{ f/s}$.</td>
</tr>
<tr>
<td>Total distance Threat Vehicle can travel from the point of detection (ID Check point) in the required $t$ seconds of delay is $D_{ib} = V_d \cdot t + 1/2 \cdot a \cdot t^2$</td>
</tr>
<tr>
<td>$D_{ib} = 458$ feet</td>
</tr>
</tbody>
</table>
Dib for Threat Scenario #3 is considerably smaller than Dib calculated above for Threat Scenarios 1&2, so use Dib for Threat Scenarios 1&2.

### Threat Scenario #4 - Covert at end of last Turn around.

Threat vehicle begins attack at the end of the last Turn at which point it is immediately detected by ID Check guards. The TV’s speed at the point of detection is the ACP speed limit, so $V_d = 25$ mph.

Since TV has been identified by guards as suspect, guard reaction time to initiate EFO is reduced from 3 to 1 seconds, thus reducing overall delay time to $t = 7$ seconds.

The distance between the ID Check point and the end of the last Turn around is $D_{it} = 90$ feet.

Total distance Threat Vehicle can travel from the point of detection (end of last Turn around) in the required t seconds of delay is $D_{tb} = V_d t + \frac{1}{2} a t^2$. With $V_d = 25$ mph and $t = 7$ seconds, $D_{tb} = 534$ feet.

Required distance from ID Check Point to the barrier to defeat Threat Scenario #4 is $D_{ib} = D_{it} + D_{tb} = 624$ feet.

Dib for Threat Scenario #4 is considerably smaller than Dib calculated above for Threat Scenarios 1&2, so use the Dib calculated for Threat Scenarios 1&2.

### Summary

To defeat TS 1&2, a large distance $D_{ib}$ is required. Even with the fairly tight turning radius in this example, the turn in the Approach Zone does not significantly reduce the required distance $D_{ib}$. See note 3.

### Notes:

1. See Figure 7 - Path of Threat Vehicle in a Curve/Turn.

2. If $V_c > 35$ mph, the turn has little value in providing delay. Use examples for Straight Approach to ACP Corridor.
In order to be effective, Approach Zone speed management features must have narrow lanes and must be brought up fairly close to the ID Check Point, which will help keep the Threat Vehicle's speed low at the ID Check Point (point of detection). This is not possible at a multi-lane, high volume gate, but may be possible at a low volume, single entry lane gate.
### Parameters of the ACP:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serpentine at beginning of Response Zone with spacing between barriers (s)</td>
<td>s 55 feet</td>
</tr>
<tr>
<td>Number of barriers in serpentine is N. Note, the minimum number of barriers to make a serpentine is 3.</td>
<td>N 3</td>
</tr>
<tr>
<td>Roadway Width is RW=</td>
<td>RW 26 feet</td>
</tr>
<tr>
<td>From Figure 9, The spinout speed in a Serpentine with s spacing between barriers is $V_s = s/2$ mph</td>
<td>$V_s$ 40.3 f/s 27.5 mph</td>
</tr>
<tr>
<td>Signs and Signals Safety System where required delay time =</td>
<td>t 9 sec</td>
</tr>
<tr>
<td>Acceleration of Threat Vehicle: $a =$</td>
<td>a 11.3 f/s/s</td>
</tr>
<tr>
<td>Deceleration of Threat Vehicle: $a_d =$</td>
<td>$a_d$ 24.1 f/s/s</td>
</tr>
<tr>
<td>Distance from ID Check Point to end of last Turn-around: $D_{it}$</td>
<td>$D_{it}$ 90 feet</td>
</tr>
<tr>
<td>Distance from ID Check Area to serpentine is $D_{is}$</td>
<td>$D_{is}$ 95 feet</td>
</tr>
</tbody>
</table>

### Threat Scenarios #1 and #2:

For the high speed threat scenarios (TS #1&#2) with no advanced overspeed detection, the point of detection is the ID Check Point.

Path of the Threat Vehicle (TV) from the point of detection is as follows:

- ID Check Point to beginning of the serpentine: $D_{is}$
- Distance through serpentine: $D_s$
- End of serpentine to final barriers: $D_{cb}$

Given $D_{is}$ and $D_s$, determine required length of $D_{cb}$ to defeat threat.

