SDDCTEA Pamphlet 55-15

TRAFFIC AND SAFETY ENGINEERING FOR BETTER ENTRY CONTROL FACILITIES

2019

US Army Military Surface Deployment
and Distribution Command
Transportation Engineering Agency

Traffic and Safety Engineering for Better Entry Control Facilities
2019
SDDCTEA Pamphlet 55-15

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Transportation Engineering Agency

SDDCTEA Traffic Engineering Team

Prepared with the assistance of

Gannett Fleming

This pamphlet was developed utilizing common engineering and architectural resources. Engineering judgment was applied where appropriate. All features and dimensions should be validated and adjusted as appropriate as part of the design process. Due to periodic changes in regulations, procedures, design guides, and policies, the content contained herein is subject to change without notice.

Pamphlet content is brief and covers multiple excerpts from reference sources that are essential for good entry control facility (ECF) design. Engineers and designers should supplement this Pamphlet with reference sources as necessary when performing ECF designs. Modifications to reference documents occurring after publication of this Pamphlet may supersede the information provided herein.

Military Surface Deployment and Distribution Command
Transportation Engineering Agency

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FORWARD

Evolution of the Entry Control Facility (ECF)

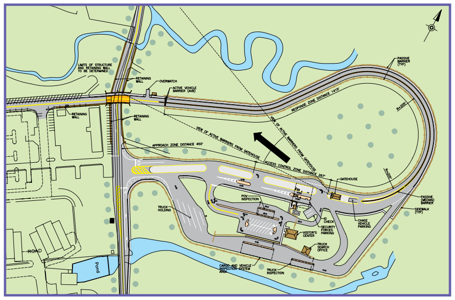
Prior to 2001, entry control varied by installation. While some installations had ECFs, most existing ECFs lacked the features and functionality required by current standards. Other installations had limited or no entry control. As a result, mandatory vehicle entry control became a Department of Defense (DoD) requirement in January 2001 and installations were required to develop a plan for entry control by the end of 2001.

The events of September 11, 2001, necessitated immediate entry control. In most cases, entry control focused on reactive measures to address security. As a result, many interim ECFs met anti-terrorism and force protection needs, but lacked the infrastructure to address traffic flow and promote a safe environment for guards and motorists.

Since September 11, 2001, specialized standards and guidance have continued to evolve even as enhancements and modifications were being made to ECFs in the field. While engineers have utilized applicable existing standards such as the *Manual on Uniform Traffic Control Devices* (*MUTCD*) to address safety and traffic flow, special guidance continues to evolve on such issues as determining response zone and traffic control requirements associated with active vehicle barriers (AVBs).

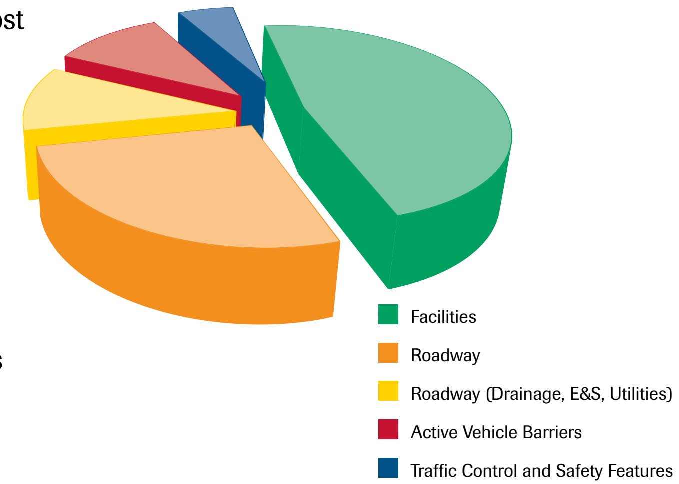
Many ECF-related reference documents have been updated since the original generation of post-September 11 references were released. As standards evolve and conditions on installations change, it is important to note that a systematic ECF assessment can help identify short-term and long-term needs that are required to address security, safety, and traffic flow.

Why is Traffic Flow and Safety Important?



Entry Control Facilities must balance security, safety, and traffic flow. If the facility is not designed with sufficient capacity, it will create extensive congestion and delays, waste time, increase transportation costs, and create safety concerns especially when traffic queues extend to public highways outside the facility. It is important to design an ECF to protect the guards, to provide sufficient time for the deployment of AVBs, to prevent unauthorized entry, to manage internal vehicle speeds, and to encourage motorist safety by applying accepted standards and by using standard traffic control devices.

While some may question the added cost to address safety, the total cost of safety is a small percentage of a major ECF construction project.



Traffic Control and Safety Features . . . . $125,000-$150,000

Active Vehicle Barriers . . . . . . $300,000-$500,000

New ECF. . . . . $6,000,000-$15,000,000+

By including safety in planning and design, installations can minimize crashes, fatalities, injuries, mission distractions, and protect themselves from potential liability and help maintain the efficiency of their work force.

✓ $9.6 million for each fatality
✓ $2.55 milliion for each severe injury
✓ $28,800 for each minor injury
✓ $4,300 for each property damage only (PDO) crash

Source: U.S. Department of Transportation, VSL Guidance 2016; Benefit-Cost Analysis Guidance for Discretionary Grant Programs.

SDDCTEA and ECFs

Military Surface Deployment and Distribution Command – Transportation Engineering Agency (SDDCTEA) executes DoD's transportation engineering program on behalf of the military services. SDDCTEA is available to assist in a variety of ECF issues by providing engineering and educational services.

✓ SDDCTEA has performed more than 500 ECF engineering assessments at military installations all over the world.
✓ SDDCTEA assisted in the development of *The Army Standard (AS) for Access Control Points (ACPs)*.
✓ SDDCTEA participated in the development of UFC 4-022-01 *Entry Control Facilities / Access Control Points*.

SDDCTEA's philosophy is to address each of the four priorities of an ECF:

✓ Security and Functional Requirements
✓ Safety (guards and motorists)
✓ Traffic Flow and Congestion
✓ Sustainability

In order to meet these diverse and sometimes conflicting priorities, SDDCTEA considers local site constraints and then uses creativity and innovation to develop design solutions that meet all of the ECF performance requirements. SDDCTEA recognizes that ECF planning and design must consider:

✓ Short- and long-term needs as well as identification of low-cost enhancements
✓ Operational and manpower issues
✓ Practical and adaptive solutions
✓ Strategic use of technology
✓ The needs of all stakeholders including planners, engineers, security forces, safety officials, emergency services, and command personnel.

Military Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA)

Mission: To improve highway safety and traffic flow efficiency (reduce congestion/delays) on DoD installation roads and on installation access routes.

Objective: To save lives, decrease injuries, minimize lost time and tort liability, and maintain readiness.

SDDCTEA ECF Services

✓ Short-term and Traffic Impact Assessments
✓ Traffic and Safety Engineering
✓ Lane Requirements Analysis
✓ Concept Development and Design Services
✓ Threat Assessment and Analysis
✓ Active Vehicle Barrier Location Assessments
✓ Active Vehicle Barrier Traffic Control and Safety Evaluations

Use Of SDDCTEA Pamphlets

This pamphlet will provide the traffic and safety related guidance necessary to plan and design an ECF, which is capable of providing the security level desired while disrupting the ingress and egress of the installation as little as possible. This pamphlet is intended to supplement other existing criteria and guidance. It is not intended to be technically exhaustive, but to provide guidance and insight on traffic and safety related issues.

SDDCTEA Pamphlets should be utilized along with Federal and State documents such as Federal Highway Administration's (FHWA) *Manual on Uniform Traffic Control Devices* (*MUTCD*), American Association of State Highway and Transportation Officials' (AASHTO) *A Policy on Geometric Design of Highways and Streets*, and AASHTO *Roadside Design Guide* when designing roadways.

Federal standards must be followed per Multi-Service Regulation (AR 55-80, OPNAVINST 11210.2, AFMAN 32-1017, MCO

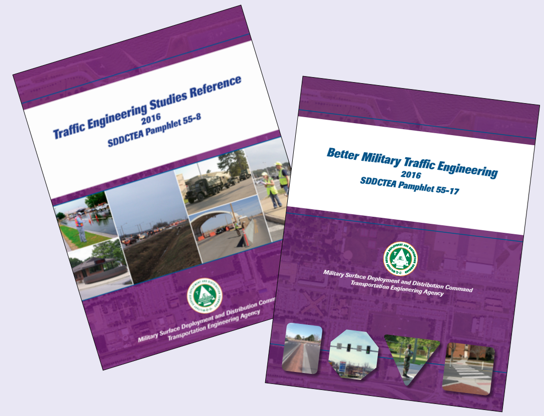
11210.2D and DLAR 4500.19), DoD Transportation Engineering Program, which states the following:

✓ Installation commanders will develop and maintain their roadways to nationally accepted standards that provide a safe driving environment for all drivers and passengers.

✓ All installation traffic signals, signs, and pavement markings will be in substantial conformance to FHWA's *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) (http://mutcd.fhwa.dot.gov). Variances in the design and application of installation traffic control devices from the standards contained in the MUTCD must be approved by SDDCTEA.

The SDDCTEA Pamphlet 55-17: *Better Military Traffic Engineering* and SDDCTEA Pamphlet 55-8: *Traffic Engineering Studies Reference* are companion documents to this pamphlet. The focus of Pamphlet 55-15 is ECFs with basic information on traffic engineering fundamentals and practices.

PAMPHLETS AVAILABLE FOR TRAFFIC AND SAFETY GUIDANCE



NOTE: Pamphlet 55-14 has been combined into a re-write of the Pamphlet 55-17 and is no longer a valid document.

Pamphlet 55-17 covers in depth topics such as Traffic Engineering Studies, Geometric Design Basics, Intersection Traffic Control, Signing and Markings, Traffic Signals and ITS, Roundabouts, Roadway Safety, Roadway Safety Improvement Plan, Pedestrian Safety, Work Zone Safety, Speed Limits, Traffic Calming, Access Management, Demand Management, Parking, Convoys, and Roadway Lighting.

Pamphlet 55-8 discusses many different types of studies common to military installations. Each topic is formatted to a discussion on study objectives, information needed, study methods, data analysis, data interpretation, and application of results.

Pamphlet 55-14 had been a pamphlet on signing and pavement markings. This pamphlet is obsolete and has been combined with Pamphlet 55-17.

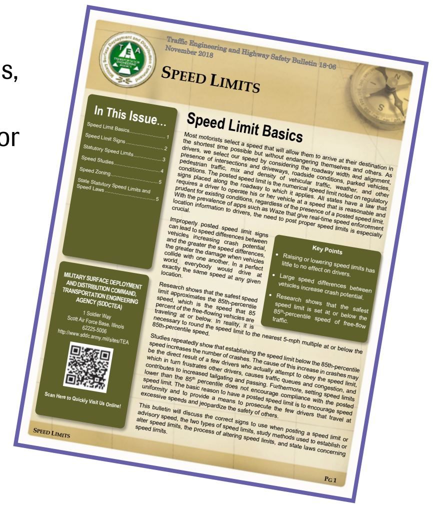
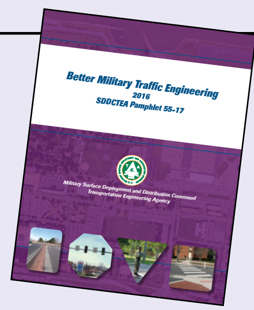
More About SDDCTEA

SDDCTEA's mission is to improve highway safety and reduce traffic congestion on DoD installation roads and on routes providing access to installations. Our objectives are to save lives, decrease injuries, minimize lost time, and maintain readiness. To achieve our mission and objectives, we focus our efforts into two key areas shown below.

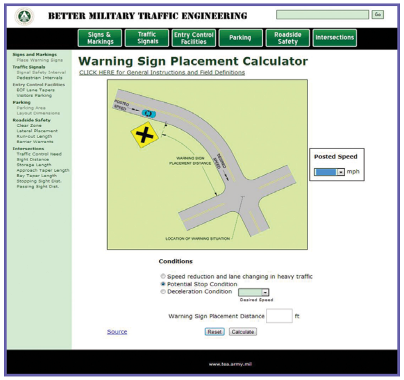
Training and Education – Includes the development of training and educational seminars and materials for distribution throughout the military. Materials include traffic engineering and highway safety bulletins, pamphlets, and interactive training materials and software.

Engineering Services – Includes traffic engineering studies, entry control facility studies and concept designs, roadway planning, geometric design, traffic safety assessments, traffic operations analysis, engineering guidance, and contract assistance.

SDDCTEA Training and Education

Training and Education Program	Subject Matter Covered
Traffic Engineering and Highway Safety Bulletins Bulletins are published three to four times yearly and address a broad range of transportation and safety topics. Bulletins are available online at https://www.sddc.army.mil/sites/TEA/Functions/SpecialAssistant/TrafficEngineeringBranch/Pages/bulletins.aspx. Join our mailing list to receive bulletins (and other announcements) at https://www.sddc.army.mil/sites/TEA/Functions/SpecialAssistant/TrafficEngineeringBranch/Lists/TrafficEnginerringMailingList/TrafficEngineeringMailingListRequest.aspx?Source=/sites/TEA/Functions/SpecialAssistant/TrafficEngineeringBranch/Pages/default.aspx.	Bulletin topics include: ✓ Sign Management ✓ Work Zone Safety ✓ Mine Resistant Ambush-Protected (MRAP) Vehicles ✓ Shuttle Bus Systems ✓ Road Safety Assessments ✓ Crashes: Reporting, Studies, and Countermeasures ✓ Accessibility Compliance for Military Installations ✓ Who is SDDCTEA ✓ Active Vehicle Barrier Safety Schemes ✓ Safe Routes to School ✓ Intersection Geometry ✓ Grade Crossings ✓ Passive Barrier Systems ✓ Speed Limits ✓ Traffic Calming ✓ Parking 
Pamphlets SDDCTEA has produced a variety of pamphlets and manuals on transportation issues. These materials provide specific, detailed engineering guidance on key issues.  Pamphlets are available online at https://www.sddc.army.mil/sites/TEA/Functions/SpecialAssistant/TrafficEngineeringBranch/Pages/pamphlets.aspx.	✓ *Pamphlet 55-8, Traffic Engineering Studies Reference* ✓ *Pamphlet 55-15, Traffic and Safety Engineering for Better Entry Control Facilities* ✓ *Pamphlet 55-17, Better Military Traffic Engineering*

SDDCTEA Training and Education (continued)

Training and Education Program	Subject Matter Covered
Traffic Engineering Software Originally released in June 2002 and updated in May 2009 and December 2012, SDDCTEA's *Better Military Traffic Engineering* (*BMTE*) software was developed to provide the military engineering community with state-of-the-art information regarding the proper use of traffic control and safety devices on military installations. The BMTE is a web-based application that can be used an instructional tool to train installation personnel, and can also be used as a reference tool to perform calculations. Illustrations are provided as an additional learning feature. Lastly, the source for reference materials are provided. The BMTE web-based application can be found on SDDCTEA's website. https://www.sddc.army.mil/sites/TEA/Pages/default.aspx .	The web-based application is divided into sections, each containing a different topic: ✓ Signs ✓ Signals ✓ ECFs ✓ Parking ✓ Roadside Safety ✓ Intersections  The *BMTE* also includes several traffic calculators for reference when planning a variety of traffic engineering projects.
Traffic Engineering and Safety (TES) Seminars SDDCTEA conducts TES Seminars at least three times per year. Each seminar is 3 days long and provides guidance on traffic engineering and safety considerations along roadways, intersections, and at ECFs. Information is also provided on planning, design, and operations of ECFs (access control point or gate) considering security, safety, and traffic requirements.	✓ ECF Background and Traffic Engineering Studies ✓ Better Military Traffic Engineering (BMTE) Software Demo ✓ Retroreflectivity and Sign Management Studies ✓ Speed Management ✓ Traffic Control for AVBs ✓ Roadway Geometric Design ✓ Signs and Markings ✓ Accessibility Standards ✓ Speed Limits ✓ Roundabouts ✓ Traffic Signals and ITS ✓ ECF Geometric Design ✓ Traffic Engineering Studies ✓ Intersection Traffic Control ✓ Roadway and Pedestrian Safety ✓ Traffic Calming ✓ Access Management and Parking ✓ Work Zone Safety

ACP MEANS ACCESS CONTROL POINT AND IS ARMY TERMINOLOGY. THE UCF USES ECF AND ACP, BOTH OF WHICH REFER TO AN EXTERNAL ACCESS POINT.

Engineering Services

If your installation requires a study, SDDCTEA can help by any one of the most frequently used methods shown on the next page. Our focus is to deliver a quality product to installations in a timely manner.

SDDCTEA offers on-site engineering studies

SDDCTEA's services include the following:

Safety

- ✓ Crash studies
- ✓ Traffic safety assessments
- ✓ Pedestrian studies
- ✓ Speed studies
- ✓ Traffic calming evaluations
- ✓ Sign management studies

Transportation Engineering

- ✓ Traffic impact studies
- ✓ Signal warrant and operations evaluations
- ✓ Corridor evaluations
- ✓ Roadway and intersection design/reviews
- ✓ Parking evaluations
- ✓ Traffic signal operational audits

Force Protection and Installation Access

- ✓ ECF/ACP conceptual designs
- ✓ ECF/ACP traffic studies for capacity requirements
- ✓ ECF/ACP traffic study validations (study done by others)
- ✓ ECF/ACP design plan reviews
- ✓ Active vehicle barrier location assessment and safety schemes design/reviews

Delivery Methods for SDDCTEA Traffic Engineering Services

Study Method	Duration
In-House These studies are conducted using SDDCTEA in-house forces. The studies conducted are typically limited in scope and can include sign management, pedestrian, safety, capacity and ECF studies. Recommendations are provided to correct deficiencies, and generally include low-cost improvements that are within installation funding capabilities.	✓ The studies are typically performed in one week. ✓ An outbrief presentation, inclusive of findings and recommendations, is given at the end of the week to installation personnel. ✓ A report, incorporating comments from the outbrief meeting, is delivered in the weeks that follow.
Quick Studies (Contract-Supported) These studies are of limited scope or with a quick duration that are performed with an existing task order between SDDCTEA and their engineer. These typically cover intersections, ECFs, safety, or pedestrian issues.	✓ The studies are typically performed over a several week period. ✓ Following SDDCTEA's review and concurrance with the contents of the draft report, an outbrief meeting is held with installation personnel to report major deficiencies, address potential improvements, and solicit installation comments. ✓ Draft and final versions of a study report, with deficiencies and recommendations documented, are provided to installation personnel.
Comprehensive (Contract-Supported) Typically studies may address 10 to 20 intersections; as well as ECFs, access roadways, master planning issues, speed limits, pedestrian safety, and access management. See the following two pages on focus areas.	✓ The studies are typically performed over a several-month period. ✓ Following SDDCTEA's review and concurrence with the contents of the draft report, an outbrief meeting is held with installation personnel to report major deficiencies, address potential improvements, and solicit installation comments. ✓ Draft and final versions of a study report, with deficiencies and recommendations documented, are provided to installation personnel.

SDDCTEA receives dedicated funding which is used to support traffic engineering services. Based on availability of funds, there may be a waiting list between when an installation makes a study request and when funds are available for the study. If an installation has a high priority, and if SDDCTEA cannot conduct the study to meet the installation's required timeline, SDDCTEA is available to assist with writing the scope of work for the installation to contract the study themselves.

Focus Areas

Study Type	Study Characteristics
Access Control Point/Entry Control Facility (ACP/ECF) Studies	The purpose of this type of study is to identify recommendations by assessing the four priorities of an ACP/ECF consisting of: ✓ Security (and Functional Requirements) ✓ Safety (guards and motorists) ✓ Capacity (Traffic Flow and Congestion) ✓ Sustainability UFC 4-022-01 requirement: 'A traffic engineering and safety study must be conducted or validated by SDDCTEA prior to initiating ECF/ACP planning and programming documentation.'
Access Control Point/Entry Control Facility (ACP/ECF) Reviews	This service involves the review of traffic studies and/or design plans prepared by others. This primarily involves a review focused on the traffic and safety, and right-sizing of the gate. Additionally, it is a UFC requirement that SDDCTEA validate traffic studies done by others prior to initiating ECF/ACP planning and programming documentation.
Crash Studies	This is similar to a CrashLES study; however, it focuses on a specific fatality at a specific location. These studies are generally considered confidential and would not be distributed without permission from the installation.
Traffic Safety Assessments (TSAs)	TSAs involve a procedural approach to evaluating roadway safety for specific corridors and/or intersections. The recommendations provided by a TSA are intended to increase roadway safety and are typically low-cost and quick-to-implement, focusing on items such as pedestrian accommodations, traffic signals, signing and pavement markings, drainage, and roadside hazards.
Pedestrian Studies	Pedestrian studies involve the evaluation of pedestrian facilities and related activity including crosswalks, overpasses, sidewalks, pedestrian signing, school walking routes, and Architectural Barriers Act (ABA) requirements.
Speed Studies	Speed studies usually involve the collection of speed data for the purpose of establishing appropriate speed limits on installation roadways.
Traffic Calming Evaluations	This study assesses the need for and appropriate application of the use of physical measures to address speeding on neighborhood streets.

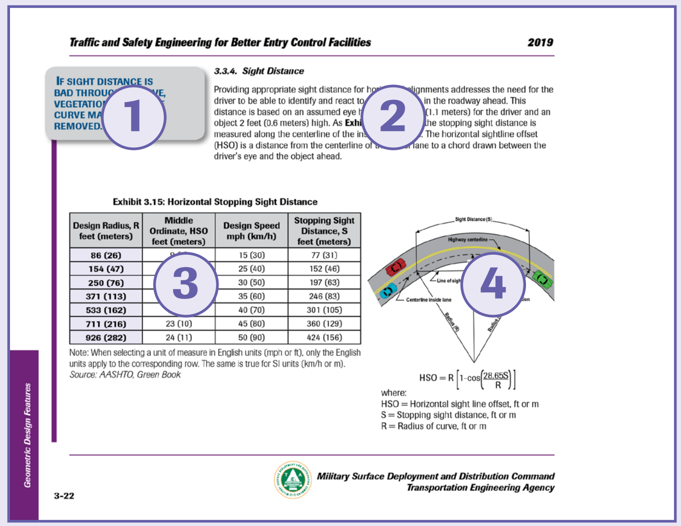
Study Type	Study Characteristics
Sign Management Studies	This type of study has a two-fold objective: ✓ To inspect installation signing to ensure that minimum retroreflectivity requirements are met for nighttime driving, to identify those signs that need replacement, and to assist the installation in developing a program for managing and replacing signs. ✓ To identify sign deficiencies and recommendations involving a multitude of sign attributes such as the appropriateness of the sign, and mounting characteristics. A sign management system (SMS) is provided which can reduce sign installation and maintenance costs, while improving motorist safety.
Traffic Impact Studies	Traffic impact studies typically involve identifying impacts and roadway or intersection improvement needs resulting from development or an increase in population. The study involves estimating the number of additional trips to be generated by the proposed development and conducting capacity analyses to assess existing and future operations.
Signal Warrant and Operations Analyses	This type of analysis involves conducting capacity analyses to identify operational conditions and comparing traffic volumes to the warrants set forth in the Manual on Uniform Traffic Control Devices (MUTCD) to determine if signalization should be considered. Operations analyses may include signal timing and phasing recommendations.
Corridor Evaluations	Corridor Evaluations involve the analysis of a group of intersections along a specific roadway corridor, and may include the identification of improvements to improve traffic flow and safety of the corridor.
Roadway and Intersection Design Reviews	This service involves the review of design plans prepared by others to ensure consistency with national and local standards. This primarily involves a review of roadway geometry, but may also include a review of supporting data utilized in the design process.
Parking Evaluations	Parking Evaluations include identifying existing parking shortages, projecting future parking demand, and developing conceptual parking improvement schemes.
Traffic Signal Operational Audits	Operational audits include the analysis of parameters such as phasing, detectors, and timing to reduce motorist delay; as well as a general inspection of the traffic signal equipment (including mast arms, signal heads, controllers, loop detectors, etc.). Measures of Effectiveness reports can be provided to convey the savings in fuel, emissions, and driver delay.

HOW TO USE THIS GUIDE

This pamphlet provides the traffic and safety related guidance necessary to plan and design an ECF, which is capable of providing the security level desired while impacting the ingress and egress of the installation as little as possible. The pamphlet is intended to supplement other existing criteria and guidance. It is not intended to be technically exhaustive, but to provide guidance and insight on traffic and safety related issues.

There are several elements associated with each topic contained in this pamphlet:

1. **Key Point** – Represents the critical information you should know about a particular topic.
2. **Content** – Provides specific, detailed guidance.
3. **Tables** – Provides easy-to-use, look-up values for a particular subject.
4. **Graphics** – Illustrate the content or represent an applied condition.



Traffic and Safety Engineering for Better Entry Control Facilities **2019**

IF SIGHT DISTANCE IS BAD THROUG[illegible]VE, VEGETATIO[illegible] CURVE MA[illegible] REMOVED.

1

3.3.4. Sight Distance

Providing appropriate sight distance for ho[illegible]lignments addresses the need for the driver to be able to identify and react to [illegible] in the roadway ahead. This distance is based on an assumed eye h[illegible] (1.1 meters) for the driver and an object 2 feet (0.6 meters) high. As **Exhi**[illegible] the stopping sight distance is measured along the centerline of the ins[illegible]. The horizontal sightline offset (HSO) is a distance from the centerline of t[illegible] lane to a chord drawn between the driver's eye and the object ahead.

2

Exhibit 3.15: Horizontal Stopping Sight Distance

Design Radius, R feet (meters)	Middle Ordinate, HSO feet (meters)	Design Speed mph (km/h)	Stopping Sight Distance, S feet (meters)
86 (26)	[illegible]	15 (30)	77 (31)
154 (47)	[illegible]	25 (40)	152 (46)
250 (76)	[illegible]	30 (50)	197 (63)
371 (113)	[illegible]	35 (60)	246 (83)
533 (162)	[illegible]	40 (70)	301 (105)
711 (216)	23 (10)	45 (80)	360 (129)
926 (282)	24 (11)	50 (90)	424 (156)

Note: When selecting a unit of measure in English units (mph or ft), only the English units apply to the corresponding row. The same is true for SI units (km/h or m).
Source: AASHTO, Green Book

3

Sight Distance (S)
Highway centerline
Line of sigh
Centerline inside lane
Radius (R)

4

$$HSO = R\left[1-\cos\left(\frac{28.65S}{R}\right)\right]$$

where:
HSO = Horizontal sight line offset, ft or m
S = Stopping sight distance, ft or m
R = Radius of curve, ft or m

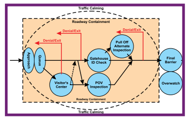
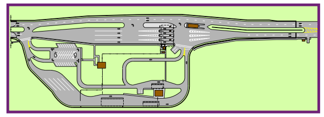
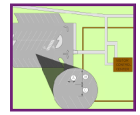
Geometric Design Features

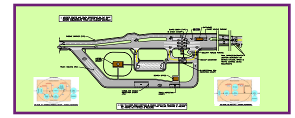
3-22

Military Surface Deployment and Distribution Command
Transportation Engineering Agency

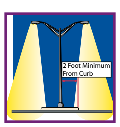
COMMON ACRONYMS AND ABBREVIATIONS USED THROUGHOUT THIS PAMPHLET

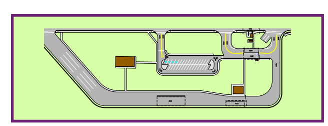
AASHTO	American Association of State Highway and Transportation Officials
ABA	Architectural Barriers Act
ACP	access control point
ADT	Average Daily Traffic
AIE	automated installation entry
AT	antiterrorism
ATRs	automated traffic recordings
AVB	active vehicle barrier
BRAC	Defense Base Closure and Realignment
CAC	common access card
CCTV	closed circuit television
CMS	changeable message sign
CRI	color rendering index
DBIDS	Defense Biometric Identification System
DMS	dynamic message sign
DoD	Department of Defense
DOT	Department of Transportation
ECF	entry control facility
EFO	Emergency Fast Operate
fc	foot-candle
FHWA	Federal Highway Administration
FPCON	force protection condition
ft	feet
IACS	USAREUR Installation Access Control System
IESNA	Illuminating Engineering Society of North America
ITE	Institute of Transportation Engineers
ITS	intelligent transportation system
LCD	liquid crystal display
LED	light emitting diode
mph	miles per hour
MUTCD	*Manual on Uniform Traffic Control Devices*
PDC	US Army Corps of Engineers - Protective Design Center
POV	privately owned vehicle
RFID	Radio-frequency Identification
R/W	right-of-way
RAM	random antiterrorism measure
SF	security forces
SDDCTEA	Surface Deployment and Distribution Command Transportation Engineering Agency
SMART	Security, Manpower, Automation, Roads and Lanes, Traffic and Safety
TYP	typical
UFC	*Unified Facilities Criteria*
USAREUR	United States Army Europe
VCC	visitor control center
vph	vehicles per hour
vphpl	vehicles per hour per lane



SECTION 1 - INTRODUCTION




1. Introduction

Mandatory vehicle entry control to military installations is a DoD requirement.

Mandatory vehicle access control to military installations is a Department of Defense (DoD) requirement (DoD Instruction 5200.08 and DoD Directive 5200.08-R).

Per Multi-Service regulation, the purpose of this pamphlet is to provide guidance on methods to improve traffic flow and traffic safety while achieving force protection at ECFs. The term "Entry Control Facility" encompasses the overall layout, organization, infrastructure, and facilities of an entry or access point. Throughout this pamphlet the term ECF will be used. It should be noted that ECF is synonymous with Access Control Point (ACP) used in some service publications. Others commonly refer to ECFs as Gates.

Generally, the purpose of an ECF is to provide security by monitoring traffic entering a military installation. The degree of security required depends on the sensitivity level of the mission and the level of force protection at any given time.

UFC 4-022-01 presents a unified approach to the design of Entry Control Facilities (ECFs).

1.1. EXISTING CRITERIA AND DESIGN GUIDANCE

Many branches of the military have written their own policies for the design and construction of ECFs. The goal of this pamphlet is to provide traffic and safety related support to those policies and guidelines.

1.1.1. Unified Facilities Criteria

UFC 4-022-01, *Entry Control Facilities / Access Control Points*, was released in July 2017. This was a significant update to the previous version dated 2005. UFC 4-022-01 identifies design features necessary to ensure that infrastructure constructed today will have the flexibility to support future technologies, a changing threat environment, and changes in operations.

UFC 4-022-01 provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and DoD Field Activities.

Other UFCs that deal with security engineering include:

- ✓ 4-010-01 DoD Minimum Antiterrorism Standards for Buildings
- ✓ 4-020-01 DoD Security Engineering: Facilities Planning Manual
- ✓ 4-022-02 Selection and Application of Vehicle Barriers
- ✓ 4-022-03 Security Fences and Gates
- ✓ 3-530-01 Interior and Exterior Lighting Systems and Controls

Each of these UFCs are integrated into the discussions of this pamphlet.

1.1.2. DoD Requirements

DoD 5200.08-R, *Physical Security Program*, requires DoD Components to determine the necessary access control based on the requirements of a developed physical security program. Where necessary, it also requires the evaluation of automated entry control systems or access devices.

DoDI 2000.12, is an instruction for the DoD Antiterrorism (AT) Program. DoDI 2000.12 reissues DoD Directive (DoDD) 2000.12 as DoD Instruction (DoDI) in accordance with the authority in DoDD 5111.1. DoDI 0-2000.16 defines the DoD Force Protection Condition (FPCON) System, which describes the potential threat levels and the applicable FPCON measures to be enacted for each level. It also requires Commanders to develop and implement Random Access Measures (RAM) as an integral part of their AT Program.

DoDI 0-2000.16, *DoD Antiterrorism (AT) Program Implementation,* and service directives require the installation or the activity Commanding Officer to define the access control measures at installations. Additionally, DoDI 0-2000.16 requires Commanders at all levels to develop and implement a comprehensive Antiterrorism (AT) Program, which should define the necessary action sets, including identification and inspection procedures, at each of the potential Force Protection Condition (FPCON) levels.

UFC 4-010-01, *DoD Minimum Antiterrorism Standards for Buildings*, was issued under the authority of DoDI 0-2000.16, which required DoD Components to adopt and adhere to common criteria and minimum construction standards to mitigate antiterrorism vulnerabilities and terrorist threats. It is critical that the infrastructure and operating procedures at the ECF are capable of that mission.

1.1.3. Service Requirements

Each service of the military has specific guidance regarding access to installations and its transportation engineering programs. A Multi-Service regulation for each service branch was created in 2003 to clarify organizational responsibilities and simplify procedures for obtaining transportation engineering guidance. **Exhibit 1.1** provides the combined regulations for each service branch.

Exhibit 1.1: DoD Transportation Engineering Programs Regulations

Service	Joint Regulation	Website
Department of Air Force	AFMAN 32-1017	www.apd.army.mil/ (available for download)
Department of Army	AR 55-80	
Department of Navy	OPNAVINST 11210.2	
Department of Navy - Marine Corps	MCO 11210.2D	
Defense Logistics Agency	DLAR 4500.19	

Source: UFC 4-022-01

1.1.4. Design Guidance

Several publications, identified in **Exhibit 1.2**, were used to develop this pamphlet and should be referred to in the planning, design, and construction of an ECF with regard to transportation and safety. Modifications to the guidelines outlined herein should be considered based on updates to these publications. *UFC 4-022-01* identifies several other publications that should be considered with regard to security systems, barriers, and guard facilities.

Exhibit 1.2: ECF Design Standard References

Department of Defense, Unified Facilities Criteria (UFC 4-022-01), *Entry Control Facilities / Access Control Points*	This document provides guidance on items related to the design of an entry control facility.	wbdg.org available for download
Institute of Transportation Engineers (ITE), *Traffic Engineering Handbook*	This document provides guidance on traffic engineering practices and principles.	ite.org available for purchase
Federal Highway Administration (FHWA) *Manual on Uniform Traffic Control Devices (MUTCD)*	This document provides guidance on the placement of signs, markings, and signals.	mutcd.fhwa.dot.gov available for download
Federal Highway Administration (FHWA), *Standard Highway Signs*	This document provides detailed drawings of the standard highway signs prescribed or provided for in the *MUTCD*.	mutcd.fhwa.dot.gov available for download
American Association of State Highway and Transportation Officials (AASHTO), *A Policy on Geometric Design of Highways and Streets* (The Green Book)	This document provides guidance for the safe and efficient design of geometric components for transportation facilities.	transportation.org available for purchase
AASHTO, *Roadside Design Guide*	This document provides guidance on design requirements and treatments outside the travel way, but in close proximity to the roadway.	transportation.org available for purchase
Transportation Research Board (TRB), *Highway Capacity Manual*	This document provides guidance on methodologies for estimating capacity and determining level of service for transportation facilities.	trb.org available for purchase
Illuminating Engineering Society of North America (IESNA), *Guidelines on Security Lighting for People, Property, and Public Spaces*	This document is intended to establish guidelines for the design and implementation of lighting.	ies.org available for purchase
The Army Standard (AS) for Access Control Points (ACPs)	This document provides guidance on items related to the design of an entry control facility.	pdc.usace.army.mil available for download

FPCON BRAVO IS THE DESIGN CONDITION / CAPACITY FOR ECFs.

1.2. FORCE PROTECTION CONDITIONS (FPCONS)

An ECF must be able to operate at all FPCONs. It is important for the designers of an ECF to understand the anticipated operations, traffic volume, and flow during all FPCONs. The level of identification and inspection requirements at an ECF will vary depending on the FPCON level. UFC 4-022-01 states that an ECF should be designed to minimize congestion at FPCON Bravo or below. Therefore, an ECF must be capable of supporting the security measures employed during FPCON Bravo, including any random anti-terrorism measure (RAM) employed in accordance with the installation AT Program.

At FPCONs Charlie and Delta, traffic congestion is expected. This is sometimes offset by reducing the population seeking to enter the installation to mission-essential personnel only.

Exhibit 1.3 identifies force protection conditions and corresponding characteristics.

1.3. RANDOM ANTI-TERRORISM MEASURE (RAM)

When installations are in lower FPCONs, RAMs describe the use of measures required at higher FPCONs to supplement the FPCON measures already in place at the lower FPCON. As a result, the use of RAMs at an ECF means that the actual procedures can vary within a FPCON. RAM can include, but are not limited to: erection of barriers and obstacles to control traffic flow; vehicle, cargo, and personnel searches; and variations in security routines.

Exhibit 1.3: Force Protection Conditions

FPCON	Application	Description	Typical Processing Characteristics
NORMAL	Applies at all times as a general threat of terrorist attacks, hostile acts, or other security threats always exists in the world.	Access control conducted at all facilities.	Random inspections.
ALPHA	Applies when there is a non-specific threat of a terrorist attack or hostile act directed against DoD elements and personnel, the nature and extent of which are unpredictable.	Must be able to sustain applicable measures indefinitely.	Increased random inspections.
BRAVO	Applies when an increased or more predictable threat of a terrorist attack or hostile act exists and is directed against DoD elements and personnel.	Must be able to sustain all applicable measures indefinitely. Will likely affect missions and base support operations during prolonged implementation.	Increased random vehicle inspections.
CHARLIE	Applies when a terrorist or hostile act incident occurs within the commander's area of interest (AOI), or intelligence is received indicating some form of terrorist action or targeting against DoD elements, personnel, or facilities is likely.	Will very likely affect missions and base support. Must sustain applicable measures throughout the entirety of the threat.	More frequent random vehicle inspection. Possibly, ID checks of all vehicle occupants.
DELTA	Applies when a terrorist attack or hostile act has occurred or is anticipated against specific installations or operating areas. *(Normally, FPCON DELTA is declared as a localized condition.)*	Should be maintained on a limited basis and only be declared so long as the necessary response capabilities are required.	ID checks of all vehicle occupants and complete inspections of all vehicles. All non-essential support functions, operations, and movement are stopped unless they are in direct support of the attack response or continuity of operations.

Source: DODI 0-2000.16, Volume 2

1.4. PURPOSE OF AN ECF

ECFs ensure the proper level of access control for all DoD personnel, visitors, and truck traffic to an installation. The objective of an ECF is to secure the installation from unauthorized access and intercept contraband while maximizing vehicular traffic flow. Several components are required for an ECF to perform this function properly. ECF priorities are detailed in **Exhibit 1.4**.

Throughout the planning of an ECF it should be remembered that often these priorities conflict with one another. For example, an increase in FPCON may result in more delays and congestion that may lead to congestion-related crashes. The change or elevation of one condition must always consider the impact to other priorities and where appropriate, corrective action must take place.

Exhibit 1.4: ECF Design Priorities

Security	It is well established that installations must focus on threats that can be mitigated at the first line of defense – the installation perimeter. ECFs/ACPs and the access control they provide are extremely important to defense-in-depth and effective risk mitigation. An ECF must accommodate RAM and must be able to operate at all FPCONs protecting against illegal entry.
Safety	ECFs/ACPs must have a working environment that is both safe and comfortable for Security Forces personnel. Security Forces safety includes provisions for personal protection against attack and errant drivers; consider climate, location, and orientation. Design the ECF/ACP so that persons and vehicles entering and leaving the facility do so in a safe and orderly manner to protect themselves, security personnel, and pedestrians from harm.
Capacity	The ECF needs to maximize the flow of traffic without compromising safety, security, or causing undue delays that may affect installation operations or off-installation public highway users.
Sustainability	The ECF should reduce energy costs, facility maintenance and operations costs through sustainable design where appropriate.

***UFC* ECF CLASSIFICATIONS:**
- ❑ PRIMARY
- ❑ SECONDARY
- ❑ LIMITED USE
- ❑ PEDESTRIAN ACCESS

1.5. ECF CLASSIFICATIONS

UFC 4-022-01 classifies ECFs into four "use" classifications: primary, secondary, limited use, and pedestrian access. ECF classifications are based on the intended function and anticipated usage of the ECF.

For the purpose of consistency, this pamphlet utilizes similar terminology, but also discusses other classifications to include Commercial Vehicle-Only ECF, Low-Volume ECF, and Internal Entry Control Point shown in **Exhibit 1.5**.

Exhibit 1.5: ECF Use Classifications

Use Classification	Traffic Volumes	Typical Hours of Operation	Highest FPCON Operation	Typical Operation
Primary	High	24/7 - open continuously	Open thru Delta	Vehicle registration/visitor pass capacity. Regular operations, visitors with authorization. Could also be designated as truck and delivery ECF/ACP.
Secondary	High-Moderate	Regular hours, closed at times	Potentially closed at or above Charlie	Regular operations, visitors with authorization. Could also be designated as truck and delivery ECF/ACP.
Limited Use	Low	Open for special purpose	Closed at most times	Tactical vehicles, HAZMAT, special events, emergency access, etc.
Commercial Vehicle-Only ECF	Moderate-Low	Regular hours, closed at times	Potentially closed at or above Charlie	Commercial/contractor access only. Visitors may also be processed.
Internal Entry Control Point	Low	Regular hours, closed at times	NA	Dependent upon installation mission. UFC does not apply.
Pedestrian Access	NA	Varies	Potentially closed at or above Charlie	Personnel only, could be located near installation housing areas, near schools, or as part of a Primary or Secondary ECF

Source: SDDCTEA

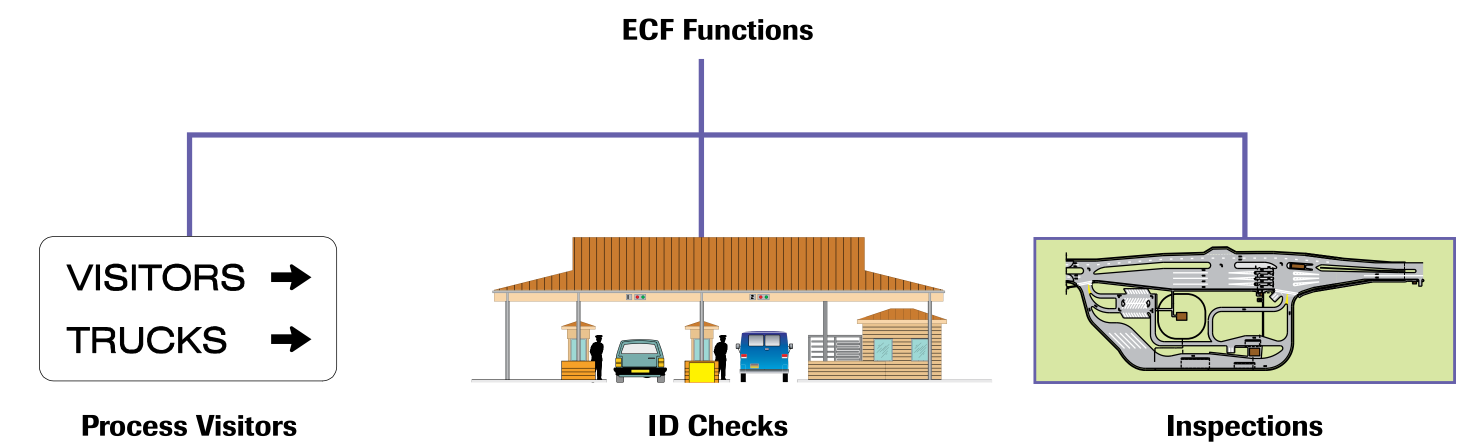
1.6. ECF FUNCTIONS

An ECF can have many functions, and not all functions are required at every ECF. Functions for each ECF are based on the installation's mission, AT Plan, ECF use classification, and land area. Functions may change to meet the demands of higher FPCON levels.

When an installation has a limited number of access points, functional requirements may need to be combined at the ECF. For example, an installation with only one ECF may combine functions, or may use a centralized truck inspection facility that is separate from the ECFs or the installation. A large installation may designate one ECF for truck inspection and truck access only. Not requiring support for all functions at each ECF will reduce the infrastructure requirements.

UFC 4-022-01 illustrates three functional relationships:

✓ ECFs with visitor processing
✓ ECFs without visitor processing
✓ Truck ECF processing



BASIC ECF FUNCTIONS:
- ❑ VISITOR PROCESSING
- ❑ VEHICLE REGISTRATION
- ❑ ID CHECK
- ❑ PRIVATELY OWNED VEHICLE (POV) INSPECTION
- ❑ TRUCK INSPECTION

1.6.1. ECFs With Visitor and DoD Personnel Processing

Exhibit 1.6 illustrates the functional relationship for an ECF that accepts visitors such as a Primary ECF. A Primary ECF must have defined operational flows to keep traffic moving at an efficient, yet safe pace.

From a traffic standpoint, the visitor control center needs to be designed such that vehicles are removed from traffic prior to the ID checkpoint, and the following are provided:

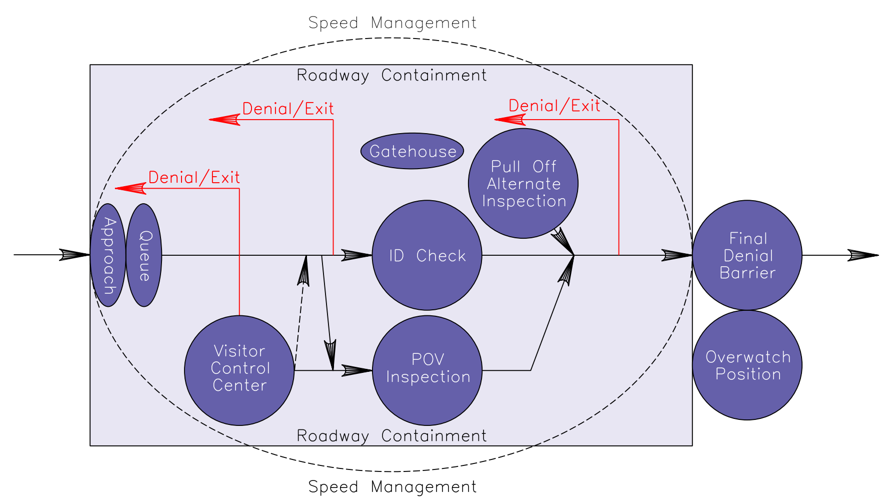
✓ Parking to meet the demand
✓ Entrance back into traffic prior to the ID checkpoint
✓ Rejection capabilities

A POV inspection area needs to have the following capabilities:

✓ Protection from adverse weather conditions
✓ Under vehicle search capability
✓ Separation of vehicles from traffic flow
✓ Screening from the ID checkpoint
✓ Rejection prior to the ID check
✓ Re-entry into the traffic flow, either prior to the ID checkpoint or after the ID checkpoint with controls in place

An alternate inspection area after the ECF should be included such that, if security conditions warrant, a vehicle can be inspected after reaching the ID checkpoint without impacting traffic flow. Alternate inspection must have an overwatch plan to restrict violators from accessing the installation. The overwatch and final barrier prevents unauthorized entry if the ID check is violated.

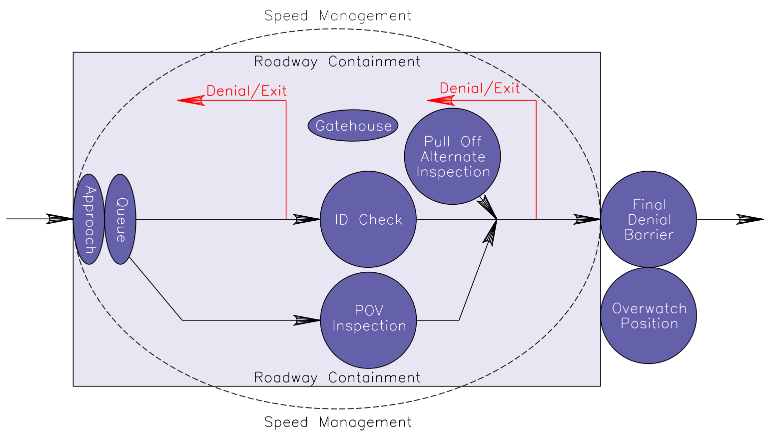
Exhibit 1.6: UFC Functional Relationships



1.6.2. ECFs With DoD/Authorized Personnel Processing Only

Exhibit 1.7 provides the same components as **Exhibit 1.6** without provisions for a visitor control center.

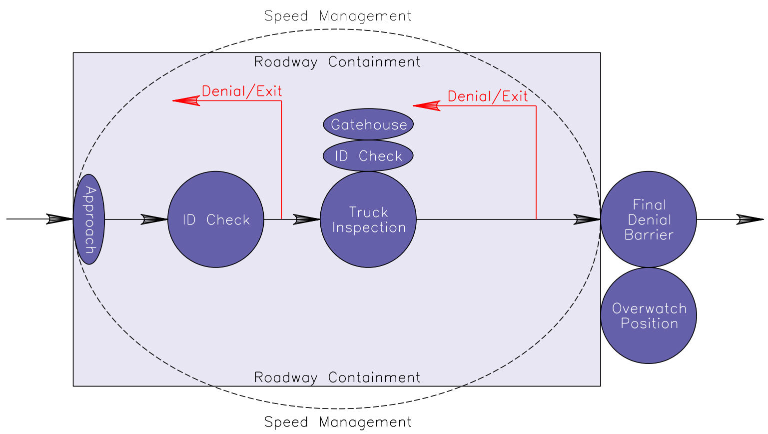
Exhibit 1.7: UFC Functional Relationships



1.6.3. Commercial Vehicle Processing

Per **Exhibit 1.8**, commercial vehicle processing requires special functions depending on whether it is part of another ECF or part of an exclusive ECF. There must be sufficient truck holding to accommodate queuing of trucks associated with inspection activities at FPCON Bravo+. Rejection capabilities may be included before the inspection area and at a minimum must be provided after truck inspection areas. Truck inspection areas must be sized for possible inclusion of current or future inspection technologies and should include an area for drivers.

Exhibit 1.8: UFC Functional Relationships



1.7. ECF ZONES

An ECF consists of four zones, as illustrated in **Exhibit 1.9**, each encompassing specific functions and operations. Beginning at the installation property boundary, the zones include the safety zone, approach zone, access control zone, and response zone.

Pages 1-13 to 1-26 show various concepts of ECFs that conform to UFC 4-022-01 and incorporate the functional relationships and zones.

Exhibit 1.9: ECF Zones

Zone	Location	Goals
Safety	Extends in all directions beyond passive and active barriers.	Protect assets and personnel from explosions.
Approach	Installation boundary to a point just before the ID checkpoint.	Reduce speed, sort vehicles, provide stacking room, identify potential threats.
Access Control	A point just before and after the ID checkpoint.	Identify vehicles and personnel; provide surveillance, random inspection, visitor processing, and rejection capabilities.
Response	A point just after the ID checkpoint to the active vehicle barriers.	Provide measures to react to and contain a threat.

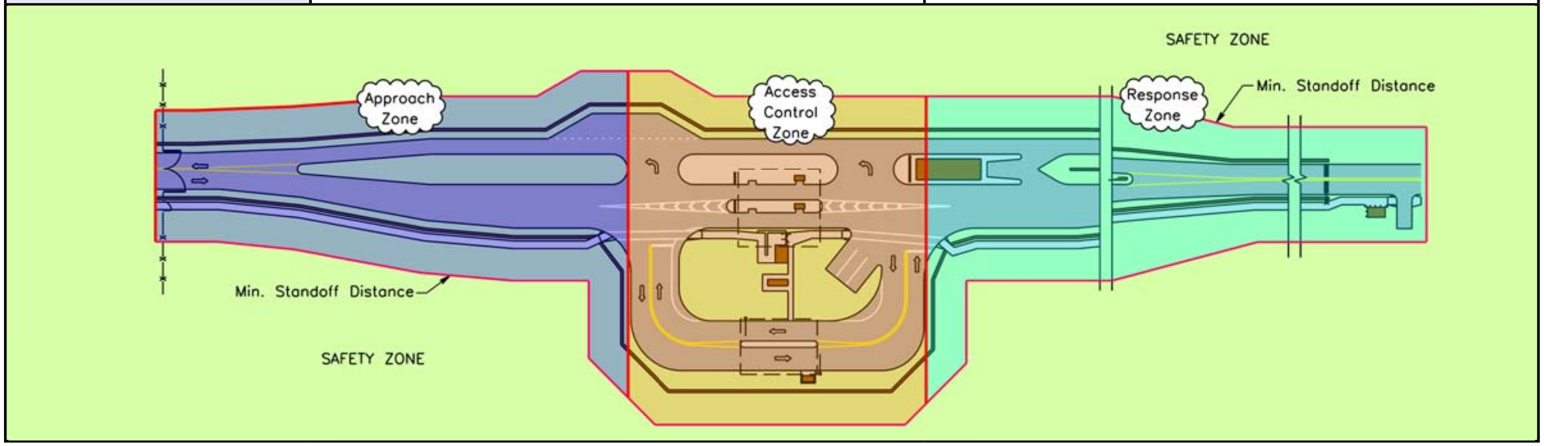


Exhibit 1.10: Primary ECF with POV, Visitor and Commercial Vehicle Processing

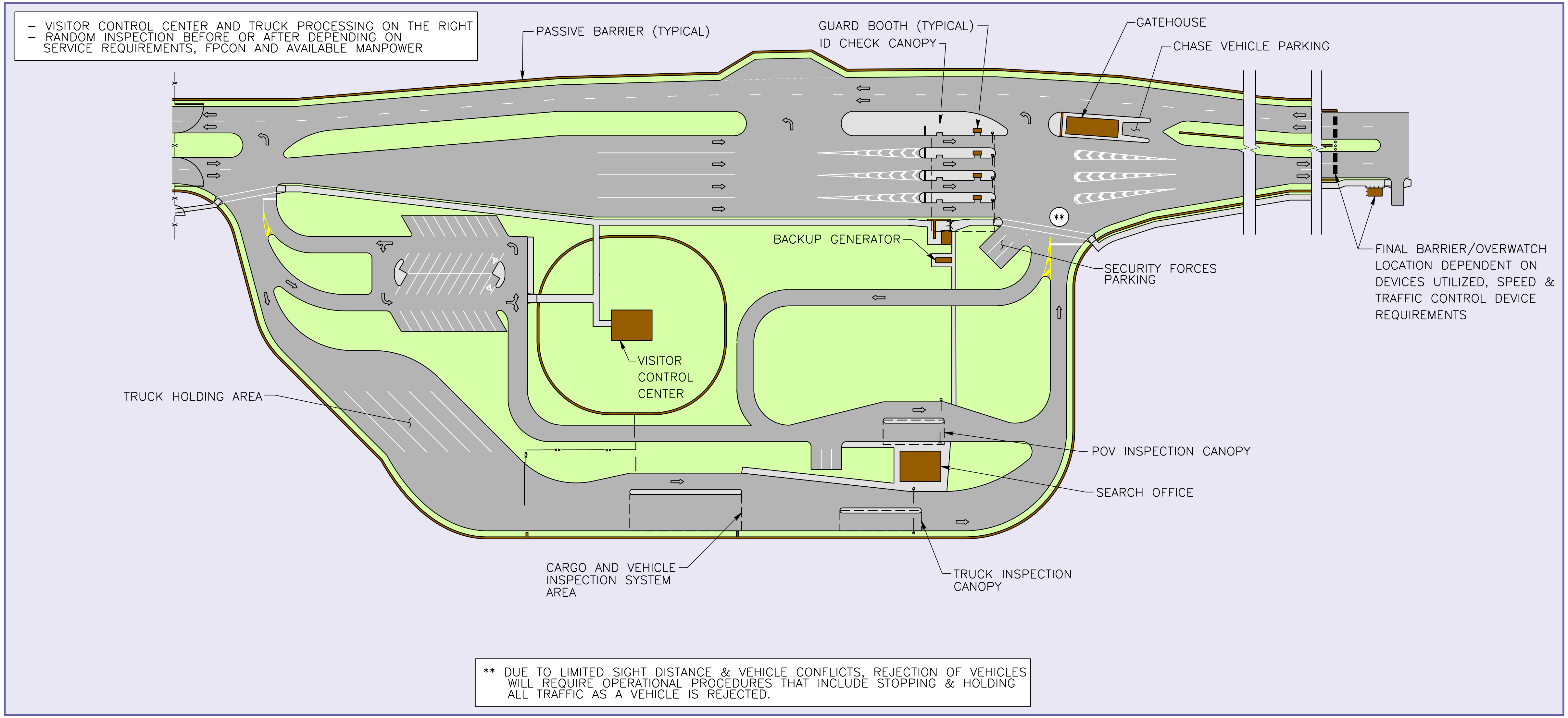


Exhibit 1.11: Restricted Real Estate ECF with POV, Visitor and Commercial Vehicle Processing

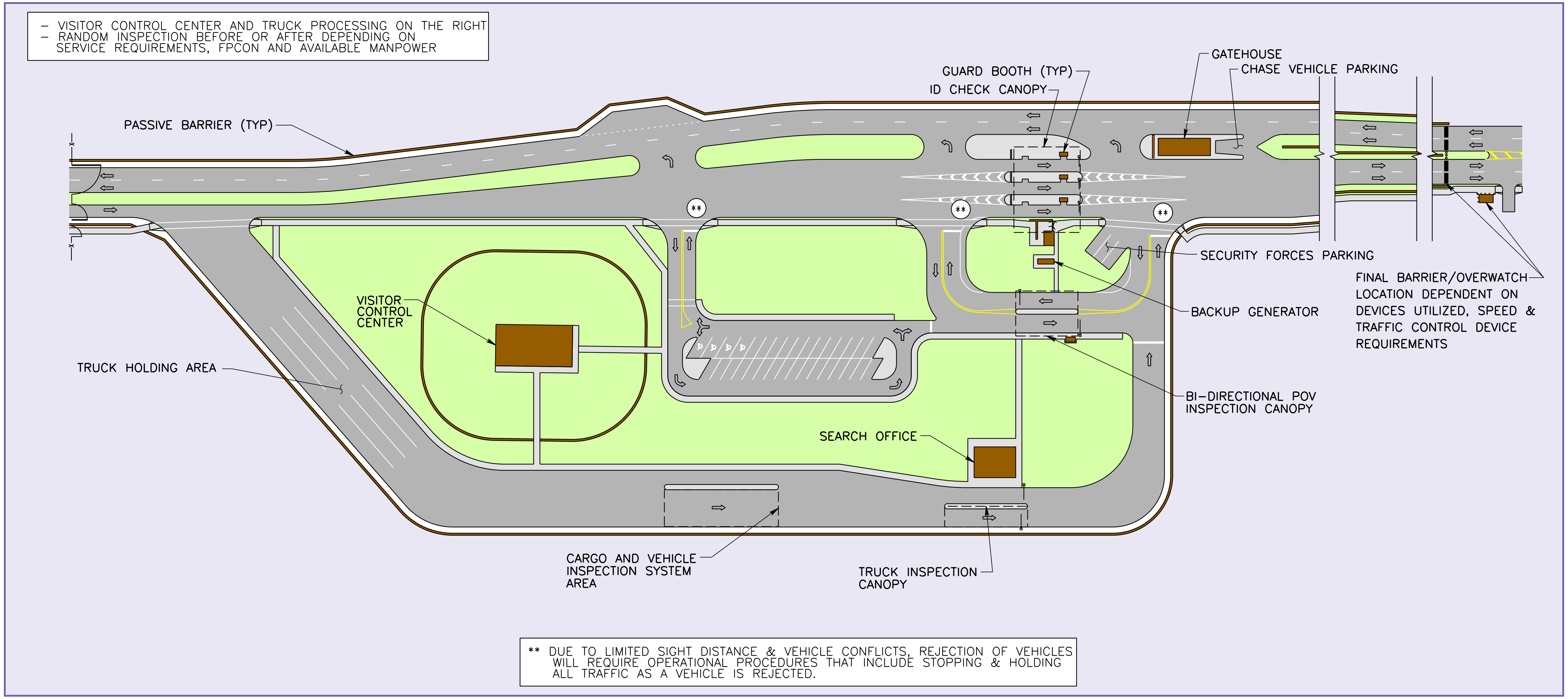


Exhibit 1.12: Commercial Vehicle Only ECF

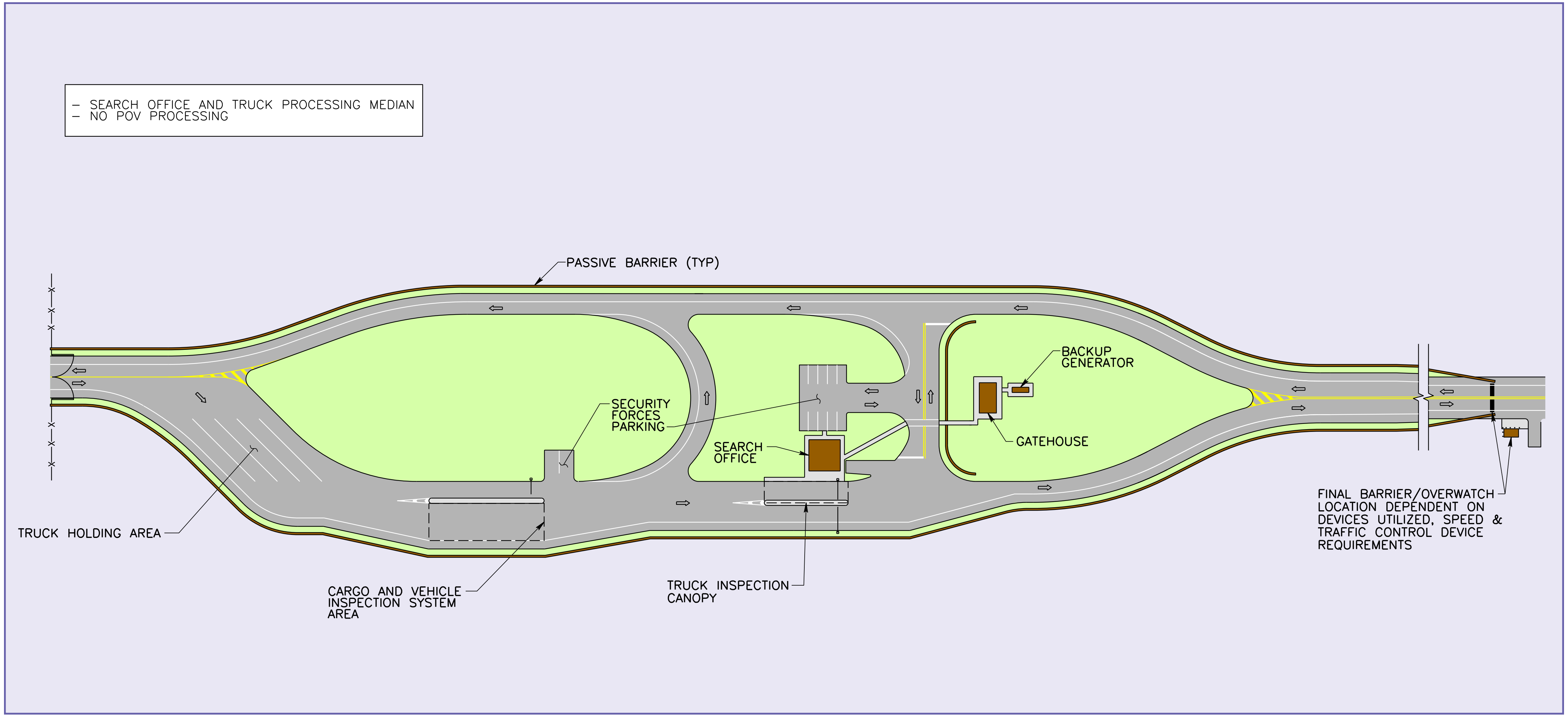


Exhibit 1.13: Commercial Vehicle Only ECF Operating with AVB Normally Deployed

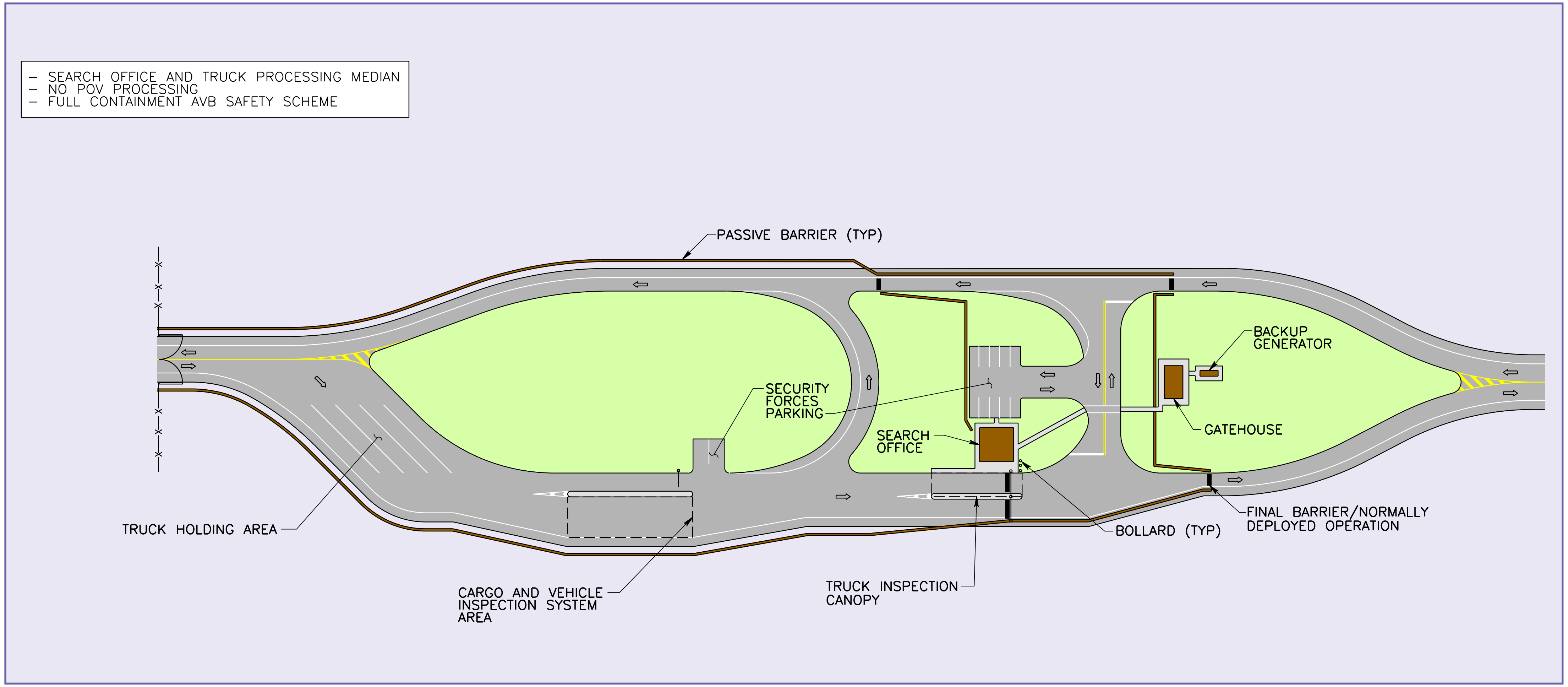


Exhibit 1.14: Primary-Secondary ECF with POV and Visitor Processing

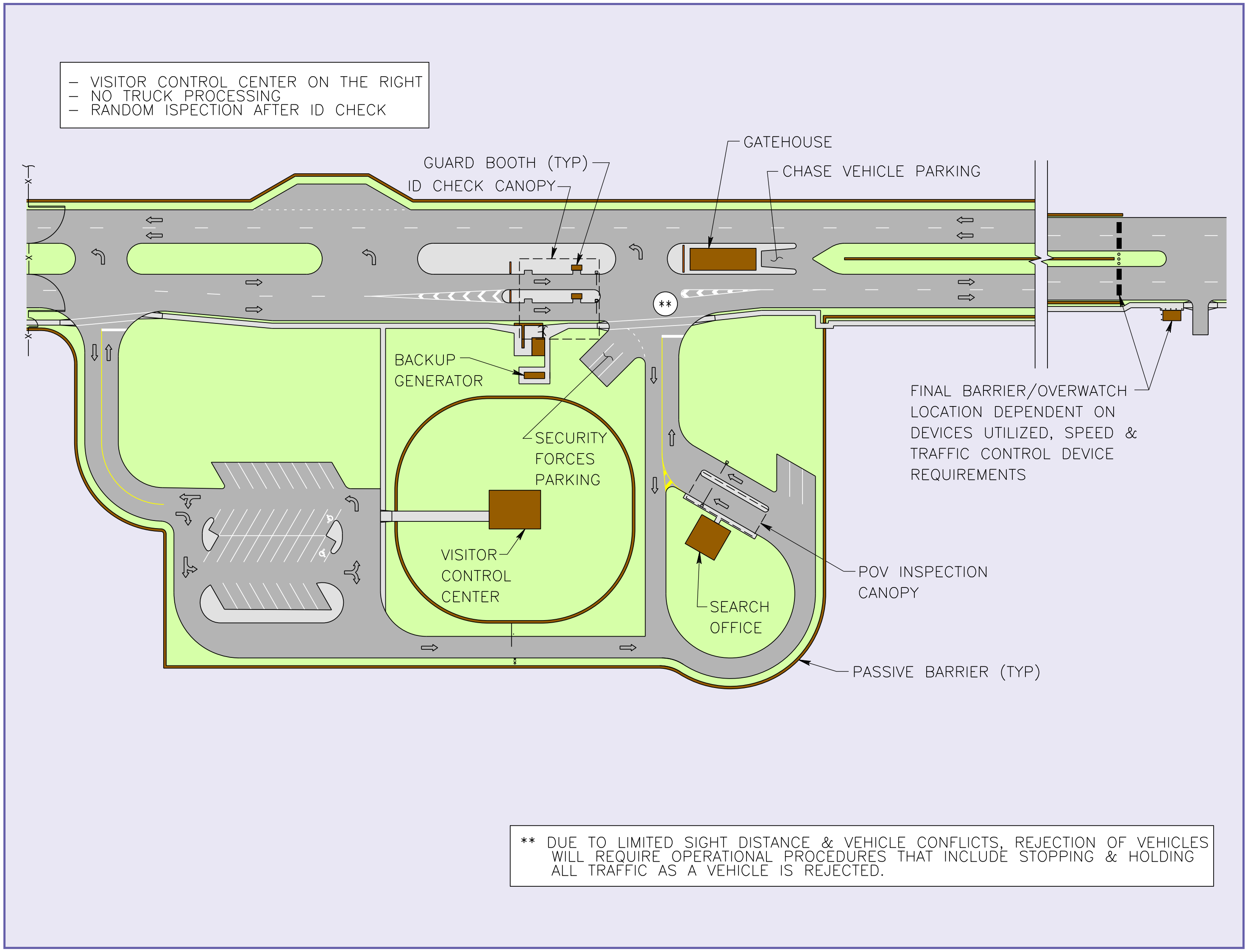


Exhibit 1.15: Primary-Secondary ECF with POV Processing Only

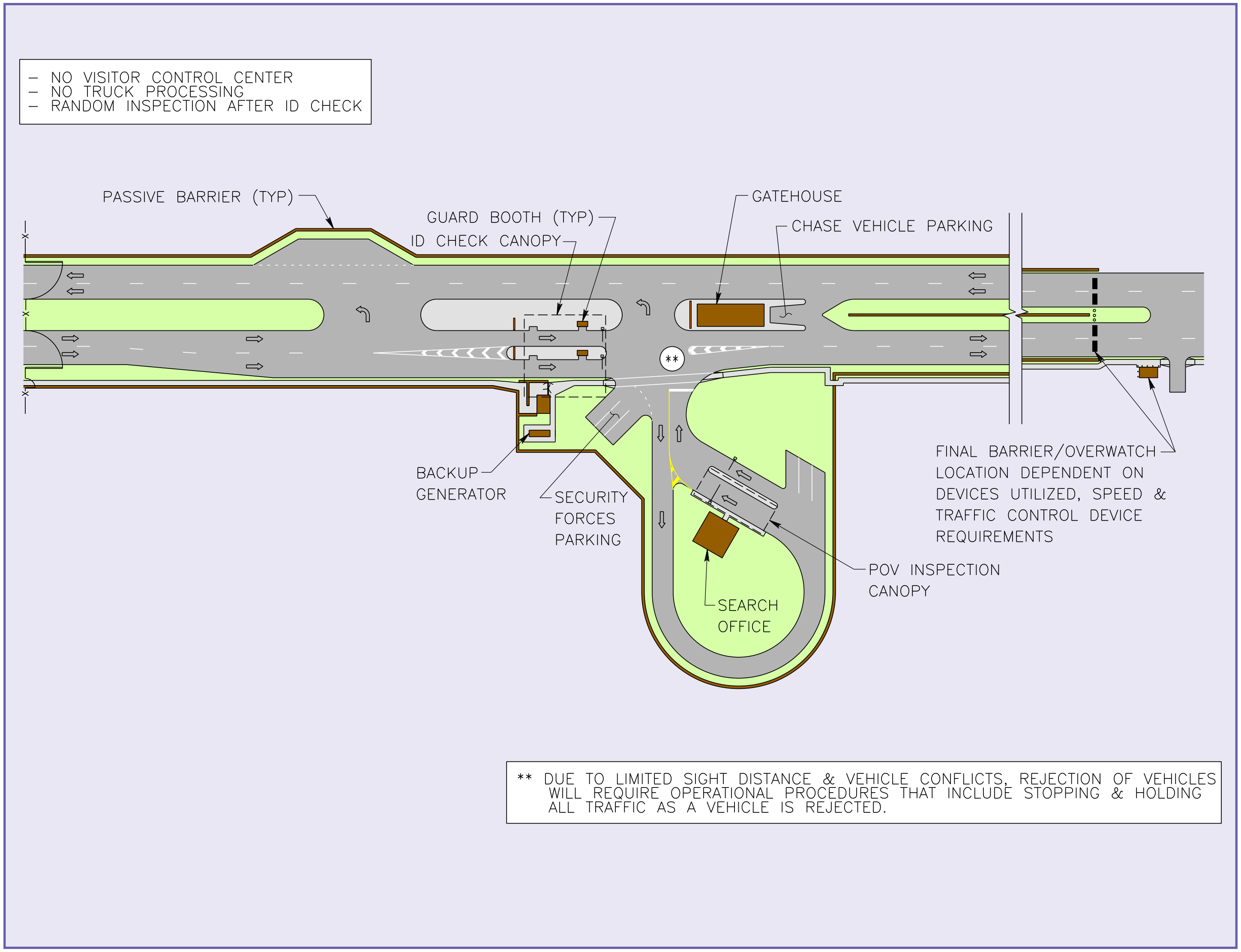


Exhibit 1.16: Loop ECF with POV Processing Only

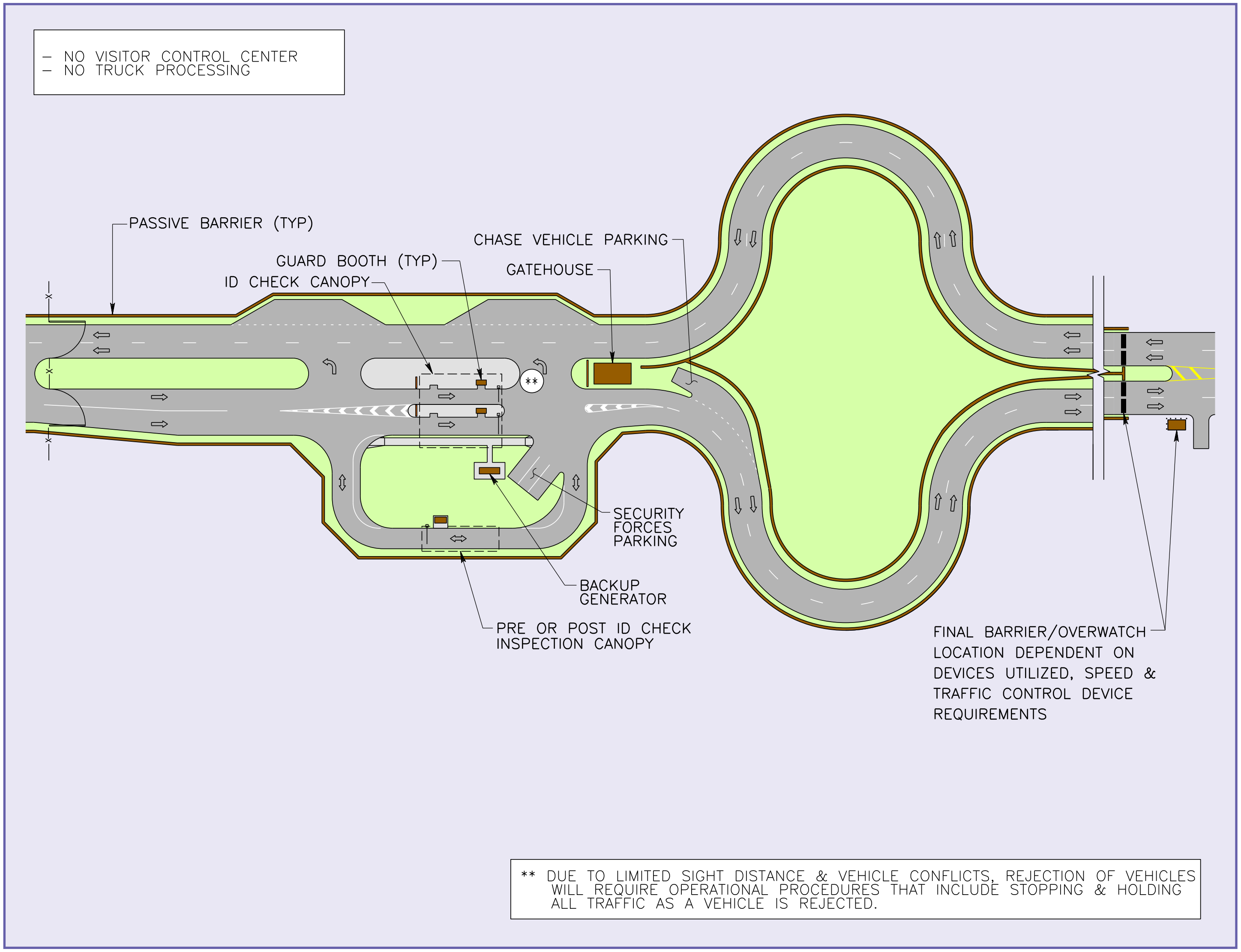


Exhibit 1.17: Restricted Real Estate ECF with POV and Commercial Vehicle Processing

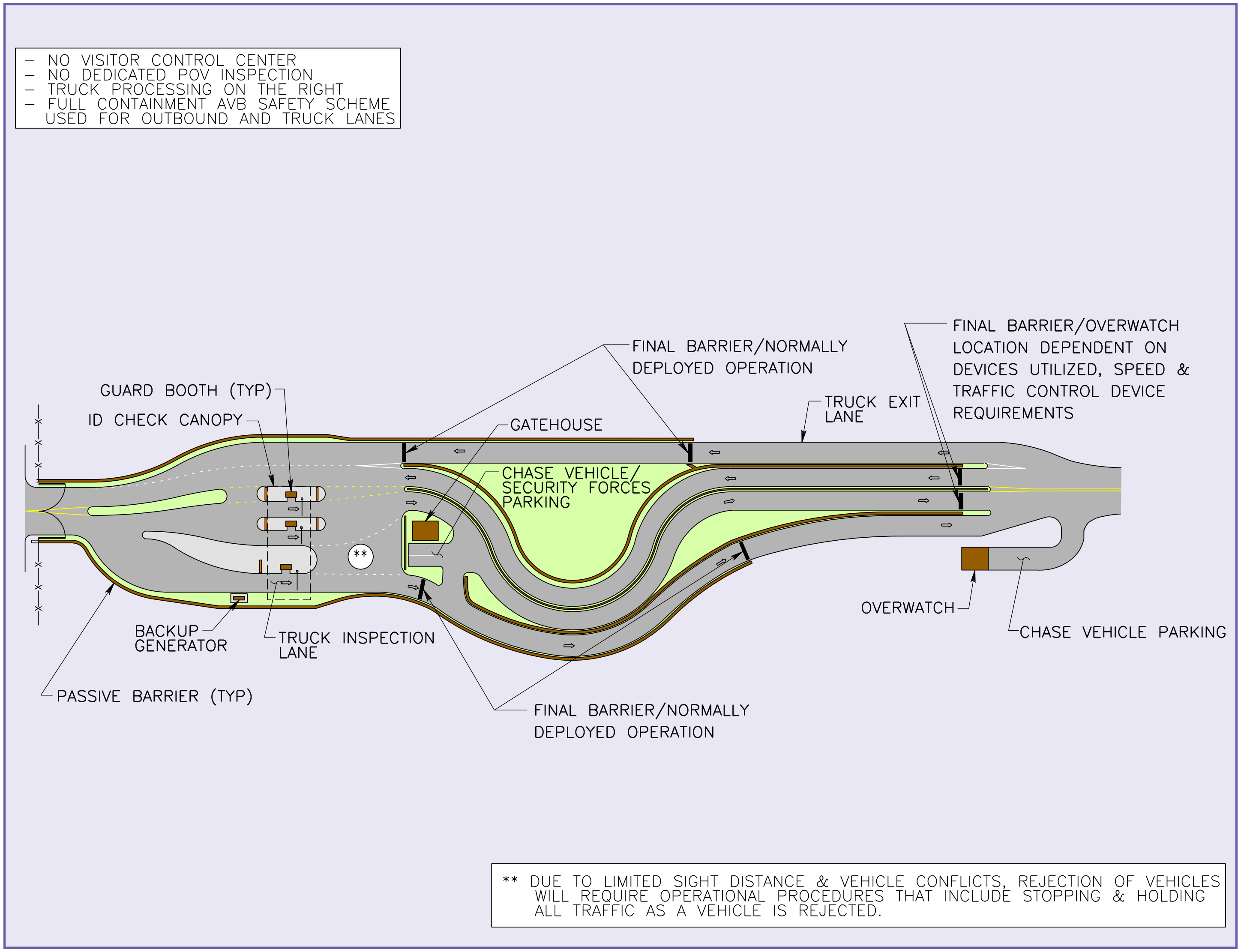


Exhibit 1.18: Restricted Real Estate ECF with POV Processing Only

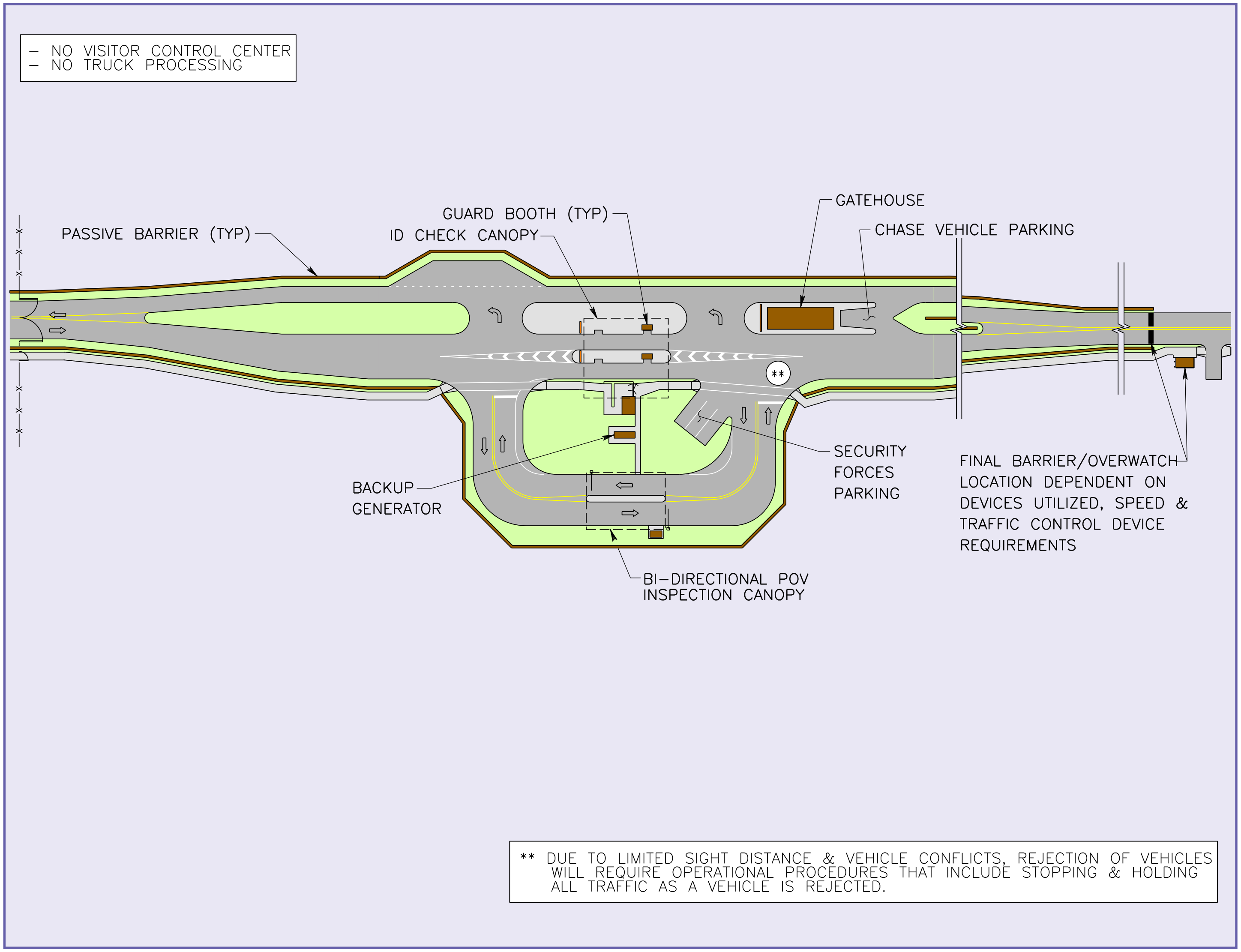


Exhibit 1.19: Restricted Real Estate ECF Operating with Full Containment AVB Safety Scheme

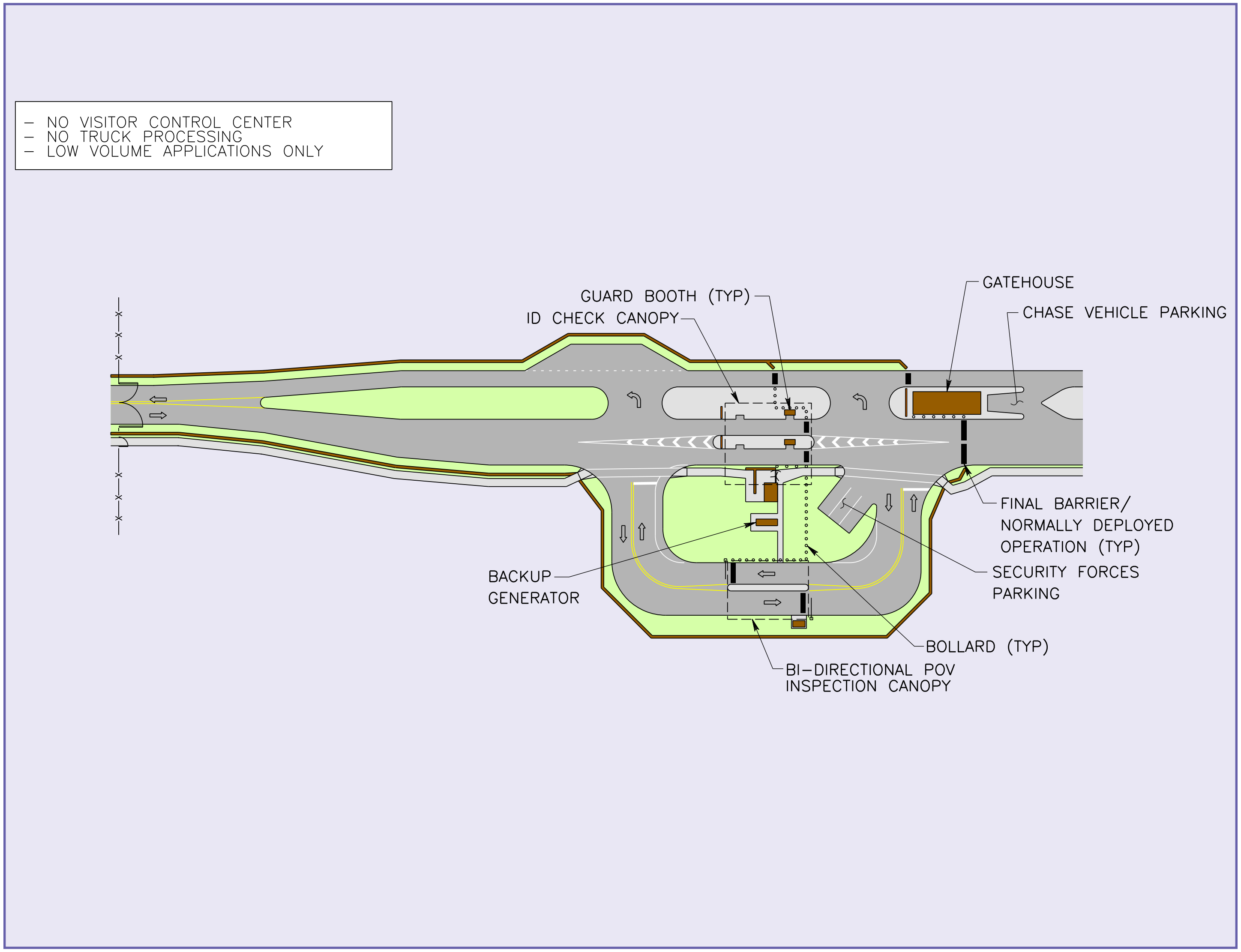


Exhibit 1.20: Restricted Real Estate ECF Operating with Full Containment AVB Safety Scheme

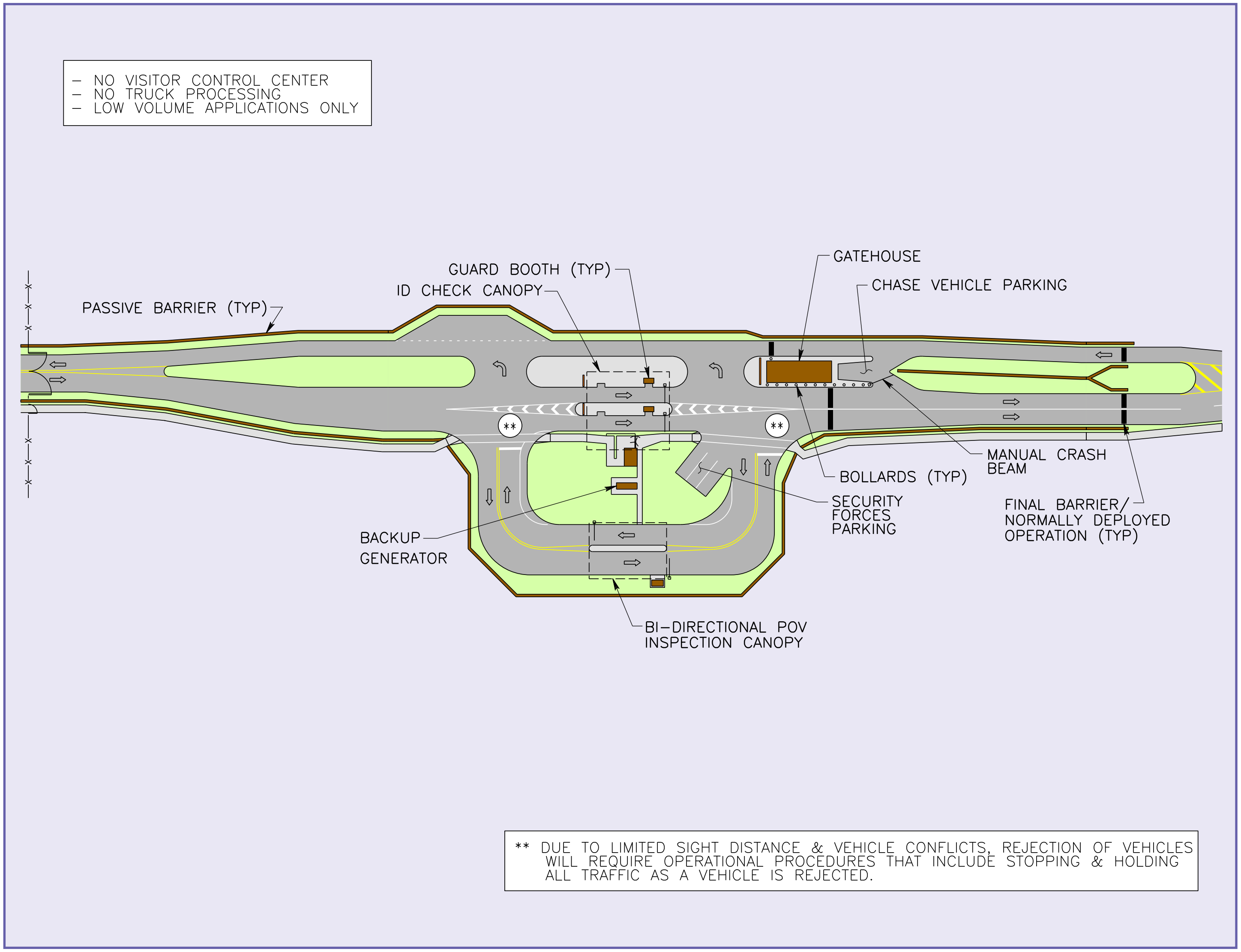


Exhibit 1.21: Limited Real Estate ECF using Half Circles with POV Processing Only

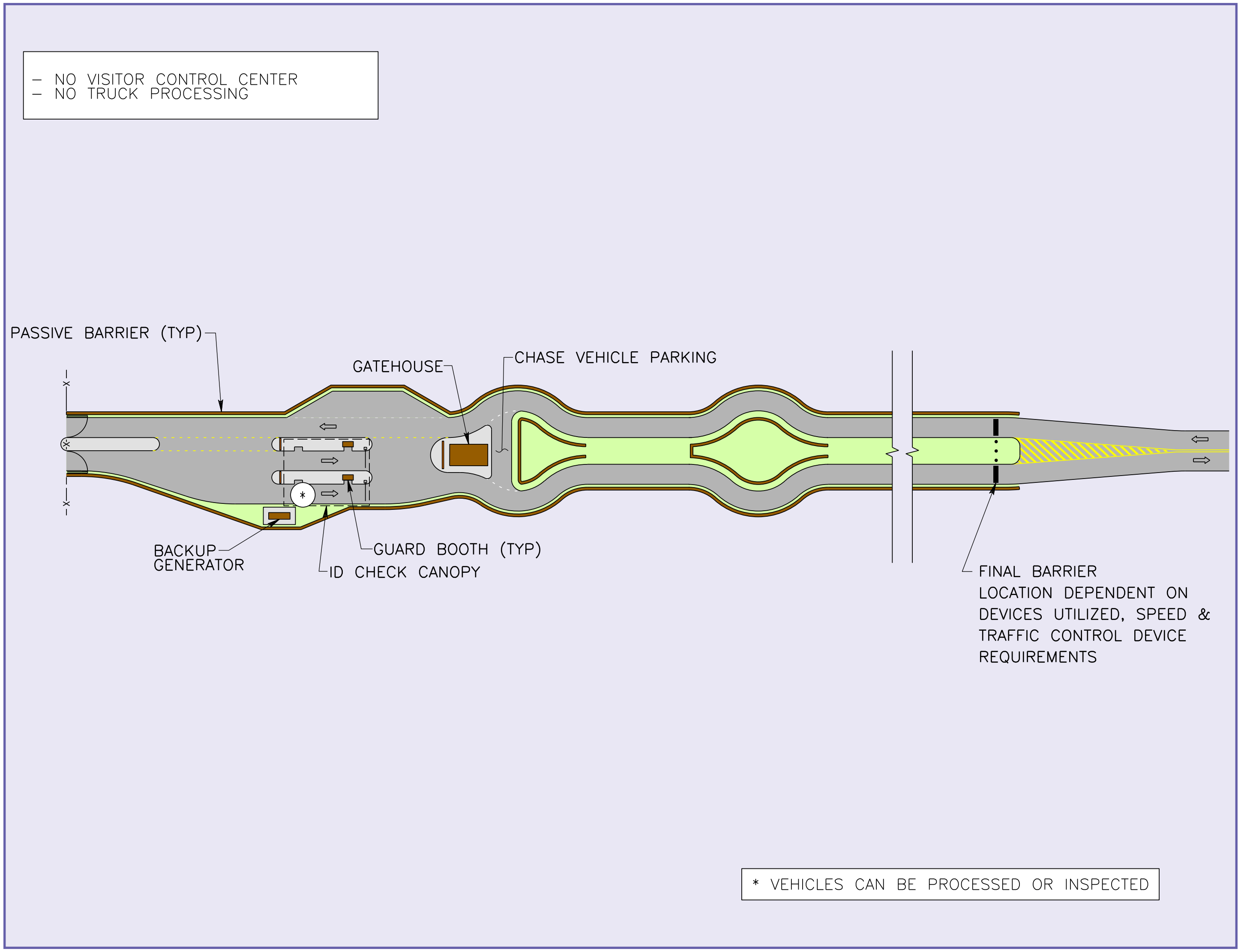
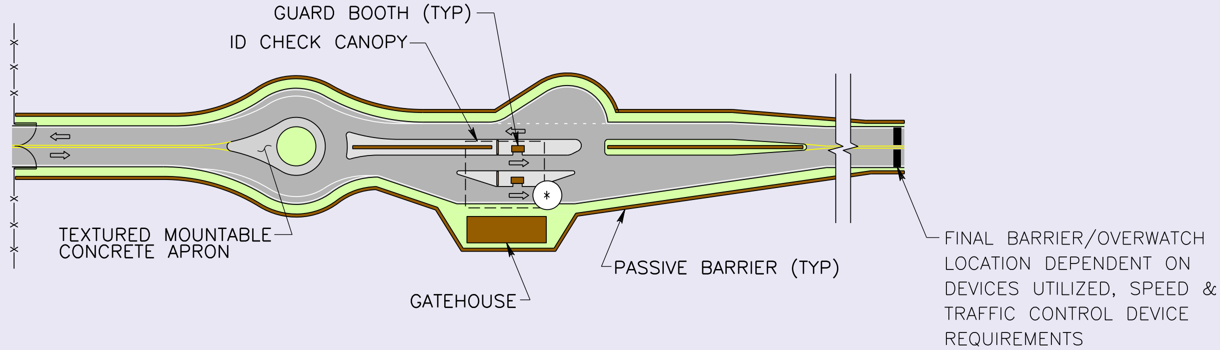


Exhibit 1.22: Limited Real Estate ECF with POV Processing Only

– NO VISITOR CONTROL CENTER
– NO TRUCK PROCESSING



THE SPEED RATCHET DESIGN IS INTENDED FOR USE AT ECF CONSISTING OF ONE LANE PER DIRECTION. CONCRETE BARRIERS SLOW VEHICLES BY DEFLECTION. THE SPEED RATCHET DEFLECTS AS WELL BUT DOES SO IN A SAFE MANNER AND ACHIEVES THE FOLLOWING GOALS:

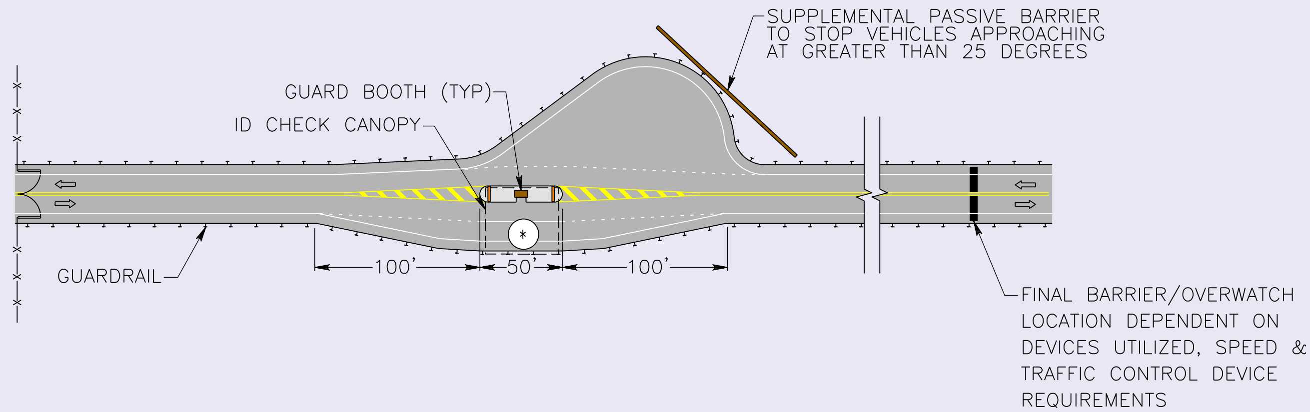
- SAFELY REDUCES VEHICLE SPEED TO BELOW 25 MPH.
- ACCOMMODATES TRUCK MOVEMENTS.
- SLOWS UNAUTHORIZED VEHICLES ATTEMPTING TO ENTER THE INSTALLATION VIA OUTBOUND LANES.
- ALLOWS FOR TURNAROUND OF PASSENGER CARS EITHER BEFORE OR AFTER GUARDBOOTH.