Maximum speed of Threat Vehicle in the serpentine ($V_s$) from above

$V_i =$maximum speed of threat vehicle at the ID Check Point to be able to decelerate to $V_s$ at beginning of curve

$$V_i = \left( V_s^2 + 2adD_{is} \right)^{1/2}$$

$V_i$ 53.7 mph 78.8 f/s
Time for TV to travel from ID Check Point (point of detection) to the serpentine is
\[ T_{is} = \frac{(V_i - V_s)}{a_d} \]
\[ T_{is} = 1.6 \text{ sec} \]

Distance thru serpentine: \[ D_s = s \times (N-1) \]
\[ D_s = 110 \text{ feet} \]

Time to go thru serpentine = \[ \frac{D_s}{V_s} \]
\[ t_s = 2.727 \text{ sec} \]

Additional time required to delay Threat Vehicle for \( T_d \) seconds: \[ t_r = t - T_{is} - t_s \]
\[ t_r = 4.7 \text{ sec} \]

Additional straight line distance required to delay Threat Vehicle for \( t_r \) seconds:
\[ D_{cb} = V_s \times t_r + \frac{1}{2} \times a \times t_r^2 \]
\[ D_{cb} = 312 \text{ feet} \]

Required distance between ID Check Point and the final barrier: \[ D_{ib} = D_{is} + D_s + D_{cb} \]
\[ D_{ib} = 517 \text{ feet} \]

**Threat Scenario #3:**

In this Threat Scenario, The threat vehicle's initial speed at the point of detection (ID Check point) is \( V_o = 0 \text{ mph} \), so this scenario is a less case than Threat Scenarios 1&2 above where \( V_i \) is much higher.

**Threat Scenario #4:**

In this Threat Scenario, the threat vehicle is detected at the end of the last Turn-around traveling at the ACP speed limit (\( V_o = 25 \text{ mph} \)).

\[ V_o = 25 \text{ mph} \quad 36.7 \text{ f/s} \]

Since the guards have identified this vehicle as a possible threat, guard reaction time is reduced from 3 to 1 seconds and the overall delay time is reduced from 9 to 7 seconds.
\[ t = 7 \text{ sec} \]

The time to go through the serpentine (\( t_s \)) plus the time to go from the end of the serpentine to the final barriers (\( t_r \)) is greater than the required time delay \( t \), so Threat Scenario #4 is contained.
\[ t_s + t_r = 7.4 \text{ sec} \]

**Summary**

- Distance between ID Check Point and serpentine, \( D_{is} = D_s \)
  \[ D_s = 95 \text{ feet} \]
- Distance through serpentine, \( D_s \)
  \[ D_s = 110 \text{ feet} \]
- Distance between end of Curve and barrier, \( D_{cb} = D_{cb} \)
  \[ D_{cb} = 312 \text{ feet} \]
- Distance between ID Check Point and barrier, \( D_{ib} = D_{ib} \)
  \[ D_{ib} = 517 \text{ feet} \]
In order to reduce $D_{eh}$, the serpentine can be extended with additional barriers. See

A serpentine requires a two lane roadway to develop. The serpentine essentially reduces the two lane roadway to one lane. Designers must consider the effect of using serpentines on traffic volumes through the ACP.
No Overspeed Detection

### Parameters of the ACP:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serpentine in Response Zone with spacing between barriers of ( s )</td>
<td>( s = 55 ) feet</td>
</tr>
<tr>
<td>Determine ( N ) = the required number of barriers in the serpentine. Note, the minimum number of barriers to make a serpentine is 3.</td>
<td>( N )</td>
</tr>
<tr>
<td>Roadway Width is ( RW )</td>
<td>( RW = 26 ) feet</td>
</tr>
<tr>
<td>From Figure 9, the spinout speed in a Serpentine with ( s ) spacing between barriers is ( V_s = \frac{s}{2} )</td>
<td>( V_s = 40.3 ) f/s, 27.5 mph</td>
</tr>
<tr>
<td>Signs and Signals Safety System where required delay time =</td>
<td>( t = 9 ) sec</td>
</tr>
<tr>
<td>Acceleration of Threat Vehicle: ( a ) =</td>
<td>( a = 11.3 ) f/s/s</td>
</tr>
<tr>
<td>Deceleration of Threat Vehicle: ( a_d ) =</td>
<td>( a_d = 24.1 ) f/s/s</td>
</tr>
<tr>
<td>Distance from ID Check Point to end of last Turn-around: ( D_s )</td>
<td>( D_s = 90 ) feet</td>
</tr>
<tr>
<td>Distance from ID Check Area to serpentine is ( D_s = 100 ) feet</td>
<td></td>
</tr>
</tbody>
</table>

### Threat Scenarios #1 and #2:

For the high speed threat scenarios (TS #1&#2) with no advanced overspeed detection, the point of detection is the ID Check Point.

Path of the vehicle from the point of detection is as follows:

| ID Check Point to beginning of the serpentine: \( D_{is} \) | \( D_{is} \) |
| Distance through serpentine: \( D_s \) | \( D_s \) |
| End of curve to final barriers: \( D_{cb} \) | \( D_{cb} \) |

Given \( D_{is} \) and \( D_s \), determine required length of \( D_{cb} \) to defeat threat.

Maximum speed of Threat Vehicle in the serpentine \( (V_s) \) from above | \( V_s = 40.3 \) f/s |

\[ V_i = \text{maximum speed of threat vehicle at the ID Check Point to be able to decelerate to } V_c \text{ at beginning of curve} = \left( V_s^2 + 2a_dD_{is} \right)^{1/2} \]

\[ V_i = 54.7 \text{ mph, 80.3 f/s} \]

Time for TV to travel from ID Check Point (point of detection) to the serpentine is \( T_{is} = \frac{(V_i-V_s)}{a_d} \) | \( T_{is} = 1.66 \) sec |

Determine additional delay time required, \( t_a = t - T_{is} \) | \( t_a = 7.34 \) sec |
<table>
<thead>
<tr>
<th><strong>Determine the approximate length of the serpentine required to get ( t_s ) seconds of delay,</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>[ D_a = V_s \times t_s ] ( D_a = 296 ) feet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Determine the number of barriers required in the serpentine,</strong> ( N' = \frac{D_a}{s} + 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( N' = 6.4 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Use ( N = )( N )</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>( N = 6 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Determine actual length of serpentine,</strong> ( D_s = (N-1) \times s )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( D_s = 275 ) feet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Time for TV to travel through serpentine is</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>( t_s = \frac{D_s}{V_s} ) ( t_s = 6.82 ) sec</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Additional straight line distance between the last serpentine barrier and the final active barrier must a minimum of ( s ) feet.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>( D_{sb} = ) ( D_{sb} = 55 ) feet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Time for TV to travel distance ( D_{sb} ) is</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_{sb} = \left( \frac{-V_s + \sqrt{V_s^2 + 2aD_{sb}}}{a} \right) ) ( T_{sb} = 1.17 ) sec</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Total time delay is</strong> ( T_d = T_{is} + t_s + T_{sb} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T_d = 10.2 ) sec</td>
</tr>
</tbody>
</table>

**Threat Scenario #3:**

In this Threat Scenario, The threat vehicle's initial speed at the point of detection (ID Check point) is \( V_o = 0 \) mph, so this scenario is a less case than Threat Scenarios 1&2 above where \( V_i \) is much higher.

**Threat Scenario #4:**

In this Threat Scenario, the threat vehicle is detected at the end of the last Turn-around traveling at the ACP speed limit (\( V_o = 25 \)mph). \( V_o \) \( 25 \) mph \( 0 \) f/s

Since the guards have identified this vehicle as a possible threat, guard reaction time is reduced from 3 to 1 seconds and the overall delay time is reduced from 9 to 7 seconds. \( t \) \( 7 \) sec

The time delay through the Serpentine is \( t_s = 6.82 \) sec

Time from last serpentine barrier to final active barrier, \( T_{sb} = \) \( T_{sb} = 1.17 \) sec

Since \( t_s + T_{sb} > \) than the required time delay of 7 seconds, TS#4 will be contained by the serpentine calculated for TS's 1&2 above.
### Summary

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance between ID Check Point and Serpentine, ( D_{is} )</td>
<td>( D_{is} ) 100 feet</td>
</tr>
<tr>
<td>Number of passive barriers in the Serpentine ( N )</td>
<td>( N ) 6</td>
</tr>
<tr>
<td>Distance through serpentine ( D_s )</td>
<td>( D_s ) 275 feet</td>
</tr>
<tr>
<td>Distance from last serpentine barrier to final active barrier ( D_{sb} )</td>
<td>( D_{sb} ) 55 feet</td>
</tr>
<tr>
<td>Distance from ID Check Point to final barriers ( D_{ib} )</td>
<td>( D_{ib} ) 430 feet</td>
</tr>
</tbody>
</table>
APPENDIX E

COST ESTIMATES
Appendix E - Cost Revised 16 Apr 2009

Note: Costs reflect Contract Cost, mid point of construction Sep 2009, and area cost factor of 1.0

ACP Parameters - Estimate below is based on Dwg C3.02 of the Army ACP Standard Design/Criteria. See the Standard Design/Criteria for complete design requirements and procedures. The approach zone and response zone distances are based on two point over speed detectors and 2 zones of continuous over speed detection.