CIRCLE AREA CAN BE USED FOR LOW–HEIGHT PLANTING, FLAGPOLE, ETC. TO CREATE AN AESTHETICALLY PLEASING GATEWAY TO THE INSTALLATION.

* VEHICLES CAN BE PROCESSED OR INSPECTED

Exhibit 1.23: Limited Use ECF (Only for Special Purposes)

- NO VISITOR CONTROL CENTER
- NO TRUCK PROCESSING
- NO GATEHOUSE



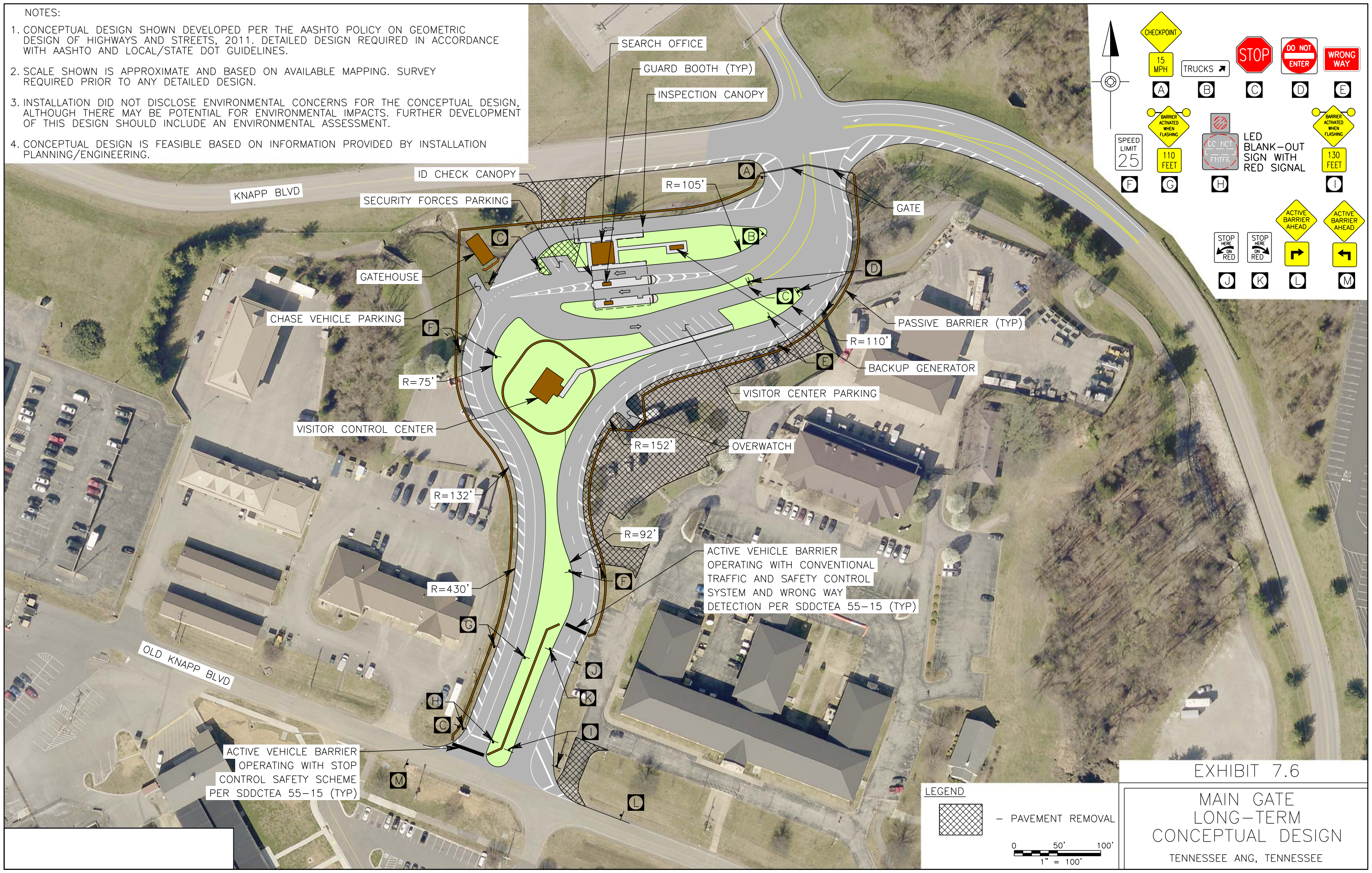
* VEHICLES CAN BE PROCESSED OR INSPECTED

OFTEN THE STANDARD LAYOUT OF AN ECF WILL NOT FIT. THE DESIGNERS OF THE FACILITY MUST BE THOROUGHLY KNOWLEDGEABLE OF THE APPLICABLE STANDARDS TO RIGHT-SIZE A SOLUTION.

1.8. APPLIED DESIGNS

When a new ECF design is to be completed, designers must first consider the standard application of UFC 4-022-01 and all applicable service specific standards and guidance. However, in most cases the standard design may not be feasible. When this occurs designers must be intimately knowledgeable about the applicable standards and understand how to fit them into the constraints of the site and other limitations of the project. The following pages show drawings where the available standards and guidance have been applied to specific locations.

Exhibit 1.24: Applied Design



Background Image Source: Google Earth

Exhibit 1.25: Applied Design

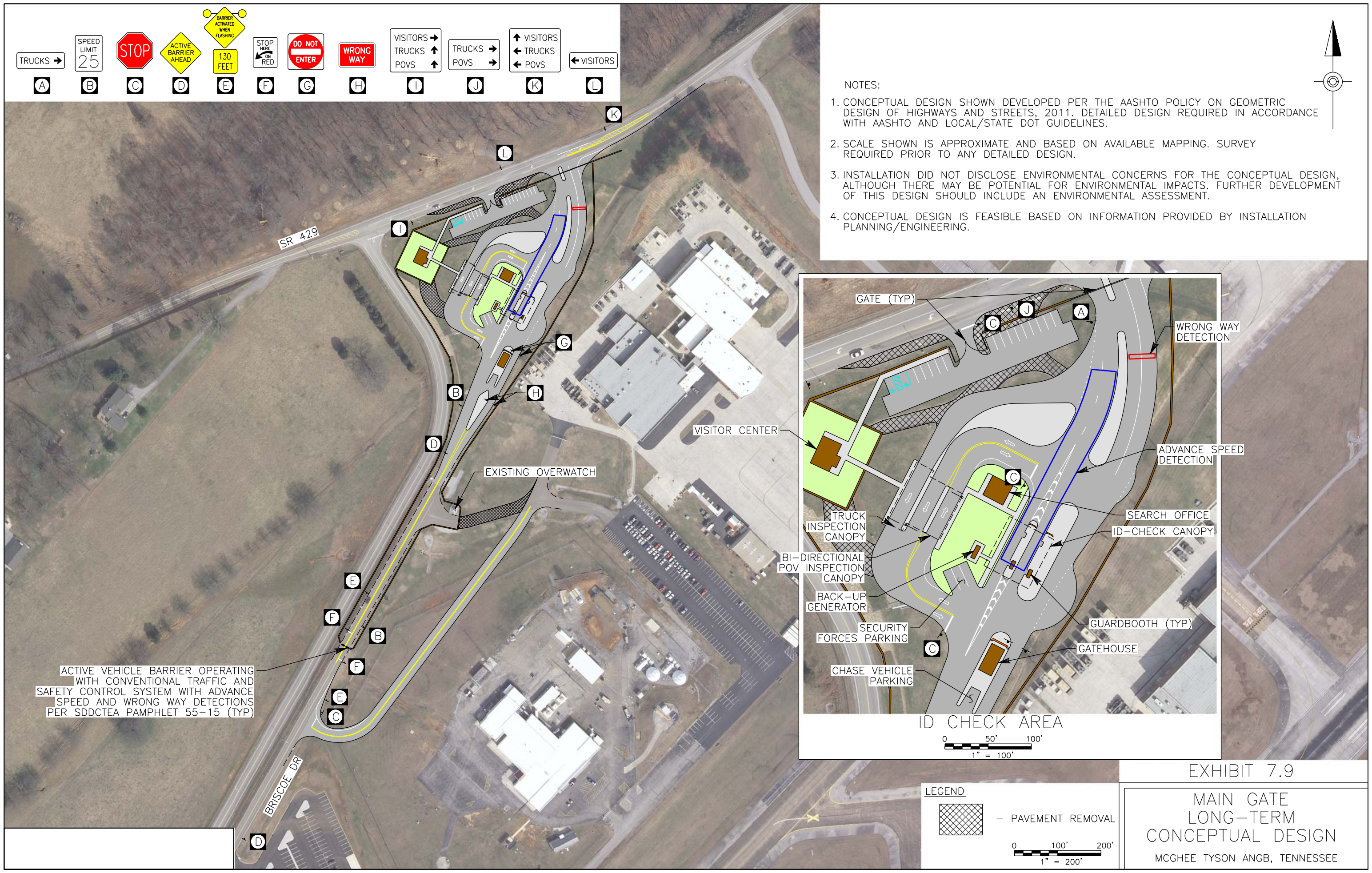


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Exhibit 1.26: Applied Design

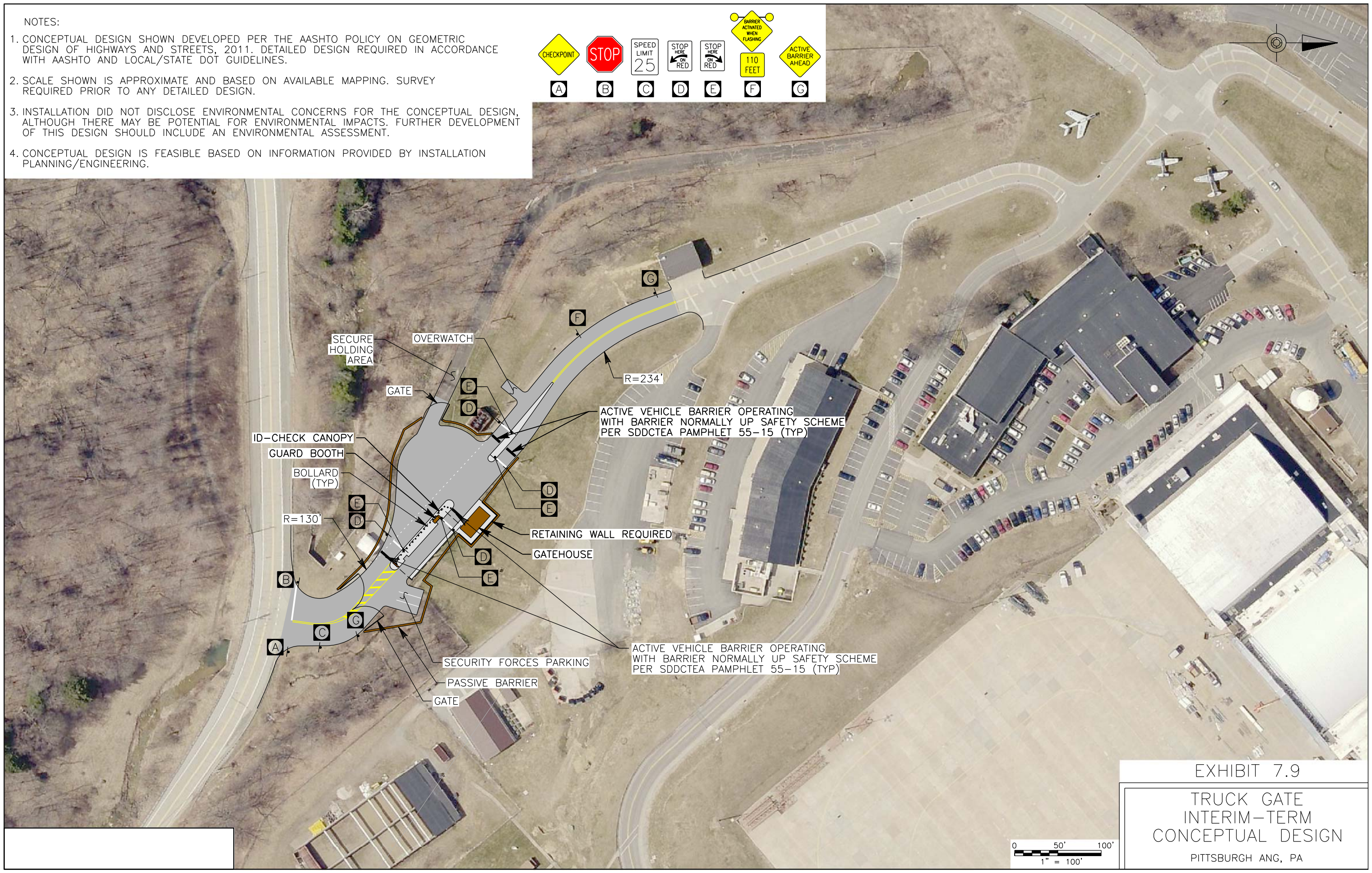

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Exhibit 1.27: Applied Design

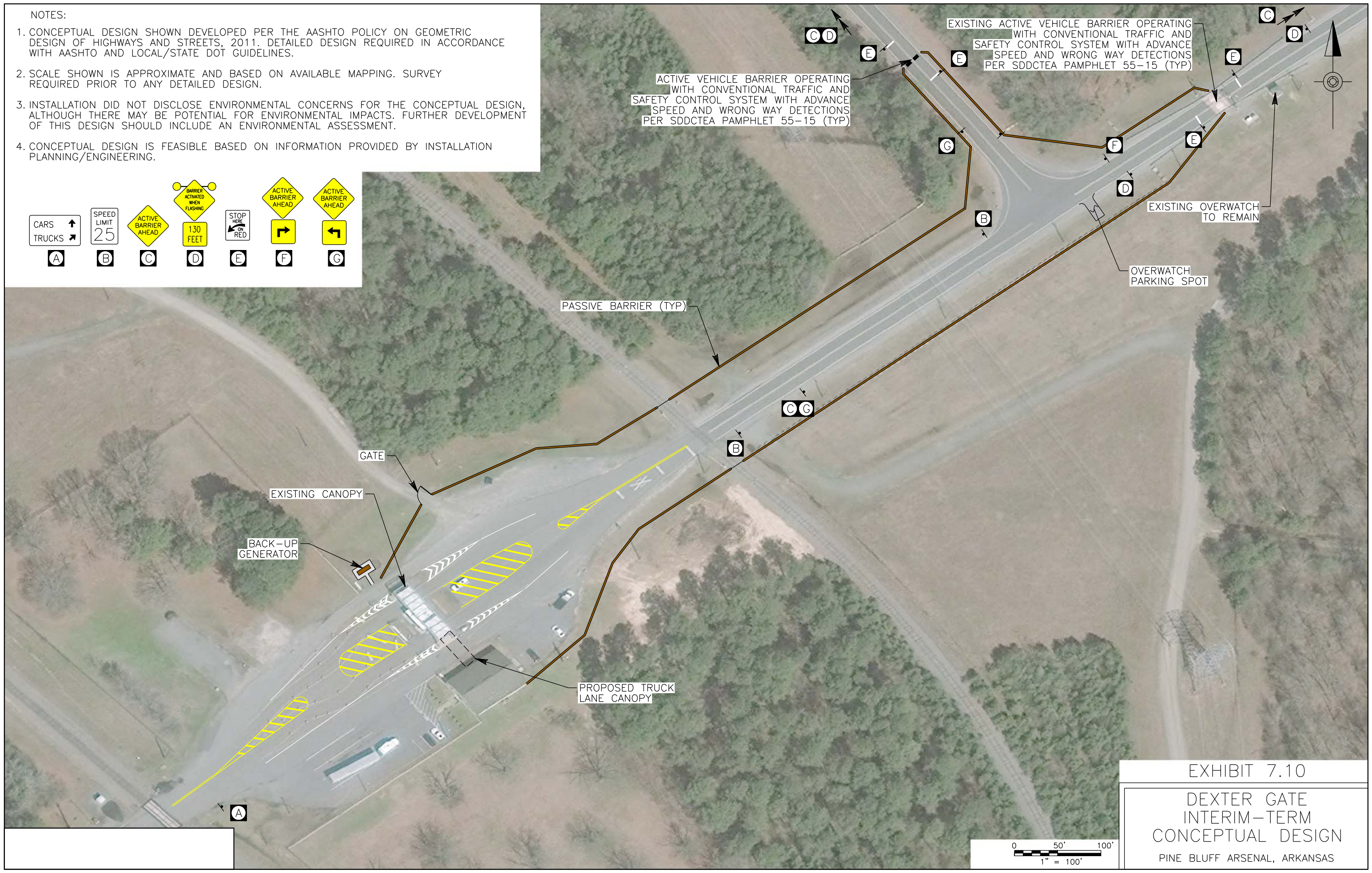

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Exhibit 1.28: Applied Design

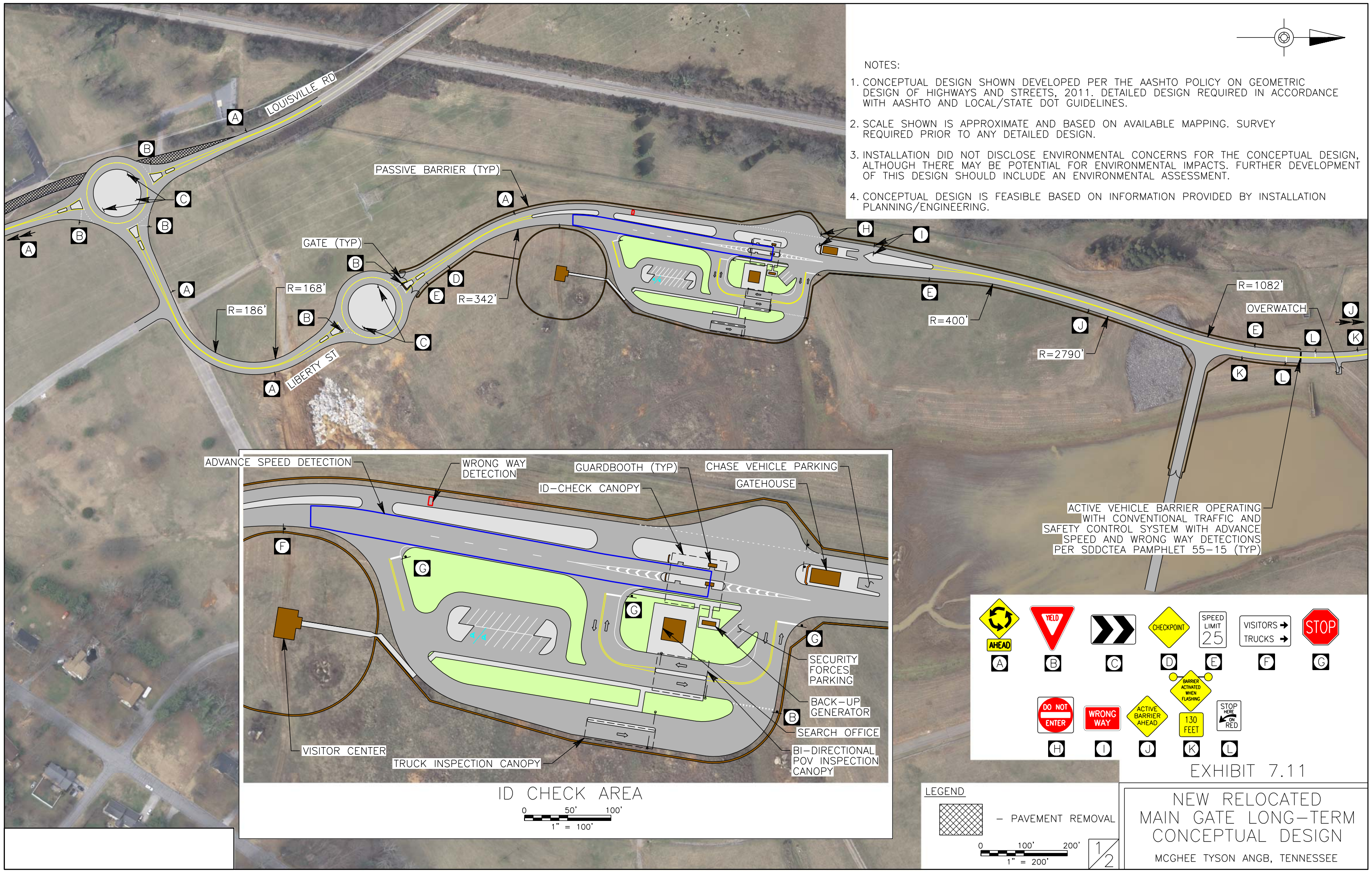

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Exhibit 1.29: Applied Design

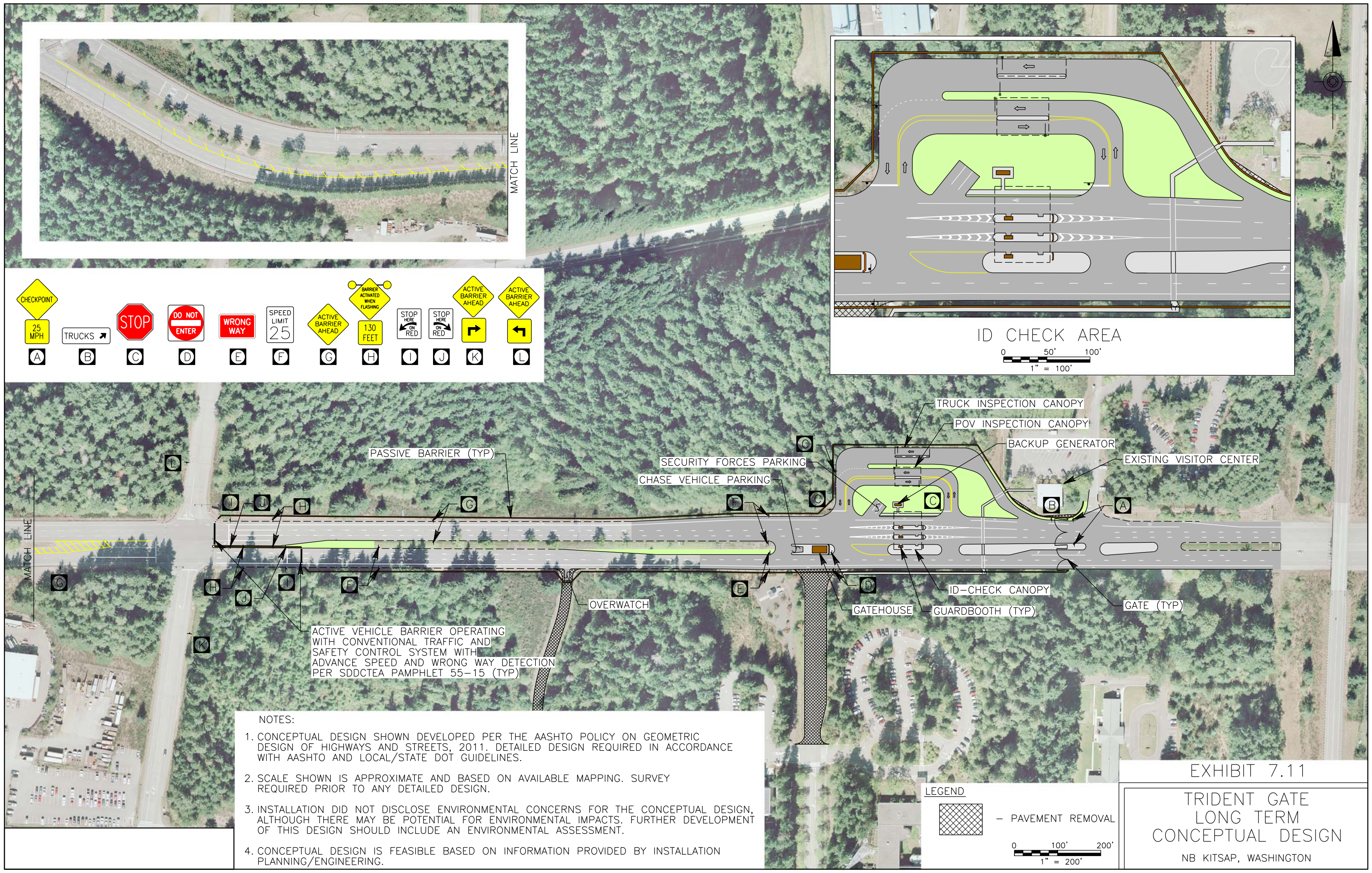

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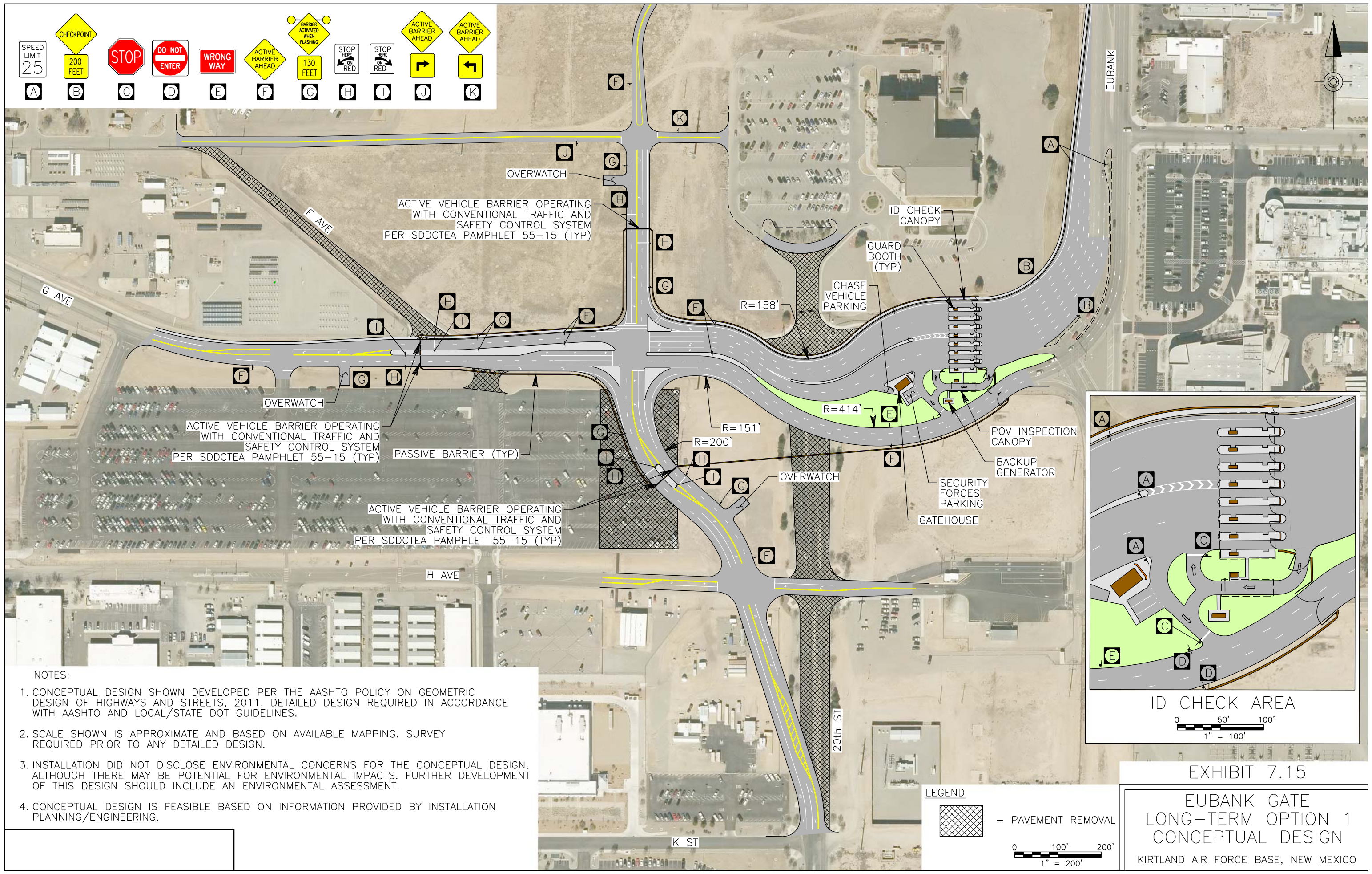
Exhibit 1.30: Applied Design



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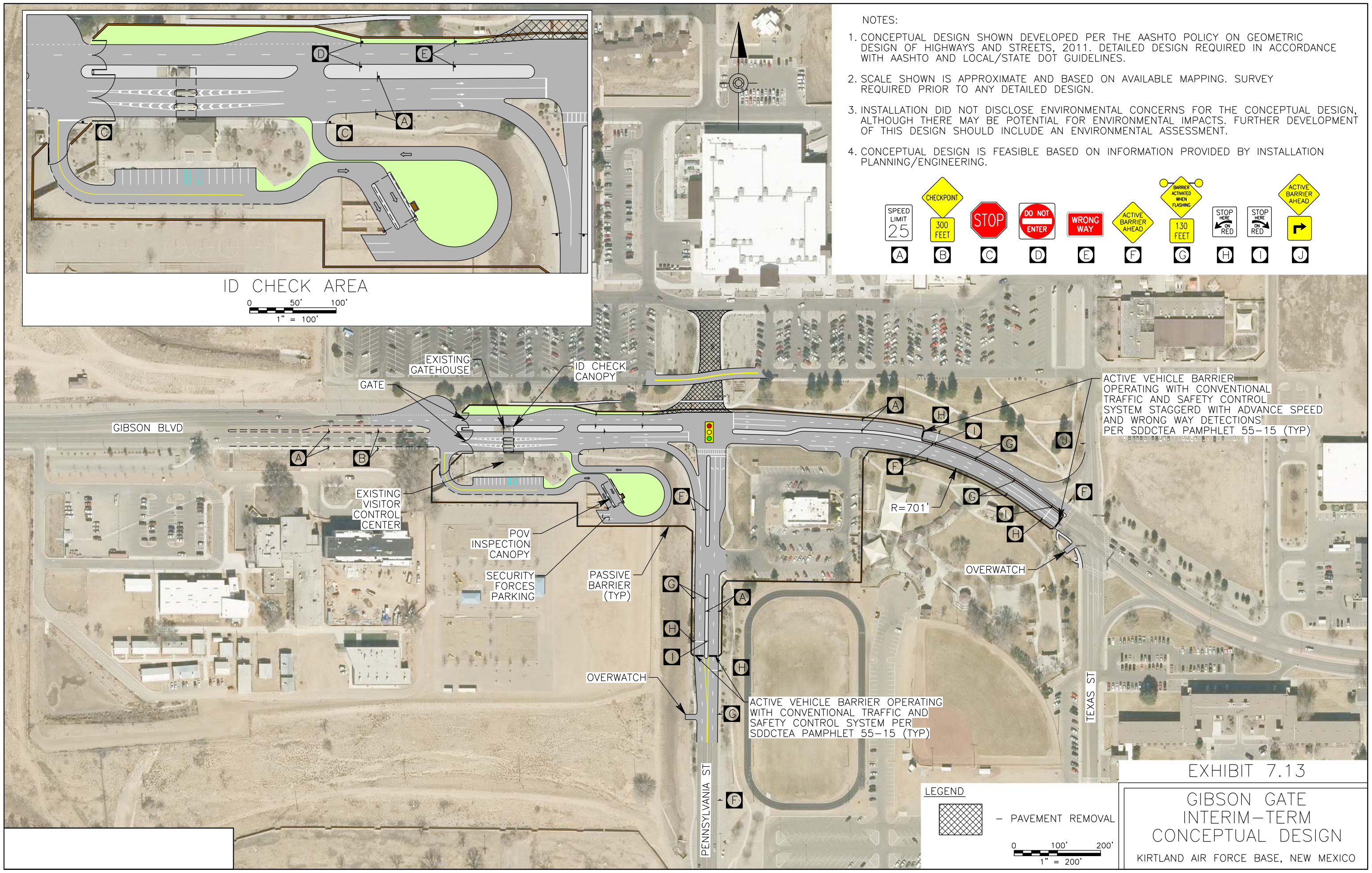

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Exhibit 1.32: Applied Design

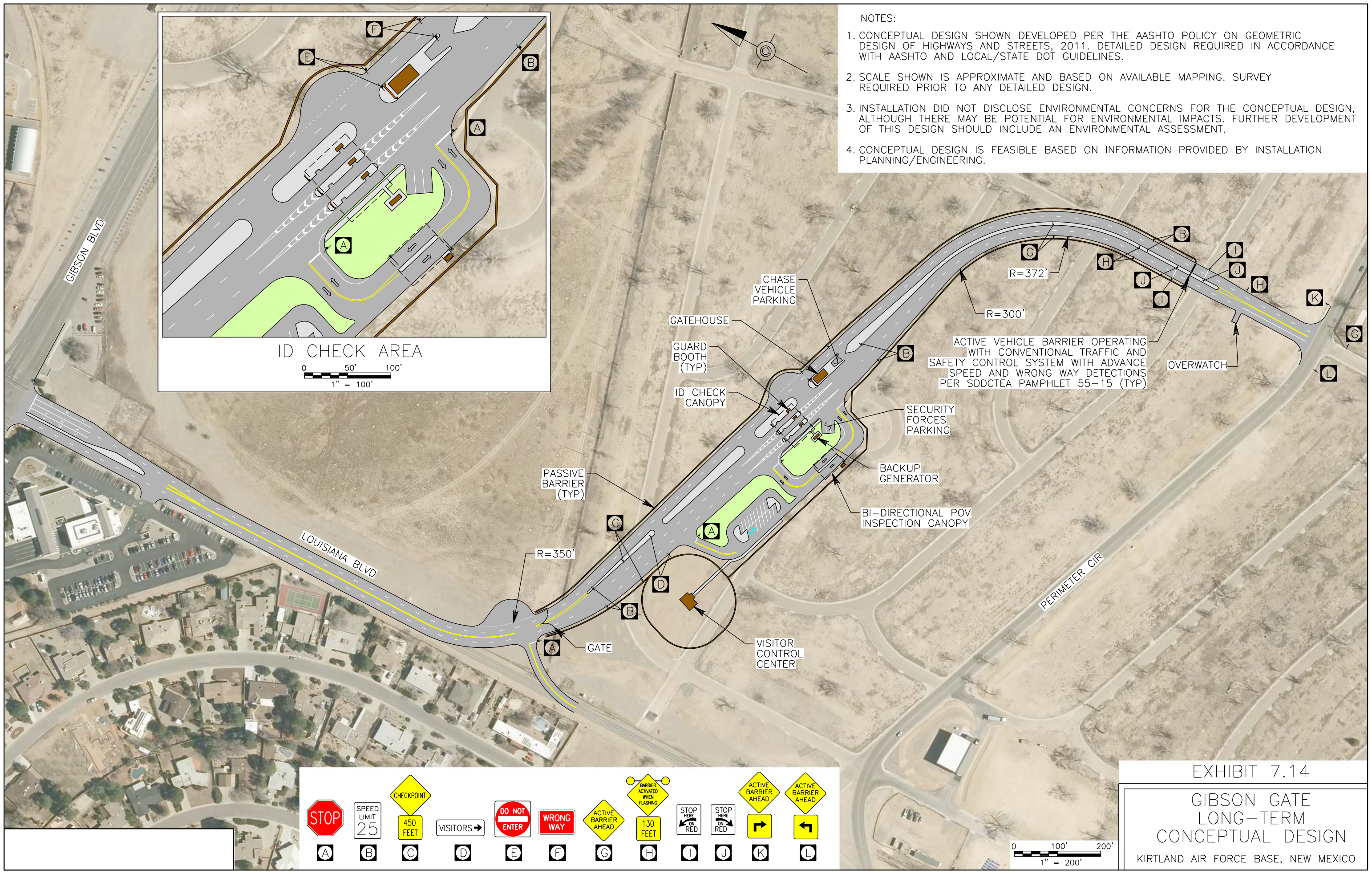

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Exhibit 1.33: Applied Design

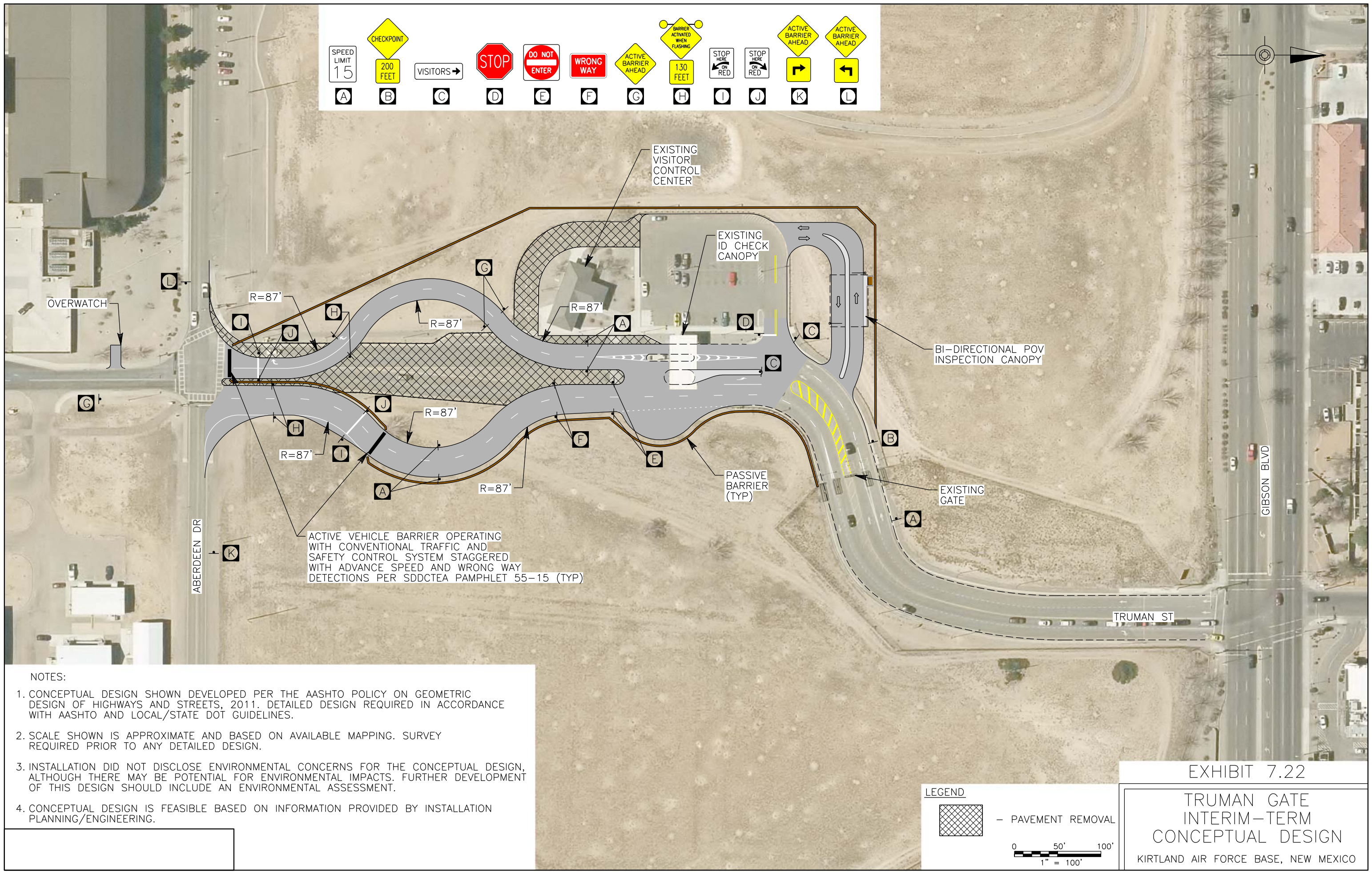

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Exhibit 1.34: Applied Design

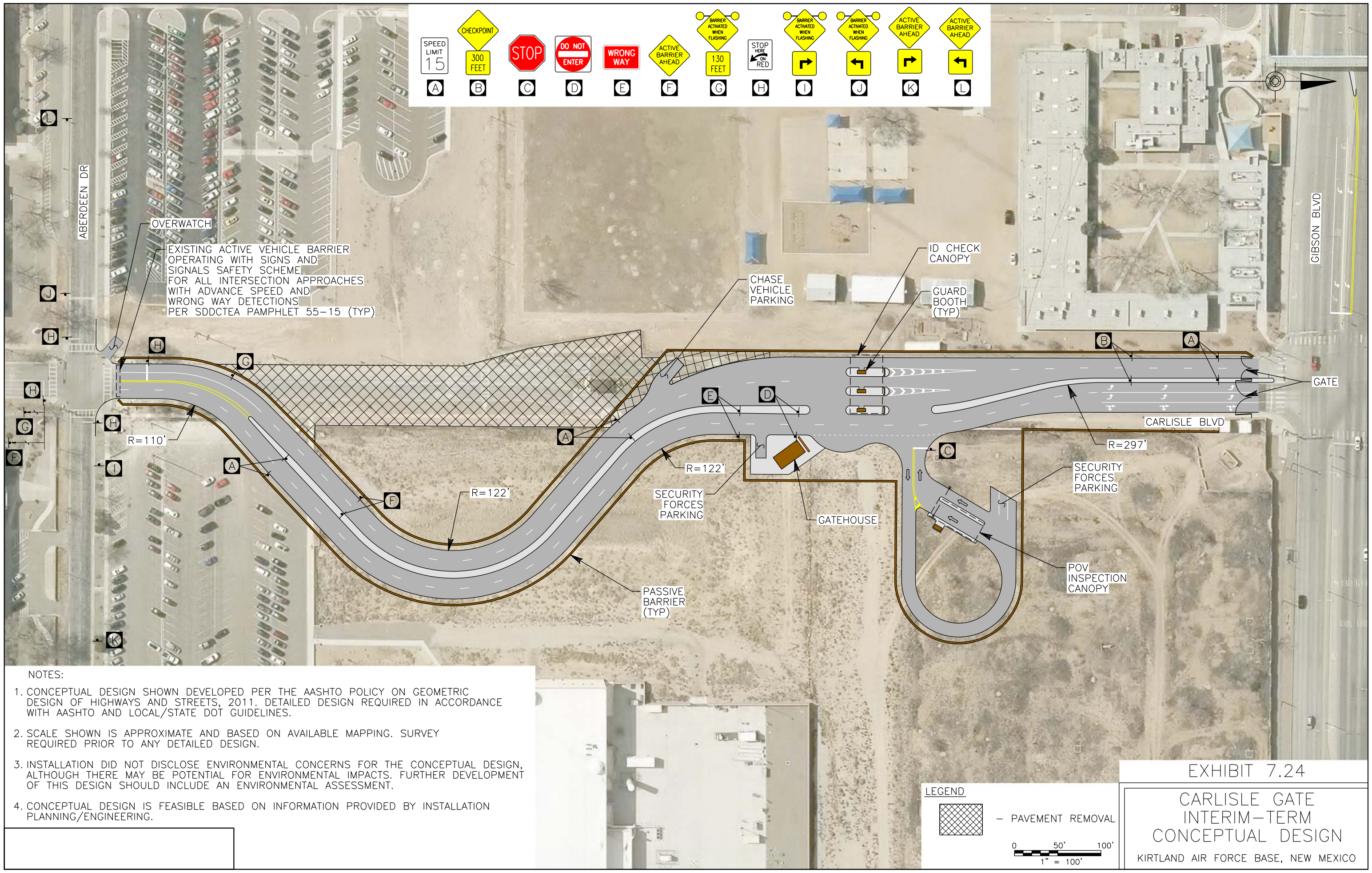

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Exhibit 1.35: Applied Design

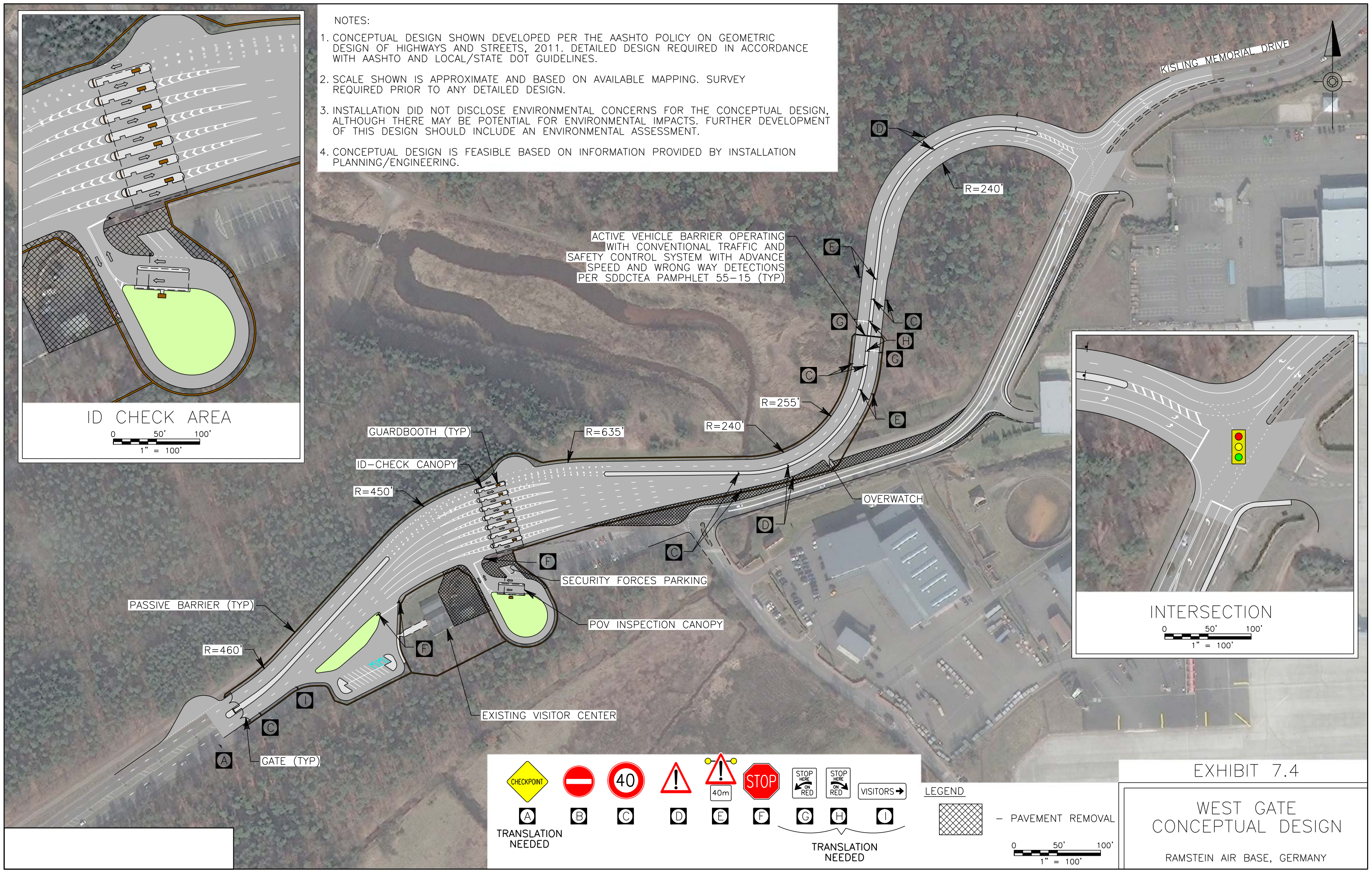

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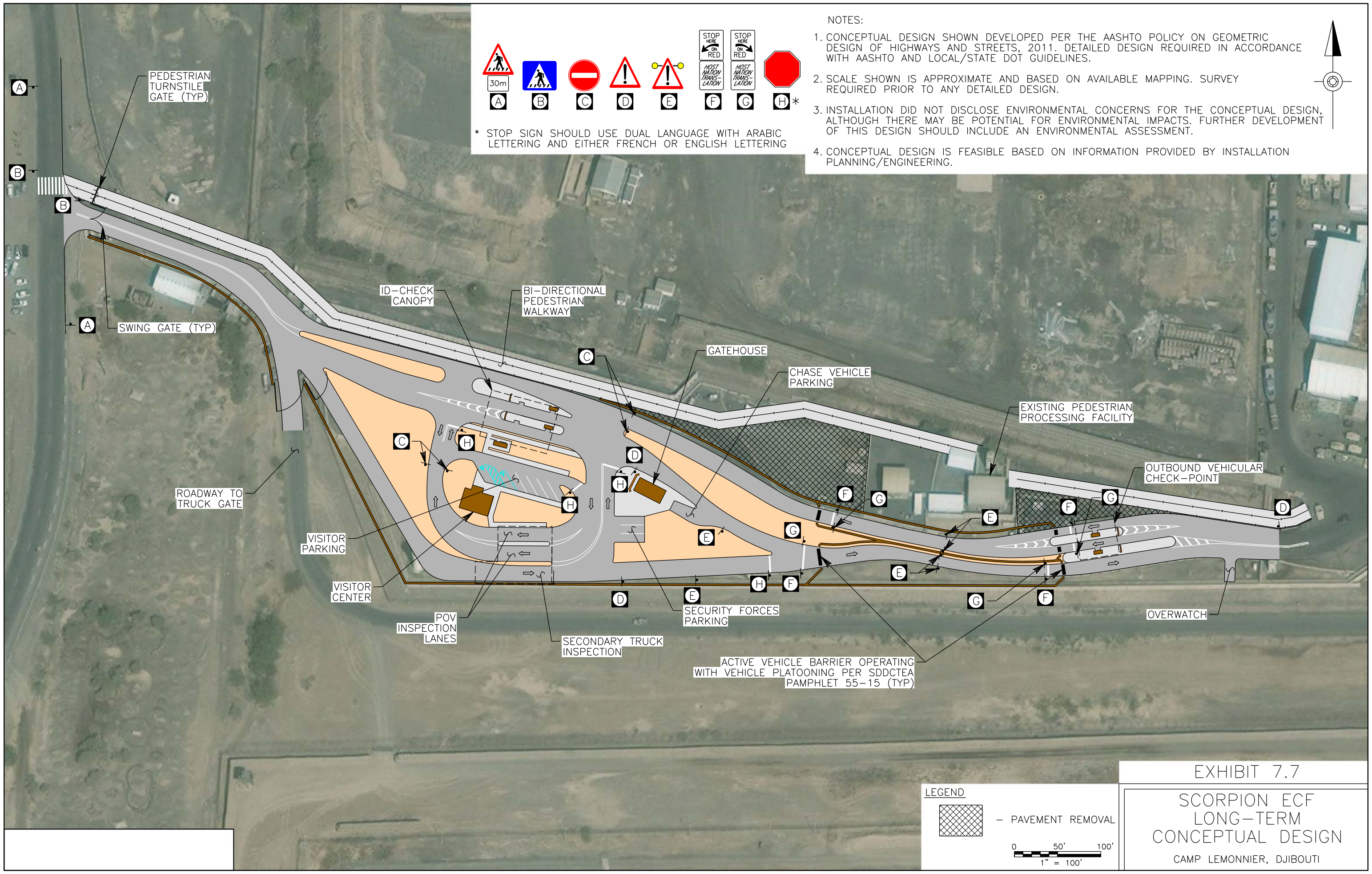
Exhibit 1.36: Applied Design



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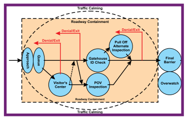
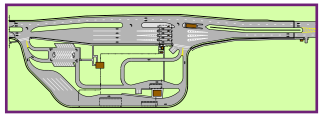
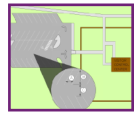
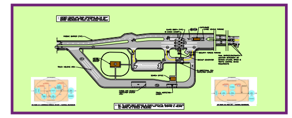
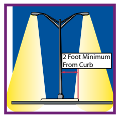
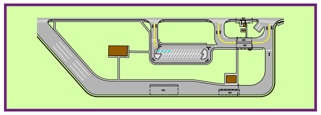






SECTION 2 - TRAFFIC ENGINEERING ASSESSMENTS AND ALTERNATIVES ANALYSIS








2. Traffic Engineering Assessments and Alternatives Analysis

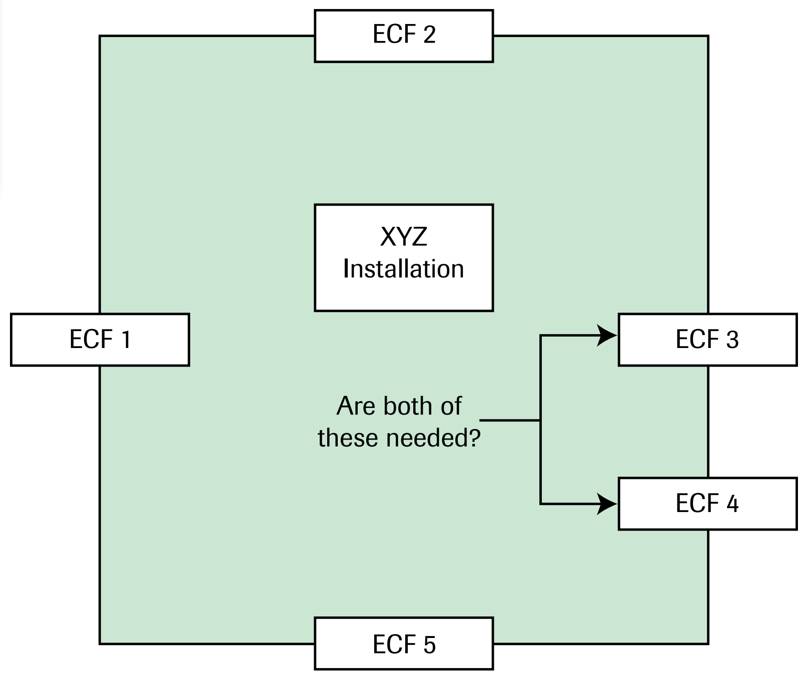
For alternatives analysis, several questions should be asked and answered:

- ❏ **Who are the decision makers that should be included?**
- ❏ **What are (or will be) the problems at the existing ECF?**
- ❏ **How serious are the problems?**
- ❏ **What future conditions should be considered?**
- ❏ **What are the alternatives to be considered?**
- ❏ **What impacts the alternatives to be considered?**

Proper planning will help ensure that ECFs meet an installation's needs, satisfy ECF priorities, satisfy ECF functions, and accommodate future development plans.

A systematic assessment of individual ECFs can help identify short-term and long-term needs that are required to address security, safety, and traffic flow.

A comprehensive and collective review of all ECFs can help in addressing how ECFs support the installation and community as well as transportation and land use needs. A comprehensive review may identify opportunities for consolidation of other approaches that may reduce operational resource needs.



2.1. AGENCY AND STAKEHOLDER COORDINATION

The initial phase in developing a new ECF is identifying the current conditions for the area in question. Early in the development process, it is important to coordinate with the stakeholders to identify what their priorities or expectations are for the ECF. This can be accomplished by holding a kickoff meeting where all of the issues can be discussed.

When an ECF may be relocated and potentially impact traffic on local roadways, it would be beneficial to reach out to the local community and neighboring residential housing areas to gather their insight and gauge resident concerns and suggestions.

Ultimately, it is not a requirement to involve some stakeholders but it may increase cooperation and acceptance later in the process.

Installation Stakeholders

- ✓ Installation Command
- ✓ Security Forces
- ✓ Engineering, Planning and Public Works
- ✓ Safety Offices
- ✓ Communication Offices
- ✓ Emergency Services
- ✓ Housing Contacts

Other Military Stakeholders

- ✓ Higher Headquarters
- ✓ US Army Corps of Engineers (USACE)
- ✓ Naval Facilities Engineering Command (NAVFAC)
- ✓ Air Force Civil Engineering Center (AFCEC)

Other Stakeholders

- ✓ Local Police
- ✓ Local Emergency Services
- ✓ Local Municipality/County
- ✓ State DOT
- ✓ FHWA

2.2. TRAFFIC ENGINEERING AND SAFETY ASSESSMENT

In evaluating ECF conditions, components below should be considered.

✓ **Security and Functional Requirements** – Does the ECF satisfy UFC 4-022-01 functional requirements for ECFs?
✓ **Safety** – Is there a documented crash history or any documented safety deficiencies? Do installation personnel routinely file complaints?
✓ **Service Requirements** – Does the ECF satisfy service standards and requirements?
✓ **Traffic Flow and Congestion** – Does the ECF accommodate existing and future traffic demands?
✓ **Manpower** – What are the manpower limitations?
✓ **Cost** – What are the cost constraints?
✓ **Sustainability** – Does the ECF reduce energy consumption and utilize renewable resources?
✓ **Accessibility and Development Plans** – Does the ECF provide suitable access to existing and future land uses?
✓ **Installation Wide Needs** – Does the ECF serve the existing and future needs of the installation in its current location?

There are three parts to an ECF evaluation: Pre-site visit data gathering, site visit, and post-site visit analyses. Historical and as-built (existing facility) information should be gathered for each ECF under consideration.

WHEN AN ECF IS TO BE EVALUATED, IT IS IMPORTANT TO HAVE EXISTING INFORMATION TO PROPERLY DETERMINE WHAT ACTIONS ARE REQUIRED. GATHERING DATA PRIOR TO CONDUCTING AN ONSITE ECF EVALUATION IS AN IMPORTANT PART OF THE EVALUATION PROCESS THAT CANNOT BE OVERLOOKED.

2.2.1. Pre-site Visit Activities

There are three primary goals that need to be accomplished during the pre-site visit activities:

✓ Determination of applicable standards and guidance
✓ Stakeholder coordination (discussed in **Section 2.1**)
✓ Data gathering

The success of the ECF evaluation will be dependent on the ability of the site visit team being able to “hit the ground running”. Lost time on site collecting background information and coordinating with stakeholders limits the time that the team can spend observing ECF operations and determining the proper placement of components. The checklist shown in **Exhibit 2.1** is information that should be gathered during pre-site visit activities.

Exhibit 2.1: Pre-Site Visit Data Gathering

Data	Considerations
Previous Studies	✓ SDDCTEA studies ✓ Major command studies ✓ Security studies
Planning Data	✓ Master planning ✓ BRAC ✓ Deployment ✓ Local growth
Electronic Mapping	✓ Aerial mapping at ½ meter resolution, geo-referenced
Force Protection Information	✓ AT measures at different FPCONs
Signalized Intersection Data	✓ Signal phasing ✓ Timing plans
Crash Data	✓ Number of crashes ✓ Location of crash ✓ Type of crash (angle, head-on, sideswipe, property damage, rear-end) ✓ Injury level ✓ Time of day
Staffing Levels	✓ Total number of staff at ECF during peak times ✓ Total number of staff at ECF during non-peak times ✓ Vehicle processing techniques (single, tandem, other) ✓ Pedestrian and bicycle processing procedure ✓ Personnel dedicated to inspections ✓ Visitor contol center staffing during peak times
Historical Traffic Volumes	✓ Automated traffic recordings of inbound and outbound traffic volumes ✓ Peak hour ECF volumes ✓ Maximum ECF queuing during peak times ✓ Peak hour turning movement counts at adjacent intersections ✓ 24-hour and peak hour truck volumes ✓ 24-hour and peak hour pedestrian and bicycle volumes ✓ Visitor control center demands and processing ✓ Inspection procedures and processing (POVs and Trucks)

2.2.2. Site Visit

The site visit should consist of a systematic compliance check of all of the applicable standards. The site visit leader should compile a detailed checklist to be handed to all participants at the start of the evaluation. While conducting the site visit, the ECF evaluation team should focus on evaluating every aspect of the existing conditions and how those conditions contribute to unsecure, unsafe, congested, and aesthetically unpleasing situations. **Exhibit 2.2** shows eight major categories that should be part of every assessment, while **Exhibit 2.3** shows a detailed evaluation checklist. This checklist should be coordinated with the applicable standards.

Exhibit 2.2: ECF Assessment Areas of Concern

Operations and Manpower	✓ Are ECF operations coordinated with traffic signal operations at either end of the ECF corridor? ✓ Do traffic signals at either end of the ECF impact efficiency? ✓ Are there queue mitigation strategies that may be effective at this location? ✓ Do inspection procedures contribute to congestion? ✓ Is staff assigned to this ECF being used effectively? ✓ What are the functional requirements of the ECF?
Security	✓ Does the ECF satisfy installation security requirements and AT measures? ✓ Does the ECF satisfy functional requirements?
Traffic Flow and Congestion	✓ Do ECF backups impact local roadways and intersections? ✓ How many vehicles are queued at the peak entry time? ✓ Are delays associated with ECF processing perceived as unacceptable? ✓ How long are delays at the peak entry time? ✓ Do ECF processing requirements result in traffic flow patterns that create or contribute to congestion? ✓ Is vehicle inspection or visitor processing conducted in the roadway, thus impacting operations? ✓ Do trucks and truck processing contribute to congestion?
Guard Safety	✓ Are guards visible to oncoming traffic? ✓ Are guard islands of adequate height and size? ✓ Are there objects that, if unintentionally hit by traffic, could become a hazard to guards? ✓ Are guards protected from errant vehicles? ✓ Is lighting sufficient to allow guards to perform their duties?
Road Safety	✓ Do ECF flow patterns create vehicle conflicts? ✓ Are there any roadway obstructions that do not have proper clearances? ✓ Are barriers, islands, and other ECF facilities properly marked and signed? ✓ Is signing visible and compliant with the *MUTCD*? ✓ Are transitions properly designed to accommodate vehicle flows? ✓ Is the ECF lighting properly designed? ✓ Do active vehicle barriers have traffic control and safety systems?
Crash History	✓ Is the ECF a high-crash location?
Accessibility and Development	✓ Does the location of the ECF support current and/or future development? ✓ Does the location of the ECF support flow patterns between the local community and primary installation resources? ✓ How much time savings would be experienced if the ECF was located to support land uses?
Sustainability	✓ Does the ECF conserve and reuse resources where possible?

2.2.3. Post-site Visit Analyses

Once existing data has been gathered and field conditions assessed, solutions and alternatives can be generated by applying engineering standards and analyses. This part of the evaluation process is substantially discussed in subsequent sections. **Exhibit 2.3** is a checklist for the entire ECF evaluation process.

Exhibit 2.3: ECF Evaluation Checklist

✓ **Early Coordination with Stakeholders**
- Installation Command
- Security forces
- Department of Public Works
- Safety officers
- First responders
- External stakeholders (county, external responders, state DOT)
- Guards
- SDDCTEA
- Others

✓ **Information Gathering**
- Previous studies
- Planning data
- Electronic mapping
- Force protection information
- Signalized intersection data
- Crash data
- Staffing levels

✓ **Traffic Data Gathering and Collection**
- Automated traffic recordings of inbound and outbound traffic volumes
- Peak hour ECF volumes
- Peak hour queue observations
- Peak hour turning movement counts at adjacent intersections
- 24-hour and peak hour truck volumes
- 24-hour and peak hour pedestrian and bicycle volumes
- Visitor control center demands and processing
- Inspection procedures and processing (POVs and Trucks)

✓ **Safety Review**
- Guard
- Motorists
- Hazards/fixed objects
- Sight distance
- Conflicts
- Signing and markings (layout/retroreflectivity)
- Lighting review

✓ **Operational and Manpower Review**
- Interaction with signals (retiming opportunities)
- Queue mitigation strategies
- Processing procedures and manpower usage

✓ **Future Traffic Projections**
- Inspection Procedures
- Planning considerations
- Master plan
- BRAC
- Deployment
- Local growth

✓ **ECF Sizing Analyses**
- Number of lanes (single vs tandem)
- Visitor control center parking
- Truck holding

✓ **Installation-wide Review**
- By ECF (lanes, ingress vs egress)
- Consolidation scenarios to maximize resources
- Total needs

✓ **Short-term, Low-cost Solutions**
- Guard safety
- Motorist safety
- Speed management
- Operations and processing
- Low-cost facility needs

✓ **Alternatives Development**
- Possible charrette
- Pros/cons matrix
  - Land use and development impacts
  - Environmental constraints
  - Utility constraints and needs
  - Force protection constraints (stand-off, etc.)
  - Wind, sun, weather, etc.
  - Traffic constraints
  - Flight line restrictions
- Preliminary active vehicle barrier assessments
- Preliminary costs
- Rationale for dismissal

✓ **Refined, Preferred Alternative**
- Standards compliance review and rationale
- Functions/feature review

✓ **Active Vehicle Barrier (AVB) Response Zone and Safety Scheme Assessment**
- Threat scenarios and response calculations
- Stand-off issues
- Scheme alternatives and selection
- Traffic and safety layout
- Intersection design, if applicable

✓ **Technology Assessment**
- Role of automation
- Overheight detection
- ITS opportunities (DMS, CCTV)

✓ **Special Events Overview (Evacuation, Housing Turnover, Public Event)**

✓ **Cost Estimates**
- By key areas (roadway, facilities, AVB, etc.)
- Programmatic approach
- Report

TO FULLY REALIZE THE BENEFIT OF A COMPREHENSIVE TRAFFIC ENGINEERING ASSESSMENT, THE ASSESSMENT MUST BE DONE IN A CONSISTENT MANNER. THIS WILL ALLOW FOR PROPER PLANNING AND PROPER PRIORITIZATION.

2.2.4. Scoping an ECF Traffic Engineering Assessment

The cost of an ECF traffic engineering assessment is less than one percent of the cost of a new ECF. Ultimately, whether an installation is conducting a self assessment or contracting the work, a standard scope of work should be followed that will provide consistency in the data that is collected and the products or outcome that is obtained. This will allow for side-by-side comparisons as work is prioritized.

A standard scope of work for a comprehensive traffic engineering assessment should include the following elements.

Standard Scope of Work for an ECF Traffic Engineering Assessment

- ✓ Conduct an inbrief with applicable stakeholders to inform them of the traffic study procedures and to solicit information, concerns and overall ECF operation.
- ✓ Assess ECF user concerns and evaluate ECF traffic origins and destinations.
- ✓ Perform an assessment of compliance of existing/proposed facilities with UFC 4-022-01, SDDCTEA Pamphlet 55-15 and all applicable service standards and guidance.
- ✓ Conduct a safety review of the ECF and internal/external intersections adjacent the ECF.
- ✓ Perform an inventory of existing infrastructure and operational procedures.
- ✓ Conduct traffic data collection activities, to include 24-hour automated traffic recordings, as well as peak-period visual observations. See Exhibit 2.4 for a detailed breakdown of ECF Traffic Data Requirements.
- ✓ Conduct a comprehensive review of overall ECF needs (number of ECFs, locations, total lanes) at the installation.
- ✓ Calculate lane requirements with consideration for current deployment, growth (BRAC, etc.), type of processing; as well as potential redistribution of ECF traffic.
- ✓ Conduct an outbrief with the installation stakeholders to discuss proposed improvements.
- ✓ Identify short-term improvements to enhance safety and/or traffic operations.
- ✓ Review proposed designs for standards compliance issues.
- ✓ Identify long-term improvements.
- ✓ Calculate manpower requirements for all short-term and long-term concepts.
- ✓ Calculate threat requirements including AVB strategy.

UFC 4-022-01 REQUIRES A TRAFFIC ENGINEERING ASSESSMENT PRIOR TO THE MAJOR MODIFICATION OF AN ECF, AND PRIOR TO THE DESIGN OF A NEW ECF.

2.3. TRAFFIC ENGINEERING ASSESSMENT ANALYSIS

Thorough assessment of traffic conditions is vital to proper planning and design of ECFs. It would be in poor judgment to plan, design, and construct an ECF without proper traffic analyses. At a minimum, existing and future demands need to be compared with processing capabilities at the design FPCON to ensure an adequate number of lanes are provided.

UFC 4-022-01 requires a traffic engineering assessment prior to the major modification of an ECF, and prior to the design of a new ECF.

Per UFC 4-022-01, site selection for a new ECF starts with an extensive evaluation of the anticipated demand for access to the installation, an analysis of traffic origin and destination, and an analysis of the capability of the surrounding road network to tie in to the ECF, including its capacity to handle additional traffic. Analyses of traffic patterns at installation entry points should include the local DOT, since any traffic changes will likely have some effect or impact on civilian traffic patterns.

Although the UFC 4-022-01 requires a traffic study for a new ECF and for major modifications to an existing ECF, an assessment is not required when making minor modifications to an existing ECF, installing AVBs, or implementing automated technologies. However, a traffic engineering assessment is still recommended.

Traffic engineering assessments shall be performed in accordance with ITE, or the host nation standards. (Also refer to applicable sections in SDDCTEA Pamphlets 55-8 and 55-15 for additional details on ECF traffic assessments.) As a minimum, the assessment shall develop and identify demand requirements/volumes for vehicles, and also include pedestrians and multi-modal transportation.

THOROUGH ASSESSMENT OF TRAFFIC CONDITIONS IS VITAL TO PROPER PLANNING AND DESIGN OF AN ECF.

PEAK PERIOD – THE BUSIEST 2 TO 3 HOURS OF OPERATIONS DURING THE MORNING, MID-DAY, OR EVENING.

PEAK HOUR – THE BUSIEST 1 HOUR DURING A PEAK PERIOD.

2.3.1. Traffic Data Collection

Traffic data collection should be conducted during a typical weekday under normal operations, if possible. As necessary, traffic counts can be adjusted to account for military deployments. Key elements of a thorough traffic data collection program are shown in **Exhibit 2.4**.

Exhibit 2.4: ECF Traffic Data Requirements

ID Check Counts	✓ For each inbound lane the amount of traffic processed should be collected in 15-minute increments during peak inbound periods. ✓ During congested conditions, the counts represent the processing capabilities of the lane. ✓ During non-congested conditions, the counts represent the inbound vehicular demand.
Queue Assessment	✓ During congested conditions, the number of queued venicles should be recorded every 15 minutes. ✓ The length of the queue will assist planners and engineers in assessing additional needed capacity, and impacts to local roadways.
Turning Movement Counts (TMCs) at Adjacent Intersections	✓ TMCs should be collected in 15-minute increments during peak periods. ✓ TMCs provide a better understanding of traffic flow patterns and allow engineers to assess if intersection operations (such as signal timings) need adjusted to complement ECF operations.
Pedestrian and Bicycle Counts	✓ The number of pedestrians and bicycles entering the installation during the peak period should be recorded. ✓ These counts assist engineers in determining the proper pedestrian and bicycle accommodations.
Automated Traffic Recorders (ATRs)	✓ ATRs automatically record traffic over a 24-hour period for several days, if necessary. ✓ ATRs provide data in 15-minute increments and permit an evaluation of daily flow patterns.
Vehicle Classification Counts	✓ As part of the ID Check Counts, TMCs and ATRs should be collected in order to assess the types of vehicles entering so that the facility can be designed properly
Visitor Processing	✓ The number of visitors processed and the typical processing rate at an ECF should be recorded.
Inspection Area	✓ Evaluate inspection elements such as demand and geometrics of vehicles to be inspected.

2.3.1.1. Existing Demand Volume

The existing demand volume for an ECF is determined by counting (in 15-minute intervals) the number of inbound vehicles processed, and those waiting to be processed, at an ECF during the peak hour periods of a normal weekday. The peak hour time period and volume can be determined from the 15-minute count data, as the highest four consecutive 15-minute interval counts - inclusive of both the vehicles processed and the vehicles queued. However, if the ATRs captured the vehicle count as vehicles arrived (rather than as vehicles were processed), the queue is not considered. Only the entering volume is considered when determining the peak hour volume for ID check lane requirements. The morning peak period typically contains the highest peak entering volume and therefore controls the design for the number of ID check lanes required.

The peak hour factor (PHF) is an adjustment to the peak hour volume and represents the distribution of traffic volume during the peak hour based on the 15-minute interval counts. The closer the PHF is to 1.00 means that the traffic volumes are constant throughout the peak hour. A lower peak hour factor, such as 0.50, implies that traffic was very inconsistent during the hour. A PHF is calculated with the following formula:

$$PHF = V / (4 \times v15)$$

where: V = peak hour volume (vph) (total of the four highest consecutive 15-minute interval counts)
v15 = highest 15-minute volume (veh/15min) during the peak hour

After determining the PHF, the maximum rate of flow within the hour (v) can be calculated. This is the baseline volume utilized to determine the number of lanes for an ECF and is calculated by using the following formula:

$$\text{Maximum flow rate } v = V / PHF$$

where: V = peak hour volume (vph)
PHF = peak hour factor

If an installation has an hourly traffic demand count, the equation above could be used to calculate the Existing Demand Volume if assumptions are made about the PHF. Typically, as with an intersection, it is fairly easy to assume. However, considering the large variabilities associated with military installations, SDDCTEA currently does not have significant data to provide recommendations on a PHF to assume. (However, Section 2.13.1 contains Traffic Volume Planning Rules of Thumb that utilize an assumed PHF.)

The more direct, and recommended, method to calculate the Existing Demand Volume is by capturing the traffic volumes in 15-minute intervals and using the highest 15-minute volume, v15, of the peak hour. Procedures for this calculation are described in the pages that follow.

2.3.1.2. Traffic Counting

The number of queued vehicles is an important part of an ECF's traffic demand. Depending on existing gate infrastructure, ECF queuing can be common. Additionally, higher FPCONs could be more prone to queues due to slower processing. It should be noted that minor queuing could occur in certain instances, such as a few vehicles that arrive during a signal phase, and dissipates shortly after it arrives. This typically would not be considered queuing. Standing queues, present for at least 15 minutes, should be observed and recorded.

2.3.1.3. ID Check Counts

The ID Check count is a critical count to obtain the true demand at an ECF. The true demand, used in determining the required number of processing lanes, is based upon the arrival volume and arrival rate of the traffic. The arrival volume is the volume approaching the gate, prior to any queue that forms. This arrival volume could easily be captured at an ECF with a long approach zone. However, as this is not typical, most gate traffic assessments consist of two other components - a count just after the ID check and a count of the traffic queue (or length of queue) prior to the ID check. A count taken immediately after the ID check is the departure (or processed) volume, because it is departing the ECF.

The two methods to obtain the arrival volume, and then account for the arrival rate and peak hour factor to determine the existing demand volume, are discussed below:

- Method 1: Obtain traffic counts (taken in 15-minute intervals) as traffic approaches the ID check (prior to the queue), such that the counting equipment records the arrival volume. Take care with this method to ensure that the counting equipment is truly before the location where the queue forms. Determine the peak hour and multiply the highest 15-minute arrival volume in the peak hour by 4 to obtain the (unadjusted) existing demand volume.

- Method 2: Install an ATR counter (set to record at 15-minute intervals) at each ID check lane, thereby obtaining the departure volume. Observe the traffic queue at the end of every 15-minute interval. Determine the change in queue from the previous interval, $Q15_{Final}$-$Q15_{Initial}$, and add it to the departure volume for that interval. The resultant is the arrival volume for that interval. Multiply the highest 15-minute arrival volume in the peak hour by 4 to obtain the (unadjusted) existing demand volume.

An example using the most common method, Method 2, is provided in **Exhibit 2.5** below. In the example, the peak hour factor and unadjusted existing demand valume can be calculated:

PHF = Peak Hour Arrival Volume / 4 x v_{15} = 786 / (4 x 242) = 0.81.

Existing Demand Volume = Peak Hour Arrival Volume / PHF = 786 / 0.81 = 968

Refer to SDDCTEA Pamphlet 55-8 for additional information regarding traffic counting and demand volumes at an ECF.

Exhibit 2.5: ECF Demand Volume Calculation (Using Method 2)

	Count Time (15-minute interval)	Departure Volume (Processed Vehicle Count)	Queue (Vehicles)	Delta Q ($Q15_{final}$ - $Q15_{initial}$)	Arrival Volume (Departure Volume + Delta Q)	
	0600 - 0615	146	0	0	146	
	0615 - 0630	176	0	0	176	
v15	0630 - 0645	176	66	66 - 0 = 66	242	Peak Hour
	0645 - 0700	223	37	37 - 66 = -29	194	
	0700 - 0715	188	16	16 - 37 = -21	167	
	0715 - 0730	173	26	26 - 16 = 10	183	
	0730 - 0745	117	0	0 - 26 = -26	91	
	Peak Hour Arrival Volume = 242+194+167+183				786	
	Maximum 15-Minute Arrival Volume, $v_{15\ (arrival)}$				242	
	*(Unadjusted) Existing Demand Volume = $v_{15\ (arrival)}$ x 4 = 242 x 4				968	

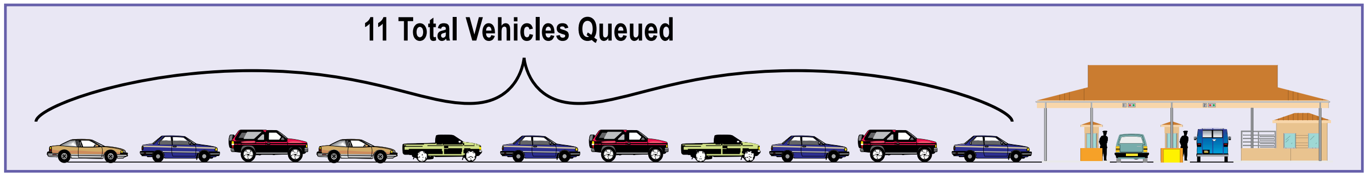
* Note: Volume is unadjusted for possible deployments at the time of data collection.

Traffic Engineering Assessments and Alternatives Analysis

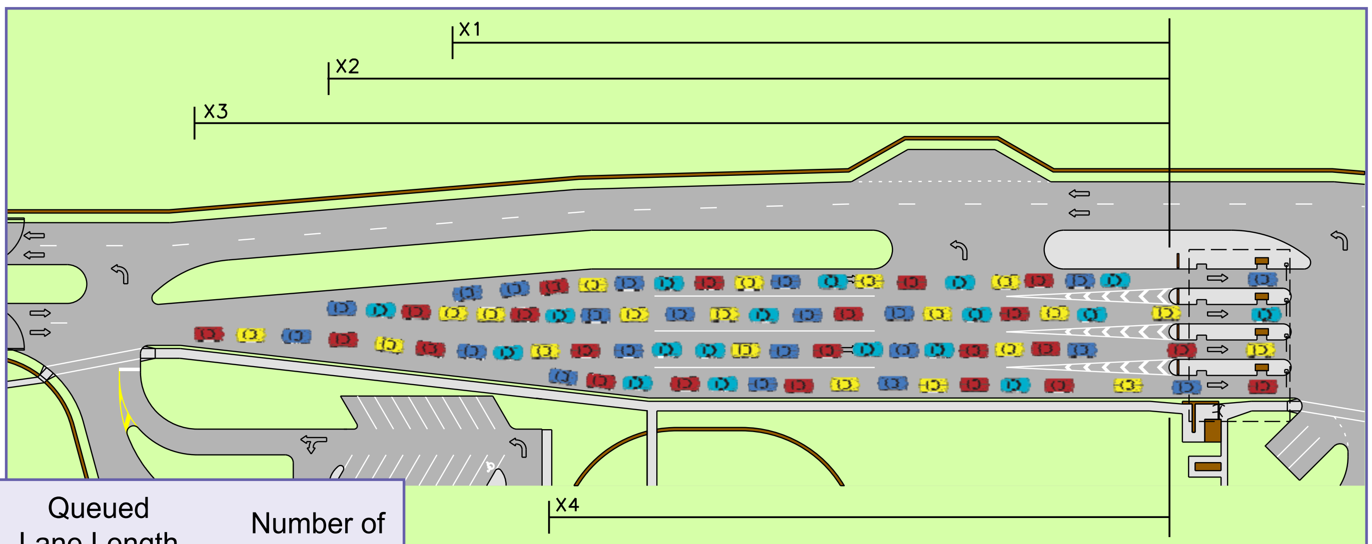
2.3.1.4. Queue Observation

There are two methods of observing queues at an ECF. The queue determined (using either method) is to be used with Method 2 - Traffic Counting discussed in the previous section to determine the true arrival volume.

- Method 1: Physically count and record the number of vehicles that were not processed in each 15-minute increment.



- Method 2: If the15-minute increment vehicle queue extends beyond limit of sight and cannot be counted by field personnel, note an object in the field where the vehicle queue begins. Measure the distance from the ID check point to the object noted in the field remembering to add the distance of additional lanes and transitions where appropriate. (Note: Distance can be measured in the field or on aerial mapping). Divide the summation of each 15-minute queue distance by 25 feet (approximate length of POV and space between queued vehicles) to determine the approximate number of vehicles in the queue.



$$\frac{\Sigma x_{1\text{-}i} \ \text{Queued Lane Length}}{25 \text{ feet}} = \text{Number of Queued Vehicles}$$

2.3.2. Traffic Adjustments

2.3.2.1. Deployment Adjustments

Traffic data should be collected at a time when the installation population is at a “normal” condition. Data collection should not be conducted on Mondays, Fridays, near or on holidays, or if weather events impact travel patterns. Periods of significant deployments should also be avoided if possible, but military missions around the world may make that unavoidable. When there are significant deployments, normal demand can be calculated if the deployment percentage is known. An example calculation to adjust for deployment is shown below.

Given:

- Existing Demand Volume = 1060 vehicles/hour
- Deployment Adjustment (DA) = Percent of total base population deployed = 10%
- DA = 100% / (100% - DA%) = 100% / (100% - 10%) = 1.11

Adjusted Existing Demand Volume = DA x Existing Demand Volume = 1.11 x 1060 = 1176 veh/hour

2.3.2.2. Future Demands

In civilian roadway projects, it is common to forecast traffic demands to a design year often 20 or 25 years into the future. The design year forecast is intended to accommodate future growth in roadway traffic. On a military installation, the population is more controlled and is dependent on the installation mission; however, planners and engineers still need to consider future development plans and possible mission changes or base realignment and closure - any of which could change installation population, resulting in a change to the traffic volumes at the gate(s). The design demand volume must account for these changes.

As an example of a design demand calculation, an installation is scheduled for an increase of 5 percent in population over the next 15 years. Inclusive of deployments, the Existing Demand Volume of the ECF was determined to be 1200 vehicles/hr. To account for the projected future growth, an adjustment is applied to the Existing Demand Volume as shown below:

Given:

- ECF Existing Demand Volume = 1200 vehicles/hr.
- Future Growth (FG) = 5%

Solution:

Adjustment factor for FG = (100% + FG%) /100% = (100% + 5%) / 100% = 1.05
ECF Design Demand Volume = 1200 x FG = 1200 x 1.05 = 1260 vehicles/hr.

ECF CAPACITY IS DEPENDENT ON:
- ❑ **NUMBER OF VEHICLES**
- ❑ **PERCENTAGE OF TRUCKS**
- ❑ **NUMBER AND WIDTH OF LANES**
- ❑ **FPCON LEVEL**
- ❑ **MANPOWER**
- ❑ **PROCESSING METHOD**
- ❑ **OTHER INSTANCES**

DESIGN CAPACITY – THE MAXIMUM VOLUME OF TRAFFIC OR THROUGHPUT THAT AN ECF NEEDS TO BE ABLE TO ACCOMMODATE DURING THE PEAK HOUR.

2.4. DETERMINING LANE REQUIREMENTS

The effect of an ECF design on the surrounding roadways and intersections is of paramount concern. If congestion occurs and there is inadequate queuing distance, the queues may extend into adjacent intersections or cause congestion on feeder roads. The design of a modified or renovation of an existing ECF should improve the throughput of the ECF, and at a minimum not reduce the throughput.

2.4.1. Design Capacity

Design capacity is the maximum volume or throughput of traffic that a proposed ECF would be able to serve without an unreasonable level of congestion occurring. Capacity is used at the design level in assessing the adequacy of ECFs to serve current and future traffic demands. Vehicles arriving at an ECF faster than they can be processed cause congestion. During the development process, sizing the ECF will be the key element in providing an efficient facility. The goal of the ECF should be to result in little or no delay under FPCON Bravo and below. If there is room for queuing within the perimeter of the installation, SDDCTEA recommends designing for a 120-second delay per vehicle during the peak hour. A design as such can be achieved either by doing a Queuing Analysis or simply by using the ACP/ECF SMART Decision Evaluator software. Since some disruption in the level of service is expected at high FPCON(s) (Charlie or Delta), design the ECF to minimize congestion at FPCON Bravo and below. As FPCON Charlie and Delta require greater amounts of vehicle inspection and personal identification, potentially traffic volumes may be lowered by a reduction in workforce and visitors during these conditions.

Lane calculations should consider not only manual processing but also possible use of handheld technologies as well as automated installation entry (AIE). The calculations should include the following scenarios:
- ✓ Manual (single)
- ✓ Manual (tandem)
- ✓ Handheld (single)
- ✓ Handheld (tandem)
- ✓ AIE (with traffic arms)
- ✓ AIE (without traffic arms)

The role of automation (handheld technologies and AIE) is discussed in **Section 9**. The calculations should also consider resulting manpower needs.

2.4.2. Lane Processing Rates

To accurately size an ECF, a lane-processing rate must be assumed. SDDCTEA performed a series of approximately 200 ECF studies during the mid-2000s and developed the table below regarding capacity and processing rates at ECFs. Since the mid-2000s when these studies occurred, SDDCTEA has continued to monitor processing capacity and found that there have been no major factors that would change these rates. The manual processing rate per lane with one ID checker ranges from 800 to 1,200 vehicles per hour with vehicle identification only. For vehicle and occupant identification, this rate drops to a range of 300 to 450 vehicles per hour per lane. These rates are variable based on processing type and manpower as noted in **Exhibit 2.6**.

Exhibit 2.6: ECF Processing Rates

Processing Technique	Manual Checks[1]		Checks Using Handheld Devices[2]		Automated Lanes[3]	
	Single Checks Per Lane	Tandem Checks Per Lane	Single Checks Per Lane	Tandem Checks Per Lane	Without Traffic Arms	With Traffic Arms (Up/Down For Each Vehicle)
	vphpl	vphpl	vphpl	vphpl	vphpl	vphpl
No identification[4]	Capacity at Roadway	NA	NA	NA	NA	NA
Vehicle identification only	800 to 1,200	NA	NA	NA	800 to 1,200	550 to 800
Vehicle and occupant identification[5]	300 to 450	400 to 600	275 to 375	350 to 475	400 to 450	325 to 350
Inspection of mission essential vehicles only	20 to 120	NA	20 to 120	NA	NA	NA

**Notes: vphpl = vehicles per hour per lane; NA - not applicable.*
Actual rates may exceed those shown (based on SDDCTEA experience).
(1) - Manual processing rates based on a compilation of SDDCTEA rates for over 200 ECF studies in the mid-2000s.
(2) - Handheld processing rates based on the Assessment of Automated Processing using Handheld Devices, December 2006; and data collected at Fort Leavenworth.
(3) - Automated lane processing rates are based on the Assessment of Phantom Express at Fort Hood, February 2008; and the US Army Evaluation Center, Assessment of Phantom Express, March 2006. Assumes "trusted traveler" type program; therefore, ID of all occupants is not required.
(4) - No identification is typically not utilized for installation access, special events only.
(5) - In reality, the average vehicle occupancy at ECFs, particularly in the morning peak period, is very close to 1.0. If multiple occupant vehicles are common with ID checks of all occupants, assume the lower range of processing rates.

There are several factors that will influence actual rates, as illustrated in **Exhibit 2.7**, including:

✓ ECF layout and design
✓ Vehicle characteristics
✓ Security considerations
✓ ID check operations
✓ Political and command pressures

When possible, actions should be taken to achieve faster rates.

Exhibit 2.7: ECF Processing Influence Factors

Influence Factor		Slower Rates	Faster Rates
ECF Layout and Design	Geometric Design	✓ ECFs with improper geometric designs (transitions, curve radii, etc) will have slower processing rates due to vehicular conflicts and abrupt maneuvers.	✓ ECFs with proper (AASHTO) geometric designs will have more efficient processing rates since there are less vehicular conflicts and abrupt maneuvers.
ECF Layout and Design	Grade	✓ Uphill grades entering an ECF result in slower acceleration rates.	✓ Downhill grades entering an ECF result in faster acceleration rates.
ECF Layout and Design	Lane Widths	✓ According to the Highway Capacity Manual, narrow lanes (10 feet) will result in slower throughput rates.	✓ According to the Highway Capacity Manual, typical lanes (12 feet) will result in the most efficient throughput rates.
ECF Layout and Design	Lateral Clearance	✓ According to the Highway Capacity Manual, the presence of fixed objects in the roadway clear zone will result in slower throughput rates.	✓ According to the Highway Capacity Manual, roadways without fixed objects in the clear zone will result in the most efficient throughput rates.
ECF Layout and Design	Signal Operations	✓ Poorly timed signals upstream and downstream from the ECF may limit the amount of traffic that is actually processed.	✓ Signals timed with consideration of ECF operations will result in the most efficient throughput rates.
ECF Layout and Design	Signs and Pavement Markings	✓ ECFs with improper signs and markings will have slower processing rates due to driver confusion.	✓ ECFs with proper (MUTCD/SDDCTEA) signs and markings will be more efficient since there will be less driver confusion.
ECF Layout and Design	Approach and Checkpoint Lighting	✓ ECFs with improper lighting will have slower processing rates due to driver confusion and since it may take guards longer to visually validate drivers.	✓ ECFs with proper (UFC) lighting will have more efficient processing rates since there will be less driver confusion and improved visibility.

Exhibit 2.7: ECF Processing Influence Factors (continued)

Influence Factor		Slower Rates	Faster Rates
Vehicle Characteristics	**Vehicle Types**	✓ ECFs with trucks and buses have slower processing times due to longer inspection times and slower vehicle acceleration. ✓ ECFs with a higher percentage of motorcycles and mopeds will have slower processing times due to the time it takes for drivers to present their ID cards.	✓ ECFs without trucks and buses have more efficient processing times since inspection times are faster and since vehicle acceleration is improved. ✓ ECFs with a lower percentage of motorcycles and mopeds will have more efficient processing times due to the time it takes for drivers to present their ID cards.
Vehicle Characteristics	**Vehicle Occupancy**	✓ ECFs with higher vehicle occupancy (more than 1 person) will have slower throughput rates when all occupants are being identified; however, higher vehicle occupancy is encouraged since it limits the overall vehicular demand.	✓ ECFs with single vehicle occupancy (1 person) will have higher throughput rates since only one person is being identified.
Vehicle Characteristics	**Visitors**	✓ ECFs with higher amounts of visitors typically have slower processing rates. This is especially true when visitors are screened at the ID check versus at a dedicated visitor control center.	✓ ECFs with limited visitors typically have more efficient processing rate.
Vehicle Characteristics	**Driver Understanding**	✓ Installations without driver education programs typically have slower processing rates due to driver confusion.	✓ Installations with driver education (being prepared, card care, system interaction) typically have more efficient processing rates.

Exhibit 2.7: ECF Processing Influence Factors (continued)

Influence Factor		Slower Rates	Faster Rates
Security Considerations	**FPCON Status**	✓ Processing rates are slower at higher FPCON levels due to the impact of security requirements.	✓ Processing rates are faster at lower FPCON levels since there are less security requirements.
	Security Posture	✓ Even within a set FPCON, processing rates may be slower when the security posture is heightened and inspection and verification is very thorough.	✓ Sometime within a set FPCON, processing rates may be faster when the security posture is lowered and inspection and verification is relaxed. This is often true during peak hours.
	Security Management Style	✓ At installations where ECF security procedures and layouts are varied, processing times may be slower due to driver confusion.	✓ At installations where ECF security procedures and layouts are relatively consistent, processing times may be faster since drivers know what to expect.
	Inspections	✓ In-lane inspections will have a significant negative impact on processing rates.	✓ Segregated inspection areas will allow processing rates to be more efficient.
	Installation Location	✓ OCONUS installations typically have slower processing times due to a heightened security posture as well as due to the number of foreign nationals entering the installation.	✓ CONUS installations typically have faster processing times since the security posture may be more relaxed and the workforce is largely comprised of U.S. citizens.
	Guard Type	✓ Contract guards are typically less efficient in processing. This may be due in part to limited training and turnover.	✓ Military guards are typically more efficient since they have more training and experience and overall have a better understanding of military protocols.
	Stopping Location	✓ Some services require vehicles to stop well in advance of the checkpoint, and are waved on by guards when its their turn.	✓ Allowing a queue of vehicles to approach without an advance stopping paint reduces lost time approaching the check point.

Exhibit 2.7: ECF Processing Influence Factors (continued)

Influence Factor		Slower Rates	Faster Rates
ID Check Operations	Processing Configuration	✓ In general, single processing is the most efficient use of manpower. When tandem or triple processing is used due to lane limitations, processing is less efficient when guards are inconsistently added and removed and when positions are not consistent.	✓ In general, single processing is the most efficient use of manpower. When tandem or triple processing is used due to lane limitations, processing is more efficient when guards are added and removed in a consistent manner and when guard positions are consistent.
ID Check Operations	Handheld Device Usage	✓ As noted on Exhibit 2.5, processing rates are slower when handheld devices are utilized to further validate traffic.	✓ As noted on Exhibit 2.5, processing rates are faster when handheld devices are not utilized.
ID Check Operations	Automated Lane Design and Traffic Arm Utilization	✓ If vehicle and card scanners are not located properly, processing rates may be less efficient. ✓ The use of traffic arms for each transaction will impact throughput efficiency.	✓ If vehicle and card scanners are located properly, processing rates may be more efficient. ✓ An "open arm" policy will improve throughput efficiency; however, there may be concerns regarding system compliance.
Political and Command Pressures		✓ Command may desire a heightened security posture which will result in slower processing rates.	✓ Command and local political pressures may require that traffic be processed more quickly even if security requirements are relaxed.

DOES ADDING GUARDS TO A LANE INCREASE ITS CAPACITY?
YES – BUT IS THE LEVEL OF INCREASE WORTH THE EXTRA MANPOWER?

2.4.3. Guards Per Lane

To reduce congestion at ECFs, many installations use additional guards per lane. This is extremely beneficial during the peak hour. Guard islands can be designed for tandem processing (i.e., processing by two guards per lane at the same time). ID check islands at the access control zone should be 75 feet in length if designing to accommodate tandem processing, versus 50 feet in length if designed to accommodate single processing.

The UFC 4-022-01 recommends the use of tandem processing as one way to reduce congestion at ECFs. However, it encourages no more than two guards per lane be used. SDDCTEA has concluded that providing more than three ID checkers per lane provides little if any benefit and may be a misuse of resources. Furthermore, it is more efficient to use two ID checkers with one in each lane versus using two ID checkers in one lane.

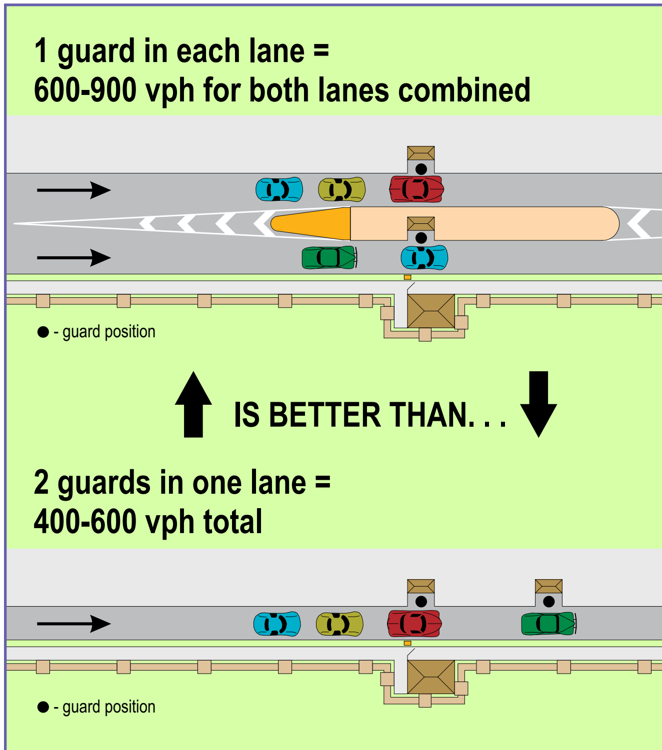
It is always more beneficial to utilize closed or new lanes if possible versus running tandem or triple processing. **Exhibit 2.8** shows the incremental increase with multiple guards per lane under Bravo force protection level.

Exhibit 2.8: Bravo Processing Efficiency

ID Checkers per Lane	Vehicle Processing Rate per Lane
1	300-450
2	400-600
3	450-675
4	475-700

Equal manpower DOES NOT mean equal processing

IT IS MORE EFFICIENT TO USE TWO ID CHECKERS WITH ONE IN EACH LANE VERSUS USING TWO ID CHECKERS IN ONE LANE.



2.4.4. Calculating Lane Requirements

The number of lanes planned for an ECF shall be sufficient to handle the expected volume of traffic (with an acceptable length of vehicle queuing) during times of peak demand (such as the morning peak hour).

When evaluating the lane requirements for the ECF, a comparison should be drawn with all of the other ECFs at the installation to determine if the ECF in question will continue to serve the installation adequately in the future. If future land uses will change the population center that the ECF is to serve, that should be considered in the design of the ECF.

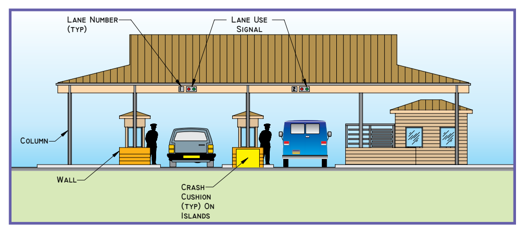
The incremental threshold for increasing the number of lanes at an ECF, under FPCON Bravo, is 375 vehicles per hour (from 300 – 450 range on **Exhibit 2.6**), which represents the processing rate of one ID checker. It is assumed that manpower will be minimized under FPCON Bravo conditions and therefore staffing will dictate one ID checker per lane. As the FPCON is elevated, additional manpower can be added to the tandem lanes, which will increase lane processing rates. **Exhibit 2.9** provides example calculations for determining the required number of ID check lanes at an ECF.

Even if ECFs are designed based on the lane capacities illustrated, some congestion may still occur due to the random arrival of vehicles and distinct peaking that typically occurs for short periods during the peak hour. Capacity can be increased and congestion reduced by:

CALCULATING THE NEEDED NUMBER OF LANES IS A FUNDAMENTAL STEP IN THE PLANNING AND DESIGN OF AN ECF.

THE INCREMENTAL THRESHOLD FOR INCREASING THE NUMBER OF LANES AT AN ECF, UNDER FPCON BRAVO, IS 375 VEHICLES PER HOUR.

✓ Setting staggered work hours
✓ Encouraging carpooling
✓ Utilizing inspection areas for processing
✓ Adding lanes
✓ Redirecting traffic to other ECFs
✓ Building new ECFs



It may also be possible to utilize an outbound lane as a reversible lane to process incoming traffic during periods of peak volume. However, priority should be given to maximizing the number of inbound lanes prior to utilizing reversible lanes.