ACP Corridor - Length = Dacp 1,650 feet

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
<th>Per Unit Price</th>
<th>Total Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gatehouse - 50'-4&quot;x16'-8&quot; See Dwg A1.05</td>
<td>840 sq-ft</td>
<td>$428.18</td>
<td>$359,670</td>
<td></td>
</tr>
<tr>
<td>Guard Booth - Prefab, See Dwg A1.09</td>
<td>2 ea</td>
<td>$50,000.00</td>
<td>$100,000</td>
<td></td>
</tr>
<tr>
<td>Guard Booth Pedestrian - See Dwg A1.09</td>
<td>1 ea</td>
<td>$70,000.00</td>
<td>$70,000</td>
<td></td>
</tr>
<tr>
<td>Overwatch Position - See Dwg A1.09</td>
<td>1 ea</td>
<td>$50,000.00</td>
<td>$50,000</td>
<td></td>
</tr>
<tr>
<td>Visitors Control Center 3 processor - 40' x 62', See Dwg A1.01</td>
<td>2,480 sq-ft</td>
<td>$273.74</td>
<td>$678,878 Note 8</td>
<td></td>
</tr>
<tr>
<td>Visitors Control Center 3 processor - 40' x 62', hardened for 50' standoff.</td>
<td>2,480 sq-ft</td>
<td>$293.89</td>
<td>Note 8</td>
<td></td>
</tr>
<tr>
<td>Visitors Control Center 6 processor - 40' x 74', See Dwg A1.05</td>
<td>2,960 sq-ft</td>
<td>$260.65</td>
<td>Note 8</td>
<td></td>
</tr>
<tr>
<td>Visitors Control Center 6 processor - 40' x 74', hardened for 50' standoff.</td>
<td>2,960 sq-ft</td>
<td>$280.65</td>
<td>Note 8</td>
<td></td>
</tr>
<tr>
<td>Search Building with Pkg Scanner &amp; Metal Detector - 30'x40', See Dwg A1.07</td>
<td>1,200 sq-ft</td>
<td>$304.00</td>
<td>$364,800 Note 1</td>
<td></td>
</tr>
<tr>
<td>Search Building w/o Pkg Scanner &amp; Metal Detector - 25'x26', See Dwg A1.08</td>
<td>650 sq ft</td>
<td>$304.00</td>
<td>Note 1</td>
<td></td>
</tr>
<tr>
<td>I.D. Check Area Canopy - 64'x69', See Dwg A1.10</td>
<td>4,416 sq-ft</td>
<td>$100.26</td>
<td>$442,738</td>
<td></td>
</tr>
</tbody>
</table>

One Gatehouse, two Guard Booths, and one Pedestrian Guard Booth per Dwgs A1.05 and A1.09.

One Visitors Control Center per Dwg A1.01 (3 processor)

Pavement Width in feet - 48

Roadway Perimeter = 4*(AZ+ACZ+RZ) 6,600 feet
Roadway Area = (AZ+ACZ+RZ)*Width 79,200 sq-ft

Number of Inbound Lanes 2
Number of Outbound Lanes 2

Median between inbound & outbound lanes varies from 24' to 8' near final barriers.

Point Speed Detection in Inbound and Outbound Lanes at 1650 feet in front of AVBs.

Wrong-way Detection at two locations in both Outbound Lanes.
<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Unit</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search Area Canopy - Passenger Vehicles - 24'x60', See Dwg A1.11</td>
<td>1,440</td>
<td>sq-ft</td>
<td>$89.04</td>
<td>$128,212</td>
</tr>
<tr>
<td>Search Area Canopy - Trucks - 26'x80', See Dwg A1.11</td>
<td>2,080</td>
<td>sq-ft</td>
<td>$80.11</td>
<td>$166,639</td>
</tr>
<tr>
<td>Equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Active Vehicle Barrier w EFO - NO Operation</td>
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<td>Active Vehicle Barrier Control System (AVBCS) - includes Traffic Controller Unit, Barrier Control Panels, Vehicle presence detectors, &amp; UPS</td>
<td>1</td>
<td>ea</td>
<td>$70k + $10k * Barrier + $10k * Guard Booth</td>
<td>$110,000.00</td>
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<tr>
<td>Traffic signals</td>
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<tr>
<td>Electronic Security System (ESS) - includes PLC/CPU, GH Control Console, Alarm Panels, IDS, Duress, Tamper, &amp; Event Recorder</td>
<td>1</td>
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<td>$53k+$5k * Barrier+$5k*guard booths &amp; overwatch</td>
<td>$93,000.00</td>
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<td>CCTV</td>
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<td>Point Overspeed Detection in both Inbound and Outbound Lanes</td>
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<td>$5k+$3K * (Lin + Lout)</td>
<td>$17,000.00</td>
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<td>Wrong-way Detection in 2 locations (loc) on Outbound Lanes</td>
<td>2</td>
<td>loc</td>
<td>$5k+$3K * loc * Lout</td>
<td>$17,000.00</td>
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<td>Continuous Overspeed Detection - One Zone</td>
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<td>$10k+$10k*Lin</td>
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<td>Continuous Overspeed Detection - Two Zones</td>
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<td>$10k+$21k*Lin</td>
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<td>Crash Beam Barrier w Rem Controls (Corridor)</td>
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<td>Fence Gate - non-crash rated (per leaf)</td>
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<td>Sitework</td>
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<tr>
<td>FE 6 fence</td>
<td>0</td>
<td>lf</td>
<td>$50.00</td>
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<td>Passive cable barriers along corridor (K4 rated triple cable system)</td>
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<td>Passive Barriers along Corridor (K8 vehicle rated fence w/dual cables)</td>
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<td>$228.00</td>
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<td>FE6 fence with 2 each 3/4&quot; cables with deadmen (based on 200 foot spacing between deadmen)</td>
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<td>Barrier Overwatch Pad &amp; Jct Box</td>
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<td>If</td>
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<td>$3,060</td>
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<td>Roadwork</td>
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<td>Pavement - Roadways in AZ+ACZ+RZ</td>
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<td>sq-ft</td>
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<td>Pavement - VCC Parking Area</td>
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<td>sq-ft</td>
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<td>Pavement - VCC &amp; Search Area Roads</td>
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<td>sq-ft</td>
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<td>Unit</td>
<td>Cost 1</td>
<td>Cost 2</td>
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<td>----------------------------------------------------------------------</td>
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<td>Curb and gutter - (Roadway &amp; Parking Perimeters)</td>
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<td>Pavement - 4' wide sidewalk (lf)</td>
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<td>$21,450</td>
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<td>Raised Island for Guard Booth</td>
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<td><strong>Total Cost</strong></td>
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<td></td>
<td><strong>$6,128,460</strong></td>
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</table>

Notes:
1. Select appropriate type of search building; typically there is only one search building per ACP.

2. Active Barrier for normally open operation, e.g., SDDC’s Signs and Signals or Presence Detection Safety Systems. Capable of blocking one traffic lane.

3. Active Barrier for normally closed operation, e.g., SDDC’s Normally Closed Safety System. Capable of blocking one traffic lane.

4. Traffic signals based on 4 lanes, no intersection (as shown on dwg C3.02). Two poles w/arms and three signal heads each (two on the arms and one on each pole). The controller cost is included with the AVB control system.

5. Select no, one, or two zones of continuous overspeed detection.

6. Corridor barriers are remotely operated from Gatehouse and do not have an EFO mode. They can be used for access to limited use areas from the ACP corridor (e.g., utility access roadway).

7. When interfacing ACP alarms with the Installation’s Central Security Monitoring System, include interface costs only and eliminate cost for a separate ESS PLC/CPU.

8. If required, select appropriate size of VCC and VCC parking area based on expected visitor requirements.
APPENDIX F

ELECTRICAL LOADS
## APPENDIX F

### ELECTRICAL DATA

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>DESCRIPTION</th>
<th>SECTION OF &quot;ACP CRITERIA FROM OPMG&quot;</th>
<th>UTILITY</th>
<th>EMER GEN</th>
<th>UPS</th>
<th>QTY</th>
<th>VOLTS AMPS</th>
<th>Utility Connected</th>
<th>DEMAND</th>
<th>Utility Demand</th>
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<tbody>
<tr>
<td>APPROACH ZONE</td>
<td>UPPER APPROACH ZONE LIGHTING FIXTURE</td>
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Total   264,942 204,122

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Note: The above totals do not include spare capacity for future expansion.
APPENDIX G

PRESENCE DETECTION

SAFETY SCHEME
Symbols for Traffic Control Layouts

Note: Sheets show a typical 4-lane divided roadway on a straight section. Similar controls would exist for a two-lane, two-way roadway. In the 4-lane divided examples, median and shoulder guardrail or longitudinal barriers are assumed to be in place (not shown). The primary objective is to show traffic control devices on a conceptual layout.

In all situations, lane barrier curbs exist instead of pavement markings shown. The detailed sheet shows a 3 lane inbound roadway with the barrier islands. Roadway islands need to separate lanes for security, control, barrier signal operations, and placement of signs, signals, and beam sensors. Under roadway drainage must be designed with the roadway islands.

- Symbol for barrier to deploy up from lane or across roadway.

- Red In-Roadway Lights that flash red when barrier is activated.
  For use when barriers do not contain lights at activation.

- Red zone quadrupole inductive loop detector (6’ X L’), with L being 6 feet beyond Stop line to 4 feet in advance of active barrier that provides input to the lane barrier signal operation.

- Queue quadrupole loop detector (6’ X 20’) about 80 feet inbound from checkpoint to provide lane barrier signal preemption capability for a preset time to clear the pocket of secured vehicles between the queue loop detector and signal Stop line.

- One or more induction loop detectors that provide input to the microprocessor controller for lane barrier signal operations for the following functions: (1) One or more loops extending back from Stop line that detect presence of vehicles at or near Stop line, and (2) loop that provides input confirmation that vehicle has cleared the active barrier.

- Post mounted sign on shoulder, lane island, or in median.

- Traffic Gate Arm in the down horizontal position with flashing red lights when barrier deployment command has been initiated by guard pressing a button or by other automated means.

- Electronic beam lane sensors that provide input to the lane barrier signal operation for low metal-mass vehicles such as scooters, motorcycles, mopeds and bicycles.
SDDCTEA Recommended Concept Plan for Lane Barrier Signal Operation (Limited Real Estate Response Zone)