Exhibit 2.9: Example ID Check Lane Requirements Calculation

Scenario 1: Traffic Volumes Recorded in 15-Minute Intervals

Line	Field	Calculation	Example Value	Example Calculation	Example Solution
1	Peak 15-Minute Arrival Volume, v_{15} (Section 2.3.1.3.)		*283*		
2	Hourly Adjustment		*4*		
3	Total Unadjusted Existing Demand Volume	Line 1 x Line 2		*283 x 4*	*1132*
4	Deployment Adjustment [DA] *Percent of Total Base Population Deployed* (Section 2.3.2.1.)	100% / (100% – DA%)	*10% deployment*	*100% / (100% – 10%)*	*1.11*
5	TOTAL (ADJUSTED) EXISTING DEMAND	Line 3 X Line 4		*1132 X 1.11*	*1257*
6	Future Growth [FG] *Percent of Estimated Future Growth* (Section 2.3.2.2.)	(100% + FG%) / 100%	*8% future growth*	*(100% + 8%) / 100%*	*1.08*
7	DESIGN DEMAND	Line 5 X Line 6		*1257 X 1.08*	*1357*
8	Design Processing Rate		*400*		
9	CALCULATED LANE REQUIREMENTS	Line 8 / Line 9		*1357 / 400*	*3.39*
10	ROUNDED LANE REQUIREMENTS				***4 lanes***

Exhibit 2.9: Example ID Check Lane Requirements Calculation (continued)

Scenario 2: Traffic Volumes Recorded in Hourly Intervals

Line	Field	Calculation	Example Value	Example Calculation	Example Solution
1	Peak Hour Arrival Volume (Observed vehicles in one hour)		*1250*		
2	Assumed Peak Hour Factor (Section 2.3.1.1.)		*0.7*		
3	Total Unadjusted Existing Demand Volume	Line 1 / Line 2		*1250 / 0.7*	*1786*
4	Deployment Adjustment [DA] *Percent of Total Base Population Deployed* (Section 2.3.2.1.)	100% / (100% – DA%)	*10% deployment*	*100% / (100% – 10%)*	*1.11*
5	TOTAL (ADJUSTED) EXISTING DEMAND	Line 3 X Line 4		*1786 x 1.11*	*1982*
6	Future Growth [FG] *Percent of Estimated Future Growth* (Section 2.3.2.1.)	(100% + FG%) / 100%	*8% future growth*	*(100% + 8%) / 100%*	*1.08*
7	DESIGN DEMAND	Line 5 X Line 6		*1982 x 1.08*	*2141*
8	Design Processing Rate		*400*		
9	CALCULATED LANE REQUIREMENTS	Line 8 / Line 9		*2141/400*	*5.35*
10	*ROUNDED LANE REQUIREMENTS*				***6 lanes***

The lane requirement should be calculated for all the various processing scenarios on every ECF assessment, to include:

✓ Manual (single)
✓ Manual (tandem)
✓ Handheld (single)
✓ Handheld (tandem)
✓ AIE (with traffic arms)
✓ AIE (without traffic arms)

MANUAL CALCULATIONS ARE NOT NECESSARY.

THE ACP/ECF SMART DECISION EVLAUATOR IS AVAILABLE ON SDDCTEA'S WEBSITE.

2.4.4.1. ACP/ECF SMART Decision Evaluator

The ACP/ECF SMART Decision Evaluator was developed to provide perspective on the issues associated with each approach to ECF processing (manual, AIE, handheld) so that when combined with practical knowledge, decisions are made with full awareness of the ramifications. The ACP/ECF SMART Decision Evaluator has been designed to require a minimal amount of data entry when determining lane requirements.

The SMART Decision Evaluator:

✓ Provides comprehensive perspective
✓ Provides awareness of ramifications through costs and associated risks
✓ Is derived from common engineering, security and economic principals
✓ Narrows the picture from "10,000 feet" to "1,000 feet"

Even though the evaluator provides the total cost of manpower, infrastructure, automation, traffic delay, and an estimated risk score, it does not eliminate the need for practical knowledge or detailed engineering assessments.

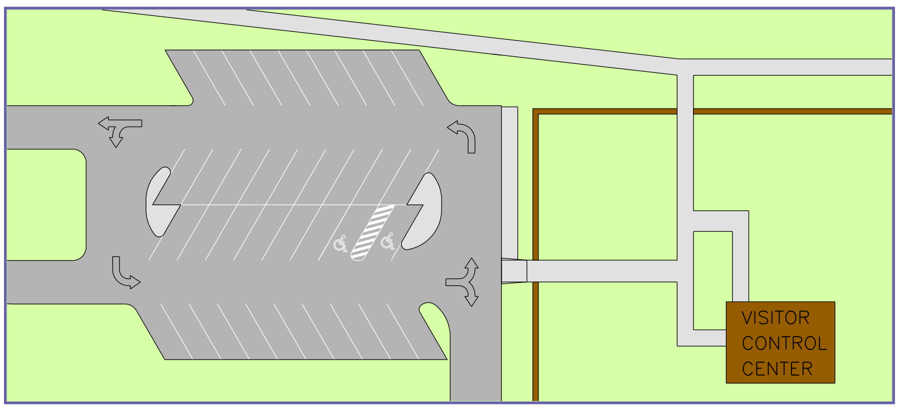
The ACP/ECF SMART Decision Evaluator is a web-application and can be found on SDDCTEA's website https://www.sddc.army.mil/sites/TEA/Functions/SpecialAssistant/TrafficEngineeringBranch/Pages/default.aspx.
Consult SDDCTEA for additional information.

2.5. SIZING VISITOR CONTROL CENTER PARKING

Primary ECFs include a visitor control center at most installations; there is usually one ECF that is the primary entrance for visitors. This ECF is commonly referred to as the Main Gate. UFC 4-022-01 states that the visitor control center should be able to process twelve to twenty visitors per hour per processor. This equals three to five minutes per visitor. In reality, the amount of parking needed at a visitor control center depends on three things:

✓ The amount of visitor traffic during the peak hour of visitor activity
✓ The amount of staffing at the visitor control center
✓ Duration for visitors to be processed (dependent on staffing and operating procedures)

In some cases, processing times may be as much as 10 to 15 minutes per person depending on functions performed and demand. As a general rule, for smaller installations, size visitor control center parking areas with a minimum of twelve spaces in excess of staff needs. Also, during the planning and design phase, consider if the parking area needs to be sized to accommodate special but reoccurring events such as new class arrivals or graduation ceremonies, and also for commercial vehicles if they are required to check in at the VCC.



Provide sufficient accessible parking in accordance with the Architectural Barriers Act (ABA). ABA requirements are one accessible space per 1 to 25 spaces and two accessible spaces per 26 to 50 spaces; in addition, 1 out of 6 ABA spaces should be van accessible. SDDCTEA suggests two accessible spaces as a minimum, one of which should be van accessible. As a general rule, four percent of parking should be reserved for accessible parking. **Exhibit 2.10** provides an example calculation for determining the required number of parking spaces at a visitor control center. For more information regarding visitor center parking refer to the BMTE web-application's parking module.

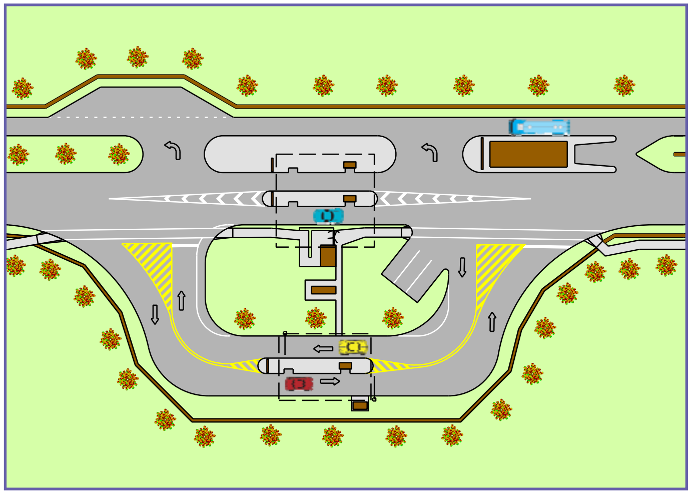
Exhibit 2.10: Example Required Visitor Control Center Parking Spaces Calculation

Line	Field	Calculation	Example Value	Example Calculation	Example Solution
1	Estimated Visitor Control Center Customers Processed in Peak Hour		*80*		
2	Future Growth [FG] *Percent of Estimated Future Growth*	(100% + FG%) / 100%	*8% future growth*	*(100% + 8%) / 100%*	*1.08*
3	ADJUSTED VISITOR CONTROL CENTER DEMAND	Line 1 X Line 2		*80 X 1.08*	*86*
4	Average Processing Time Per Visitor (in minutes)		*15 min*		
5	VISITOR CONTROL CENTER CUSTOMER PARKING DEMAND	Line 3 X (Line 4 / 60)		*86 X (15 / 60)*	*21.6 ROUNDED TO 22*
6	Estimated Staff Parking Demand		*6*		
7	Security Forces Personnel Parking Demand		*2*		
8	NON-ABA PARKING DEMAND	Line 5 + Line 6 + Line 7		*22+6+2*	*30*
9	ABA Parking Requirement	1 if Line 8 is <26 2 if Line 8 is 26-50			*2*
10	TOTAL PARKING DEMAND	Line 8 + Line 9		*30 + 2*	***32 Spaces***

The number of processors needed to achieve recommended processing rates can be calculated as shown below.

$$\text{Number of Processors} = \frac{\text{Peak Hour Visitors (Visitors/Hour)}}{\text{Processing Rate (Visitors/Hour/Processor)}}$$

2.6. SIZING INSPECTION AREAS



Removing inspection procedures from the ID check lanes (approach roadway) is critical in maintaining efficient ECF operations. At many existing ECFs, in-lane vehicle inspection is a primary cause of traffic backups.

Sizing of inspection areas is similar to sizing visitor control center parking areas and is dependent on the number of vehicles to be inspected as well as the amount of time it takes to inspect a vehicle. Ultimately, SF should be consulted in determining inspection area sizing, but these factors should be brought to their attention so that they can make an appropriate decision.

At a minimum, Primary and Secondary ECFs should provide space for inspection of three to five vehicles including the roadway leading to the area. If available real estate is restricted at an ECF and additional lanes are needed to meet the peak hour demand, consider providing an inspection area capable of processing vehicles as well. Provide a bi-directional POV inspection area so that inbound vehicles in the true processing lanes can be inspected if necessary. The inspection area should only be utilized for vehicle processing if high demand periods are an hour or less. If high vehicle demands are constant for over an hour during the peak period additional processing lanes should be provided.

At Low Volume and Limited Use ECFs, a turnout lane for vehicle rejections can be used if a pull-off area or parking spaces cannot be provided elsewhere due to geometric constraints and security requirements. The turnout should be large enough to accommodate at least two vehicles. If a turnout lane or parking cannot be provided, the outside/second processing lane may be used as an inspection area if the traffic volume can be accommodated with one processing lane only.

PROCESSING TIMES VARY BASED ON SECURITY PROCEDURES.

OFTEN, TIMES RANGE FROM 3 TO 5 MINUTES PER VEHICLE, WHICH EQUATES TO 12 TO 20 TRUCKS PER HOUR PROCESSED.

2.7. SIZING TRUCK HOLDING AREAS

In terms of processing, large trucks and their respective inspection activities are much different from those activities associated with other vehicle types. Some installations with high truck demands prefer a separate truck entrance. This preference is dependent on several factors:

✓ Mission
✓ Location
✓ Population
✓ Truck traffic volume
✓ Security procedures
✓ Availability of land

Regardless if truck inspection activities occur as part of a Primary ECF or if they are conducted at an exclusive location, inspection areas should be sized to accommodate peak hour demands. The calculations are similar to visitor and vehicle processing calculations, but must consider the longer processing times of trucks and also the larger vehicle size. In some cases, where there is significant truck volume over several hours, the cumulative demands should be considered. All hours of the day when trucks are being accepted should be reviewed to determine the actual design truck demand.

Processing times vary based on security procedures, but often range from three to five minutes per vehicle, which equates to twelve to twenty trucks per hour processed. Where multiple inspection lanes are present and in use, these rates are increased by a factor equalling the number of lanes in use. Once the maximum number of vehicles not processed is known, that number represents the size of holding area needed.

The largest number of commercial vehicles, on a typical busy day, that must wait to be processed is essentially the commercial vehicle storage requirement. However, capturing this queue volume is not as easy for commercial vehicles when compared to POV traffic. Commercial vehicle traffic is not as consistent as POV traffic. Therefore, contrary to one-day POV counts, performing commercial vehicle counts for one day will more than likely not capture an accurate peak hour volume and associated queue. SDDCTEA has seen fluctuations in commercial vehicle traffic volumes by as much as 400% between two consecutive days. Realizing this, the most accurate methodology for determining peak hour commercial vehicle counts and the required holding area (storage) is to review commercial vehicle logs for the gate, and to solicit queuing information from security forces. The staff that processes and inspects these vehicles are the best source for this information. If commercial vehicle logs are not part of the typical routine, it is recommended to have the inspection staff maintain a commercial vehicle log for a minimum of two weeks. The required holding area should equal the highest maximum queue observed over two weeks of the commercial vehicle logs.

The commercial vehicle log should capture the following information:

✓ Commercial vehicle counts in one hour increments
✓ Commercial vehicle counts separated into two categories - - tractor trailers and all other commercial vehicles
✓ Average inspection time per vehicle
✓ Number of inspection bays and inspectors utilized during peak periods
✓ Maximum number of vehicles observed in queue during each one hour period

Exhibit 2.11 illustrates a sample Commercial Vehicle Processing Log necessary to accurately size the commercial vehicle holding area.

Exhibit 2.11: Example Commercial Vehicle Processing Log

Installation: ______________________ Date: *24-Apr-19*

Gate: ______________________

Time	# Tractor Trailers	# All Other Commercial Vehicles	Total Commercial Vehicles Inspected/Vetted	Maximum Queue (largest number commercial vehicles waiting to be processed)	Number of Bays Open for Inspection
0600 - 0700	*16*	*3*	*19*	*6*	*1*
0700 - 0800	*1*	*4*	*5*	*0*	*1*
0800 - 0900	*7*	*11*	*18*	*4*	*1*
0900 - 1000	*5*	*22*	*27*	*8*	*1*
1000 - 1100	*3*	*9*	*12*	*0*	*1*
1100 - 1200	*5*	*10*	*15*	*0*	*1*
1200 - 1300	*5*	*11*	*16*	*1*	*1*
1300 - 1400	*0*	*7*	*7*	*0*	*1*
1400 - 1500	*2*	*9*	*11*	*0*	*1*
1500 - 1600	*2*	*5*	*7*	*0*	*1*
1600 - 1700		*6*	*6*	*0*	*1*
1700 - 1800	*1*		*1*	*0*	*1*
1800 - 1900	*0*	*0*			

Answer Below Questions:

Days and hours of operation:	*0600 - 1900 Monday - Friday*
Average inspection time per vehicle:	*27 vehicles per hour / 2.25 minutes per vehicle*
Number of guards per bay used for inspections:	*2*
Are all commercial vehicles inspected or is it random?	*All*
Largest maximum queue, required holding area:	*8*

WEB-BASED SURVEY TOOLS CAN GATHER ECF USAGE INFORMATION QUICKLY AND AT A RELATIVELY LOW COST.

2.8. ORIGIN AND DESTINATION STUDIES

One traffic assessment often overlooked in evaluating ECFs is an Origin and Destination (O&D) Study. An O&D Study is useful in identifying travel patterns between external and internal installation land uses. By determining current and potentially future travel patterns, smart transportation decisions can be made to improve operations and distribute manpower. O&D Studies are especially useful if you are considering a new ECF, closing an existing ECF and/or if you are considering significant land use changes.

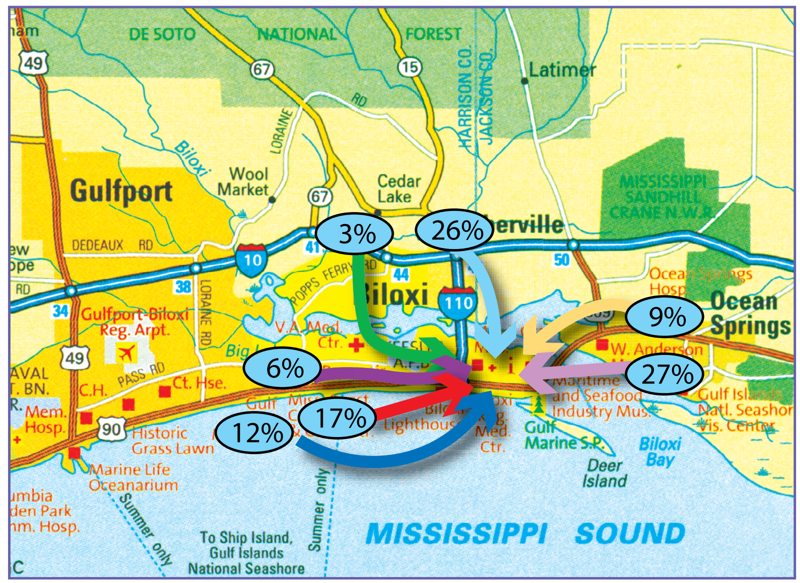
There are several methods to evaluate O&D patterns, which include:

- ✓ Using installation employment data (ZIP Codes) and building employee data to develop flow patterns
- ✓ Interviewing motorists as they enter the installation
- ✓ Distributing a mail-back survey to motorists at the ECF
- ✓ E-mailing a survey to installation employees
- ✓ Web-based surveys
- ✓ Using Location-Based Services and Navigation GPS data from smartphone apps and connected cars and trucks to develop O&D matrices.

The key questions to be asked are included below.

- ✓ Where does your trip originate?
- ✓ What is the ZIP Code there?
- ✓ What is your destination on the installation?
- ✓ What is the building number?
- ✓ Which ECF do you normally use?
- ✓ Which ECF would you prefer to use?
- ✓ What are your normal work hours?
- ✓ How often do you leave the installation throughout the day?

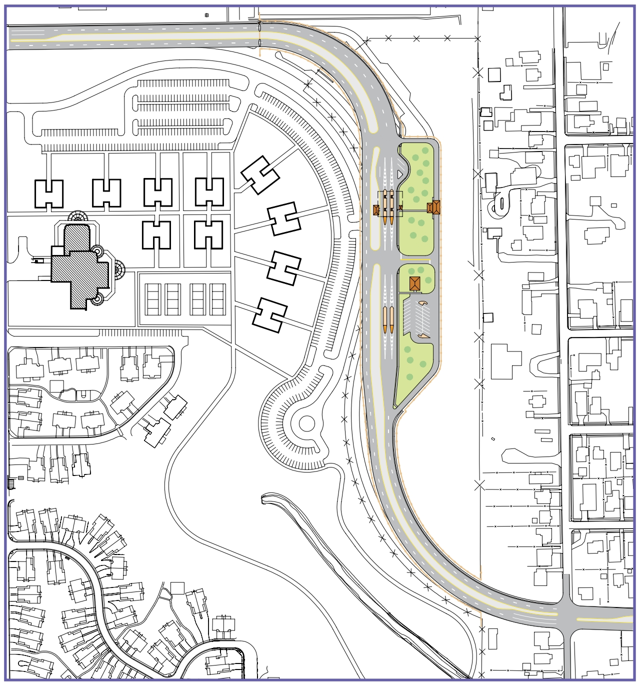
A sample size of 30 percent of entering traffic during the peak period is desirable. Data collected can then be summarized in a database and can be used in assessing ECF and land use changes.



2.9. ALTERNATIVES EVALUATION

Site selection for a new ECF starts with an extensive evaluation of the anticipated demand for access to the installation, an analysis of origin and destination data, and an analysis of the capability of the surrounding road network to accommodate anticipated traffic volumes.

When considering alternative locations for a new ECF, a properly designed concept of the new ECF is needed. The concept should be drawn to a scale satisfying geometric design requirements, meet service requirements and should include the appropriate number of lanes and needed features. The concept can be used to determine if a site is a feasible location for an ECF. It is important to include the stakeholders in the alternative evaluation process as they may have considerations to be addressed.



2.10. OTHER CONSIDERATIONS FOR ALTERNATIVES

As well as a traffic assessment, an ECF study should take into consideration the potential impacts shown in **Exhibit 2.12** when evaluating alternatives to ensure the site is capable of accommodating ECF process requirements. Additionally, UFC 4-022-01 discusses Planning and Site Selection Criteria to consider.

Exhibit 2.12: Other Alternative Evaluation Considerations

Topography	Preferred: ✓ Flat terrain ✓ Lack of vegetation	✓ Slight raise in elevation from approach zone to ID checkpoint
Land Use and Development Plans	Not located near: ✓ Restricted zones ✓ Commercial areas ✓ Vulnerable assets	✓ Housing ✓ Schools
Environmental	Consider: ✓ Wetlands ✓ Protected habitats	✓ Historic resources
Utilities	Plan for: ✓ Utilities in close proximity that need relocated	✓ Utility tie-in points that minimize cost and power loss
Force Protection	Comply with: ✓ *UFC 4-010-01 DoD Minimum Antiterrorism Standards for Buildings*	✓ AT measures ✓ Standoff distances
Criteria	Comply with: ✓ UFC 4-022-01, *Entry Control Facility / Access Control Points* ✓ Service Requirements ✓ National design standards (*MUTCD, AASHTO*)	
Cost	Consider versus: ✓ Quality ✓ Future needs	✓ Serviceability
Sustainability	Consider: ✓ Fuel consumption	✓ Emmissions from idling
Other Considerations	✓ Flight line restrictions ✓ Intersection proximity ✓ Manpower impacts	✓ Prevailing wind direction ✓ Angle of the sun

IT IS GOOD PRACTICE TO CONSIDER ALL ALTERNATIVES AND DOCUMENT WHY ALTERNATIVES ARE DISMISSED.

THIS IS BENEFICIAL IN THE EVENT NEW LEADERSHIP WANTS TO RE-EVALUATE PROJECTS AND TO DOCUMENT THE PROCESS IF LEGAL OR ENVIRONMENTAL ISSUES ARISE.

2.11. ECF SIZE AND RIGHT-OF-WAY (R/W) CONSIDERATIONS

The R/W for an ECF is a cross section that contains the travel lanes, shoulders, medians, passive barriers, all buildings associated with the ECF, drainage, clear zones, and borders. In nonmilitary applications, R/W is set depending on the classification of the roadway to which it is being applied. For collector roads, a range of 40-60 feet (12-18 meters) is most often used. For arterial roads, the R/W cannot be defined in a range, but rather must be determined based on a number of factors. These factors include, but are not limited to, available land, drainage, topography, economic development, access points, and future widening. **Exhibit 2.13** summarizes ECF right-of-way considerations.

Exhibit 2.13: ECF Right-of-Way

ECF Type	Assumed Roadway	Assumed Processing Lanes	Assumed Features	Approximate ECF Length feet (meters)	Approximate ECF Width feet (meters)
Primary	3 lanes per direction	4	✓ Inspection ✓ Visitor Control Center ✓ Trucks	1600 (488)	600 (183)
Secondary	2 lanes per direction	2	✓ Inspection	1400 (427)	400 (122)
Limited Use	1 lane per direction	1	✓ Limited inspection	1000 (305)	120 (37)

2.12. EVALUATION AND SELECTION

In the final evaluation, it is beneficial to quantify each consideration to the best level possible. However, the decision is usually partially subjective, based on planners, engineers, and stakeholders' assessment of the considerations. When comparing alternatives, it is useful to develop a matrix to be used by decision makers. An example matrix is shown as **Exhibit 2.14**.

Exhibit 2.14: Example ECF Alternatives Matrix

Category	Existing	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Satisfy ECF Needs	No	Yes	Yes	No	Yes
Traffic Flow and Safety	Poor - ID checkpoint 50 feet from off post intersection	GOOD	GOOD	FAIR - not a logical location to serve installation	POOR - close to external intersection
Topography	GOOD	GOOD	FAIR - grades near 6 percent	GOOD	GOOD
ECF Size and R/W	POOR - insufficient processing	GOOD	POOR - need to acquire R/W from external use	GOOD	FAIR - may need to demolish installation building
Land Use	POOR - buildings within 500 feet	GOOD	GOOD	POOR - does not provide easy connection for motorists	POOR - near residential area
Environmental	GOOD	GOOD	POOR - may impact wetlands	FAIR - may require significant tree removal	GOOD
Utilities	GOOD	GOOD	FAIR - no utility service nearby	POOR - may require relocation of water line	GOOD
Force Protection	POOR - improper surveillance and inspection	FAIR - one building in close proximity	GOOD	POOR - Mission critical building within 500 feet	GOOD
Other	GOOD	GOOD	POOR - near flightline	GOOD	GOOD
Final Ranking	5	1	3	4	2

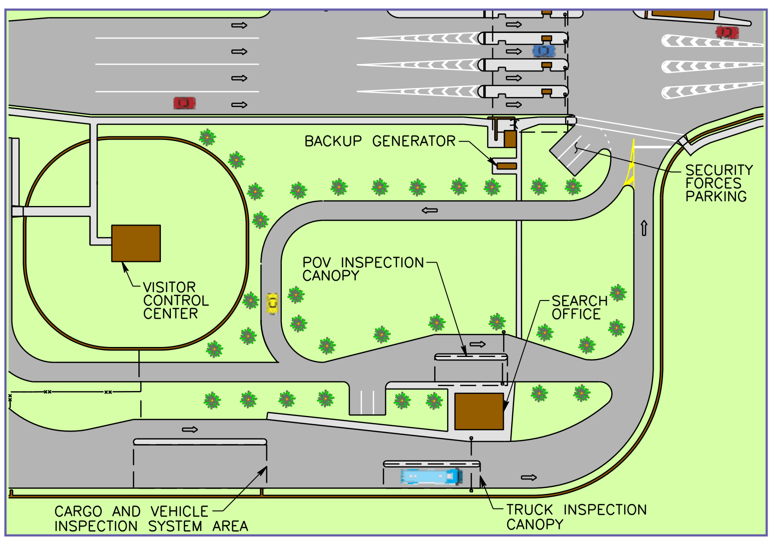
2.13. MANPOWER CONSIDERATIONS

An ECF not only must have adequate lanes to accommodate traffic demands at FPCON Bravo+ (100% ID of all occupants), it must have adequate manpower to support efficient processing in those lanes as well as in visitor control centers and inspection areas.

At ID check areas, consider manpower needs over the entire day. Considerations are shown in **Exhibit 2.15**.

Exhibit 2.15: Simple Methodology for Determining Manpower for ID Check Processing Only

For each hour, calculate the hourly "true demand"	
If the per lane volume exceeds 375	Then provide two ID checkers for each lane
If the per lane volume is between 175 and 375	Then provide one ID checker per lane
If the per lane volume is between 115 and 175	Close one half of the processing lanes and provide one ID checker per lane for each open lane
If the per lane volume is less than 115	Close two thirds of the processing lanes and provide one ID checker per lane for each open lane
If pedestrian activity exceeds ten in a 15-minute period	Consider providing dedicated manpower to process pedestrians



Traffic Engineering Assessments and Alternatives Analysis

Gatehouse and overwatch needs will be dependent on FPCON and RAM and should be determined by security forces. The amount of support in visitor control centers will vary based on the demand and services provided. Inspection area requirements will vary based on the volume and classification of traffic as well as the RAM. Consider consolidating separate POV and truck inspection facilities if low demands are expected and if staff can adequately support both functions.

Where the ability to provide manpower is an issue, consider the following strategies.

- ✓ Consider military staffed, peak hour volunteer programs to assist security forces during peak periods. If implemented, proper security, safety and processing training should be provided.
- ✓ Utilize contract resources; however, sufficient oversight is needed by military security forces.
- ✓ Consider automated ECF technologies as discussed in **Section 9**; however, many of these technologies decrease processing capabilities.
- ✓ Consider consolidating neighboring ECF functions to one location during off-peak periods. Although the per lane ID check demands may remain the same, other staff functions such as gatehouse operations, overwatch, visitor control center processing and inspection activities may be reduced.

2.13.1. Traffic Volume Planning Rules of Thumb

SDDCTEA has analyzed limited data on different variables to arrive at a planning level peak hour demand at an ECF. This should not replace a detailed traffic engineering study, but it can be used for planning level peak hour volume. For example, if a brigade of a certain number of troops were going to be relocated to an installation, the number of anticipated troops can be used to determine a rough peak hour volume, and in turn the number of additional ECF lanes needed. This can in turn be used to determine a planning level cost for expanding existing gates or providing additional gates.

Existing Demand Volume = (0.2 to 0.5) X Inbound ADT

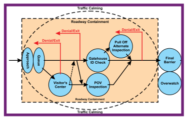
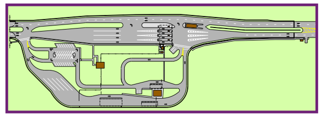
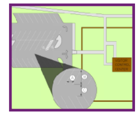
Existing Demand Volume = (0.2 to 0.4) X Base Population

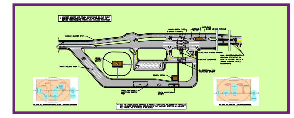
Existing Demand Volume = (0.4 to 0.5) X Morning Peak Period Traffic (05:30 - 09:30 roughly)

Existing Demand Volume = Processed Hourly Volume after the ID Check / (0.4 to 0.75)

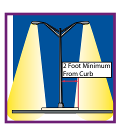
Existing Demand Volume = 0.65 x Total Personnel Drilling (applicable to National Guard bases)

Check with SDDCTEA for updates to these factors.

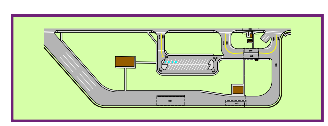






SECTION 3 - GEOMETRIC DESIGN FEATURES








3. Geometric Design Features

Design criteria

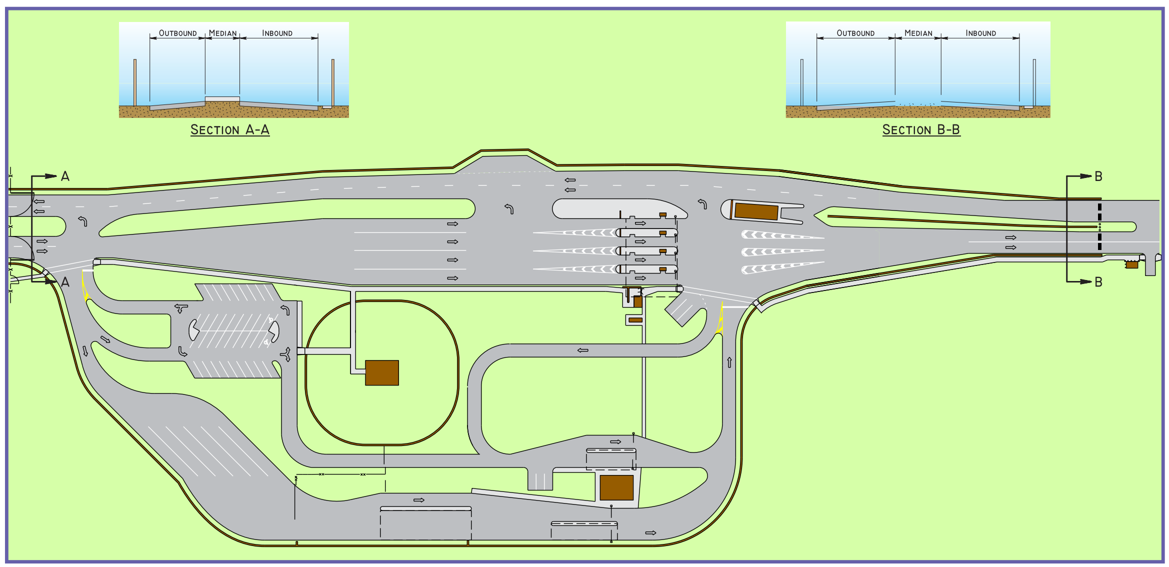
- DoD, Unified Facilities Criteria (UFC) on Entry Control Facilities
- AASHTO, A Policy on Geometric Design of Highways and Streets (The Green Book)
- AASHTO, Roadside Design Guide
- FHWA, Manual on Uniform Traffic Control Devices (MUTCD)

3.1. DESIGN GUIDELINES AND CRITERIA

Geometric design is dependent on design speed, roadway classification, and design vehicle. Also, the type of ECF, space available, and traffic volume may impact design. This section is intended to provide basic guidance on general design features.

Design criteria are intended to reflect the knowledge and application of research and implementation over the years. Use of design criteria provides a measure of consistency and quality when used by different engineers. Design criteria can be loosely classified into three areas: cross-section features; horizontal alignment; and vertical alignment and clearances.

Many design guidelines document minimum design criteria. Whenever possible, minimum design criteria should be exceeded in order to promote safe operations and to enhance roadway operations.



DESIGN SPEED IS USED TO DETERMINE THE VARIOUS GEOMETRIC FEATURES OF AN ECF.

3.1.1. Design Speed

Design speed is used to determine the various geometric features of an ECF. The design speed should be a logical speed that considers the anticipated operating speed, adjacent facility operations, and functional classification of the roadway. *MUTCD* defines design speed as a selected speed used to determine the various geometric design features of the roadway. The design speed for most ECFs is 25 mph (40 km/h). However, constrained or low volume locations may be designed for 15 mph (25 km/h) based on the results of an engineering study.

The roadways surrounding the ECF zones may have a higher posted speed limit, or design speed, then that selected for the ECF design. For these circumstances, a logical reduction in design speed is warranted to promote safe vehicle speed. Common practice for speed reductions is to avoid changes in design/posted speed of more than 10 mph from section to section. This speed reduction should occur prior to the beginning of the approach zone of the ECF. The ECF typically requires motorists to stop and be vetted per FPCON level promoting slower traffic speeds. As such, selection of a single design speed throughout the ECF zones is not necessarily applicable. Consideration of a typical design speed profile may be considered.

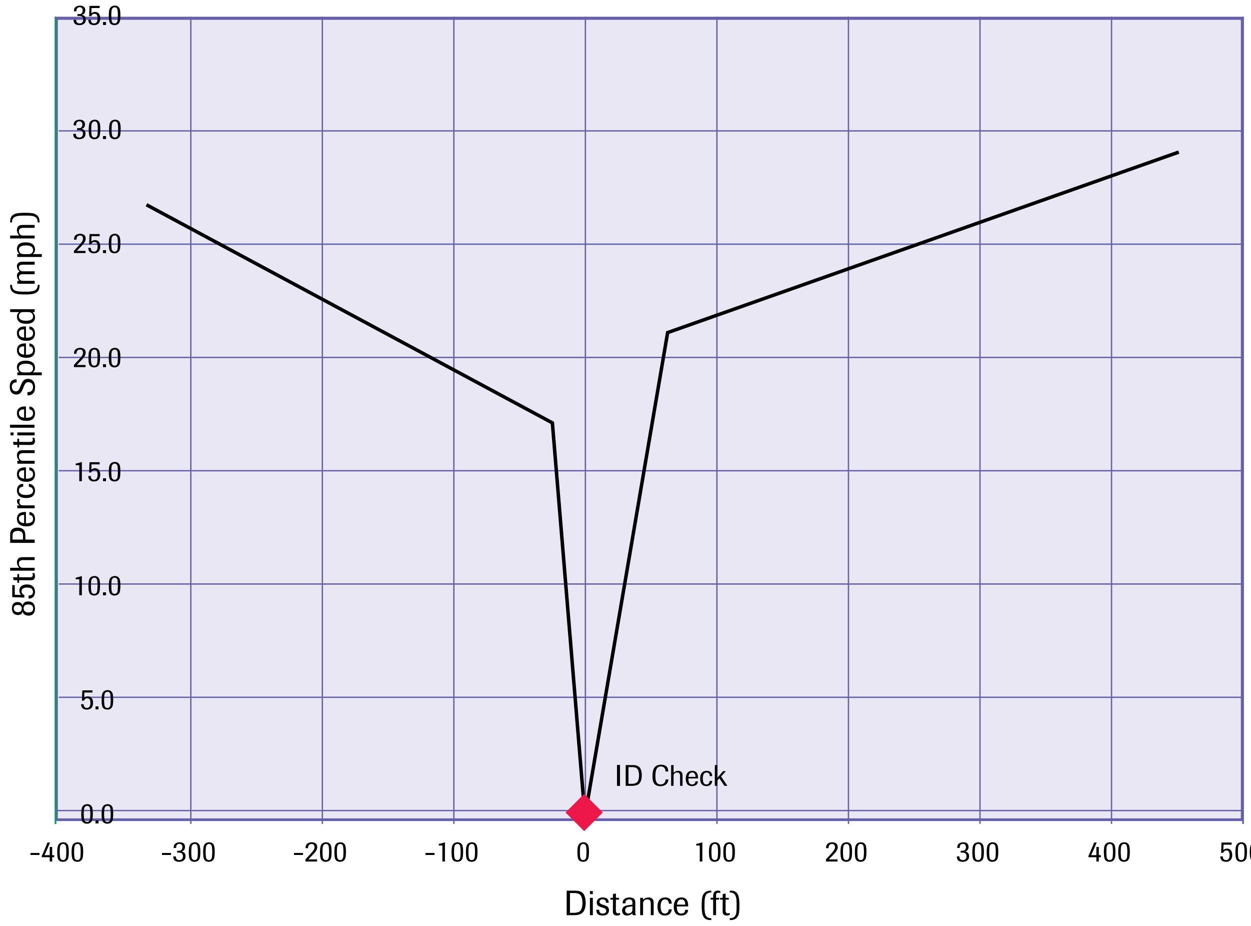
Exhibit 3.1 depicts a composite speed profile for the entry lanes of a typical ECF before, at, and after the ID check point when entering vehicles are required to stop at the ID check point. Typically, one might enter the approach zone of an ECF from an arterial or local road that likely has a posted and design speed higher than 25 mph. The design and posted speed should be transitioned to a constant speed of 25 mph in the approach zone of the ECF, and then transition to zero at the ID check area (or at the back of vehicle queues approaching the ID check area). Past the ID check area, vehicles continuing to enter the installation will transition back up to 25 mph through the response zone and then likely transition to the posted speed limit of the installation. When transitioning from the outside road to the approach zone, it should be reduced in 10 mph increments, or a reduced speed limit ahead sign should be used when the speed limit is being reduced by more than 10 mph. For safety, outbound traffic throughout the ECF should be held at 25 mph or lower in the vicinity of the ID check area.

AASHTO states that the definition of design speed is the minimum safe speed that can be maintained over a specified section of roadway when conditions are so favorable that the design features of the roadway govern.

The Highway Capacity Manual (HCM) describes how the design speed can be determined by the 85th percentile speed of traffic traveling on the roadway.

Logical design speed for ECFs:
- ✓ 25 mph
- ✓ Avoid changes in design speed of more than 10 mph.
- ✓ The posted speed limit should not exceed the design speed.

Exhibit 3.1: Composite Speed Profile For Entry Lanes Only at an ECF



3.1.2. Roadway Classification

Roadways can be classified in one of four ways. In most cases, roadways approaching ECFs are collector roadways. In some instances, these roadways can be classified as arterials. On rare occasions, at large installations, controlled access roadways provide access to installation ECFs. These classifications are described in **Exhibit 3.2**.

Exhibit 3.2: Roadway Classifications

Classification		Features	Usage
Controlled Access (Freeway, Expressway)		✓ Controlled access by interchanges or other grade-separated facilities ✓ No cross traffic movements provided ✓ Wide or barrier medians provided ✓ Wide shoulders and long acceleration and deceleration lanes	✓ High volumes of traffic ✓ Speeds above 55 mph (88 km/h) ✓ Connect urban areas ✓ Provide efficient movement between points of origin
Arterials		✓ At-grade intersections (mostly signalized) ✓ Limited access points ✓ Driveway spacing at large intervals ✓ Cross traffic movement discouraged ✓ Shoulders or curb and gutter provided	✓ High volumes of traffic ✓ Speeds of 35-55 mph (56-88 km/h) ✓ Provides connection to major points within an area ✓ Provides connection to controlled access
Collectors		✓ At-grade intersections (mix between signalized and unsignalized intersections) ✓ Access points spaced at smaller intervals ✓ Cross traffic frequent ✓ Small shoulders or curb and gutter provided	✓ Lower volumes of traffic than arterials or controlled access ✓ Speeds of 25-40 mph (40-64 km/h) ✓ Connect local facilities ✓ Access abutting land uses ✓ Contribute to arterial volumes
Local		✓ Narrow lanes that are sometimes unstriped ✓ At-grade intersections (mostly unsignalized) ✓ Access points spaced at irregular intervals ✓ Mostly curb and gutter provided ✓ Cross slopes are not usually superelevated	✓ Low volumes ✓ Speeds of 25 mph (40 km/h) ✓ Access specific land uses or developments

Source: ITE, Traffic Engineering Handbook

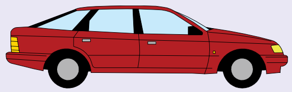
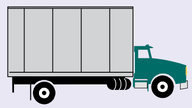
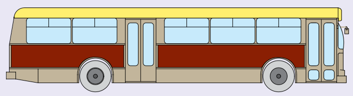
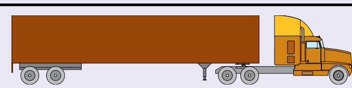
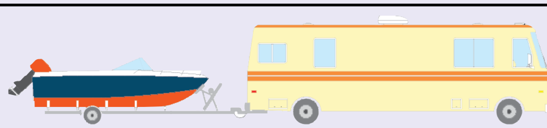
THE DESIGN VEHICLE IS DEFINED AS THE LARGEST VEHICLE LIKELY TO USE THE FACILITY WITH CONSIDERABLE FREQUENCY.

3.1.3. Design Vehicle

The ECF design team must determine what design vehicle is appropriate for the ECF being designed. Design vehicles have critical dimensions and operating conditions such that they influence or control the design of one or more roadway elements. The design vehicle is the largest vehicle likely to use the facility with considerable frequency. The design vehicle is used to establish critical geometric features such as turning radii, lane widths, and vertical clearances.

For the purpose of ECFs, a WB-67 (WB-20) design vehicle should be used in areas that accommodate trucks. At ECFs where trucks are not permitted, a single unit truck (SU) or a bus (school, transit, or other) may be the appropriate design vehicle. However, per the UFC, a pre-ID check turnaround capable of rejecting WB-67 vehicles must be provided, even at gates that do not accept trucks. Also consider outbound needs - if the installation's truck ECF is inbound only, or if trucks are simply allowed to exit any gate, the non-truck gates will need to be designed for outbound truck traffic. **Exhibit 3.3** summarizes ECF design vehicle features.

Exhibit 3.3: ECF Design Vehicles

Design Vehicle	Minimum design turning radius feet (meters)	Center line turning radius feet (meters)	Minimum inside radius feet (meters)
 **Passenger Car (P)**	24 (7.3)	21 (6.4)	15 (4.4)
 **Single Unit Truck (SU)**	42 (12.8)	38 (11.6)	29 (8.6)
 **City Transit Bus (CITY-BUS)** **Note: Design for this vehicle will accommodate school buses also**	42 (12.8)	38 (11.5)	25 (7.5)
 **Interstate Semitrailer (WB-67)**	45 (13.7)	41 (12.5)	1.9 (0.6)
 **Motor Home and Boat Trailer (MH/B)** **Note: Design for this vehicle will accommodate all AASHTO recreational variations**	50 (15.2)	46 (14.0)	35 (10.7)

Source: AASHTO, Green Book

THE MINIMUM RADIUS FOR ANY TURN IN THE ECF AREA IS DEPENDENT ON THE DESIGN VEHICLE TO BE USED.

AT NON-TRUCK ECFS, CONSIDER THE NEED FOR CITY BUSES AND SCHOOL BUSES AND THEIR EFFECT ON TURNING RADII.

3.1.4. Turning Movements

An ECF that only accommodates passenger vehicles will require a significantly less amount of area than one that accommodates trucks. When initially laying out the ECF, make sure that all involved parties are in agreement on what the design vehicle should be. Also consider the available right-of-way, the angle of the intersection, and pedestrian activity.

3.1.4.1. Turning Radii

Characteristics of a design vehicle include: minimum centerline turning radius, out-to-out track width, wheelbase, and the path of the inner rear tire. For classifying the vehicles, AASHTO assumes the speed for determining the minimum turning radius is less than 10 mph (15 km/h). **Exhibit 3.4** shows the AASHTO values for design vehicle turning radii.

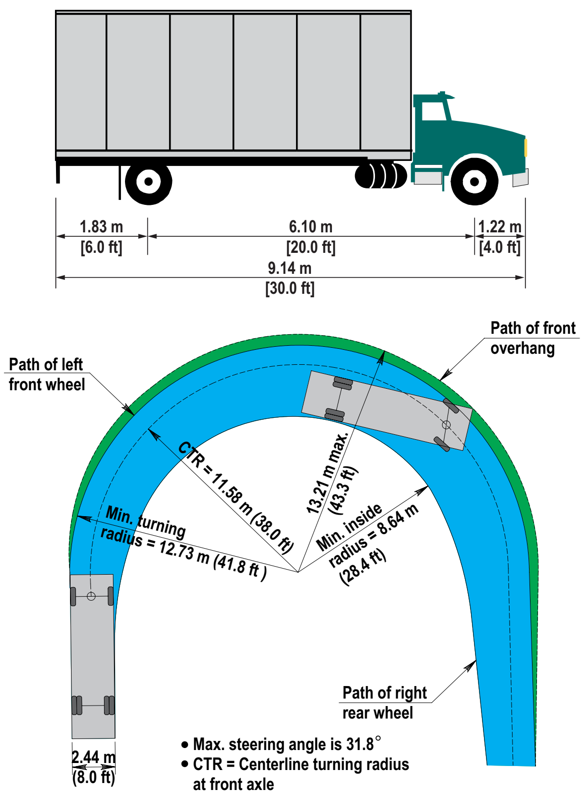
Exhibit 3.4: ECF Design Radii

Design Vehicle Serviced	Minimum Design Radius feet (meters)
P	24 (7.3)
SU	42 (12.8)
MH/B	50 (15.2)
WB-67 (WB-20)	45 (13.7)

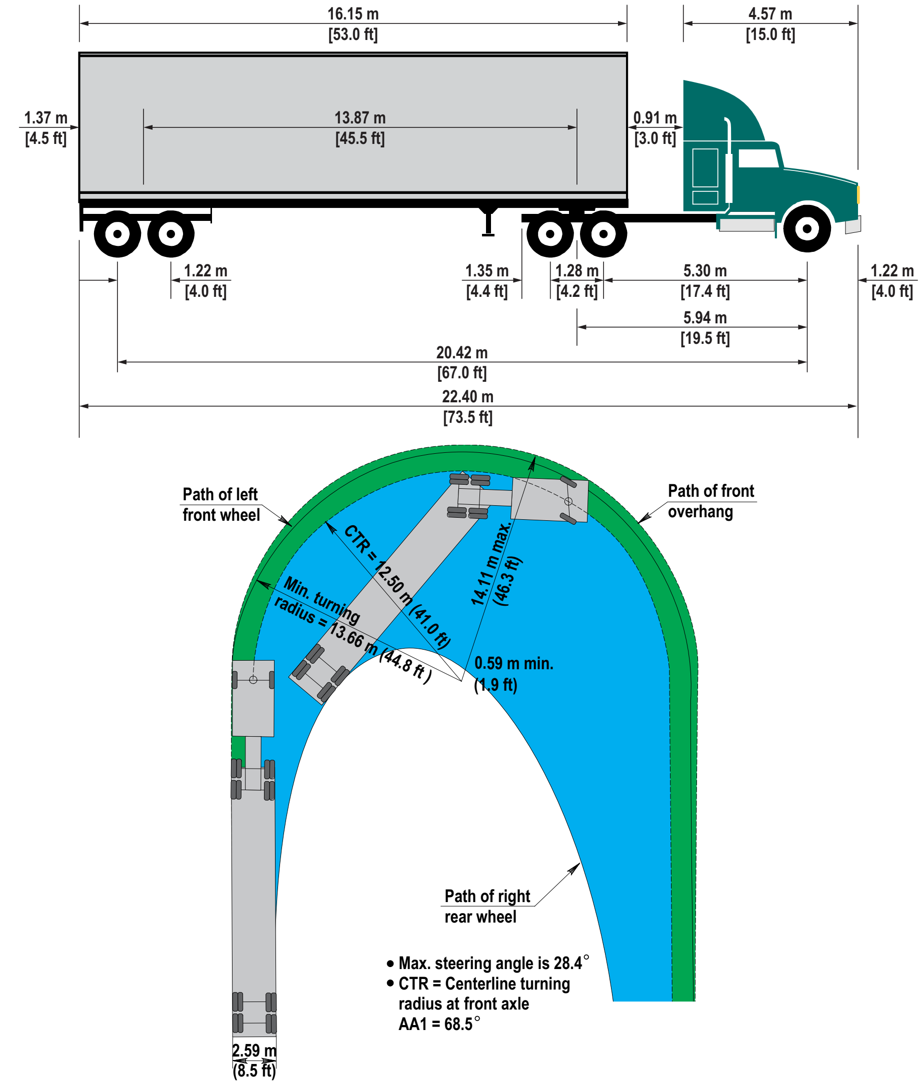
Source: AASHTO, Green Book

At ECFs that do not accept large vehicles such as semitrailers, the SU or bus design vehicle should be used. However, in areas where trucks are expected, use the WB-67 (WB-20) as the design vehicle. **Exhibit 3.5** shows the minimum turning path for a SU and WB-67 design vehicle.

Exhibit 3.5: Minimum Turning Path for SU and WB-67 Design Vehicles



AASHTO Exhibit 2-2 Minimum Turning Path for Single-Unit Truck (SU-9[SU-30])
Design Vehicle from AASHTO Green Book



AASHTO Exhibit 2-15 Minimum Turning Path for Interstate Semitrailer (WB-20[WB-67])
Design Vehicle from AASHTO Green Book

PROVIDE AT A MINIMUM 10-FOOT (3.0 METERS) WIDE LANES, AND PREFERABLY 12-FOOT (3.6 METERS) WIDE LANES.

3.2. CROSS SECTION

The cross section of a roadway and associated features is the width available for use by vehicles, pedestrians, drainage, and other ECF features. The cross section of the roadway should be adequate to accommodate the design vehicle but restricted enough to discourage unpredictable movements. The cross section of the travel way should channelize vehicles into a uniform pattern of movement.

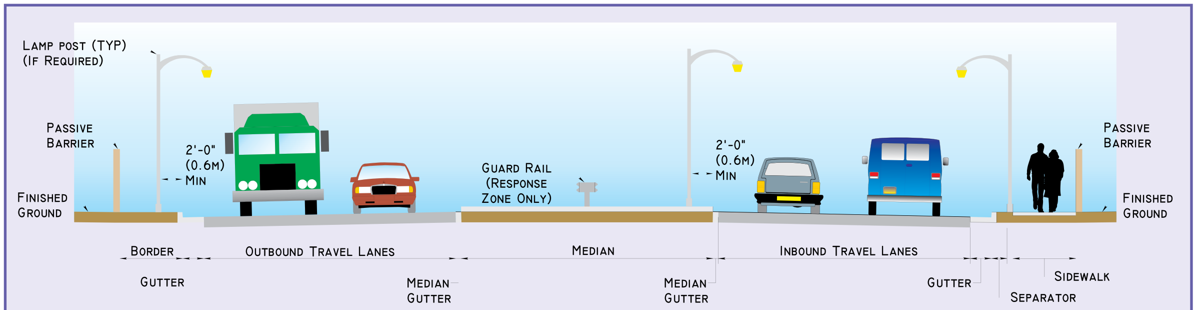
3.2.1. Travel Way and Lane Width

As a general rule, when free flow through an ECF is desired, travel lanes should be at least 12 feet (3.6 meters) wide. Narrower lanes approaching and departing the ID check area will restrict the flow and contribute to congestion. At the ID checkpoint itself, a lane width of 10 feet (3.0 meters) will not impede traffic flow, as congestion is inherent with stopping or slowing. Narrow lanes through the ID check are only acceptable when ID checks are expected to be in effect throughout the useful life of the ECF, and when no truck traffic is expected to use the ECF. If not, 12-foot (3.6 meter) lanes should be used. Under specific circumstances, narrow lanes (10 feet) may be used for traffic calming.

Other considerations regarding 10-foot (3.0 meter) lanes include:

✓ Narrow lanes are highly restrictive to large vehicles, including some emergency vehicles.
✓ Narrow lanes can impact traffic flow. When the lane width is less than 12 feet (3.6 meters) motorists drive very cautiously and also tend to increase the spacing between vehicles.

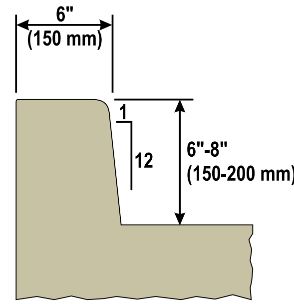
Snow removal requirements including the necessary width between ID check islands for snow removal equipment should be considered. If moderate-to-heavy bicycle traffic is expected, a 5-foot (1.5 meter) bike lane between the travel lane and gutter is recommended.



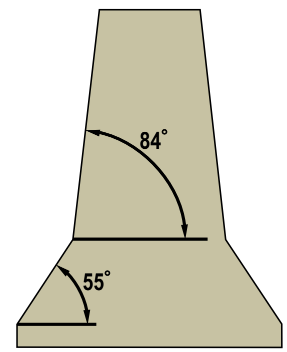
Approach and Response Zone Typical Section

CURBS IN ASSOCIATION WITH GUTTER SECTIONS ARE USED TO CONTROL DRAINAGE AND CHANNEL IT LONGITUDINALLY TO DRAINAGE INLETS.

3.2.2. Curb and Gutter



Curbed roadways within the ECF are primarily intended to collect water, provide traffic calming, and provide roadway delineation / lane containment. The UFC recommends a 6-inch vertical curb for the checkpoint areas of the ECF. This curbing gives visual guidance to the driver, provides vehicle containment, and affords an elevated platform for the ID checker to inspect the vehicle and view the driver. SDDCTEA has tested and found a precast 8-inch curb and found that it will disable vehicles traveling at speeds of 25 mph or more. See Section 4.2.1 for further information. Wherever vertical curbs are used they should not exceed 9-inches in height.



Curbing exceeding 9-inches in height warrants special consideration. Sometimes taller curbing is requested to be used as a passive barrier to control the movement of potential threats. All passive and active barriers must be included on the DoD Anti-Ram Vehicle Barrier List. The list is updated periodically, so the list must be consulted as part of deciding whether to use curbing as a passive barrier. See Section 8 for additional information.

Longitudinal barriers should incorporate special design features to lessen the severity of impact when struck. The most common example of this is a Jersey-style barrier (example shown) which is sloped to lessen the severity of impact if struck. The F-shaped barrier is considered a superior shape (to the Jersey-style) and was specifically engineered to limit the potential of roll-over. When selecting a longitudinal barrier design, refer to the *AASHTO Roadside Design Guide* for assistance.

Curbing can assist in defining vehicle paths and provide delineation, as well as channelizing runoff. The impact to drainage must be considered with curbing. Curbing will collect water, so it requires drainage inlet locations in different locations than uncurbed roadway.

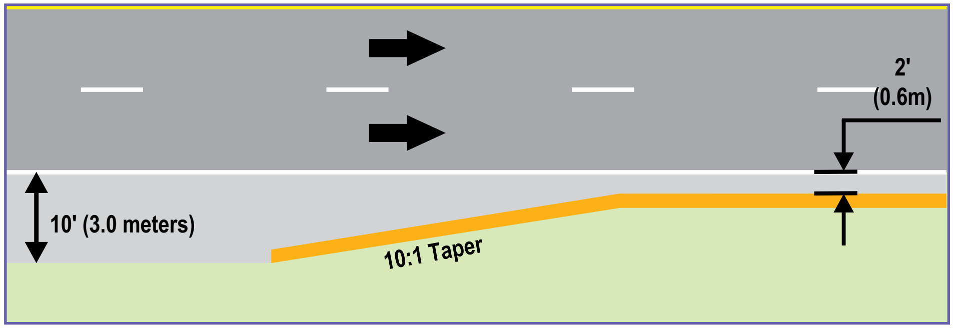
3.2.3. Shoulders

Curbs and gutters are preferable in areas where lane control is desired and to improve safety. Shoulders are discouraged near the access control zone because motorists tend to go faster where there are shoulders. Also, shoulders make it harder to constrain and control the movement of vehicles. Therefore, shoulders should only be considered for use in the approach and response zones and not in the ID check area itself. Shoulders should not be provided within the limits of the access control zone, so transitional sections may be needed from shouldered to unshouldered areas.

Exhibit 3.6: Roadway Classification Shoulder Widths

Roadway Classification	Average Daily Traffic <400 Vehicles feet (meters)	Average Daily Traffic 400-1,499 Vehicles feet (meters)	Average Daily Traffic 1,500-2,000 Vehicles feet (meters)	Average Daily Traffic >2,000 Vehicles feet (meters)
Arterials	4 (1.2)	6 (1.8)	6 (1.8)	8 (2.4)
Collectors	2 (0.6)	5 (1.5)		
Local				

Source: AASHTO, Green Book



The shoulder width needed depends upon the type of roadway and traffic volumes. The AASHTO *Greenbook* provides specific guidance on the selection of shoulder widths. UFC 4-022-01 states that if used, shoulders should be 6-8 feet (1.8-2.4 meters) wide. As a minimum, when a shoulder is present, all fixed objects, such as signs, fence posts, structures, and trees, should be at least 6 feet (1.8 meters) from the shoulder or 12 feet (3.6 meters) from the lane edge, whichever provides the greater clearance from the lane edge. See **Exhibit 3.6** for various recommended shoulder widths.

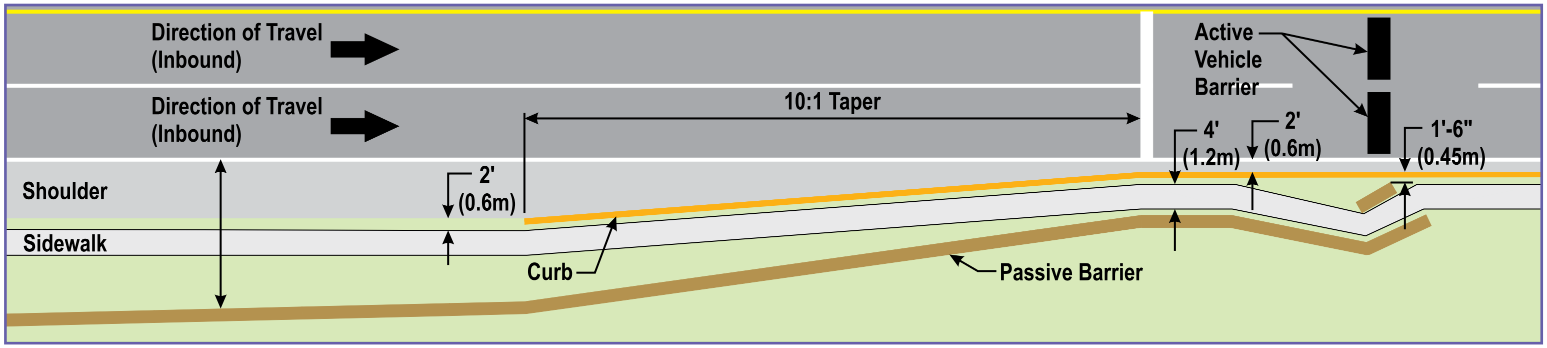
Shoulders should be pitched to drain away from the road surface, but not so much as to make their use hazardous. Their design should be a compromise between slope needs and drivability.

Shoulder width should be consistent and continuous. Where transition is made from a shouldered roadway to a curbed, unshouldered roadway (such as approaching the gatehouse or fence gate), the curb should not be abruptly introduced in place of the shoulder. Rather, a transition zone, with a 10:1 (Longitudinal:Offset) minimum taper, should be used to give a driver time to react, especially at night. When a new lane is added on the right, the shoulder should continue at full width through the transition; otherwise, the new lane may appear to be a continuation of the shoulder.

3.2.3.1. Shoulder Transitions at Active Vehicle Barriers

Where no curbing exists approaching the active vehicle barrier, a shoulder-to-curb transition should be used to allow the passive and active vehicle barriers to create a contiguous perimeter around the ECF. The use of curbing will allow the passive barrier to come within 1.5 feet (0.45 meters) of the face-of-curb. Two feet (0.6 meters) should be maintained between the face-of-curb and the edge of the travel lane. See **Exhibit 3.7**.

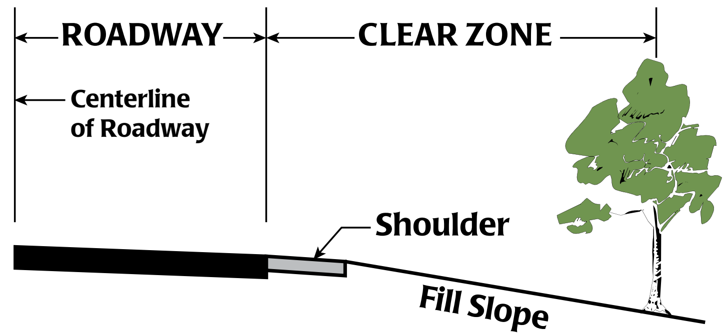
Exhibit 3.7: Shoulder Transitions at Active Vehicle Barriers



CLEAR ZONE IS A MEASURED DISTANCE FROM THE EDGE OF THE ROAD THAT SHOULD BE FREE FROM OBSTRUCTIONS.

3.2.4. Clear Zone

A clear zone is the total roadside border area from the edge of the travel way that is available for safe use by errant drivers. Providing adequate clear zones can enhance roadway safety by providing motorists with certain levels of expectation.



The required clear zone, summarized in **Exhibit 3.8**, is a function of the design speed of the adjacent roadway, the average daily traffic (ADT) volumes, and roadside geometry.

Exhibit 3.8: Clear Zone Requirements

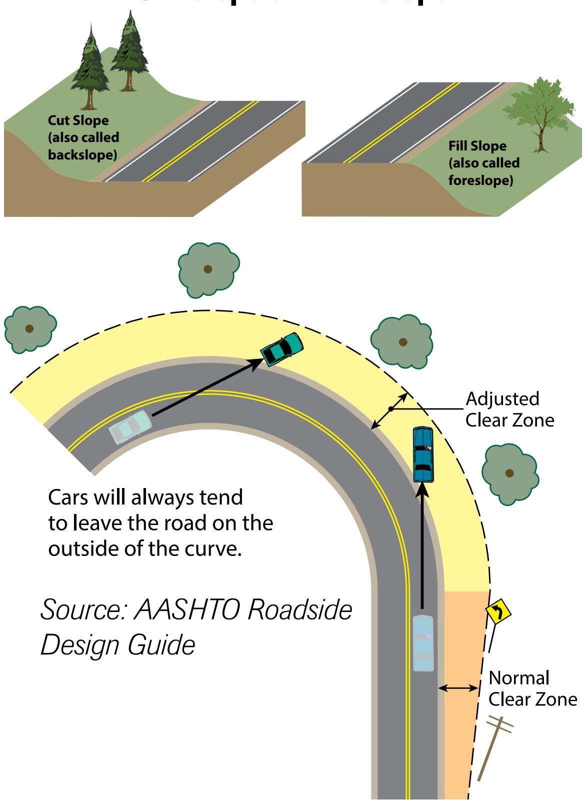
Design Speed	Design ADT	Fill Slopes			Cut Slopes		
		6:1 or Flatter feet (meters)	5:1 to 4:1 feet (meters)	3:1 feet (meters)	3:1 feet (meters)	4:1 to 5:1 feet (meters)	6:1 or flatter feet (meters)
40 mph (64 km/h) or Less	Under 750	7-10 (2.1-3.0)	7-10 (2.1-3.0)	*	7-10 (2.1-3.0)	7-10 (2.1-3.0)	7-10 (2.1-3.0)
	750-1,500	10-12 (3.0-3.7)	12-14 (3.7-4.3)	*	10-12 (3.0-3.7)	10-12 (3.0-3.7)	10-12 (3.0-3.7)
	1,500-6,000	12-14 (3.7-4.3)	14-16 (4.3-4.9)	*	12-14 (3.7-4.3)	12-14 (3.7-4.3)	12-14 (3.7-4.3)
	Over 6,000	14-16 (4.3-4.9)	16-18 (4.9-5.5)	*	14-16 (4.3-4.9)	14-16 (4.3-4.9)	14-16 (4.3-4.9)
45-50 mph (72-81 km/h)	Under 750	10-12 (3.0-3.7)	12-14 (3.7-4.3)	*	8-10 (2.4-3.0)	8-10 (2.4-3.0)	10-12 (3.0-3.7)
	750-1,500	14-16 (4.3-4.9)	16-20 (4.9-6.1)	*	10-12 (3.0-3.7)	12-14 (3.7-4.3)	14-16 (4.3-4.9)
	1,500-6,000	16-18 (4.9-5.5)	20-26 (6.1-7.9)	*	12-14 (3.7-4.3)	14-16 (4.3-4.9)	16-18 (4.9-5.5)
	Over 6,000	20-22 (6.1-6.7)	24-28 (7.3-8.5)	*	14-16 (4.3-4.9)	18-20 (5.5-6.1)	20-22 (6.1-6.7)

* Note: Since recovery is less likely on the unshielded, traversable 3:1 slopes, fixed objects should not be present in the vicinity of the toe of these slopes. Determination of the width of the recovery area at the toe of the slope should take into consideration right-of-way availability, environmental concerns, economic factors, safety needs, and crash histories.
Source: AASHTO Roadside Design Guide, Table 3-1

Often, meeting the distances outlined in **Exhibit 3.8** in the ECF area is not feasible due to geometric requirements. The minimum lateral clearance for an object adjacent to the travel way behind vertical curbing is 2 feet (0.6 meters), but should not be construed as an acceptable clear zone. The values presented in **Exhibit 3.8** should be used as the minimum and every other option should be exhausted before using values less than those presented.

THE MINIMUM LATERAL CLEARANCE FOR AN OBJECT ADJACENT THE TRAVEL WAY BEHIND VERTICAL CURBING IS 2 FEET, BUT SHOULD NOT BE CONSTRUED AS AN ACCEPTABLE CLEAR ZONE.

Cut slope and Fill slope



Source: AASHTO Roadside Design Guide

The clear zones described in **Exhibit 3.8** are appropriate for tangent sections and the inside of horizontal curves. On the outside of horizontal curves, a correction factor from **Exhibit 3.9** should be applied to the value shown in **Exhibit 3.8**. For curves with a radius greater than 2,900 feet (880 meters) a correction factor for the outside of the curve is not necessary.

Lateral obstructions present a safety hazard and tend to negatively impact traffic flow. The location of obstructions adjacent to the travel way in the approach and response zones, including the passive vehicle barriers, shall be a minimum of 7 feet (2.1 meters) from the travel way.

Exhibit 3.9: Clear Zone Curve Adjustments for the Outside of Horizontal Curves

Radius (Feet) [Meters]	Design Speed (mph) [kmh]		
	40 [64]	45 [72]	50 [80]
2950 [899]	1.1	1.1	1.1
2300 [701]	1.1	1.1	1.2
1970 [600]	1.1	1.2	1.2
1640 [500]	1.1	1.2	1.2
1475 [450]	1.2	1.2	1.3
1315 [401]	1.2	1.2	1.3
1150 [351]	1.2	1.2	1.3
985 [300]	1.2	1.3	1.4
820 [250]	1.3	1.3	1.4
660 [201]	1.3	1.4	1.5
495 [151]	1.4	1.5	
330 [101]	1.5		

Source: AASHTO Roadside Design Guide

MEDIANS SEPARATE OPPOSING DIRECTIONS OF TRAVEL.

TRAFFIC ISLANDS PROVIDE CHANNELIZATION, DIVISION, AND REFUGE.

3.2.5. Medians and Traffic Islands

Roadside features such as medians, guard islands, and traffic islands can help delineate the travel path to users of an ECF. All three features normally have a vertical face (curb) of not less than 6 inches (150 millimeters) and should be placed at least 2 feet (0.6 meters) from the edge of the travel way.

3.2.5.1. Medians

Medians separate opposing directions of travel and can provide control for left-turns. Raised median islands often used on urban arterials are also appropriate for use in an ECF. When plantings are provided in a median, the AASHTO *Roadside Design Guide* should be followed for obstructions adjacent to the travel way, and no plantings should be provided that obstruct the view of turning vehicles. Typically, medians should not be less than 4 feet (1.2 meters) wide and in the area of the gatehouse the median should not be less than 12 feet (3.6 meters) wide.

3.2.5.2. Traffic Islands

Curbed islands can be difficult to identify at night because of glare. When curbed islands are used, lighting should be installed at the intersection or curb top delineators should be used. When islands are used in succession along a corridor, a common geometric design should be implemented. Traffic islands do not have common dimensions since they can be provided in any shape necessary to control traffic. However shaped, traffic islands should not be less than 75 square feet (7 square meters) in area. Islands that are less than 75 square feet (7 square meters) lose effectiveness and can become a hazard. If a smaller island is necessary, proper pavement markings and signing should be installed to delineate the island.

Exhibit 3.10: Types of Traffic Islands

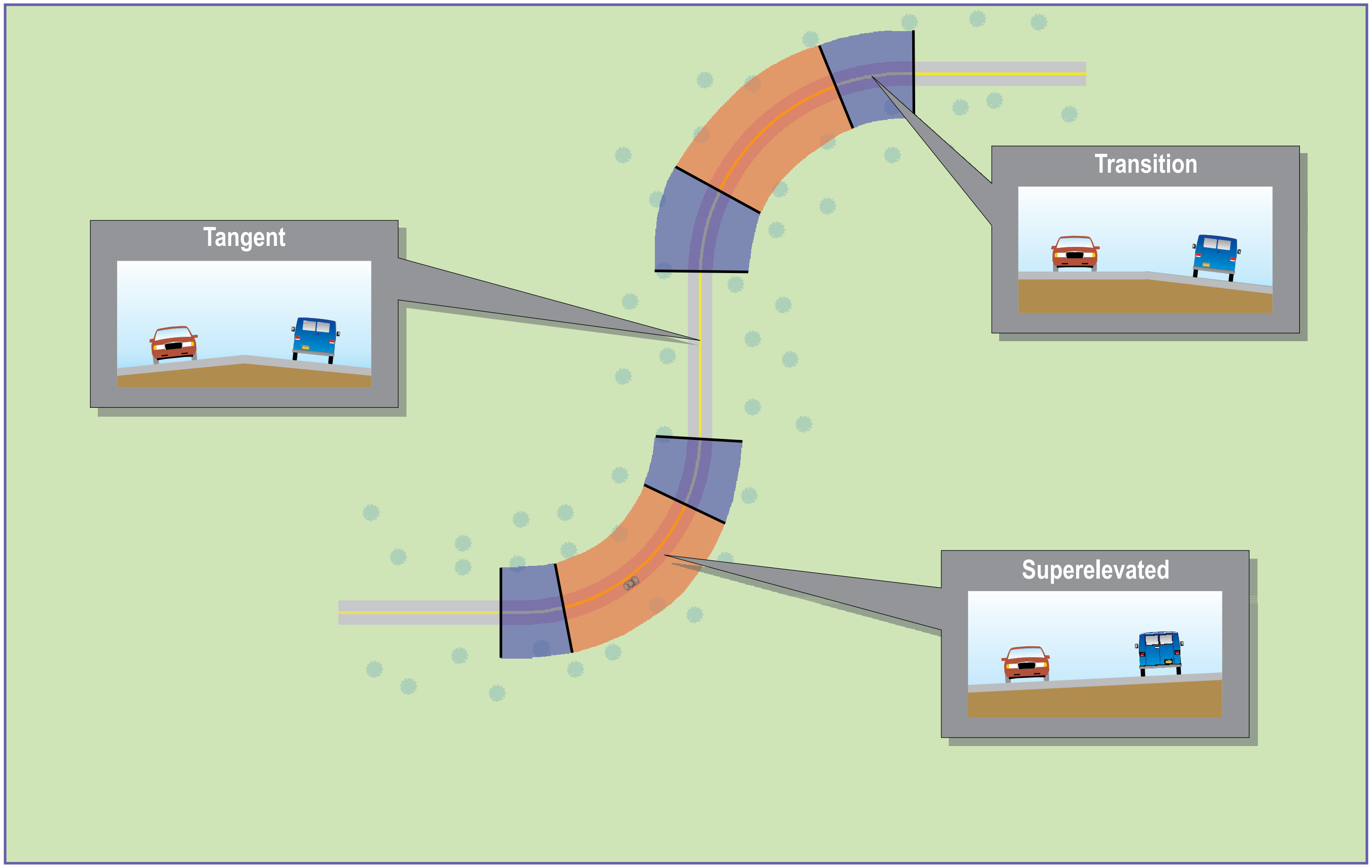
Traffic Island Type	Features	Geometrics	Typical Usage
Channelization	Raised or flush	Normally triangular	When providing a free right turn movement from one roadway to another
Division	Raised or flush	Normally elongated	When a left-turn lane tapers away from the through lane
Refuge	Raised	Triangular or elongated	When pedestrians cross a distance that they may not be able to make in one signal cycle

Source: ITE, Traffic Engineering Handbook

AS THE SPEED AROUND A CURVE INCREASES IT IS NECESSARY TO BANK OR SUPERELEVATE THE CURVE TO COMPENSATE FOR CENTRIPETAL FORCES.

3.3. HORIZONTAL ALIGNMENTS

A horizontal alignment is comprised of curves, tangents, and curve transitions. The goal of a horizontal alignment is to provide a roadway that is suitable in usage to the land that surrounds it, and reinforces the speed that is compatible with that land.



3.3.1. Horizontal Curves

The approach and response zones at an ECF should be designed with curves at Normal Crown (NC) especially in areas where speed reduction is necessary prior to the ID check. Often it is desired to design chicanes (reverse curves approaching the ID check) to implement speed mitigation. A curve designed with normal crown does not require superelevation transitioning allowing reverse curves in a shorter distance. Certain constructability, drainage and costs issues are also reduced by utilizing normal crown curves.

In some instances, it may be desirable to use superelevation instead of normal crown. Remove Crown (RC) is an optional alternative to Normal Crown (NC) when design specific situation arises. Superelevation other than NC or RC should be carefully evaluated in ECF applications in order to provide adequate transition lengths. **Exhibit 3.11** displays the minimum radius for corresponding superelevation rates within the ECF. Note that increases in SE above RC produce only minor reductions in curve size for lower speed roadways and may only beneficial for higher design or posted speed sections.

Exhibit 3.11: Minimum Curve Radius at ECF's

	Superelevation	Design Curve 15 mph (24 kph)	Design Curve 20 mph (32 kph)	Design Curve 25 mph (40 kph)	Design Curve 30 mph (48 kph)	Design Curve 35 mph (56 kph)	Design Curve 40 mph (64 kph)	Design Curve 45 mph (72 kph)
	e (%)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)	R (ft)
Normal Crown (NC)	-2.0	44	83	134	206	316	472	644
	-1.5	43	82	132	201	307	456	620
Remove Crown (RC)	1.5	40	75	121	179	260	378	507
	2.0	39	74	119	176	255	368	492
	2.2	39	74	118	175	254	363	487
	2.4	39	73	118	174	252	360	481
	2.6	39	73	117	173	251	355	476
	2.8	39	72	116	172	249	352	470
	3.0	38	72	116	171	247	348	465
	3.2	38	72	115	170	246	345	460
	3.4	38	71	114	169	245	341	455
	3.6	38	71	114	169	243	337	450
	3.8	38	71	113	168	242	334	445
	4.0	38	70	113	167	240	330	441

Source: SDDCTEA—Geometric Criteria Study

For roadways outside the ECF or for an ECF with a long approach and/or response zone, it may be necessary to utilize the open roadway superelevation criteria which is different from ECF superelevation criteria. Refer to AASHTO Roadside Design Guide for guidance on superelevation criteria for open roadway conditions.

3.3.2. Horizontal Tangents and Transitions

In order for vehicles to safely negotiate a superelevated curve as outlined in the previous section, the vehicle needs to transition from normal crown to full superelevation, traverse the curve, and then transition from full superelevation back to normal crown. The distance of this transition varies based on the design speed. **Exhibit 3.12** shows the minimum tangent and transition lengths between reverse horizontal curves. Tangent and transition requires additional roadway length that is sometimes not achievable and in such a case a normal crown design should be considered through the curve (see Section 3.3.1). Also constructability, drainage and cost issues can incur due to transitions and superelevated sections in the approach and response zones.

Spiral transitions can increase driver comfort and safety for curves. A spiral transition is one that has a constantly changing radius. They are used primarily on curves with large radii and high speeds. For a discussion of spiral transitions, see AASHTO's *A Policy on Geometric Design of Highways and Streets*.

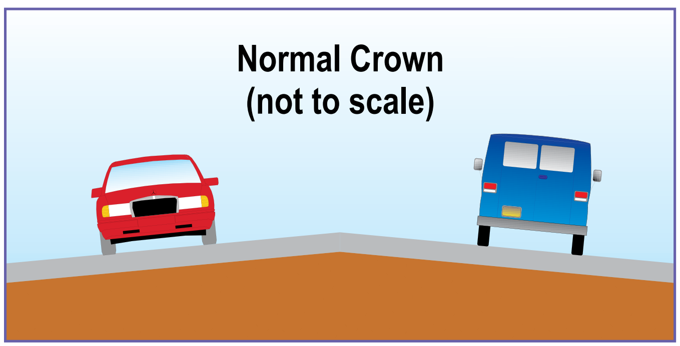
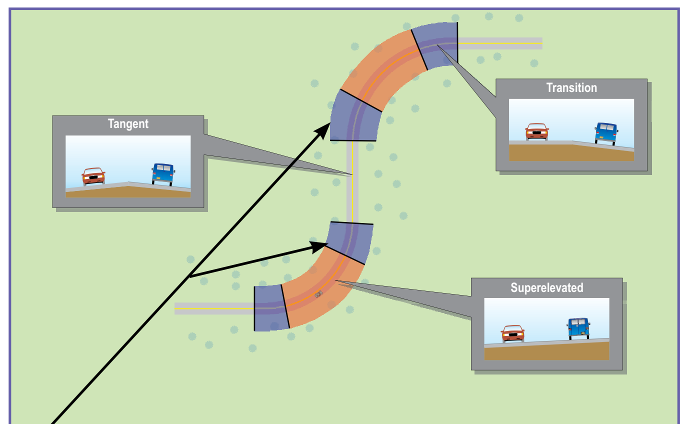


Exhibit 3.12: Minimum Tangent Distance at Various Superelevations

Superelevation	Design Speed mph (km/h)	Design Tangent feet (meters)(1)	Design Transition feet (meters)(1)
2%	15 (30)	31 (10)	31 (10)
2%	25 (40)	34 (10)	34 (10)
2%	35 (60)	39 (12)	39 (12)
2%	45 (80)	44 (14)	44 (14)
4%	15 (30)	31 (10)	62 (19)
4%	25 (40)	34 (10)	69 (21)
4%	35 (60)	39 (12)	77 (24)
4%	45 (80)	45 (14)	89 (29)

(1) Assumes one lane rotated
Source: AASHTO, Green Book



Required tangent and transition distances, between curves, can be eliminated with the use of normal crown (see Section 3.3.1).

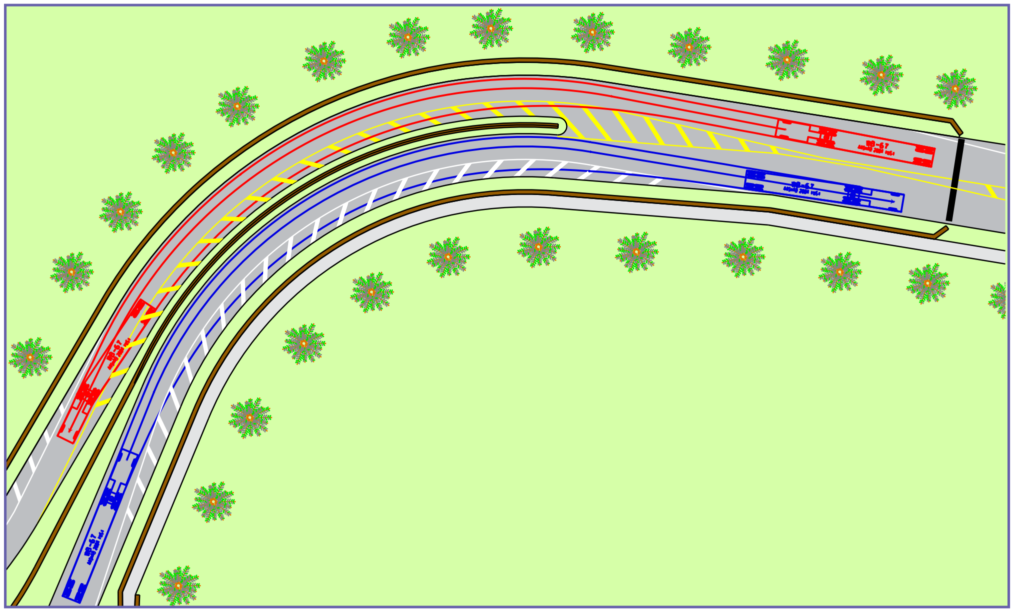
SOMETIMES LANES NEED TO BE WIDENED AROUND CURVES SO THAT THE REAR WHEELS STAY IN THE TRAVELING LANE AND DRIVERS CAN EASILY STEER THEIR VEHICLE AROUND THE CURVE.

IF LANES ARE NOT WIDE ENOUGH FOR TRUCKS, THEY WILL ENCROACH ONTO SHOULDERS OR CURBS.

3.3.3. Lane Widening

There are two reasons why the lane needs to be wider around a curve. First, if a lane around a curve is too narrow, drivers may have difficulty steering the vehicle to the center of the lane. If a driver is traveling at a fairly high speed and encounters a sharp curve, the lane should widen so that the driver can safely drive around the curve.

The second reason lanes need to be wider around a curve is to be sure that the rear wheels stay in the traveling lane; this reason may be the most important reason for widening lanes on curves in ECFs. When vehicles make turns, their rear wheels do not follow the same path as the front wheels. Usually, the rear wheels track inside the front wheels, but at higher speeds, the rear wheels may track outside the front wheels. Since vehicles do not follow a perfect path around turns, the lanes must be widened on horizontal curves. The widening depends on the characteristics of the design vehicle and the sharpness of the curve. The amount of widening needed increases with the size of the design vehicle, and decreases as curves become less sharp, or tight.



The actual impact of the design vehicle should be compared to the width of the lane provided. Ideally, an add-on program to CADD platforms that simulates turning paths of AASHTO vehicles should be used to verify that lane widths are appropriate for the design conditions.

Widening should transition gradually on the approaches to the curve to provide a reasonably smooth travel way edge. On simple (unspiraled) curves, widening should be applied to the inside edge of the traveled way only. On curves designed with spirals, widening may be applied on the inside edge or divided equally on either side of the centerline. **Exhibit 3.13** depicts the lane widening needed for a WB-67.

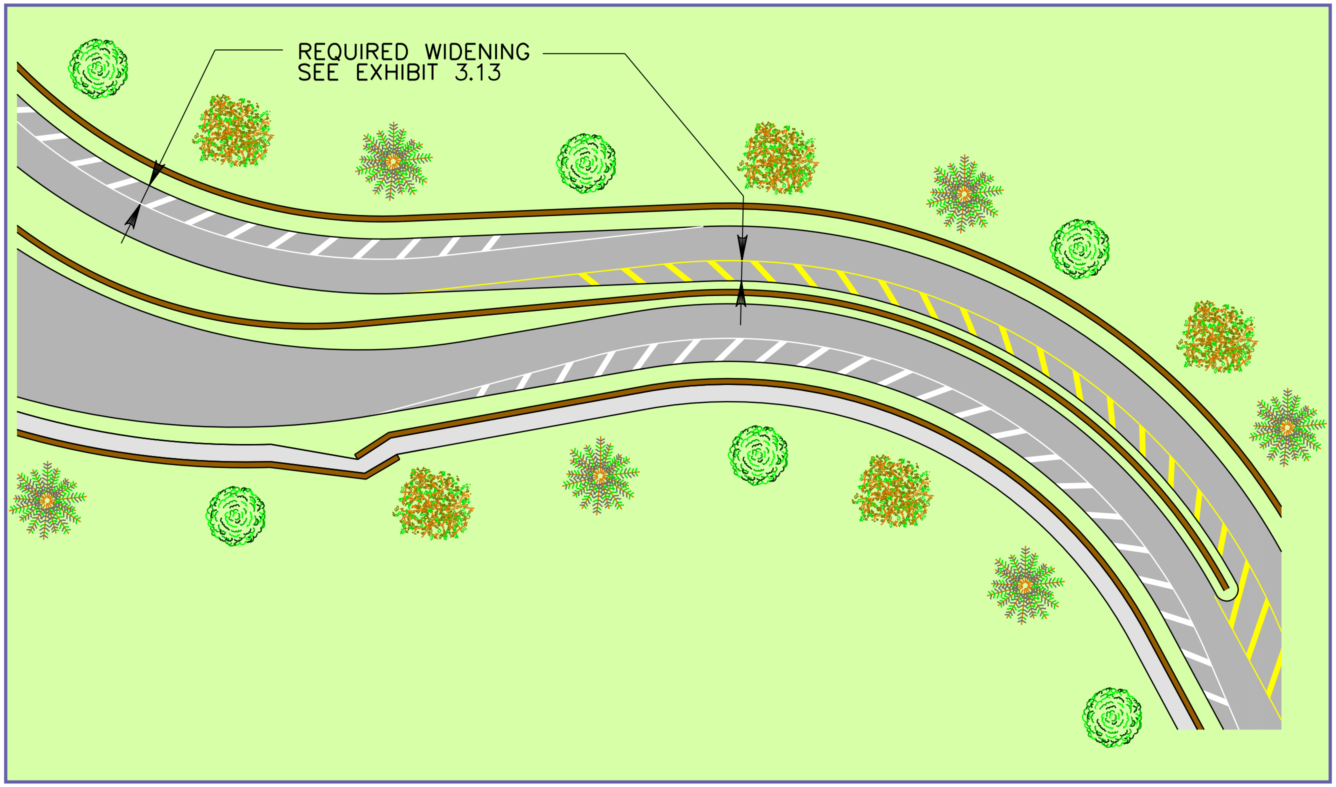
Exhibit 3.13: Lane Widening Needed for an Interstate Semitrailer (WB-67) for Two-Lane Highways (One-Way or Two-Way)

Design Radius feet (meters)	Widening Required for Roadway Width 24 ft. (7.2m)		New Roadway Width Including Widening	
	Design Speeds		Design Speeds	
	15 mph (25 kph)	25 mph (40 kph)	15 mph (25 kph)	25 mph (40 kph)
86 (26)	34.0 (10.4)	34.1 (10.4)	58.0 (17.6)	58.1 (17.7)
154 (47)	17.2 (5.2)	18.0 (5.5)	41.2 (12.4)	42.0 (12.8)
250 (76)	10.2 (3.1)	10.9 (3.3)	34.2 (10.4)	34.9 (10.6)
371 (113)	6.7 (2.0)	7.2 (2.2)	30.7 (9.4)	31.2 (9.5)
533 (162)	4.5 (1.4)	4.9 (1.5)	28.5 (8.7)	28.9 (8.8)
711 (216)	3.2 (1.0)	3.6 (1.1)	27.2 (8.3)	27.6 (8.4)
926 (282)	2.3 (0.7)	2.6 (0.8)	26.3 (8.0)	26.6 (8.1)

Note: When selecting a unit of measure in English units (mph or ft), only the English units apply to the corresponding row. The same is true for SI units (km/h or m).
Source: AASHTO, Green Book

Exhibit 3.14 illustrates the proper way to stripe a horizontal curve with significant widening. For more information on lane widening, see AASHTO's *A Policy on Geometric Design of Highways and Streets (Green Book)*.

Exhibit 3.14: Lane Striping for Horizontal Curve Widening



IF SIGHT DISTANCE IS BAD THROUGH A CURVE, VEGETATION WITHIN THE CURVE MAY NEED TO BE REMOVED.

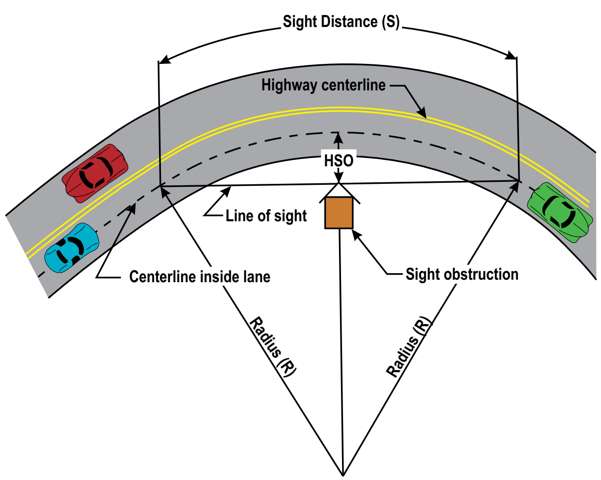
3.3.4. Sight Distance

Providing appropriate sight distance for horizontal alignments addresses the need for the driver to be able to identify and react to an obstruction in the roadway ahead. This distance is based on an assumed eye height of 3.5 feet (1.1 meters) for the driver and an object 2 feet (0.6 meters) high. As **Exhibit 3.15** shows, the stopping sight distance is measured along the centerline of the inside travel lane. The horizontal sightline offset (HSO) is a distance from the centerline of the travel lane to a chord drawn between the driver's eye and the object ahead.

Exhibit 3.15: Horizontal Stopping Sight Distance

Design Radius, R feet (meters)	Middle Ordinate, HSO feet (meters)	Design Speed mph (km/h)	Stopping Sight Distance, S feet (meters)
86 (26)	9 (5)	15 (30)	77 (31)
154 (47)	18 (6)	25 (40)	152 (46)
250 (76)	19 (6)	30 (50)	197 (63)
371 (113)	20 (8)	35 (60)	246 (83)
533 (162)	21 (8)	40 (70)	301 (105)
711 (216)	23 (10)	45 (80)	360 (129)
926 (282)	24 (11)	50 (90)	424 (156)

Note: When selecting a unit of measure in English units (mph or ft), only the English units apply to the corresponding row. The same is true for SI units (km/h or m).
Source: AASHTO, Green Book



$$HSO = R\left[1-\cos\left(\frac{28.65S}{R}\right)\right]$$

where:
HSO = Horizontal sight line offset, ft or m
S = Stopping sight distance, ft or m
R = Radius of curve, ft or m

THE DISTANCE REQUIRED TO IDENTIFY, REACT, AND STOP BEFORE HITTING AN OBJECT IN THE VEHICLE PATH IS THE STOPPING SIGHT DISTANCE.

3.3.4.1. Stopping Sight Distance

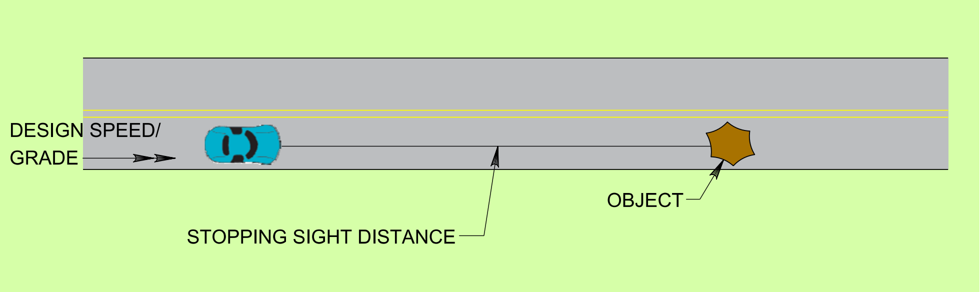
Exhibit 3.16 shows the calculated stopping sight distances for various design speeds. The correct stopping sight distance for a motorist to perceive and react to an object in the roadway should be provided at all locations along a roadway, including horizontal and vertical curves, and at intersections.

Exhibit 3.16: Stopping Sight Distance

STOPPING SIGHT DISTANCES FT (M)					
SPEED MPH (KPH)	LEVEL GRADE	DOWNGRADE		UPGRADE	
		3%	9%	3%	9%
15 (30)	80 (35)	80 (32)	85 (35)	75 (31)	73 (29)
25 (40)	155 (50)	158 (50)	173 (53)	147 (45)	140 (43)
35 (50)	250 (65)	257 (66)	287 (74)	237 (61)	222 (58)
45 (60)	360 (85)	378 (87)	427 (97)	344 (80)	320 (75)
55 (70)	495 (105)	520 (110)	593 (124)	469 (100)	433 (93)

Note: When selecting a unit of measure in English units (mph or ft), only the English units apply to the corresponding row. The same is true for SI units (km/h or m).

Source: AASHTO, Green Book



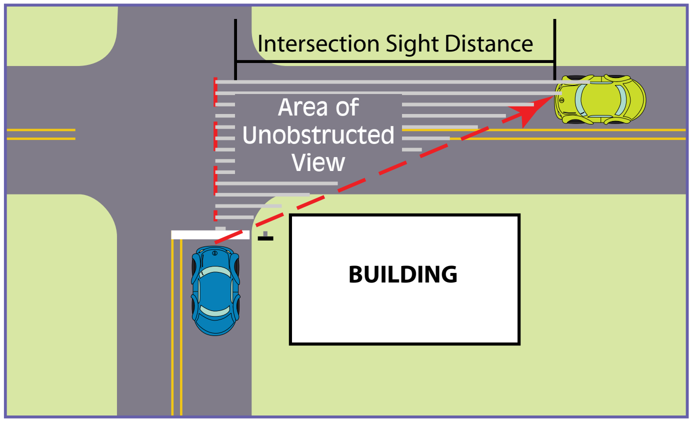
3.3.4.2. Intersection Sight Distance

Intersection sight distance is the sight distance required by drivers to see one another (i.e., the driver at the entrance on the minor road pulling out onto the major road and the driver traveling along the major road). The sight distance requirements vary based on the type of intersection traffic control. Section 9.5 in the AASHTO Green Book provides equations, calculations, additional information and traffic control scenarios for intersection sight distance.

Perhaps the most common form of traffic control that requires sight distance calculations is Stop Control. With Stop Control, the clear sight triangle required for two-way stop control is comprised of one leg being the distance from the center of the intersection to a point 14.5 feet from the edge of travelway on the minor roadway, and second leg being a calculated distance along the major roadway. In reference to the stopped vehicle in **Exhibit 3.17**, for left turn and crossing maneuvers from the minor roadway, this calculated 'sight' distance applies to both directions (i.e., major roadway traffic approaching from the left and traffic approaching from the right); however, for right turn maneuvers from the minor roadway, the calculated 'sight' distance applies only to the left side (i.e., major roadway traffic approaching from the left). The calculated distance varies based on vehicle type, speed, grade, skew angle, number of lanes to be crossed, median width, and movement type. Right turns require less sight distance than left-turns. Traffic crossing the intersection requires less distance than left-turns, and rarely govern over left-turns. Therefore, right-turn and left-turn sight distance must be provided for both side street approaches of a typical bidirectional four-leg intersection. **Exhibit 3.17** shows sight distance requirements for a passenger car on a flat grade at a stop controlled intersection with a two-lane roadway. SDDCTEA's BMTE calculator can be used to determine the required sight distances for other variables (such as grade, vehicle type, etc.) in this type of control, as well as other forms of traffic control. Section 4.5 of SDDCTEA Pamphlet 55-17 discusses sight distance requirements for other forms of traffic control.

Exhibit 3.17: Minimum Intersection Sight Distance

STOP CONTROL INTERSECTION SIGHT DISTANCES FT (M) AT LEVEL GRADE		
SPEED MPH (KPH)	MANEUVER FROM CROSS ROAD	
	LEFT TURNS	RIGHT TURNS AND CROSSING
15 (30)	170 (65)	145 (55)
25 (40)	280 (85)	240 (75)
35 (50)	390 (105)	335 (95)
45 (60)	500 (130)	430 (110)
55 (70)	610 (150)	530 (130)



VERTICAL CLEARANCE IS A MEASURE FROM THE HIGHEST POINT ON THE PAVEMENT TO THE LOWEST POINT OF THE OVERHEAD STRUCTURE.

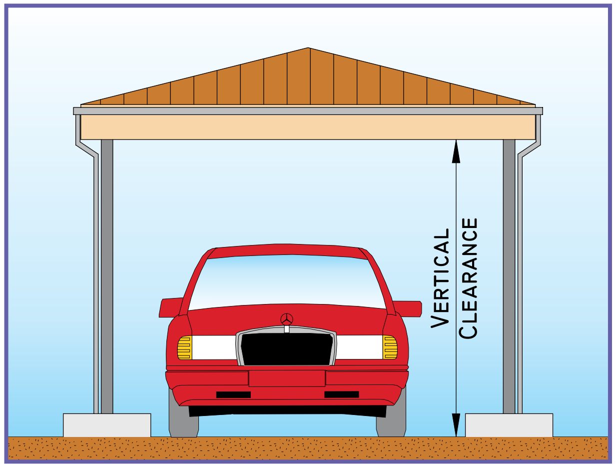
3.4. VERTICAL ALIGNMENTS

Vertical clearances are an important consideration in the ECF area since military installations can experience taller vehicles than normal conditions.

In areas where grade is a factor, the proper design of vertical curves is vital to the safety and security of an ECF. If a vertical curve is not designed properly, the approaching driver will have an insufficient amount of time to identify the ECF and any signals that the guard may be communicating. Also, an improperly designed vertical curve in the approach zone can contribute to rear-end crashes.

3.4.1. Vertical Clearance

Ample vertical clearance must exist at ECFs to permit the safe passage of large trucks, heavy equipment transporters, and engineering maintenance equipment.



Typically, public arterials and freeways are designed with a minimum clearance of **16 feet (4.9 meters)** plus an allowance for future resurfacing. Collector and local roads are designed with a minimum clearance of **14 feet (4.3 meters)** plus an allowance for future resurfacing. Per the UFC, at an ECF that will allow commercial traffic, 'the minimum desirable clear height (i.e., the vertical clearance from the highest point of the roadway to the lowest point on the canopy) must be **17.5 feet (5.3 meters)**'. This provides the minimum required clearance and a margin for future resurfacing. At ECFs that do not accommodate truck traffic, a minimum vertical clearance of **15.0 feet (4.6 meters)** is allowable. Emergency vehicles and buses should also be considered when planning an ECF; however, heights typically do not exceed that of the WB-67 (WB-20).

VERTICAL CURVATURE IMPACTS SIGHT DISTANCE. CURVES THAT ARE TOO STEEP CAN RESULT IN SIGNIFICANT SAFETY ISSUES.

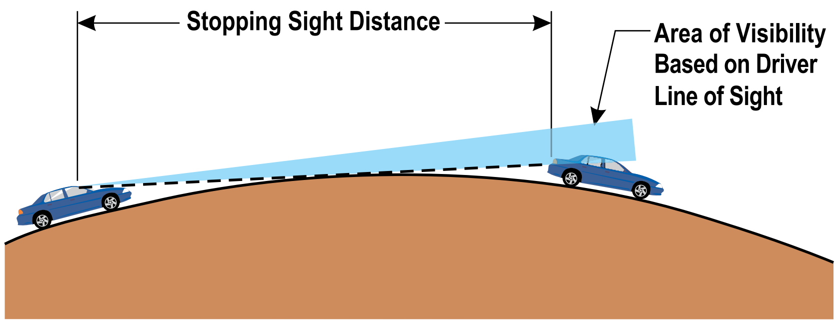
3.4.2. Vertical Curvature

Like horizontal curves, acceptable vertical curvature is dependent on the design speed of the roadway and the sight distance needed to identify and react to an object in the roadway. The stopping sight distance (SSD) for vertical curves is based on the driver's eye/headlight height of 3.5 ft for crests and 2.0 ft for sags. Acceptable vertical curves are defined by the rate of vertical curvature, commonly known as the "K" value. Rate of vertical curvature, K, is the length of curve per percent algebraic difference in intersecting grades (A), where $K = L/A$. The SSD values are the same for both crest and sag vertical curves, the only difference is in the K values. For a complete discussion about the K values, see the AASHTO, *Green Book*.

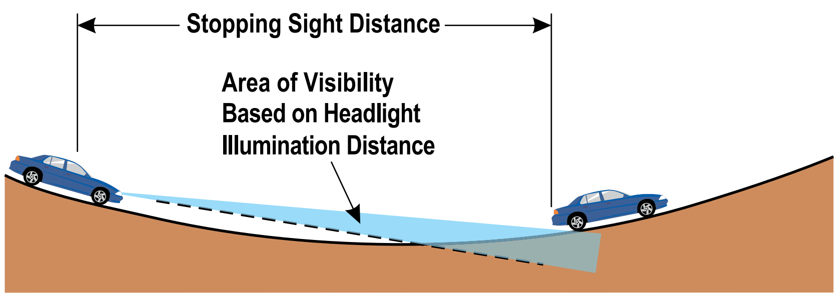
Exhibit 3.18: Stopping Sight Distance on Vertical Curves

Design Speed mph (km/h)	Vertical Stopping Sight Distance[1] feet (meters)
25 (40)	155 (50)
30 (50)	200 (65)
35 (60)	250 (85)
40 (70)	305 (105)
45 (80)	360 (130)
50 (90)	425 (160)

(1) Values are the same for crest and sag curves
Note: When selecting a unit of measure in English units (mph or ft), only the English units apply to the corresponding row. The same is true for SI units (km/h or m).
Source: AASHTO, Green Book



Crest Curve Stopping Sight Distance



Sag Curve Stopping Sight Distance

TRANSITION TAPERS SHOULD BE PROPERLY DESIGNED IN AN ECF TO CREATE A SAFE GRADUAL CHANGE IN ROADWAY ALIGNMENT.

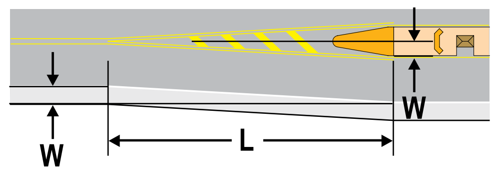
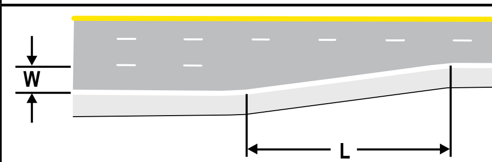
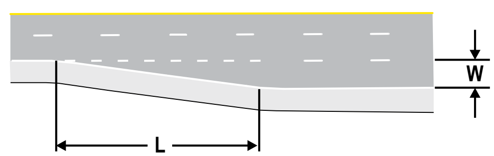
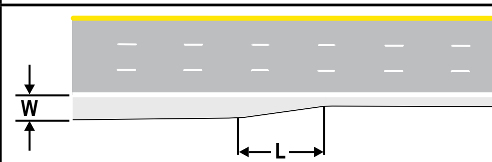
3.5. OTHER GEOMETRIC CONSIDERATIONS

3.5.1. *Transition Tapers*

A taper is a lateral shift in roadway alignment. Properly constructed tapers enhance safety and efficient use of pavement. They allow drivers to recognize a change in conditions and to react accordingly.

Tapers are typically based on calculations dependent on the width of the lateral shift (W) in feet and the design speed (S) in mph. In some cases, they are referenced in ratios of length of roadway to width of change. For example, 10:1 means that 10 feet (3 meters) of roadway length is needed for every 1-foot (0.3 meters) of lateral shift in width.

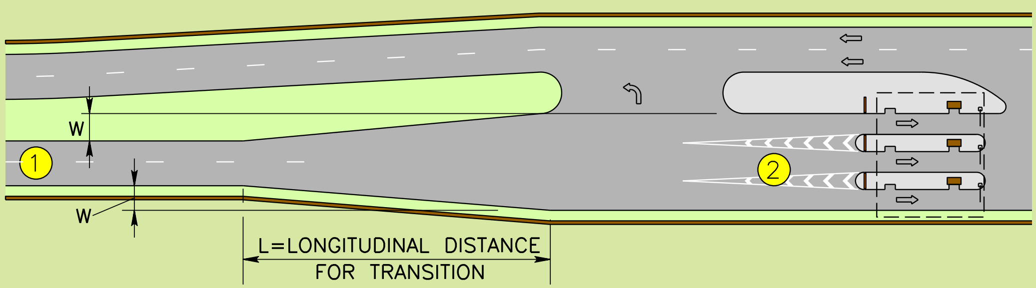
Exhibit 3.19: Transition Tapers

TYPE		CRITERIA	
LANE REDIRECTED Source: *MUTCD Fig 3B-15*		✓ Speeds less than 45 mph: $L = \frac{WS^2}{60}$ ✓ Speeds of 45 mph or more: $L = WS$	✓ Minimum L = 100 feet in urban areas ✓ Minimum L = 200 feet in rural areas
LANE REDUCTION Source: *MUTCD Fig 3B-14 and AASHTO Green Book Equations 3-37 and 3-38*		✓ Speeds less than 45 mph: $L = \frac{WS^2}{60}$	✓ Speeds of 45 mph or more: $L = WS$
LANE ADDED Source: *AASHTO Green Book Page 3-137*		✓ Speeds less than 45 mph: $L = \frac{WS^2}{90}$ ✓ Speeds of 45 mph or more: $L = \left(\frac{2}{3}\right) WS$	✓ Minimum L = 100 feet in urban areas ✓ Minimum L = 200 feet in rural areas
SHOULDER-TO-CURB TRANSITION Source: *SDDCTEA*		✓ All speeds: L=10W (10:1 ratio) is recommended	

W = Width of Lateral Shift (feet)
S = Posted, 85th-percentile, or Statutory Speed (mph)
L = Length of Taper (feet)

At ECFs, it is common to add processing lanes (lane and ID check island) when approaching the ID checkpoint. For example, a roadway may have two approach lanes, but may need five processing lanes and islands. For this condition, lanes are added and lanes are redirected. Since the 'Lane Redirected' taper calculation results in a more conservative length required, this equation is typically used to calculate the taper length. **Exhibit 3.20** provides an example calculation for determining the required length of roadway taper with a 25 mph (40 km/h) design speed assuming symmetrical widening (i.e., equal widening on both sides of the roadway). If asymmetrical (all lanes added to left or right) widening would require twice the transition since W is effectively doubled.

Exhibit 3.20: Example Approach Zone Transition for 25 mph (40 km/h) Design Speed



(1) Lane width is assumed to be 12 feet approaching transition area
(2) ID check width (ft) = 10-foot travel lanes + 10-foot ID check islands
(3) Assumes symmetrical (to both sides) widening
(4) Widths and distances are in feet

Given:
Approach Width = 24'
ID Check Area Width = 50'
Speed = 25 mph

Solution:
Change in Total Width (Lateral Shift) = 26'
For symmetrical widening, W = 26'/2 = 13'
Longitudinal Distance for Transition, $L = WS^2/60 = (13')(25mph^2)/60 = 135.4'$

Note: For asymmetrical widening, W = 26', resulting in $L = WS^2/60 = 271'$

ATTENUATORS IMPROVE SAFETY BY MINIMIZING OR ALTERING IMPACT FORCES DURING A CRASH.

3.5.2. Attenuators

Attenuators, or crash cushions, are used to prevent vehicles from colliding with fixed objects such as poles, large trees, buildings, and so forth, near the roadway. Such barriers minimize or alter impact forces on the car and driver by deflecting or gradually decelerating the vehicle. This also prevents damage to the fixed object, which may be more expensive to replace than a section of the barrier.

Attenuators can be used for any hazard but are particularly useful to shield ID check lanes. They provide the head-on protection that is not possible with a deflective barrier and are preferable for use at ECF ID checkpoints.

ID check islands are special cases. The island is vulnerable at the nose and from the side. In normal practice, the decision on whether to provide attenuator protection is based on traffic volume and speed. Although not always warranted from a design standpoint, SDDCTEA suggests attenuator usage at all primary/secondary ECFs in order to enhance guard and driver safety.

Impact attenuators must conform to FHWA *National Cooperative Highway Research Program Report 350* (NCHRP 350) or the Manual for Assessing Safety Hardware (MASH) criteria. It is critical to understand that strict specifications exist for the performance of attenuating devices. FHWA issues letters of eligibility of roadside safety hardware. Military installations are encouraged to ensure that impact attenuators in use conform to current criteria and are approved by FHWA.

NCHRP 350 identifies three evaluation factors that must be considered when testing a crash cushion:

✓ Structural Adequacy
  - Redirect vehicles
  - Provide controlled penetration
  - Provide controlled stopping of the vehicle

✓ Occupant Risk
  - Not enter the vehicle's passenger compartment
  - Not create projectiles for other vehicles and pedestrians in the area
  - Have the vehicle end in an upright position

✓ Vehicle Trajectory
  - Not intrude into other lanes of traffic

One significant factor that the MASH criteria considers is whether the fuel tank of the impacting vehicle remains intact.

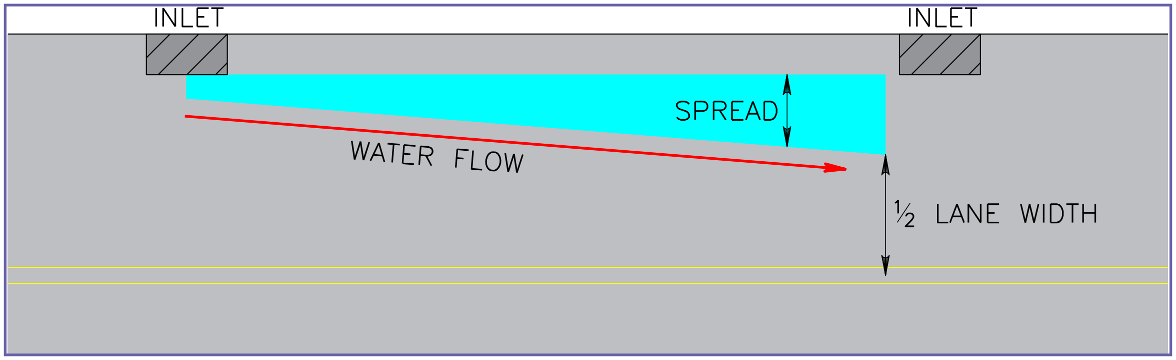
PROPER DRAINAGE IS IMPORTANT. DRAINAGE MUST BE CONSIDERED IN FINAL DESIGN OF AN ECF.

3.5.3. Drainage

Since it is desirable to have an ECF area that is relatively flat, control of water is very important. Standing water can decrease the overall efficiency of the ECF and create hazardous situations for ECF users. In cold weather climates, standing water is of paramount concern because of the potential for ice. All roadways should have a sloped cross section to facilitate the quick and efficient removal of water from the roadway. In roadway design, drainage design can dictate final alignment.

Since the ECF will often have curbs and gutters adjacent to the travel lanes, inlets should be provided to capture the water from the gutter and redirect it to an acceptable location. The minimum slope provided should be 0.5 percent. As the amount of water in the gutter increases, the velocity of the water also increases, causing the water to flow away from the gutter towards the travel lane or spread. The spacing of inlets is determined by the spread of water as it travels through the gutter. Normally, an inlet is required when the calculated spread reaches half the lane width. In other words, for a 12-foot (3.6 meter) lane, an inlet is required when the calculated spread reaches 6 feet (1.8 meters). However, this is just a rule of thumb; the local municipality or state department of transportation should be consulted to determine what the acceptable spread is in the area. For more information on calculating the spread for a facility, consult AASHTO's *Highway Drainage Guidelines*.

Exhibit 3.21: Inlet Spacing



CARE SHOULD BE TAKEN THAT LANDSCAPING DOESN'T RESTRICT SIGHT DISTANCE.

3.5.4. Landscaping

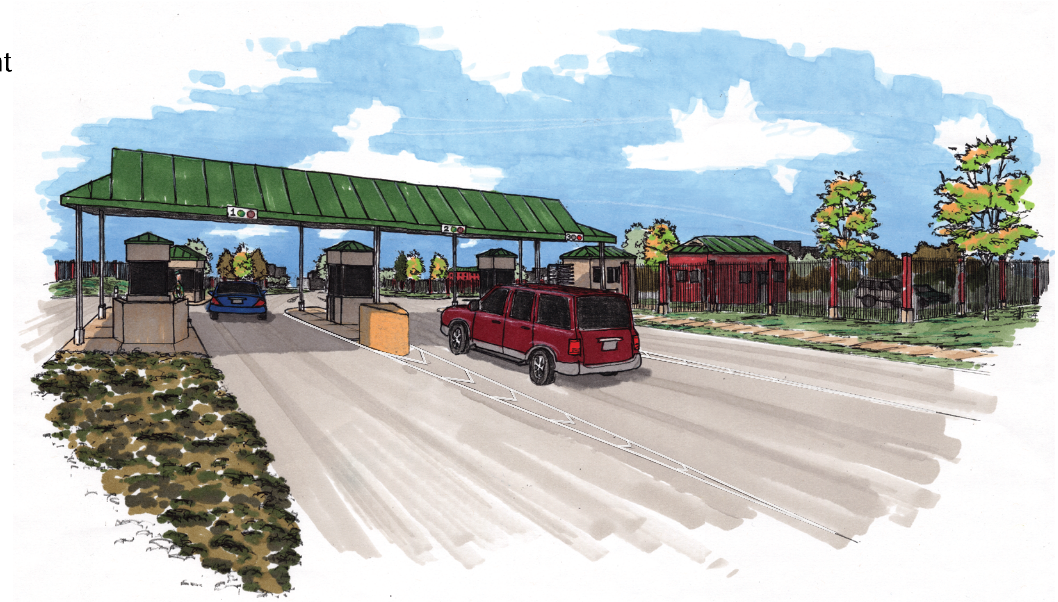
To integrate the ECF and approach roadways into the environment, landscape design principles should be considered during all design phases. For aesthetic and safety benefits, landscaping should not be confined to the ECF, but should continue into the installation.

Landscaping can help minimize erosion and reduce roadside maintenance requirements. It can make an ECF aesthetically pleasing, which is important since this often contributes to a visitor's first impression of installation facilities. When an option is selected, it should be evaluated to ensure proper lines of sight are provided for the overwatch position.

Plantings can be useful to:

- ✓ Screen housing and inspection areas
- ✓ Screen opposing traffic from headlight glare
- ✓ Prevent driver distraction
- ✓ Improve aesthetics surrounding the visitor center
- ✓ Improve aesthetics by blocking unsightly areas

Care should be taken that landscaping doesn't become a hazard or restrict sight distance. Trees in the clear zone should be limited to less than 4 inches (100 millimeters) in diameter.



3.6. OUTSIDE CONTINENTAL UNITED STATES (OCONUS) CONSIDERATIONS

OCONUS installations require special considerations. Each location may have its own unique requirements due to:

✓ Host country regulations
✓ Traffic codes
✓ Threat conditions
✓ Traffic volume
✓ Type of traffic (design vehicles)
✓ Security screening requirements for local national workers
✓ Requirements to design to local host nation standards

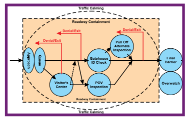
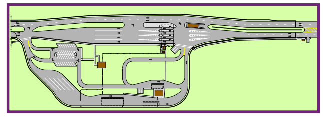
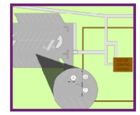
In addition to the challenges above, OCONUS installations often have limited real estate which can cause problems when designing a compliant ECF. Master planning is imperative in order to reserve the proper footprint for an ECF. When real estate isn't available, installations should consider alternative ECF designs in Section 1 and alternative AVB strategies in Section 8.

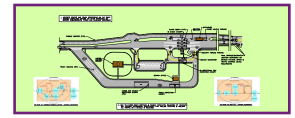
Note that per 32 C.F.R and AR 420-72, OCONUS installations must follow Host Nation Standards.

✓ 32 C.F.R. Subpart D—Traffic Supervision Title 32 - National Defense notes that it is the commander's responsibility to develop traffic codes based on the Status of Forces Agreement (SOFA) with the host nation.

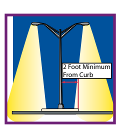
✓ AR 420-1 - The OCONUS installation streets and roads are to be considered an extension of the road system of the host country and shall use traffic control device standards and criteria of the host country.

Per the regulations above, traffic signs and pavement markings shall be in accordance with the Host Nation. When designing roadways to accommodate US and military design vehicles, US design standards should be evaluated as well and the more stringent standard applied. If a unique situation would arise, consult SDDCTEA for guidance.

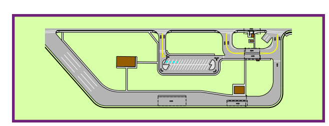






SECTION 4 - SPEED MANAGEMENT ISSUES








4. Speed Management Issues

THERE ARE THREE REASONS TO REDUCE SPEEDS IN THE ECF AREA:

- ❑ **SAFETY OF GUARDS AND MOTORISTS.**
- ❑ **CLEARER DISTINCTION BETWEEN THREATS AND EVERYDAY COMMUTERS WHO ARE SPEEDING.**
- ❑ **TO PHYSICALLY CONTROL THE MAXIMUM THREAT SPEED**

The control of vehicle speeds at ECFs is a common concern. There are two different types of speeding vehicles that must be considered at ECFs: threat vehicles, and everyday commuters who are speeding. It must be assumed that threat vehicles will attempt to travel as fast as possible through the ECF without regard for their comfort. Their speeds are only limited by geometry through horizontal curves and barriers. This is discussed more in Section 8. If everyday commuters are speeding, several other options such as traffic control, signing, or vertical deflections, can be effective to lower speeds. Everyday commuters would likely respect ID check guards and travel at speeds that are comfortable. As a result, other traffic calming options can be effective in lowering vehicle speeds.

The use of traffic calming strategies may be appropriate at select ECFs but must be evaluated by an engineering assessment.

There are methods available to the designer to reduce the speed in the ECF area in addition to the geometric design. However, as stated in the signing and pavement marking section of this text, signs, markings, and other speed reduction strategies should never replace a good design.

4.1. SPEED MANAGEMENT TECHNIQUES

4.1.1. Four E's

There are various ways to control the normal or non-threat motorists at ECFs. To control speeds in the ECF area, use the four E's as a guide:

✓ Engineering ✓ Enforcement
✓ Education ✓ Evaluation

As discussed in this manual, it is the responsibility of the engineer and maintenance staff to maintain the infrastructure of the ECF. Education of all users can help ensure that everyone understands their responsibilities. Education of users can be accomplished through outreach programs such as bulletins, newspaper campaigns, electronic mail, and other media sources.

Enforcement is the final but very critical aspect of the ECF. The enforcement of laws will greatly determine the safety and efficiency of the ECF.

4.1.2. Traffic Calming Devices

The chosen traffic calming device may be based on initial costs, traffic volumes, impacts to emergency vehicles, maintenance costs as well as impacts to the everyday commuters. Some common traffic calming devices are shown in **Exhibit 4.1**.

Exhibit 4.1: Traffic Calming Devices

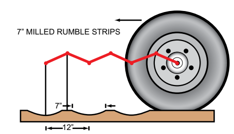
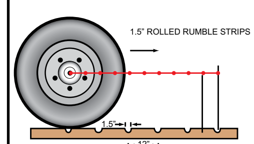
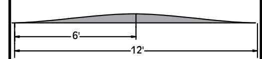
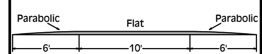
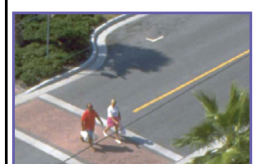
<table>
<tr><th colspan="2">Category</th><th>Application Restrictions</th><th>Installation Requirements</th><th>Benefits</th><th>Graphic</th><th>Other Issues</th></tr>
<tr><td colspan="2">Roadway Curvature</td><td>✓ Commercial vehicle access</td><td>✓ Must meet AASHTO design requirements</td><td>✓ Reduces speed
✓ Decreases required response zone length</td><td></td><td>✓ Need passive barrier to force threat vehicles to negotiate curve</td></tr>
<tr><td colspan="2">Roundabout</td><td>✓ None</td><td>✓ Must meet AASHTO design requirements</td><td>✓ Reduces speed
✓ Decreases required response zone length</td><td></td><td>✓ Need passive barrier to force threat vehicles to negotiate the roundabout</td></tr>
<tr><td rowspan="2">Rumble Strips</td><td>Milled Style</td><td rowspan="2">✓ Consider use when housing is not adjacent to the ECF
✓ Place far enough in advance so the sound created does not interfere with the guard's ability to communicate
✓ Embedded rumble strips may be allowed</td><td>✓ Longitudinal width of 7 inches (180 millimeters)
✓ Transverse width of 16 inches (400 millimeters)
✓ Depth of 0.5 inches (12) millimeters</td><td rowspan="2">✓ Reduces speeds and makes the driver aware of upcoming roadway features
✓ In a shoulder application, the PA Turnpike experienced a 70% decrease in run-off-road crashes</td><td></td><td rowspan="2">✓ Noise
✓ Snow removal
✓ Bicycles</td></tr>
<tr><td>Rolled or Formed Style</td><td>✓ Longitudinal width of 1.5 inches (38 millimeters)
✓ Spaced 8 inches (200 millimeters) apart
✓ Depth of 1.25 inches (32 millimeters)</td><td></td></tr>
</table>

Exhibit 4.1: Traffic Calming Devices (continued)

Category		Application Restrictions	Installation Requirements	Benefits	Graphic	Other Issues
Speed Humps	Watts Profile Style	✓ Recommended only for local streets having a posted speed limit of 30 mph (48kph) or less ✓ UFC approved for Installation at ECFs	✓ Longitudinal width of 12 feet (3.6 meters) ✓ Height of 3-4 inches (75-100 millimeters)	✓ 6.5-8.0 mph (10.5 -12.9 km/h) speed reduction		✓ Emergency vehicle response times ✓ Drainage ✓ Bicycles ✓ Proximity to intersections ✓ Grade ✓ Curves
Speed Humps	Seminole Style	✓ UFC approved for installation at ECFs	✓ Longitudinal width of 22 feet (6.7 meters) ✓ Height of 3-4 inches (75-100 millimeters)	✓ 6.5-8.0 mph (10.5 -12.9 km/h) speed reduction		
Textured Pavements		✓ Not suitable on roadways with speed limits of 45 mph or greater	✓ Natural colors that do not conflict with the MUTCD should be used ✓ Brick, cobblestone, stamped pavement are styles	✓ Minor speed reduction ✓ Improved aesthetics ✓ May create a minor rumble effect depending on style		✓ Noise depending on style ✓ Textured style may impact those in wheelchairs, strollers, etc.
Speed Warning Systems		✓ Locate outside clear zone	✓ Must be MUTCD compliant ✓ The speed warning system should display “YOUR SPEED XX, SAFE SPEED XX” or “YOUR SPEED XX, SPEED LIMIT XX”	✓ Speed reduction ✓ In Colorado, this system was installed and average speeds were reduced from 66 mph (106 kph) to 45 mph (72 kph)		✓ Maintenance

Note: Speed bumps are prohibited and should be removed or replaced with an acceptable speed hump design.

Exhibit 4.1: Traffic Calming Devices (continued)

Category		Application Restrictions	Installation Requirements	Benefits	Graphic	Other Issues
Roadway Narrowing		✓ Not suitable on roadways with an AADT above 10,000 ✓ Not suitable on roadways less than 20 feet wide	✓ Provide transitions into and out of lane narrowing ✓ Maintain at least a 10 feet lane	✓ Minor speed reduction ✓ Wider shoulders ✓ Additional separation from bike lanes/ sidewalks		✓ Minimal speed reduction without physical constraints (raised median, curbing, flexible delineator posts, etc) ✓ Maintenance ✓ Potential reduction in level of service
Flashing Warning Devices		✓ Locate outside clear zone	✓ Must be MUTCD compliant	✓ Can increase awareness and recognition of ECF features thus encouraging lower speeds		✓ Maintenance
Advance Speed Detection and Signing	Radar	✓ None	✓ Advance speed detection monitors speed of approaching vehicles and notifies guards ✓ It can be used to detect threats but can also be used to proactively encourage speed reduction	✓ Guards can warn motorists of speed making enforcement more proactive		✓ Privacy concerns ✓ Maintenance ✓ Operations
	Photo	✓ State legislation allowing use	✓ Advance speed detection monitors speed of approaching vehicles and notifies guards ✓ It can be used to detect threats but can also be used to proactively encourage speed reduction	✓ Guards can warn motorists of speed making enforcement more proactive ✓ Can track reoccurring offenders		✓ Privacy concerns ✓ Maintenance ✓ Operations

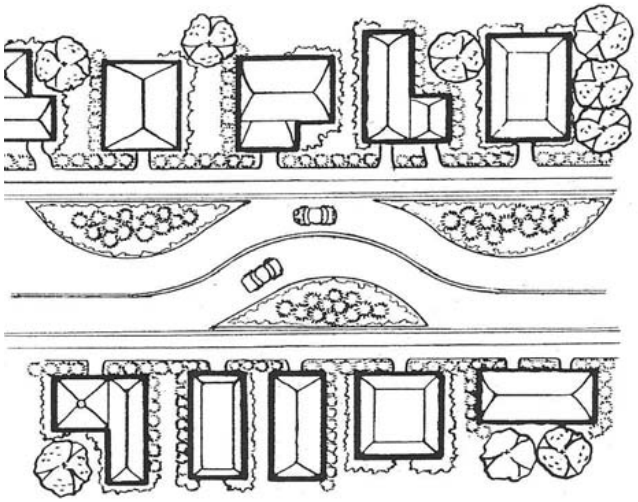
4.2. ROADWAY CHICANES

A chicane is a serpentine curve used to reduce vehicle speeds and typically provides horizontal deflection by using bulbouts or introducing curvature along the roadway. **SDDCTEA does not recommend using in-roadway bollards or barriers to create a chicane on a tangent section of roadway.** Chicanes act as a restraint to capacity and could have negative safety effects due to curvature with sharper radii that are not commonly experienced by motorists. It is recognized that without other viable means to physically slow vehicles, chicanes are a viable means of retrofitting an existing ECF to limit a threat vehicle speed.

In non ECF uses, a chicane made by roadway curvature or bulbouts is most appropriate on two-lane, two-way streets or one-lane, one-way local streets.

At ECFs, chicanes are often created by blocking lanes with in-roadway bollards or barriers. These are most commonly used to reduce a roadway from two or more lanes in one direction to one. Note that leaving other gaps is not appropriate. Three lanes reduced to two provides no security benefit since a threat vehicle can travel through the middle lane. Four or five lanes reduced to two would require two vehicles to navigate the chicane side by side, thereby increasing potential for sideswipe collisions and being a generally unexpected and confusing configuration. A chicane should not be used if the width of the original roadway is less than two lanes since a gap would be open in the middle thereby not providing adequate deflection to slow travel paths. An exception to this would be if the entire roadway is built with the chicane curvature. Depending on type of barrier used, chicanes can be removed for peak times and put back in place during other hours so as to not constrain capacity during the peak periods.

A chicane can allow for landscaping improvements in the areas not taken up with pavement. However, it is important to use low-lying shrubs and vegetation so that sight lines are not obstructed; this applies to any objects placed in these areas. It is also crucial to utilize retroreflective pavement markings to properly delineate the chicane during nighttime conditions.



Source: PennDOT Publication 383, Traffic Calming Handbook

4.2.1. Chicane Options

Chicanes can be formed through the use of several different types of barriers. Some barriers are intended to be removed easier or quicker than others, while some barriers remain in the roadway on a permanent basis. The table on the following page summarizes different types of barriers. Note that when the word permanent is used to describe a barrier, it implies that the barrier can be removed with equipment if needed, perhaps for special events, but is not removed regularly to accommodate peak traffic.

For a chicane to be effective at limiting the maximum attainable speed of a threat vehicle in an ECF area, 8-inch curbing or passive barriers must be used. SDDCTEA studies have shown that vehicles traveling more than 25-mph will become disabled when striking 8-inch curbing; however, a vehicle can traverse the curbing at very low speeds. This is acceptable since the function of the 8-inch curb is to mitigate the high speeds of a threat vehicle.

In-Roadway Barriers

In-Roadway Bollards

Chicane Comparison

Barrier Type	Considerations
Concrete Barrier	• Often commonly available • Large surface for delineation • Considered to be passive barrier • Permanent installation since difficult to move
Water-Filled Barrier	• Often commonly available • Large surface for delineation • Considered to be passive barrier when used properly • When used properly, permanent installation since difficult to move or refill. • Often used incorrectly without water
Bollard	• Smaller surface but since multiple bollards are used per lane, can be delineated adequately • Can be a passive barrier • Can be easily removed by able-bodied personnel
8-Inch Curbing	• Not a passive barrier • Disabling for vehicles traveling over 25 mph • Tested safe for non-threat vehicles while still disabling or damaging to threat vehicles • Allows tractor trailers to navigate over without damaging wheels and tires. • Precast and doweled into pavement
Swing Gate	• Not tested as a passive barrier • Variable strength based on construction • Easy to open for peaks • Frame allows for large surface for delineation

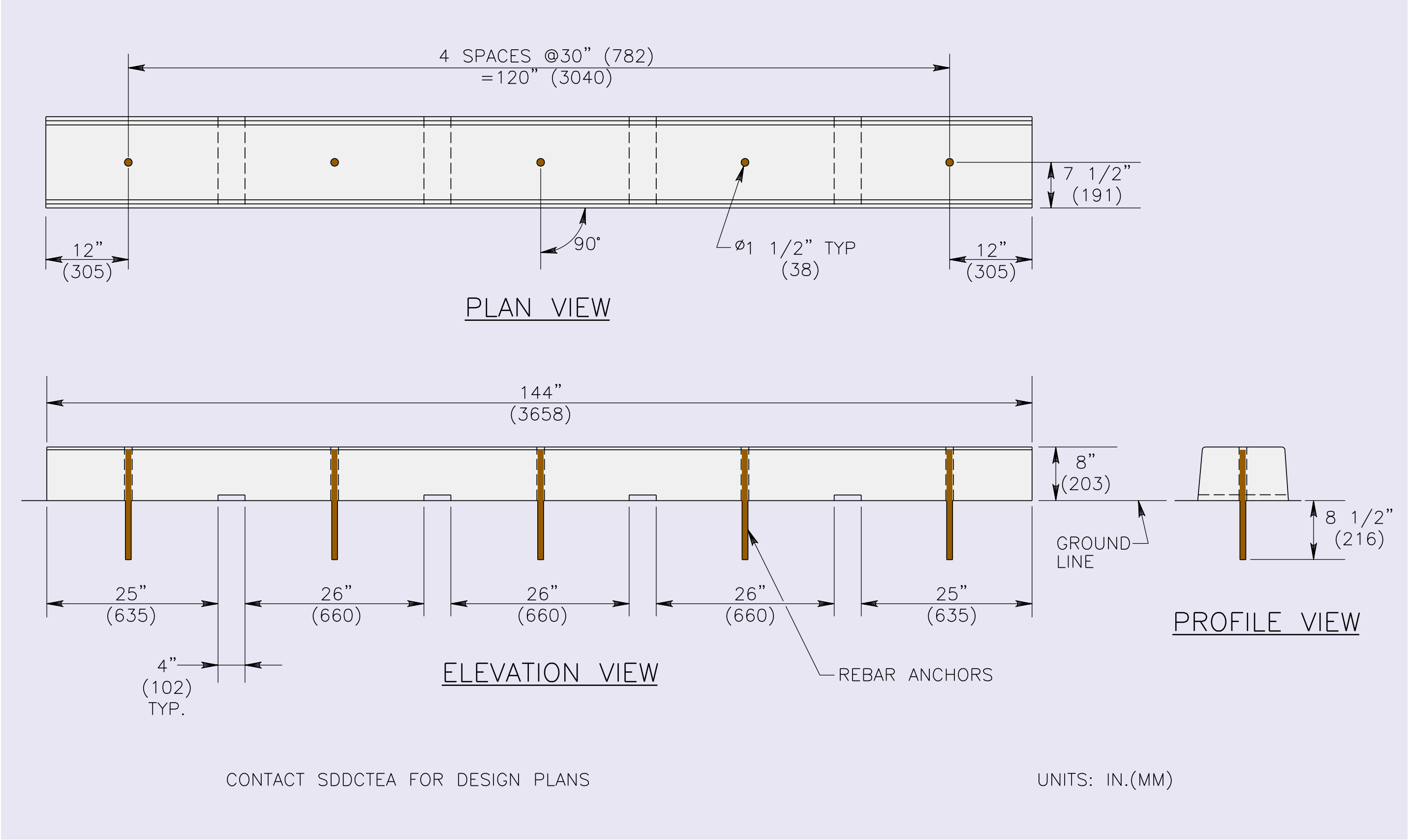
In-roadway bollards or barriers have been deployed at numerous military installations in order to provide security benefits by limiting vehicular speeds and movements. **SDDCTEA does not endorse the use of in-roadway bollard or barrier systems and encourages other design options to address security concerns (e.g., installing 8-inch curbing doweled into the pavement).** However, installations often see it as the only temporary means of controlling traffic before a permanent fix can be installed.

Since a bollard is a fixed object like a tree or utility pole, existing standards such as the *MUTCD* and AASHTO Roadside Design Guide discourage their use. Also, bollards are not continuous like other barrier systems. Vehicular impacts may result in significant penetration increasing the potential severity of the crash. In some vehicles, bollards may penetrate the passenger compartment depending on the vehicular speed upon impact.

Some installations use swinging gates rather than bollards to accomplish similar results as a chicane. Rather than the bollards in the roadway, swinging gates can be retracted to a fully open position more easily than removing the bollards. While they are still not endorsed by SDDCTEA, since they are in use, the preferred delineation is shown in **Exhibit 4.5**. Use the same layout guidelines as with a bollard chicane, but use the panel attached to the gate instead of retroreflective tape for the red and white delineation.

In an attempt to increase roadway safety when using an in-roadway system, SDDCTEA has tested and found that an 8-inch high precast section of curb will disable vehicles traveling at 25 mph or more. The 8-inch curb design in **Exhibit 4.2** has been safety tested and is intended to be used as an in-roadway barrier to create chicanes (as shown in **Exhibit 4.3** and **Exhibit 4.4**), replacing the (detrimental) bollards, crash gates and the Type F concrete barriers.

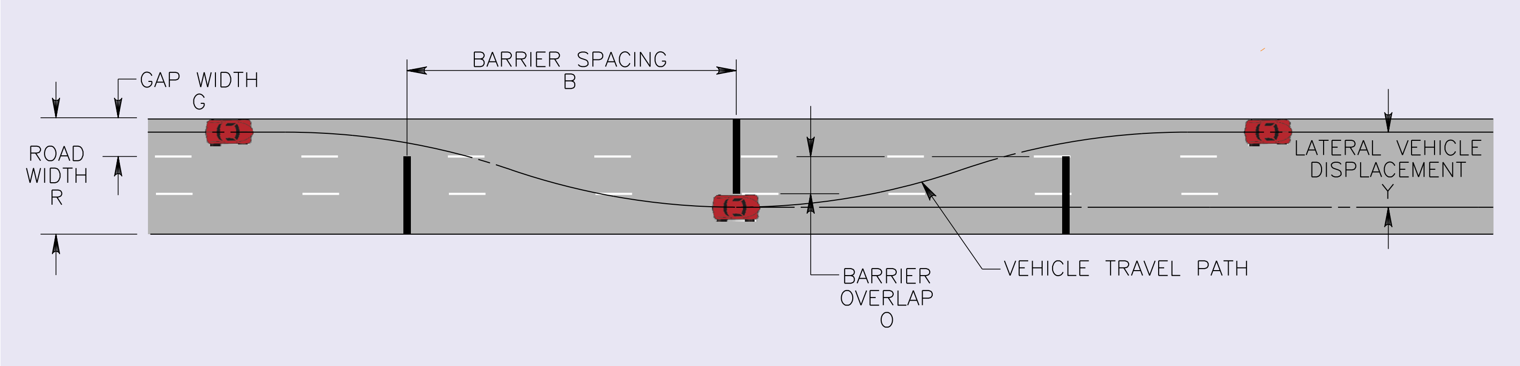
Exhibit 4.2: SDDCTEA Vertical Precast Concrete Curb



4.2.2. Chicane Spacing

SDDCTEA has performed a research and physical testing study to determine the appropriate chicane layout and spacing based on roadway width and threat vehicle design speeds, for chicane designs with or without accomodating trucks. For designs without trucks, consider the need for all vehicles that may need to use the gate, including school buses and emergency vehicles. Exhibits 4.3 and 4.4 show the recommended barrier spacing. **Exhibit 4.3**, the aggressive chicane barrier design, has a closer barrier spacing which does not allow for truck access, while **Exhibit 4.4**, the standard chicane design, is spaced to accommodate trucks. The aggressive chicane is intended to be used with three barriers. The standard chicane should be used with four barriers. When selecting design speed, consider amount of space available for chicane placement, as well as the actual speed desired.

Exhibit 4.3: Aggressive 3-Chicane Barrier Design With 12-Ft Chicane Gap Width
(Barrier Spacing Based on Road Width)

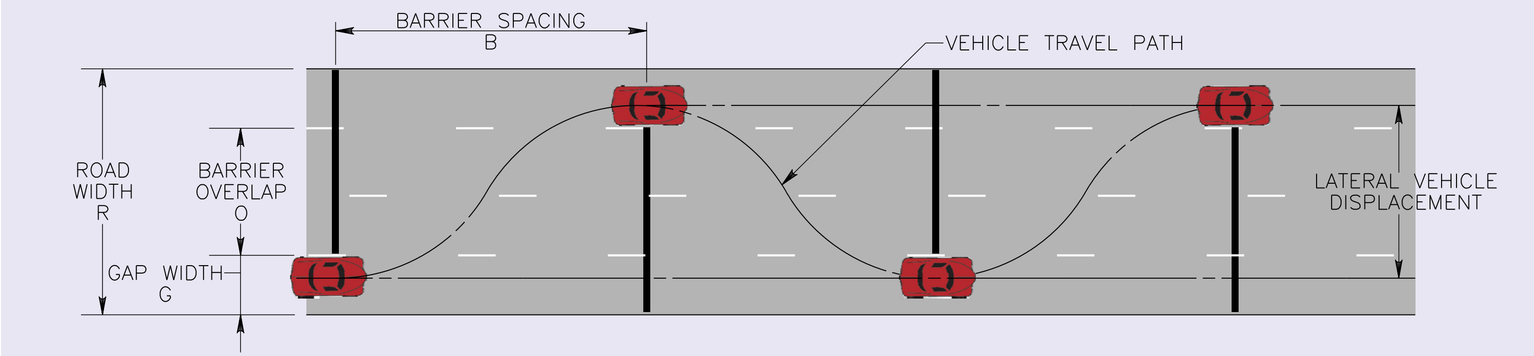


	12-ft Gap Opening, G								
	Aggressive Barrier Spacing, B, (ft), based on Road Width, R								
Threat Design Speed, V (mph)	**R=20 ft**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
25	NR[1]	29	39	48	56	64	71	77	84
30	NR	35	47	58	68	77	85	93	100
35	NR	41	55	67	79	89	99	108	117
40	NR	47	63	77	90	102	113	124	134
45	NR	53	70	87	101	115	128	139	150
50	NR	59	78	96	113	128	142	155	167
55	NR	65	86	106	124	141	156	170	184
60	NR	71	94	116	135	153	170	186	201
65	NR	76	102	125	146	166	184	201	217
70	NR	82	110	135	158	179	198	217	234
75	NR	88	117	144	169	192	213	232	251
Barrier Overlap, O (ft):	NR	1	6	11	16	21	26	31	36

1: NR = Not recommended. A 12-ft wide chicane gap opening, G, used in conjunction with a 20-ft roadway, R, will leave a 4-ft, unobstructed path down the centerline of the road.

NOTE: Barrier spacing does not accommodate large trucks passing through noted chicane designs.

Exhibit 4.4: Standard 4-Chicane Barrier Design With 12-Ft Chicane Gap Width
(Barrier Spacing Based on Road Width)



	12-ft Gap Opening, G								
	Barrier Spacing, B, (ft) Based on Road Width, R								
Threat Design Speed, V (mph)	**R=20 ft**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
15	NR[1]	23	30	34	37	39	41	41	41
20	NR	30	39	46	52	55	59	61	63
25	NR	38	49	59	66	71	77	82	85
30	NR	45	59	70	79	86	93	99	105
35	NR	52	68	81	92	101	110	117	124
40	NR	62	80	94	106	118	128	136	142
45	NR	72	91	106	121	135	147	154	160
50	NR	77	99	116	131	146	160	168	176
55	NR	82	108	126	142	157	172	182	191
60	NR	90	117	137	155	172	187	199	210
65	NR	99	126	148	168	186	203	216	230
Barrier Overlap, O (ft):	NR	1	6	11	16	21	26	31	36

1: NR = Not recommended. A 12-ft wide chicane gap opening, G, used in conjunction with a 20-ft roadway, R, will leave a 4-ft, unobstructed path down the centerline of the road.

NOTE: Chicane designs which permit SUTs, buses, and WB-67 tractor-trailers (i.e., trailers up to 53 ft long) to pass through are denoted in blue. Barrier spacing does not accommodate trucks with longer trailer lengths.

4.2.3. Chicane Traffic Control

If used, chicanes require proper traffic control to alert motorists of the condition. The proper delineation of barrier placements is critical to increase traffic safety and avoid operational conflicts. Red and white retroreflective markings (such as tape) must be installed on the barrier to improve barrier delineation, though the specific type of material used for barrier delineation will vary by type of barrier. In addition, chicanes need appropriate advance warning signing, and the travel paths through the chicane must be delineated using signs with traffic cones or panels.

The recommended traffic control for an in-roadway chicane system is shown in **Exhibit 4.5** and **Exhibit 4.6**.

Exhibit 4.5: Traffic Control Plan for In-Roadway Chicane System

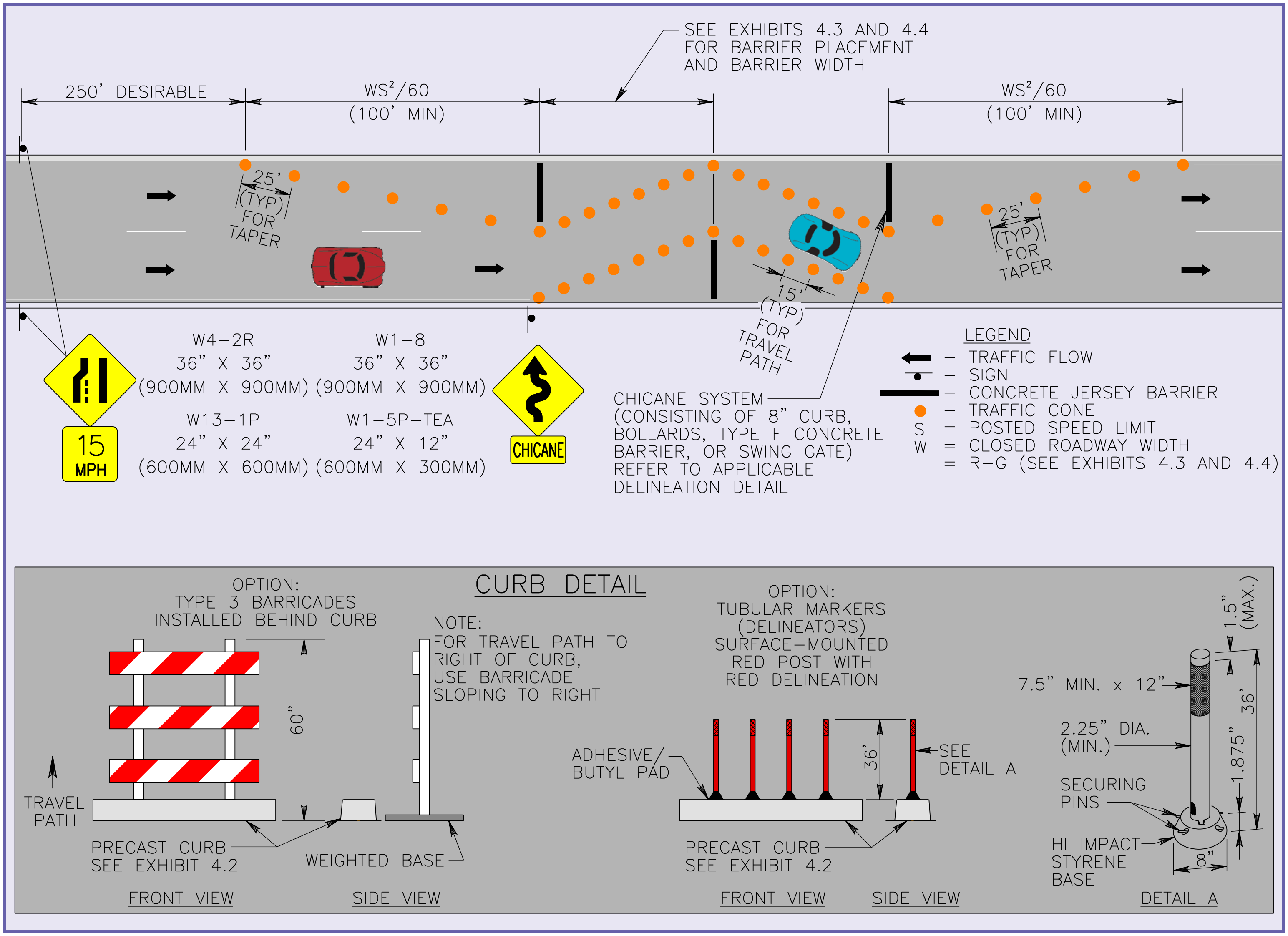
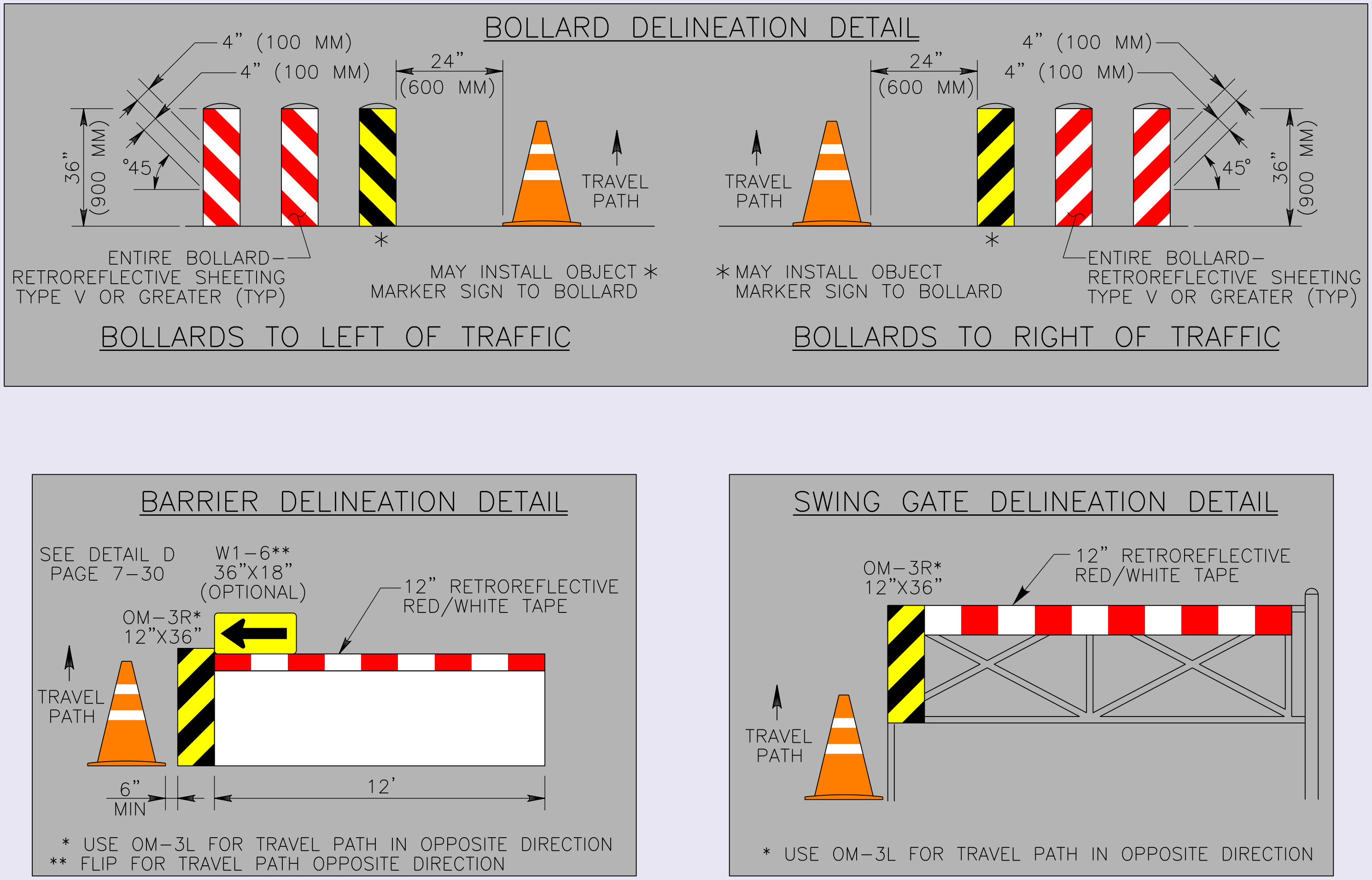


Exhibit 4.5: Traffic Control Plan for In-Roadway Chicane System (Continued)



SPEED HUMPS DO NOT HAVE A SIGNIFICANT IMPACT ON THREAT VEHICLES; HOWEVER, THEY CAN BE USEFUL FOR GAUGING THE INTENT OF A MOTORIST AND REDUCING THE SPEEDS OF NON-THREAT VEHICLES BOTH IN THE INBOUND AND OUTBOUND DIRECTIONS PRIOR TO THE ID CHECKPOINT.

4.3. ADDITIONAL TRAFFIC CALMING DEVICES FOR ECFs

4.3.1. Speed Humps

While speed humps are commonly found in residential areas and other low volume roadways, they can also be used at ECFs. Although SDDCTEA has done extensive testing that shows speed humps do not have a significant impact on threat vehicles, they can be useful for gauging the intent of a motorist and reducing the speeds of non-threat vehicles both in the inbound and outbound directions prior to the ID checkpoint.

Guidelines for implementing speed humps at ECFs are shown below. Note that the guidelines assume that there are no major geometric measures already in place (i.e., chicanes, roundabouts, etc.) to reduce vehicle speeds.

ECF Zone*	Guidelines
Approach Zone *(Installation boundary to the beginning of the last rejection point prior to the ID check area.)*	✓ In most cases, a single speed hump is appropriate. ✓ Place at least 150 feet from the ID checkpoint. ✓ For approach zones greater than 400 feet, an additional set of speed humps can be installed to keep vehicle speeds below 25-mph throughout the zone. ✓ Speed humps should not be placed in the outbound direction since they can meter traffic into the adjacent intersection external to the ECF.
Access Control Zone *(End of the approach zone to the end of the last rejection point after the ID check area.)*	✓ Speed humps should not be placed in the inbound direction as it can only cause inefficiencies in operation at the ID checkpoint. ✓ In most cases, a single speed hump is appropriate for the outbound direction just before the ID checkpoint to reduce the speed of vehicles as they pass the ID check area.
Response Zone *(End of all inspection access and rejection points to the active vehicle barriers.)*	✓ Speed humps are not recommended in the response zone for the inbound direction since they would have no effect on response time or the safety of the ECF personnel. ✓ Speed humps can be placed in the response zone for the outbound direction to reduce vehicle speeds as they approach the ID check area.

** Refer to Exhibit 1.9 for an illustration of the ECF Zones.*

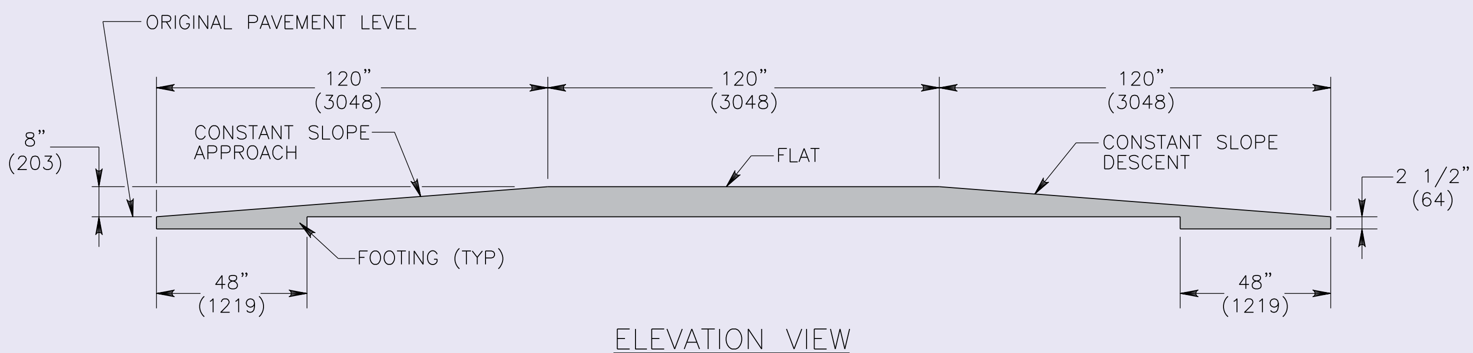
In cases where there are geometric measures in place, speed humps are not recommended since the geometry should already reduce vehicle speeds and the addition of a speed hump would have negative impacts on operations.

THE SDDCTEA AGGRESSIVE SPEED TABLE IS INTENDED FOR USE WHEN THE INSTALLATION DEEMS IT NECESSARY TO INSTALL A MORE AGGRESSIVE DESIGN; HOWEVER, THE WATTS PROFILE AND SEMINOLE PROFILE ("FLAT TOP") HUMP DESIGNS ARE STILL PREFERRED.

4.3.1.1. Aggressive Speed Table

SDDCTEA conducted research to design an aggressive speed hump that optimized comfort and safety for motorists driving over them. Tested for comfort and safety for compact, sports, and large cars, as well as motorcycles and cars pulling different types of trailers; the optimal speed hump has a height of 8 inches, a 10-foot approach slope, and a 10-foot long speed table; as well as a departure slope symmetrical to the approach slope. This speed hump design is intended to be used when a more aggressive design is desired, but the Watts or Seminole profile is still the preferred speed hump design. Note that speed humps do not mitigate threat vehicle speeds on tangent sections, but can be used to gauge intent of approaching vehicles. **Exhibit 4.6** shows the recommended agressive speed table design.

Exhibit 4.6: SDDCTEA Aggressive Speed Table



NOTES

1. VERTICAL DOWELS AND/OR BENT RODS WILL BE EPOXIED INTO THE CONCRETE TARMAC. DRIVEWAY MESH OR REINFORCEMENT PER INSTALLER PREFERENCE WILL BE USED EVERYWHERE ELSE.
2. MILLING, SUCH AS CURB GRINDING, WILL LIKELY BE NEEDED TO ANCHOR THE SPEED HUMP ENDS INTO THE TARMAC.
3. FOOTING DIMENSIONS ARE APPROXIMATE.
4. USE CONCRETE WITH MIN f'c=4 ksi (27.6 MPa).

UNITS: IN.(MM)

AT INTERSECTIONS WITH BALANCED APPROACH VOLUMES THAT SATISFY MULTIWAY STOP OR TRAFFIC SIGNAL WARRANTS, A ROUNDABOUT CAN BE USED TO REDUCE VEHICLE CONFLICTS WHEN NEITHER A MULTIWAY STOP OR TRAFFIC SIGNAL IS DESIRED.

4.3.2. Roundabouts

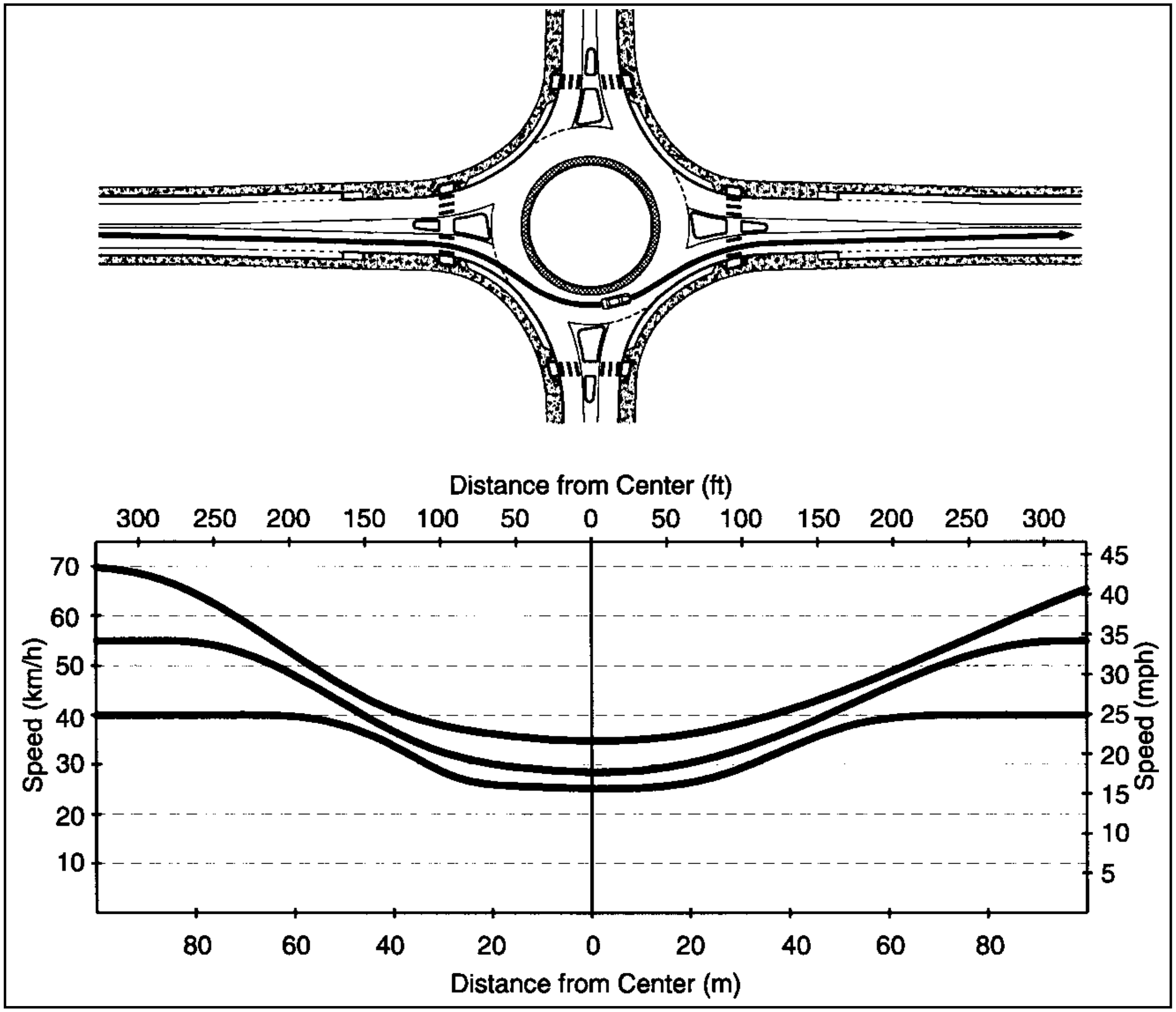
A roundabout is a channelized intersection at which all traffic moves counterclockwise around a central traffic island. They can be used to reduce vehicle conflicts at intersections with balanced approach volumes that satisfy multiway stop warrants or traffic signal warrants when neither of these improvements are desired. Though roundabouts can be aesthetically pleasing, they are costly to construct. However, the improvement may provide an acceptable benefit-to-cost ratio due to the minimal costs to maintain when compared to the operation and maintenance costs of a signalized intersection.

Two key characteristics of any roundabout include:

✓ Entering traffic must yield to circulating traffic.
✓ Each approach has a splitter island designed to slow traffic and to ensure that all vehicles travel in the proper direction around the central island.

Roundabouts come in different sizes depending on the traffic volume, available footprint, and design vehicle. The geometry coupled with the yield condition at each approach can result in a significant reduction in travel speeds. **Exhibit 4.7** shows the speed transition of typical vehicles (initially traveling 25, 35, and 45 mph) approaching and negotiating a roundabout in the eastbound direction. As a vehicle approaches the roundabout, the vehicle begins to decelerate approximately 150 to 300 feet in advance of the roundabout, with vehicles initially traveling faster decelerating farther in advance. Vehicles in the circulatory roadway operate at approximately the same speed, between 15 mph and 25 mph, in the roundabout.

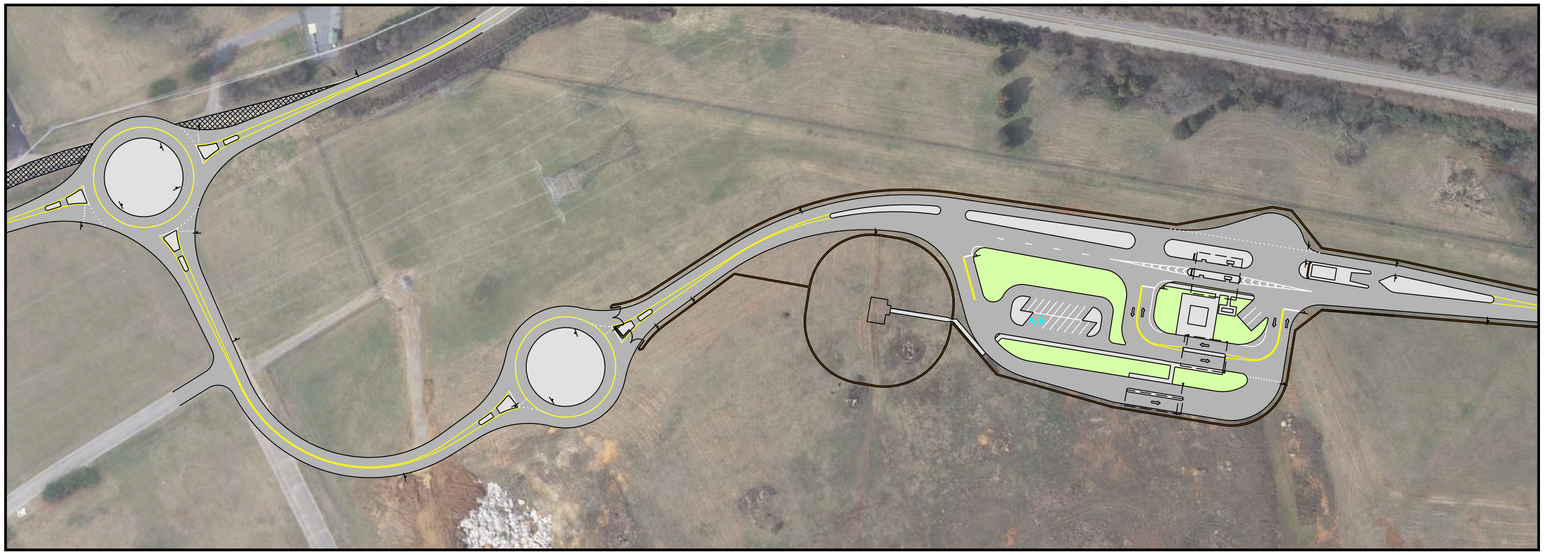
Exhibit 4.7: Sample Theoretical Speed Profile at Roundabouts



Source: Roundabouts: An Informational Guide, FHWA

While roundabouts are typically used at intersecting roadways, they can also be used on a tangent section of roadway to introduce roadway curvature and thereby reduce speeds. **Exhibit 4.8** shows an example of two roundabouts used in an ECF design: one at the intersection external to the ECF and a second roundabout used in the approach zone of the ECF. Since a turnaround prior to the ID check is required by UFC 4-022-01, the roundabout can fulfill this requirement if designed for rejecting a commercial vehicle (WB-67). Like the chicane, roundabouts have the potential to reduce the speed of a threat vehicle if 8-inch curbing is utilized around the central traffic island.

Exhibit 4.8: Roundabout at ECF Example



Background Image Source: Google Earth

STUDIES PROVE THAT IN-LANE RUMBLE STRIPS PROMOTE SAFER STOPPING BEHAVIOR ON APPROACHES TO STOP-CONTROLLED INTERSECTIONS, SIMILAR TO THE ID CHECK AREA OF AN ECF.

STUDIES ALSO SHOW THE USE OF TWO SETS OF STRIPS (MIN), RATHER THAN ONE, RESULTS IN A GREATER DIFFERENCE IN SPEEDS.

4.3.3. Transverse Rumble Strips

Rumble strips are a series of either bumps or depressions in the pavement. They are intended to alert drivers of a special situation, such as a speed reduction or stop ahead condition. They are typically 1/2 to 1 1/2 inches high or deep, 3 to 4 inches wide and placed 90 degrees to traffic flow.

Rumble strips produce both an audible rumble and a vibration that creates an awareness of a condition for which a driver must react. They are used most frequently on shoulders of high-speed roadways to alert drivers that they are not driving in the travel lanes of a road. They are also commonly installed transversely to alert drivers in rural or high-speed areas of an unexpected stop-ahead condition.

Some research has been conducted on transverse (in-lane) rumble strips. The Minnesota Department of Transportation conducted a series of three studies that evaluated the strips on approaches to stop-controlled intersections; this would be most applicable for ECFs since motorists must come to a stop.

In all three studies, drivers reduced speed earlier and to a greater extent at intersections with rumble strips. The three studies provide compelling evidence that in-lane rumble strips promote safer stopping behavior on approaches to stop-controlled intersections. Stopping behavior is safer when rumble strips are installed because drivers slow down earlier on the approach and thus they have more time to respond to an unexpected event (e.g., a slippery road surface).

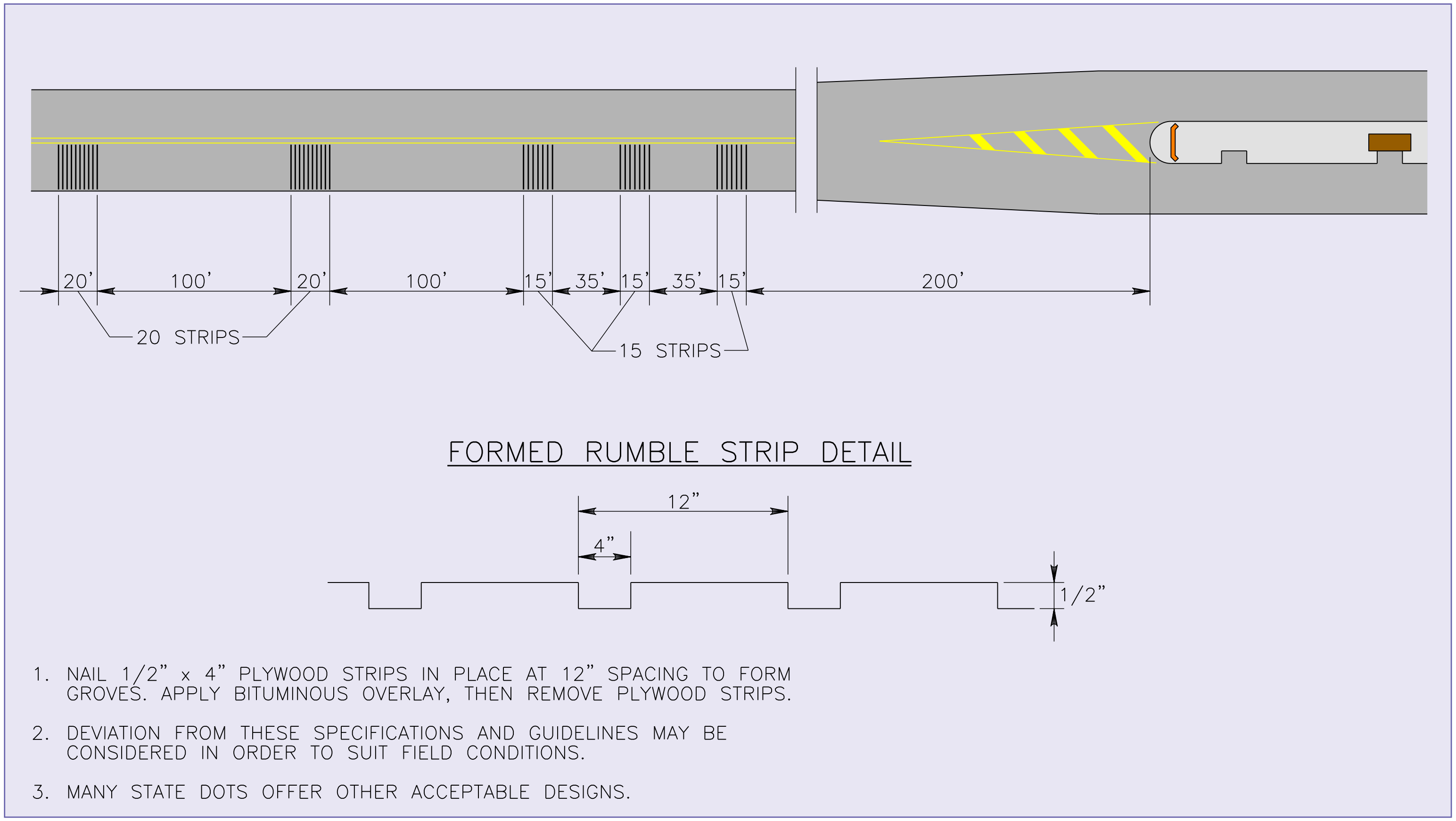
The Texas Department of Transportation and FHWA conducted a similar study at rural intersections. In order to gauge the effectiveness of in-lane rumble strips on driver speeds, rumble strips were installed on 14 approaches to rural intersections. An analysis of the speed data revealed a small and statistically significant decrease, generally 1 to 2 mph in mean and 85th percentile speeds on the approaches. The largest difference in mean speeds occurred between two sets of rumble strips.

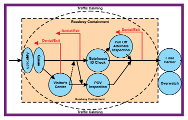
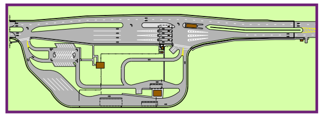
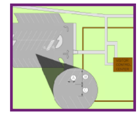
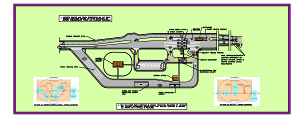
4.3.3.1. Design Guidelines for Transverse Rumble Strips

Several state departments of transportation have developed their own design guidelines for use of transverse rumble strips. **Exhibit 4.9** is one example illustration of rumble strips used in an ECF approach zone.

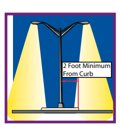
The two common rumble strip styles are the milled style and the rolled or formed style; both are appropriate for ECFs. Rumble strips applied to the surface are for temporary situations such as work zones and are not recommended for ECFs. When considering the placement of rumble strips, ensure that they are placed far enough advance of the ID checkpoint so the sound created does not interfere with the guard's ability to communicate. Additionally, they should not be placed in an ECF that is adjacent to residential areas where the noise can disturb residents.

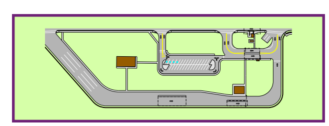
Exhibit 4.9: Detail for Transverse Rumble Strips



SECTION 5 - MULTIMODAL CONSIDERATIONS



5. Multimodal Considerations

PROVIDE DEDICATED PERSONNEL AND FACILITIES WHEN THE PEDESTRIAN TRAFFIC EXCEEDS TEN USERS PER 15- MINUTE PERIOD DURING THE PEAK ONE HOUR OF VEHICULAR TRAFFIC.

The use of transit as well as pedestrian and bicycle activity should be considered while analyzing the conditions at an existing ECF or developing a new ECF. All modes should be accommodated to the appropriate level at ECFs. Accommodating alternate modes of transportation can help reduce the demand of vehicles seeking entry during peak periods.

A simple way to analyze multi-modal conditions is to create a survey for installation personnel. The survey should identify existing conditions/operations and if additional services, infrastructure, or operations were improved, would personnel utilize them.

5.1. PEDESTRIANS

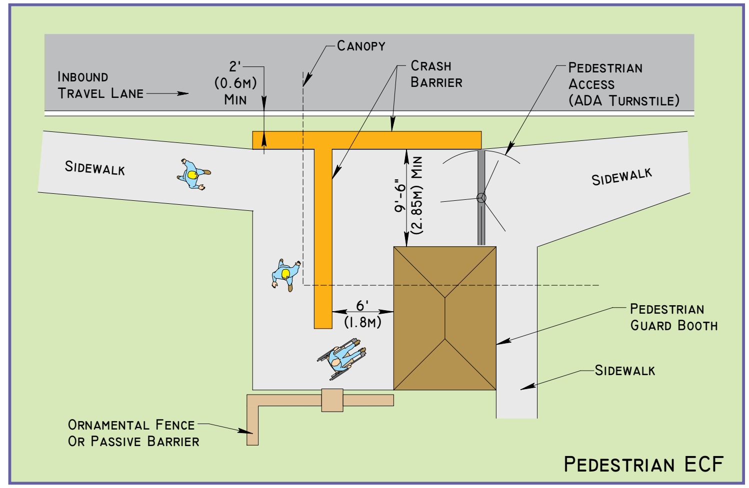
It is important to accommodate alternative modes of transportation at the ECF. Pedestrian design features should be included to promote a healthy lifestyle and reduce the vehicular congestion in the ECF area.

When a high level of pedestrian activity is present, the erection of a dedicated pedestrian ECF should be considered to better accommodate the demand. A dedicated pedestrian ECF may be warranted when pedestrian volume exceeds 10 users per 15-minute period during the peak hour, assuming vehicular traffic is constant through that hour. Additional congestion and delay for vehicles may occur if a dedicated pedestrian facility is not provided. If vehicle arrival rates fluctuate throughout the peak hour, the ID check guard may have adequate time to hold traffic and verify credentials of the pedestrian without creating excessive delay for motorist.

Where pedestrian access is warranted, sidewalk and crosswalks shall be provided. The number of pedestrian crossings should be minimized at ECFs to enhance safety, security, and operations. Pedestrian access should be avoided along the outbound lanes where security and the safety of pedestrians and ID check guards may be compromised. When pedestrian traffic is light, ID check guards can process pedestrians. When pedestrian volumes exceed 10 users during a 15-minute period of the peak hour of vehicular traffic, a separate pedestrian gate is needed. There are two types of pedestrian gates, manned and unmanned. Manned pedestrian gates have a dedicated pedestrian ID checkpoint. Unmanned pedestrian gates could operate by card access and PIN entry. Unmanned pedestrian gates can be useful where pedestrian security threats are considered low and it would be impractical to provide manning for a pedestrian checkpoint. Manned pedestrian checkpoints are needed where pedestrian volumes are higher, or where pedestrian threats are higher. Depending on installation needs, manned pedestrian checkpoints could require metal detectors and package scanners. These features could be more common at OCONUS installations. Either way, perimeter fencing (as illustrated on page 6-3) could be used to funnel pedestrians to the Visitor Control Center to be processed there.

Due to the variable nature of pedestrian checking, pedestrian rates are not available. The processing rate of a card reader style gate can vary based on the amount of time to scan a card and enter a PIN, speed of communication equipment, and whether interaction from SF staff is needed from a remote location. Capacity of manned pedestrian checkpoints varies based on requirements for the checkpoint and manning. If a metal detector and package scanner is used, capacity will depend on manning of the checkpoint and how efficiently each position operates.

When providing any pedestrian accommodations, compliance with the ABA is required, including curb ramps, wheelchair friendly ECFs, adequate crossing width, and other provisions as outlined in the act. Curb ramps should be less than a 12:1 slope and include a landing area and a tactile surface.



Pedestrian ECF

5.1.1. Pedestrian Campuses

An idea that can be considered for small installations where most destinations are within walking distance, or for larger installations where the housing areas are very close to the BX, commissary, schools, other shopping areas, restaurants, and MWR facilities, is to create a pedestrian campus without vehicular traffic. Vehicular parking lots are located at the perimeter of a pedestrian zone, then people walk from their cars to their destination. If people work, live, shop and recreate in a small area, they do not need their automobiles on a day-to-day basis. Vehicular-pedestrian conflict locations are reduced, traffic capacity problems are eliminated, and the campus promotes a healthy lifestyle. Some vehicular traffic would still have access to these areas, including delivery, maintenance and emergency vehicles.

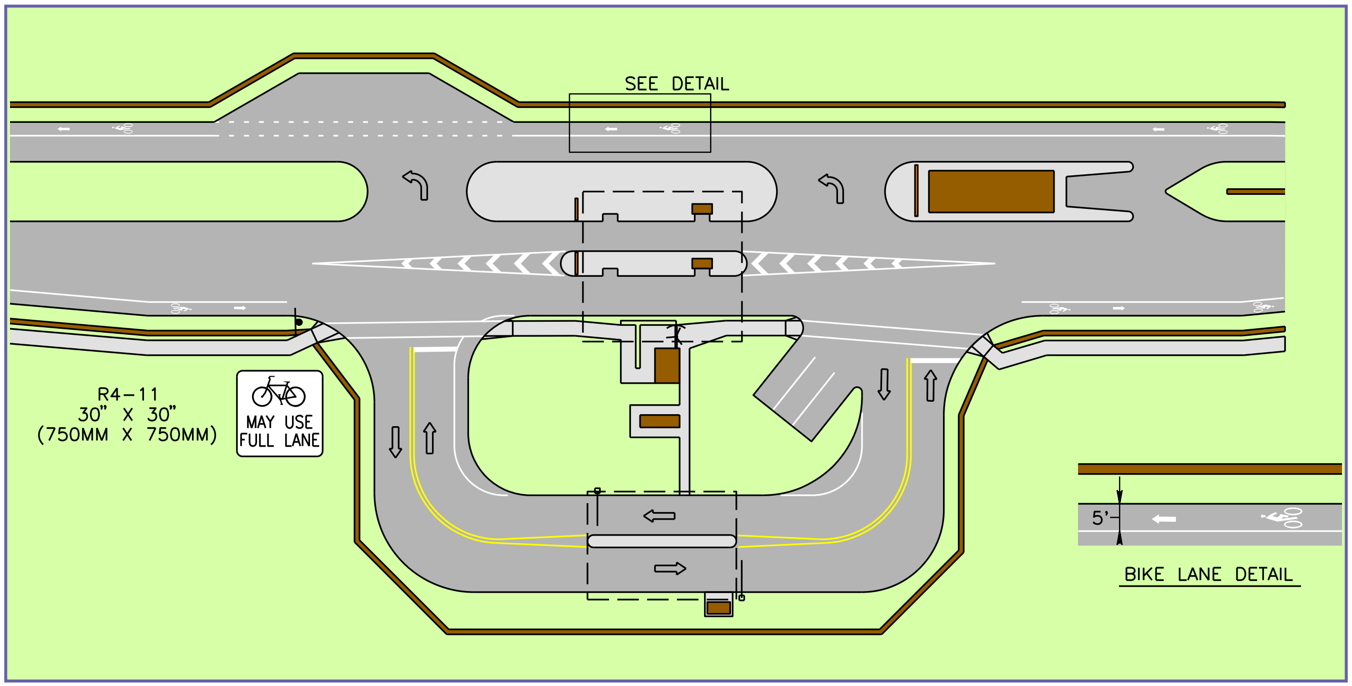
Depending on the configuration, the parking lots on the perimeter of these areas could either be secure or unsecure. If it is secure, the primary access to the parking lots should be located right after an ECF. If it is unsecure, there would be a pedestrian gate between the parking lot and the campus; however, an ECF for vehicular traffic granted access to the campus would still be required.

5.2. BICYCLES

As fuel costs continue to increase, many commuters are being forced to consider alternative modes of transportation such as bicycles. Bicycling provides a sustainable mode of transportation while promoting a healthy and affordable lifestyle. Bicycle lanes and design features shall be considered to reduce congestion and increase safety for both cyclist and motorist in the ECF area.

When bicycle activity through an ECF is present, designated bicycle lanes should be considered in the approach and response zones to better accommodate users. If bicycle lanes are to be provided, the inbound approach bike lane shall transition into a shared use lane at the ID check to assist security personnel in the vetting process. The bike lane should begin again after the ID Check area to improve traffic flow onto the installation.

Where bicycles are permitted to share the road with motor vehicles, shared lane markings (sharrows) may be used. Shared lane markings are typically utilized where the travel way is too narrow for both a motor vehicle and bicycle to travel side by side within the same traffic lane. Shared lane markings encourage safe passing of bicyclists by motorists and reduce the incidence of wrong-way bicycling.



Bike lanes provide a safe travel lane for cyclists while producing a traffic calming effect on motorist. When providing bicycle accommodations the following guidelines should be utilized:

- ✓ Provide minimum width of 5 feet
- ✓ Utilize bicycle safe drainage grates
- ✓ White edgeline(s) and bike symbol pavement markings are required
- ✓ Provide shared use markings and USE FULL LANE signing at the ID Check Area
- ✓ Bike lane signs are optional
- ✓ Provide minimum width of 10 feet for multi-use paths where pedestrians and bikes are expected
- ✓ Shared lane markings (sharrows) should not be placed on roadways that have a speed limit above 35 mph

5.3. TRANSIT AND PARK-N-RIDE SERVICES

At military installations, the younger service members are likely to value their personal transportation. However, the installation should consider if other installation personnel would be interested in using public transportation. Below are two types of transit arrangements to consider.

✓ External service provided on installation (with guard at higher FPCONs)
- Most efficient
- Guard can help minimize security risks, but security may still be an issue since some passengers are not destined to the installation

✓ External/internal services meet at transit center
- Requires dedicated on-installation service—may get transit to provide or share service
- Requires transit center
- Allows for park-n-ride opportunities at transit center

Park-n-ride is an external parking lot where motorists can leave their vehicles and be picked up by transit vehicles to be taken to their final destination. If a park-n-ride area is provided, consider offering incentives for usage such as, time off or discounts at stores on the installation. The cost of the incentives program can be offset by the infrastructure's continued serviceability. The park-n-ride can be located near the visitor control center and integrated with the transit center.

If transit service currently exists, discontinuing that service should be viewed as a last resort if security concerns cannot be accommodated. Before any decision to eliminate or restrict transit service is made, the ridership's impact on the ECF processing capability should be considered. If a new ECF is being planned, at a minimum a basic transit stop should be considered as part of an ECF design with turnaround capabilities before the ID check area if needed. **Exhibits 5.1** and **5.2** depict examples of transit stops at an ECF.

Exhibit 5.1: Transit Stop in Approach Zone

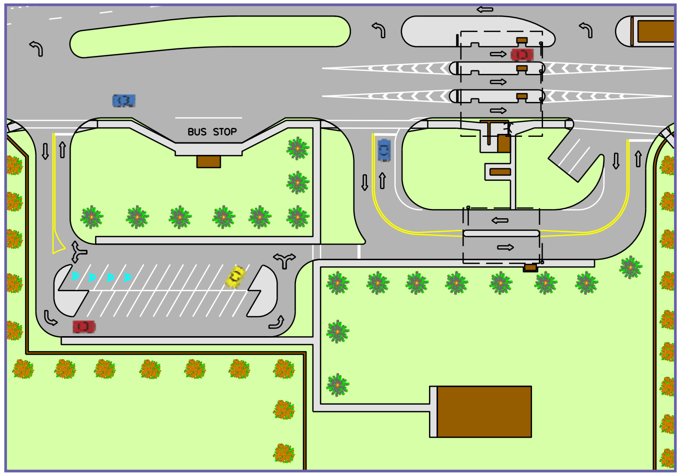
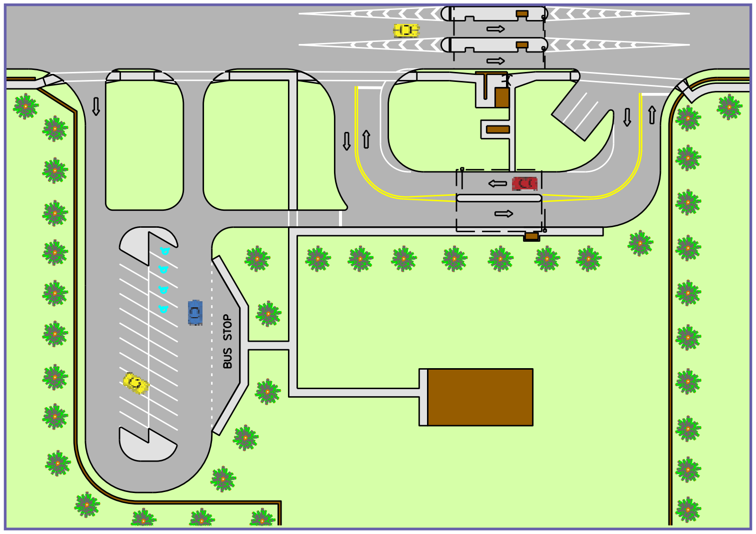
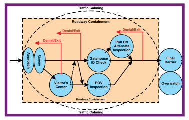
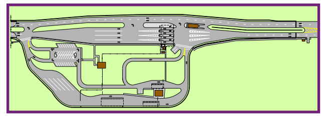
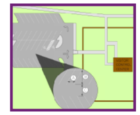
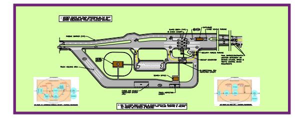


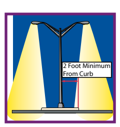
Exhibit 5.2: Transit Stop in VCC Parking Lot



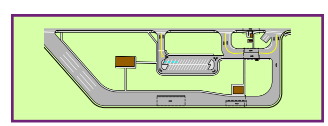






SECTION 6 - BUILDING AND FACILITY CONSIDERATIONS








6. Building and Facility Considerations

- ❑ Visitor control center
- ❑ Gatehouse
- ❑ Guard booth
- ❑ Canopies
- ❑ Inspection areas
- ❑ Truck inspection areas
- ❑ Overwatch

UFC 4-022-01 and other reference materials provide requirements and guidance on the design of buildings and facilities at ECFs. *UFC* Series 4-020, *Security Engineering* provides guidance on the design of facilities. The appearance of the facilities should be in accordance with the installation exterior architectural plan. Consult UFC 4-010-01 or service-specific, local AT/FP guidance when considering building standoffs for ECFs. Additional information regarding standoff distances is provided in **Chapter 8**.

The purpose of this section is to highlight issues involving the design of those facilities as they relate to the overall ECF, including traffic and safety engineering. Care must be taken to ensure facilities are adequately sized to accommodate traffic and usage. Be sure that no facility creates roadside hazards or limits sight distance. Roadways, as well as pedestrian facilities, connecting buildings need to be designed to accommodate facility users while maintaining the desired operational flow patterns.

Facilities at the ECF should provide a comfortable, safe working environment for security personnel. The basic considerations in determining the size of the facility are:

- ✓ Number of personnel assigned during normal operations
- ✓ Usage
- ✓ Space required for electronic, electrical, and mechanical equipment, and counter or work space

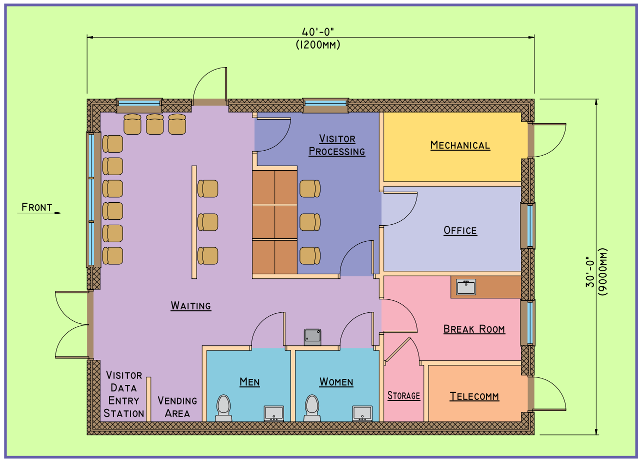
6.1. VISITOR CONTROL CENTER

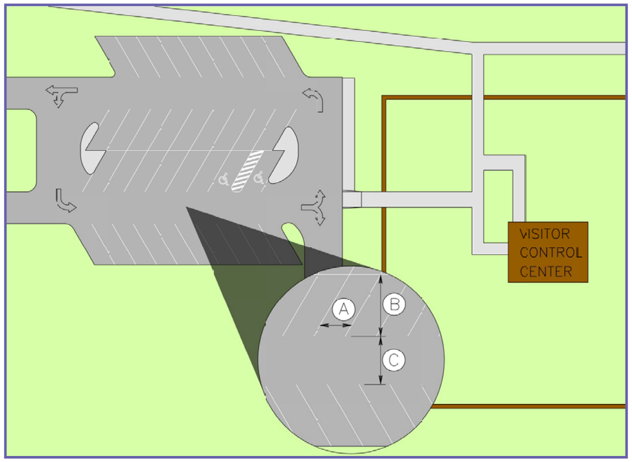
Every installation should have a visitor control center (VCC). If an installation is composed of separate physical sites, each site may need its own VCC. **The VCC should be able to process a minimum of twelve to twenty visitors per hour per processor.** The processing capacity required is determined by the peak hourly visitor demand at the installation, the number of processors, and the time it takes to process. Where appropriate, future demands and accommodations for installations with special periodic demands (education at facilities, etc.) should be considered. Adequate parking should be provided for all visitors and employees. Parking should be angled since angled parking is preferred over 90-degree parking in short-term parking applications. To reduce pedestrian-driver conflicts, parking aisles should be oriented so that pedestrians walking along the aisles are facing the VCC. This orientation will limit the pedestrian and vehicle conflicts in the parking area.

The building and surrounding site should be highly visible and should be understandable to visitors. The building and site should be designed and constructed in accordance with the ABA and should include reserved accessible parking, curb ramps, and sidewalks. The VCC may need to meet stand-off distance if it is considered an "inhabited" facility (see UFC 4-010-01). If an "inhabited" VCC cannot meet the required distances, it may need to be hardened.

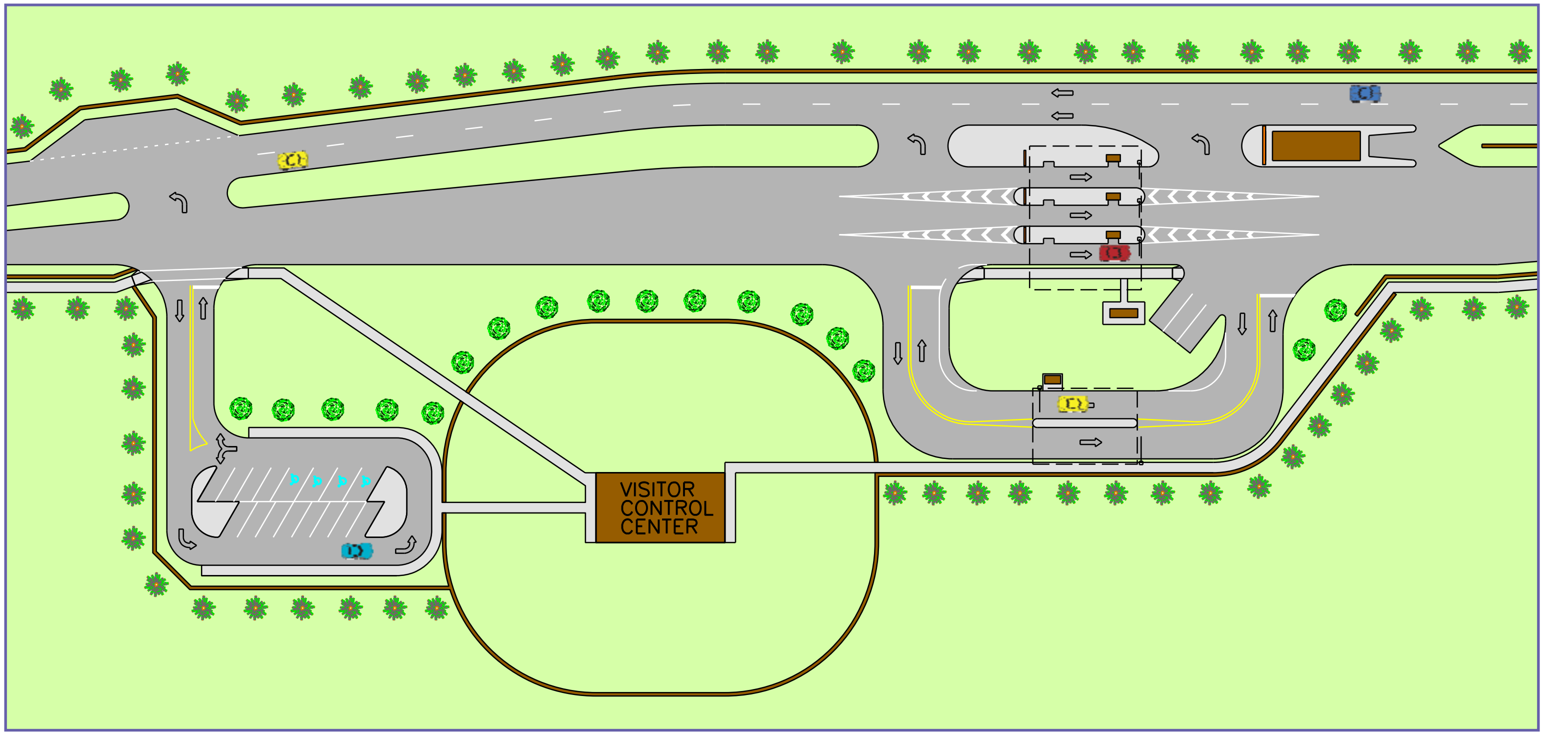
Exhibit 6.1: Visitor Control Center Parking Dimensions

Parking Dimensions		45-degree Parking	60-degree Parking
A	Stall Width feet (meters)	12.7 (3.9)	10.4 (3.2)
B	Stall Depth feet (meters)	19.5 (5.9)	20.5 (6.2)
C	One Way Aisle Width feet (meters)	12 (3.7)	16 (4.9)





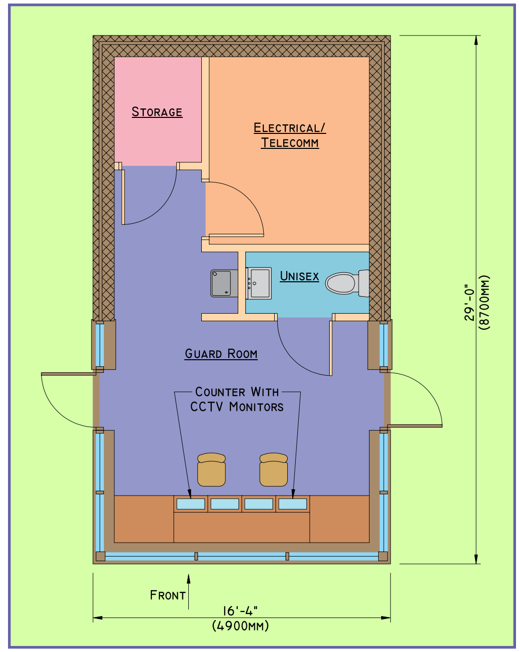
Where high pedestrian or transit rider volumes are anticipated at ECFs, consider utilizing the VCC to process pedestrians. Perimeter fencing could be utilized to force all pedestrians to pass through the VCC to be vetted instead of performing the process at the ID check area.



A GATEHOUSE IS THE CENTRAL CONTROL CENTER FOR AN ECF.

6.2. GATEHOUSE

The gatehouse serves as the central control center for the ECF by providing shelter for security personnel and controls for the vehicle barriers, traffic control devices, access controls, lighting, and surveillance equipment.

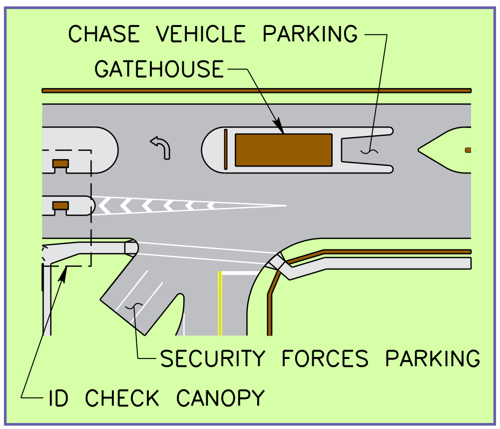


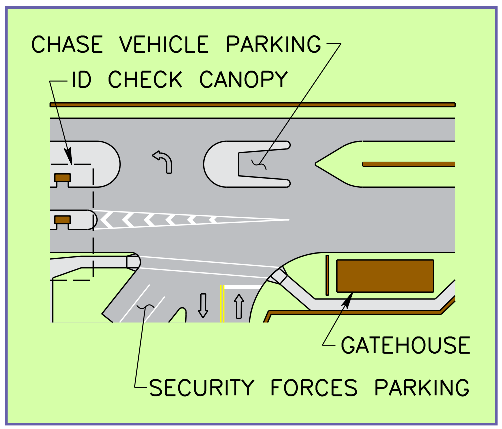
The gatehouse is typically located in the median or on the right shoulder.

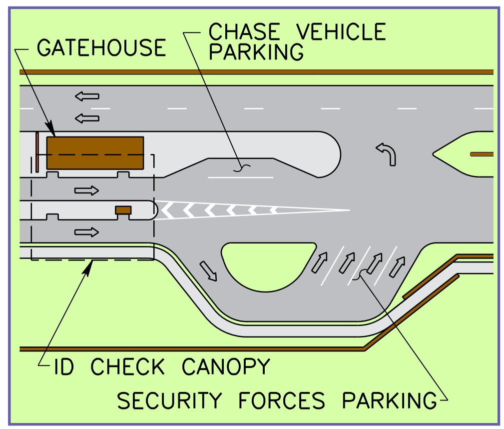
- ✓ Some branches of the military collocate the gate house with the ID check area for logistical and operational reasons.
- ✓ Other branches put the gatehouse immediately after the ID check area and vehicle turnaround so that they can oversee any rejections.

Where appropriate, it is beneficial to provide parking for security forces staff in close proximity to the gatehouse. At a minimum, one space for a chase vehicle should be sited as close to the gatehouse as practical. The chase vehicle parking should be located for quick response and should be sized for the planned response vehicle.

Parking turnouts can provide a location for chase vehicle parking as well and can be used as an alternative inspection area.