Notes:
1. Concept drawing is Not To Scale.
2. Actual sign placements shall be based on MUTCD, local conditions, geometry, roadway islands, other traffic control devices, landscape, roadside features, etc.
3. Detection loops (1, 2, 3, and 4) per lane, detection queue loop 5 in each inbound lane, and electronic beam lane sensors (6, 7, and 8) per lane, their operability, and logic shall be operated and monitored by a microprocessor controller similar to traffic control signal controller. See next sheets for details.
4. Pavement defined by DO NOT STOP IN RED ZONE sign consists of red textured pavement by aggregate or other means to indicate area (about one car length) that needs to be kept free of vehicles, vehicle backups, etc.
5. Lane Barrier Signal normally displays circular red. When beam sensor 6 or loop 2 are activated and barrier button has not been pressed, then circular green is given after a preset delay (adjustable) and turns back to red when beam sensor 7 or loop 3 are activated. Signal remains red when beam sensor 6 or loop 2 are activated and barrier button has been pressed. Beam sensor 8 or Loop 4 provide confirmation that vehicles have cleared the red zone prior to barrier deployment.
6. Detection loop 5 shall preempt the microprocessor controller for a preset time (adjustable) after it detects vehicle presence for 15 seconds (adjustable). The preset preemption time is the time required to clear the number of guard approved vehicles stopped between the Stop line and Queue loop detector 5.

B – Logic, Video, and other Detection methods and alarms are available to detect a vehicle traveling the wrong direction (in on out-bound side) with automatic traffic control devices response such as vertically aligned, red beacons (not shown above) start alternating flash on the DO NOT ENTER and WRONG WAY signs prior to outbound barriers being fully deployed from guard response.
SDDCTEA Recommended Concept Plan for Lane Barrier Signal Operation (Limited Real Estate Response Zone)

Basic Layout Operation:
1. Road users warned of ACTIVE BARRIER and distance (Advance Warning Sign).
2. Motorists come to complete stop at the Lane Barrier Signal that normally displays a circular red at 24” Thermoplastic Stop Line. Military Police shall periodically monitor motorists compliance with the lane barrier signal and stopping at Stop line on the circular red and prior to red zone. Red zone is red textured pavement or other acceptable means.
3. Motorists told ONE VEHICLE PER GREEN (Regulatory Sign below Lane Barrier Signal). If barrier button has not been pressed, the green signal is given when detection loops 1 or 2 detect presence for 2 seconds (adjustable) or lane sensor number 6 beam has been broken (with adjustable delay). Lane control signal reverts back to normally red after loop 3 is activated or after beam sensor 7 is broken. All times shall be adjustable.
4. Steady green LED lights at the guardhouse shall indicate the satisfactory operation of each individual loop detector and beam sensor. Similarly, LED light(s) shall flash red for the specific loop or beam sensor that fails or is offline with the microprocessor controller. The lane barrier signal operation shall safeguard innocent road users at the active barriers.
5. Upon guard activation of lane barrier, lane control signal shall “hold” circular red. Traffic Gate Arm is flashed and lowered after delay. Active barriers shall not deploy until after loops 3 and 4 are cleared of vehicles and after beam sensors 8 has cleared following an adjustable delay after beam sensor 7 activation. See beam sensor and loop table.
6. Use red color pavement (aggregate instead of paint) from 2 feet forward of the Stop line to 10 feet beyond the pop-up barrier. Install DO NOT STOP IN RED ZONE Sign (Regulatory).
7. The following controls prevent vehicles extending into red zone: (1) Normally Red Lane Barrier Signal, (2) Stop Line, (3) DO NOT STOP IN RED ZONE, and (4) Traffic Gate Arm location.

Electronic Blank-out Signs – If electronic blank-out signs are used, then legend shall be white on a black or opaque background. The ONE VEHICLE PER GREEN sign shall illuminate message only when the circular red and green operate in the “metering for security” mode. If blank-out, the PROCEED WITH CAUTION ON FLASHING YELLOW sign shall be modified to PROCEED WITH CAUTION. The latter message shall illuminate only when the circular yellow is flashing. Circular yellow is used for (1) Queue Preemption to clear approved vehicles in a backup, (2) system start-up, (3) low-threat conditions, and (4) other situations per the Commanding Officer.
SDDCTEA Recommended Concept Plan for Lane Barrier Signal Operation (Limited Real Estate Response Zone)

Inbound Layout Detail

- Median
- Inner Lane
- Lane Barrier Island
- Center Lane
- Lane Barrier Island
- Outside Lane

Note: Signs and signals shown from left shoulder to island between center and outside lanes since the driver’s position/view is closer to this side of each lane.
### SDDCTEA Recommended Concept Plan for Lane Barrier Signal Operation (Limited Real Estate Response Zone)