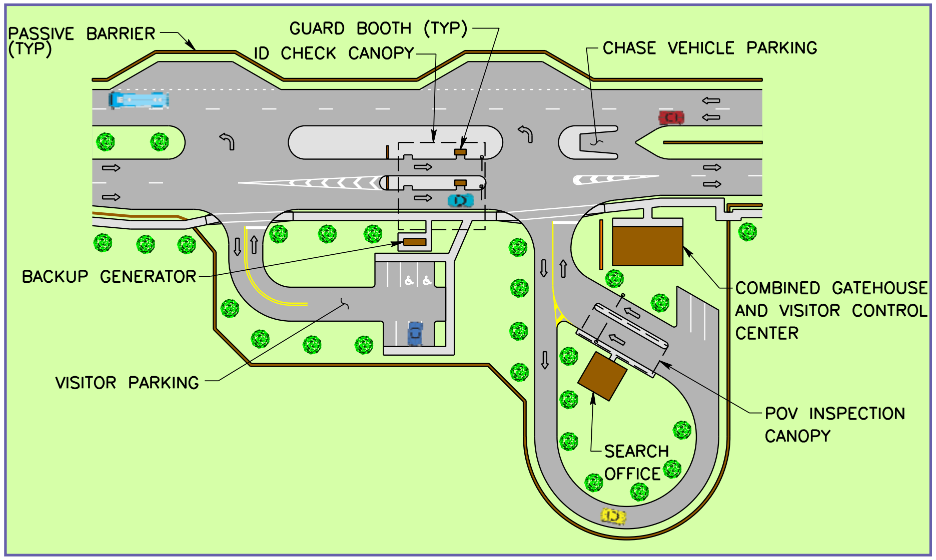






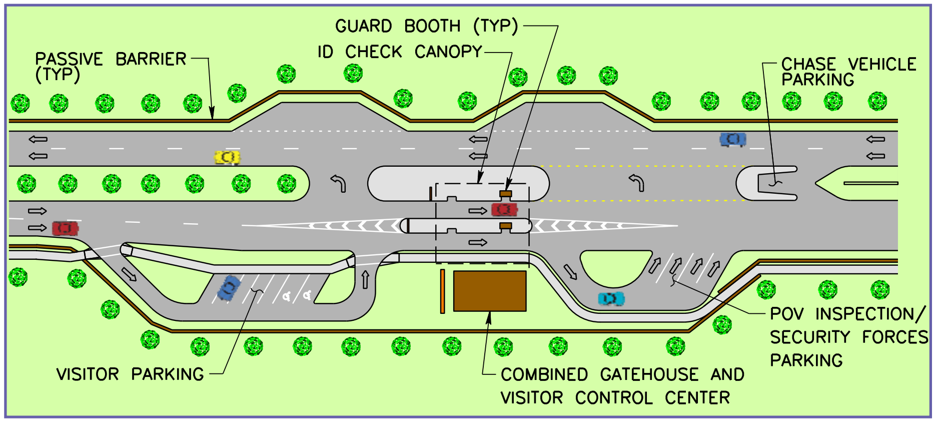
6.3. COMBINING FACILITIES

Typically the VCC and gatehouse are segregated facilities due to the operations performed at each. Where low numbers of visitors are expected, the visitor center may be combined with the gatehouse to reduce the ECF footprint and maximize manpower. If considering a combined facility, the total number of occupants in the combined facility shall meet the requirements for a low occupancy building to minimize standoff distance per UFC 4-010-01. The combined facility shall meet the security requirements outlined in this pamphlet, UFC 4-022-01, and service branch design documents for gatehouses and VCCs.



The UFC does not specifically indicate that the gatehouse and VCC operations must be separated within the combined facility. However, a gatehouse is required and if the guards that staff the gatehouse also have some pass/ID or visitor vetting responsibilities (typically only very low visitor volumes) they must be separated from those visitors by ballistic rated products/construction. So, although there are not specific words requiring separation - they must be separated by something ballistic rated.

From UFC 4-022-01, Section 5-7.4.2. ‘Physical Security and Protective Design’: Threats that may commonly be considered include forced entry and ballistic attack. Provide ballistic protection equivalent to Underwriters Laboratories (UL) 752 Level III for all guard facilities as a minimum.



All routine transactions between the gatehouse guards (or guards in any other position) must occur without interruption of that ballistic rated separation (deal tray or pass thru drawer).

DESIGN THE ID CHECK AREA SO:

- ❑ **GUARDS CAN FUNCTION FREELY AND SAFELY**
- ❑ **PLATFORM SURFACES ARE MADE WITH ANTI-SKID PROPERTIES**
- ❑ **RAISED ISLANDS ARE A MINIMUM WIDTH OF 10 FEET (3 METERS) AND LENGTH OF 50 FEET (15 METERS), BUT PREFERRABLY 75 FEET (23 METERS) IN LENGTH**

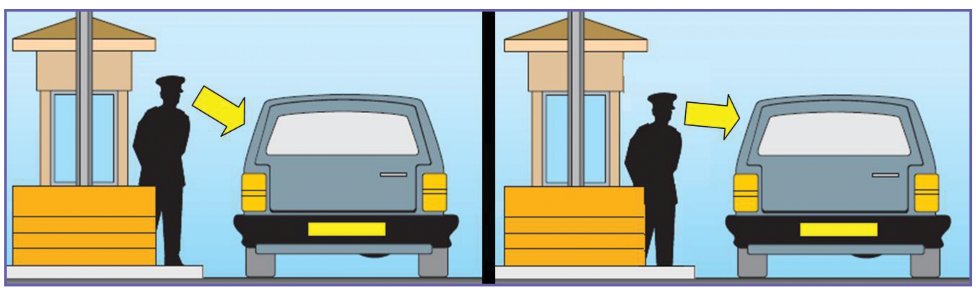
6.4. ID CHECK AREA

The ID check is located in a median island or channelization island between traffic lanes. The area should provide one or two guards with protection against the weather and potential threats. The island should have appropriate pavement markings as discussed in the pavement marking section and an impact attenuator as suggested.

The guard booth should have space allotted for electronic control panels for ECF automation equipment, workspace incorporating space for computer monitors, and an electrical panel board. It should be possible to enter or exit the booth from either side of the structure.

Since tandem processing capabilities are common, there may be up to two guard booths per lane; however, at installations where the second processing area is not readily utilized, it may be more appropriate to not construct a second guard booth but to reserve an area for processing.

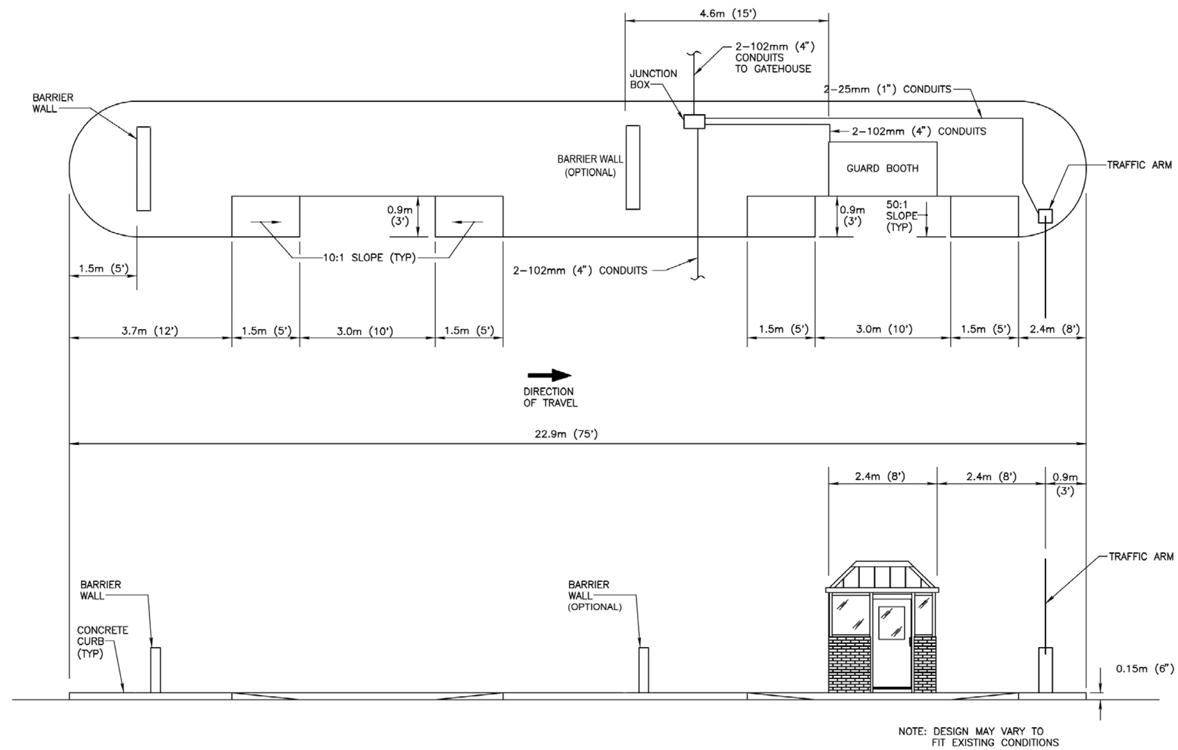
When guards need to stand between lanes of traffic, raised islands provide a measure of safety and separation. It is preferred to design the ID check area with a depressed step down area so that guards can process motorists at eye-level without having to bend over or step into traffic. The depressed area or sloped area should be designed to drain properly and not become an impediment to vehicular traffic or the guard. ID check area islands should not be less than 10 feet (3 meters) wide and 50 feet (15 meters) long, however, a length of 75 feet (23 meters) is preferred. Providing 75 feet (23 meters) of length will allow tandem checking of vehicles and room for future technology.



Full Curb **Depressed Curb**

Following are two examples of the ID check area illustrating the raised island, crash walls, guard booth and associated depressed or sloped area. If automation is being considered, it may be prudent to locate the guard booth at the second position. This is illustrated in **Section 9**.

Exhibit 6.2: ID Check Area

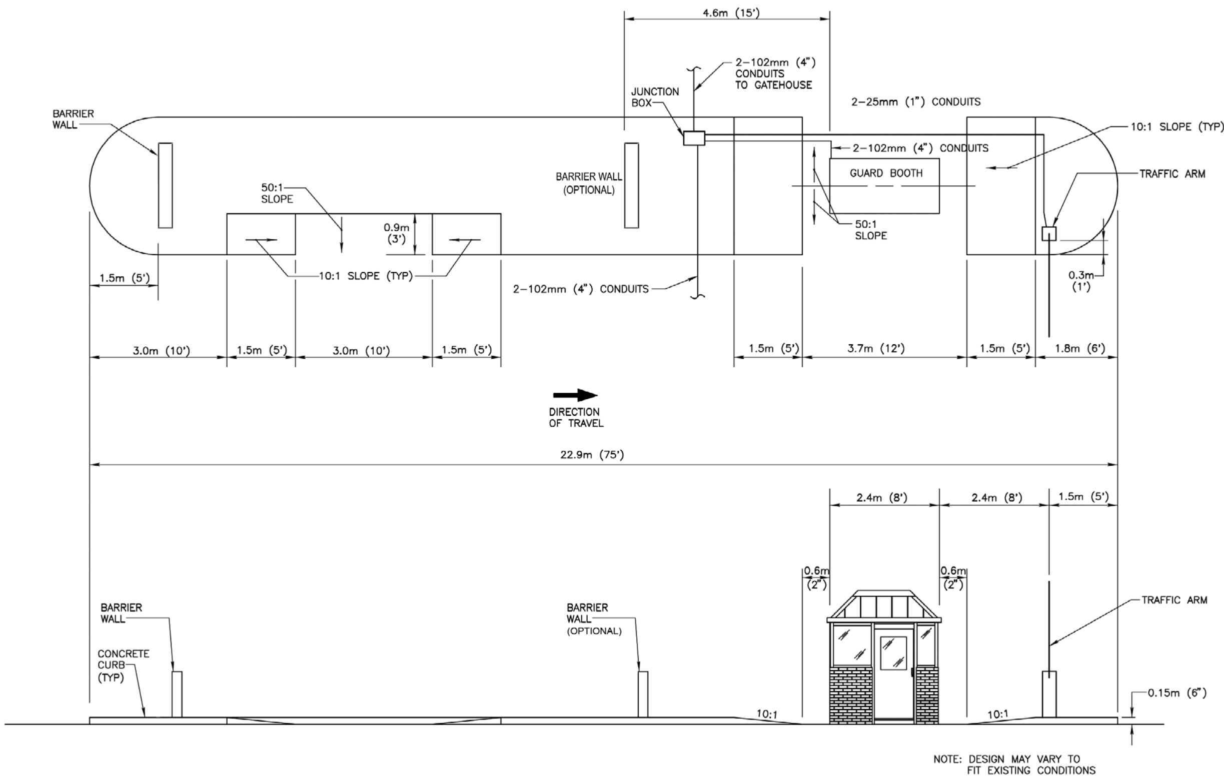
Options	**Option 1** 
Pros	✓ Maximizes island protection ✓ Ideal for guard booths without a subfloor ✓ Better for drainage ✓ Rear guard booth accommodates future automation ✓ Rear guard booth allows oversight of secondary tandem processors in the front of the island
Cons	✓ Minor tripping hazard

Source: Army ACP Standard Design/Criteria

Exhibit 6.2: ID Check Area (continued)

Options

Option 2



Pros

- ✓ Limits tripping hazards
- ✓ Ideal for guard booths with a subfloor (>2")
- ✓ Rear guard booth accommodates future automation
- ✓ Rear guard booth allows oversight of secondary tandem processors in the front of the island

Cons

- ✓ Less island protection
- ✓ Drainage

Source: Army ACP Standard Design/Criteria

These configurations may vary slightly from service-branch specific requirements.

IN SHORT-TERM SITUATIONS, EFFORTS SHOULD BE MADE TO MAXIMIZE GUARD SAFETY AND EFFICIENCY BY PROVIDING DELINEATION, AND WHERE POSSIBLE, TEMPORARY ISLANDS.

6.4.1. Short-Term Island Enhancements

Although the island configuration presented previously is the preferred condition for major rehabilitations or redesigns, it may not always be practical in the short-term.

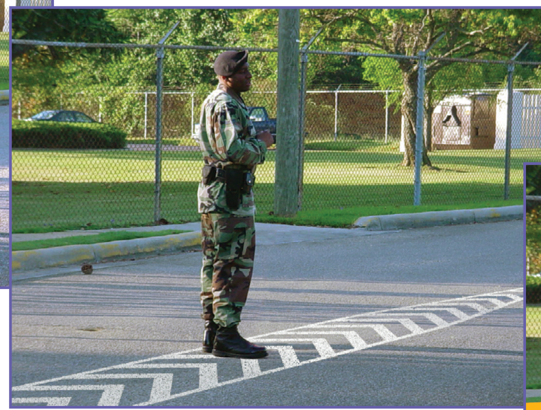
✓ Pavement markings (with or without an island) can enhance the visibility of the ID check area.

✓ In many cases, the width needed for a temporary island can be obtained by reducing the effective lane width.

✓ Temporary islands can be made of concrete but islands can also be made from temporary curbing products, especially if near-term removal is possible.

Where possible, a guard cut-out should be provided so that the guard is at road level. If a cut-out is provided, verify water drains away from the guard position to prevent ponding water.

No Delineation or Refuge



Delineation

Delineation and Refuge

6.5. INSPECTION AREAS

All ECFs must have a mechanism to conduct select inspections. Vehicle inspections are dependent on local directives and RAM, but generally take two forms:

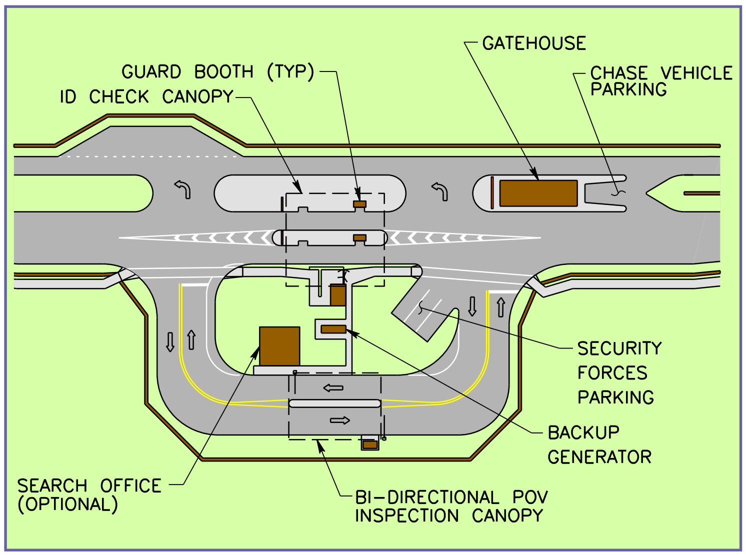
✓ Random inspection
✓ Select inspection based on guard concern

Some service branches perform random inspections prior to the ID check area in the approach zone, whereas other branches perform random inspection after the ID check area. Based on where and when random inspection activities occur, facilities and procedures should be developed to minimize the impact to traffic flow on the main approach.

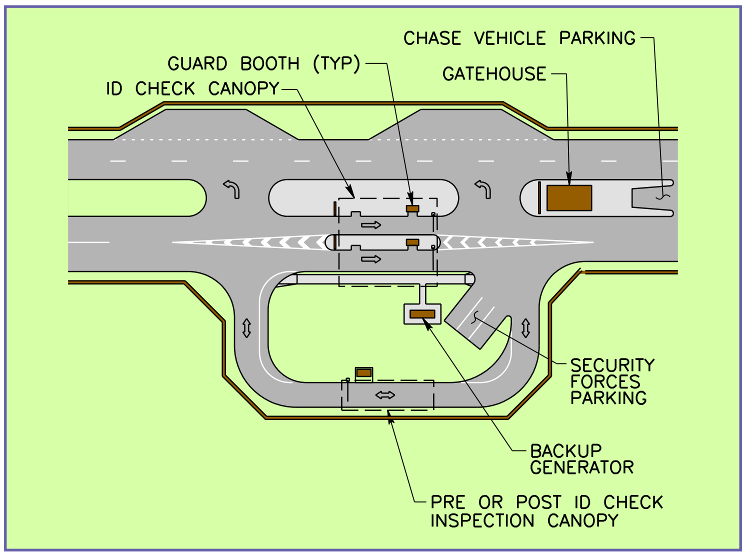
If possible, design inspection facilities to allow bi-directional access. This permits advance random inspections as well as post ID inspections and maximizes operational flexibility.

Once a vehicle has been inspected, the exit lane from the inspection area may bypass entry control and merge into other inbound traffic downstream. Active vehicle barriers and procedures must be in place to prevent unauthorized vehicles from bypassing entry control.

Bi-directional Inspection Area



One-way Inspection Area

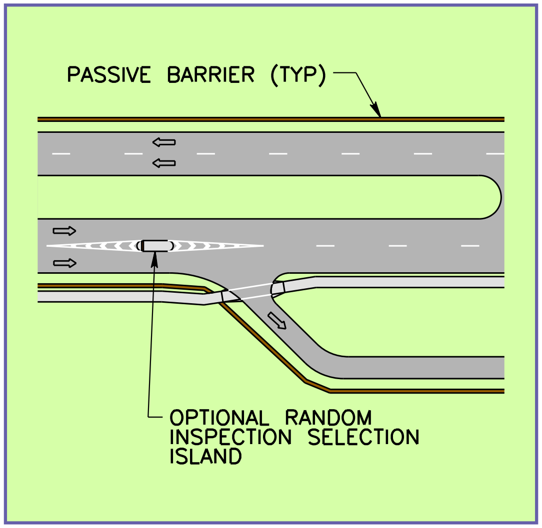


For advance random inspections, especially when there are numerous lanes, it may be beneficial to provide advance islands for the guard to stand on as they select and direct motorists into random inspection areas.

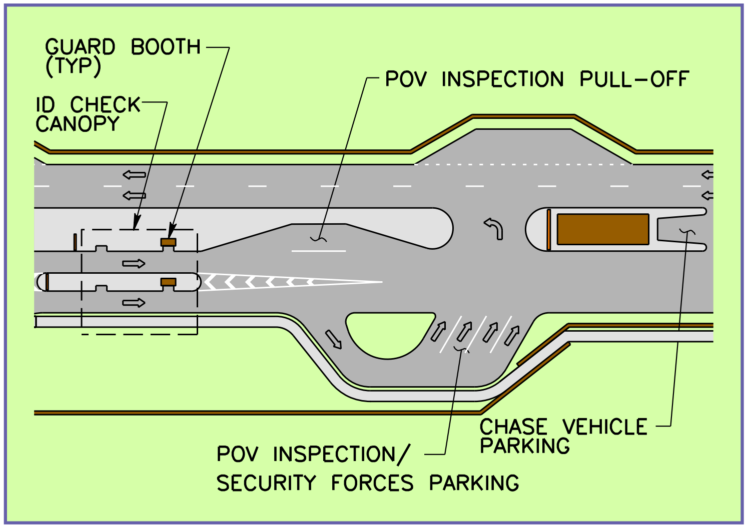
When inspections take place after the ID check area, the access to the inspection area needs to be as close as geometrically possible and should be within the line of sight of the guard.

A pull-off area provides an area just beyond the ID check area and gatehouse where alternate inspections can be conducted, ID discrepancies addressed, or driver's questions answered.

Advance Island



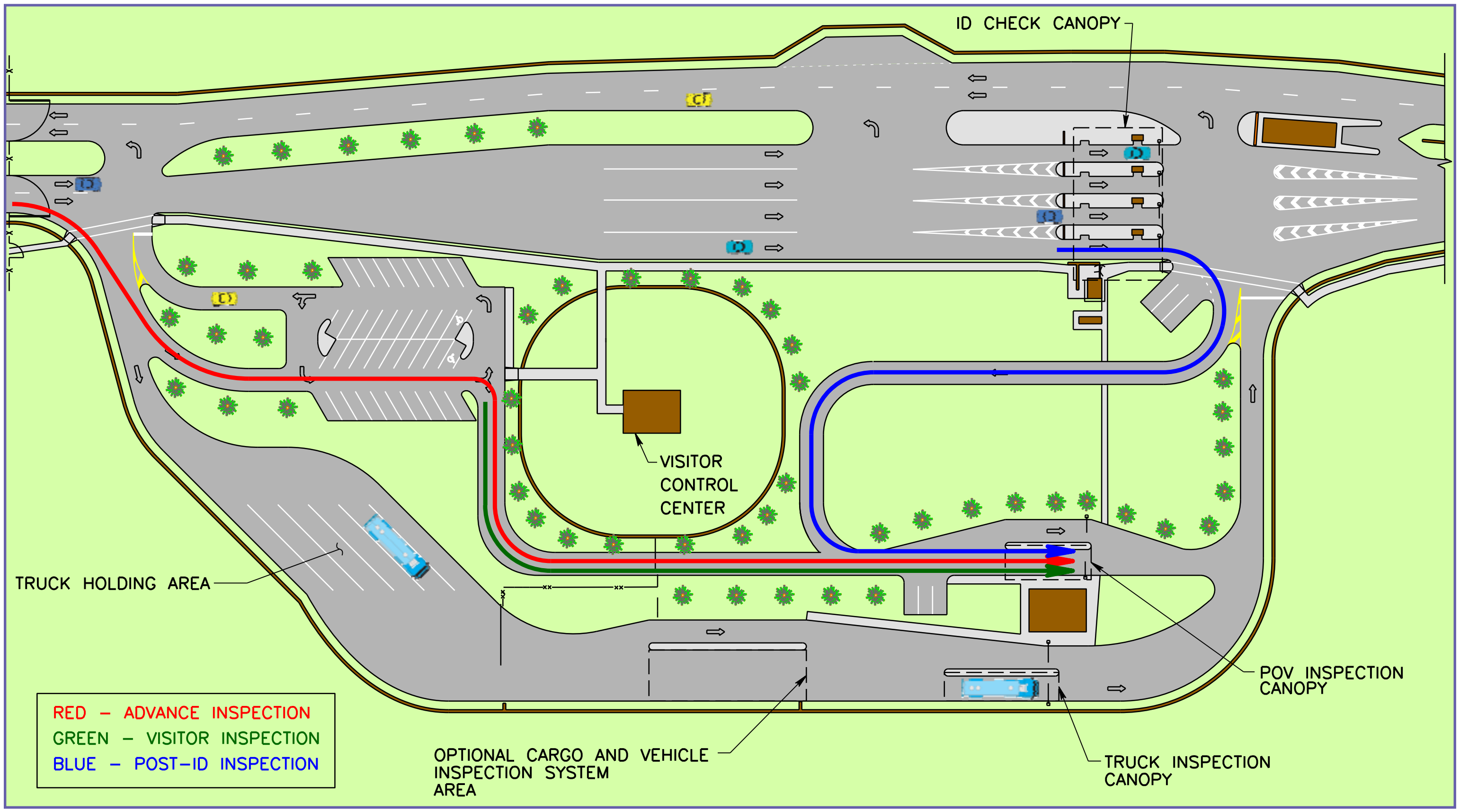
Alternate Pull-Off Inspection Area



To the extent possible, the inspection area should not be immediately adjacent to inbound traffic lanes. While this separation is primarily for safety reasons, some screening of the inspection procedure from public view is also desired. Appropriate landscape plantings should be placed to accomplish this. Also, the inspection area should be equipped with a search office that is ADA compliant.

At ECFs with VCCs, direct access from the VCC to the inspection area should be provided if practical.

The actual layout will vary on the layout of the ECF and neighboring facilities.



TRUCK INSPECTIONS SHOULD BE SEGREGATED FROM POV INSPECTIONS BECAUSE:

- **INSPECTING ALL TRUCKS CAUSES UNDUE DELAY TO POVS**
- **THERE ARE DIFFERENT INSPECTION PROCEDURES**
- **INSPECTIONS TAKE SIGNIFICANTLY LONGER THAN POV INSPECTIONS**

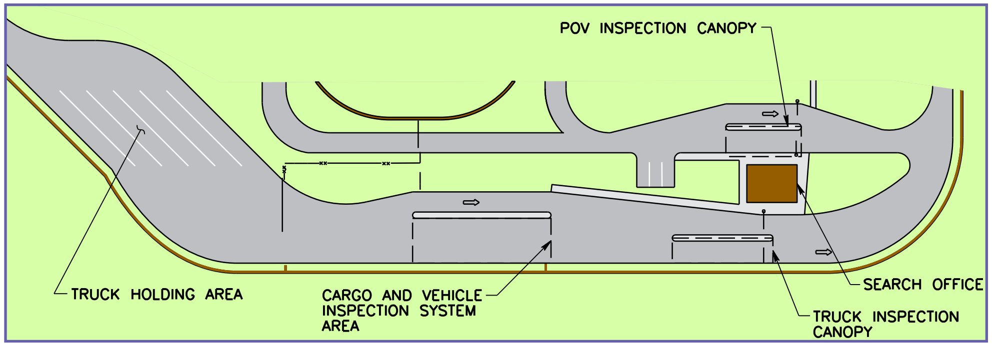
6.6. TRUCK INSPECTION AREA

At installations with a significant truck demand, dedicated truck ECFs should be considered.

The truck inspection area should be equipped with a holding area sized to accommodate peak periods of truck demands, an area for inspection systems, and the main inspection area itself. Truck parking demands can range from 2 (at a small installation) to 70+ (at a large installation). It is desirable to have a turnaround area between the holding areas and the main inspection area, but this is not always practical. A mechanism to control accepted or rejected traffic after the inspection area must be included in the site design. This may include the use of barriers and/or barrier normally up operations, if appropriate. Similar to the POV inspection area, a truck inspection area should be equipped with a search office that is ABA compliant. While ECF POV and truck inspection areas should be segregated, especially at larger ECFs, it may be practical to combine them at smaller ECFs. If the inspection areas are segregated, it may be practical for both facilities to share a search office. (Note: The Army Standard for ACPs allows truck and POV search operations to be co-located. Additionally, it allows for a vehicle search area to be incorporated into the ID check area as a second lane under the ID check area canopy when peak hour traffic volumes do not exceed 290 vehicles per hour.)

The roadways connecting the site should be designed to accommodate the largest vehicle expected to use the facility on a regular basis. In many cases this is a WB-67 (WB-20).

Many installations have begun to utilize cargo and vehicle inspection systems. Where these systems are used be sure to meet setback requirements set forth in UFC 4-022-01. In many cases radiation setbacks dictate geometric design requirements.



Building and Facility Considerations

PROVIDING AN OVERHEAD CANOPY AT THE ID CHECK AREA CAN:

- ❑ PROVIDE LIGHTING LOCATIONS
- ❑ PROTECT GUARDS AND DRIVERS FROM INCLEMENT WEATHER
- ❑ SERVE AS A PLATFORM FOR TRAFFIC CONTROL DEVICES, SIGNAGE, AND SECURITY EQUIPMENT
- ❑ PROVIDE A LOCATION TO MOUNT LANE USE INDICATIONS
- ❑ BE A GATEWAY TO ENCOURAGE LOWER SPEEDS

6.7. CANOPY

Canopies are used in three areas of an ECF:

✓ ID check area
✓ POV inspection area
✓ Truck inspection area

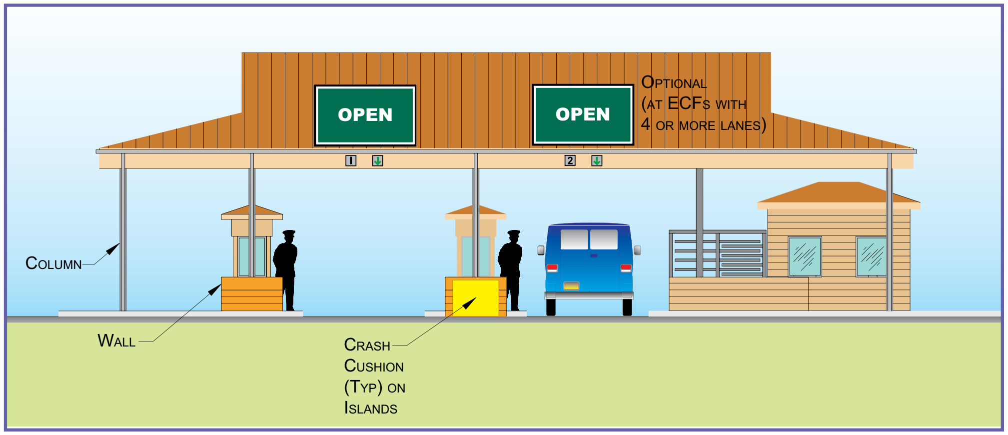
Canopies offer several benefits to both guards and motorists. An overhead canopy should be provided for all ECF areas routinely occupied by security personnel unless otherwise directed by the installation.

When canopies are installed, provide:

✓ Cover for the entire access control area
✓ Protection for all potential guard positions
✓ Proper overhang
✓ Lane control signals in all lanes, similar to toll collection or parking facilities, to inform incoming vehicles of the current lane status
✓ Lane control signals for outbound traffic where reversible lanes are utilized

The minimum desirable clear height shall be 17.5 feet (5.3 meters) to support common vehicle heights and facilitate use of the overhead canopy for lighting or security equipment. This clear height shall be measured from the pavement to the lowest point on the overhead canopy, including light fixtures and other equipment.

The architectural appearance of the canopy shall match surrounding features and meet the requirements of the installation architectural plan. Structural elements should be strategically located where possible behind attenuators or barrier walls and should be placed at least 3 feet (0.9 m) behind the face of curb.



6.8. OVERWATCH

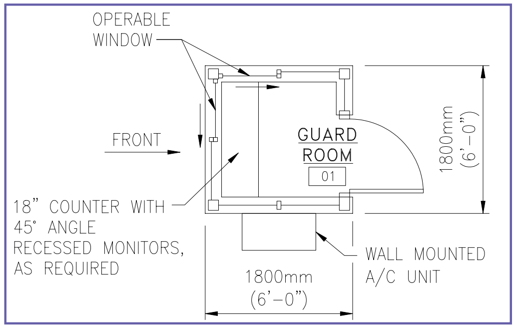
Many installations desire additional position(s) for security personnel to facilitate response to a threat. These positions are normally placed in the response zone to facilitate surveillance and armed response. This position may be fixed or temporary/portable. Manning of the overwatch position is in accordance with the installation physical security plans. Design the facility to permit security personnel to respond to any attackers from a protected position.

The position should be provided with emergency fast operation (EFO) controls to activate the active vehicle barrier system. Provide an intercom, as well as an enunciator in the overwatch position to alert security personnel of the duress alarm being triggered at the other guard facilities. **Maximize visibility from the facility, with 360-degree visibility. The overwatch position must have a direct line of sight to the access control zone of the ECF including identification and inspection areas. (As for guards elsewhere in the ECF, there is no requirement for any direct view or CCTV view of the AVB for EFO.)** If a permanent facility is provided, a ballistic protection equivalent of UL 752 Level III or higher must be provided at a minimum per UFC 4-022-01, Section 5-7.4.2. 'Physical Security and Protective Design'. For additional requirements consult each service branches design guidelines.

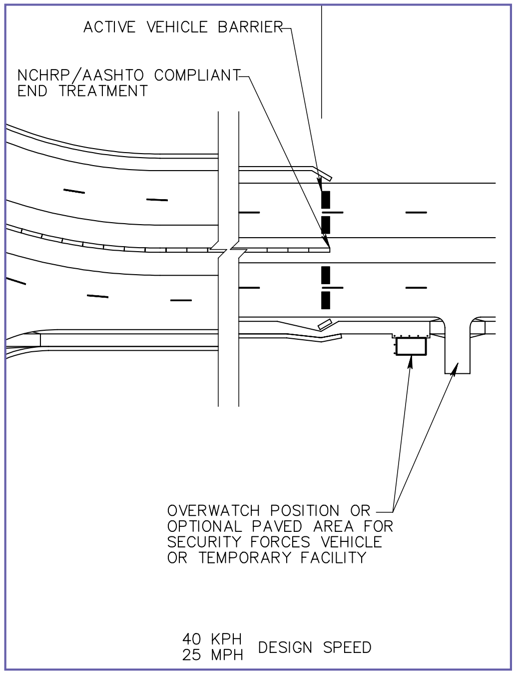
The location of the overwatch position should also be designed to afford personnel the ability to assess the threat, initiate alarms, activate the barrier system (if other personnel are incapacitated), and respond to the attack with force if necessary and authorized.

In most cases the overwatch position will be located at or near the end of the response zone in order to provide sufficient distance for this response. Coordinate the facility location with security personnel to ensure proper line of fire and safety considerations. If required, elevate the facility to aid the observation of incoming traffic and reduce incidental/collateral damage by creating a plunging fire scenario.

Permanent Overwatch



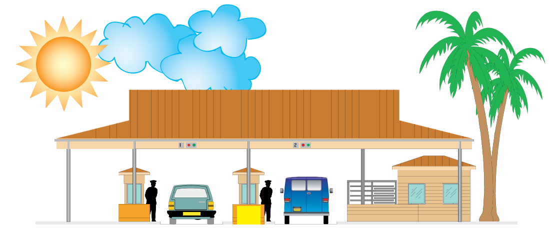
Temporary Paved Pad Overwatch

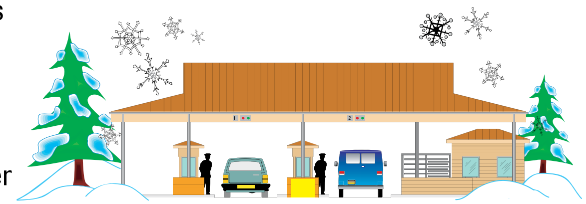


Source: Army ACP Standard Design/Criteria - Both Drawings

If the overwatch position is established as a temporary facility; an asphalt or otherwise paved pad should be provided at the overwatch location, to accommodate a security forces vehicle or temporary facility during increased FPCONs. A utilities communications stub should be provided for this facility.

6.9. CLIMATE CONSIDERATIONS





Consideration must be given to the effects of nature on the ECF and the personnel assigned to it. When possible, buildings and checkpoints should be orientated in a way that sunlight will not blind the approaching driver or the ID checker. Additionally, the direction of prevailing wind should be considered.

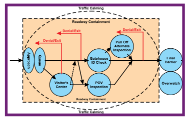
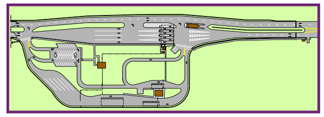
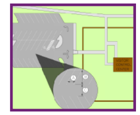
Hot and cold climates may affect the operation of the ECF in different ways. In cold climate locations, pavement warming devices and enclosed buildings should be provided to protect all control points in the ECF area, including the main ID check area, inspection areas and any other area where security personnel interact with approaching vehicles.

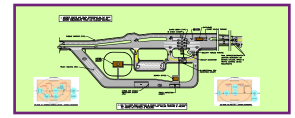
In hotter climates, provide sun protection for guards. In rainy climates, proper precautions should be taken to protect all ID check and inspection areas from both windblown rain and vertical rain. The installation's architectural compatibility plan should be consulted and all structures proposed for mitigating environmental effects in the ECF area should follow that plan.

Exhibit 6.3: Climate Considerations

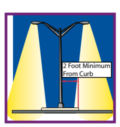
Cold Climate Considerations	Warm Climate Considerations
Shelter	Shelter
Wind breaks	Air conditioning and other cooling devices
Pavement warming devices	Water coolers
External heaters	Shielding from intense sun and glare

In climates that experience moderate to heavy precipitation, proper pavement grades and inlet locations are imperative to prevent ponding water. Ponding water can result in hydroplaning and create an unsafe condition for motorists and security personnel. Ponding water near ID check islands is a particular area of concern especially during the winter months when it could freeze and become a slipping hazard. Special attention should be given to drainage around ID check islands with a depressed or cut-out curb to verify water drains away from the island.

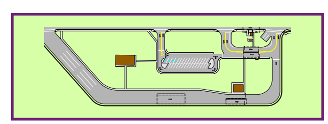






SECTION 7 - TRAFFIC CONTROL DEVICES

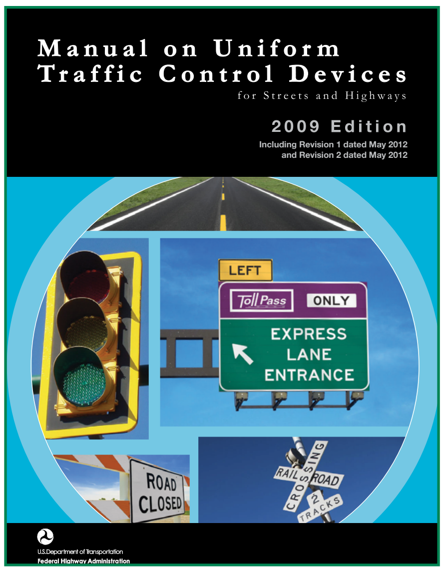







7. Traffic Control Devices

THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (*MUTCD*) IS RECOGNIZED AS THE NATIONAL STANDARD FOR ALL TRAFFIC CONTROL DEVICES INSTALLED ON ANY STREET, HIGHWAY, OR BICYCLE TRAIL OPEN TO PUBLIC TRAVEL.



Source: FHWA

Traffic control devices are defined as all signs, signals, markings, and other devices used to regulate, warn, or guide traffic. These devices can be placed on, over, or adjacent to a street, highway, pedestrian facility, or bikeway by authority of a public agency having jurisdiction. When necessary, proper traffic control devices should be used to ensure the safe and efficient movement of traffic through ECFs.

Traffic control devices should never be used in place of a good design. The first step in effectively controlling traffic in the ECF area is providing a design that lends itself to slow traffic and helps drivers make incremental decisions that encourage predictable movements. The ECF area presents decision points to the driver that they may not encounter elsewhere. The use of appropriate traffic control devices can help reduce driver confusion and increase the efficiency of the ECF. Conversely, the over use of traffic control devices can create unsafe conditions. The rationale that extra traffic control "can't do any harm" is not true because unnecessary traffic control devices not only clutter streets, but de-emphasize necessary traffic control devices.

The *MUTCD* provides guidance and warrants for the installation of traffic control devices. These guidelines and warrants (along with any local requirements) should be followed to limit the military installation's tort liability associated with the inappropriate use of traffic control devices.

The MUTCD is incorporated by reference in 23 Code of Federal Regulations (CFR), Part 655, Subpart F and shall be recognized as the national standard for all traffic control devices installed on any street, highway, or bicycle trail in accordance with 23 U.S.C. 109(d) and 402(a).

By military regulations, Commanders are required to conform to the MUTCD, in accordance with Joint Regulation of the DoD Transportation Engineering Program (AR 55-80, OPNAVINST 11210.2, AFMAN 32-1017, MCO 11210.2D and DLAR 4500.19).

From Section 3-11 the Military's Highway Safety Program requirements:

✓ Under General: *"This section prescribes the policies and procedures related to DoD highway safety needs. It implements 23 USC 402, DODD 4510.11, and DoDI 6057.4."*

✓ Under Policies: *"Installation commanders will develop and maintain their roadways to nationally accepted standards that provide a safe driving environment for all drivers and passengers."*

✓ Under Traffic Control Device Plan: "All installation traffic signals, signs, and pavement markings will be in substantial conformance to FHWA's Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) (http://mutcd.fhwa.dot.gov). Variances in the design and application of installation traffic control devices from the standards contained in MUTCD must be approved by MTMC (now SDDC) and FHWA."

✓ Under Program Applicability: This chapter applies to public highways (those open to general public travel) in the United States, including nonrestricted roads on military installations.

Please note the *MUTCD* is under constant update. Please consult www.mutcd.fhwa.dot.gov for the current edition.

The *MUTCD* defines a "public road" as "any road or street under the jurisdiction of and maintained by a public agency and open to public travel." Public are the people. Military roads are funded by taxpayers and used by motorists from across the nation who expect travel, safety and traffic control devices on a military installation to be no different from those off the installation. A good rule of thumb is that if civilians are permitted to drive on the road then it is open to the public and must meet Federal requirements. An example of a DoD only road is tank trails. Civilians are not permitted to drive on them therefore Federal requirements do not apply.

Furthermore, even if someone argues that military roads are "private" roads it really doesn't matter because Section 15-117 of the National Uniform Vehicle Code (used by most states), notes that "*no person shall install or maintain in any area of private property used by the public a sign, signal, pavement marking or other device intended to regulate, warn, or guide traffic unless it conforms with the State manual and specifications adopted under Section 15-104 of the Uniform Vehicle Code.*"

Section 15-104 of the Uniform Vehicle Code states that: "*The State shall adopt a manual and specification for a uniform system of traffic control devices consistent with the provisions of the UVC. Such uniform system shall correlate with and conform to the system set forth in the most recent edition of the Manual on Uniform Traffic Control Devices for Streets and Highways, and other standards issued or endorsed by the Federal Highway Administration.*"

Per 23 CFR, Part 655, Subpart F, the MUTCD approved by the Federal Highway Administrator is the national standard for all *traffic control devices installed on any street, highway, or bicycle trail open to public travel in accordance with 23 U.S.C. 109(d) and 402(a). For the purpose of MUTCD applicability, open to public travel includes toll roads and roads within shopping centers, airports, sports arenas, and other similar business and/or recreation facilities that are privately owned but where the public is allowed to travel without access restrictions. Except for gated toll roads, roads within private gated properties where access is restricted at all times are not included in this definition. Parking areas, driving aisles within parking areas, and private highway-rail grade crossings are also not included in this definition.*

In addition to the national *MUTCD*, installations located in the Continental United States must also reference state requirements, specifically a state *MUTCD* or equivalent, for state-specific requirements. Also refer to SDDCTEA's DoD *Supplement to the MUTCD* for military-specific requirements.

THE GENERAL RULE FOR TRAFFIC CONTROL AT ECFS IS KEEP IT SIMPLE.

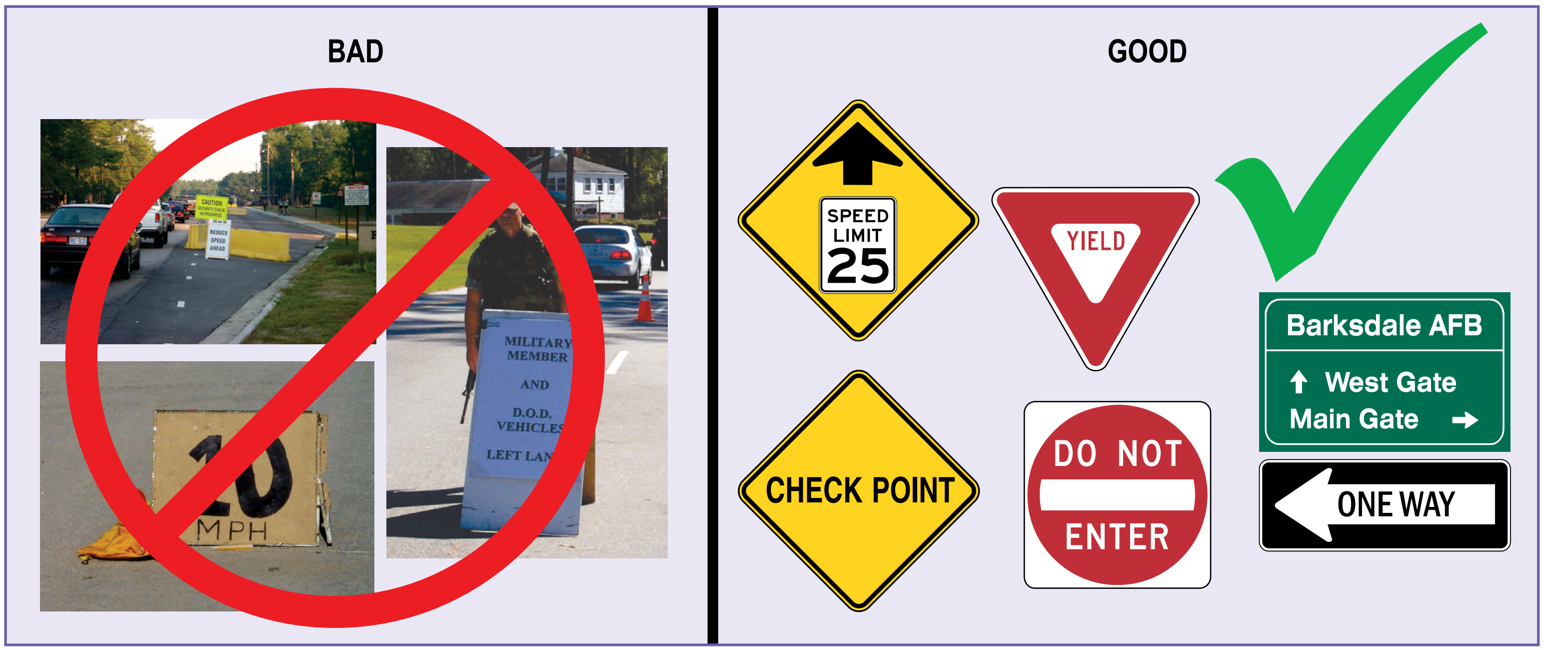
7.1. SIGNS

7.1.1. Requirements of a Sign

A traffic control device should meet five basic requirements:

✓ Fulfill a need
✓ Command attention
✓ Convey a clear, simple meaning
✓ Command respect
✓ Give adequate time for response

To determine if a sign will fulfill a need, a traffic engineering study must be done to collect and analyze data. The data will be compared to *MUTCD* warrants governing the installation of the specific sign and a determination will be made as to whether the installation is appropriate. In all cases, the minimum required level of traffic control devices to achieve safe and efficient traffic operation should be used.



To command attention, a sign must be:

Legible:

- ✓ Use a symbol when available
- ✓ Use 6-inch high (150 millimeters) lettering at a minimum
- ✓ Match the width of series D or E from FHWA's *Standard Alphabets for Highway Signs and Pavement Markings*

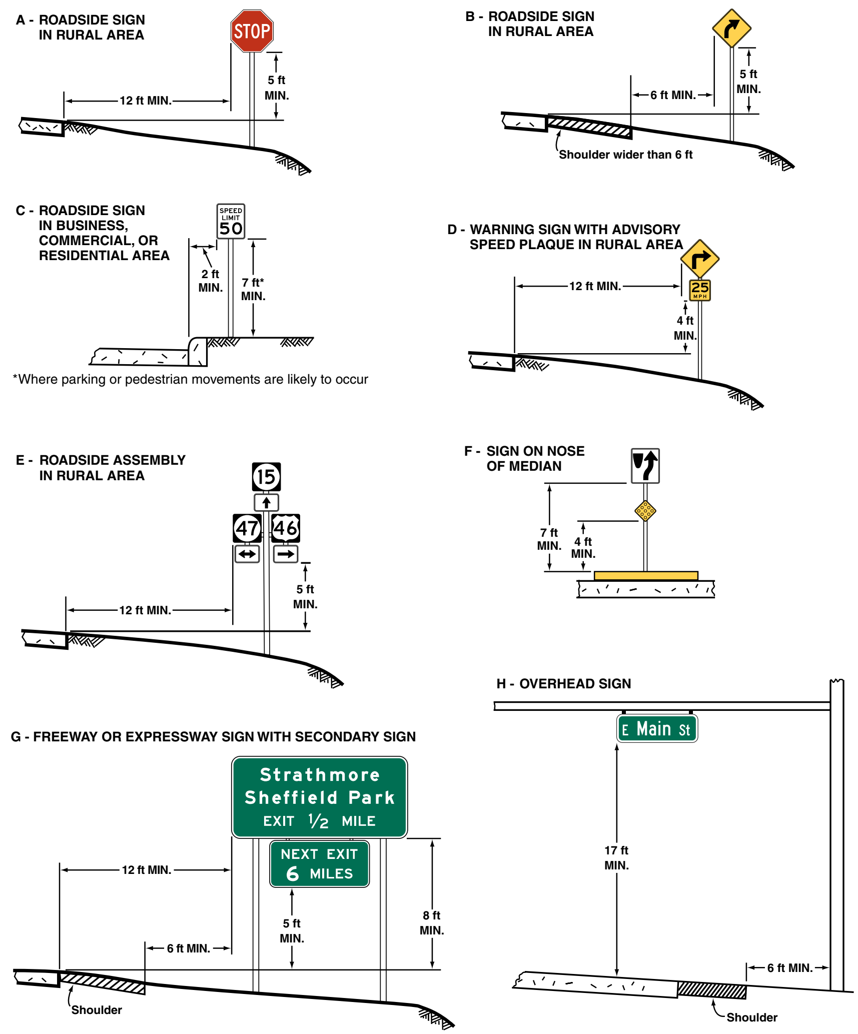
Visible:

- ✓ Use as few signs as possible
- ✓ Space at least 100 feet (30 meters) from the other signs
- ✓ Clear obstructions and roadside features such as vegetation, utility poles, and pedestrian facilities
- ✓ Use retroreflective sheeting to meet minimum retroreflectivity requirements per the MUTCD **(See Section 7.3)**

Placed Correctly:

- ✓ Use appropriate mounting height as shown at right
- ✓ Place according to clear zone requirements
- ✓ Be of breakaway design according to AASHTO standards
- ✓ Use overhead lane use signs for three or more lanes in one direction or when a single lane can serve multiple movements
- ✓ Located at the proper location at intersections as shown in **Exhibit 7.2**.

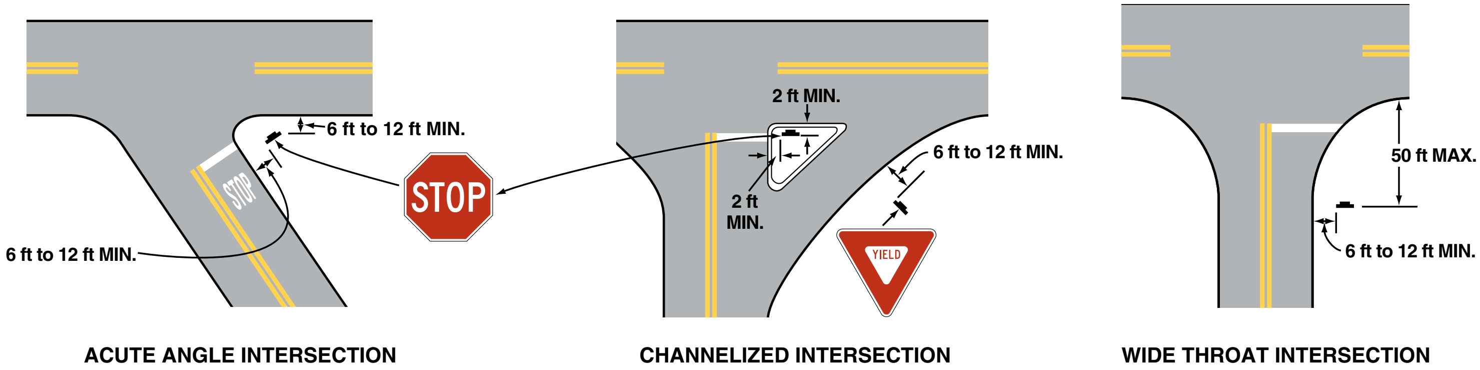
Exhibit 7.1: Examples of Heights and Lateral Locations of Sign Installations



Note:
See Section 2A.19 for reduced lateral offset distances that may be used in areas where lateral offsets are limited, and in business, commercial, or residential areas where sidewalk width is limited or where existing poles are close to the curb.

Source: FHWA - MUTCD

Exhibit 7.2: Lateral Locations for Sign Installations at Intersections



Note: Lateral offset is a minimum of 6 feet measured from the edge of the shoulder, or 12 feet measured from the edge of the traveled way. See Section 2A.19 for lower minimums that may be used in urban areas, or where lateral offset space is limited.

Source: FHWA - MUTCD

7.1.2. Sign Types

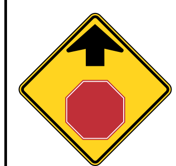
Regulatory signs inform drivers of traffic laws and regulations and indicate the applicability of the legal requirements. Regulatory signs utilize red, black and white colors on a rectangular shape except in the case of STOP (octagon) and YIELD (triangle) signs.

Warning signs call attention to unexpected conditions that might not be readily apparent to road users. Warning signs alert road users to conditions that might call for a reduction in speed or another action. In most cases, warning signs include black lettering on a yellow background. The shape is typically a diamond with some exceptions. Warning signs should never be a substitute for good ECF design.

Guide signs are essential in directing motorists along roadways and streets. There is more information on guide signs as they relate to ECFs in subsequent sections.

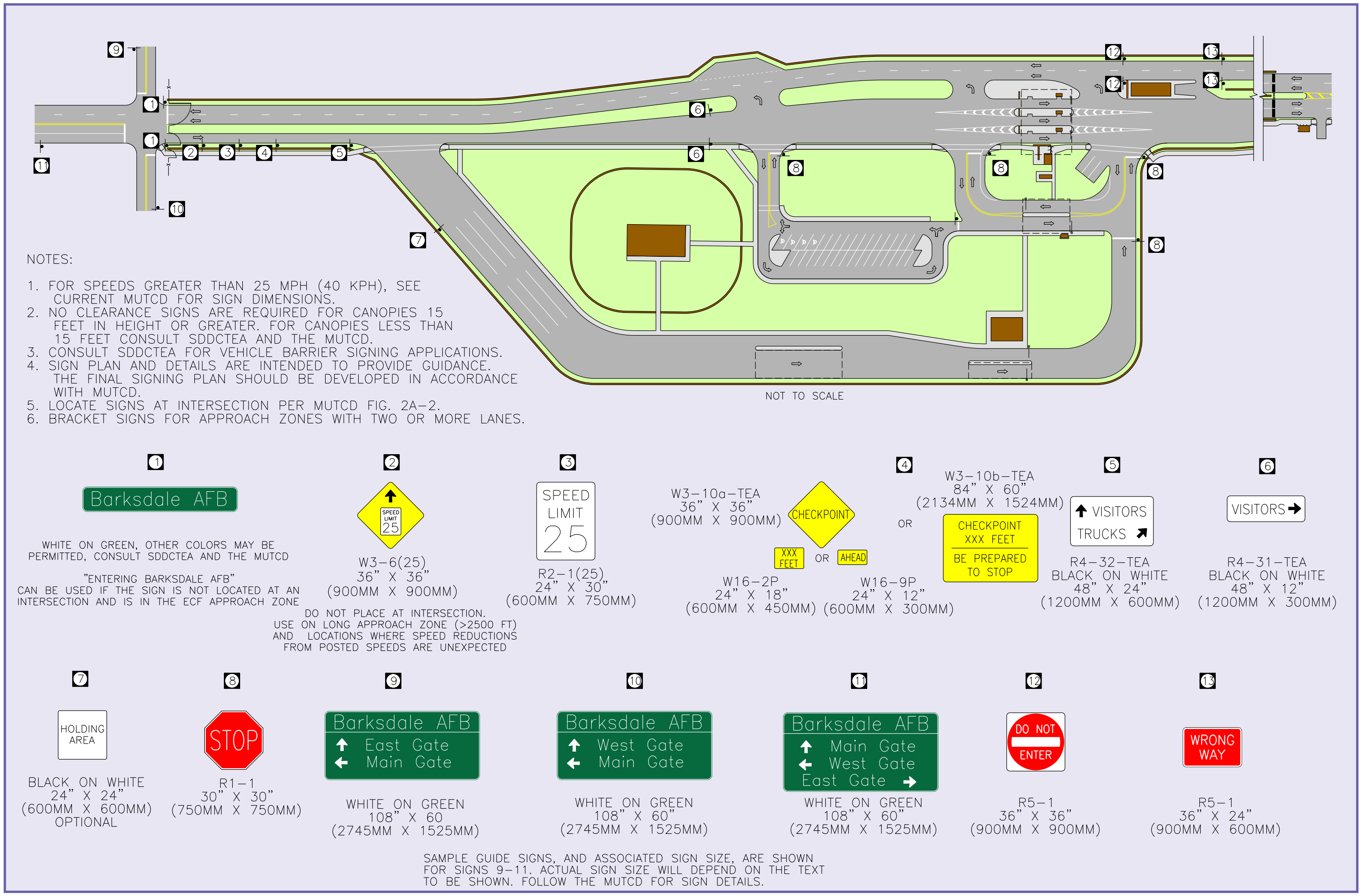
Exhibit 7.3 on the following page provides a summary of the sign types and characteristics, and also includes example signs that may be found within and adjacent to an ECF. The graphic in **Exhibit 7.4** shows a typical sign layout at a primary ECF.

Exhibit 7.3: Sign Types and Characteristics

Sign Category	Definition	Color	Shapes	Sign Examples
Regulatory	✓ Inform drivers of traffic laws and regulations	White, Black, Red	Rectangular, Octagonal (STOP sign only), Triangular (YIELD sign only)	 R1-2  R5-1  R6-1
Warning	✓ When needed, to point out features of the ECF or its approach that are not readily visible or obvious ✓ Warning signs should never be used as a substitute for a good ECF design	Black lettering on a Yellow background	Diamond, Pentagon (school zone only), Circle (railroad crossing only), Rectangular	 W3-1  W3-5  W-Series Modified (TEA sign)
Guide	✓ Gives direction to destinations or points of interest	White lettering on a Green background	Rectangular	 D1-2a

Source: FHWA, MUTCD

Exhibit 7.4: Sample Sign Layout



Sign Sizes and Legibility

For a sign to be effective, it must be legible. The size of the sign and the size of the legend on the sign are two very important elements of a legible sign. Generally, a motorist can see 1-inch (25 millimeters) text 40 feet (12 meters) away, 6-inch (150 millimeter) text can be seen 240 feet (72 meters) away and 12-inch (300 millimeter) text can be seen 480 feet (144 meters) away. Where possible, signs that conform with the *MUTCD* and the FHWA *Standard Highway Signs* (*SHS*) should be used. The *SHS* is a companion document to the *MUTCD* and outlines the size and dimensions of *MUTCD* standard signs. The *MUTCD* also defines sign sizes for three types of highway facilities:

✓ Freeways – A divided highway with full control of access
✓ Expressway – A divided highway with partial control of access
✓ Conventional Road – A street or highway other than freeways and expressways

The minimum desirable text height on signs for a conventional road is 6 inches (150 millimeters), and 8 inches (200 millimeters) is the minimum height for freeways and expressways. Every effort should be made to meet the minimum desirable text heights; however, if necessary a minimum text height of 5 inches (125 millimeters) may be used on conventional roads. In most usages, roadways on a military base should conform to the dimensions shown in the SHS for a conventional road.

7.1.3. Sign Clutter

Many installations have signing not relevant to the ECFs posted in the area of ECFs. Since an ECF is a busy area with many different visual distractions, signing not related to the ECF should be avoided, or relocated to an area away from the gate, after the response zone. Examples of signs installed frequently that are not relevant to ECFs relate to seat belt use, tobacco use, or general variable message marquee signs. There are also stop signs at ID check locations, as well as installation perimeter designation. As a general rule of thumb, only critical signs for giving the driver ECF-related information should be installed at the area of the ECF.

7.1.4. Speed Signing Considerations

Design speeds and posted speed limits are typically set at 25 mph within the access control and response zones of an ECF. Providing a sign warning of this condition in or prior to the approach zone can increase driver awareness of the changing condition and promote observance of the regulatory condition by reinforcement.

7.1.4.1. Outbound Speed Limit Signing

A similar approach to outbound speed limit signing should be utilized even though motorists may not be required to stop. Outbound speed limits should be set at 25 mph and should be established at least ¼ mile in advance of active vehicle barriers (or the end of response zone) on the outbound side. If an intersection is less than ¼ mile from the outbound active vehicle barriers (or the end of response zone), then ECF speed limits should be introduced in advance of the intersection. Transitional speed limit signing rules should be applied as well, if needed.

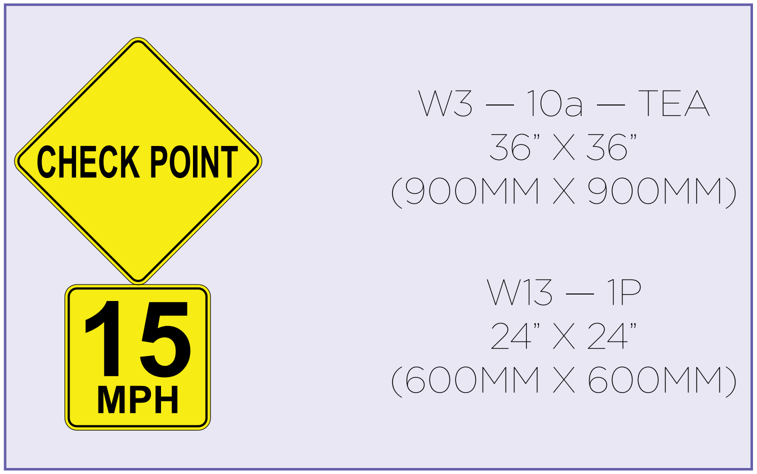
7.1.4.2. Regulatory Speed Limits versus Warning Speeds

Many installations desire to post speed limits at speeds less than 25 mph due to safety and security issues; however, most State Vehicle Codes do not permit posted speed limits below 25 mph. Therefore, any posted regulatory speed limits below 25 mph may not be enforceable. It may be appropriate to maintain a 25 mph speed limit but display a suggested warning speed of 10 or 15 mph. Vehicles can still be ticketed for reckless driving.

7.1.4.3. Speed Limits Lower Than 25 mph

The recommended speed limit for an ECF is 25 mph, and most states do not allow a posting lower than 25 mph. There are some states, however, that do allow posting speed limits less than 25 mph. In November 2018, SDDCTEA published a Traffic Engineering and Highway Safety Bulletin on speed limit postings, which summarized speed laws in each state and territory. There are some states that allow speed limits lower than 25 mph, with certain restrictions. See this bulletin on SDDCTEA's website for more information and to learn the exact restrictions for your state.

Exhibit 7.5: Alternate Checkpoint Sign



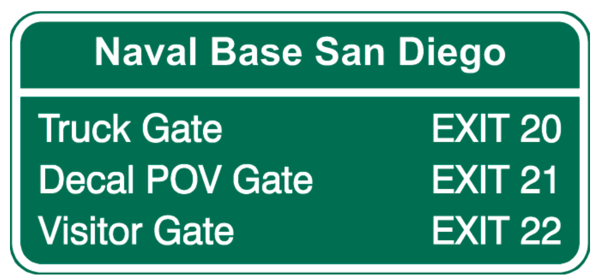
7.1.5. Guide Signs

A comprehensive guide sign plan should be implemented at installations with two or more ECFs. One of the keys to an efficient ECF is sorting traffic and getting the motorists to the appropriate locations. A guide sign plan will most likely require coordination with local officials but will aid the processing capability of the ECF. Signs approaching the installation can inform drivers of the various ECF locations. Where appropriate, signs should detail:

- ✓ Location
- ✓ Gate name
- ✓ Usage type (visitors, decal POVs, trucks)
- ✓ Hours of operation

Guide signs should be made with a reflective green background and white lettering. Lettering, in most cases, should be at least 6 inches (150 millimeters) high; preferably 8 inches (200 millimeters). The arrow angle on the sign should approximate the exit angle of the turning roadway.

Once on the installation, many military installations still use ladder signs for guide signing. These sign assemblies typically contain more information than can be processed by passing motorists and should not be used. Visitors should be provided with easy-to-read maps that show major visitor destinations. Install large map signs, showing driver location and major destinations, at VCCs, and provide printed copies of the map for drivers. Small maps can also be printed on the back of visitors' passes.

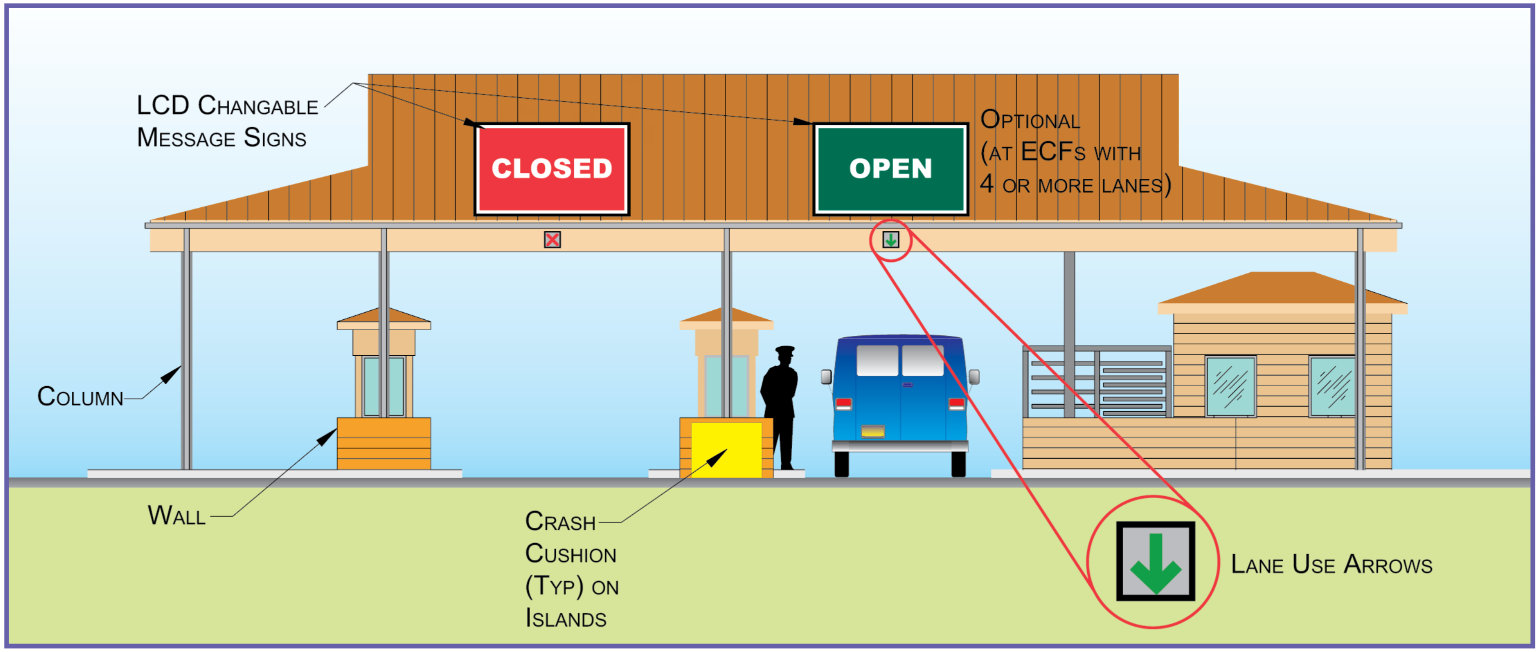


7.1.6. Signing for Automation

As noted in **Section 9**, consideration should be given to traffic control needs when considering future ECF automation.

Chapter 2F of the *MUTCD* provides guidance on toll plazas which produce similar motorist behavior to that of an ECF. This guidance should be applied to ECFs. In general the following recommendations should be considered.

✓ Advance signing is necessary and recommended especially where mixed (manual and automated) checking is used. Advance signs should be placed ½ mile in advance if feasible. This will allow for motorists to prepare to enter the proper lanes prior to the ID check point. The FHWA recommends that the background color for advance signs should be green. The preference is to have all automated lanes on the left, but if upstream or downstream weaving is an issue, it may be necessary to have automated lanes spread throughout the ECF.



✓ Lane assignment guidance may be needed where mixed (manual and automated) checking is used and at locations where there are four or more ID check lanes. Providing clear and consistent advance information helps the traveler to make early decisions on lane selection. Ideally, automated lanes should be clustered to the left unless this is not possible due to upstream or downstream weaving. These signs can be located on the canopy or overhead prior to the canopy. If a lane assignment sign is used for an automated lane, it is desirable to use them for all lanes so that drivers can readily tell which lanes are open or closed, for visitors, etc. Installations are strongly encouraged to use dynamic signs for lane assignment signs to facilitate changing operations. Several examples of dynamic lane assignment signs are included below.

✓ If dynamic lane assignment signs are not used for all lanes, then provide static lane assignment signs and use lane-use control signals over all ID check lanes to indicate an open or closed status. The lane-use control signal with the downward pointing green arrow should be used to indicate the lane is open and the red X should be used to indicate the lane is closed. Static or changeable message signs may accompany the lane use signals on the canopy as needed. Flashing (yellow) beacons should not be installed together with lane-use signals.

If all lanes are automated (decals and visitors), signing for automation may not be required.

7.1.7. Stop Sign Use at ID Check Location

Some Services install a STOP sign, or a placard indicating such, at the ID Check area. SDDCTEA does not support the use of either because the guard serves the purpose of the traffic control device. However, if used, sign installation should conform as close as reasonable to requirements given in the *MUTCD* and the DOD Supplement to the *MUTCD*.

The use of a STOP sign at an ID Check station greatly affects the processing rates achieved, thereby contributing to congestion during the peak hours of entry. SDDCTEA has no data-based evidence or experience that demonstrates that the sign placement fulfills a useful purpose nor that the sign corrects a problem or deficiency. STOP signs are not required, and not recommended by SDDCTEA, at the ID check. SDDCTEA discourages the placement of a STOP sign because (1) it impedes the flow of the ID Check station thus reducing the throughput, and (2) it will breed a tendency for drivers to ignore STOP signs when the application is inconsistent (i.e., the guard will sometimes wave drivers on during busy or slow times so a stop is not required).

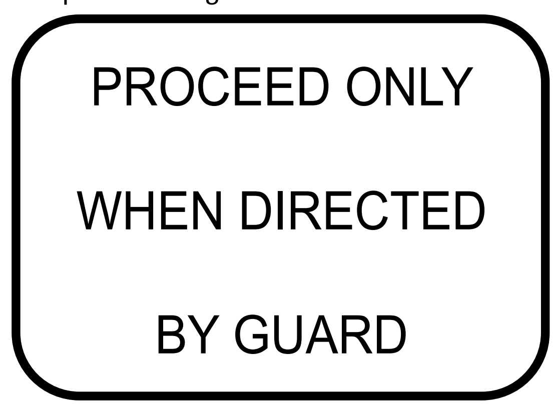
A TEA standard sign currently does not exist as it is not a recommended sign installation and usage. However, considering that some installations are using a STOP sign (or similar sign) at the ID check, SDDCTEA has developed a solution to make it workable, safe, and with a clear conveyance to drivers.

Though SDDCTEA discourages its placement, if used, the proper application should be a standard 8-sided STOP sign with a supplemental placard below it. The signing needs to be placed at the appropriate height, lateral offset, and meet retroreflectivity requirements as outlined in the *MUTCD*.

The STOP sign size shall be 30” x 30”. This is the minimum size STOP sign which is adequate for single lane conventional roadways, and will also accommodate a single ID check lane.

The supplemental sign shall meet the following requirements:

- ✓ Word message stating ‘PROCEED ONLY WHEN DIRECTED BY GUARD’.
- ✓ All upper-case letters and 3 inch letter height.
- ✓ Sign dimension of 30” width x 18” height.
- ✓ Black lettering on white background.



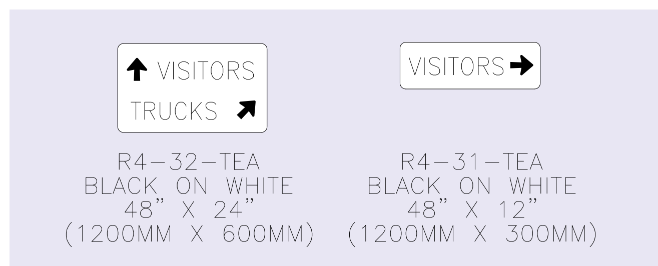
7.1.8. Installation Perimeter Designation

Some service branches desire to post the installation property line. This is often done through marking the property line with a blue pavement marking across the roadway at the boundary location. Blue pavement markings are not allowed per the *MUTCD*, and therefore a blue marking is not permitted for this use.

SDDCTEA recommends installing signing indicating the boundary, similar to a sign used for a municipal boundary. The sign should be white letters on a green background, similar to a guide sign.

7.1.9. ECF Vehicle Separation Signs

It is beneficial to properly sign the appropriate destination for vehicles that are required to travel within the ECF. Typically, these include truck inspection areas and visitor centers. Signs, such as those shown below, indicating a Visitor/Truck message with appropriate arrows should be used. Left arrows should be placed to the left side of the word and right arrows should be placed to the right side of the word.



7.2. PAVEMENT MARKINGS

Pavement markings, like signs, should be placed in accordance with the *MUTCD* standards. Markings work with signs to help the motorist, providing continuous guidance.

PAVEMENT MARKINGS AND DELINEATION ARE ECONOMICAL WAYS TO INCREASE SAFETY.

✓ Pavement markings shall be retroreflectorized.
  - Unreflectorized markings that may be adequate in the daytime are useless at night or when wet.

✓ Special retroreflective paints and thermoplastic tapes are available.

✓ Inlaid blocks, bricks, or metal strips should not be used as pavement markings.

The normal life expectancy of pavement markings is two years. Pavement markings should be inspected annually to ensure they are in acceptable condition.

Pavement markings may be categorized into two primary groups:

✓ Longitudinal markings help facilitate vehicle guidance and location

✓ Transverse markings provide warning and regulatory information to the motorist

Both types of pavement markings provide vital information to the vehicle operator, and as such must be uniform in design, position, and application.

Before

After

THE PRIMARY ADVANTAGE OF LONGITUDINAL PAVEMENT MARKINGS IS THAT THEY PROVIDE CONTINUOUS GUIDANCE.

7.2.1. Longitudinal Markings

Longitudinal markings are the primary source of information for positioning vehicles on the roadway; therefore, they must be uniform in design, position, and application. It is imperative that markings be uniform so they can be recognized and understood instantly by all drivers. The *MUTCD* provides the basic principles and meanings to which all pavement markings should adhere. **Exhibit 7.6** shows longitudinal pavement markings.

Exhibit 7.6: Primary Longitudinal Pavement Markings

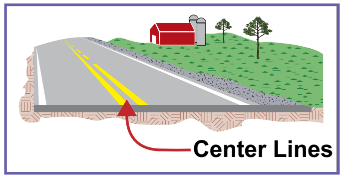
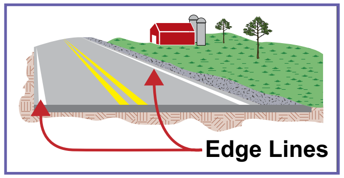
Solid Yellow Line		The solid yellow line indicates a no-passing zone applying to traffic with the solid line to its immediate left. A double solid yellow line divides lanes of traffic flow in opposing directions, and prohibits passing where marked.
Broken Yellow Lines		A broken yellow line defines the center of a two-lane, two-way roadway where passing is permitted.
Broken White Lines		A broken white line is used to delineate lanes for travel in the same direction. Lane changing is permitted.
Solid White Line		A solid white line is used to mark the right edge of the roadway, and to mark lanes for travel in the same direction where lane changing is discouraged. Its normal application is as a lane line on multilane approaches to intersections and, particularly, to delineate left- and right-turn lanes.
Double Solid White Line		The double solid white line is used for travel in the same direction, but crossing the double line is prohibited. For example, a bridge my utilize the double solid white line to prevent lane changing.
Dotted Lines		The dotted line delineates the extension of pavement markings through an intersection or interchange area. It should be the same width and color as the line it extends.

Source: FHWA, MUTCD

Proper installation and maintenance of pavement markings is important since longitudinal construction joints can sometimes be falsely interpreted as pavement markings. When markings become worn, drivers tend to follow these joints, particularly in adverse weather or at night. Often, when a gatehouse is placed on an old road, the construction joint will lead directly into the gatehouse. Such problems should be anticipated and addressed in the design and construction stages of an ECF project.

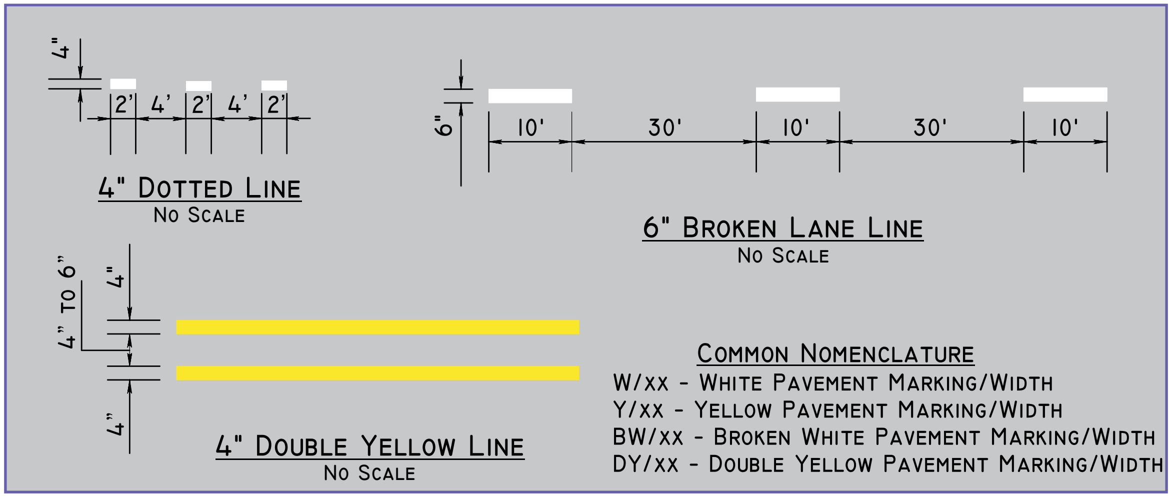
Exhibit 7.7 provides warrants for the use of centerline and edgeline pavement markings as given in the *MUTCD*. **Exhibit 7.8** details dimensions for longitudinal markings, including dotted extension lines, lane separation lines, and double yellow lines.

Exhibit 7.7: Warrants for Pavement Markings

Type		Purpose/ Application	*MUTCD* Criteria	Benefits
Center lines		✓ Provides separation of traffic traveling in opposite directions ✓ Provides delineation of separation	Standard: ✓ Mandatory for all paved urban arterials and collectors with a travel way width of 20 feet or more and an ADT of 6,000 or more ✓ Mandatory for all paved two-way streets or highways that have three or more traffic lanes Guidance: ✓ Should be placed on all urban arterials and collectors with a travel way of 20 feet or more and ADT of 4,000 or more ✓ Should be placed on all paved rural arterials with a travel way width of 18 feet or more and an ADT of 3,000 or more ✓ Should be placed on other paved areas and travel ways less than 16 feet wide as a traffic engineering assessment indicates	30% reduction in head-on crashes
Edge lines		✓ Provides an edge of pavement guide for drivers ✓ May result in lower speeds since travel lanes appear narrower	Standard: ✓ Mandatory for freeways, expressways and paved rural arterials with travel way widths of 20 feet or more and an ADT of 6,000 or more Guidance: ✓ Should be placed on all rural arterials and collectors with a travel way of 20 feet or more and an ADT of 3,000 or more Options: ✓ May be placed where center lines are not present ✓ May be used to minimize driving on shoulders	11 to 25% reduction in run-off-the-road crashes

Source: FHWA, MUTCD

Exhibit 7.8: Longitudinal Pavement Marking Dimensional Details



7.2.2. Retroreflective Raised Pavement Markers (RRPMs)

RRPMs can be used to increase the visibility of all lane and channelization pavement markings. They should be the same color as the pavement markings they supplement (except on divided roadways, where the backside facing wrong-way traffic may be red). RRPMs can be used in snow zones through depressed/cut-in installation or the use of special snowplow blades that will not damage them.

TRANSVERSE PAVEMENT MARKINGS ARE USED IN APPLICATIONS WHERE AN IMMEDIATE ACTION IS REQUIRED BY THE DRIVER.

7.2.3. Transverse Markings

Transverse markings may indicate a command to stop at an intersection, to advise caution for pedestrians in a crosswalk, or to advise against travel within boundaries defined by crosshatching or painted islands.

There are several types of transverse markings including stop lines, yield lines, word and symbol markings, arrows, crosswalk lines, speed hump markings, shoulder markings, parking space markings, and others.

7.2.4. Chevron and Diagonal Crosshatch Markings

Chevron and diagonal crosshatch markings may be used to discourage travel on certain paved areas, such as shoulders, gore areas, flush median areas between solid double yellow center line markings or between white channelizing lines approaching obstructions in the roadway, between solid double yellow center line markings forming flush medians or channelized travel paths at intersections, buffer spaces between preferential lanes and general-purpose lanes, and at grade crossings. At ECFs, chevron markings are used approaching guard islands with travel is in the same direction. Diagonal crosshatch markings are used approaching median islands or guard islands comprising the median, when travel is in the opposite direction. Crosshatch lines should be sloped in the direction of major flow of traffic. They must comply with the *MUTCD* standards and satisfy transitional requirements. Details of chevron and diagonal crosshatch markings used at an ECF are shown in **Exhibit 7.9**.

Exhibit 7.9: Chevron and Diagonal Crosshatch Marking Details

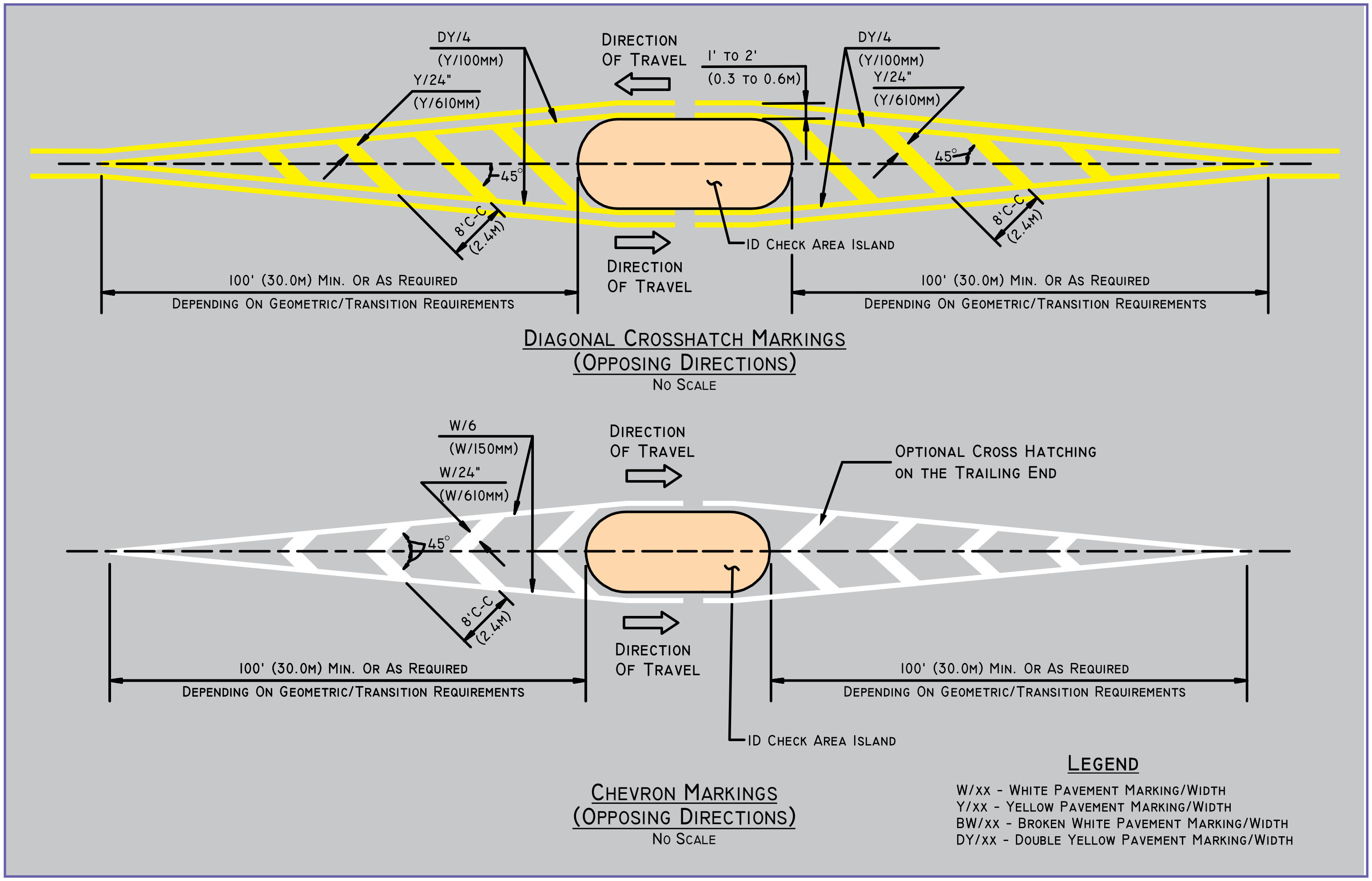
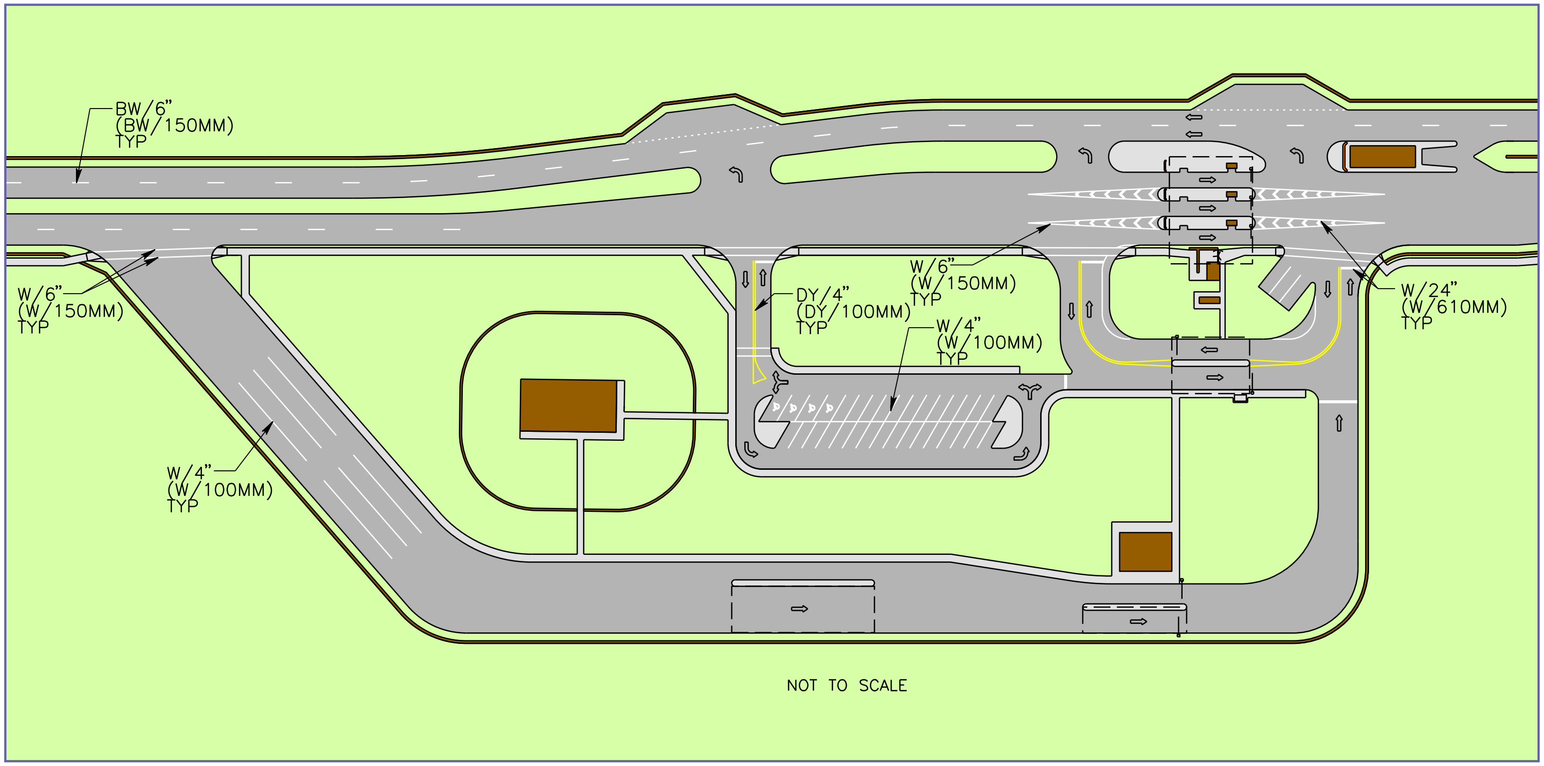


Exhibit 7.10 shows a sample pavement marking plan for an entire ECF.

Exhibit 7.10: Sample ECF Pavement Marking Plan



RETROREFLECTIVITY IS THE MEASURE OF AN OBJECT'S (SIGNS AND PAVEMENT MARKINGS) ABILITY TO RETURN LIGHT TO THE SOURCE (HEADLIGHT).

7.3. SIGN AND PAVEMENT MARKING RETROREFLECTIVITY

The fatality rate for motorists during the night is three times higher than during the day. Things that contribute to this nighttime problem include the reduction of visual cues that delineate the roadway and the inability of drivers to see and read traffic signs and pavement markings. Retroreflection is the unique ability of a surface to reflect light back toward the light source, even when the surface is not perpendicular to the light source. Retroreflectivity is the measure of this unique property. Simplisticly, retroreflectivity is a measure of how bright the sign, or pavement marking, is at night.

Daytime

Night (Non-retroreflective)

Night (Retroreflective)

Source: FHWA

7.3.1. Sign Retroreflectivity

Rulemaking effective in January 2008, by the FHWA, established new nighttime visibility requirements that apply to traffic signs installed on all roadways open to public travel.

The *MUTCD* sets retroreflectivity requirements that should be followed. Signs that are visible during daylight periods may not have acceptable retroreflective properties at night. During daylight periods, the driver has visibility of many "cues" such as signs, pavement markings, guardrails and objects along the road. At night, signs may be one of the few driver cues. To ensure adequate retroreflectivity and visibility at night, install regulatory, warning, and guide signs with Type III or better retroreflective sign sheeting type. Types I and II provide the minimum acceptable level of retroreflectivity when new, but have a higher lifetime annualized cost when compared to higher grades of sheeting type (such as the Type III). Therefore, though they are cheaper in cost when initially installed, Types I and II sheeting should not be used.

The photos to the right show a sign with good color and visibility by day, along with the variation in visibility at night by quality of sheeting. Non-retroreflective signs can barely be seen at night, while retroreflective signs can reflect a light source and be seen easily at night.

How to Ensure Adequate Retroreflectivity

- ❑ Obtain all signs from a reputable sign shop.
- ❑ Require a minimum Type III retroreflective sheeting material for all signs.
- ❑ Require Type VII, VIII, IX, or X material for white legends on all overhead guide signs.
- ❑ Annually inspect signs at night to ensure they are visible and performing properly, and replace damaged or missing signs.
- ❑ Replace all signs at intervals based on the sheeting manufacturer's warranty.

7.3.2. Types of Retroreflective Materials Available

Per SDDCTEA's DoD Supplement to the *MUTCD*, the retroreflective sheeting type for all regulatory, warning, and guide signs used on military installations shall be Type III or better. The retroreflectivity of new Type III or greater materials is about four times brighter than new Type I materials. Moreover, because Type I materials deteriorate much faster than Type III or greater materials, after 7 years the Type III materials will be about six or seven times brighter.

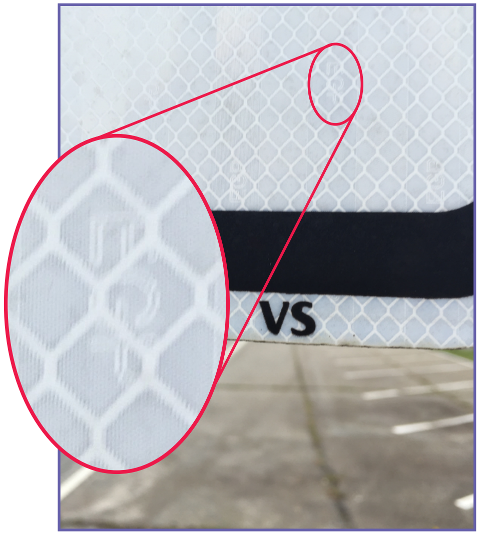
Because of minimum retroreflectivity values required by FHWA (in the *MUTCD*), even new signs made with Type I and Type II materials may not meet some of the minimum values. Therefore, military installations should no longer use any Type I (Engineering Grade) or Type II (Super Engineering Grade) materials. For more information on preferred sheeting types, contact SDDCTEA. **Exhibit 7.11** shows information on different types of retroreflective materials.

Type I and II materials both have a uniform appearance similar to metallic paint; whereas all Type III, IV, VII, VIII, IX, and X materials have a pattern of hexagons, diamonds, or circular shapes

Exhibit 7.11: Available Types of Retroreflective Materials

Type Retroreflective Material*	Common Name	Life Expectancy (years)	Comments
I	Engineering Grade	7	These two types are not allowed per the DoD MUTCD.
II	Super-Engineering Grade	7-10	
III & IV	High-Intensity or High-Performance Grades	10+	Recommended material, except use a higher type material for all white legend on overhead signs.
VII, VIII, IX & X	Super-High Intensity or Very High-Intensity Grades	10+	Microprismatic materials.

* Two types classified by ASTM D4956 are not included in this table: (1) Type V material, which is used for delineation; and (2) Type VI material, which is used for roll-up signs in work zones.



Type I EGP Sheeting Example

measuring about one-eighth-inch across. Therefore, most of the time it is easy to recognize the inferior Type I and II materials.

Some sign sheeting manufacturers have a type of Type I that has an appearance of a higher grade sheeting at first glance by the unsuspecting eye. It has a diamond-shaped honeycomb pattern; but, it also has small EGP (i.e., Engineering Grade Prismatic) watermarks visible in the sheeting itself, as shown in the photo at left. This type of sheeting is only Type I, and therefore cannot be used.

Special inks are required on all retroreflective materials. In addition, all colored inks need to be a transparent-type ink applied at the proper thickness over white retroreflective material so that the color is correct and the sign is visible at night. Therefore, it is essential to obtain all signs from a reputable sign shop. For more information regarding retroreflective sheeting materials refer to FHWA Publication: FHWA-SA-11-14 or consult SDDCTEA.

As part of the official FHWA ruling, Federal Land Management agencies with jurisdiction of roadways open to public travel must have in place an assessment or management method that is designed to maintain traffic sign retroreflectivity at or above the minimum levels specified in the *MUTCD*. Signs identified as not meeting minimum retroreflectivity levels must be replaced. Contact SDDCTEA for more information on developing a plan to maintain minimum sign retroreflectivity.

DIFFERENCES IN RETROREFLECTIVE MATERIALS

TYPE I

TYPE III

Source: FHWA

7.3.3. Pavement Marking Retroreflectivity

Highly visible markings assist motorists in inclement weather and during nighttime driving. Pavement markings have a typical life of approximately two years and should be reviewed no less than annually to identify where replacement is necessary. Adding glass beads is one method to reflectorize pavement markings. Some manufacturers offer thermoplastic markings or inlaid markings with similar properties.

LANE REVERSAL INVOLVES ASSIGNING CERTAIN TRAFFIC LANES TO FLOW IN ONE DIRECTION DURING PART OF THE DAY AND IN THE OPPOSITE DIRECTION DURING ANOTHER PART OF THE DAY IN ORDER TO MEET HIGHLY DIRECTIONAL DEMANDS.

7.4. LANE REVERSAL

Lane reversal can be a cost-effective tool to increase the capacity of an existing ECF and its access roads. However, because of the consequences if reversible lanes are used improperly, lane reversal should only be used after a traffic engineering study shows it to be practical and safe. Lane-reversal signals, markings, and other pertinent devices must conform to the *MUTCD*.

If the following conditions are met, lane reversal may be considered:

- ✓ Roadway cannot be widened because of physical or monetary constraints
- ✓ At least 65 percent, or preferably 75 percent, of the traffic is traveling in one direction during peak periods
- ✓ Cyclic congestion is evident
- ✓ Off-peak, opposite direction capacity is adequate during reversal
- ✓ Route and width are continuous

To accommodate lane reversal, a roadway should be three or more lanes. This would accommodate through traffic and emergency situations, such as breakdowns or other minor vehicle stoppages. Left turns and parking are restricted in areas where reversible lanes are used.

For long lane-reversal sections, overhead lane use control signals are necessary. These have 12-inch (300 millimeters) rectangular faces displaying a RED X or a DOWNWARD GREEN ARROW. A YELLOW X indication is not necessary for ECF applications. When changing cones would endanger workers because of heavy traffic during off-peak hours, overhead lane use control signals could provide a safe and fast method of changing lane configurations. Overhead signals should be spaced so that a driver always has at least one in view, with a maximum spacing of ¼ mile (0.4 kilometers).

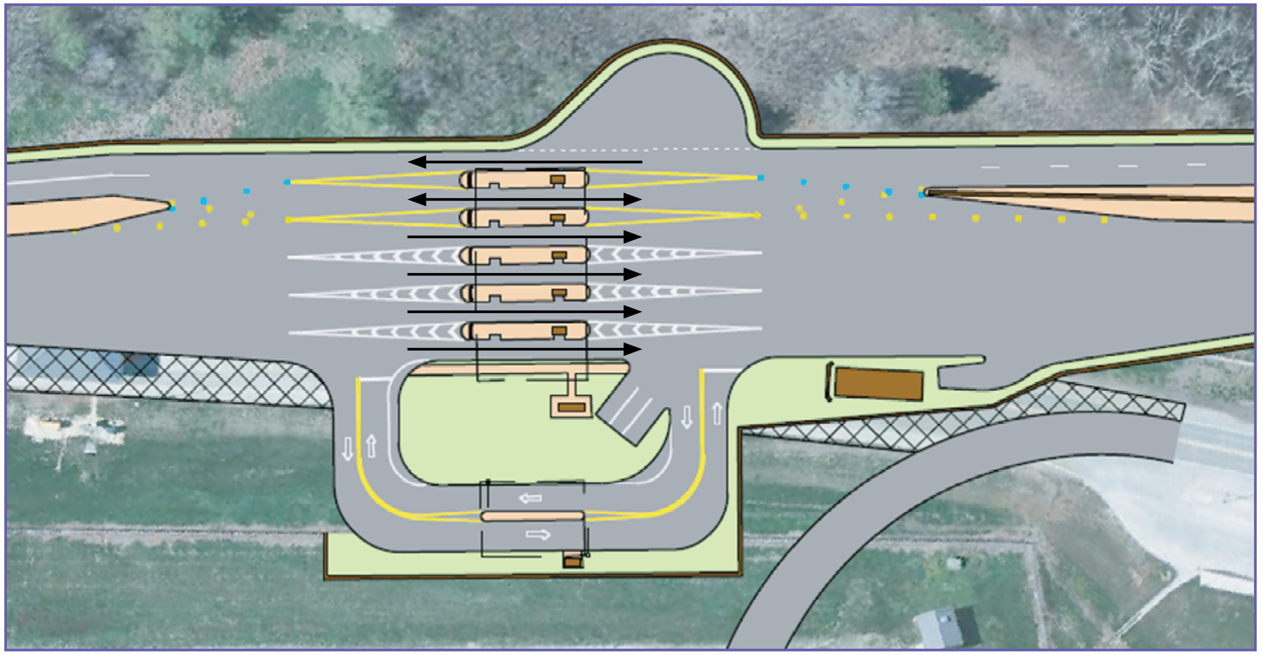
For short lane-reversal sections, such as through a high-security ECF area, cones and signing are adequate for control.