**Loop Detector and Signal Operation:**
1. Loops 1, 2, 3, 4, and 5 shall operate in the presence mode. Loop No. 5 operates as a queue detector.
2. Barrier Close Suppression Logic - When guards initiate a barrier “Emergency Fast Operate” command to close the barriers, each barrier’s “close” circuit will be suppressed until the Lane Control Signal in that barrier’s lane is circular red and loop detectors 3 and 4 and break beam sensors 7 and 8 in that barrier’s lane do not detect a vehicle. In the case of break beam 7, the logic will include an adjustable time delay after break beam 7 drops out to hold the suppression circuit for the time delay. This time delay will allow a small vehicle (e.g., a bicycle), which may not have been detected by the loops, to proceed safely beyond the barrier if the barrier “Emergency Fast Operate” command was initiated right after the bicycle passed break beam 7. See “Loop Detection and Beam Sensor Priority Control During Preemption” table next sheet.
3. The microprocessor controller shall meet NEMA standards for timing, preemption, and detector capabilities. The basic operation is lane metering for threat response of each lane separately (having barrier island) with two preemption capabilities:

   a.) Normal Operation – Normal operation is circular red signal in each lane with a circular green given after an adjustable delay on loops 1 and 2 (typically just enough for the vehicle to come to a complete stop) or beam sensor 6 is broken. The signal reverts back to red when loop 3 detects presence or beam sensor 7 is broken.

   b.) Barrier Deployment Preemption – Barrier deployment preemption is initiated by gatehouse or checkpoint guards pressing a button. Lane barrier signals are preempted for lane barrier deployment according to the logic shown in the table.

   c.) Queue Preemption during Peak Demand Periods – Queue detector preemption is initiated after loop 5 detects constant presence for a preset adjustable time (for example 15 seconds). Lane barrier signal shall go to flashing yellow for a preset time to clear vehicles between loop 5 and the Stop line. After the preset (adjustable) preemption time expires, the signal shall time 4 seconds of steady circular yellow before going to circular red, and then to standard lane barrier signal metering operation.

   d.) Barrier Deployment During Queue Preemption – If guards initiate the “Emergency Fast Operate” command during queue preemption, the lane control signal shall change from flashing “Yellow” to solid “Yellow” for 3 seconds and then to solid “Red” for 2 second. When lane barrier signal is red (hold), the sequence shall follow “Clear to Barrier Preemption” shown in the chart. The barrier “close” circuit shall be suppressed in accordance with the table and clearance sequence chart.

<table>
<thead>
<tr>
<th>Barrier Activated Regardless of Reason T=0</th>
<th>Signal Color Time After Activation, T = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9</th>
<th>SAFETY CONTROLS (separately for each lane)</th>
<th>Automatic Gate</th>
<th>Barrier Lights</th>
<th>Barrier Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vehicle Presence on Loop (L) or Beam Sensor Broken (BB)</td>
<td>Lights</td>
<td>Arm</td>
<td>Pavement or Barrier</td>
<td>Post Mounted</td>
</tr>
<tr>
<td>L - 1 &amp; 2 or BB - 6</td>
<td>L - 3 or BB - 7</td>
<td>L - 4 or BB - 8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 0</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>FR</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 1</td>
<td>Y or N</td>
<td>N</td>
<td>N</td>
<td>FR</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 2</td>
<td>Y or N</td>
<td>N</td>
<td>N</td>
<td>FR</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 3</td>
<td>Y or N</td>
<td>N</td>
<td>N</td>
<td>FR</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 0</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 1</td>
<td>Y or N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 2</td>
<td>Y or N</td>
<td>N</td>
<td>N</td>
<td>FR</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 3</td>
<td>Y or N</td>
<td>N</td>
<td>N</td>
<td>FR</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 4</td>
<td>Y or N</td>
<td>N</td>
<td>N</td>
<td>FR</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 0</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>FR</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 1</td>
<td>Y or N</td>
<td>N</td>
<td>Y</td>
<td>FR</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 2</td>
<td>Y or N</td>
<td>N</td>
<td>N</td>
<td>FR</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 3</td>
<td>Y or N</td>
<td>N</td>
<td>N</td>
<td>FR</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 4</td>
<td>Y or N</td>
<td>N</td>
<td>N</td>
<td>FR</td>
</tr>
<tr>
<td>X</td>
<td>Red (hold), 5</td>
<td>Y or N</td>
<td>N</td>
<td>N</td>
<td>FR</td>
</tr>
</tbody>
</table>
SDDCTEA Recommended Concept Plan for Lane Barrier Signal Operation (Limited Real Estate Response Zone)

Cont.  

<table>
<thead>
<tr>
<th>Barrier Activated Regardless of Reason</th>
<th>Signal Color Time After Activation, T = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9</th>
<th>SAFETY CONTROLS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vehicle Presence on Loop (L) or Beam Sensor Broken (BB)</td>
<td>Automatic Gate Lights</td>
<td>Barrier Lights Pavement or Barrier Mounted</td>
</tr>
<tr>
<td></td>
<td>L – 1 &amp; 2 or BB – 6</td>
<td>L – 3 or BB – 7</td>
<td>L – 4 or BB – 8</td>
</tr>
<tr>
<td>Normal State</td>
<td>- - -</td>
<td>Dark Upright</td>
<td>Dark Dark Down</td>
</tr>
<tr>
<td>X</td>
<td>Green, 0</td>
<td>Y Y or N Y or N</td>
<td>Dark Upright</td>
</tr>
<tr>
<td>Red (hold), 1</td>
<td>Y or N</td>
<td>Y Y or N</td>
<td>Dark</td>
</tr>
<tr>
<td>Red (hold), 2</td>
<td>Y or N</td>
<td>Y or N</td>
<td>Y</td>
</tr>
<tr>
<td>Red (hold), 3</td>
<td>Y or N</td>
<td>N Y</td>
<td>FR</td>
</tr>
<tr>
<td>Red (hold), 4</td>
<td>Y or N</td>
<td>N N</td>
<td>FR</td>
</tr>
<tr>
<td>Red (hold), 5</td>
<td>Y or N</td>
<td>N N</td>
<td>FR</td>
</tr>
<tr>
<td>Red (hold), 6</td>
<td>Y or N</td>
<td>N N</td>
<td>FR</td>
</tr>
<tr>
<td>Red (hold), 7</td>
<td>Y or N</td>
<td>N N</td>
<td>FR</td>
</tr>
</tbody>
</table>