In the access control zone, movable barriers may be used if only the ID check lane is reversible and to control vehicle movements.

Exhibit 7.12 is an example of a short-lane reversal through the access control zone to increase processing capacity during the peak hour of a new ECF. Due to real estate and environmental constraints, reversible lanes were provided in the design to meet the necessary lane requirements during the peak hour. Proper traffic cone spacing and tapers shall be utilized when implementing a reversible lane.

When modifying or designing a new ECF with reversible lane(s), an ID check island must be provided between each lane designed to process vehicles. In addition, consider providing a canopy over the reversible lanes to assist security personnel performing ID checks. Reversible lanes are not preferred because of potential crash increases but when correctly implemented can increase capacity during the peak hour. Consult SDDCTEA for additional guidance.

Exhibit 7.12: Access Control Zone Reversible Lane Conceptual Design



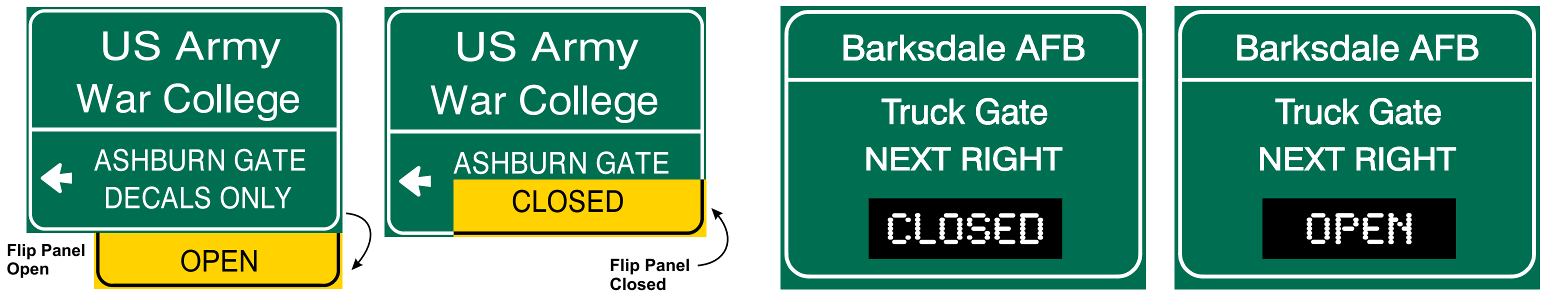
Note: Traffic cones and required signing not shown

Background Image Source: Google Earth

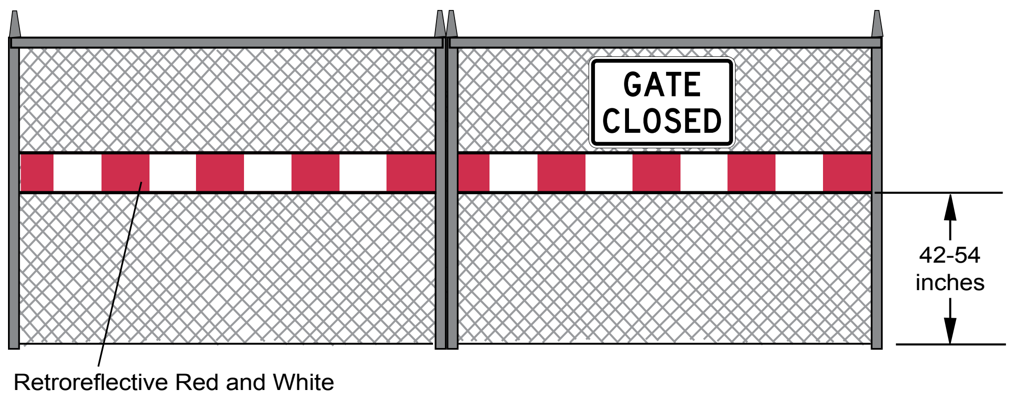
7.5. CLOSURES

Install signs showing the hours of ECF operation in advance of the ECFs that have limited-use hours and are more than one mile away from the public roadway. In some cases, basic technology can be used with a sign to indicate if an ECF is open or closed. The control of these signs can be manual or on a timer and can be designed with remote controls.

When gates are used to close off a roadway, a GATE CLOSED sign shall be used in combination with retroreflective, alternating, vertical red and white stripes (16 inches in width) on a sign panel (see section 8C.04 of the national *MUTCD*). The sign panel must be a minimum of 4 inches in width and span the entire length of the gate on both sides. The total surface area of the retroflective strip shall not be less than 1152 square inches per approach lane. A minimum of two GATE CLOSED (R11-2g-TEA) signs are required, one for the in-bound approach and one for the out-bound approach. STOP signs or other intersection signing shall not be used. When gates are used to close an ECF, a sign displaying ECF hours of operation shall be posted.



R11-2g-TEA



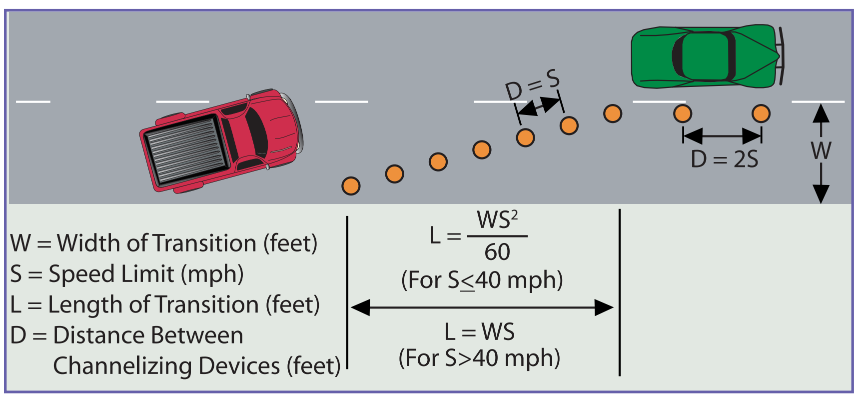
Gate closure signing per approach

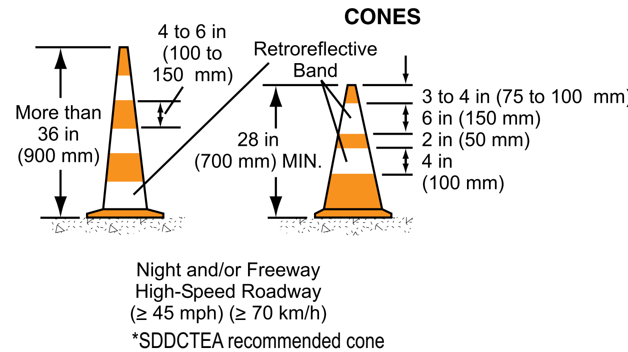
7.6. TRAFFIC CONES AND MARKERS

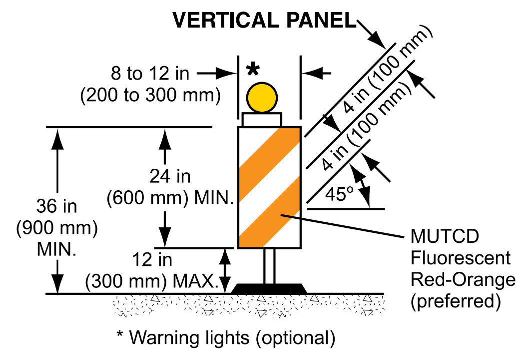
AS A GENERAL RULE, THE DISTANCE BETWEEN CONES IN FEET SHOULD EQUAL THE POSTED SPEED LIMIT.

Traffic cones and markers can be used effectively for temporary channelization of traffic during lane reversal and lane closures. These devices are convenient since, unlike steel drums, they can be quickly placed and removed and, if struck, will not damage vehicles. All traffic cones shall be orange, fluorescent red-orange or fluorescent yellow in color and a minimum of 28 inches high with white retroreflective bands per Occupational Safety & Health Administration (OSHA) standards.

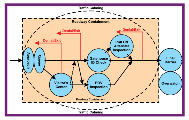
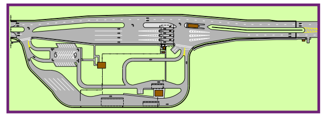
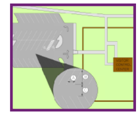
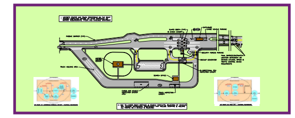
Within transitions, the distance between cones in feet should equal the posted speed limit in miles per hour. For example, if the posted speed limit is 25 mph (40 km/h) then space cones at 25 feet (7.6 meters). The use of traffic cones should follow standard transition requirements and should not result in an abrupt change in traffic patterns. As a general rule, the taper length in feet should equal $WS^2/60$ for a speed limit of 40 mph or less, or WS for speed limits greater than 40 mph (where W is the width of the shift in feet and S is the posted speed in miles per hour) or 100 feet, whichever is greater.



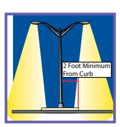


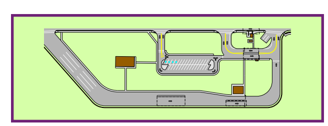


Source: FHWA - MUTCD

SECTION 8 - FORCE PROTECTION ISSUES



8. Force Protection Issues

8.1. STANDOFF DISTANCES

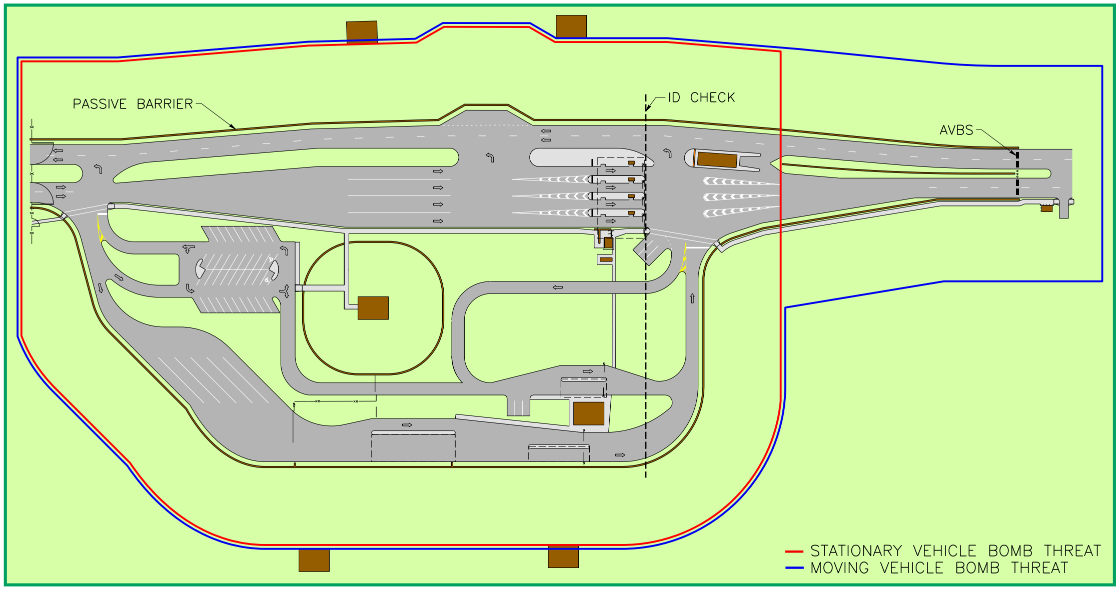
The ECF is designed to dampen possible threats from outside sources. For this reason, the probability of a terrorist explosion in an ECF is higher than at other areas on an installation. When planning for an ECF location, it is important for planners to understand the design strategies used in determining standoff distances from protected facilities. Standoff distance refers to the shortest straight line distance between a structure and a potential explosion location. For an ECF, the closest potential explosion location a point on the passive and active barriers closest to the structure. The standoff distances are shown in **Exhibit 8.1**, and include a specified distance beyond the passive and active barriers around the entire ECF. UFC 4-020-01, DoD *Security Engineering Facilities Planning Manual* explains that the design strategies for mitigating moving and stationary vehicle bomb tactics are the same and it identifies four criteria for dampening vehicle bomb tactics:

- ✓ Standoff distance
- ✓ Building hardening
- ✓ Barriers
- ✓ Manpower and procedures

UFC 4-010-01 identifies minimum standards for standoff distance requirements. The installation must follow the Security Engineering Planning Process identified in UFC 4-020-01. Standoff distances calculated through this process may vary. At a minimum, standoff distance requirements are either of the following:

- The minimum standoff distance for new construction and additions to existing buildings to the

Exhibit 8.1: Required Standoff



Force Protection Issues

installation perimeter is 20 feet when 30 feet of clear zone outside of the installation perimeter is available.
- Where there is no clear zone outside of the installation perimeter, the minimum standoff distance is 50 feet.

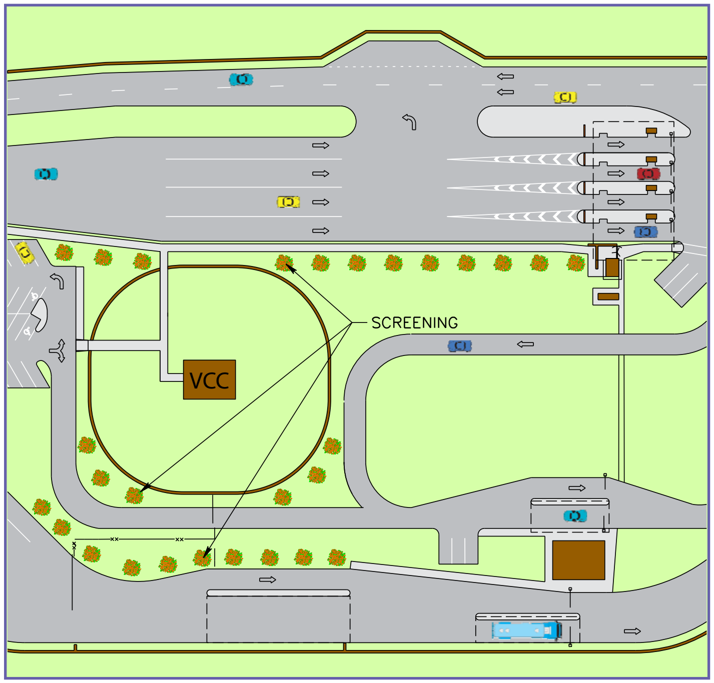
In other words, 50 feet of clear zone standoff distance is required, but up to 30 feet can be outside of the installation perimeter. Clear zones require unobstructed views, and not access control. Additionally, buildings require a 33-foot unobstructed space standoff distance, or to the installation perimeter as described above.

If additional considerations are deemed necessary by an installation, for stationary vehicle bomb threats, standoff distances from buildings to ECFs should be measured from the ID check area to the closest part on the building exterior or inhabited portion of the building or to specific building components. For moving vehicle bomb threats, standoff distances should be measured to the nearest final denial active vehicle barrier.

ACTIVITIES IN THE ECF SHOULD BE PROTECTED FROM UNABATED SIGHT AS MUCH AS POSSIBLE WITHOUT LIMITING THE SIGHT LINES NEEDED BY ECF PERSONNEL.

8.2. SCREENING

The overwatch position must have a clear line of sight to each area of the ECF where personnel are concentrated. Limiting the observation capabilities of a potential threat can be achieved by screening different positions. The perimeter of the ECF should be screened so that viewing of operations from outside the passive barriers cannot be accomplished. Furthermore, when the vehicle inspection area is in close proximity to the queuing area for the main ID check area, screening should be provided to limit the casual viewing of operations at the inspection area. At a primary ECF that has a VCC, if the main ID check or inspection area can be viewed from the parking area, consider placing screening in these locations. Screening can be accomplished in a number of different ways; the most aesthetically pleasing way is by providing plantings that will also contribute to the overall quality of the ECF. Earthen berms and walls are other means of screening areas when sufficient space is not available to use natural screening.



8.3. THREAT SCENARIOS

Consider all scenarios when designing an ECF (especially the response zone), determine which scenario governs, and verify the adequacy of the response time and active vehicle barrier selected. Consider the four threat scenarios detailed in **Exhibit 8.2** as a minimum. Additional threat scenarios and initial velocity conditions may have to be analyzed if supported by a local vulnerability assessment.

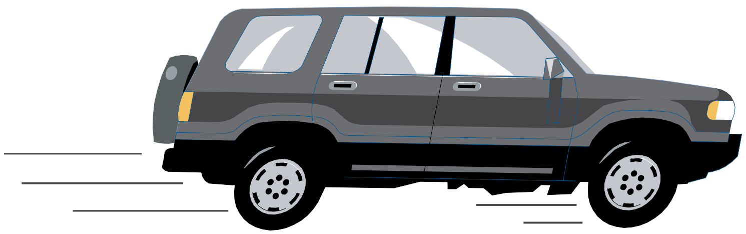
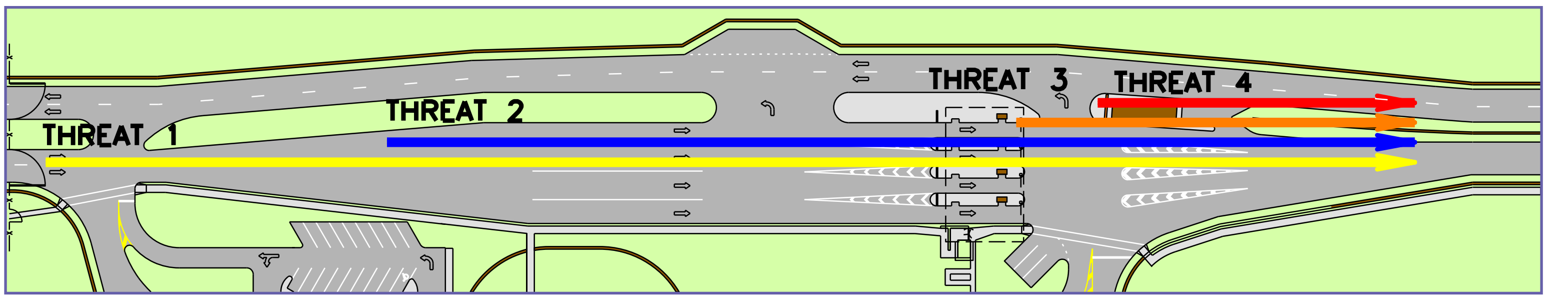


Exhibit 8.2: Threat Scenarios

Scenario	Action
Threat 1	Vehicle approaches the ECF in the inbound or outbound lanes at a moderate or high rate of speed
Threat 2	Vehicle enters the ECF in the inbound or outbound lanes at or under the posted speed limit and then accelerates at some point farther in the approach zone, after an advance speed detector
Threat 3	Vehicle appears legitimate until the ID check area
Threat 4	Vehicle is rejected or directed to proceed to the inspection area; however, once away from the guard, attempts to enter the installation

Source: UFC 4-022-01



WHEN SELECTING BARRIERS, THE MOST CRASHWORTHY BARRIERS THAT ALSO SATISFY SECURITY REQUIREMENTS SHOULD BE USED.

PASSIVE BARRIERS PARALLEL TO THE ROADWAY SHOULD BE LOCATED OUTSIDE THE CLEAR ZONE UNLESS THEY ARE NCHRP OR MASH TESTED FOR CRASH SAFETY.

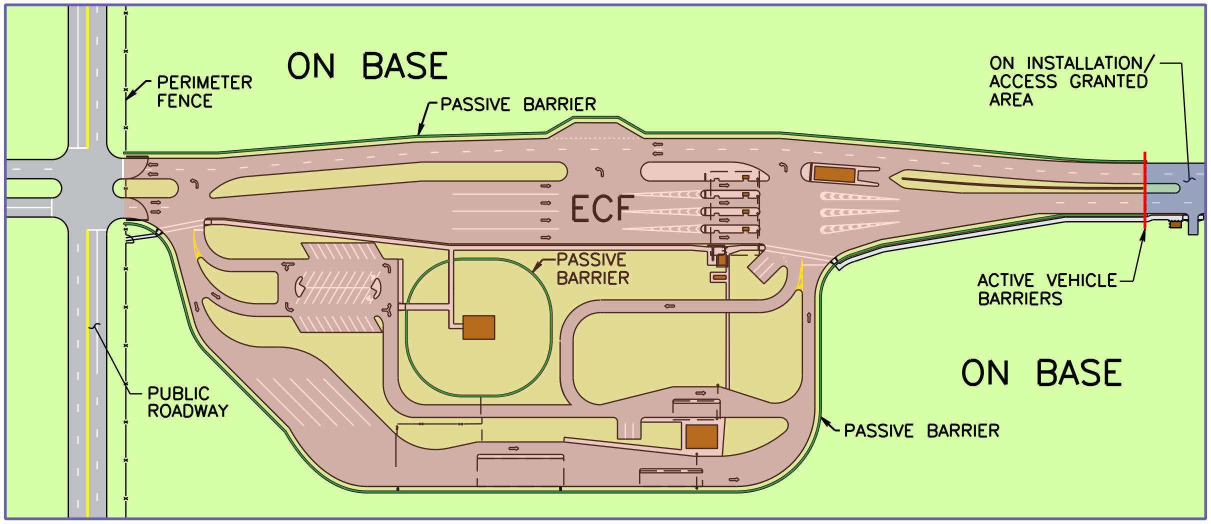
BARRIERS WITHIN THE ROADWAY SHOULD BE SIGNED AND MARKED FOR SAFETY CONSISTENT WITH THE *MUTCD*.

8.4. VEHICLE BARRIERS

The containment of potential threats to the ECF is accomplished by the installation of barriers. Roadway containment is necessary to prevent inbound vehicles from unauthorized access and must extend from the installation perimeter to the active vehicle barrier in order to be effective. There are two basic types of barriers:

- ✓ **Passive Barriers** – Stationary barrier typically used along the roadway ending at the AVB
- ✓ **Active Vehicle Barriers (AVBs)** – Requires action by personnel and/or equipment to permit or deny entry

The design of an ECF should ensure that vehicles are contained through an arrangement of passive and active vehicle barrier systems. Passive and active vehicle barriers form a contiguous perimeter around the ECF. Passive barriers are used to direct and channelize the flow of traffic in the desired direction. Active vehicle barriers require some action, either by personnel, equipment, or both, to prevent entry of a vehicle. *UFC 4-022-01* provides additional discussion on the selection and application of active and passive vehicle barriers, and the USACE Protective Design Center's Anti-Ram Vehicle Barrier List for DoD.



Force Protection Issues

8.4.1. Passive Barriers

Passive barriers are normally placed longitudinally or at an angle that encourages deflection back into the direction of travel. They are typically parallel to the ECF within the access control zone and response zone but may be used for containment in areas near the VCC and inspection areas.

Consideration should be given to the potential debris hazard produced by passive barrier systems exposed to blasts during a potential attack and the effect on any nearby buildings or assets. The aesthetics and design of the barrier system should be consistent with the installation's exterior architectural plan and the surrounding architectural and landscape features.

Passive barriers should always be installed outside the roadway clear zone (which varies based on volume and speed). Breaks in the passive barrier system for pedestrian access to the ECF should not exceed 3.3 feet (1 meter) in width for traffic having a 90-degree approach and 4.1 feet (1.25 meters) in width for traffic paralleling the barrier.

8.4.1.1. Passive Barrier Testing Standards

When planning and selecting passive vehicle barriers to be used for facility perimeter protection, the first step is to determine the design basis threat (DBT) for any given location in the facility. The two main factors to consider are the amount of kinetic energy absorbed and the vehicle penetration distance. The appropriate penetration distance for a given facility is determined by the threat and risk assessments and physical security survey results as indicated by the process outlined in UFC 4-020-01, *DoD Security Engineering Facilities Planning Manual*, UFC 4-020-02FA, *Concept Design*, and 4-020-03FA, *Security Engineering: Final Design*.

The list of passive barrier systems approved by the DoD is contained within the DoD Anti-Ram Vehicle Barrier List. The USACE-PDC maintains and updates the listing on a quarterly basis. According to the DoD Anti-Ram Vehicle Barrier List: "The list does not represent an overall endorsement of any product or design or address its operational suitability or maintainability. The list merely verifies that particular vehicle barriers have been certified in accordance with the performance standards in ASTM F2656/F2656M-18a, or previously tested to the U.S. Department of State (DoS) SD-STD-02.01 standard, and that the appropriate test reports have been submitted to, and validated by, the Protective Design Center." Note that the DoS SD-STD-02.01 has been superseded by ASTM F2656/F2656M-18a Crash Testing of Vehicle Security Barriers.

Each type of passive barrier system has a condition designation and a penetration rating. The condition designation is the maximum kinetic energy the system can absorb for a given vehicle type, mass and velocity. The penetration ratings categorize the range of allowable penetration for the barrier system.

In the ASTM F2656/F2656M-18a test standards, condition designation is based on a combination of test vehicle classes and nominal test velocities and is associated with three penetration ratings beginning with the letter "P". In the now obsolete DoS SD-STD-02.01 standards, kinetic energy rating has a "K" label and the penetration rating has an "L" label. A table showing the different ratings used in the DoD Anti-Ram Vehicle Barrier List is shown below in **Exhibit 8.3**.

Exhibit 8.3: Kinetic Energy Rating Characteristics

Standard	Condition Designation	Vehicle Weight (lbs)	Vehicle Speed (mph)
DoS SD-STD-02.01	K4	15,000	30
	K8	15,000	40
	K12	15,000	50
ASTM F2656/F2656M-18a	SC30, SC40, SC50, SC60	2,430	30, 40, 50, 60
	FS30, FS40, FS50, FS60	4,630	30, 40, 50, 60
	PU30, PU40, PU50, PU60	5,000	30, 40, 50, 60
	M30, M40, M50	15,000	30, 40, 50
	C730, C740, C750	15,000	30, 40, 50
	H30, H40, H50	65,000	30, 40, 50
	U30, U40, U50	User-defined*	30, 40, 50

* Any specific vehicle type as per end user's requirements to accommodate interests of various U.S. agencies

Penetration ratings are shown below in **Exhibit 8.4**.

Exhibit 8.4: Passive Barrier Penetration Ratings Characteristics

Standard	Penetration Rating	Allowable Penetration (ft)
DoS SD-STD-02.01	L1	20 – 50
	L2	3 – 20
	L3	Less than 3
ASTM F2656/ F2656M-18a	P3	23.1 – 98.4
	P2	3.31 – 23
	P1	Less than 3.3

The abbreviations for the various vehicle classes used to create the condition designations are shown below in **Exhibit 8.5**.

Exhibit 8.5: Typical Vehicle Condition Designations

Designation	SC	FS	PU	M	C7	H
Vehicle Type	Small passenger car	Full-size sedan	Pickup truck	Standard test truck	Class 7 Cabover	Heavy goods vehicle
Vehicle Weight (lbs)	2,430	4,630	5,000	15,000	15,000	65,000

8.4.1.2. Certified and DoD Approved Passive Barrier

Only passive barriers from the DoD approved list can be used on installations. The various types of passive barrier systems on the DoD approved list are shown below in **Exhibit 8.6**.

Exhibit 8.6: Certified Passive Barrier

Type	Kinetic Energy Ratings	Penetration Ratings	Example
Bollards	PU50, M30-M50, K4-K12	P1-P3, L3	
Cable	M30-M50	P1-P3	
Portable Modular	M30	P2	

Type	Kinetic Energy Ratings	Penetration Ratings	Example
Portable Bollards	M30	P3	
Post and Beam	M30-M50, FS30	P1-P2	
Reinforced Fence	M50, K8-K12	P1-P2, L1-L3	
Inertial	M50, K12	P1, L3	

THE MGS IS A LOW-COST, NON-PROPRIETARY, SAFE PASSIVE BARRIER SYSTEM MEETING M30 P1 OR FS30 P1 DESIGNATIONS AND IS ON THE DOD APPROVED LIST FOR PASSIVE BARRIERS.

8.4.1.3. Non-Proprietary Modified Midwest Guardrail System

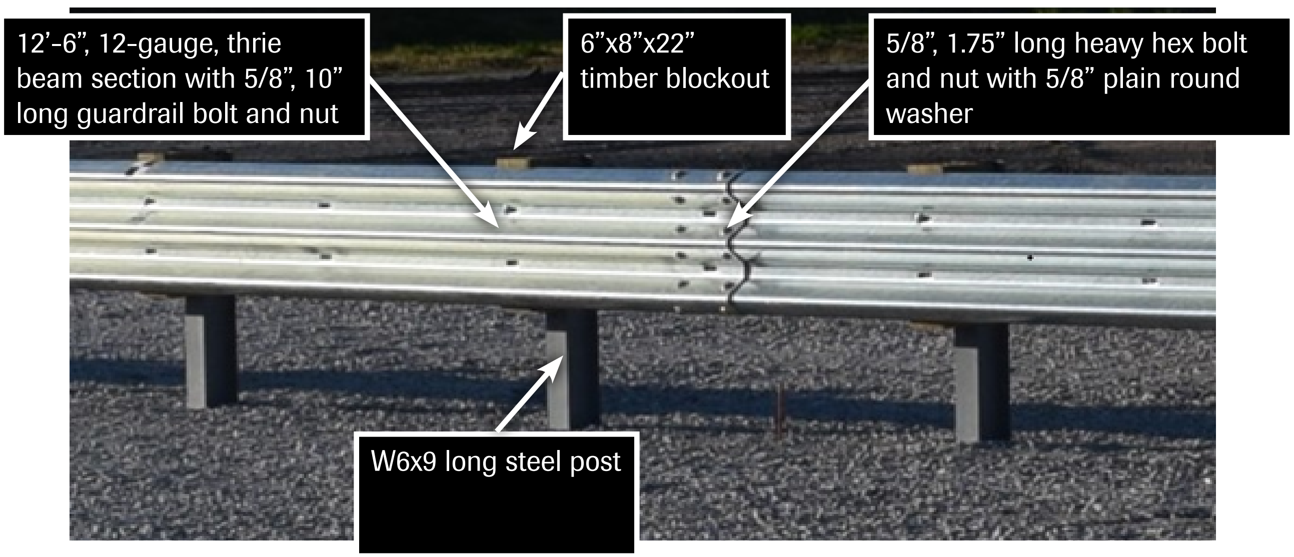
The MGS (Midwest Guardrail System), shown in **Exhibit 8.7**, is a non-proprietary W-beam guardrail system that was specifically designed for today's vehicles which have a high center of gravity and is recommended by the Federal Highway Administration for its superior performance over other guardrail systems at little to no additional cost. It is widely available and has proven to be very versatile in a number of demanding applications, including at high flare rates (5:1), adjacent to steep 2:1 slopes, over long-span culverts, on bridges as bridge rails, and as attachments to temporary concrete barriers.

A modified version of this MGS was recently approved by the USACE-PDC to be added to the DoD Anti-Ram Vehicle Barriers listing, under the passive barrier description 'Non-Proprietary M30 P1 Barrier'. **Being DoD approved for use on all installations, SDDCTEA believes that the modified MGS (as designed) provides a solution for installations seeking a low-cost, non-proprietary, and safe passive barrier system that meets the M30 P1 or FS30 P1 designations.** Researchers have stated that minor modifications can be made to the modified guardrail system to achieve the M40 or FS40 designations with increasing the cost by approximately 20%. Note that this system is not MASH-certified and is not authorized for use within the clear zone according to the UFC 4-022-01. Although the test was not conducted according to MASH impact conditions, test results would have been satisfactory according to MASH TL-1 occupant risk evaluation criteria. SDDCTEA's next step is to MASH certify the Modified MGS system, so check the SDDCTEA website for updates. The design plans, as well as general information, can also be downloaded from the website.

Exhibit 8.7: Non-Proprietary MGS
Front View of End Anchor

Rear View of End Anchor

Front View of Guardrail Section



WHERE POSSIBLE, BARRIERS DESIGNED TO BE NONLETHAL SHOULD BE USED TO MINIMIZE THE SEVERITY OF IMPACT TO MOTORISTS.

8.4.2. Active Vehicle Barriers

The majority of installations require AVBs at the end of the threat response zone as a final denial barrier—a mechanism to provide containment if the ECF's security is compromised by a potential threat. There are many different types of AVBs and the barrier rating utilized is dependent on service requirements and installation needs. Design AVBs with a safety scheme that allows all road users to safely clear the barrier or stop in advance of it prior to deployment. Safety loops should prevent deployment as the AVB is being traversed by a vehicle.

The location of AVBs is dependent on the length of the response zone. The minimum length of the response zone is calculated based on:

- ✓ **Velocity** and location of the threat vehicle when it is detected
- ✓ Rate of threat vehicle **acceleration**
- ✓ **Guard response**, **safety**, and **deployment time**

The rate of acceleration is dependent on the type of vehicle. Generally, the acceleration capabilities of threat vehicles are known.

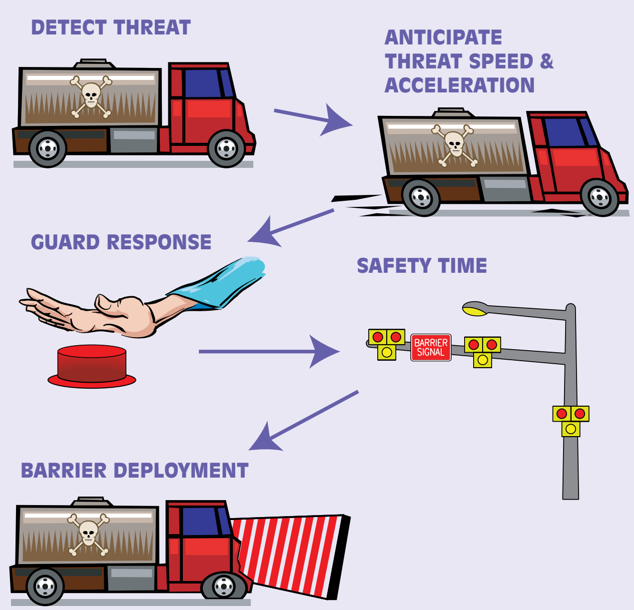
8.4.2.1. Types of Active Vehicle Barriers

There are many types of AVBs available. The decision on which type to install lies with an individual installation. Selected active vehicle barriers must be included on the list of DoD Certified Anti-Ram Vehicle Barriers maintained by the U.S. Army Corps of Engineers (USACE) Protective Design Center (PDC). The DoD certified anti-ram vehicle barrier lists are available on the PDC Web site: https://pdc.usace.army.mil. Additional guidance is detailed in UFC 4-022-02.

Overwatch

The overwatch is a position that is designed to oversee the entire ECF. The overwatch should have 360° visibility of ECF operations and should be located at the best location to respond to a threat scenario. The design, location, and functionality is dependent on the RAM employed by the branch of service and the installation. The overwatch should be placed using the same parameters as the active vehicle barriers. The overwatch position must have a direct line of sight to the access control zone of the ECF, including the ID check area and inspection areas.

THREAT CONTAINMENT



Force Protection Issues

When evaluating AVBs consider these factors:

✓ Crash rating
✓ Impact severity
✓ Time for deployment
✓ Reliability
✓ Cost

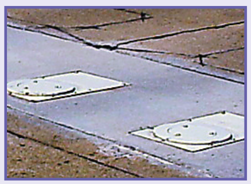
The *Army Standard (AS) for ACPs* and UFC 4-022-01 require that AVBs have the ability to mitigate or defeat kinetic energy up to 1,200,000 ft-lbs except where threat vehicles in excess of 15,000 lbs are identified in 'local' threat assessment and/or policy. The Army Standard and UFC also states that AVBs shall be selected from the DoD anti-ram vehicle barrier list.

There are two basic modes that AVBs can function at:

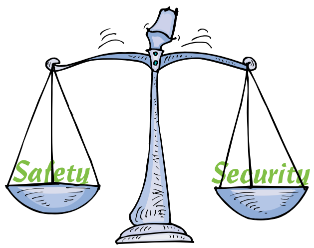
✓ Normally Closed Mode – guard opens and closes AVB for each vehicle entering the installation
✓ Normally Open Mode – guard closes barriers only when a threat is detected

Exhibit 8.8 shows the types of AVBs available as well as pros and cons of each type.

Exhibit 8.8: Types of AVBs

Type	Pros	Cons
Nets 	✓ Less likely to be lethal ✓ Can deploy in less than 2 seconds ✓ Limited hydraulics below grade ✓ Spans multiple lanes (reduce costs) ✓ Reusable after impact ✓ More than one manufacturer	✓ Limited surface area for delineation ✓ Concerns over motorcycles when traversing in down position ✓ Need to channel pedestrians away from roadside AVB area ✓ Multiple lanes cannot operate independently
Wedges 	✓ Can deploy in less than 2 seconds ✓ Significant surface for delineation	✓ Fixed object ✓ In-ground hydraulics ✓ May require replacement if struck
Bollards 	✓ Can deploy in less than 2 seconds ✓ Can be used for partial closures	✓ Vehicle intrusion on impact ✓ Gaps greater than 3 feet are a potential vulnerability ✓ Limited surface area for delineation ✓ In-ground hydraulics ✓ May require replacement if struck
Crash Beams 	✓ Most suited to barrier normally closed use in low volume conditions ✓ Better suited for cold weather locations	✓ Vehicle intrusion on impact ✓ Limited surface area for delineation ✓ In-ground hydraulics ✓ Deployment times may exceed 2 seconds ✓ May require replacement if struck
Portable Barriers 	✓ Most suited to barrier normally closed use in low volume conditions	✓ May damage undercarriage of vehicles through normal use ✓ May require replacement if struck

8.4.2.2. Active Vehicle Barrier Considerations



It is often stated or questioned that security provisions should outweigh safety considerations. The argument is that if a threat attempts an attack, the number of innocent motorists injured or killed due to AVB deployments and the threat itself at the final denial barrier, should be less than if the threat is not contained and is able to reach its intended target. These are valid points and considerations; however, safety can be designed into AVB systems. There are many reasons for AVB deployment in addition to a "true" and immediate threat. In these situations, **it is not acceptable for innocent road users to be injured or killed.** In some cases, unsafe AVB systems have been "locked down", thus providing no security benefit. The following are potential reasons, other than a "true" threat, for AVB deployment:

✓ **False Threats** – Often a vehicle is considered a threat due to its actions at the ECF; however, upon further investigation some of these "threats" are just confused motorists. Here are representative examples:
   - **Retirees** – Many installations have a significant retired population who use installation facilities. Often, these retirees are less familiar with present day security procedures, especially at ECFs where there is significant signing and motorist decisions.
   - **Toll Plaza** – At one installation, directly adjacent to a limited access roadway, officials noted that many unfamiliar/lost motorists thought the installation's ECF was a toll plaza. After they tossed 50 cents toward the guard, they drove away not realizing they had just violated the ECF.

✓ **Accidental Deployment** – Although protective features should be in place to prevent accidental deployments, several have occurred injuring road users and destroying vehicles.

✓ **Protesters** – One installation had two separate gate runners who thought that land occupied by the military was still theirs. Both gate runners (foreign nationals) were protesters and were apprehended. Each posed no physical threat by vehicle, weapon, or explosive to personnel or property.

✓ **AVB Testing** – Many AVB systems require periodic testing to keep the system operational. Incorporating safety schemes with AVB deployments allow testing under traffic conditions.

✓ **Other Security Deployments** – Many installations will deploy barriers if a security alarm is activated anywhere on installation property. Although these may be valid security concerns (thefts, robberies, internal security violations, etc.) that may warrant "locking down" the installation, there is often sufficient reaction time to deploy AVBs in a secure and safe manner. Also, installations will often deploy barriers when lanes or gates are closed during the day or night.

AVBs SHALL BE EQUIPPED WITH A MINIMUM OF 1152 SQUARE INCHES OF RETROREFLECTIVE SHEETING.

8.4.2.3. Active Vehicle Barrier Markings and Delineation

AVBs are often improperly delineated. The use of red and white stripes is appropriate for the in-roadway hazard. Additionally, since these devices are typically centered within the travel way, striping should be oriented vertically.

AVBs shown from inbound perspective (2-Inbound Lanes)

The minimum amount of retroreflectorized surface visible to oncoming traffic shall be 1152 square inches. When it is impossible to meet the 1152 square inches of visible surface area due to the AVB design, supplemental in-road lighting or AVB attached warning lights are required. In addition to the front face of barriers, the backside of barriers should be delineated to the extent possible. Delineation should match the same vertical configuration.

SDDCTEA has been asked what materials that AVB markings should be made of on numerous occasions. While the markings should be durable to withstand daily traffic, they should have retroreflective properties as discussed previously. In practice, this is not a common situation and manufacturers of signing and pavement marking materials are continuing to develop products that may satisfy both requirements. When designing AVB markings, consult SDDCTEA and/or your state DOT for a list of manufacturers that may be able to provide markings that satisfy both requirements. Also, in your material specifications, require that AVB suppliers provide barriers sheeted with markings that satisfy FHWA retroreflective requirements for warning signs and will maintain retroreflectivity based on expected traffic for a minimum of two years.

Improper Orientation and Colors

Correct Orientation and Colors

AVBs shown from inbound perspective (1-Inbound Lane)

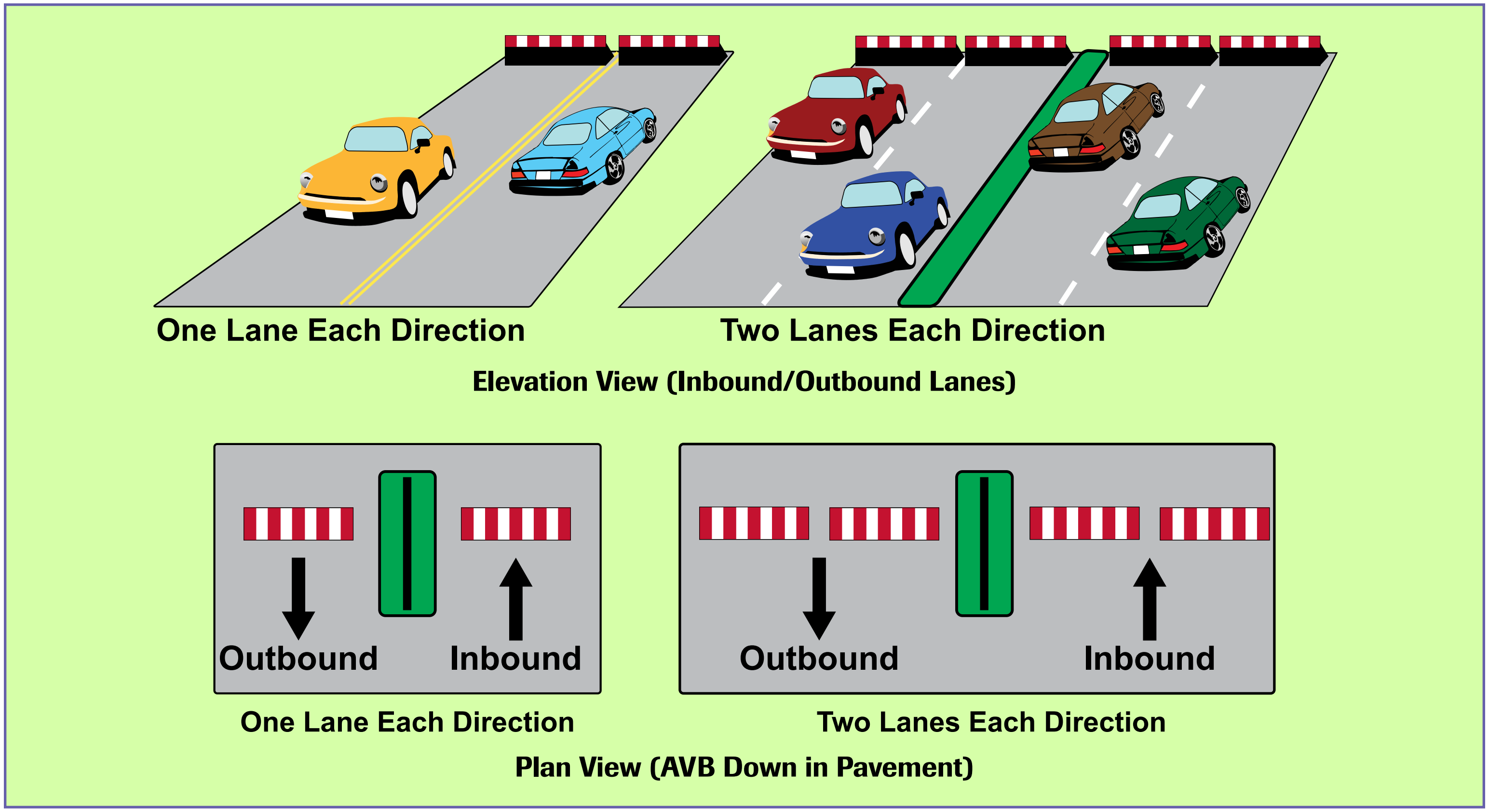
Force Protection Issues

When required, AVB markings should be supplemented with lights to maximize driver visibility. Depending on the type of AVB and site conditions, barrier lights can be mounted:

✓ On both sides of the barrier such that they are visible as the barrier is deployed
✓ In the roadway on both sides of the barrier
✓ On crashable traffic arms that are lowered approaching both sides of the barrier

Whenever practical, lights mounted on the barrier itself are preferred. Lights should be light emitting diodes to maximize visibility and operational efficiency.

Exhibit 8.9: Active Vehicle Barrier Delineation



8.4.2.4. Existing Guidance on AVB Systems

UFC Guidance on Deployment of AVBs

UFC 4-022-01 presents a unified approach between military service branches regarding the design features necessary to ensure that infrastructure constructed today will have the flexibility to support future technologies, a changing threat environment, and changes in operations. UFC 4-022-01 provides planning, design, construction, sustainment, restoration, and modernization criteria, which applies to the military departments, the defense agencies, and DoD field activities. With regard to AVBs or final denial barriers, UFC 4-022-01 states what is quoted in the box to the right.

What does that mean? Basically, it means that not only should you consider the force protection requirements (guard reaction and barrier deployment) when implementing AVBs, but also safety requirements (signaling sequence and sufficient reaction time for motorists to either clear the barrier area or stop in advance of it).

UFC 4-022-01 (2017), Section 5-5.4:

The design and operation of the ECF must include provisions to protect innocent users of the ECF from operation of the AVB whether deployment is accidental, during a test, or during an actual response to a threat. AVBs must be programmed with the required response time necessary to allow the sequencing of the AVB safety system to warn motorists of the activation, and to allow non-threat vehicles within the vicinity of the AVBs to safety traverse or stop before the AVBs prior to their deployment.

AVBs must be designed, implemented, and operated in accordance with UFC 4-022-02, UFGS 34 71 13.19 Active Vehicle Barriers, and UFGS 34 41 26.00 10 Access Control Point Control System. AVB safety requirements include proper signage, signals and delineation as well as providing adequate sequencing and timing… A SDDCTEA Pamphlet 55-15 recommended safety scheme must be implemented. Deviations from these safety schemes must be approved by the appropriate service representative with consultation from SDDCTEA.

The Army Standard for Access Control Points

"AVBs shall include an AVB safety scheme developed and/or approved by the SDDCTEA"

8.4.2.5. AVB Safety

AVB safety requirements include providing indication to road users of AVB activation and providing sufficient clearance time for road users to clear or stop prior to AVB deployment. When considering AVB designs and locations, the total response time must be considered:

✓ Guard reaction = 3 seconds minimum
✓ Time for safety and signalization
✓ Deployment time = 2 seconds minimum

The time for safety and signalization includes time to give an indication to motorists that they must stop approaching the barrier, alerting of the AVB deployment. Depending on the barrier operating safety scheme, the actual time will vary. Signals must provide time for motorists approaching the barrier to either pass over it or safely stop in front of it. Also, at 25 mph (40 km/h), 150 feet (45.7 meters) of stopping sight distance is needed for a driver to react and stop the vehicle.

The 2 seconds minimum deployment time for the AVB must start at the completion of the safety and signalization time. However, the AVB can deploy in less than 2 seconds if the AVB is capable of it.

Some may question if the time for safety and signalization is warranted, but all comparable real world conditions include these safety operations into their systems.

- ✓ **Railroad Crossing Activations** – Flashing red signals to road users must operate at least 20 seconds before arrival of any train when train speeds are greater than 20 mph. An activation requires at least 3 seconds of flashing red signals prior to the start of the arm's downward movement and 5 seconds of arm deployment prior to the train's arrival. Minimum safety clearance time equals 8 seconds plus time for arm movement from vertical to horizontal position.
- ✓ **Emergency Vehicle Preemption** – Requires that traffic see a yellow change (3 to 6 seconds) and red clearance (not exceeding 6 seconds) depending on traffic speeds and engineering judgment.
- ✓ **Automated Movable Bridges** – Requires that traffic see a yellow change (3 to 6 seconds) and red clearance (not exceeding 6 seconds) depending on traffic speeds and engineering judgment.

Most AVB systems are capable of being operated by several devices such as push button switches; wired and wireless hand operated switches; computer control systems; and radar or detection loops monitoring excessive speed or unauthorized entry. All control systems shall be based on the actions of the security personnel manning the ECF (such as push button or hand operated switches). This will provide an opportunity for security personnel to distinguish confused, inattentive, or intoxicated drivers from potential threats attempting forced entry. Automatic detection equipment such as detection loops or radar for excessive speed could be utilized for warning security personnel of potential threats. Final selection of control systems should follow UFC 4-022-01 guidance.

Security and safety considerations should be at the forefront of designs and operation for ECFs and AVBs. The installation officials must also be mindful of the potential tort liability that exists if AVBs are not properly functioning and have approved safety schemes.

THREAT CONTAINMENT STRATEGY
- ❏ DETECT
- ❏ DELAY
- ❏ DEPLOY
- ❏ DEFEAT

8.4.2.6. Calculating Response Zone Length

The determination of the response zone length requirements must consider the various type(s) of threat scenarios, the means of detection, the initial velocity, and the acceleration of the threat vehicle. *UFC 4-022-01,* as well as most service branches, have specific guidance on these calculations. Ultimately, the calculated response zone requirement should be considered a minimum and should be maximized whenever feasible to further ensure threat containment and road user safety.

The response zone length calculation may be the most critical calculation made when developing an ECF since threat containment and road user safety are of paramount importance. UFC 4-022-01 provides the primary equations for calculating response zone length and discusses minimum values for velocity, acceleration, and reaction time when evaluating each threat scenario. See UFC 4-022-01, Section 5-5.1.4 for example equations.

Depending upon the horizontal alignment through the ECF, response zone lengths can vary significantly. If a high-speed attack can be delayed through alignment curvature or be detected through manual or automated means in the approach zone, the response zone may be reduced enough as to where the covert threats govern the response zone length. If there is no curvature to delay, or no advance detection (speed, wrong-way, etc.) to alert of high-speed threats, the response zone lengths may need to be significantly longer to accommodate high-speed threats.

THE NEEDED RESPONSE ZONE LENGTH SHOULD:

✓ Be calculated by engineers with input from security forces staff

✓ Be developed with consideration of service and *UFC* requirements

✓ Consider specific design threat characteristics:
- Type of threat (high-speed, covert, etc.)
- Location of detection
- Initial velocity
- Maximum threat velocity
- Threat vehicle acceleration

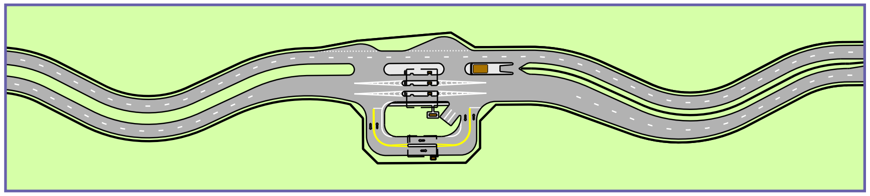
✓ Accommodate guard response

✓ Incorporate road user traffic controls to enable safe barrier deployment per *MUTCD* standards and SDDCTEA

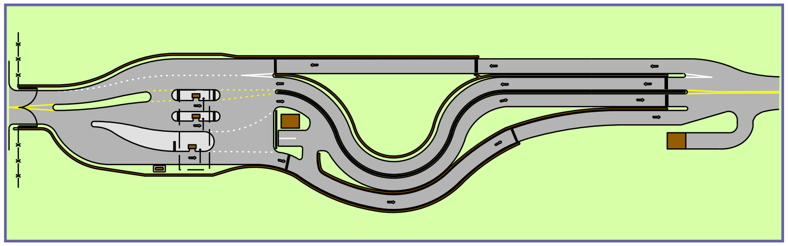
In general, treat calculated response as minimums such that both security and safety can be better addressed. Where reasonable and practical, locate AVBs at a site that makes the implementation of security and safety devices more practical. If necessary, one can locate AVBs at the first major intersection beyond the ID check area, provided that minimum response zone requirements are met. When colocated at the first major intersection, integrate AVBs preemption design with the intersection traffic control. Ultimately, the placement of AVBs requires:

✓ Calculation of minimum response zone lengths based on specific threat scenarios
✓ Extra distance when practical and feasible
✓ Site assessments to determine the feasibility of placement
✓ Coordination with traffic control devices and nearby intersections

8.4.2.7. Response Zone Alternatives



In many cases, it is not practical or feasible to provide the distance needed for a conventional, straight response zone to accommodate the threat scenario and response and safety time. The only way to minimize the total distance is to do the following options.



✓ **Manage Threat Speed** - Use geometric constraints to physically limit the maximum attainable threat speed. The length of the response zone can be minimized, or the available response time increased, by using roadway layout and passive barriers or 8-inch curbing to control the velocity of threat vehicles as they travel through the ECF zones. See **Exhibit 8.10** for examples and pros/cons.
✓ **Manage Threat Time** - Change the operational features through traffic control or technology so that the time can be managed. Manage time includes alternatives to better manage response and safety time. See **Exhibit 8.11** for examples and pros/cons. Although many of these strategies can reduce the minimum length of the response zone, they often put more reliance on the use of other technologies, or delay motorists. In all cases, they still must include traffic and safety control in conformance with the *MUTCD*.

Force Protection Issues

Exhibit 8.10: Threat Speed Management

Category and Treatment	Thread Speed Management Chicanes, Traffic Calming, Curves/Turns
Pros	✓ Utilizes geometric constraints to physically limit both “normal” and “threat” speeds ✓ Can be designed to complement aesthetic attributes ✓ Helps address some AT requirements prohibiting “straight” approaches
Cons	✓ May cause some minor reductions in roadway capacity due to controlled speeds - make sure you consider traffic flow impacts ✓ May not be suitable for trucks ✓ Potential for more sideswipe collisions ✓ Roadway controls (passive barriers and lane separators) may be necessary to control threat vehicle paths ✓ Snow removal may be challenging in cold weather climates
Design and Traffic Control Considerations	✓ Additional drainage features may be required ✓ In all cases, conventional safety and traffic control requirements must be satisfied ✓ Additional signs and markings are required in conformance with the *MUTCD*

Exhibit 8.11: Threat Time Management

Category and Treatment	Threat Time Management Overspeed and Wrong Way Detection
Pros	✓ Earlier point of detection for high speed and wrong way threats ✓ Cameras utilized for detection can provide additional surveillance coverage
Cons	✓ May fail due to dependence on technology ✓ False alarms ✓ Weather conditions may impact devices
Design Considerations	✓ Specify proper technology to insure adequate coverage for detection zones ✓ Provide redundant technology when possible ✓ Overspeed detection often reports false alarms due to innocent drivers traveling faster than the set overspeed limit

8.4.2.8. AVB Control Systems

AVB control systems should be controlled by an approved programmable logic controller approved by the state DOT. Active vehicle barrier deployment should be triggered through the traffic signal controller and should be dependent on the signaling and safety sequence. AVBs and their associated traffic control should not be controlled independently by barrier controllers. If AVBs are tied to a traffic signal, the AVB traffic control shall not control the traffic signal. The AVB traffic control shall send a signal to the traffic signal preempting it into the yellow and red phase.

Duress alarms should initiate the barrier deployment sequence in the controller. The phase selector is similar to those used in emergency vehicle or railroad preemption at signalized intersections.

Ideally, AVB and associated control systems should be procured as one complete system. There are many benefits of soliciting for complete systems:

✓ System performance becomes the responsibility of one party
✓ Integration is linked with the component providers
✓ Warranty and maintenance can be linked with system supplier

To ensure a reliable system, system specifications should include requirements for component testing, system testing, commissioning and reliability, training and warranty. The U.S. Army Corps of Engineers has developed a guide specification (UFGS 34 41 26.00 10) for active access control point systems including active vehicle barrier systems. For more on active vehicle barrier control systems, contact SDDCTEA.

8.4.2.9. AVB Maintenance Temporary Traffic Control

Routine maintenance and inspections are required for all AVB systems. When performing maintenance on an AVB system, it's preferred to conduct activities when the ECF is closed. If the ECF is operational 24 hours 7 days a week, then a temporary traffic control zone must be provided. Temporary traffic control zones shall be utilized in accordance with *MUTCD* requirements. Section 6 of the *MUTCD* provides typical temporary traffic control schematics.

When conducting maintenance, AVB signals shall be switched to flashing yellow sequence while the temporary work zone is being established and operational. Once the temporary traffic control zone has been completely removed, the AVB signal system can resume normal operation. Under no circumstances shall the signals have different indications during temporary traffic control situations. Utilizing a steady red or green indication during maintenance may contradict the intended traffic control resulting in an unsafe condition. Flaggers or temporary traffic control devices shall provide direction to motorists through the temporary traffic control zone.

8.4.3. AVB Safety Schemes

The purpose of traffic control devices associated with the AVBs is to protect the innocent driver. SDDCTEA has developed several AVB safety schemes that utilize traffic control and warning devices to notify drivers when the AVB is activated, but the schemes also provide the necessary timeline to operate the system. When speaking of threat containment time or threat response time, it is essentially the time required for a guard to perceive and react to an incoming threat vehicle, and for the safety scheme to operate. When the AVB is correctly located in accordance with the time required by the given safety scheme, both safety and threat containment are provided. The schemes are to be used on roadways with relatively flat horizontal and vertical alignments. Stopping sight distance and a clear view of the warning devices near the AVB must be provided for motorists approaching the AVB. It is highly recommended that that the approach to an AVB be located on a tangent section of roadway. If the calculated threat response time falls within 300 feet of an intersection, an intersection safety scheme is highly recommended to avoid driver confusion with the intersection control.

Traffic control and safety devices common to all schemes include:

- Advance warning signs
- Regulatory signs
- Advance and post-AVB vehicle detection loops
- Audible alarm
- Retroreflective markings on the AVB
- Retroreflective pavement marking envelope surrounding the AVB
- Traffic signals or hybrid beacons
- Lighting

Exhibit 8.12 provides an overview of the developed AVB safety schemes. Detailed descriptions and layouts for each scheme are provided in subsequent sections. Note that the schemes summarized are only the four primary schemes. They can be used in combination, such as one scheme for the inbound direction, and another for the outbound direction. In the following pages, this section summarizes the primary schemes, as well as identifies several scheme combinations.

Exhibit 8.12: Summary of AVB Safety Scheme

AVB Scheme	Response Time	Capacity	Advantages	Disadvantages
Full Containment	0 seconds	200 veh/hr/ln	✓ 100% threat containment at all times ✓ Can be utilized in land-constrained areas	✓ Can only be used at low volume ECFs ✓ Can have significant traffic capacity impacts ✓ Maintenance intensive due to excessive use of the AVBs
Stop Control	5 seconds	800 veh/hr/ln	✓ Shortest response zone possible with exception to Full Containment Safety Scheme ✓ Ability to retrofit existing response zones	✓ All traffic must stop at the AVB at all times ✓ Drivers may not obey the STOP signs ✓ Driver frustration
Hybrid Beacon	7 seconds	1800 veh/hr/ln	✓ Free-flowing traffic	✓ Longer vehicle detection loops as compared to the other safety schemes
High Efficiency Presence	7 seconds	1200 veh/hr/ln	✓ Allows free-flowing traffic when continuous traffic is present ✓ 100% threat containment when not processing vehicles ✓ Provides 100% containment for the outbound lane, if a single lane	✓ Complex system ✓ With lane separation islands at the AVBs, overwidth vehicles cannot be accommodated ✓ Cannot utilize an AVB that spans multiple lanes

The following AVB safety schemes, as described and as shown on the associated drawings, have been developed by SDDCTEA. Deviations from a developed scheme must be reviewed and approved by SDDCTEA. The intersections shown on the drawings are for illustration purposes only, actual intersection geometry and number and length of storage bays will be determined per site and traffic volume requirements. Unified Facilities Guide Specifications (UFGS) have been developed by USACE for operation of the systems, specifically UFGS 34 41 26.00 10 - Access Control Point System; as well as UFGS 34 71 13.19 - Active Vehicle Barriers.

Existing signs, signals, and markings conforming to earlier versions of SDDCTEA safety schemes are considered grandfathered in and may remain in place until the end of their useful service life.

8.4.3.1. Full Containment Safety Scheme

The Full Containment Safety Scheme, consisting of two AVBs in series, operates with a minimum of one barrier deployed at all times; resulting in a threat response time requirement of 0-seconds. This safety scheme utilizes typical traffic control signals in coordination with manually operated AVBs.

At the start of the system, the first AVB is in the retracted position and the second AVB is deployed to provide containment. After the inbound traffic is vetted, vehicles traverse the first AVB and queue at the second AVB. Once the area is filled, or no more vehicles are entering, the ID check guard(s) deploy the first AVB behind the vehicles to maintain containment. Once fully deployed, the guard(s) retract the second AVB to allow the vetted personnel to enter the installation. After all traffic has cleared, the second AVB is fully deployed and then the first AVB is retracted to run the system again.

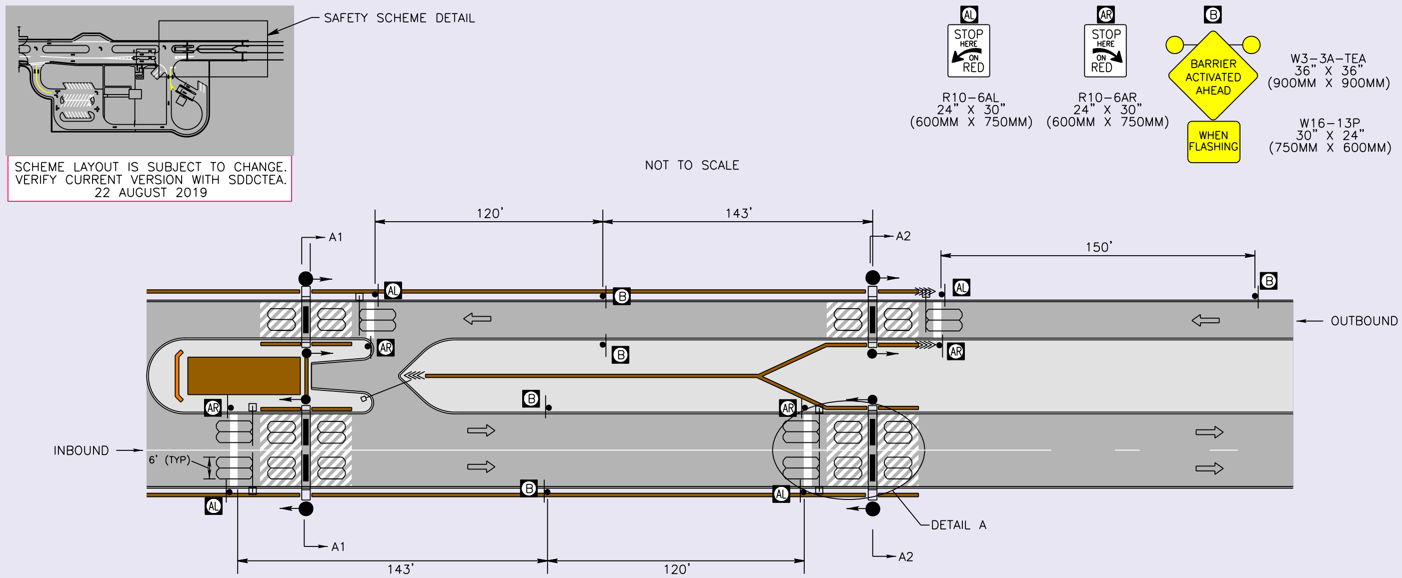
The Full Containment Safety Scheme can be sized to fit many situations, but typically AVBs should be spaced 300-ft apart to maximize traffic capacity. Maximum capacity for this safety scheme is approximately 200 vehicles per hour per lane.

Advantages of this scheme include:
- 100% threat containment at all times
- Can be utilized in land-constrained areas

Disadvantages of this scheme include:
- Can only be used at low volume ECFs
- Can have significant traffic capacity impacts
- Maintenance intensive due to excessive use of the AVBs

This safety scheme is illustrated in **Exhibit 8.13**.

Exhibit 8.13: Full Containment Safety Scheme - Page 1



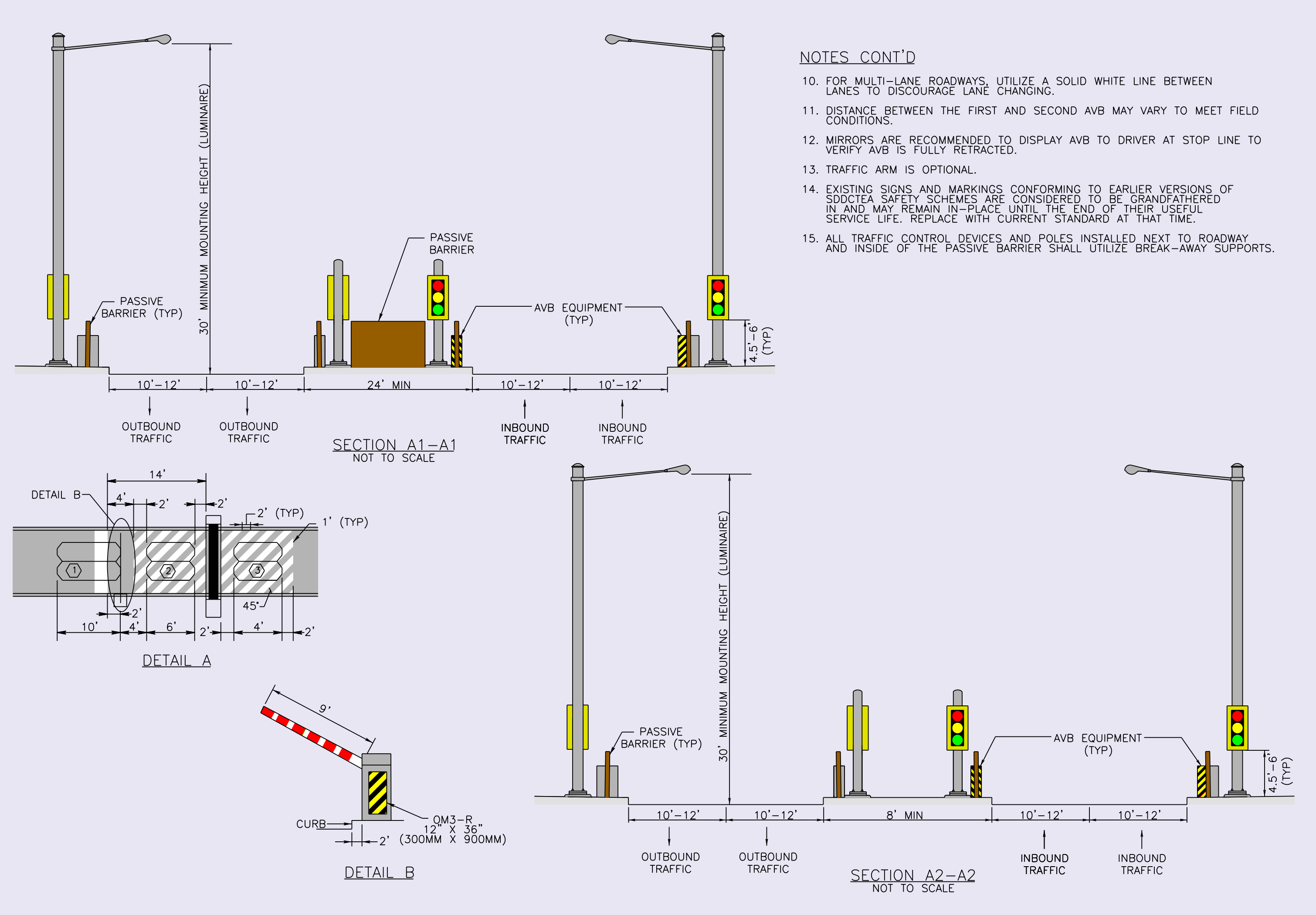
NOTES

1. SIGNS, SIGNALS, AND PAVEMENT MARKINGS SHALL CONFORM TO MUTCD, DOD SUPPLEMENT TO THE MUTCD, SDDCTEA PAMPHLET 55-15 AND LOCAL REGULATIONS.
2. ALTERNATING RED AND WHITE TYPE X RETROREFLECTIVE SHEETING REQUIRED ON TRAFFIC ARMS AND ACTIVE VEHICLE BARRIERS AS PER SDDCTEA PAMPHLET 55-15.
3. OBJECT MARKERS ARE REQUIRED ON TRAFFIC ARM BASE AND NORMALLY EXPOSED ACTIVE VEHICLE BARRIER EQUIPMENT.
4. ALL PAVEMENT MARKINGS SHALL BE RETROREFLECTIVE AND DESIGNED TO ENHANCE TRACTION.
5. LOOP 1 - GATE ARM LOOP (IF USED), LOOP 2 - ENTRY SAFETY LOOP, LOOP 3 - EXIT SAFETY LOOP.
6. DESIGN, CONSTRUCTION AND MATERIALS FOR TRAFFIC CONTROL AND RELATED EQUIPMENT SHALL CONFORM TO THE STATE DOT OR LOCAL STANDARDS.
7. AVB EQUIPMENT WIDTHS SHOWN ON SECTIONS A1-A1 AND A2-A2 VARY BY AVB TYPE, MODEL, AND MANUFACTURER.
8. ALL SIGNALS SHALL BE LED AND HAVE FULL CIRCLE TUNNEL VISORS WITH BACKPLATES WITH RETROREFLECTIVE STRIP. 12-INCH INDICATIONS SHALL BE USED.
9. PLAN DETAILS ARE TYPICAL AND MAY BE ADJUSTED TO MEET SITE CONDITIONS. ANY ALTERATION IN TRAFFIC CONTROL (TRAFFIC ARM, SIGNALS, BEACONS, SIGNING, MARKINGS AND DETECTION LOOPS) REQUIRE APPROVAL THROUGH SDDCTEA.

LEGEND

- ACTIVE VEHICLE BARRIER AND EQUIPMENT
- QUADRUPOLE INDUCTIVE LOOP DETECTOR
- # LOOP DETECTION AREA NUMBER
- POST MOUNTED SIGN
- POLE-MOUNTED TRAFFIC SIGNAL
- POLE-MOUNTED TRAFFIC SIGNAL WITH LUMINAIRE
- STOP LINE PAVEMENT MARKING
- WHITE CROSSHATCHING PAVEMENT MARKINGS
- PASSIVE BARRIER
- TRAFFIC ARM (OPTIONAL)
- CRASHWORTHY END TERMINAL/CRASH CUSHION

Exhibit 8.13: Full Containment Safety Scheme - Page 2



NOTES CONT'D

10. FOR MULTI-LANE ROADWAYS, UTILIZE A SOLID WHITE LINE BETWEEN LANES TO DISCOURAGE LANE CHANGING.
11. DISTANCE BETWEEN THE FIRST AND SECOND AVB MAY VARY TO MEET FIELD CONDITIONS.
12. MIRRORS ARE RECOMMENDED TO DISPLAY AVB TO DRIVER AT STOP LINE TO VERIFY AVB IS FULLY RETRACTED.
13. TRAFFIC ARM IS OPTIONAL.
14. EXISTING SIGNS AND MARKINGS CONFORMING TO EARLIER VERSIONS OF SDDCTEA SAFETY SCHEMES ARE CONSIDERED TO BE GRANDFATHERED IN AND MAY REMAIN IN-PLACE UNTIL THE END OF THEIR USEFUL SERVICE LIFE. REPLACE WITH CURRENT STANDARD AT THAT TIME.
15. ALL TRAFFIC CONTROL DEVICES AND POLES INSTALLED NEXT TO ROADWAY AND INSIDE OF THE PASSIVE BARRIER SHALL UTILIZE BREAK-AWAY SUPPORTS.

8.4.3.2. Stop Control Safety Scheme - Midblock

The Stop Control Safety Scheme-midblock utilizes stop signs at the AVB (inbound and outbound), is located in-between intersections, and requires a 5-second (minimum) threat response time for both inbound and outbound lanes. **Refer to the 5-second timeline given on the Stop Control Safety Scheme-midblock drawings for time allowances for individual safety scheme components.**

Additional key characteristics include:
- 'DO NOT ENTER' LED blank-out regulatory signs
- Red signals mounted on top of the LED signs

This scheme is appropriate when the incoming traffic volume is less than 800 vehicles per hour per inbound lane.

Advantages of this scheme include:
- Shortest response zone with exception to the Full Containment Safety Scheme
- Ability to retrofit an existing ECF's response zone and AVB(s)

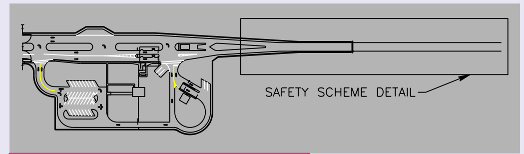
Disadvantages of this scheme include:
- All traffic must stop at the AVB at all times
- Drivers may not obey the STOP signs
- Driver frustration

This safety scheme is not intended to be used on new ECF designs. It is primarily intended to be used for retrofit ECF designs where the response zone is inadequate.

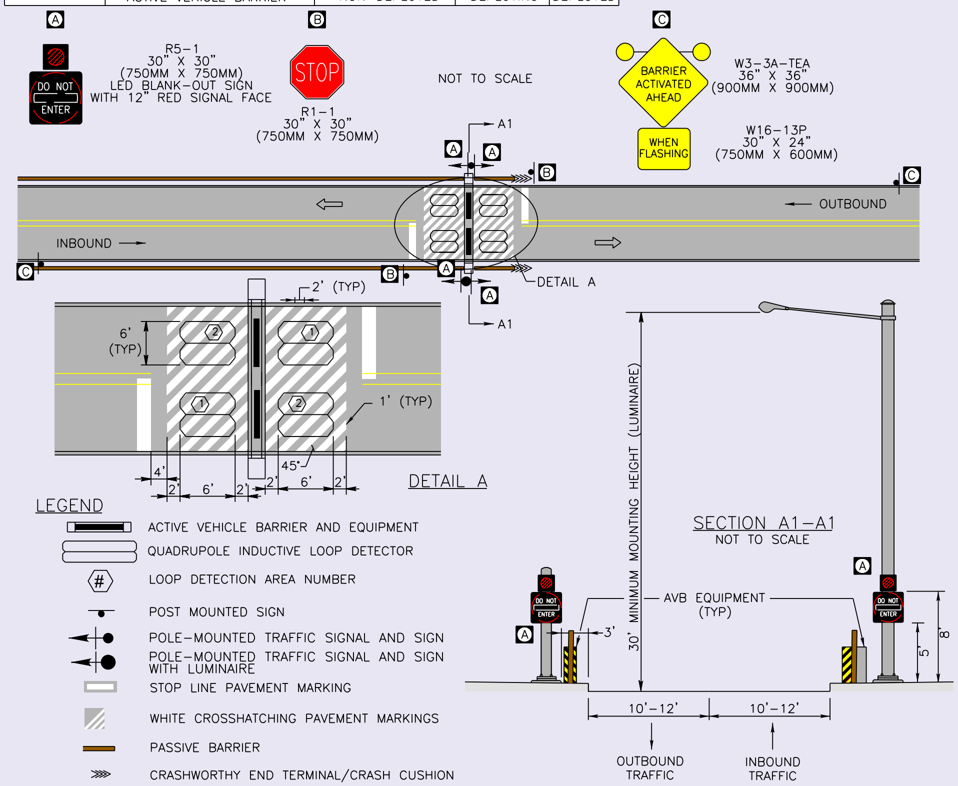
This safety scheme is illustrated in **Exhibit 8.14** (one-lane) and **Exhibit 8.15** (two lanes).

Exhibit 8.14: Stop Control Safety Scheme – Midblock (One Lane)

		OPERATIONAL SEQUENCING FOR EMERGENCY FAST OPERATION					
	TRAFFIC CONTROL	GUARD REACTION			DEPLOYING BARRIER		BARRIER DEPLOYED
STOP CONTROL AVB SAFETY SCHEME – 1 LANE	TIMELINE (SEC)	1	2	3	4	5	6
	W3-3A-TEA WARNING SIGN WITH BEACONS	BEACONS DARK			ALTERNATING FLASHING YELLOW		
	DO NOT ENTER LED BLANK-OUT SIGN	DARK			"DO NOT ENTER" ILLUMINATED		
	RED SIGNAL	DARK			STEADY RED		
	100dB HORN	SILENT			ACTIVATED		
	ACTIVE VEHICLE BARRIER	NON-DEPLOYED			DEPLOYING		DEPLOYED



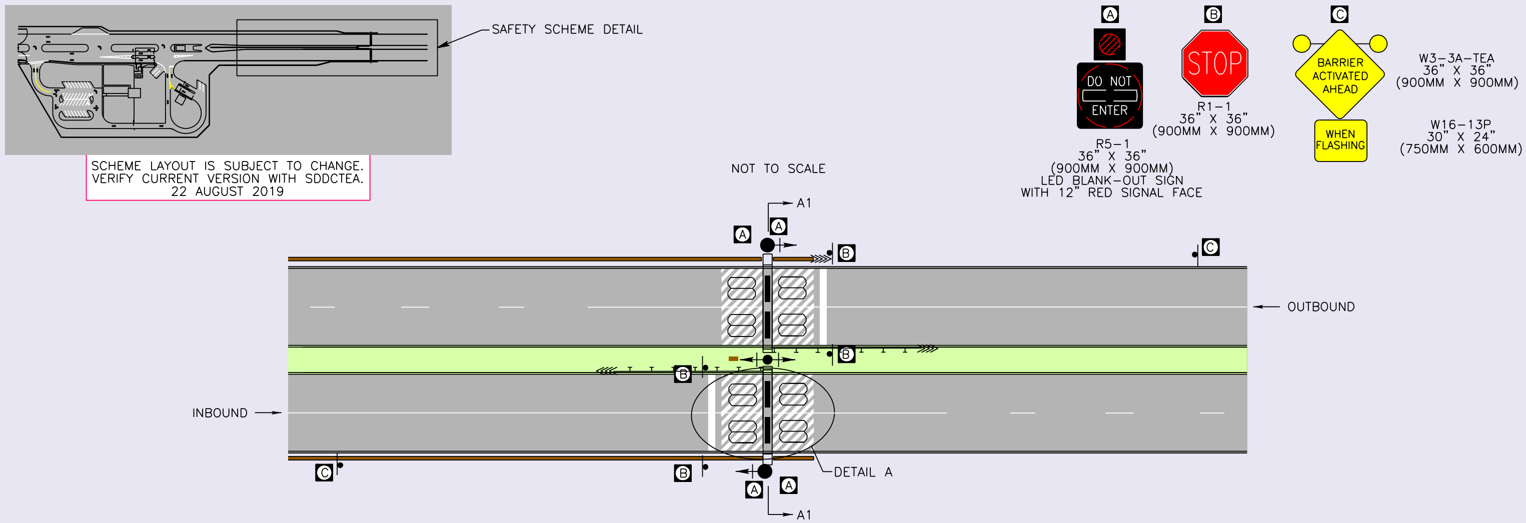
SCHEME LAYOUT IS SUBJECT TO CHANGE. VERIFY CURRENT VERSION WITH SDDCTEA. 7 AUGUST 2019



NOTES

1. THIS SCHEME NOT INTENDED FOR USE WHERE INBOUND OR OUTBOUND TRAFFIC VOLUME EXCEEDS 800 VEHICLES PER HOUR PER LANE.
2. ILLUSTRATION SHOWS ONE LANE PER DIRECTION, BUT SCHEME CAN BE USED FOR MULTIPLE LANES PER DIRECTION.
3. WHEN EFO IS ACTIVATED, A 100db AUDIBLE ALARM LOCATED AT THE AVB SHALL SOUND FOR AT LEAST 10 SECONDS, AND BE DIRECTED TOWARDS ONCOMING TRAFFIC FOR BOTH DIRECTIONS.
4. SIGNS, SIGNALS, AND PAVEMENT MARKINGS SHALL CONFORM TO MUTCD, DOD SUPPLEMENT TO THE MUTCD, SDDCTEA PAMPHLET 55-15 AND LOCAL REGULATIONS.
5. ALTERNATING RED AND WHITE TYPE X RETROREFLECTIVE SHEETING REQUIRED ACTIVE VEHICLE BARRIERS AS PER SDDCTEA PAMPHLET 55-15.
6. OBJECT MARKERS ARE REQUIRED ON NORMALLY EXPOSED ACTIVE VEHICLE BARRIER EQUIPMENT.
7. ALL PAVEMENT MARKINGS SHALL BE RETROREFLECTIVE AND DESIGNED TO ENHANCE TRACTION.
8. LOOP 1 – ENTRY SAFETY LOOP, LOOP 2 – EXIT SAFETY LOOP.
9. INFRARED CAMERAS OR RADAR MAY BE USED IN LIEU OF LOOP DETECTORS.
10. LED BLANK-OUT SIGN SHALL NOT AUTOMATICALLY DIM.
11. DESIGN, CONSTRUCTION AND MATERIALS FOR TRAFFIC CONTROL AND RELATED EQUIPMENT SHALL CONFORM TO THE STATE DOT OR LOCAL STANDARDS.
12. AVB EQUIPMENT WIDTHS SHOWN ON SECTION A1-A1 VARY BY AVB TYPE, MODEL, AND MANUFACTURER.
13. ALL SIGNALS SHALL BE LED AND HAVE FULL CIRCLE TUNNEL VISORS WITH BACKPLATES WITH RETROREFLECTIVE STRIP. 12-INCH INDICATIONS SHALL BE USED.
14. UNDER EFO CONDITION, AVBS SHALL BE DESIGNED TO OPERATE INDEPENDENTLY IN CONJUNCTION WITH SAFETY LOOP DETECTION.
15. PLAN DETAILS ARE TYPICAL AND MAY BE ADJUSTED TO MEET SITE CONDITIONS. ANY ALTERATION IN TRAFFIC CONTROL (SIGNALS, BEACONS, SIGNING, MARKINGS AND DETECTION LOOPS) REQUIRE APPROVAL THROUGH SDDCTEA.
16. FOR MULTI-LANE ROADWAYS, UTILIZE A SOLID WHITE LINE BETWEEN LANES TO DISCOURAGE LANE CHANGING.
17. FOR SINGLE LANE ROADWAYS WITH NO MEDIAN, A NO PASSING ZONE SHALL EXTEND FROM THE ID CHECK AREA TO 300 FEET BEYOND THE AVB ON THE INSTALLATION SIDE OF THE BARRIER.
18. EXISTING SIGNS AND MARKINGS CONFORMING TO EARLIER VERSIONS OF SDDCTEA SAFETY SCHEMES ARE CONSIDERED TO BE GRANDFATHERED IN AND MAY REMAIN IN-PLACE UNTIL THE END OF THEIR USEFUL SERVICE LIFE. REPLACE WITH CURRENT STANDARD AT THAT TIME.
19. ALL TRAFFIC CONTROL DEVICES AND POLES INSTALLED NEXT TO THE ROADWAY AND INSIDE OF THE PASSIVE BARRIER SHALL UTILIZE BREAK-AWAY SUPPORTS.

Exhibit 8.15: Stop Control Safety Scheme – Midblock (Two Lanes) - Page 1



NOTES

1. THIS SCHEME NOT INTENDED FOR USE WHERE INBOUND OR OUTBOUND TRAFFIC VOLUME EXCEEDS 800 VEHICLES PER HOUR PER LANE.
2. WHEN EFO IS ACTIVATED, A 100db AUDIBLE ALARM LOCATED AT THE AVB SHALL SOUND FOR AT LEAST 10 SECONDS, AND BE DIRECTED TOWARDS ONCOMING TRAFFIC FOR BOTH DIRECTIONS.
3. SIGNS, SIGNALS, AND PAVEMENT MARKINGS SHALL CONFORM TO MUTCD, DOD SUPPLEMENT TO THE MUTCD, SDDCTEA PAMPHLET 55-15 AND LOCAL REGULATIONS.
4. ALTERNATING RED AND WHITE TYPE X RETROREFLECTIVE SHEETING REQUIRED ON ACTIVE VEHICLE BARRIERS AS PER SDDCTEA PAMPHLET 55-15.
5. OBJECT MARKERS ARE REQUIRED ON NORMALLY EXPOSED ACTIVE VEHICLE BARRIER EQUIPMENT.
6. ALL PAVEMENT MARKINGS SHALL BE RETROREFLECTIVE AND DESIGNED TO ENHANCE TRACTION.
7. LOOP 1 – ENTRY SAFETY LOOP, LOOP 2 – EXIT SAFETY LOOP.
8. INFRARED CAMERAS OR RADAR MAY BE USED IN LIEU OF LOOP DETECTORS.
9. LED BLANK-OUT SIGN SHALL NOT AUTOMATICALLY DIM.
10. DESIGN, CONSTRUCTION AND MATERIALS FOR TRAFFIC CONTROL AND RELATED EQUIPMENT SHALL CONFORM TO THE STATE DOT OR LOCAL STANDARDS.
11. AVB EQUIPMENT WIDTHS SHOWN ON SECTION A1-A1 VARY BY AVB TYPE, MODEL, AND MANUFACTURER.

LEGEND

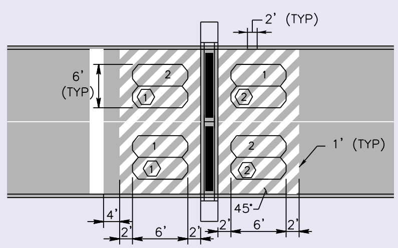
- ACTIVE VEHICLE BARRIER AND EQUIPMENT
- QUADRUPOLE INDUCTIVE LOOP DETECTOR
- # LOOP DETECTION AREA NUMBER
- POST MOUNTED SIGN
- POLE-MOUNTED TRAFFIC SIGNAL AND SIGN
- POLE-MOUNTED TRAFFIC SIGNAL AND SIGN WITH LUMINAIRE
- STRUCTURE MOUNTED SIGN
- STOP LINE PAVEMENT MARKING
- WHITE CROSSHATCHING PAVEMENT MARKINGS
- PASSIVE BARRIER
- CRASHWORTHY END TERMINAL/CRASH CUSHION
- GUARDRAIL

Exhibit 8.15: Stop Control Safety Scheme – Midblock (Two Lanes) - Page 2

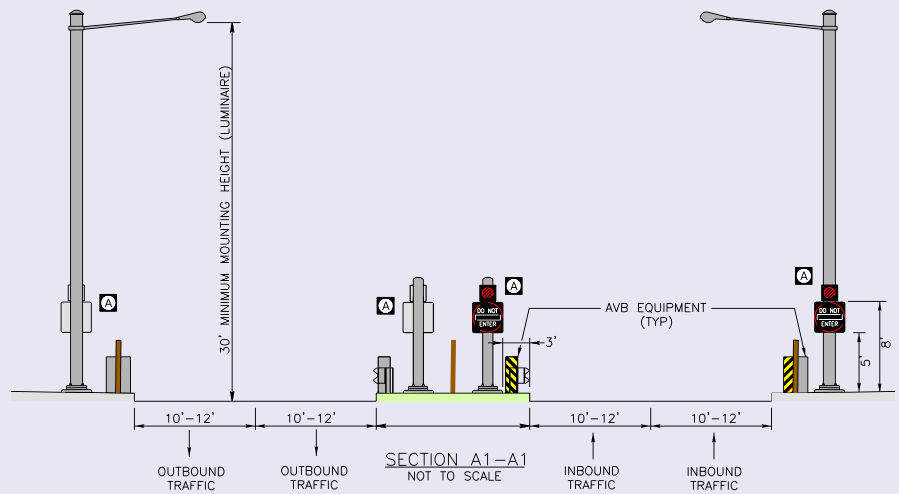
		OPERATIONAL SEQUENCING FOR EMERGENCY FAST OPERATION					
	TRAFFIC CONTROL	GUARD REACTION			DEPLOYING BARRIER		BARRIER DEPLOYED
STOP CONTROL AVB SAFETY SCHEME – 2 LANE	TIMELINE (SEC)	1	2	3	4	5	6
	W3-3A-TEA WARNING SIGN WITH BEACONS	BEACONS DARK			ALTERNATING FLASHING YELLOW		
	DO NOT ENTER LED BLANK-OUT SIGN	DARK			"DO NOT ENTER" ILLUMINATED		
	RED SIGNAL	DARK			STEADY RED		
	100dB HORN	SILENT			ACTIVATED		
	ACTIVE VEHICLE BARRIER	NON-DEPLOYED			DEPLOYING		DEPLOYED

NOTES CONT'D

12. ALL SIGNALS SHALL BE LED AND HAVE FULL CIRCLE TUNNEL VISORS WITH BACKPLATES WITH RETROREFLECTIVE STRIP. 12-INCH INDICATIONS SHALL BE USED.
13. UNDER EFO CONDITION, AVBS SHALL BE DESIGNED TO OPERATE INDEPENDENTLY IN CONJUNCTION WITH SAFETY LOOP DETECTION.
14. PLAN DETAILS ARE TYPICAL AND MAY BE ADJUSTED TO MEET SITE CONDITIONS. ANY ALTERATION IN TRAFFIC CONTROL (SIGNALS, BEACONS, SIGNING, MARKINGS AND DETECTION LOOPS) REQUIRE APPROVAL THROUGH SDDCTEA.
15. FOR MULTI-LANE ROADWAYS, UTILIZE A SOLID WHITE LINE BETWEEN LANES TO DISCOURAGE LANE CHANGING.
16. EXISTING SIGNS AND MARKINGS CONFORMING TO EARLIER VERSIONS OF SDDCTEA SAFETY SCHEMES ARE CONSIDERED TO BE GRANDFATHERED IN AND MAY REMAIN IN-PLACE UNTIL THE END OF THEIR USEFUL SERVICE LIFE. REPLACE WITH CURRENT STANDARD AT THAT TIME.
17. ALL TRAFFIC CONTROL DEVICES AND POLES INSTALLED NEXT TO THE ROADWAY AND INSIDE OF THE PASSIVE BARRIER SHALL UTILIZE BREAK-AWAY SUPPORTS.



DETAIL A



SECTION A1–A1
NOT TO SCALE

8.4.3.3. Stop Control Safety Scheme - Intersection

Same as the midblock Stop Control Safety Scheme, this safety scheme uses stop control at the AVBs (inbound and outbound) and requires a 5-second (minimum) threat response time for both inbound and outbound lanes. **Refer to the 5-second timeline given on the Stop Control Safety Scheme-Intersection drawings for time allowances for individual safety scheme components.** This scheme differs from the Stop Control Safety Scheme-Midblock in that it relocates the inbound AVB to an intersection.

Additional key characteristics include:
- Outbound AVB must be located a minimum of 155 feet from intersection radius point
- Passive barrier must be installed in the median connecting the inbound and outbound AVBs
- 'DO NOT ENTER' LED blank-out regulatory signs
- Red signals mounted on top of the LED signs

This scheme is appropriate when the incoming traffic volume is less than 800 vehicles per hour per lane and the intersected roadway (inside the installation) has relatively lower traffic volumes. As it is required that the intersection be unsignalized, the default intersection traffic control is all-way stop control. However, an intersection capacity analysis should be performed to ensure that all legs of the intersection operate at an acceptable level of service under all-way stop control.

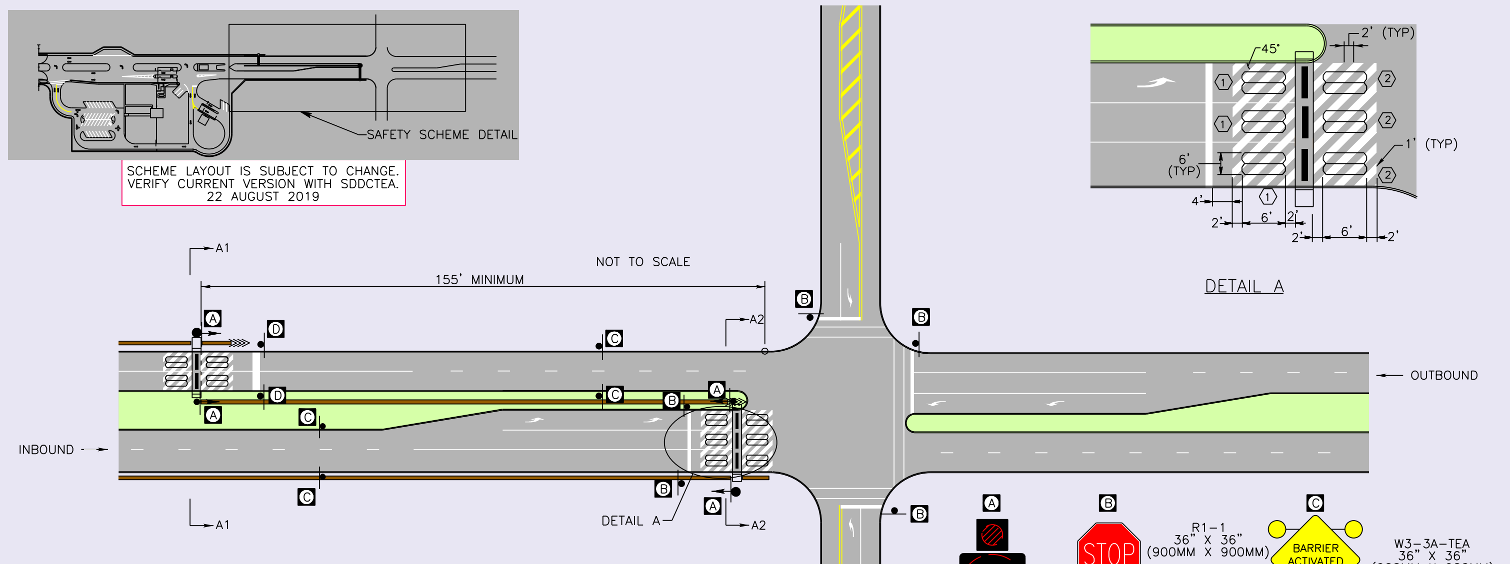
Advantages of this scheme include:
- Shortest response zone with exception to the Full Containment Safety Scheme
- Ability to retrofit an existing ECF's response zone and AVB(s)
- Inbound drivers stop at an intersection which is more intuitive than stopping at a midblock location, as required in the midblock Stop Control Safety Scheme

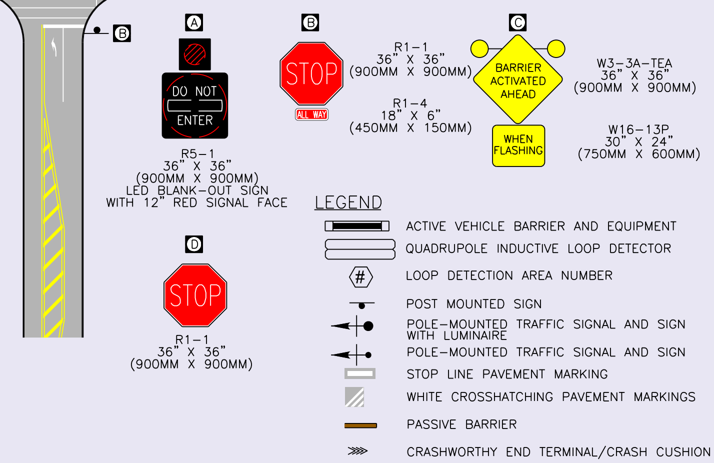
Disadvantages of this scheme include:
- Exiting traffic is required to stop at the intersection and then stop again at the outbound AVB.
- Drivers may not obey the STOP signs (outbound AVB)
- Driver frustration (outbound AVB)
- All-way stop control for intersection may not be warranted

This safety scheme is not intended to be used on new ECF designs. It is primarily intended to be used for retrofit ECF designs where the response zone is inadequate. If at all possible, it is recommended that the Combination Intersection Stop Control/ Hybrid Beacon Safety Scheme be used which allows free flow traffic for the outbound lane(s). Also, though this safety scheme is intended to be used only at unsignalized intersections, the mere presence of an unsignalized intersection does not require the use of this scheme if another scheme is more appropriate.

This safety scheme is illustrated in **Exhibit 8.16**.

Exhibit 8.16: Stop Control Safety Scheme - Intersection - Page 1





NOTES

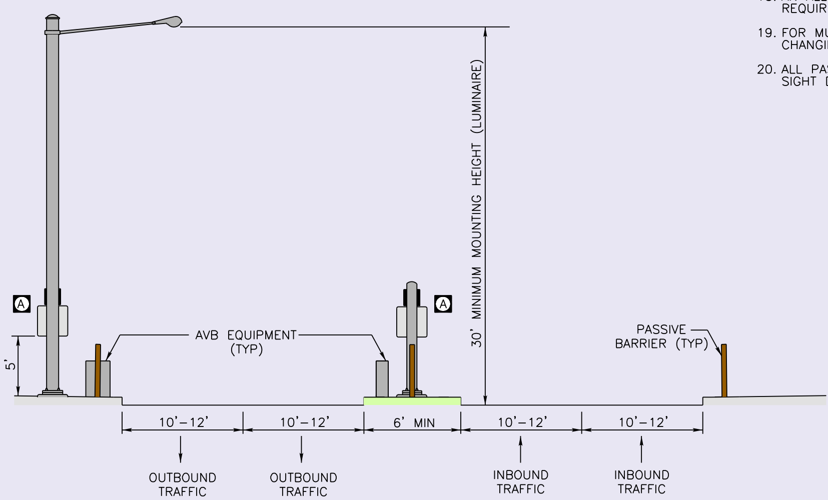
1. THIS SCHEME NOT INTENDED FOR USE WHERE INBOUND OR OUTBOUND TRAFFIC VOLUME EXCEEDS 800 VEHICLES PER HOUR PER LANE.
2. SCHEME CAN BE USED FOR ONE LANE PER DIRECTION OR FOR MULTIPLE LANES PER DIRECTION.
3. WHEN EFO IS ACTIVATED, A 100db AUDIBLE ALARM LOCATED AT THE AVB SHALL SOUND FOR AT LEAST 10 SECONDS, AND BE DIRECTED TOWARDS ONCOMING TRAFFIC FOR BOTH DIRECTIONS.
4. SIGNS, SIGNALS, AND PAVEMENT MARKINGS SHALL CONFORM TO MUTCD, DOD SUPPLEMENT TO THE MUTCD, SDDCTEA PAMPHLET 55-15 AND LOCAL REGULATIONS.
5. ALTERNATING RED AND WHITE TYPE X RETROREFLECTIVE SHEETING REQUIRED ON ACTIVE VEHICLE BARRIERS AS PER SDDCTEA PAMPHLET 55-15.
6. OBJECT MARKERS ARE REQUIRED ON NORMALLY EXPOSED ACTIVE VEHICLE BARRIER EQUIPMENT.
7. ALL PAVEMENT MARKINGS SHALL BE RETROREFLECTIVE AND DESIGNED TO ENHANCE TRACTION.
8. LOOP 1 - ENTRY SAFETY LOOP, LOOP 2 - EXIT SAFETY LOOP.
9. SECTION A1-A1, A2-A2, AND OPERATIONAL SEQUENCING FOR EFO SHOWN ON THE FOLLOWING PAGE.
10. INFRARED CAMERAS OR RADAR MAY BE USED IN LIEU OF LOOP DETECTORS.
11. ALL TRAFFIC CONTROL DEVICES AND POLES INSTALLED NEXT TO THE ROADWAY AND INSIDE OF THE PASSIVE BARRIER SHALL UTILIZE BREAK-AWAY SUPPORTS

Exhibit 8.16: Stop Control Safety Scheme - Intersection - Page 2

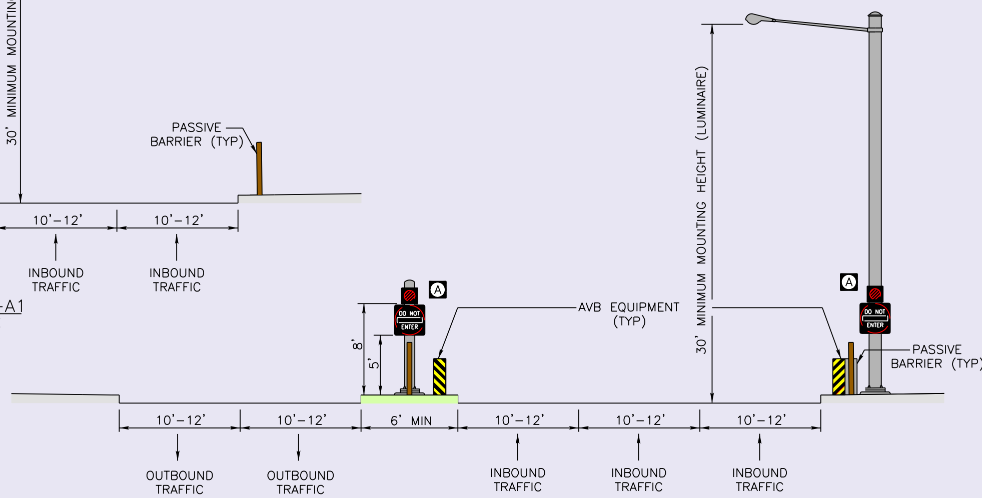
STOP CONTROL AVB SAFETY SCHEME – INTERSECTION		OPERATIONAL SEQUENCING FOR EMERGENCY FAST OPERATION					
	TRAFFIC CONTROL	GUARD REACTION			SAFETY INTERVAL		BARRIER DEPLOYED
	TIMELINE (SEC)	1	2	3	4	5	6
	W3-3B-TEA WARNING SIGN WITH BEACONS	BEACONS DARK			ALTERNATING FLASHING YELLOW		
	DO NOT ENTER LED BLANK-OUT SIGN	DARK			"DO NOT ENTER" ILLUMINATED		
	RED SIGNAL	DARK			STEADY RED		
	100dB HORN	SILENT			ACTIVATED		
	ACTIVE VEHICLE BARRIER	NON-DEPLOYED			DEPLOYING		DEPLOYED

NOTES CONT'D

12. LED BLANK-OUT SIGN SHALL NOT AUTOMATICALLY DIM.
13. DESIGN, CONSTRUCTION AND MATERIALS FOR TRAFFIC CONTROL AND RELATED EQUIPMENT SHALL CONFORM TO THE STATE DOT OR LOCAL STANDARDS.
14. AVB EQUIPMENT WIDTHS SHOWN ON SECTION A1-A1 AND A2-A2 VARY BY AVB TYPE, MODEL, AND MANUFACTURER.
15. ALL SIGNALS SHALL BE LED AND HAVE FULL CIRCLE TUNNEL VISORS WITH BACKPLATES WITH RETROREFLECTIVE STRIP. 12-INCH INDICATIONS SHALL BE USED.
16. UNDER EFO CONDITION, AVBS SHALL BE DESIGNED TO OPERATE INDEPENDENTLY IN CONJUNCTION WITH SAFETY LOOP DETECTION.
17. PLAN DETAILS ARE TYPICAL AND MAY BE ADJUSTED TO MEET SITE CONDITIONS. ANY ALTERATIONS IN TRAFFIC CONTROL (SIGNALS, BEACONS, SIGNING, MARKINGS AND DETECTION LOOPS) REQUIRE APPROVAL THROUGH SDDCTEA.
18. AN ALL-WAY STOP IS THE PREFERRED TRAFFIC CONTROL; HOWEVER A TWO-WAY STOP MAY BE REQUIRED. A TRAFFIC STUDY WILL NEED TO VALIDATE TRAFFIC CONTROL.
19. FOR MULTI-LANE ROADWAYS, UTILIZE A SOLID WHITE LINE BETWEEN LANES TO DISCOURAGE LANE CHANGING.
20. ALL PASSIVE BARRIERS PLACED AT INTERSECTION MUST NOT OBSTRUCT INTERSECTION SIGHT DISTANCE.



SECTION A1–A1
NOT TO SCALE



SECTION A2–A2
NOT TO SCALE

8.4.3.4. Hybrid Beacon Safety Scheme

The Hybrid Beacon Safety Scheme uses hybrid beacons for traffic control and extended vehicle detection loops to detect the presence of vehicles approaching the AVB. The safety scheme's design provides adequate stopping sight distance for an innocent driver to stop prior to, or to clear, the AVB. The operation of this scheme requires a 7-second (minimum) threat response time. **Refer to the 7-second timeline given on the Hybrid Beacon Safety Scheme drawings for time allowances for individual safety scheme components.**

Additional key characteristics include:

- Design based on a roadway grade of 3% or less and a design speed of 25 mph
- Lengthened advance vehicle detection loops (6-ft x 76-ft quadrupoles)
- 'DO NOT ENTER' LED blank-out regulatory signs

Advantages of this scheme include:

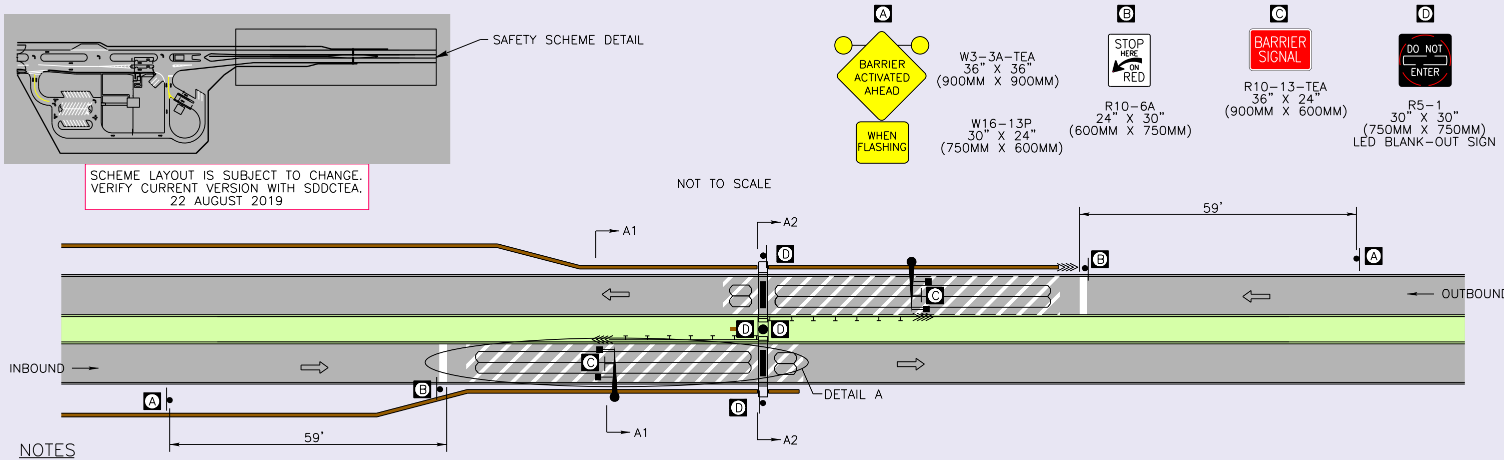
- Free-flowing traffic

Disadvantages of this scheme include:

- Longer vehicle detection loops as compared to the other safety schemes

This safety scheme is illustrated in **Exhibit 8.17** (one lane) and **Exhibit 8.18** (two lanes).

Exhibit 8.17: Hybrid Beacon Safety Scheme (One Lane) – Page 1



NOTES

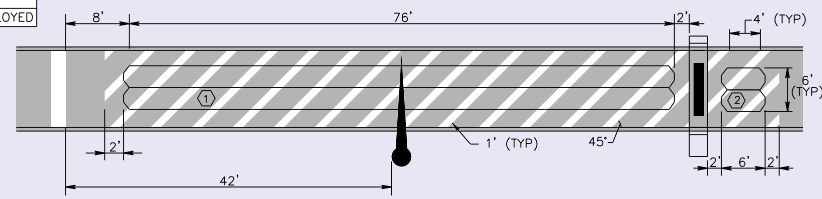
1. WHEN EFO IS ACTIVATED, A 100db AUDIBLE ALARM LOCATED AT THE AVB SHALL SOUND FOR AT LEAST 10 SECONDS, AND BE DIRECTED TOWARDS ONCOMING TRAFFIC FOR BOTH DIRECTIONS.
2. SIGNS, SIGNALS, AND PAVEMENT MARKINGS SHALL CONFORM TO MUTCD, DOD SUPPLEMENT TO THE MUTCD, SDDCTEA PAMPHLET 55-15 AND LOCAL REGULATIONS.
3. ALTERNATING RED AND WHITE TYPE X RETROREFLECTIVE SHEETING REQUIRED ON ACTIVE VEHICLE BARRIERS AS PER SDDCTEA PAMPHLET 55-15.
4. OBJECT MARKERS ARE REQUIRED ON NORMALLY EXPOSED ACTIVE VEHICLE BARRIER EQUIPMENT.
5. ALL PAVEMENT MARKINGS SHALL BE RETROREFLECTIVE AND DESIGNED TO ENHANCE TRACTION.
6. LOOP 1 – ENTRY SAFETY LOOP, LOOP 2 – EXIT SAFETY LOOP.
7. SECTION A1-A1, A2-A2, DETAIL A, AND OPERATIONAL SEQUENCING FOR EFO SHOWN ON THE FOLLOWING PAGE.
8. INFRARED CAMERAS OR RADAR MAY BE USED IN LIEU OF LOOP DETECTORS.
9. MEDIAN LENGTH SHALL EXTEND AT LEAST 25 FEET PRIOR TO THE STOP LINE ON EACH APPROACH.
10. LED BLANK-OUT SIGN, IF USED, SHALL NOT AUTOMATICALLY DIM.
11. DESIGN, CONSTRUCTION AND MATERIALS FOR TRAFFIC CONTROL AND RELATED EQUIPMENT SHALL CONFORM TO THE STATE DOT OR LOCAL STANDARDS.
12. AVB EQUIPMENT WIDTHS SHOWN ON SECTION A2-A2 VARIES BY AVB TYPE, MODEL, AND MANUFACTURER.
13. ALL SIGNALS SHALL BE LED AND HAVE FULL CIRCLE TUNNEL VISORS WITH BACKPLATES WITH RETROREFLECTIVE STRIP. 12-INCH INDICATIONS SHALL BE USED.
14. PLAN DETAILS ARE TYPICAL AND MAY BE ADJUSTED TO MEET SITE CONDITIONS. ANY ALTERATION IN TRAFFIC CONTROL (SIGNALS, BEACONS, SIGNING, MARKINGS AND DETECTION LOOPS) REQUIRE APPROVAL THROUGH SDDCTEA.
15. DESIGN IS BASED ON A 25 MPH DESIGN SPEED. SDDCTEA APPROVAL REQUIRED FOR POSTED SPEEDS HIGHER THAN 25 MPH.
16 UNDER EFO CONDITION, AVBS SHALL BE DESIGNED TO OPERATE INDEPENDENTLY IN CONJUNCTION WITH SAFETY LOOP DETECTION.
17. ALL TRAFFIC CONTROL DEVICES AND POLES INSTALLED NEXT TO THE ROADWAY AND INSIDE OF THE PASSIVE BARRIER SHALL UTILIZE BREAK-AWAY SUPPORTS.
18. EXISTING SIGNS AND MARKINGS CONFORMING TO EARLIER VERSIONS OF SDDCTEA SAFETY SCHEMES ARE CONSIDERED GRANDFATHERED IN AND MAY REMAIN IN-PLACE UNTIL THE END OF THEIR USEFUL SERVICE LIFE. REPLACE WITH CURRENT STANDARD AT THAT TIME.
19. THE LONGER LOOPS MAY INTRODUCE ADDITIONAL SECURITY RISKS WHICH MAY BE CONSIDERED WHEN DETERMINING AVB PLACEMENT

LEGEND

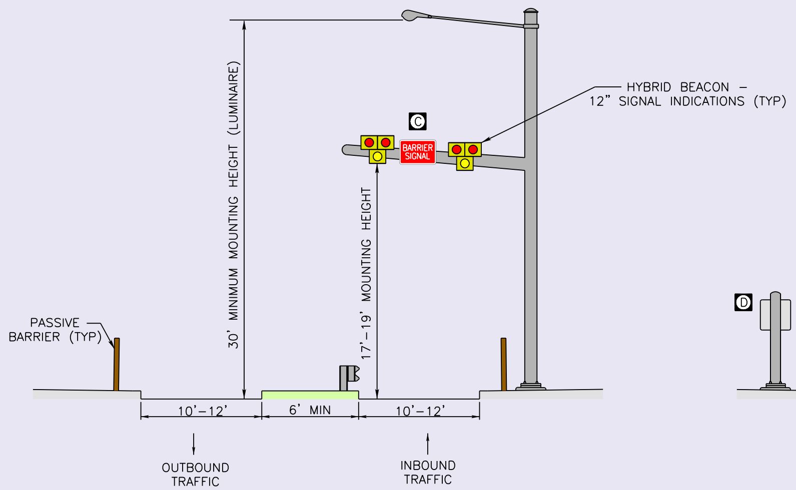
- ACTIVE VEHICLE BARRIER AND EQUIPMENT
- QUADRUPOLE INDUCTIVE LOOP DETECTOR
- # LOOP DETECTION AREA NUMBER
- POLE-MOUNTED SIGN WITH LUMINAIRE
- POST MOUNTED SIGN
- HYBRID BEACON
- STRUCTURE MOUNTED SIGN
- MAST ARM WITH LUMINAIRE
- STOP LINE PAVEMENT MARKING
- GUARDRAIL
- WHITE CROSSHATCHING PAVEMENT MARKINGS
- PASSIVE BARRIER
- CRASHWORTHY END TERMINAL/CRASH CUSHION

Exhibit 8.17: Hybrid Beacon Safety Scheme (One Lane) – Page 2

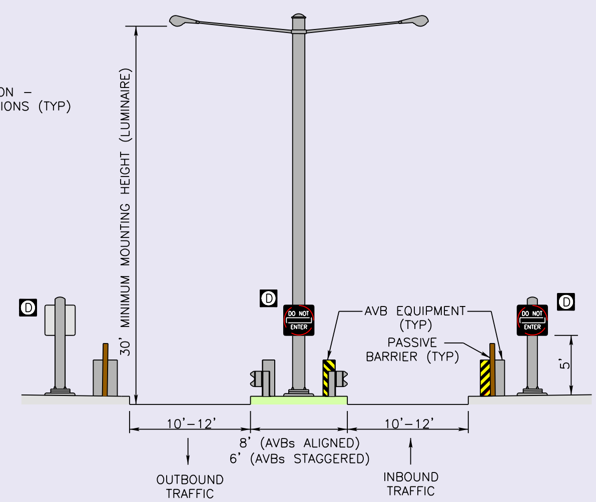
		OPERATIONAL SEQUENCING FOR EMERGENCY FAST OPERATION							
ONE-LANE HYBRID BEACON SAFETY SCHEME	TRAFFIC CONTROL	GUARD REACTION			SAFETY INTERVAL		DEPLOYING BARRIER		BARRIER DEPLOYED
	TIMELINE (SEC)	1	2	3	4	5	6	7	8
	W3-3B-TEA WARNING SIGN WITH BEACONS	DARK			ALTERNATING FLASHING YELLOW				
	DO NOT ENTER LED BLANK-OUT SIGN	DARK			"DO NOT ENTER" ILLUMINATED				
	HYBRID BEACON	DARK			SOLID YELLOW		ALTERNATING FLASHING RED		
	100dB HORN	SILENT			ACTIVATED				
	ACTIVE VEHICLE BARRIER	NON-DEPLOYED					DEPLOYING		DEPLOYED



DETAIL A

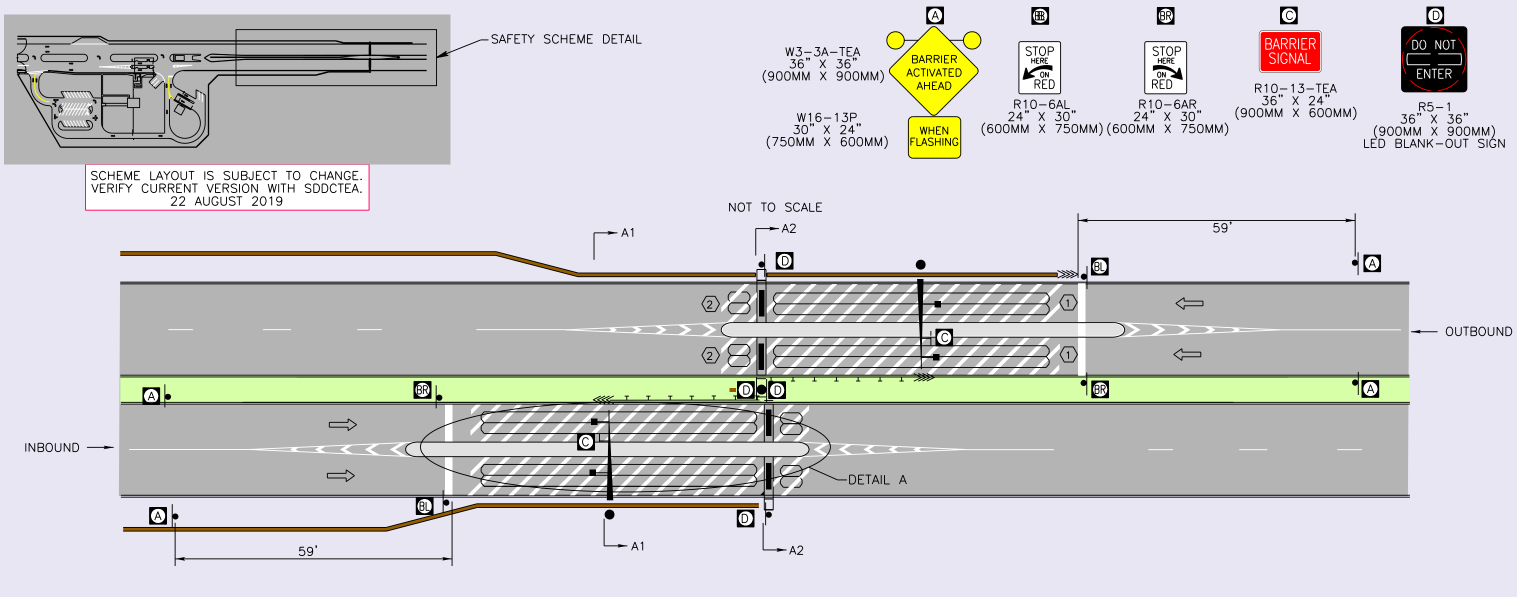


SECTION A1–A1
NOT TO SCALE



SECTION A2–A2
NOT TO SCALE

Exhibit 8.18: Hybrid Beacon Safety Scheme (Two Lanes) – Page 1



NOTES

1. WHEN EFO IS ACTIVATED, A 100db AUDIBLE ALARM LOCATED AT THE AVB SHALL SOUND FOR AT LEAST 10 SECONDS, AND BE DIRECTED TOWARDS ONCOMING TRAFFIC FOR BOTH DIRECTIONS.
2. SIGNS, SIGNALS, AND PAVEMENT MARKINGS SHALL CONFORM TO MUTCD, DOD SUPPLEMENT TO THE MUTCD, SDDCTEA PAMPHLET 55-15 AND LOCAL REGULATIONS.
3. ALTERNATING RED AND WHITE TYPE X RETROREFLECTIVE SHEETING REQUIRED ON ACTIVE VEHICLE BARRIERS AS PER SDDCTEA PAMPHLET 55-15.
4. OBJECT MARKERS ARE REQUIRED ON NORMALLY EXPOSED ACTIVE VEHICLE BARRIER EQUIPMENT.
5. ALL PAVEMENT MARKINGS SHALL BE RETROREFLECTIVE AND DESIGNED TO ENHANCE TRACTION.
6. LOOP 1 - ENTRY SAFETY LOOP, LOOP 2 - EXIT SAFETY LOOP.
7. SECTION A1-A1, A2-A2, DETAIL A, AND OPERATIONAL SEQUENCING FOR EFO SHOWN ON THE FOLLOWING PAGE.
8. INFRARED CAMERAS OR RADAR MAY BE USED IN LIEU OF LOOP DETECTORS.
9. MEDIAN LENGTH SHALL EXTEND AT LEAST 25 FEET PRIOR TO THE STOP LINE ON EACH APPROACH.
10. LED BLANK-OUT SIGN, IF USED, SHALL NOT AUTOMATICALLY DIM.
11. DESIGN, CONSTRUCTION AND MATERIALS FOR TRAFFIC CONTROL AND RELATED EQUIPMENT SHALL CONFORM TO THE STATE DOT OR LOCAL STANDARDS.
12. ALL TRAFFIC CONTROL DEVICES AND POLES INSTALLED NEXT TO THE ROADWAY AND INSIDE OF THE PASSIVE BARRIER SHALL UTILIZE BREAK-AWAY SUPPORTS.

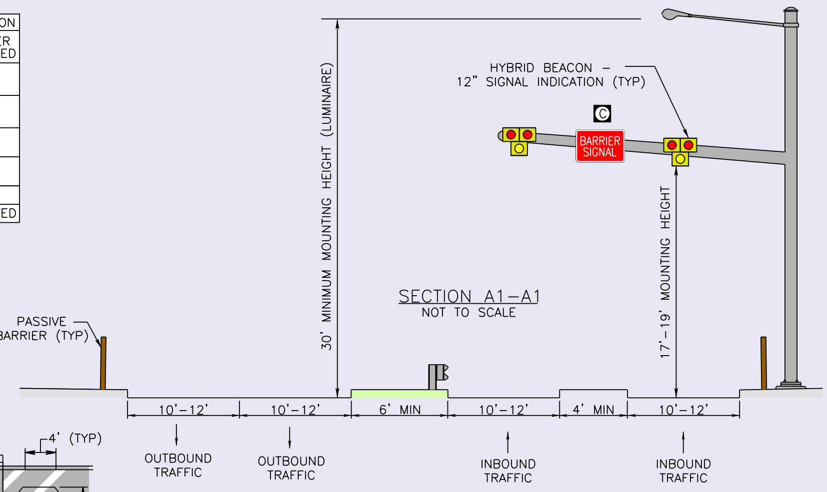
LEGEND

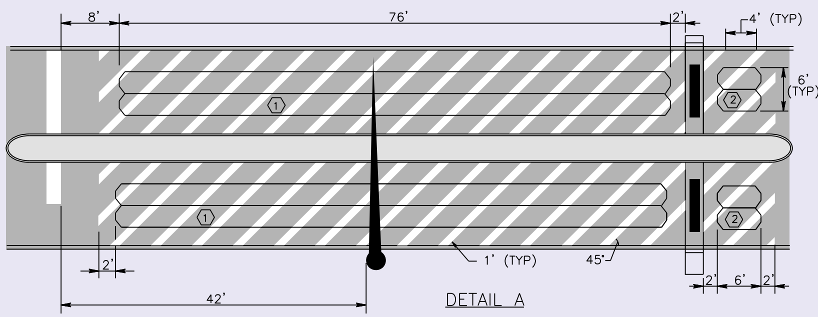
- ACTIVE VEHICLE BARRIER AND EQUIPMENT
- QUADRUPOLE INDUCTIVE LOOP DETECTOR
- # LOOP DETECTION AREA NUMBER
- POLE-MOUNTED SIGN WITH LUMINAIRE
- POST MOUNTED SIGN
- HYBRID BEACON
- STRUCTURE MOUNTED SIGN
- MAST ARM WITH LUMINAIRE
- STOP LINE PAVEMENT MARKING
- GUARDRAIL
- WHITE CROSSHATCHING PAVEMENT MARKINGS
- PASSIVE BARRIER
- CRASHWORTHY END TERMINAL/CRASH CUSHION

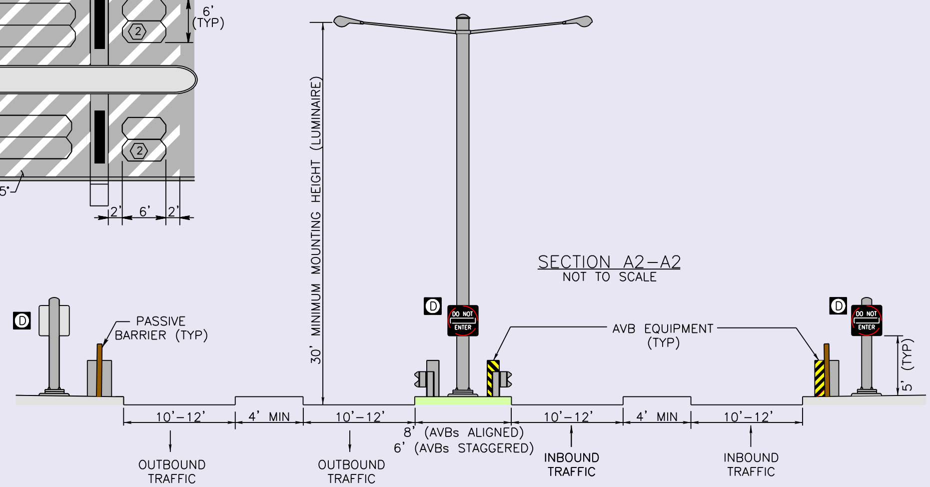
Force Protection Issues

Exhibit 8.18: Hybrid Beacon Safety Scheme (Two Lanes) – Page 2

		OPERATIONAL SEQUENCING FOR EMERGENCY FAST OPERATION							
TWO-LANE HYBRID BEACON SAFETY SCHEME	TRAFFIC CONTROL	GUARD REACTION			SAFETY INTERVAL		DEPLOYING BARRIER		BARRIER DEPLOYED
	TIMELINE (SEC)	1	2	3	4	5	6	7	8
	W3-3B-TEA WARNING SIGN WITH BEACONS	DARK			ALTERNATING FLASHING YELLOW				
	DO NOT ENTER LED BLANK-OUT SIGN	DARK			"DO NOT ENTER" ILLUMINATED				
	HYBRID BEACON	DARK			SOLID YELLOW		ALTERNATING FLASHING RED		
	100dB HORN	SILENT			ACTIVATED				
	ACTIVE VEHICLE BARRIER	NON-DEPLOYED					DEPLOYING		DEPLOYED







NOTES CONT'D

13. AVB EQUIPMENT WIDTHS SHOWN ON SECTION A2–A2 VARY BY AVB TYPE, MODEL, AND MANUFACTURER.
14. ALL SIGNALS SHALL BE LED AND HAVE FULL CIRCLE TUNNEL VISORS WITH BACKPLATES WITH RETROREFLECTIVE STRIP. 12-INCH INDICATIONS SHALL BE USED.
15. PLAN DETAILS ARE TYPICAL AND MAY BE ADJUSTED TO MEET SITE CONCERNS. ANY ALTERATIONS IN TRAFFIC CONTROL (SIGNALS, BEACONS, SIGNING, MARKINGS AND DETECTION LOOPS) REQUIRE APPROVAL THROUGH SDDCTEA.
16. DESIGN BASED ON A 25 MPH DESIGN SPEED. SDDCTEA APPROVAL REQUIRED FOR POSTED SPEEDS HIGHER THAN 25 MPH.
17. UNDER EFO CONDITION, AVBs SHALL BE DESIGNED TO OPERATE INDEPENDENTLY IN CONJUNCTION WITH SAFETY LOOP DETECTION.
18. FOR MULTI-LANE ROADWAYS, UTILIZE A SOLID WHITE LINE BETWEEN LANES TO DISCOURAGE LANE CHANGING.
19. EXISTING SIGNS AND MARKINGS CONFORMING TO EARLIER VERSIONS OF SDDCTEA SAFETY SCHEMES ARE CONSIDERED GRANDFATHERED IN AND MAY REMAIN IN-PLACE UNTIL THE END OF THEIR USEFUL SERVICE LIFE. REPLACE WITH CURRENT STANDARD AT THAT TIME.
20. THE LONGER LOOPS MAY INTRODUCE ADDITIONAL SECURITY RISKS WHICH MAY BE CONSIDERED WHEN DETERMINING AVB PLACEMENT

8.4.3.5. Combination Intersection Stop Control/Hybrid Beacon Safety Scheme

This scheme is a combination of the intersection Stop Control Safety Scheme for the inbound lane and the Hybrid Beacon Safety Scheme for the outbound lane. Note that this combination safety scheme should only be used at unsignalized intersections. It shall not be used at signalized intersections or roundabouts. Each scheme acts independently, so the minimum threat response time for the inbound lane is 5-seconds (Stop Control Safety Scheme) and 7-seconds (Hybrid Beacon Safety Scheme) for the outbound lane. **Refer to the 5-second and 7-second timelines given on the Combination Intersection Stop Control/Hybrid Beacon Safety Scheme drawings for time allowances for individual safety scheme components.** Note that the outbound AVB requires a longer threat response time than the inbound AVB. This increased threat response time can often be mitigated with wrong way detection and added roadway curvature for the outbound lanes.

Additional key characteristics include:
- Outbound AVB must be located a minimum of 155 feet from intersection radius point
- Design based on a roadway grade of 3% or less and a design speed of 25 mph for the outbound AVB
- Passive barrier must be installed in the median connecting the inbound and outbound AVBs
- 'DO NOT ENTER' LED blank-out regulatory signs
- Red signals mounted on top of the LED signs (inbound AVB)
- Lengthened advance vehicle detection loops (6-ft x 76-ft quadrupoles) for the outbound AVB

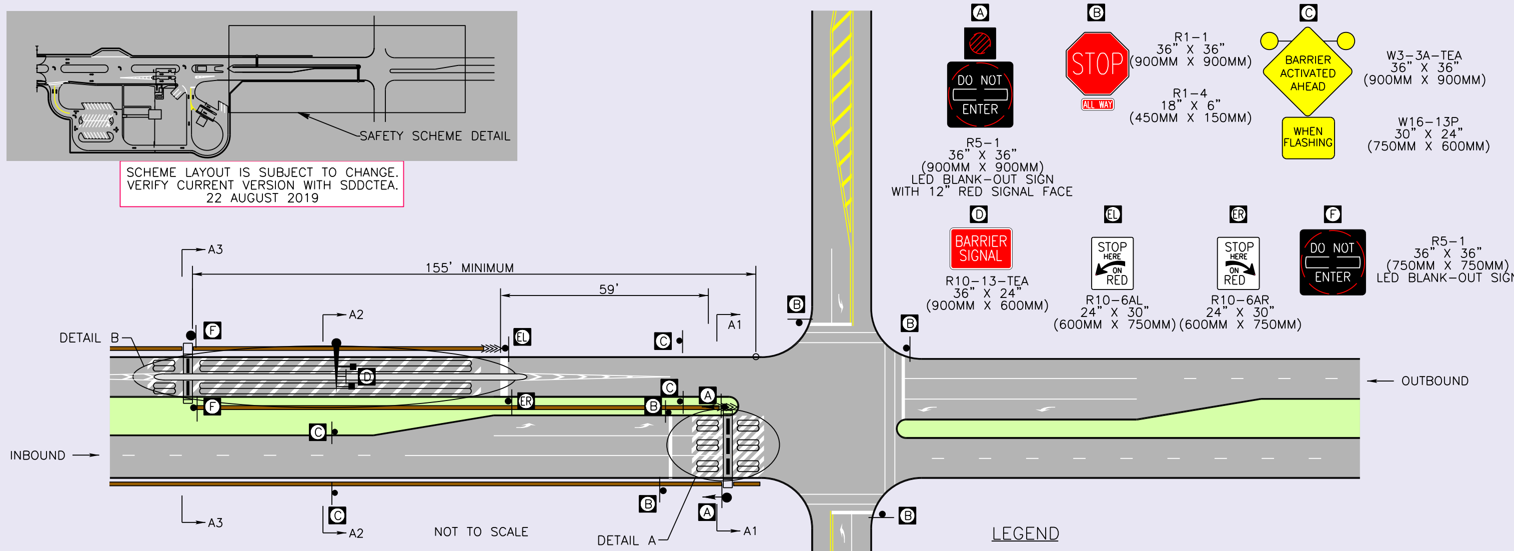
This scheme is appropriate when the inbound traffic volume is less than 800 vehicles per hour per lane and the intersected roadway (inside the installation) has relatively lower traffic volumes. As it is required that the intersection be unsignalized, the default intersection traffic control is all-way stop control. However, an intersection capacity analysis should be performed to ensure that all legs of the intersection operate at an acceptable level of service under all-way stop control.

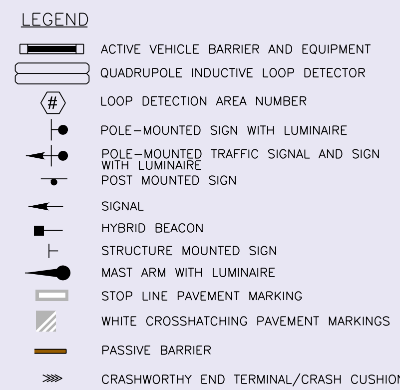
Advantages of this scheme include:
- Shortest response zone with exception to the Full Containment Safety Scheme (inbound AVB)
- Ability to retrofit an existing ECF's response zone and AVB(s)
- Inbound drivers stop at an intersection which is more intuitive than stopping at a midblock location, as required in the midblock Stop Control Safety Scheme
- Outbound traffic is free flowing

Disadvantages of this scheme include:
- Longer vehicle detection loops as compared to the other safety schemes
- All-way stop control for intersection may not be warranted

This safety scheme is illustrated in **Exhibit 8.19**.

Exhibit 8.19: Combination Intersection Stop Control/Hybrid Beacon Safety Scheme – Page 1





NOTES

1. THIS SCHEME NOT INTENDED FOR USE WHERE INBOUND TRAFFIC VOLUME EXCEEDS 800 VEHICLES PER HOUR PER LANE.
2. ILLUSTRATION SHOWS MULTIPLE LANES PER DIRECTION, BUT SCHEME CAN BE USED FOR ONE LANE PER DIRECTION.
3. WHEN EFO IS ACTIVATED, A 100db AUDIBLE ALARM LOCATED AT THE AVB SHALL SOUND FOR AT LEAST 10 SECONDS, AND BE DIRECTED TOWARDS ONCOMING TRAFFIC FOR BOTH DIRECTIONS.
4. SIGNS, SIGNALS, AND PAVEMENT MARKINGS SHALL CONFORM TO MUTCD, DOD SUPPLEMENT TO THE MUTCD, SDDCTEA PAMPHLET 55-15 AND LOCAL REGULATIONS.
5. ALTERNATING RED AND WHITE TYPE X RETROREFLECTIVE SHEETING REQUIRED ON ACTIVE VEHICLE BARRIERS AS PER SDDCTEA PAMPLET 55-15.
6. OBJECT MARKERS ARE REQUIRED ON NORMALLY EXPOSED ACTIVE VEHICLE BARRIER EQUIPMENT.
7. ALL PAVEMENT MARKINGS SHALL BE RETROREFLECTIVE AND DESIGNED TO ENHANCE TRACTION.
8. LOOP 1 – ENTRY SAFETY LOOP, LOOP 2 – EXIT SAFETY LOOP
9. SECTION A1-A1, A2-A2, A3-A3, DETAIL A, DETAIL B AND OPERATIONAL SEQUENCING FOR EFO SHOWN ON THE FOLLOWING PAGES.
10. INFRARED CAMERAS OR RADAR MAY BE USED IN LIEU OF LOOP DETECTORS.

Force Protection Issues

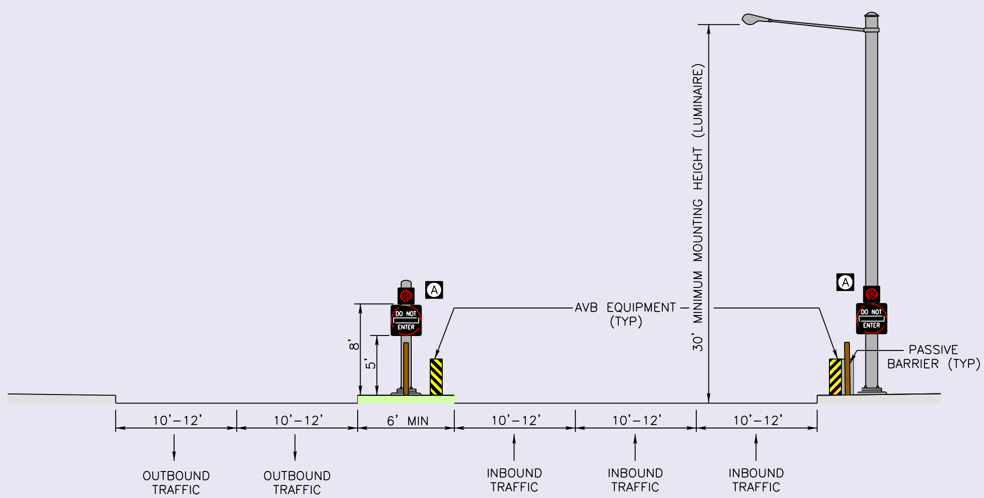
Exhibit 8.19: Combination Intersection Stop Control/Hybrid Beacon Safety Scheme – Page 2

STOP CONTROL AVB SAFETY SCHEME – INTERSECTION	TRAFFIC CONTROL	OPERATIONAL SEQUENCING FOR EMERGENCY FAST OPERATION					
		GUARD REACTION			SAFETY INTERVAL		BARRIER DEPLOYED
	TIMELINE (SEC)	1	2	3	4	5	6
	W3-3B-TEA WARNING SIGN WITH BEACONS	BEACONS DARK			ALTERNATING FLASHING YELLOW		
	DO NOT ENTER LED BLANK-OUT SIGN	DARK			"DO NOT ENTER" ILLUMINATED		
	RED SIGNAL	DARK			STEADY RED		
	100dB HORN	SILENT			ACTIVATED		
	ACTIVE VEHICLE BARRIER	NON-DEPLOYED			DEPLOYING		DEPLOYED

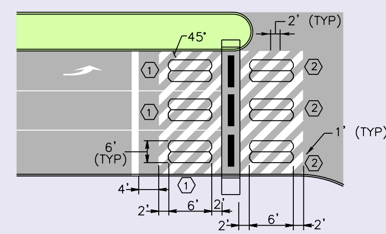
HYBRID BEACON SAFETY SCHEME	TRAFFIC CONTROL	OPERATIONAL SEQUENCING FOR EMERGENCY FAST OPERATION							
		GUARD REACTION			SAFETY INTERVAL		DEPLOYING BARRIER		BARRIER DEPLOYED
	TIMELINE (SEC)	1	2	3	4	5	6	7	8
	W3-3B-TEA WARNING SIGN WITH BEACONS	DARK			ALTERNATING FLASHING YELLOW				
	DO NOT ENTER LED BLANK-OUT SIGN	DARK			"DO NOT ENTER" ILLUMINATED				
	HYBRID BEACON	DARK			SOLID YELLOW		ALTERNATING FLASHING RED		
	100dB HORN	SILENT			ACTIVATED				
	ACTIVE VEHICLE BARRIER	NON-DEPLOYED					DEPLOYING		DEPLOYED

NOTES CONT'D

11. ALL TRAFFIC CONTROL DEVICES AND POLES INSTALLED NEXT TO THE ROADWAY AND INSIDE OF THE PASSIVE BARRIER SHALL UTILIZE BREAK-AWAY SUPPORTS.
12. LED BLANK-OUT SIGN, IF USED, SHALL NOT AUTOMATICALLY DIM.
13. DESIGN, CONSTRUCTION AND MATERIALS FOR TRAFFIC CONTROL AND RELATED EQUIPMENT SHALL CONFORM TO THE STATE DOT OR LOCAL STANDARDS.
14. AVB EQUIPMENT WIDTHS SHOWN ON SECTION A1-A1 AND A3-A3 VARY BY AVB TYPE, MODEL, AND MANUFACTURER.
15. ALL SIGNALS SHALL BE LED AND HAVE FULL CIRCLE TUNNEL VISORS WITH BACKPLATES WITH RETROREFLECTIVE STRIP. 12-INCH INDICATIONS SHALL BE USED.
16. PLAN DETAILS ARE TYPICAL AND MAY BE ADJUSTED TO MEET SITE CONDITIONS. ANY ALTERATION IN TRAFFIC CONTROL (SIGNALS, BEACONS, SIGNING, MARKINGS AND DETECTION LOOPS) REQUIRE APPROVAL THROUGH SDDCTEA.
17. DESIGN IS BASED ON A 25 MPH DESIGN SPEED. SDDCTEA APPROVAL REQUIRED FOR POSTED SPEEDS HIGHER THAN 25 MPH.
18. UNDER EFO CONDITION, AVBS SHALL BE DESIGNED TO OPERATE INDEPENDENTLY IN CONJUNCTION WITH SAFETY LOOP DETECTION.
19. AN ALL-WAY STOP IS THE PREFERRED TRAFFIC CONTROL; HOWEVER A TWO-WAY STOP MAY BE REQUIRED. A TRAFFIC STUDY WILL NEED TO VALIDATE TRAFFIC CONTROL.
20. FOR MULTI-LANE ROADWAYS, UTILIZE A SOLID WHITE LINE BETWEEN LANES TO DISCOURAGE LANE CHANGING.
21. ALL PASSIVE BARRIERS PLACED AT INTERSECTION MUST NOT OBSTRUCT INTERSECTION SIGHT DISTANCE.

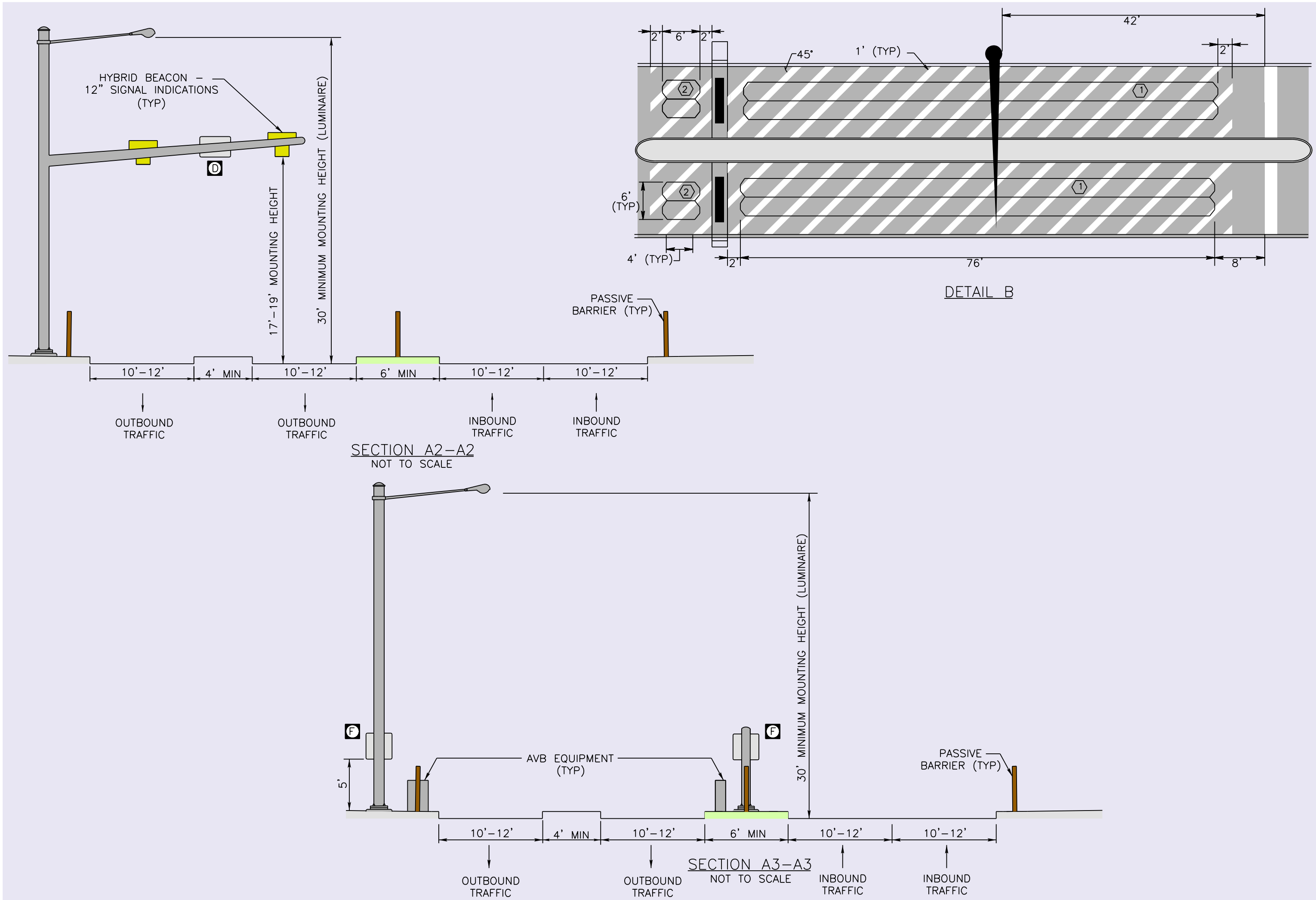


SECTION A1–A1
NOT TO SCALE



DETAIL A

Exhibit 8.19: Combination Intersection Stop Control/Hybrid Beacon Safety Scheme – Page 3



8.4.3.6. High Efficiency Presence Detection Safety Scheme

The High Efficiency Presence Detection (HEPD) Safety Scheme uses typical traffic control signals, traffic arm(s) and a series of quadrupole vehicle detection loops to detect the presence of vehicle(s) approaching the AVB. This safety scheme operates with the AVB normally deployed when no vehicle is present, but allows free-flow traffic once a vehicle is detected. The operation of this scheme requires a 7-second (minimum) threat response time. **Refer to the 7-second timeline given on the HEPD Safety Scheme drawings for time allowances for individual safety scheme components.** It is important to note that with this safety scheme, the AVB and associated traffic control devices for each travel lane operate independently of each other.

This scheme is appropriate when the incoming traffic volume is less than 1200 vehicles per hour per lane.

Additional key characteristics include:

- Design based on a roadway grade of 3% or less and a design speed of 25 mph
- Lane separation (i.e., a median) is required for all lanes, in the same or opposite direction, to locate the HEPD equipment
- Individual AVBs must be used for each lane
- AVBs and associated traffic control devices must operate independently; a delay to one barrier cannot delay a barrier in another lane
- Vehicle detection loops at the traffic arm (6-ft x 10-ft loop), in advance of the AVB (6-ft x 34-ft loop), and just after the AVB (6-ft x 6-ft loop)

For normal operations, all vehicles spaced 3 seconds or less apart will be able to free-flow through the system due to the vehicle detection loops. Vehicles spaced more than 3 seconds apart will encounter a yellow or red light with the traffic arm down or in the process of lowering. The driver must wait for the signal to cycle to green and the traffic arm to raise before proceeding. When EFO is activated, the system allows the last vehicle in the line of free-flowing traffic to clear the AVB during the yellow and red signal cycles. Vehicles that arrive after the 3 second delay will encounter a red light with the traffic arm down or in the process of lowering. After the traffic light has changed to red and the traffic arm lowered, the AVB will begin to deploy.

Advantages of this scheme include:

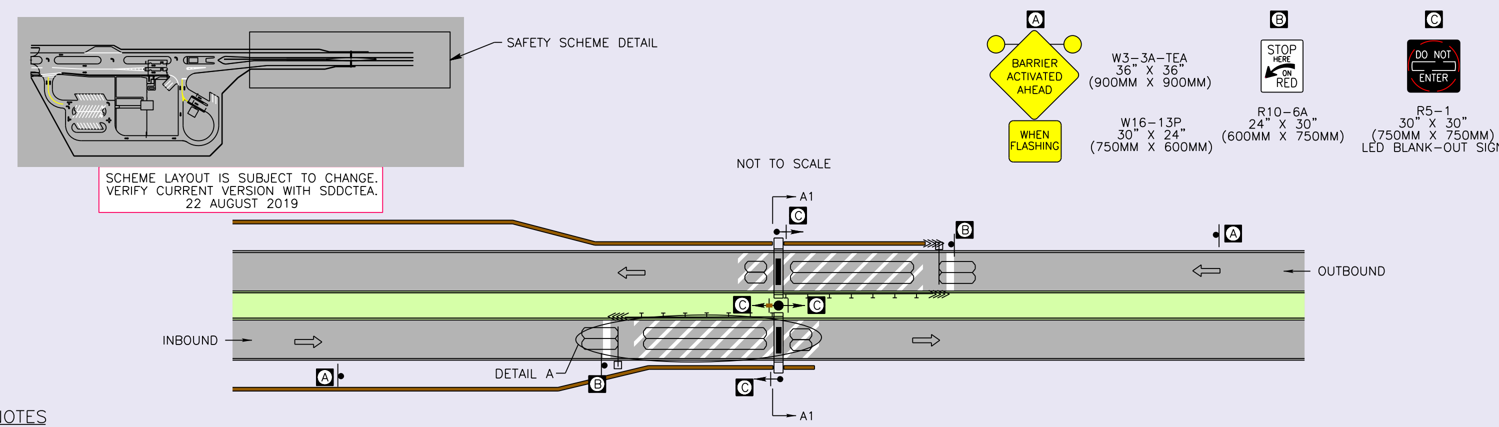
- Allows free-flowing traffic when continuous traffic is present
- 100% threat containment when not processing vehicles
- Favorable option to use with a single outbound lane as it provides 100% containment. When traffic is not present, the AVB is up; when traffic is present, the AVB is down and the traffic flow restricts threat vehicle entry

Disadvantages of this scheme include:

- Complex system
- With lane separation islands at the AVBs, overwidth vehicles cannot be accommodated
- Cannot utilize an AVB that spans multiple lanes

This safety scheme is illustrated in **Exhibit 8.20** (one lane) and **Exhibit 8.21** (two lanes).

Exhibit 8.20: High Efficiency Presence Detection Safety Scheme (One Lane) – Page 1



NOTES

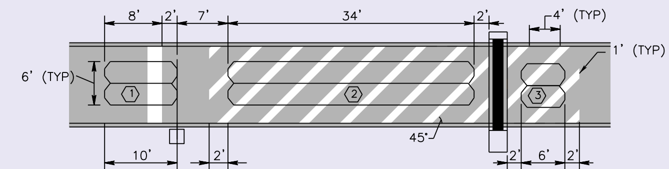
1. SIGNAL PROGRAMMING SHALL INCLUDE A MINIMUM OF 3 SECONDS OF YELLOW DURING NORMAL OPERATIONS. TWO SECONDS OF YELLOW IS PERMITTED FOR EFO.
2. WHEN EFO IS ACTIVATED, A 100db AUDIBLE ALARM LOCATED AT THE AVB SHALL SOUND FOR AT LEAST 10 SECONDS, AND BE DIRECTED TOWARDS ONCOMING TRAFFIC FOR BOTH DIRECTIONS.
3. SIGNS, SIGNALS, AND PAVEMENT MARKINGS SHALL CONFORM TO MUTCD, DOD SUPPLEMENT TO THE MUTCD, SDDCTEA PAMPHLET 55-15 AND LOCAL REGULATIONS.
4. ALTERNATING RED AND WHITE TYPE X RETROREFLECTIVE SHEETING REQUIRED ON TRAFFIC ARMS AND ACTIVE VEHICLE BARRIERS AS PER SDDCTEA PAMPHLET 55-15.
5. OBJECT MARKERS ARE REQUIRED ON TRAFFIC ARM BASE AND NORMALLY EXPOSED ACTIVE VEHICLE BARRIER EQUIPMENT.
6. ALL PAVEMENT MARKINGS SHALL BE RETROREFLECTIVE AND DESIGNED TO ENHANCE TRACTION.
7. LOOP 1 - GATE ARM LOOP, LOOP 2 - ENTRY SAFETY LOOP, LOOP 3 - EXIT SAFETY LOOP.
8. SECTION A1-A1, DETAIL A, DETAIL B, AND OPERATIONAL SEQUENCING FOR EFO SHOWN ON THE FOLLOWING PAGE.
9. INFRARED CAMERAS OR RADAR MAY BE USED IN LIEU OF LOOP DETECTORS.
10. ALL TRAFFIC CONTROL DEVICES AND POLES INSTALLED NEXT TO THE ROADWAY AND INSIDE OF THE PASSIVE BARRIER SHALL UTILIZE BREAK-A-WAY SUPPORTS.
11. MEDIAN LENGTH SHALL EXTEND AT LEAST 25 FEET PRIOR TO THE STOP LINE ON EACH APPROACH.
12. LED BLANK-OUT SIGN SHALL NOT AUTOMATICALLY DIM.
13. DESIGN, CONSTRUCTION AND MATERIALS FOR TRAFFIC CONTROL AND RELATED EQUIPMENT SHALL CONFORM TO THE STATE DOT OR LOCAL STANDARDS.
14. AVB EQUIPMENT WIDTHS SHOWN ON SECTION A1-A1 VARIES BY AVB TYPE, MODEL, AND MANUFACTURER.
15. ALL SIGNALS SHALL BE LED AND HAVE FULL CIRCLE TUNNEL VISORS WITH BACKPLATES WITH RETROREFLECTIVE STRIP. 12-INCH INDICATIONS SHALL BE USED.
16. PLAN DETAILS ARE TYPICAL AND MAY BE ADJUSTED TO MEET SITE CONDITIONS. ANY ALTERATION IN TRAFFIC CONTROL (TRAFFIC ARM, SIGNALS, BEACONS, SIGNING, MARKINGS AND DETECTION LOOPS) REQUIRE APPROVAL THROUGH SDDCTEA.
17. DESIGN IS BASED ON A 25 MPH DESIGN SPEED. SDDCTEA APPROVAL REQUIRED FOR POSTED SPEEDS HIGHER THAN 25 MPH.
18. UNDER EFO CONDITION, AVBS SHALL BE DESIGNED TO OPERATE INDEPENDENTLY IN CONJUNCTION WITH SAFETY LOOP DETECTION.
19. EXISTING SIGNS AND MARKINGS CONFORMING TO EARLIER VERSIONS OF SDDCTEA SAFETY SCHEMES ARE CONSIDERED GRANDFATHERED IN AND MAY REMAIN IN-PLACE UNTIL THE END OF THEIR USEFUL SERVICE LIFE. REPLACE WITH CURRENT STANDARD AT THAT TIME.
20. ALL TRAFFIC CONTROL DEVICES AND POLES INSTALLED NEXT TO THE ROADWAY AND INSIDE OF THE PASSIVE BARRIER SHALL UTILIZE BREAK-AWAY SUPPORTS.

LEGEND

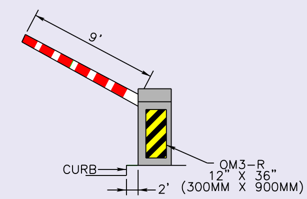
- ACTIVE VEHICLE BARRIER AND EQUIPMENT
- QUADRUPOLE INDUCTIVE LOOP DETECTOR
- LOOP DETECTION AREA NUMBER
- POST MOUNTED SIGN
- TRAFFIC GATE ARM
- POLE-MOUNTED TRAFFIC SIGNAL AND SIGN WITH LUMINAIRE
- POLE-MOUNTED TRAFFIC SIGNAL AND SIGN
- STOP LINE PAVEMENT MARKING
- GUARDRAIL
- WHITE CROSSHATCHING PAVEMENT MARKINGS
- PASSIVE BARRIER
- CRASHWORTHY END TERMINAL/CRASH CUSHION

Exhibit 8.20: High Efficiency Presence Detection Safety Scheme (One Lane) – Page 2

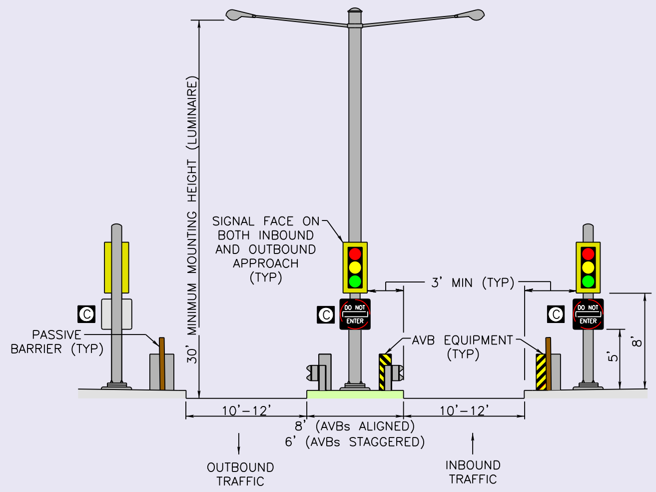
		OPERATIONAL SEQUENCING FOR EMERGENCY FAST OPERATION							
ONE-LANE HIGH EFFICIENCY PRESENCE DETECTION SAFETY SCHEME	TRAFFIC CONTROL	GUARD REACTION			SAFETY INTERVAL		DEPLOYING BARRIER		BARRIER DEPLOYED
	TIMELINE (SEC)	1	2	3	4	5	6	7	8
	W3-3B-TEA WARNING SIGN WITH BEACONS	DARK			ALTERNATING FLASHING YELLOW				
	DO NOT ENTER LED BLANK-OUT SIGN	DARK			"DO NOT ENTER" ILLUMINATED				
	TRAFFIC SIGNALS	NORMAL OPERATIONS			YELLOW		RED		
	100dB HORN	SILENT			ACTIVATED				
	TRAFFIC ARM (WITH TRAFFIC IN SYSTEM)	NORMAL OPERATIONS			DEPLOYING		DEPLOYED		
	ACTIVE VEHICLE BARRIER (WITH TRAFFIC IN SYSTEM)	NON-DEPLOYED					DEPLOYING		DEPLOYED
	TRAFFIC ARM (WITH NO TRAFFIC IN SYSTEM)	DEPLOYED							
	ACTIVE VEHICLE BARRIER (WITH NO TRAFFIC IN SYSTEM)	DEPLOYED							



DETAIL A

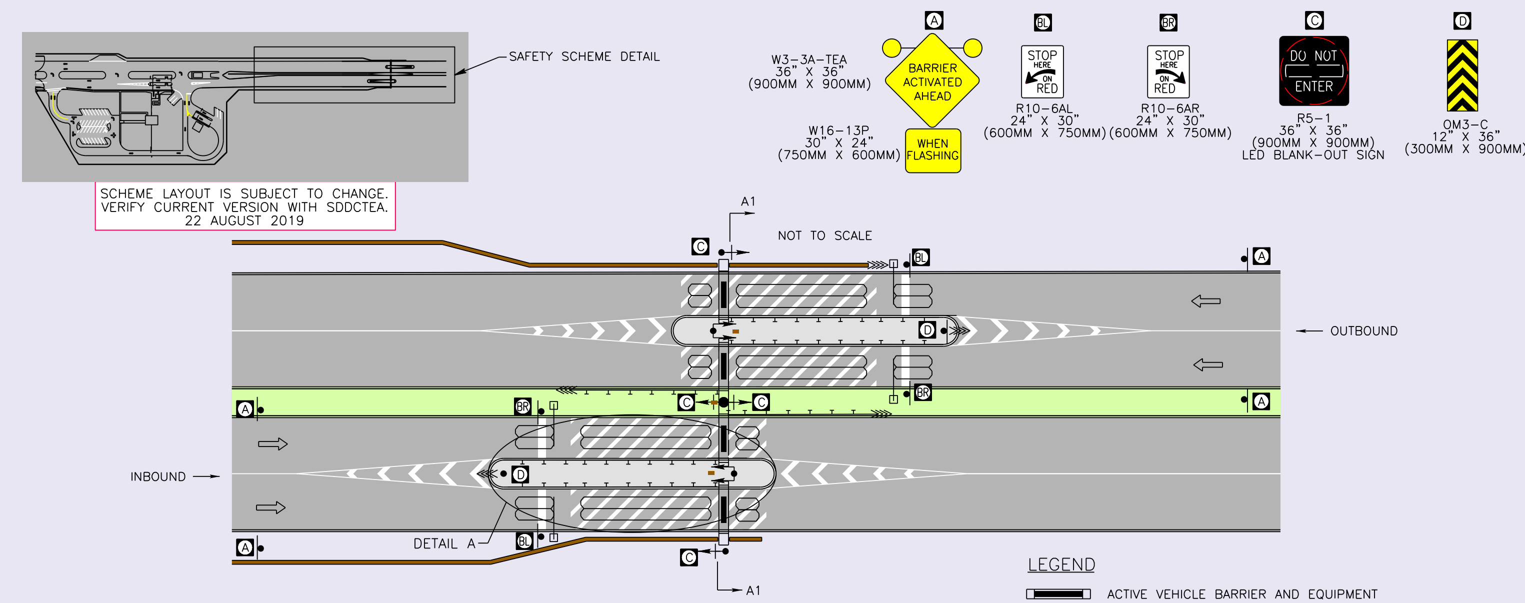


DETAIL B



SECTION A1–A1
NOT TO SCALE

Exhibit 8.21: High Efficiency Presence Detection Safety Scheme (Two Lanes) – Page 1



NOTES

1. SIGNAL PROGRAMMING SHALL INCLUDE A MINIMUM OF 3 SECONDS OF YELLOW DURING NORMAL OPERATIONS. TWO SECONDS OF YELLOW IS PERMITTED FOR EFO.
2. WHEN EFO IS ACTIVATED, A 100db AUDIBLE ALARM LOCATED AT THE AVB SHALL SOUND FOR AT LEAST 10 SECONDS, AND BE DIRECTED TOWARDS ONCOMING TRAFFIC FOR BOTH DIRECTIONS.
3. SIGNS, SIGNALS, AND PAVEMENT MARKINGS SHALL CONFORM TO MUTCD, DOD SUPPLEMENT TO THE MUTCD, SDDCTEA PAMPHLET 55-15 AND LOCAL REGULATIONS.
4. ALTERNATING RED AND WHITE TYPE X RETROREFLECTIVE SHEETING REQUIRED ON TRAFFIC ARMS AND ACTIVE VEHICLE BARRIERS AS PER SDDCTEA PAMPHLET 55-15.
5. OBJECT MARKERS ARE REQUIRED ON TRAFFIC ARM BASE AND NORMALLY EXPOSED ACTIVE VEHICLE BARRIER EQUIPMENT.
6. ALL PAVEMENT MARKINGS SHALL BE RETROREFLECTIVE AND DESIGNED TO ENHANCE TRACTION.
7. LOOP 1 – GATE ARM LOOP, LOOP 2 – ENTRY SAFETY LOOP, LOOP 3 – EXIT SAFETY LOOP.
8. SECTION A1-A1, DETAIL A, DETAIL B, AND OPERATIONAL SEQUENCING FOR EFO SHOWN ON THE FOLLOWING PAGE.
9. INFRARED CAMERAS OR RADAR MAY BE USED IN LIEU OF LOOP DETECTORS.
10. ALL TRAFFIC CONTROL DEVICES AND POLES INSTALLED NEXT TO THE ROADWAY AND INSIDE OF THE PASSIVE BARRIER SHALL UTILIZE BREAK-AWAY SUPPORTS.
11. MEDIAN LENGTH SHALL EXTEND AT LEAST 25 FEET PRIOR TO THE STOP LINE ON EACH APPROACH.
12. LED BLANK-OUT SIGN SHALL NOT AUTOMATICALLY DIM.
13. DESIGN, CONSTRUCTION AND MATERIALS FOR TRAFFIC CONTROL AND RELATED EQUIPMENT SHALL CONFORM TO THE STATE DOT OR LOCAL STANDARDS.
14. AVB EQUIPMENT WIDTHS SHOWN ON SECTION A1-A1 VARY BY AVB TYPE, MODEL, AND MANUFACTURER.

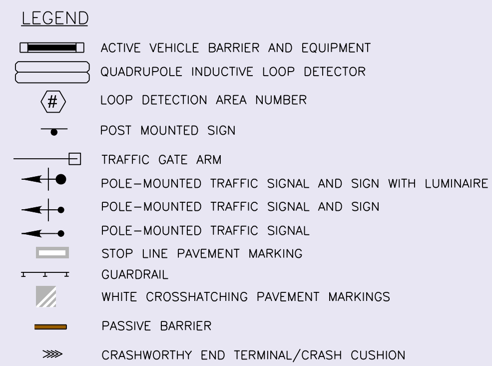
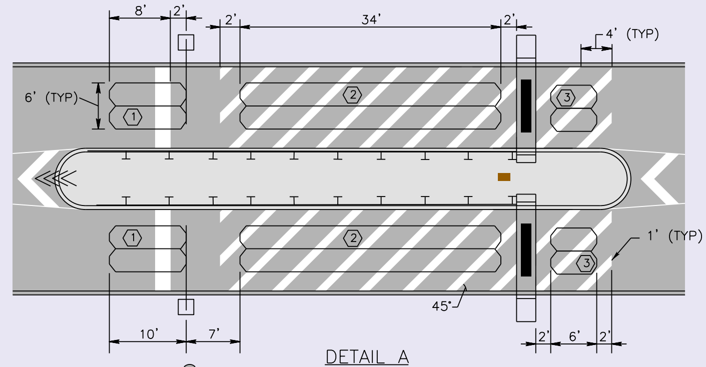


Exhibit 8.21: High Efficiency Presence Detection Safety Scheme (Two Lanes) – Page 2

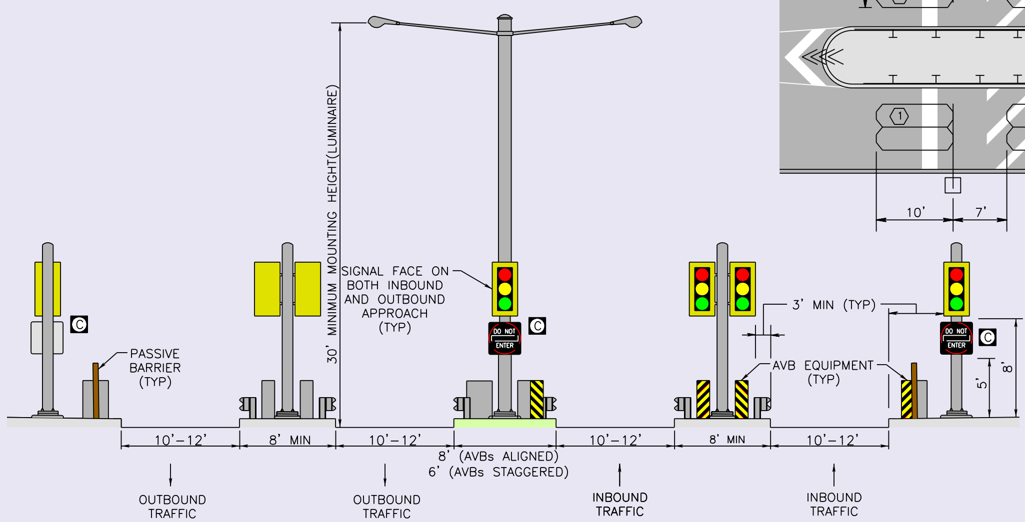
TWO-LANE HIGH EFFICIENCY PRESENCE DETECTION SAFETY SCHEME		OPERATIONAL SEQUENCING FOR EMERGENCY FAST OPERATION							
	TRAFFIC CONTROL	GUARD REACTION			SAFETY INTERVAL		DEPLOYING BARRIER		BARRIER DEPLOYED
	TIMELINE (SEC)	1	2	3	4	5	6	7	8
	W3-3B-TEA WARNING SIGN WITH BEACONS	DARK			ALTERNATING FLASHING YELLOW				
	DO NOT ENTER LED BLANK-OUT SIGN	DARK			"DO NOT ENTER" ILLUMINATED				
	TRAFFIC SIGNALS	NORMAL OPERATIONS			YELLOW		RED		
	100dB HORN	SILENT			ACTIVATED				
	TRAFFIC ARM (WITH TRAFFIC IN SYSTEM)	NORMAL OPERATIONS			DEPLOYING		DEPLOYED		
	ACTIVE VEHICLE BARRIER (WITH TRAFFIC IN SYSTEM)	NON-DEPLOYED					DEPLOYING		DEPLOYED
	TRAFFIC ARM (WITH NO TRAFFIC IN SYSTEM)	DEPLOYED							
	ACTIVE VEHICLE BARRIER (WITH NO TRAFFIC IN SYSTEM)	DEPLOYED							

NOTES CONT'D

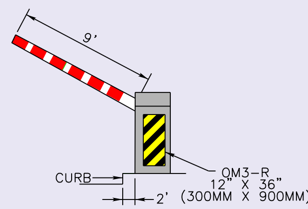
15. ALL SIGNALS SHALL BE LED AND HAVE FULL CIRCLE TUNNEL VISORS WITH BACKPLATES WITH RETROREFLECTIVE STRIP. 12-INCH INDICATIONS SHALL BE USED.
16. PLAN DETAILS ARE TYPICAL AND MAY BE ADJUSTED TO MEET SITE CONDITIONS. ANY ALTERATION IN TRAFFIC CONTROL (TRAFFIC ARM, SIGNALS, BEACONS, SIGNING, MARKINGS AND DETECTION LOOP) REQUIRE APPROVAL THROUGH SDDCTEA.
17. DESIGN IS BASED ON A 25 MPH DESIGN SPEED. SDDCTEA APPROVAL REQUIRED FOR POSTED SPEEDS HIGHER THAN 25 MPH.
18. UNDER EFO CONDITION, AVBS SHALL BE DESIGNED TO OPERATE INDEPENDENTLY IN CONJUNCTION WITH SAFETY LOOP DETECTION.
19. FOR MULTI-LANE ROADWAYS, UTILIZE A SOLID WHITE LINE BETWEEN LANES TO DISCOURAGE LANE CHANGING.
20. EXISTING SIGNS AND MARKINGS CONFORMING TO EARLIER VERSIONS OF SDDCTEA SAFETY SCHEMES ARE CONSIDERED TO BE GRANDFATHERED IN AND MAY REMAIN IN-PLACE UNTIL THE END OF THEIR USEFUL SERVICE LIFE. REPLACE WITH CURRENT STANDARD AT THAT TIME.



DETAIL A



SECTION A1-A1
NOT TO SCALE



DETAIL B

Force Protection Issues

8.4.3.7. Intersection Traffic Signal Safety Scheme

This scheme collocates the AVBs at the intersection and utilizes typical traffic control signals. This safety scheme requires the AVB signals to be coordinated with the intersection signals. The operation of this scheme requires a 9-second inbound and an estimated 12-second outbound threat response time (minimums). **Refer to the 9-second and 12-second timelines given on the Intersection Traffic Signal Safety Scheme drawings for time allowances for individual safety scheme components.** Note that the outbound AVB requires a longer threat response time than the inbound AVB. This increased threat response time can often be mitigated with wrong way detection and added roadway curvature for the outbound lanes.

Additional key characteristics include:
- Additional traffic control signals are required at the inbound AVB
- Actual outbound AVB threat response time is dependent on the width of the intersection that an exiting vehicle must cross
- 'NO TURN ON RED' LED Blank-out regulatory signs

Advantages of this scheme include:
- AVB signal and intersection traffic control signals are collocated and operate together
- Can process a high volume of traffic

Disadvantages of this scheme include:
- Longer threat response times as compared to the other safety schemes

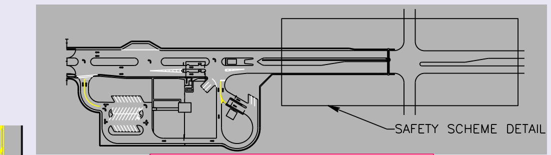
This scheme should only be used at signalized intersections. However, the mere presence of a signalized intersection does not require the use of this safety scheme if another intersection traffic control is more appropriate. An intersection capacity analysis should be performed to ensure that all legs of the intersection operate at an acceptable level of service under traffic signal control and that the operations of the intersection require signalization to process the traffic volume and that the *MUTCD* signal warrants are met. The traffic volumes (capacity) achieved by this scheme will be governed by the operations at the traffic signal.

This safety scheme is illustrated in **Exhibit 8.22**.

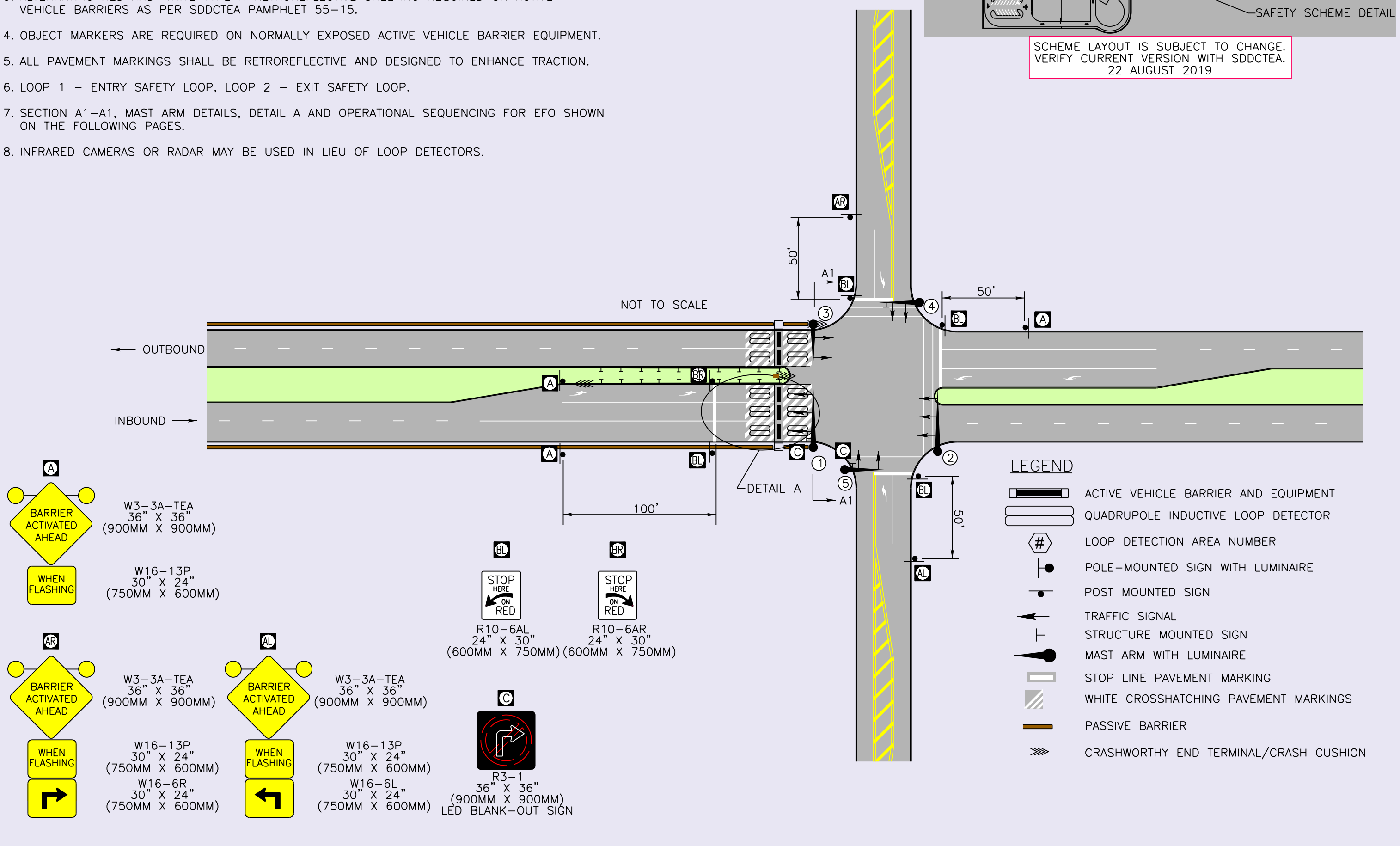
Exhibit 8.22: Intersection Traffic Signal Safety Scheme – Page 1

NOTES

1. WHEN EFO IS ACTIVATED, A 100db AUDIBLE ALARM LOCATED AT THE AVB SHALL SOUND FOR AT LEAST 10 SECONDS, AND BE DIRECTED TOWARDS ONCOMING TRAFFIC FOR BOTH DIRECTIONS.
2. SIGNS, SIGNALS, AND PAVEMENT MARKINGS SHALL CONFORM TO MUTCD, DOD SUPPLEMENT TO THE MUTCD, SDDCTEA PAMPHLET 55–15 AND LOCAL REGULATIONS.
3. ALTERNATING RED AND WHITE TYPE X RETROREFLECTIVE SHEETING REQUIRED ON ACTIVE VEHICLE BARRIERS AS PER SDDCTEA PAMPHLET 55–15.
4. OBJECT MARKERS ARE REQUIRED ON NORMALLY EXPOSED ACTIVE VEHICLE BARRIER EQUIPMENT.
5. ALL PAVEMENT MARKINGS SHALL BE RETROREFLECTIVE AND DESIGNED TO ENHANCE TRACTION.
6. LOOP 1 – ENTRY SAFETY LOOP, LOOP 2 – EXIT SAFETY LOOP.
7. SECTION A1–A1, MAST ARM DETAILS, DETAIL A AND OPERATIONAL SEQUENCING FOR EFO SHOWN ON THE FOLLOWING PAGES.
8. INFRARED CAMERAS OR RADAR MAY BE USED IN LIEU OF LOOP DETECTORS.



SCHEME LAYOUT IS SUBJECT TO CHANGE.
VERIFY CURRENT VERSION WITH SDDCTEA.
22 AUGUST 2019

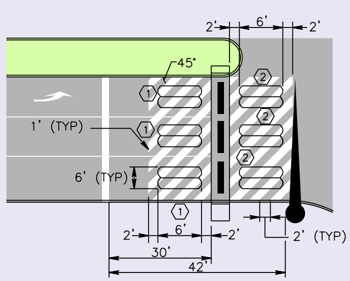


Force Protection Issues

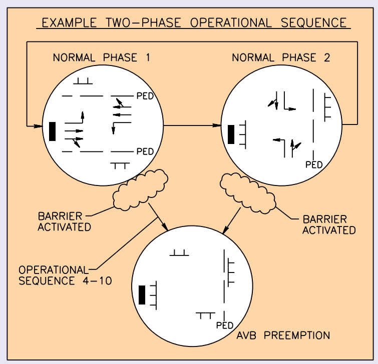
Exhibit 8.22: Intersection Traffic Signal Safety Scheme – Page 2

INTERSECTION TRAFFIC SIGNAL SAFETY SCHEME INBOUND		OPERATIONAL SEQUENCING FOR EMERGENCY FAST OPERATION										
	TRAFFIC CONTROL	NORMAL OPS	GUARD REACTION			YELLOW CHANGE (MUTCD MINIMUM)			RED SAFETY	DEPLOYING BARRIER		BARRIER DEPLOYED
	TIMELINE (SEC)	–	1	2	3	4	5	6	7	8	9	10
	W3–3A–TEA WARNING SIGN WITH BEACONS	DARK				ALTERNATING FLASHING YELLOW						
	TRAFFIC SIGNAL	GREEN				YELLOW			RED			
	100dB HORN	SILENT				ACTIVATED						
	ACTIVE VEHICLE BARRIER	NON–DEPLOYED								DEPLOYING		DEPLOYED
	NO RIGHT TURN LED BLANKOUT (POLE 1)	DARK							R3–1 ILLUMINATED			

INTERSECTION TRAFFIC SIGNAL SAFETY SCHEME OUTBOUND		OPERATIONAL SEQUENCING FOR EMERGENCY FAST OPERATION										
	TRAFFIC CONTROL	NORMAL OPS	GUARD PERCEPTION AND REACTION TIME TO THREAT (EFO BUTTON)			YELLOW CHANGE (MUTCD MINIMUM)			RED SAFETY			DEPLOYING BARRIER	BARRIER DEPLOYED
	TIMELINE (SEC)	–	1	2	3	4	5	6	7	8	9	10–11	12
	W3–3A–TEA WARNING SIGN WITH BEACONS	DARK				ALTERNATING FLASHING YELLOW							
	TRAFFIC SIGNAL	GREEN				YELLOW			RED			RED	
	ACTIVE VEHICLE BARRIER	NON–DEPLOYED										DEPLOYING	DEPLOYED
	NO RIGHT TURN LED BLANKOUT (POLE 5)	DARK							R3–1 ILLUMINATED				
	NO LEFT TURN LED BLANKOUT (POLE 4)	DARK							R3–2 ILLUMINATED				



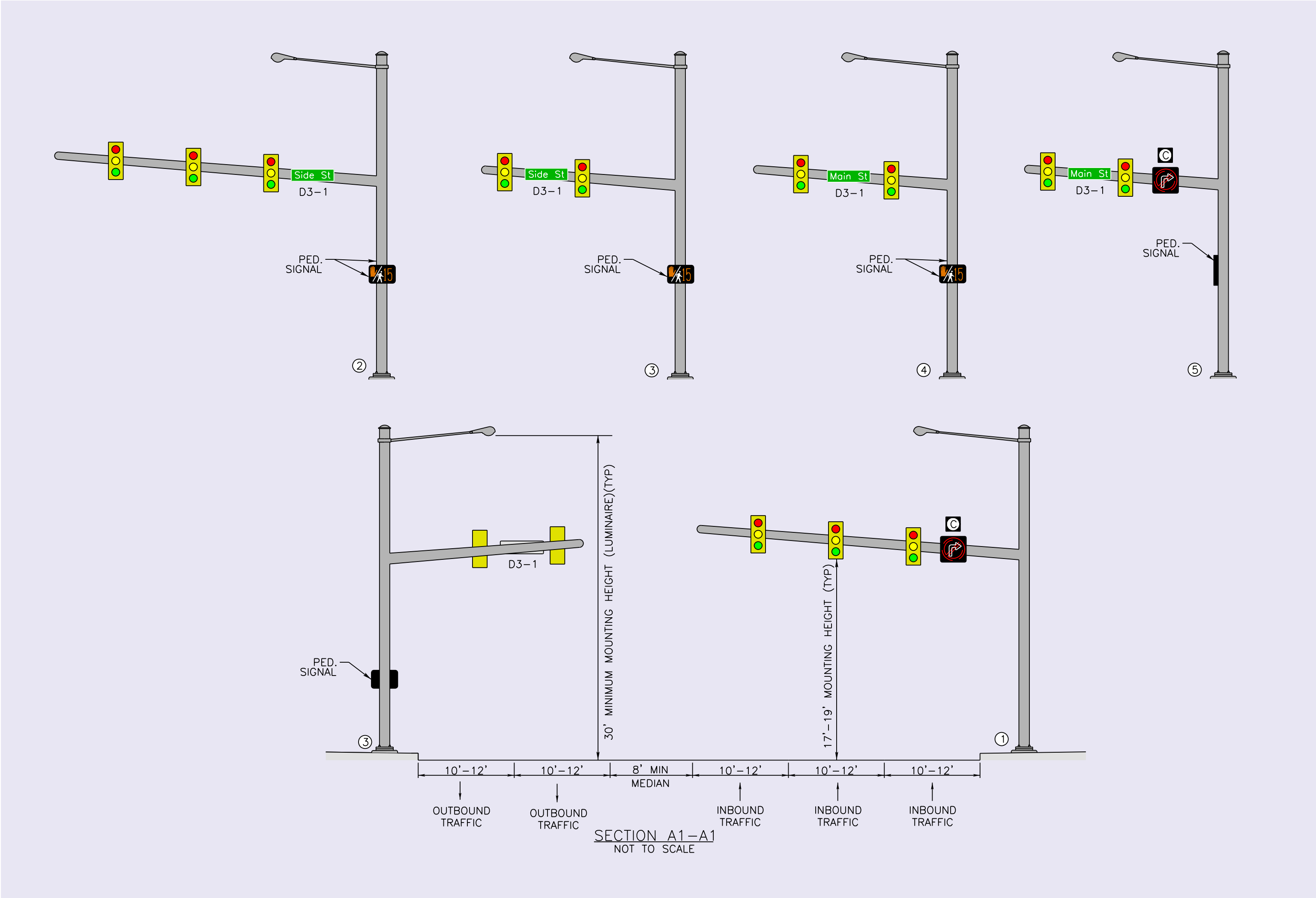
DETAIL A



NOTES CONT'D

9. LED BLANK–OUT SIGN SHALL NOT AUTOMATICALLY DIM.
10. DESIGN, CONSTRUCTION AND MATERIALS FOR TRAFFIC CONTROL AND RELATED EQUIPMENT SHALL CONFORM TO THE STATE DOT OR LOCAL STANDARDS.
11. AVB EQUIPMENT WIDTHS SHOWN ON SECTION A1–A1 VARY BY AVB TYPE, MODEL, AND MANUFACTURER.
12. ALL SIGNALS SHALL BE LED AND HAVE FULL CIRCLE TUNNEL VISORS WITH BACKPLATES WITH RETROREFLECTIVE STRIP. 12–INCH INDICATIONS SHALL BE USED.
13. PLAN DETAILS ARE TYPICAL AND MAY BE ADJUSTED TO MEET SITE CONDITIONS. ANY ALTERATION IN TRAFFIC CONTROL (SIGNALS, BEACONS, SIGNING, MARKINGS AND DETECTION LOOPS) REQUIRE APPROVAL THROUGH SDDCTEA.
14. DESIGN IS BASED ON A 25 MPH DESIGN SPEED. SDDCTEA APPROVAL REQUIRED FOR POSTED SPEEDS HIGHER THAN 25 MPH.
15. UNDER EFO CONDITION, AVBS SHALL BE DESIGNED TO OPERATE INDEPENDENTLY IN CONJUNCTION WITH SAFETY LOOP DETECTION.
16. FOR MULTI–LANE ROADWAYS, UTILIZE A SOLID WHITE LINE BETWEEN LANES TO DISCOURAGE LANE CHANGING.
17. FINAL DESIGN AND OPERATIONAL ANALYSIS SHALL BE PERFORMED BY A TRAFFIC ENGINEER. PLANS SHALL BE REVIEWED BY SDDCTEA.
18. FINAL YELLOW AND RED CLEARANCE INTERVALS FOR NORMAL OPERATIONS SHALL BE CALCULATED IN ACCORDANCE WITH THE MUTCD.
19. INTERSECTION SIGNALIZATION GOES TO ALL–RED IN COORDINATION WITH THE AVB SIGNAL.
20. SIGNS AND SIGNAL INDICATIONS MAY VARY BASED ON THE SPECIFIC PHASING OPERATION.
21. SIGNAL TO RUN NORMAL PHASING PLAN WHEN EFO IS NOT ACTIVATED.
22. UPON EFO ACTIVATION, ALL INTERSECTION TRAFFIC SIGNALS WILL IMMEDIATELY CEASE THE GREEN INTERVAL AND TRANSITION TO INBOUND OPERATIONAL SEQUENCE 4 IF THE SIGNAL IS FLASHING, TRANSITION TO INBOUND OPERATIONAL SEQUENCE 4.
23. ALL "WALK" INDICATIONS WILL IMMEDIATELY TRANSITION TO "FLASHING DON'T WALK" (FDW) INTERVAL. NORMAL FDW SHALL BE PROVIDED AND MAY BE COMPLETED BEYOND INBOUND OPERATIONAL SEQUENCE 10.
24. ALL DEVICES TO REMAIN IN INBOUND OPERATIONAL SEQUENCE 10 AND OUTBOUND OPERATIONAL SEQUENCE 12 UNTIL THE SYSTEM IS RESET. NORMAL OPERATIONS TO RESET IN MAINLINE GREEN ONCE ALL AVBS HAVE BEEN FULLY RETRACTED.
25. EXISTING SIGNS AND MARKINGS CONFORMING TO EARLIER VERSIONS OF SDDCTEA SAFETY SCHEMES ARE CONSIDERED GRANDFATHERED IN AND MAY REMAIN IN–PLACE UNTIL THE END OF THEIR USEFUL SERVICE LIFE. REPLACE WITH CURRENT STANDARD AT THAT TIME.
27. ALL PASSIVE BARRIERS PLACED AT INTERSECTION MUST NOT OBSTRUCT INTERSECTION SIGHT DISTANCE.
28. ALL TRAFFIC CONTROL DEVICES AND POLES INSTALLED NEXT TO THE ROADWAY AND INSIDE OF THE PASSIVE BARRIER SHALL UTILIZE BREAK–AWAY SUPPORTS.

Exhibit 8.22: Intersection Traffic Signal Safety Scheme – Page 3



8.4.3.8. Combination Intersection Traffic Signal/Hybrid Beacon Safety Scheme

This scheme is a combination of the Traffic Signal Safety Scheme for the inbound lane and the Hybrid Beacon Safety Scheme for the outbound lane, and is to be used only at signalized intersections. Each scheme acts independently, so the minimum threat response time for the inbound lane is 9-seconds (Intersection Traffic Signal Safety Scheme) and 7-seconds for the outbound lane (Hybrid Beacon Safety Scheme). **Refer to the 9-second and 7-second timelines given on the Combination Intersection Traffic Signal/Hybrid Beacon Safety Scheme drawings for time allowances for individual safety scheme components.**

This scheme should only be used at signalized intersections. However, the mere presence of a signalized intersection does not require the use of this safety scheme if another intersection traffic control is more appropriate. An intersection capacity analysis should be performed to ensure that all legs of the intersection operate at an acceptable level of service under traffic signal control and that the operations of the intersection require signalization to process the traffic volume and that *MUTCD* signal warrants are met. The traffic volumes (capacity) achieved by this scheme will be governed by the operations at the traffic signal.

Additional key characteristics include:

- Design based on a roadway grade of 3% or less and a design speed of 25 mph
- Outbound AVB must be located a minimum of 155 feet from intersection radius point
- Passive barrier must be installed in the median connecting the inbound and outbound AVBs
- Additional traffic control signals are required at the inbound AVB
- 'NO TURN ON RED' LED Blank-out regulatory signs
- Lengthened advance vehicle detection loops (6-ft x 76-ft quadrupoles)

Advantages of this scheme include:

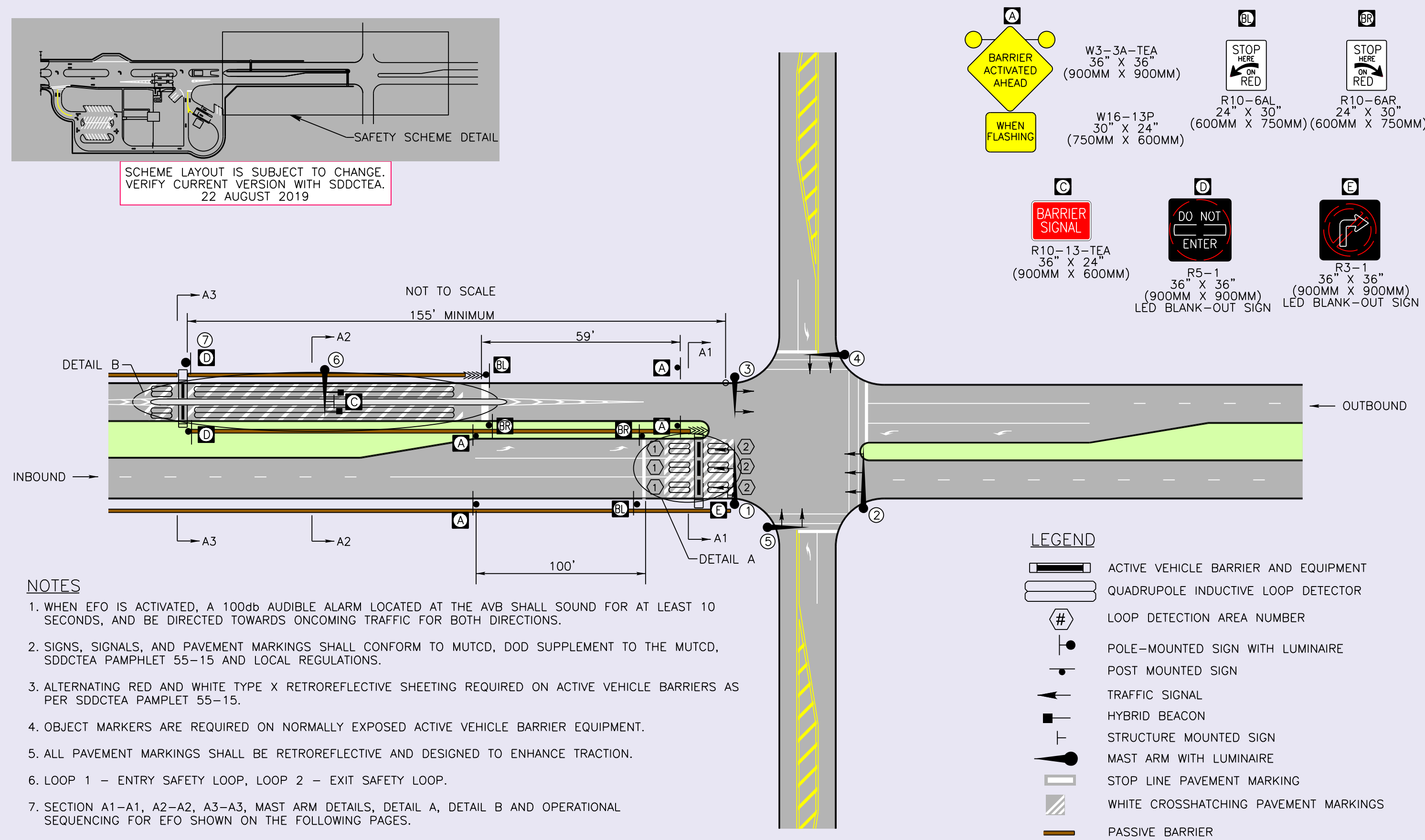
- Shortened threat response time (7-seconds) in the outbound lane as compared to the Intersection Traffic Signal Safety Scheme (estimated 12-seconds).
- Can process a high volume of traffic

Disadvantages of this scheme include:

- Additional traffic control (i.e., hybrid beacons) is required for outbound traffic as opposed to the Intersection traffic Signal Safety Scheme where the outbound AVB is located at the signalized intersection and controlled by the intersection
- Longer vehicle detection loops as compared to the other safety schemes (hybrid)
- The longer loops may introduce additional security risks which may be considered when determining AVB placement (hybrid)
- Longer inbound threat response time as compared to the other safety schemes (signal)

This safety scheme is illustrated in **Exhibit 8.23**.

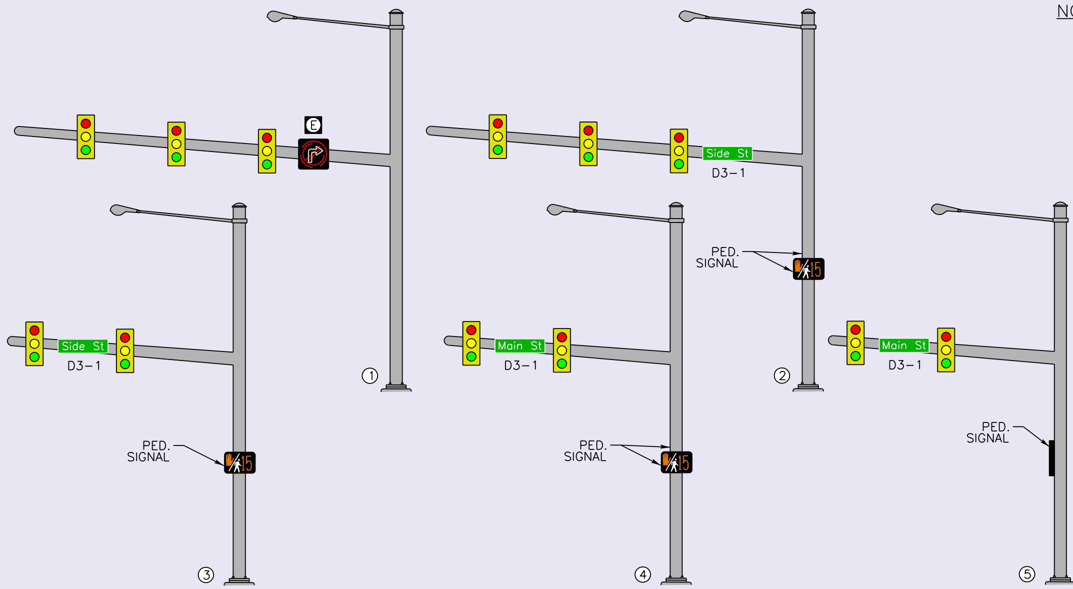
Exhibit 8.23: Combination Intersection Traffic Signal/Hybrid Beacon Safety Scheme – Page 1



NOTES

1. WHEN EFO IS ACTIVATED, A 100db AUDIBLE ALARM LOCATED AT THE AVB SHALL SOUND FOR AT LEAST 10 SECONDS, AND BE DIRECTED TOWARDS ONCOMING TRAFFIC FOR BOTH DIRECTIONS.
2. SIGNS, SIGNALS, AND PAVEMENT MARKINGS SHALL CONFORM TO MUTCD, DOD SUPPLEMENT TO THE MUTCD, SDDCTEA PAMPHLET 55-15 AND LOCAL REGULATIONS.
3. ALTERNATING RED AND WHITE TYPE X RETROREFLECTIVE SHEETING REQUIRED ON ACTIVE VEHICLE BARRIERS AS PER SDDCTEA PAMPLET 55-15.
4. OBJECT MARKERS ARE REQUIRED ON NORMALLY EXPOSED ACTIVE VEHICLE BARRIER EQUIPMENT.
5. ALL PAVEMENT MARKINGS SHALL BE RETROREFLECTIVE AND DESIGNED TO ENHANCE TRACTION.
6. LOOP 1 – ENTRY SAFETY LOOP, LOOP 2 – EXIT SAFETY LOOP.
7. SECTION A1-A1, A2-A2, A3-A3, MAST ARM DETAILS, DETAIL A, DETAIL B AND OPERATIONAL SEQUENCING FOR EFO SHOWN ON THE FOLLOWING PAGES.
8. INFRARED CAMERAS OR RADAR MAY BE USED IN LIEU OF LOOP DETECTORS.
9. MEDIAN LENGTH SHALL EXTEND AT LEAST 25 FEET PRIOR TO THE STOP LINE ON EACH APPROACH.
10. ALL TRAFFIC CONTROL DEVICES AND POLES INSTALLED NEXT TO THE ROADWAY AND INSIDE OF THE PASSIVE BARRIER SHALL UTILIZE BREAK-AWAY SUPPORTS.