Cont.  

Loop Detector and Signal Operation:
4. System Safety Check prior to Barrier Deployment – The microprocessor controller shall check both operational status and detection status of L-3, L-4, BB-7, and BB-8 prior to its “Start Up” deployment. Under no circumstance will the lane barrier deploy when one or more detectors is (are) not operational, is (are) off line with system, or have a call.

Loop Detection and Beam Sensor Priority Control During Preemption

<table>
<thead>
<tr>
<th>Loop</th>
<th>Break Beam Sensor</th>
<th>Likely Signature</th>
<th>Governs Microprocessor Timing/Clearance prior to Barrier Deployment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence on 3</td>
<td>Beam 7 broken</td>
<td>Motor vehicle</td>
<td>Loop Governs Beam Sensor 7 governs and times 3 seconds passage (adjustable) after beam 7 reconnects. Additional breaks of beam 7 resets passage time. If Beam 8 is not broken within 5 seconds (adjustable), the call is assumed false (bird, animal, leaf, weather, etc.) and the barrier deploys.</td>
</tr>
<tr>
<td>No call on 3</td>
<td>Beam 7 broken</td>
<td>Bicycle, Moped, scooter, etc.</td>
<td>Beam 8 Governs and times one second passage (adjustable) after each beam 8 reconnects. Additional breaks of beam 8 resets passage time.</td>
</tr>
<tr>
<td>Presence on 4</td>
<td>Beam 8 broken</td>
<td>Motor Vehicle</td>
<td>Loop Governs</td>
</tr>
<tr>
<td>No call on 4</td>
<td>Beam 8 broken following Beam 7</td>
<td>Bicycle, Moped, scooter, etc.</td>
<td>Beam 8 Governs and times one second passage (adjustable) after each beam 8 reconnects. Additional breaks of beam 8 resets passage time.</td>
</tr>
<tr>
<td>No call on 4</td>
<td>Beam 8 broken following no breaks of Beam 7</td>
<td>False Call (bird, animal, leaf, weather, etc.)</td>
<td>Beam 8 Governs and times one second passage (adjustable) after each beam 8 reconnects. Additional breaks of beam 8 resets passage time of one second.</td>
</tr>
</tbody>
</table>
# SDDCTEA Recommended Concept Plan for Lane Barrier Signal Operation (Limited Real Estate Response Zone)

<table>
<thead>
<tr>
<th>Control</th>
<th>Normal Operation</th>
<th>Clear to Barrier Preemption</th>
<th>Clear 1 from Barrier Preemption</th>
<th>Clear 2 from Barrier Preemption</th>
<th>Clear to Queue Preemption</th>
<th>Clear 1 from Queue Preemption to Normal Ops</th>
<th>Clear 2 from Queue Preemption to Barrier Preempt</th>
<th>Clear 1 from Queue Preemption to Barrier Preempt</th>
<th>Clear 2 from Queue Preemption to Barrier Preempt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal</td>
<td>No activation on Loops 1 and 2 or BB 6</td>
<td>Activation on Loops 1 and 2 or BB 6</td>
<td>Activation on Loops 3 or BB 7 regardless of activation on Loops 1 and 2 or BB 6</td>
<td>Traffic held at Stop line. Activations on Loops 3 or 4 or BB 7 or 8 holds barrier from deployment.</td>
<td>Activation on Loops 1 and 2 or BB 6. Traffic held at Stop line.</td>
<td>Activation on Loops 1 and 2 or BB 6. Traffic held at Stop line.</td>
<td>Loop 5 activated by vehicle occupancy greater than preset time, say 15 seconds (adjustable)</td>
<td>Automatic 3 seconds yellow clearance</td>
<td>All red for 2 seconds before return to Normal Operation</td>
</tr>
<tr>
<td>Signs</td>
<td>Static Signs or Electronic Blank-out</td>
<td>Static Signs or Electronic Blank-out</td>
<td>Static Signs or Electronic Blank-out</td>
<td>Static Signs or Electronic Blank-out</td>
<td>Static Signs or Electronic Blank-out</td>
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</tr>
</tbody>
</table>