Exhibit 8.23: Combination Intersection Traffic Signal/Hybrid Beacon Safety Scheme – Page 2



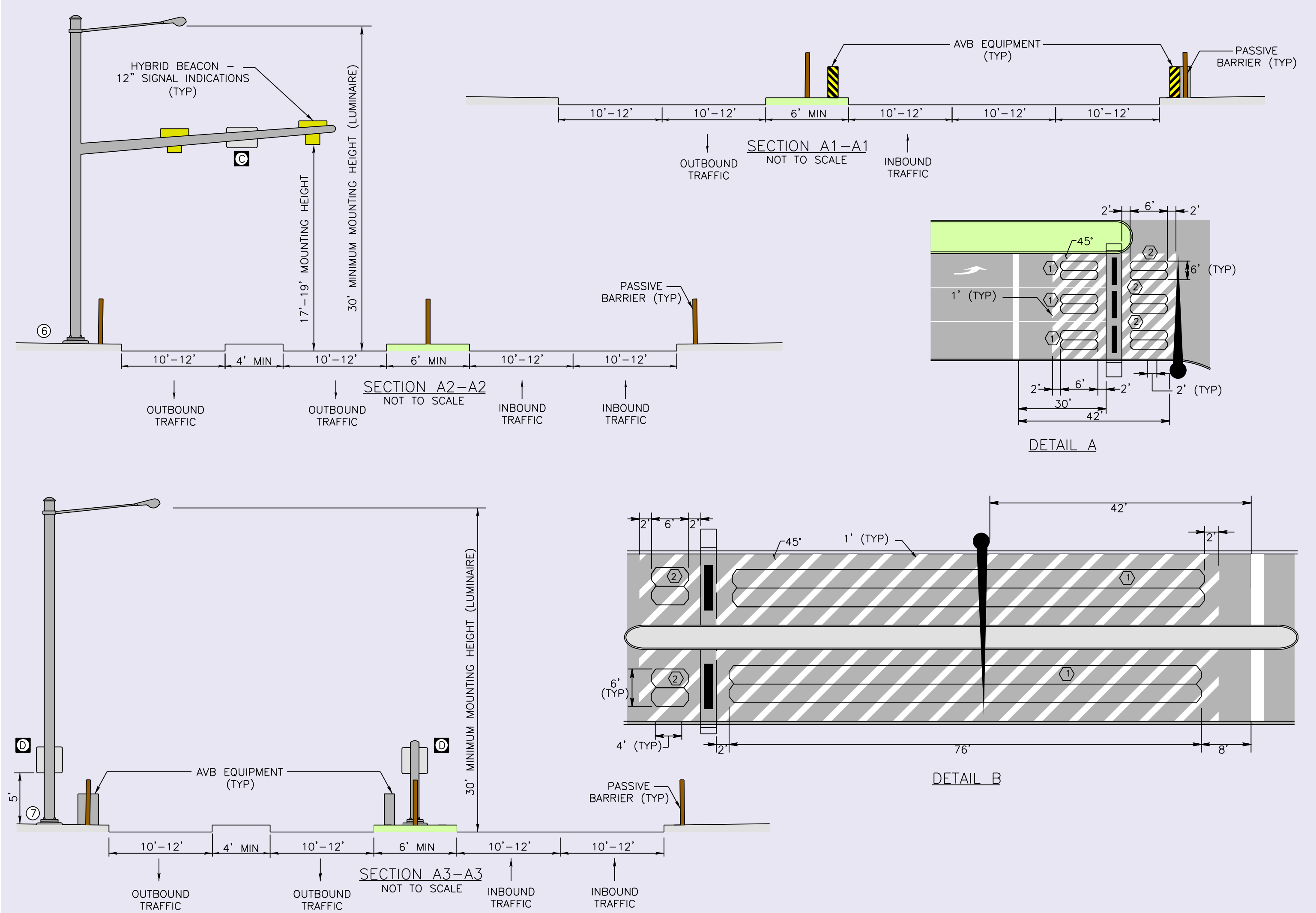
TWO-LANE HYBRID BEACON SAFETY SCHEME OUTBOUND		OPERATIONAL SEQUENCING FOR EMERGENCY FAST OPERATION							
	TRAFFIC CONTROL	GUARD REACTION			SAFETY INTERVAL		DEPLOYING BARRIER		BARRIER DEPLOYED
	TIMELINE (SEC)	1	2	3	4	5	6	7	8
	W3-3A-TEA WARNING SIGN WITH BEACONS	DARK			ALTERNATING FLASHING YELLOW				
	DO NOT ENTER LED BLANK-OUT SIGN	DARK			"DO NOT ENTER" ILLUMINATED				
	HYBRID BEACON	DARK			SOLID YELLOW		ALTERNATING FLASHING RED		
	100dB HORN	SILENT			ACTIVATED				
	ACTIVE VEHICLE BARRIER	NON-DEPLOYED					DEPLOYING		DEPLOYED

INTERSECTION TRAFFIC SIGNAL SAFETY SCHEME INBOUND		OPERATIONAL SEQUENCING FOR EMERGENCY FAST OPERATION										
	TRAFFIC CONTROL	NORMAL OPS	GUARD REACTION			YELLOW CHANGE (MUTCD MINIMUM)			RED SAFETY	DEPLOYING BARRIER		BARRIER DEPLOYED
	TIMELINE (SEC)	–	1	2	3	4	5	6	7	8	9	10
	W3-3A-TEA WARNING SIGN WITH BEACONS	DARK				ALTERNATING FLASHING YELLOW						
	TRAFFIC SIGNAL	GREEN				YELLOW			RED			
	100dB HORN	SILENT				ACTIVATED						
	ACTIVE VEHICLE BARRIER	NON-DEPLOYED								DEPLOYING		DEPLOYED
	NO RIGHT TURN LED BLANKOUT (POLE 1)	DARK							R10-11 ILLUMINATED			

NOTES CONT'D

11. LED BLANK-OUT SIGN, IF USED, SHALL NOT AUTOMATICALLY DIM.
12. DESIGN, CONSTRUCTION AND MATERIALS FOR TRAFFIC CONTROL AND RELATED EQUIPMENT SHALL CONFORM TO THE STATE DOT OR LOCAL STANDARDS.
13. AVB EQUIPMENT WIDTHS SHOWN ON SECTION A1-A1 AND A3-A3 VARY BY AVB TYPE, MODEL, AND MANUFACTURER.
14. ALL SIGNALS SHALL BE LED AND HAVE FULL CIRCLE TUNNEL VISORS WITH BACKPLATES WITH RETROREFLECTIVE STRIP. 12-INCH INDICATIONS SHALL BE USED.
15. PLAN DETAILS ARE TYPICAL AND MAY BE ADJUSTED TO MEET SITE CONDITIONS. ANY ALTERATION IN TRAFFIC CONTROL (SIGNALS, BEACONS, SIGNING, MARKINGS AND DETECTION LOOPS) REQUIRE APPROVAL THROUGH SDDCTEA.
16. DESIGN IS BASED ON A 25 MPH DESIGN SPEED. SDDCTEA APPROVAL REQUIRE FOR POSTED SPEEDS HIGHER THAN 25 MPH.
17. UNDER EFO CONDITION, AVBS SHALL BE DESIGNED TO OPERATE INDEPENDENTLY IN CONJUNCTION WITH SAFETY LOOP DETECTION.
18. FOR MULTI-LANE ROADWAYS, UTILIZE A SOLID WHITE LINE BETWEEN LANES TO DISCOURAGE LANE CHANGING.
19. FINAL DESIGN AND OPERATIONAL ANALYSIS SHALL BE PERFORMED BY A TRAFFIC ENGINEER. PLANS SHALL BE REVIEWED BY SDDCTEA.
20. FINAL YELLOW AND RED CLEARANCE INTERVALS FOR NORMAL INTERSECTION OPERATIONS SHALL BE CALCULATED IN ACCORDANCE WITH THE MUTCD.
21. INTERSECTION SIGNALIZATION GOES TO ALL-RED IN COORDINATION WITH THE AVB SIGNAL.
22. SIGNS AND SIGNAL INDICATIONS MAY VARY BASED ON THE SPECIFIC PHASING OPERATION.
23. SIGNAL TO RUN NORMAL PHASING PLAN WHEN EFO IS NOT ACTIVATED.
24. UPON EFO ACTIVATION, ALL INTERSECTION TRAFFIC SIGNALS WILL IMMEDIATELY CEASE THE GREEN INTERVAL AND TRANSITION TO INBOUND OPERATIONAL SEQUENCE 4. IF THE SIGNAL IS FLASHING TRANSITION TO INBOUND OPERATIONAL SEQUENCE 4.
26. ALL "WALK" INDICATIONS WILL IMMEDIATELY TRANSITION TO "FLASHING DON'T WALK" (FDW) INTERVAL. NORMAL FDW SHALL BE PROVIDED AND MAY BE COMPLETED BEYOND INBOUND OPERATIONAL SEQUENCE 10.
27. ALL DEVICES TO REMAIN IN INBOUND OPERATIONAL SEQUENCE 10 AND OUTBOUND OPERATIONAL SEQUENCE 8 UNTIL THE SYSTEM IS RESET. NORMAL OPERATIONS TO RESET IN MAINLINE GREEN ONCE ALL AVBS HAVE BEEN FULLY RETRACTED.
28. ALL PASSIVE BARRIERS PLACED AT INTERSECTION MUST NOT OBSTRUCT INTERSECTION SIGHT DISTANCE.

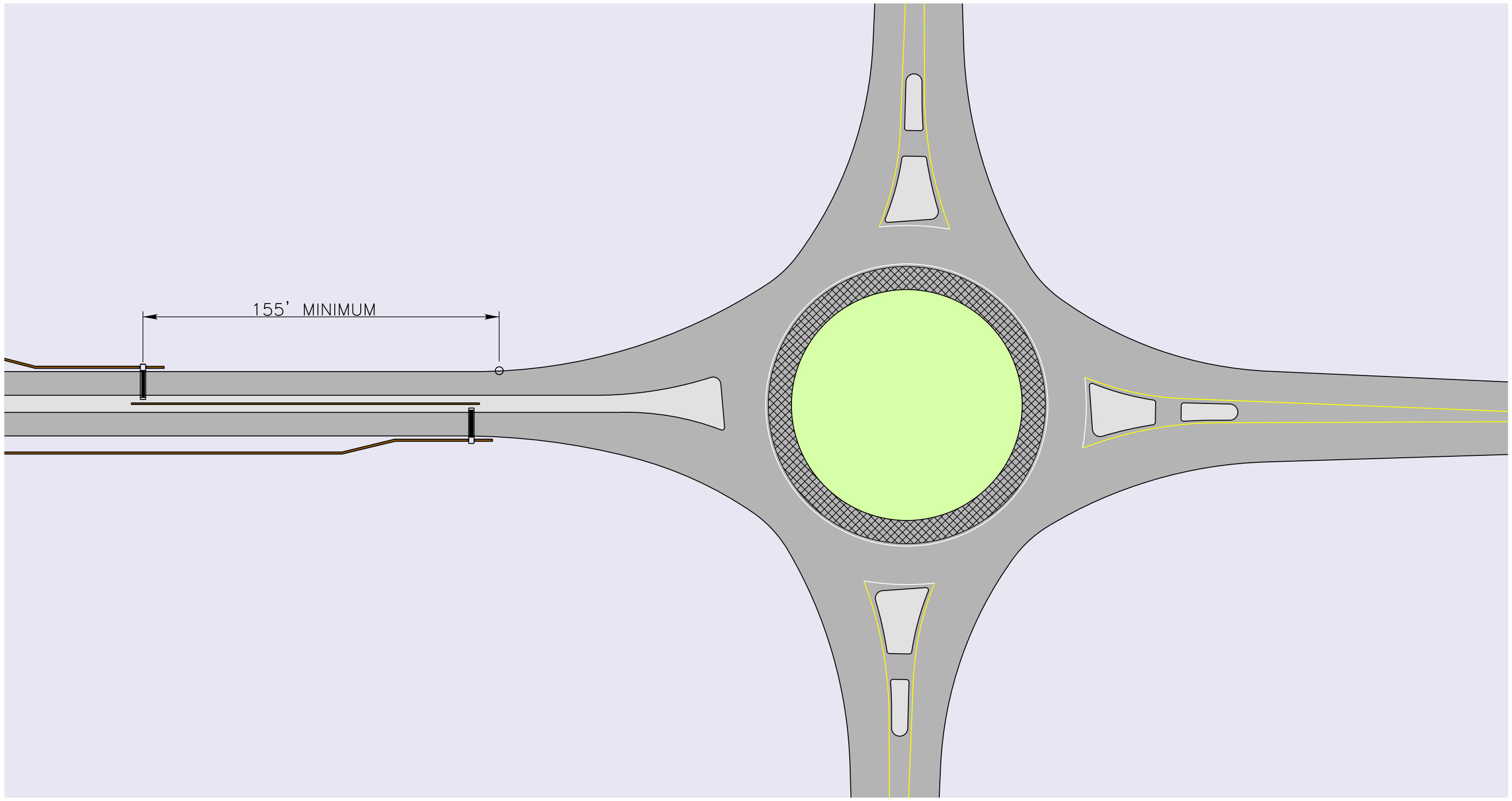
Exhibit 8.23: Combination Intersection Traffic Signal/Hybrid Beacon Safety Scheme – Page 3



8.4.4. AVBs at Roundabouts

Roundabouts have many documented benefits for use, including sustainability and increased traffic operations. **Exhibit 8.24** shows a typical detail for placing AVBs near a roundabout. The placement of the outbound AVBs is the key consideration in this scenario. Provide a minimum of 155 feet from the roundabout to the barrier on the outbound side, which is the required stopping sight distance for a speed of 25 mph. Specifically, the 155 feet is measured from the point at which the horizontal deflection from the roundabout stops and the roadway tangent section begins. The barrier on the inbound side should be located at the point at which the roadway tangent section stops and the horizontal deflection from the roundabout begins. Any closer and the barrier traffic control will conflict with the yield traffic control from the roundabout.

Exhibit 8.24: AVB Placement at Roundabouts

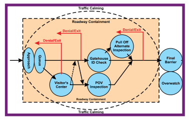
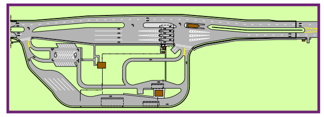
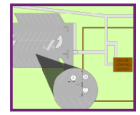


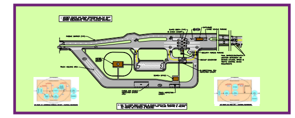
8.5. OTHER AVB SOLUTIONS

Ultimately, innovation is needed in addressing safety and security. In some cases, “out-of-the-box” ideas are needed. In other cases, more costly solutions must be considered. Other potential solutions to address safety and security may include the following.

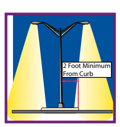
- ✓ **Deploying multiple barrier systems** – consider deploying multiple sets of AVBs on each leg of the intersection that meets the required response time if the response zone is constrained by a downstream intersection. AVBs on each leg of the intersection must meet the minimum required response time.
- ✓ **Relocating or closing downstream intersections** – consider closing or relocating intersections that constrain the response zone if alternate access can be provided.
- ✓ **Relocating ECFs** – In some cases, it may be practical to relocate or realign an ECF in such a way that the response zone can be accommodated.
- ✓ **Gauging the intent of ECF violators** – utilize passive systems such as speed humps/tables and overspeed detection to gauge the intent of violators before deploying more active systems. Overspeed detection can be used, but consider the potential for false positive calls, due to otherwise innocent drivers driving above the set overspeed limit. Consult SDDCTEA when implementing overspeed detection.

SDDCTEA is continuing to work with ECF stakeholders in developing alternatives; however, any solution must be consistent with FHWA’s *MUTCD*.

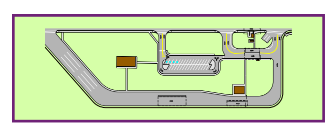






SECTION 9 - AUTOMATION AND SMART DECISIONS








9. Automation and SMART Decisions

AUTOMATED ECF CONFIGURATIONS VARY. GENERALLY A DEVICE RECOGNIZES THE VEHICLE, AND / OR THE DRIVER IS IDENTIFIED USING DEVICE READERS. THEN, THE DRIVER'S INFORMATION IS DISPLAYED ON A READER, AND THE PERSON IS EITHER ACCEPTED OR REJECTED.

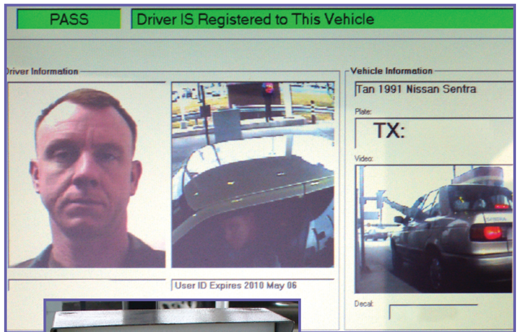
THINGS TO CONSIDER:

- ❑ **WHAT IS THE PREFERRED PROCESSING TECHNIQUE?**
- ❑ **WHAT IS THE POTENTIAL SECURITY BENEFIT?**
- ❑ **WHAT ARE THE TECHNOLOGY COSTS?**
- ❑ **WHAT ARE THE INFRASTRUCTURE COSTS?**
- ❑ **WHAT ARE THE MANPOWER IMPACTS/COSTS?**
- ❑ **WHAT ARE THE TRAFFIC IMPACTS/ COSTS?**

In practice, ECF designers are charged with maximizing security and limiting impacts to traffic while minimizing resource needs such as manpower and infrastructure expansion costs. Automation is viewed as a tool that may offer manpower benefits and enhance security, but it must be implemented in the context of other considerations.

Automation consists of a variety of card and vehicle readers along with other supporting technologies. The configurations of device readers can include radio frequency (RF) tags that identify a vehicle. Device readers may also include card scanners that retrieve person-specific information about the ID holder. Information can be displayed on a monitor in the gatehouse. Information can also be relayed to various types of handheld devices depending on the type of system.

9.1. TYPES OF AUTOMATION



There are two general configurations of automation being used.

Automated installation entry (AIE) - the use of technology to provide permanent automated credentialing (ID checks) through an ECF. Others refer to it as Phantom Express which was an early deployment at Fort Hood, or SmartGate© which is an Air Force version deployed as a test at Hancom AFB.

Handheld technologies - the use of handheld technology to provide credentialing (ID checks) through an ECF. Commonly referred to as Defense Biometric Identification System (DBIDS) or IACS (USAREUR Installation Access Control System). There are several vendor products available as well.

Ideally, both AIE and handheld technologies may be integrated to a permanent solution as well as a portable solution that operate in the same computer environment.

9.2. AIE SYSTEM ELEMENTS

At the most basic level, AIE systems are designed to verify vehicles and drivers versus an existing database.

To overcome the requirement to identify all occupants under higher FPCONs, early deployments have included registration requirements in a "trusted traveler" program. Under these types of programs, the driver is prescreened and assumes responsibility for future occupants. These types of programs will likely require command approval. The usage of the system may vary based on FPCON.

Another factor that influences AIE is the use of traffic arms for each transaction. While the use of traffic arms is preferred as a way to "control" each transaction, their use adds approximately two seconds to each transaction. "Open-arm" operations may reduce the ability to control traffic, possibly reducing security benefits, but would promote more efficient processing during peak periods. Open arm operations may also reduce the number of lanes and manpower required.

Early deployment studies conducted by SDDCTEA have shown that AIE can process at comparable or more efficient rates if traffic arms are not used. If traffic arms are used, AIE rates may be slightly lower than manual rates. See **Exhibit 9.1**.

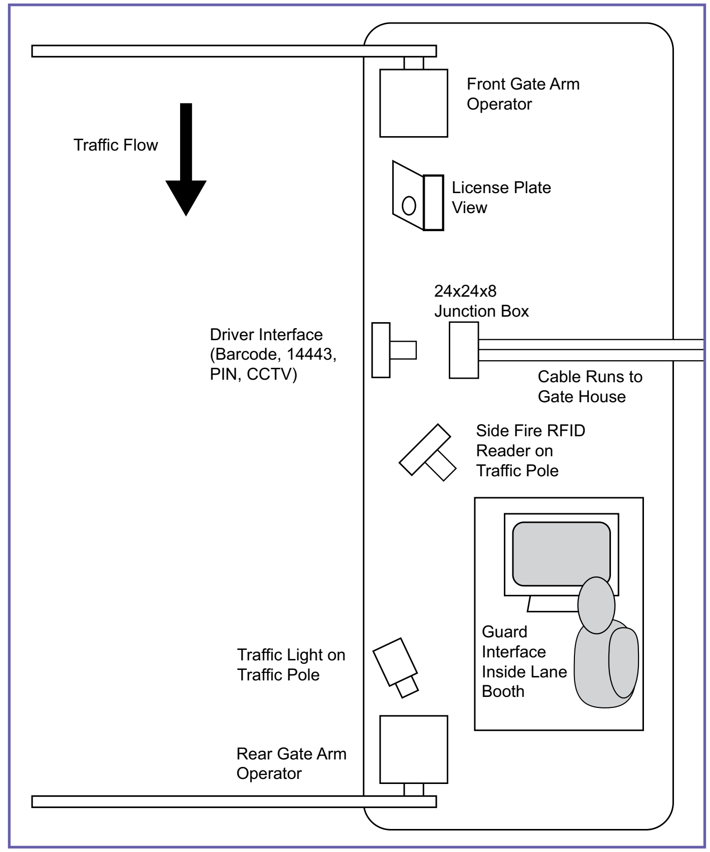
Exhibit 9.1: Automated Lane Processing Rates

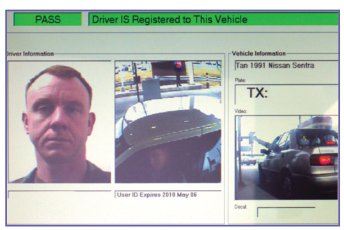
Processing Technique	**Automated Lanes (AIE, SmartGate, etc)**	
	Without Traffic Arms	With Traffic Arms (up/down for each vehicle)
	vphpl	vphpl
✓ Vehicle decal identification only • RFID vehicle scan only	800 to 1200	550 to 800
✓ Vehicle and occupant identifications • RFID vehicle scan and driver card scan	400 to 450	325 to 350

AIE typically consists of the following elements:

- ✓ Advance signing
- ✓ Lane use signing as needed
- ✓ Front traffic arm for lane closure and rear traffic arm for admitting access to the installation
- ✓ Traffic signal near rear traffic arm
- ✓ RFID antenna to read RFID tag on registered vehicles
- ✓ Proximity and/or swipe card reader
- ✓ CCTV cameras for facial recognition and license plate reading with overview cameras viewing incoming traffic, exiting traffic, and vehicles in the ECF lanes
- ✓ Proximity sensor or inductive loops at the card reader and rear traffic arm
- ✓ Electrical distribution enclosure at card reader
- ✓ LCD screen in the guard booth to display status and images of license plate and of the driver
- ✓ Gatehouse monitoring system/central server

Early deployments have cost approximately $150 to $200K per lane.





In summary:

- ✓ AIE processing appears to improve security through verification of drivers.
- ✓ AIE processing rates (with traffic arms) are slightly lower than manual (single) processing rates.
- ✓ AIE processing rates (without traffic arms) are comparable or more efficient than manual (single) processing rates.
- ✓ AIE programs that allow "open-arm" operations may (but not always) realize greater manpower benefits and may also (but not always) require fewer processing lanes.
- ✓ AIE processing does not appear to reduce per lane manpower requirements.
- ✓ Proper island and system design is critical in providing a reliable AIE system.
- ✓ Other factors (driver understanding, traffic arms, rejections, inspections) have an impact on processing.

9.3. HANDHELD SYSTEM ELEMENTS

Handheld systems offer more transportability than AIE systems; however, early deployment studies conducted by SDDCTEA have found that processing rates are slightly lower than manual processing. This may impact the amount of manpower and/or the number of lanes required.

Handheld systems can be configured to include a vehicle bar code scan as well as a card scan. Handheld systems can also be configured to conduct card scans only. Many of the systems are expandable to include biometrics for additional verification. See **Exhibit 9.2**.

Exhibit 9.2: Handheld Process Rates

Processing Technique	**Handheld Devices Checks (DBIDS, IACS, etc)**	
	Single Checker per lane	Tandem Checkers per lane
	vphpl	vphpl
Vehicle decal identification only	NA	NA
Vehicle and occupant identifications	275 to 375	350 to 475

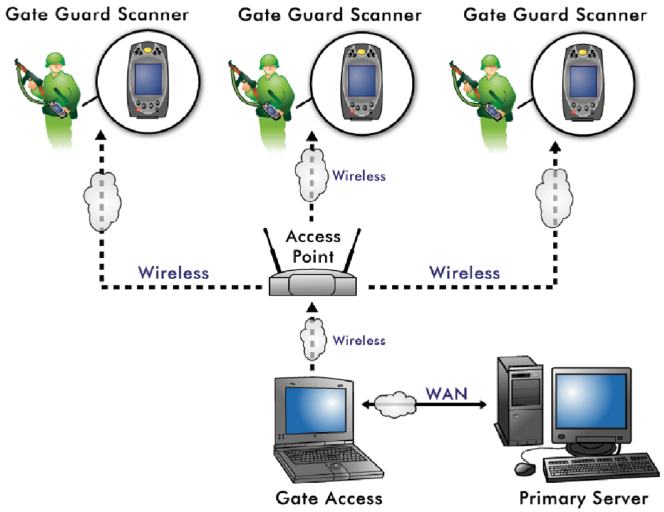
Handheld systems include the following elements:

- ✓ Front traffic arm for lane closure and rear traffic arm for admitting access to the installation, if desired
- ✓ Cameras viewing incoming traffic, leaving traffic, and vehicles in the ECF lanes, if desired
- ✓ Ruggedized card scanner (PDA)
- ✓ Wireless router
- ✓ Gatehouse monitoring system/central server

Unlike AIE, most handheld systems are wireless and are more susceptible to the elements. SDDCTEA's evaluation noted the following issues that often impacted processing:

- ✓ Guards had to "bend" certain card types to acquire signal
- ✓ Guards noted some issues in rain and snow
- ✓ Handhelds sometimes lose wireless signal if the router is not designed properly

Early deployments have cost approximately $15 to $20K per unit.



In summary:

- ✓ Handheld automated processing appears to improve security through verification of occupants (and vehicles).
- ✓ Handheld automated processing lowers processing capabilities versus manual rates but not significantly.
- ✓ Handheld automated processing has a limited impact on manpower requirements.
- ✓ Other factors (traffic arms, in-lane inspections) have more impact on processing than the use of handheld automated processing.

9.4. SMART PLANNING

When considering automation, manpower, and infrastructure issues, ECF designers must ask the appropriate questions in order to properly assess the impacts of their decisions. Blindly focusing on one near-term issue without considering ramifications will result in unmet priorities and wasted resources. **Exhibit 9.3** provides a list of questions ECF designers need to consider.

All of the concerns discussed below are inter-related. The SMART approach is to consider the ramifications of decisions. SDDCTEA has developed the ACP/ECF SMART Decision Evaluator web-application to assist ECF Designers with answering the questions in **Exhibit 9.3**. Refer to **Section 2.4.4.1** of this pamphlet for additional information regarding the SMART approach.

Exhibit 9.3: SMART Questions

Security	✓ What AT measures are required? ✓ How do these requirements impact traffic (processing) and will that impact necessitate additional manpower or lanes? ✓ Can automation enhance security? ✓ Is the system providing positive access control?
Manpower	✓ Is manpower utilized efficiently? ✓ Would additional lanes allow for more efficient processing thus reducing manpower demands? ✓ Will automation help reduce manpower costs?
Automation	✓ Will automation provide a manpower cost savings? ✓ Will automation provide a security benefit? ✓ Will automation be able to achieve comparable processing rates to manual processing? ✓ Is there the proper infrastructure (lanes) to support automation initiatives? ✓ Are there policy decisions that need to be implemented to support efficient automation?
Roads & Lanes	✓ Are there sufficient lanes to accommodate manual processing? ✓ If additional lanes were constructed, could manpower be reduced? ✓ Are there sufficient lanes to accommodate automation?
Traffic & Safety	✓ How do security decisions impact processing (traffic)? ✓ How do manpower decisions impact processing (traffic)? ✓ How do automation decisions impact processing (traffic)?

Manual processing offers the most efficient use of manpower and in many cases the most efficient processing; however, security benefits are limited.

AIE processing improves security; however, automation costs are a significant consideration. If traffic arms are not utilized, AIE processing is comparable to manual.

Handheld processing offers some security enhancements at a lower cost than AIE; however, processing efficiency and manpower are impacted. Handheld processing may be a good interim solution where automation is desired, but constraints require tandem processing.

9.4.1. Traffic Considerations

The methodologies to analyze traffic are detailed in **Section 2**; however, all methods for processing should be considered when planning an ECF. This includes:

- ✓ Manual
- ✓ Handheld
- ✓ AIE

As was explained in **Section 2**, each processing/credentialing technique is influenced by several variables.

Exhibit 9.4: Automation Influences

<table>
<tr><th>Influences</th><th>Manual Checks</th><th>Handheld Device Checks</th><th>Automated Lanes (AIE)</th></tr>
<tr><td>Manpower</td><td colspan="2">✓ Under manual and handheld device checks, additional guards can be added per lane to increase design processing rates.
✓ In general, it is more efficient to use two guards with one in each lane versus using two guards in one lane; however, the cost of additional infrastructure needs to be compared with the efficiency of processing and best use of manpower.
✓ SDDCTEA has concluded that providing more than three guards per lane provides little if any benefit and may be a misuse of resources. SDDCTEA discourages configurations with more than two guards per lane except in special conditions.
✓ In summary, the best use of manpower to gain efficiency is to add lanes, if possible, but infrastructure constraints may dictate that tandem processing be utilized.</td><td>✓ No benefit, since present AIE models utilize one man per lane.</td></tr>
<tr><td>Signage</td><td colspan="3">✓ Signing can improve processing by clearly defining what specific lanes can be used for. This is especially true at locations where there is a mix of manual processing lanes and lanes with automation.
✓ Clear and concise lane use signing can help to reduce the number of vehicles that enter the wrong type of lane. By doing this, processing rates can be enhanced.</td></tr>
<tr><td>Card Scanning</td><td>✓ Not applicable</td><td colspan="2">✓ Card reading/authentication delays can have a negative impact on processing.
✓ Driver education can assist in promoting awareness of card care as well as driver readiness and understanding on how to interact with systems.
✓ Next generation CAC card systems should authenticate in equal or less time than existing systems if possible; otherwise, future card types may disrupt processing efficiency.</td></tr>
</table>

Exhibit 9.4: Automation Influences (continued)

<table>
<tr><th>Influences</th><th>Manual Checks</th><th>Handheld Device Checks</th><th>Automated Lanes (AIE)</th></tr>
<tr><td>Traffic Arm Utilization</td><td colspan="2">✓ When utilizing a traffic arm for manual and handheld processing, both the USACE-PDC and SDDCTEA recommend open traffic arm usage during peak time periods due to the adverse impact on processing.
✓ While it is acceptable to assume that traffic arms may be utilized for non-peak periods, design assumptions should be based on non-arm usage for peak periods.
✓ The use of traffic arms during peak periods should not be justification for constructing additional lanes.</td><td>✓ Current models of AIE utilize traffic arms for each transaction.
✓ While the use of traffic arms provides a level of active traffic control, their usage adds approximately 2 seconds of processing per vehicle.
✓ “Open-arm” operations may reduce the ability to control traffic (thus possibly reducing security benefits), but promotes more efficient processing.
✓ Consider “up/down” operations at locations where congestion is not an issue and where there are sufficient lanes, but consider “open-arm” operations at installations where congestion exists and there are limited expansion possibilities.</td></tr>
<tr><td>FPCON</td><td colspan="3">✓ FPCON can have a significant impact on processing rate due to the variations in processing.
✓ The goal of the ACP/ECF should be to result in little or no delay under FPCON Bravo conditions.
✓ It is not practical to design for FPCON Delta. It should be assumed that under FPCON Delta, that only mission essential personnel will be permitted to enter and that alternative travel measures may be required.</td></tr>
</table>

9.4.2. Security Considerations

The purpose of utilizing risk analysis in making ECF technology implementation decisions is to provide an additional tool to the decision maker that will enable the comparison of credential checking strategies relative to security risk. It provides a methodology for evaluating how one type of credential checking strategy may be different from another in terms of security risk. The ECF strategies addressed in this section provide three different methods of checking the validity of a credential being used by person or persons attempting to gain admission to a military installation through an ECF checkpoint. The legitimacy of that person(s) is based on a credential verification process that can be addressed in several ways. These include:

- ✓ The manual verification of a credential by a guard
- ✓ The use of vetting processes contained in an AIE system
- ✓ The use of a handheld device by the guard in order to verify the credential with a personnel database

The particular ECF credential verification process does not prevent a person or persons from entering the installation or penetrating the gate. It only does what in essence an alarm system does – it flags that something is incorrect; the guard(s), active vehicle barrier or some other interdicting force or system will actually prevent the physical incursion by that person(s) into the installation space.

Automated systems should provide positive access control. Feedback from automated systems should not validate if an individual is or is not on a specific watch list. Additionally, an individual should not be granted access strictly due to the fact that they are not identified on a watch list. The decision regarding resource allocation and its impact on security requires a systematic approach that considers for each installation the combination of the following items:

- ✓ Likelihood of the attempted use of a false credential to gain admittance to the installation, termed the Probability of Attack (PA).
- ✓ Consequences to the installation and military operations given a successful attack, defined here as an Importance Factor (IF).
- ✓ Effectiveness of the particular entry control/credential verification strategy being utilized or considered, defined as Probability of Effectiveness (PE).

PA = Probability of Attack. A measure of the relative probability or likelihood of the threat of person(s) attempting to use a false credential to gain access to the installation occurring, is computed as a combination of the following:

✓ Threat Intelligence indicating an attack is plausible
✓ Criticality to Military Mission
✓ Ease of public access to the installation
✓ Visibility or attractiveness of the installation as a target
✓ Number of times the installation has been threatened in the past

IF = Importance Factor. For the purpose of this calculation, IF is equivalent to the concept of “Consequence” in standard risk calculation methodologies; it is the consequence of losing the installation or its operation for some period of time. The importance Factor is defined as a measure of the importance of the installation’s operation to the military’s mission and other criteria. In essence it states that if the facility is of no or little importance, someone illicitly entering the installation would be of little importance. The more important a facility, the more warranted would be efforts to recognize an attempted false entry. Importance can be computed as a combination of a number of installation attributes including:

✓ Inclusion on the AIE installation list
✓ Definition as Mission Critical
✓ Historical and symbolic importance
✓ Importance to the regional economy
✓ Large exposed population on or near the installation

PE = Probability of Effectiveness. A measure of the existence in an ECF lane of various credential validation strategies and their effectiveness at recognizing the use of a false credential [more credential checking strategies utilized equals greater effectiveness at recognizing an attempted false entry], computed as a combination of the following:

✓ Guard
✓ Manual credential check
✓ Database validation of credential
✓ License plate check
✓ Radio Frequency Identification (RFID) of vehicle

9.4.3. Ramifications of Non-SMART Decisions

The ramifications of these decisions are best illustrated by some representative examples.

Exhibit 9.5: Example 1

Existing Conditions	✓ An ECF has four ID check lanes. ✓ The morning peak hour exceeds 1,500 vehicles. ✓ To accommodate morning and mid-day per lane demands, the ECF utilizes two guards per lane (tandem processing) resulting in a total manpower requirement of eight guards during peak periods.
Direction	✓ The installation wants to implement automated installation entry (AIE) to enhance security and also because it is believed that it may reduce manpower requirements.
Blind Decisions	✓ The installation implements AIE without assessing the impacts. ✓ Prior to implementation, Command is notified that manpower will be reduced and security enhanced. ✓ While manpower is reduced, on the day the system is implemented it is realized that no one considered that AIE processes at a slower rate than tandem processing and as a result, a half mile backup of traffic occurs. ✓ Command is infuriated and is under pressure from local authorities to address the “back-up” issue. ✓ As a result, the AIE system is temporarily shut down.
Corrective Actions	✓ Eventually, the installation consults with experts to develop a plan. ✓ An assessment is conducted and it is concluded that an additional lane is needed during peak periods to support the AIE system. ✓ The installation concludes that adding a fifth lane is an option, but design and construction will take two years. ✓ In the interim, three temporary options are considered: 1. The installation could run manual tandem processing to alleviate traffic impacts; however, manpower and security needs will not be addressed. 2. The installation could utilize handheld technologies to alleviate traffic and to address security; however, manpower needs will not be addressed. 3. The installation could utilize AIE, but not utilize traffic arms (for each transaction). This option would address manpower and traffic needs as well as provide some security benefits. ✓ While all agree that it would be preferred to utilize traffic arms for each transaction, it is agreed that option 3 provides the most benefits and fewest drawbacks.

Exhibit 9.6: Example 2

Existing Conditions	✓ An ECF has two ID check lanes. ✓ The morning peak hour exceeds 700 vehicles. ✓ To accommodate morning demands, the ECF utilizes one guard per lane (single processing) resulting in a total manpower requirement of two guards during peak periods.
Direction	✓ The installation wants to implement handheld technologies to enhance security.
Blind Decisions	✓ The installation implements handheld technologies without assessing the impacts. ✓ On the day the system is implemented it is realized that no one considered that handheld automation processes at a slower rate than manual, single processing. ✓ As a result, tandem processing is required in one lane while single processing occurs in the other lane. The total resulting manpower requirement increases from two guards to three guards during peak periods.
Corrective Actions	✓ An assessment is conducted and it is concluded that AIE can provide similar security benefits without requiring additional manpower. ✓ However, it concluded that implementation of AIE requires additional funding and will take two years. ✓ In the interim, three temporary options are considered: 1. The installation could increase staffing during peak periods and utilize handheld technologies until AIE is implemented. 2. The installation could abandon handheld technologies and return to manual processing with two guards. 3. The installation could utilize handheld technologies for every vehicle during non-peak periods, and could use handheld technologies only on random vehicles during peak periods. This operation would not require additional guards. ✓ The installation implements option 3 as a temporary measure while AIE is funded and implemented.

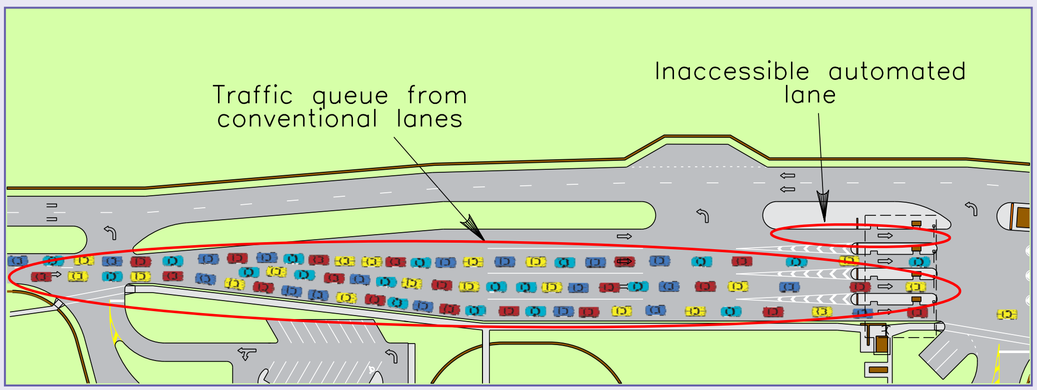
9.5. DESIGN CONSIDERATIONS

The design issues associated with handheld processing systems are similar to those with manual processing which are discussed in other sections. Below is a summary of design issues associated with AIE processing.

In general, SDDCTEA recommends that installations consider the possible ramifications of implementing AIE processing when assessing ECFs even if AIE is not planned in the near term.

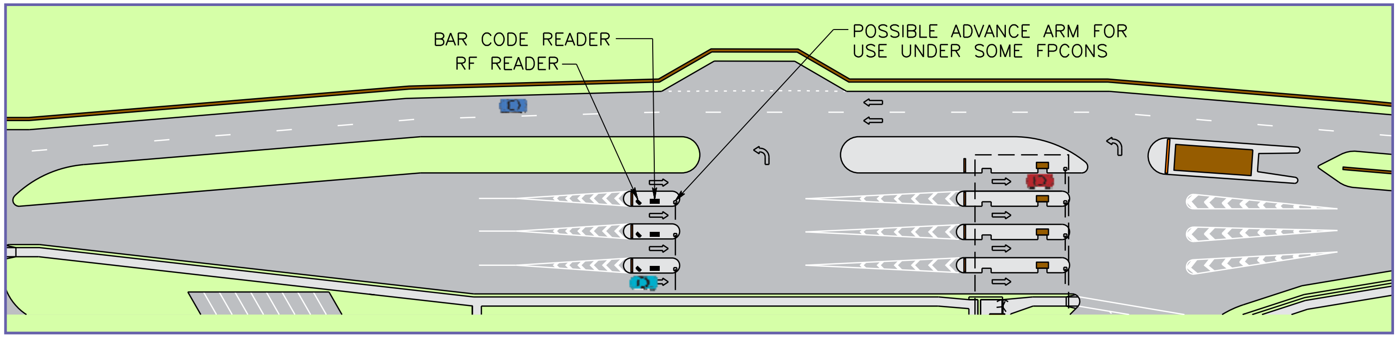
9.5.1. Geometric Layout

When automated processing and conventional processing are planned at an ECF, care should be taken to ensure that queuing associated with conventional processing (under various FPCONs) does not impede access to automated lanes. In toll plaza applications (with electronic toll collection), a common practice has been to keep electronic toll lanes to the far left. It is preferred to have all automated lanes to the left; but if upstream and downstream weaving is an issue, it may be necessary to have automated lanes spread throughout the ECF.



9.5.2. Island Design

Some early automation deployments and early design guidance utilized advance islands for automated preprocessing. The concept was that preprocessing would provide an opportunity to screen and reject prior to the ID check area.

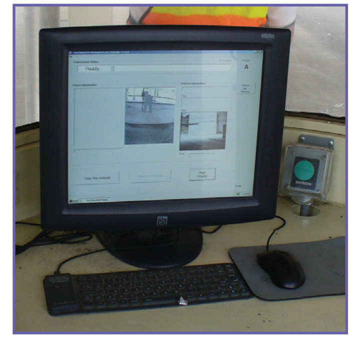


Early automation guidance with advance islands may not be applicable

As most systems have evolved, the advance islands are seldom utilized. Advance islands can be used, if desired, and may provide other benefits such as a position for advance screening and a speed management feature.

In practice, most automation systems have been deployed on a single island. This minimizes space impacts, but does require manual rejections. If automation is deployed on a single island, below are some design considerations.

- ✓ **Canopy** – A canopy is vital to the success of an automated system. Not only will it protect components from the elements, but it will also improve the reliability of vehicle and driver identifications. The canopy is also a platform for additional lighting which may be necessary.
- ✓ **Island length** - Early deployments have occurred on islands less than 50 feet in length, but ideally the island length should be approximately 75 feet which is the same as manual processing islands. This will provide adequate distance for vehicle identification, license plate scanning, driver identification and acceptance or rejection.
- ✓ **RFID placement** – The RFID should be positioned and tuned so that it reads approaching vehicles, but not vehicles from other lanes. If the RFID is placed too far back on the island, the vehicles won't be identified prior to the driver being scanned. This will disrupt the system. Most deployments have found that when the antenna is placed near the driver scan location, it provides adequate vehicle scanning without disruption from other lanes.



✓ **Card scanner** - The card scanner should not overhang the roadway, but needs to be placed at a location and height where cards can easily be scanned. In general, proximity scanners are preferred versus swipe scanners.

✓ **Guard position** – In an automated system, the guard position is at the secondary area on the ID check island. If you are planning new facilities that will be transitioned from manual to automated processing, it may be prudent to locate the guard booth at the secondary area in preparation for automation. The guard position should include system monitor and controls.

✓ **CCTV** - A CCTV will be needed at the following locations:

- License plate view - This view is needed to confirm the vehicle identification. Placement is challenging due to varying vehicle lengths and queued vehicles encroaching on the view.
- Driver scan position – This view is needed to confirm the driver identification versus the database. Placement is challenging due to varying vehicle heights and lighting.
- Lane operations – It may be desired to have an overall view of the lane operations to include the vehicle and ID check guard.

✓ **Traffic arms and traffic indications** – It may be desired to have up to two traffic arms on an automated ID check island.

- Advance arm for lane closures – This arm can be a manual arm that is used when the lane is physically closed. It should meet MUTCD retroreflectivity and color requirements. The arm should be a breakaway design.

- Post-ID arm for active control - This arm should be integrated into the system, if used, and should be used to control traffic until alternative authorization has been given. The traffic arm should be integrated with a traffic signal indication. Inductive loops should be installed before and after the arm to prevent accidental closure on moving vehicles. It should meet MUTCD retroreflectivity and color requirements. The arm should be a breakaway design.

✓ **Conduit and junction boxes** – Conduit and junction boxes should be installed to incorporate planned and possible future automation. Conduit should have adequate capacity to link to other lanes as well as to the gatehouse itself.

9.5.3. Signing

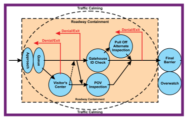
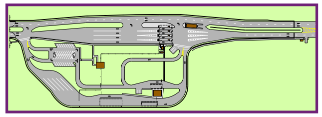
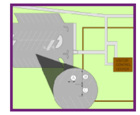
As noted in **Section 7** consideration should be given to traffic control needs when considering future ECF automation.

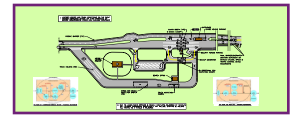
When automated and conventional processing is planned, signing needs should also be considered. Advance signing should instruct automated users to keep left, if possible. As vehicles approach the ID check area, lane use signing should be used, if required.

Consult with SDDCTEA regarding specific signing needs for your ECF.

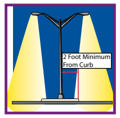
In general the following recommendations should be considered.

- ✓ Advance signing is necessary and recommended especially where mixed (manual and automated) checking is used. Advance signs should be placed ½ mile in advance if feasible. This will allow for motorists to prepare to enter the proper lanes prior to the ID checkpoint. The Federal Highway Administration recommends that the background color for advance signs should be green. When a pictograph (representing the automation program name) is used, it should have a white underlay and should be placed on a purple square panel with a wide white border that is then incorporated into the green guide sign.
- ✓ Lane assignment guidance may be needed where mixed (manual and automated) checking is used and at locations where there are four or more ID check lanes. Providing clear and consistent advance orientation information helps the traveler to make early decisions on lane selection. When used, these signs should be installed on the canopy. In addition, if visibility of the signs is restricted, an additional set of signs can be located on an overhead sign assembly installed after the pavement widening transition.
- ✓ Lane-use signals should be used over an ID check lane to indicate an open or closed status. Use of the traditional traffic signal heads may cause confusion because the circular red and green signal indications are generally recognized as meaning “stop” and “go.” The lane-use control signal with the downward pointing green arrow should be used to indicate the lane is open and the red X should be used to indicate the lane is closed. Static or changeable message signs may accompany the lane use signals on the canopy as needed. Flashing (yellow) beacons should not be installed together with lane-use signals.

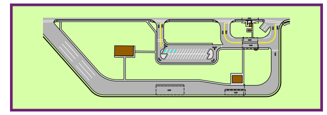






SECTION 10 - TECHNOLOGY AND COMMUNICATIONS








10. Technology and Communications

Intelligent Transportation Systems (ITS) involve the application of technologies and innovative practices to improve all aspects of transportation service.

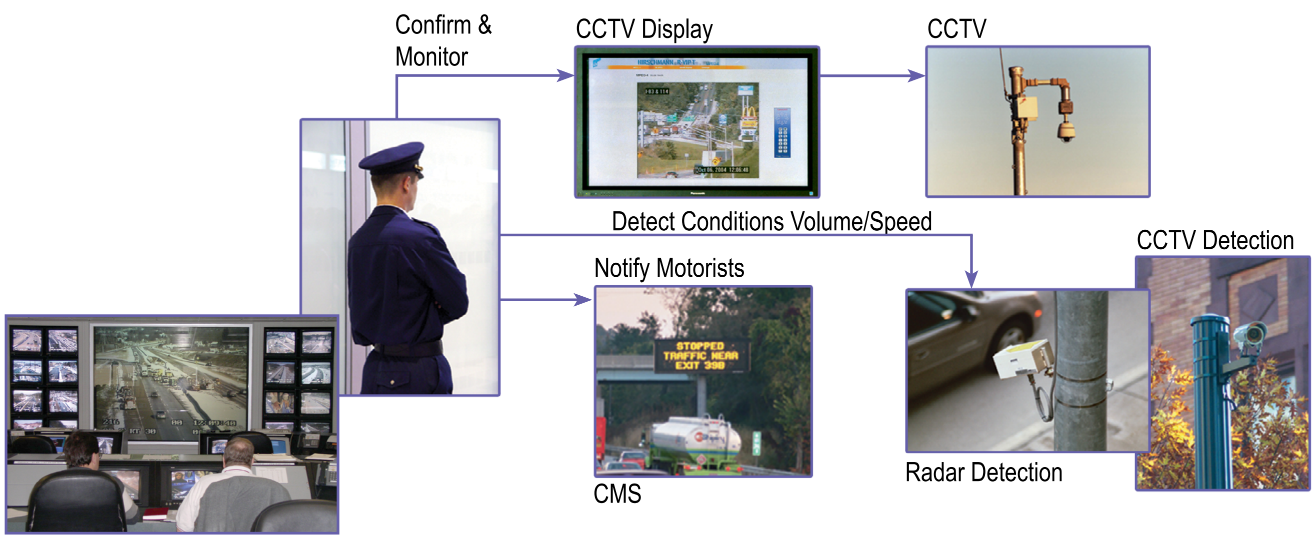
Intelligent Transportation Systems (ITS) involve the application of technologies and innovative practices to improve all aspects of transportation service.

Better-known examples of ITS technologies that may be applicable to ECFs include:

- ✓ Detection devices
- ✓ Changeable Message Signs (CMS)
- ✓ Closed Circuit Television (CCTV)
- ✓ Automated ECF technologies (discussed in Section 9)
- ✓ Overheight detection
- ✓ Traffic control systems
- ✓ Information and control systems

Many of the technologies being deployed on public roadways were developed from military applications. The strategic deployment of ITS devices and systems may offer several benefits at ECFs including improved security, safety, and traffic flow.

Additionally, many of these elements (detectors, signals, signal controllers) should be integrated into active vehicle barrier control systems.



DETECTION DEVICES CAN MONITOR TRAFFIC SPEEDS, THE VOLUME OF TRAFFIC, AND THE TYPE (VEHICLE CLASSIFICATION) OF TRAFFIC.

10.1. DETECTION DEVICES

As summarized in **Exhibit 10.1**, there are a variety of detection devices that can be used for transportation projects.

Exhibit 10.1: Detection Devices

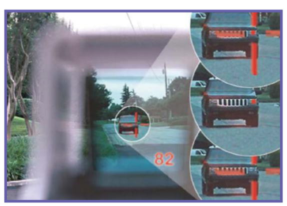
Type		Description	Considerations	ECF Applications
Loop Detectors		✓ Wires in roadway monitor magnetic inductance ✓ Multiple loops are needed to detect direction and speed	✓ Low-cost ✓ Limited capabilities ✓ In-roadway maintenance required if failure occurs	✓ Wrong-way detection ✓ Point overspeed detection ✓ Vehicle presence/AVB safety
Radar		✓ Use radar technology to detect vehicles and speeds ✓ There are two categories: Frequency Modulated Continuous Wave sensors (FMCW) and Continuous Wave (CW) Doppler sensors	✓ Used in many traffic monitoring applications ✓ Design and initial calibration is critical ✓ Some FMCW manufacturers have indicated a ± 10% error range	✓ Wrong-way detection ✓ Point overspeed detection ✓ Continuous overspeed detection (within line of sight and depending on type of unit)
Lidar		✓ A lidar unit transmits light to a target which backscatters a small portion of the light back along the line of sight ✓ This return light is analyzed to determine the distance, speed, rotations, chemical composition and concentration	✓ The most common use of lidar equipment is speed detection by law enforcement agencies ✓ Most existing applications have not been integrated with other systems	✓ Point overspeed detection ✓ Continuous overspeed detection (within line of sight)

Exhibit 10.1: Detection Devices (continued)

Type		Description	Considerations	ECF Applications
Forward Looking Infrared		✓ Measures the heat waves emitted by objects and living things to create images based on the variations in radiant energy across it's viewing area ✓ Uses zones "painted" on the fixed video image to recognize if the image changes	✓ Video feeds can also be used for traffic and security surveillance, as needed ✓ Systems can detect vehicles up to an accuracy of 96% in adverse conditions (fog, rain, snow)	✓ Wrong-way detection ✓ Point overspeed detection ✓ Continuous overspeed detection (within line of sight) ✓ Vehicle presence/AVB safety ✓ Surveillance/ security
Video	 	✓ Uses zones "painted" on the fixed video image to recognize if the image changes ✓ When zones recognize change, algorithms can determine vehicle type and speed	✓ Systems have improved but there are still some issues with snow, fog, and nighttime conditions ✓ Lenses can get dirty and need occasional cleaning ✓ Most applications permit as many as 99 point detections or multiple detection intervals of variable length which can be used to provide continuous detections ✓ Video feeds can also be used for traffic and security surveillance, as needed	✓ Wrong-way detection ✓ Point overspeed detection ✓ Continuous overspeed detection (within line of sight) ✓ Vehicle presence/AVB safety
Break Beam		✓ A beam of light is transmitted between the emitter and the detector which are aligned with each other and detection is noted when the light beam is broken ✓ The emitter is usually made out of a light-emitting diode (an LED), and the detector is usually a photodiode/ phototransistor	✓ Since break beams must be placed near the road, they should be placed behind curbing for protection ✓ Snow removal should be considered when designing ✓ Break beam sensors are a good secondary system for vehicle presence detection because they can detect vehicles with low metal content	✓ Point overspeed detection ✓ Vehicle presence/AVB safety ✓ Overheight detection

Most of the detection technologies noted can be configured to collect basic vehicular speeds and volumes. Some of the systems can be further configured to collect direction of flow and vehicle class. The limitation of many technologies, not considering the development of algorithms and software, is the inability of some types of radar, induction loops, break beam, and passive infrared to collect continuous speed data. The best approach is to deploy a continuous technology such as video detection (or other) as the primary detection technology and to utilize other technologies at critical point locations for system redundancy and for more accurate readings, as needed.

Some examples of how detection devices may improve ECF security, safety, and traffic flow are included below.

- ✓ **Wrong-Way Detection** - Wrong-way sensors can be deployed in all outbound lanes at the ECF entrance and after each turn-around to monitor for illegal outbound entry.
- ✓ **Overspeed Detection** - Detection devices in the approach zone can be used to monitor vehicles approaching at a high rate of speed. In many cases, the system can be developed to distinguish between cars and trucks. Point overspeed monitors speed at a particular location, while, continuous overspeed detection provides overspeed for the entire approach zone and access control zone. Continuous overspeed detection may be more suitable for addressing the various threat scenarios.
- ✓ **Vehicle Presence Detection and AVB Safety** - Vehicle presence and AVB safety sensors shall be deployed at all active vehicle barriers to detect a vehicle immediately over the barrier. Detection of a vehicle immediately over the barrier will suppress a barrier “up” command. Where practical and when the vehicle presence safety scheme is utilized, redundancy should be integrated into the design by deploying multiple technologies such as loops and break beams. This will provide protection should one technology fail and will increase the likelihood that motorcycles and bicycles are detected.
- ✓ **Traffic Flow Monitoring** - Detection devices can be used to monitor queuing traffic at an ECF or on a neighboring roadway. This information can be used by personnel in adjusting processing procedures or can be relayed to motorists through changeable message sign (CMS) so that they can use an alternate ECF, if appropriate.
- ✓ **Overheight vehicles** - Break beam technologies can be used to monitor for overheight vehicles.

Exhibit 10.2 shows the use of approach zone detection in conjunction with an operational concept for displaying information to guards and drivers.

Exhibit 10.2: Example of Approach Zone Detectors

CHANGEABLE MESSAGE SIGNS (CMS) OFFER THE ABILITY TO CHANGE THE INFORMATION BEING PROVIDED TO MOTORISTS.

10.2. CHANGEABLE MESSAGE SIGNS (CMS)

When used, a CMS should be located where the driver has an opportunity to react and take an alternate route if appropriate. A CMS placed in the approach zone provides little benefit if alternate routes are not easily accessible. When deployed, a CMS should be:

✓ Clear and concise
✓ Limited to no more than three alternating screens
✓ Be located so that the driver can read the entire message and react
✓ Display a message that states:
- What is the condition
- Where is the condition
- What the driver should do

Protocols should be established so that messages address traffic and security in a consistent manner:

✓ ECF status
- BUCHAN GATE CLOSED, USE TAYLOR GATE

✓ Traffic conditions
- CRASH ON HIGHWAY 66, EXPECT DELAYS
- METIL GATE 10 MIN DELAY, USE PALMER GATE

✓ FPCON condition
- DAVIS AFB – DELTA , ESSENTIAL STAFF ONLY

CLOSED CIRCUIT TELEVISION (CCTV) SYSTEMS PROVIDE SECURITY BENEFITS AND PROVIDE A MECHANISM TO MONITOR TRAFFIC CONDITIONS.

10.3. CLOSED CIRCUIT TELEVISION (CCTV)

There are a variety of CCTV systems with costs varying based on quality and functionality. Most CCTV systems being deployed are color digital video and offer Pan-Tilt-Zoom (PTZ) functionality. Video management software helps manage CCTV systems and provides a mechanism to store and archive digital video.

Common uses at an ECF include:

- ✓ ID check area
- ✓ Inspection areas
- ✓ Visitor control center
- ✓ The approach and response zone to monitor traffic approaching from both directions
- ✓ Neighboring intersections and roadways that may be impacted by ECF operations

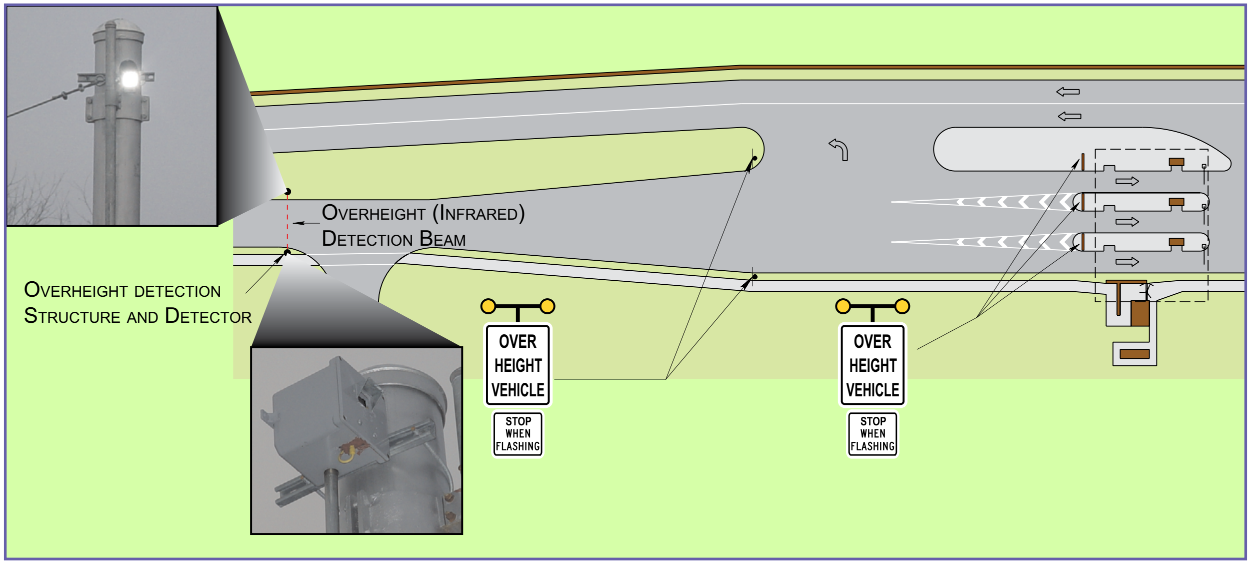
In some applications, license plate recognition may be required. CCTV systems that record license plates are special, fixed camera systems that require specialized lighting. When used, license plate systems should be configured to record the back plate since some states don't require front plates.

OVERHEIGHT DETECTION IS APPROPRIATE AT LOCATIONS WHERE THE VERTICAL CLEARANCE OF THE CANOPY OR OTHER ROADWAY FEATURES ARE OF CONCERN.

10.4. OVERHEIGHT DETECTION

The system detects overheight vehicles and warns drivers of an impending problem by using warning signs and/or warning bells.

Detection devices are placed in advance of the feature of concern and at a location far enough in advance that the driver can be warned and take corrective action.



10.5. TRAFFIC CONTROL SYSTEMS

Traffic signal indications may be used at two locations within an ECF in addition to signal indications that may be present at neighboring intersections:

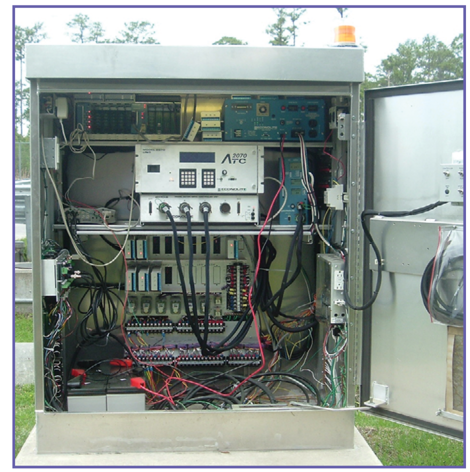
- ✓ Green (open) and red (closed) lane use indications located on the overhead canopy and visible to traffic approaching the ID check area
- ✓ Traffic control and signaling approaching active vehicle barriers

The *MUTCD* provides detailed guidance on the design and operation of traffic signals and signal indications. These guidelines should be adhered to when utilizing signal indications in ECF operations.

10.5.1. Signal Indications

There are two nominal sizes for signal indications: 8-inch and 12-inch. SDDCTEA specifies using 12-inch lenses in most cases, including at active vehicle barrier locations.

SDDCTEA also recommends the use of light emitting diode (LED) signal indications rather than traditional incandescent bulbs. Benefits of LEDs over incandescent bulbs include:



- ✓ Better visibility
- ✓ Gradual burn-out versus abrupt burn-out
- ✓ Energy savings estimated at 80 percent
- ✓ Lower life-cycle costs

10.5.2. Signal Controllers

Traffic signal systems, whether they are at signalized intersections or part of active vehicle barrier traffic control systems, should be controlled by solid-state controllers to ensure efficient operations. Controllers should be equipped with a conflict monitor. A conflict monitor monitors the signal controller for conflicts such as conflicting indications, voltage drops or other events that could result in vehicular conflicts.

ACTIVE VEHICLE BARRIER CONTROL

- CONTROLS OPERATIONAL SAFETY SEQUENCE AND BARRIER DEPLOYMENT
- BY REGULATION, CONTROLS SHOULD SATISFY STATE AND LOCAL DOT REQUIREMENTS AS WELL AS NATIONAL STANDARDS
- ADVANCED FEATURES AND CAPABILITIES VERSUS TRADITIONAL TRAFFIC CONTROLLERS
- PROGRAMMABLE FOR SPECIAL USES
- TRANSPORTATION ENGINEERING PROGRAMMABLE LOGIC CONTROLLERS

10.6. ACTIVE VEHICLE BARRIER CONTROL

Controllers used should be approved for use by the local or state DOT. Consider specifying National Electrical Manufacturers Association (NEMA) TS1 or NEMA TS2 for traditional intersections, but consider specifying a state approved traffic controller for AVB control systems. Controllers should be installed by local or state DOT approved installers or by someone with International Municipal Signal Association (IMSA) certification.

Where an AVB control system is interconnected with a nearby traffic signal per Staggered or Collocated Safety Schemes, the traffic signal controller operates like a traditional traffic signal under normal conditions. Once the EFO sequence is initiated, the AVB control system pre-empts the normal operations of the traffic signal controller immediately initiating the change interval for green approaches. Refer to **Exhibit 10.3 and 10.4** for the operational sequencing diagrams for AVB signals and intersection traffic signals.

Ideally, AVB and associated control systems should be procured as one complete system. There are many benefits of soliciting for complete systems:

✓ System performance becomes the responsibility of one party
✓ Integration is linked with the component providers
✓ Warranty and maintenance can be linked with system supplier

To ensure a reliable system, system specifications should include requirements for component testing, system testing, commissioning and reliability, training and warranty. The U.S. Army has developed a guide specification (UFGS 34 41 26.00 10) for access control point control systems including active vehicle barrier systems. For more on active vehicle barrier control systems, contact SDDCTEA.

Exhibit 10.3: Typical Components of a Complete AVB System

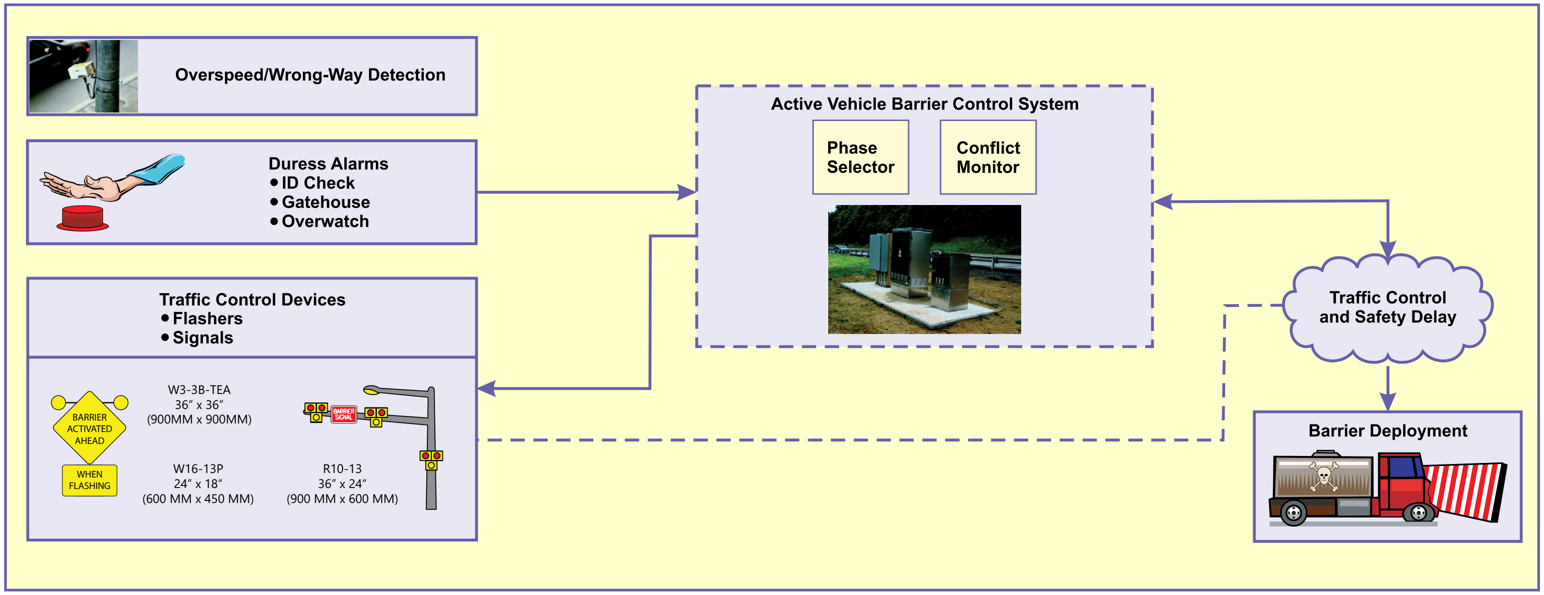
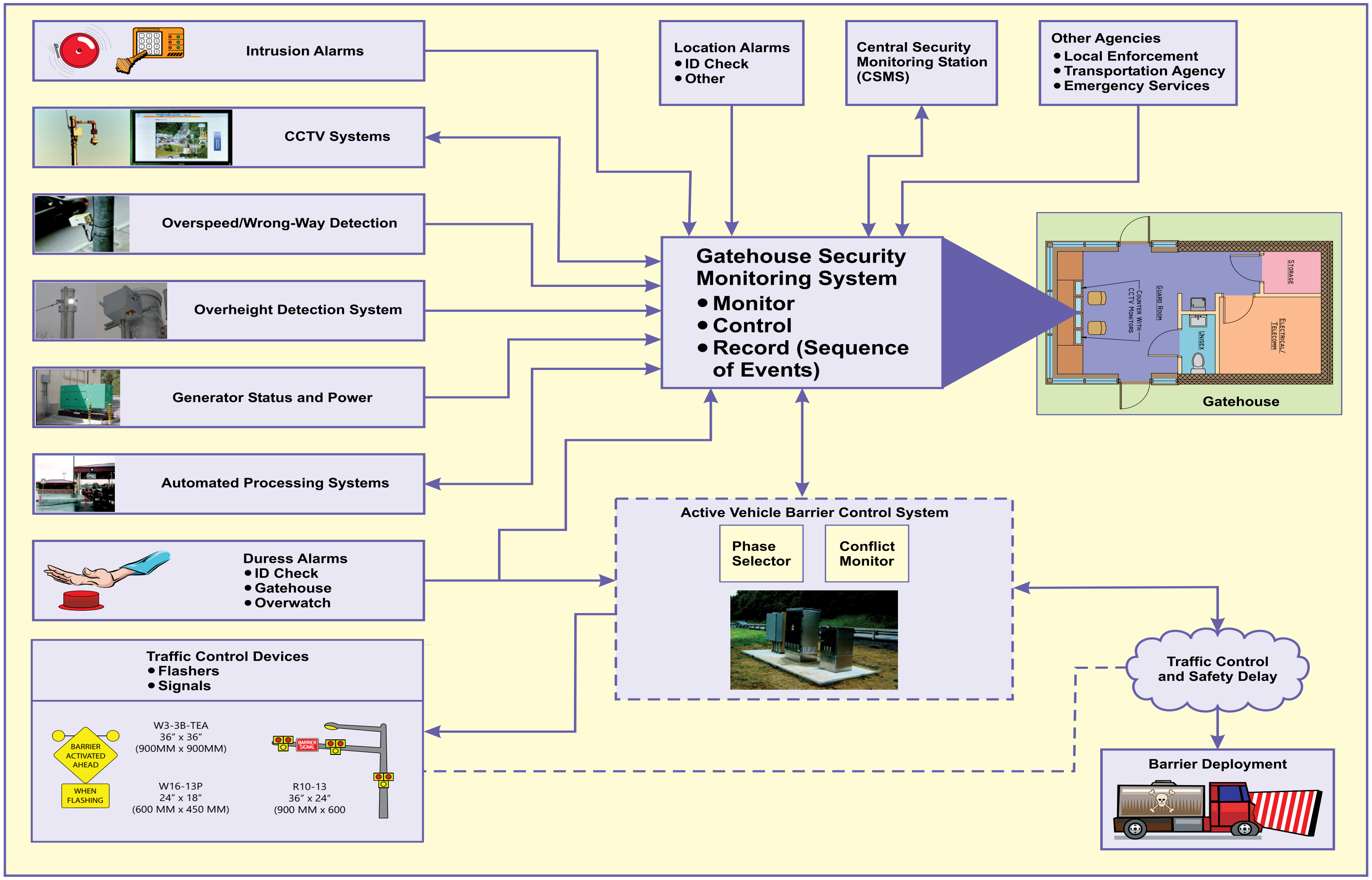


Exhibit 10.4: Typical ECF Technology and Communication Systems



10.7. INFORMATION AND CONTROL SYSTEMS

Information and Control Systems at ECFs provide an opportunity to bring all the systems together in one intuitive system that can be understood by ECF guards and allows staff to monitor, record and control subsystems. Some service branches have described such a system as a Gatehouse Security Monitoring System (GSMS). While you would expect such a system to be high in cost, commercial software can be utilized to develop a system for a relatively low cost when compared to other ECF elements. Furthermore, a system developed for one ECF or installation could be modified for use at other ECFs or installations.

A GSMS could provide numerous functions from one location:

- ✓ Monitor active vehicle barrier and associated traffic control through the state approved traffic controller
- ✓ Monitor intrusion alarms and provide alarms to gatehouse and other locations
- ✓ Monitor overspeed and wrong-way detection systems and provide alarms to gatehouse and other locations
- ✓ Monitor overheight detection systems
- ✓ Control and view CCTV systems
- ✓ Display power and generator status
- ✓ Record system events (sequence of events recorder)
- ✓ Provide a link to a Central Security Monitoring Station (CSMS)
- ✓ Provide a communication link to external agencies (enforcement, transportation departments, emergency services)

THE BACKBONE OF AN ITS PLAN IS A SUITABLE COMMUNICATION SYSTEM.

10.8. COMMUNICATION NEEDS

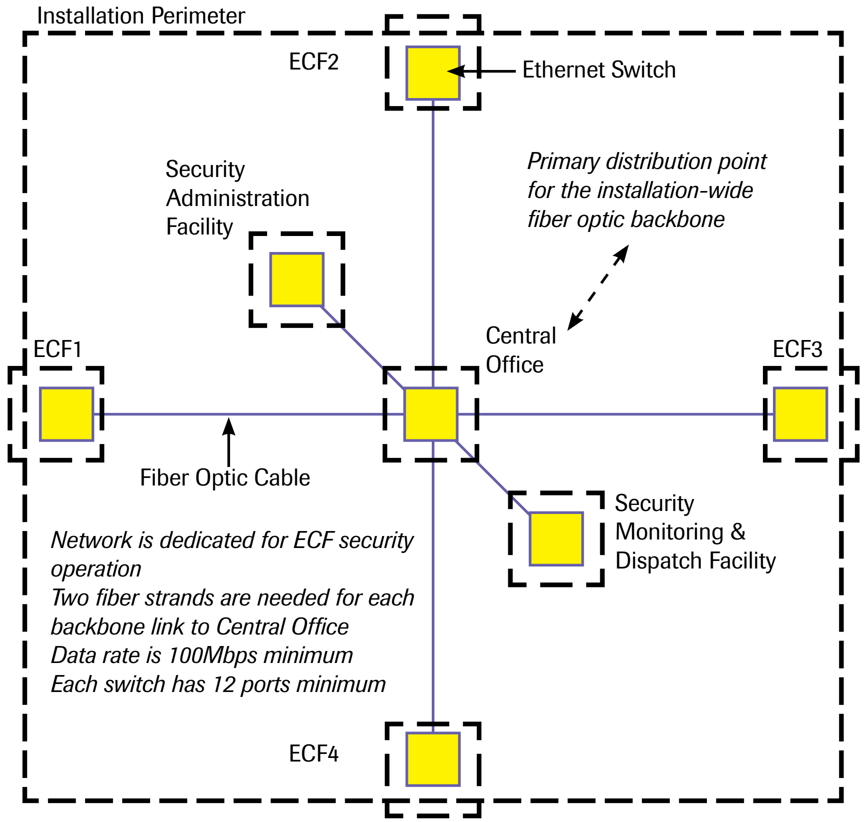
ITS elements must be managed and controlled from the gatehouse and another central monitoring point. The type of communication is dependent on the devices being utilized and site conditions. CCTV systems require higher bandwidth communications than CMSs alone. The location of some devices may make physical connections cost-prohibitive.

As services continue to enhance security at ECFs, the need for reliable, high-speed data connectivity at installation perimeters becomes increasingly important. While many installations have been proactive in extending their fiber optic backbone to the perimeter, many ECF security upgrade projects continue to be hampered by the inability to transmit data from ECFs back to security monitoring and administration facilities. Although a dedicated copper phone circuit is generally sufficient for transmitting basic ECF alarm messages (guard duress, door forced, enclosure tamper, etc.), ECF video and access control data demand a much faster connection that is best provided by fiber optic cable. To ensure adequate connectivity for an ECF security upgrade, the project team must first confirm the availability of fiber at each ECF and then design and build a network capable of transmitting all required data.

Exhibit 10.5: Types of Communication

Communication Type	Key Features	Support Detection Devices?	Support CMS?	Support CCTV?
Hardwire (Fiber Optic or Copper)	This communication technique includes physically connecting equipment using either fiber optic or copper cable. The line can be installed either aerially (attached to poles) or in underground conduit.	YES	YES	YES
Leased Line	This communication consists of a dedicated phone drop at each site or device. The bandwidth and quality of the line can be adjusted based on the type of device.	YES	YES	YES (with higher bandwidth service)
Cellular (CDMA or GPRS)	This technology is cellular in nature and is the next generation version of Cellular Digital Package Data (CDPD).	YES	YES	NO
Spread Spectrum Radio	This technology utilizes FCC-governed spread spectrum radio to communicate between equipment.	YES	YES	YES
Mesh Radio Network	Mesh radio networking is the concept of using routers with RF transceivers to create multi-point to multi-point “mesh” connections.	YES	YES	YES

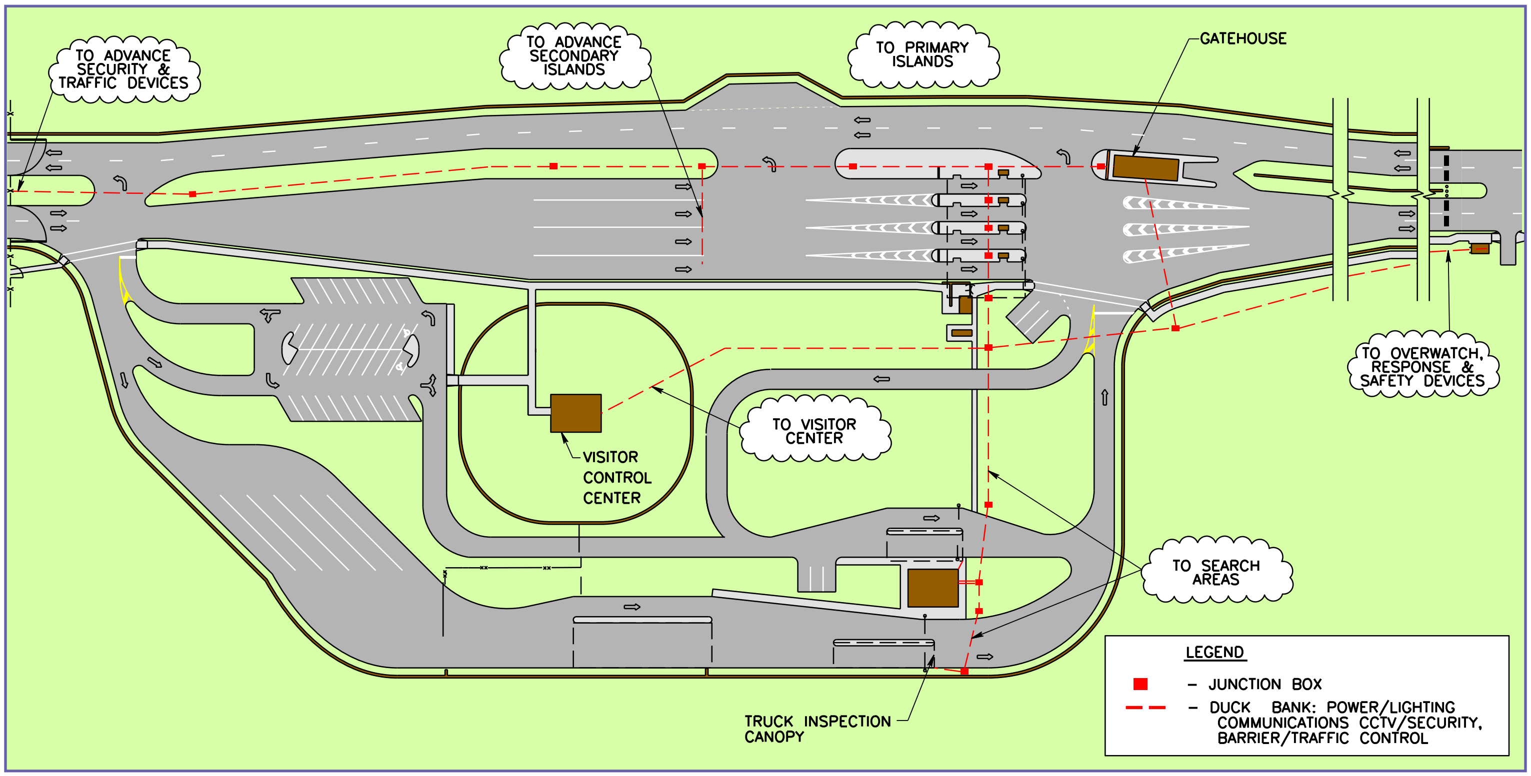
A stand-alone ECF network, physically separated from the existing Directorate of Information Management (DOIM) network, is preferred due to the criticality and sensitivity of the data being transferred. This network must provide multiple connections at each ECF and at security administration, monitoring and dispatch facilities. For example, the network switch at a single ECF could require local ports/connections for a digital video recorder (DVR), video workstation computer, automated installation entry (AIE) file server and an AIE workstation computer. The port configuration of the ECF switch should include a fiber optic uplink to the backbone switch and enough local spares to accommodate new equipment in the future. The network should support Ethernet and TCP/IP protocols, and the data rate should be no less than 100 Mbps. A properly designed ECF network will support "plug-and-play" connectivity for a wide range of security equipment and ultimately enhance the force protection posture at the installation perimeter.



In areas close to the gatehouse, physical interconnection is more feasible. In those cases, conduits and duct banks should be part of the overall design. Communication conduits should be separated from power conduits and spare conduits should be included so that future devices can be added to the ECF. Conduits should connect all key features to the gatehouse including: guard booths, inspection areas, active vehicle barriers, overwatch positions, and the VCC.

At ECFs, communication is also needed to link all the facilities to and from the gatehouse to a central monitoring point. *UFC 4-022-01* requires that there be two means of communication from the ECF to the central monitoring point for system redundancy purposes. Additionally, fail-safe communication should be provided to all critical ECF components. **Exhibit 10.6** shows a model duct bank layout.

Exhibit 10.6: Model Duct Bank Plan



10.9. OTHER CONSIDERATIONS

Although ITS elements can improve the security, safety, and traffic conditions at an ECF, there are some additional considerations that need to be made before deploying these devices.

10.9.1. Operations

Traditionally, roadway construction has been a “design, build, and maintain” practice. ITS introduces a new element - “operations.” Although ITS can help reduce overall manpower in some situations, there must be operational monitoring of the systems. In many cases, these responsibilities can be shared with other responsibilities by someone in the gatehouse and central monitoring point.

10.9.2. Software

How ITS can be utilized to address transportation and security issues is limitless; however, the more unique the application, the more costly it is to deploy. Many elements, such as detection devices, are supported by commercial off-the-shelf (COTS) software. For example, most CMS suppliers have software that will allow the user to monitor sign messages, store standard messages, and allow the user to easily change messages. Higher costs are experienced when new software must be developed to support a specific, unique need. In many cases this is not warranted, but in all cases it should be considered.

BUILD

OPERATE

MAINTAIN

10.10. POWER AND COMMUNICATIONS REQUIREMENTS

THE FOLLOWING SHOULD BE CONSIDERATIONS WHEN PLANNING FOR UTILITIES WITHIN AN ECF:

WHAT IS NEEDED NOW AND

WHAT WILL BE NEEDED IN THE FUTURE

In the ECF area, utilities should be buried for several reasons: vulnerability, clear zone obstructions, visibility, and aesthetics. *UFC 4-022-01* states that "Electrical design must consider current power demands as well as the communication and power requirements for future traffic control devices, identification equipment, and other devices associated with potential automation of the ECF."

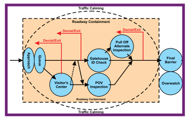
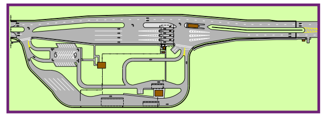
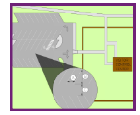
An alternate power source must be provided at each ECF. The alternate source must provide power to the following ECF components for a minimum of 12 hours (supply durations may vary depending on installation refueling plans):

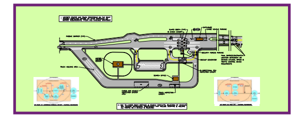
- ✓ Gatehouse interior and exterior lighting
- ✓ Canopy lighting
- ✓ Exterior lighting in the Access Control Zone
- ✓ Roadway lighting within 100 feet (30.5 meters) of both sides of the Access Control Zone
- ✓ Roadway lighting at the active vehicle barriers
- ✓ Exterior lighting at the search areas
- ✓ Access control equipment
- ✓ Uninterruptible power supply (UPS)

Location of generators is determined based on:

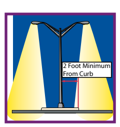
- ✓ Type of energy source and exhaust
- ✓ Noise generated
- ✓ Prevailing winds
- ✓ Point of electrical service

Future technological advances should be anticipated and provisions should be included with underground conduit and duct banks. Layouts similar to the ones shown in **Exhibit 10.6** should be used for accommodating future technology.

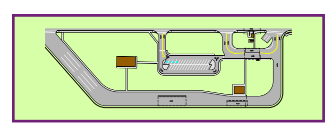






SECTION 11 - LIGHTING CONSIDERATIONS








11. Lighting Considerations

The Illuminating Engineering Society (IES) [www.ies.org] publishes lighting guidance on a variety of issues including transportation and security lighting.

Lighting is required for guards to perform their security functions. ECF lighting is important so that motorists and guards can see each other. ECFs should be designed with lighting features that support the operational requirements during dawn, dusk, or night time periods. Even if the ECF is intended to be used only during daylight hours, lighting should be considered in the event there is a change in usage.

Lighting should be complete and continuous. Specific areas of the ECF require their own lighting requirements. These requirements are governed by service and *UFC 3-530-01*. The lighting plan for the ECF must transition from the existing roadway lighting so that it does not blind the driver or backlight signs. Proper design of the lighting system will increase safety and efficiency, aid security forces, enhance appearance, and reduce light pollution.

Image provided courtesy of the International Dark-Sky Association (http://www.darksky.org)

Image provided courtesy of the International Dark-Sky Association (http://www.darksky.org)

ILLUMINATION IS A MEASURE OF THE INTENSITY OF LIGHT ON A SURFACE.

11.1. ILLUMINATION REQUIREMENTS

Illumination is measured in foot-candles (lux). A foot-candle is the U.S. customary unit of measure of the intensity of light on a surface, equal to one lumen per square foot and originally defined with reference to a candle burning at 1-foot from a given surface. Lux is the SI unit of illuminance. One lux is one lumen per square meter. **Exhibit 11.1** summarizes the lighting levels of common sources.

Exhibit 11.1: Typical Illumination Values

Lighting Source	Illuminance footcandles (lux)
Moon	0.01 (0.1)
Gas Station Canopy	10-20 (100-200)
Office Building	20-50 (200-500)
NFL Football Stadium	300 (3000)
Sun	10,000 (100 kilolux)

Source: IES

11.1.1. Illumination Levels

The level of illumination is dependent on the task being performed and the needed visibility to perform those tasks.

UFC 3-530-01 Interior and Exterior Lighting Systems and Controls, with Change 3 summarizes lighting requirements at ECFs among other locations. The lighting levels identified may be appropriate where practical and desired. It may also be necessary to provide additional task lighting in the ID check and inspection areas to support adequate identification of vehicle occupants and contents. Such lighting should be directed transverse to the roadway; it will then illuminate the roadway in front of the gatehouse, the driver, and the guard. Lighting may also be mounted at or below pavement level to facilitate under vehicle inspection, or associated with under vehicle inspection systems, but should not be directed towards the guard's eyes. Refer to the UFC 3-530-01 for additional and specific design requirements. **Exhibit 11.2** summarizes ECF lighting levels.

Exhibit 11.2: ECF Illumination Levels

Location	Horizontal Illuminance Footcandles (lux)
Approach Zone	✓ 1 (10) at Primary & Secondary ECFs ✓ Portable lights or as determined by lighting specialists at Limited-Use ECFs
Access Control Zone (general areas)	✓ 1 (10) in general areas
Identification, Inspection Areas, and Under Vehicle Inspection	✓ 10 (100)
Under ID Check and Inspection Canopies	✓ 10 (100)
At ID Check Station	✓ 10 (100)
Response Zone (Roadway)	✓ 3 (30)

Source: UFC 3-530-01

THE COLOR RENDERING INDEX (CRI) IS A MEASURE OF THE ABILITY TO DISTINGUISH BETWEEN COLORS.

11.1.2. Color Rendering Index

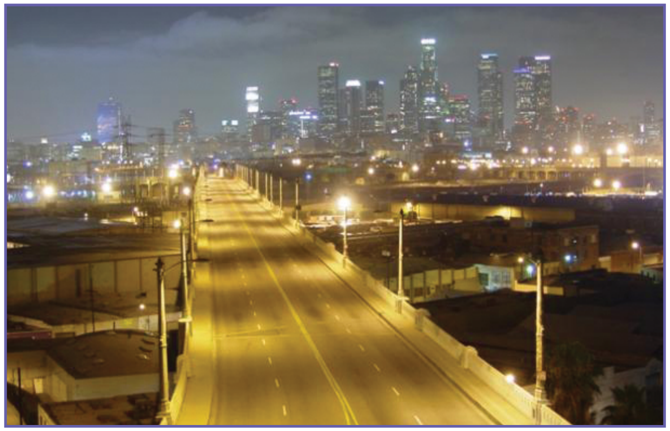
The ability to identify and distinguish colors accurately and confidently is important at ECFs. The measure of the ability to distinguish colors is commonly referred to as CRI. To ensure an appropriate CRI, a light source with CRI greater than 65 should be used in the ID check areas, and a light source with CRI greater than 50 should be used elsewhere throughout the ECF.

When closed circuit television (CCTV) is used as part of the traffic and security operations, it is important to coordinate the lighting and CCTV system.

11.1.3. Power Loss and Luminaire Restrike

Another important consideration in the design of site lighting is the restart or restrike time for the selected lamps. Restart occurs when a lamp experiences a loss of power and there is a time delay before power is restored to the lamp. Once power is restored the time it takes for the light to come back on is the restrike time of the lamp. High Intensity Discharge (HID) lamps were very commonly used at ECFs prior to LEDs. HID lamps conserve more energy than other incandescent lamps; however, they have a longer restrike time. This period of time may be unsatisfactory for security operations. The installation should designate the maximum acceptable period for which loss of illumination can be tolerated. It may be necessary to provide lamps and auxiliary equipment for rapid startup and restrike to provide minimal adequate lighting in the event of a power interruption.

Where possible, a backup power source should be implemented in the event of power loss. If the ECF is equipped with a generator, it should be sized such that it can power the lighting in addition to other necessary components.



11.1.4. Luminaire Selection

A qualified lighting engineer should develop a lighting plan that meets lighting requirements within the site constraints.

Exhibit 11.3: Types of Luminaires

Lamp Type	Time Required for Lamp to Cool Down and Restrike (Minutes)	Time to 60% Light Output After Restrike (Minutes)	Light Color	Color Rendition Index	Recommended ECF Application	Notes
Metal Halide (Standard Lamp)	10-15	3	White	65 or greater	If existing: ✓ Approach zone ✓ Access control zone ✓ Under canopy ✓ Search area ✓ Response zone	✓ Lower lumen output and life
Metal Halide (Pulse Start)	4	2	White	65 or greater		✓ Improved lumen output and life
High Pressure Sodium (Color Improved Lamp)	1	3	White	65 or greater		✓ Lower lumen output and life ✓ Good re-strike time
High Pressure Sodium (Standard Clear Lamp)	1	3	Yellow	20 or greater	Lighting transition (before approach zone and after response zone), if existing	✓ CRI under 65 (transition and blend with an exiting lighting) ✓ Not to be used in new applications
Backup Quartz-Halogen	N/A (Automatically switched on when outage occurs and has backup power)	N/A (Remains on until main lamp re-strikes and reaches 60% output)	White	97-100	Secondary "spotlight" usage only	✓ Plug-in and hand-carry with stand
					Provides emergency lighting during outages with approximately 1/7th the normal lighting level for specified areas	✓ Some manufacturers offer a combination metal halide or HPA with Quartz backup built in for automatic switchover
Light Emitting Diode (LED)	0	0	White	70 or greater	Must be the first consideration for all exterior lighting, including roadway and security lighting	✓ Can experience 20-50% in energy savings ✓ LED lighting is more directed, requiring more luminaires versus traditional. More luminaires may be needed for retrofits

Note: low pressure sodium lamps not recommended due to CRI of 0 and no quartz back-up built into luminaire.

Metal Halide are HID lamps that satisfy CRI requirements, but must be supplemented by a backup lighting source such as Quartz lights due to their long restrike time after power has been restored or a backup power source has been connected.

With the emergence of LEDs and their potential cost savings, the use of LEDs for roadway lighting is now much more widespread by transportation agencies and local officials. Some of the potential advantages of LEDs include:

- ✓ Reduced energy consumption
- ✓ Reduced maintenance costs
- ✓ More uniform illuminance
- ✓ No need for backup lamps (no restricted time)
- ✓ Reduced number of insects attracted to the light

Due to the significant energy savings, LED lighting is now required to be the first consideration for all exterior lighting, including building, area, roadway, parking lot, pathway, sidewalk, signage, landscape, and security lighting. As with any lighting system, LED lighting must be designed by a qualified lighting professional. The angles from the cone of illumination are less than that of a traditional luminaire, meaning that more luminaires are needed to light the same area. Incorporating more luminaires into the design could be accomplished with a closer pole spacing or using two luminaire arms on a pole instead of one with the appropriate arm length.

Many state DOTs were slow to approve LED lighting due to the concern that as they gradually burn out, the lighting level will become deficient over time, and not be noticed and corrected when necessary. If considering LEDs, contact the local state DOT for local guidance.

WHEN CONVENTIONAL LIGHTING IS USED, TRANSITIONAL LIGHTING IS TO BE PROVIDED TO ALLOW THE DRIVER'S EYES TO ADJUST TO THE CHANGE IN LIGHTING LEVELS ON ARRIVAL OR DEPARTURE.

11.2. TRANSITIONAL LIGHTING

Transitional lighting is necessary on approaches and departures to the ECF to minimize blinding effects as drivers travel into and out of a brightly illuminated ECF.

Standard conventional lighting is mounted at 30 to 60 feet (9.1 to 18.3 meters). When standard conventional lighting is used, transitional lighting is to be provided to allow the driver's eyes to adjust to the change in lighting levels on arrival or departure. Departure lighting is more critical since the eye has more trouble adjusting from light to dark than from dark to light. Provide gradual change in lighting levels using the minimum number (typically three or more) of lighting poles possible, with an approximate 33 percent or less change between poles. Actual lighting locations and spacing must be determined by an engineering assessment and will depend on luminaire height, light source type, and lens distribution.

High mast lighting in the range of 60 to 120 feet (18.3 to 36.6 meters) high is practical, because it provides broader and more natural light distribution. It also requires fewer poles than standard conventional lighting and may reduce or limit the need for transitional lighting.

High mast lighting in the range of 120 to 180 feet (36.6 to 54.9 meters) high does not require transitional lighting since it provides its own transition through distance; however, high mast lighting exceeding 120 feet typically requires stronger luminaries of 1,000 watts and may create light pollution on neighboring properties.

The final determination of the lighting type selected should consider the life-cycle cost of each system. Although one high mast light can often replace six conventional lights, the cost of high mast lights are often five times more than conventional lights not including power requirements.

11.3. VISITOR CONTROL CENTER PARKING LOT LIGHTING

In addition to security, lighting in large visitor center parking lots plays a critical role in maximizing visibility between motorists and pedestrians since pedestrians typically walk next to vehicle parking aisles.

Mounting height and spacing of luminaires should be sufficient to distribute the desired lighting intensity to the entire parking area. Pole heights range from 20 to 50 feet high or more. A normal lighting level for enhanced security parking lots is 0.5 foot-candles. The maximum-to-minimum illuminance uniformity should be 20:1 for basic levels, or 15:1 for enhanced security, per UFC 3-530-01. Light poles should be placed away from traffic aisles and parking stalls protected by raised curbs. Refer to SDDCTEA Pamphlet 55-17 for additional guidance regarding lot layout, and the UFC 3-530-01 for lighting requirements.

11.4. PEDESTRIAN LIGHTING

At ECFs with moderate pedestrian/bicycle traffic, additional lighting should be considered. Additional lighting may be necessary along pedestrian walkways, bike lanes, intersections, and entrances to buildings to improve safety and security for users and installation security. In pedestrian/bicycle areas, a minimum illuminance of 0.5 foot-candles is required. In order to meet this requirement, shorter light poles or roadway luminaries with a supplemental mast at a lower height should be utilized to enhance illumination. By using shorter poles with illuminance from multiple directions, adequate vertical illuminance should be provided to light individuals and their faces. Typical pedestrian light poles range in heights from 10-20 feet but designers should check with local jurisdictions for applicable design standards. Also, refer to the design guidelines of the IES and UFC 3-530-01.

11.5. LIGHTING GLARE, SKY-GLOW AND TRESPASS

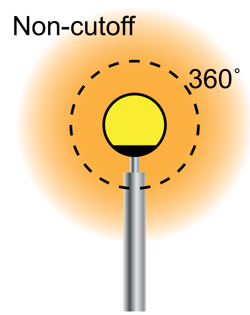
The lighting system design should consider the effect of the lighting system on the general aesthetic environment of the area.

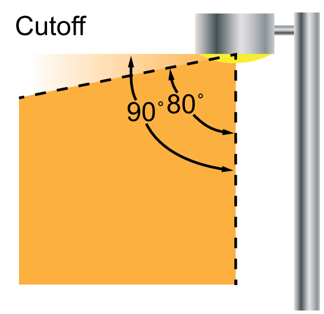
The evaluation of glare from the lighting system should be conducted to ensure disability glare will not impact drivers. In conjunction with the luminance method of lighting calculations, disability glare (veiling luminance) has been quantified to identify the veiling effect of glare as a percent of average overall luminance. Veiling luminance ratio should be limited to 0.30 maximum. As a general rule of practice, luminaries with cut-off optics should be used.

An increasing number of communities are adopting lighting ordinances to reduce sky-glow and prevent light trespass. Check local ordinances when considering any lighting adjacent to private property. Unwanted light can generally be reduced or eliminated by using cutoff or shielded luminaires. To help promote dark skies and minimize light trespass, cutoff luminaires should be considered.

Exhibit 11.4: Cutoff Classification

Classification	Maximum Intensity (% Lamp Lumens)	
	Above Horizontal	80° Above Vertical
Full Cutoff	0	10
Cutoff	2.5	10
Semi-Cutoff	5	20
Non-Cutoff	n/a	n/a

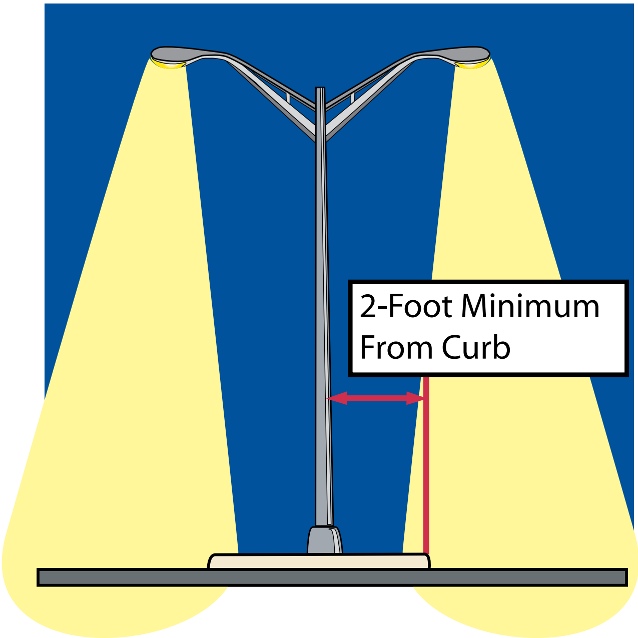


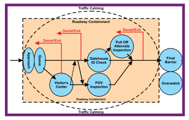
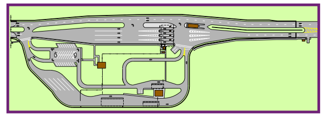
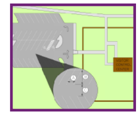


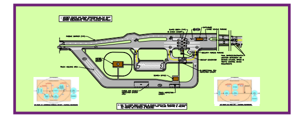
11.6. PLACEMENT OF LUMINAIRES

Light poles can be placed along the roadway or in the median. In some cases, light poles in the median may reduce the number of poles needed. However, at wider ECFs with numerous lanes the needed illumination may not be achievable with light poles only in the median. Therefore, light poles should be placed on both sides of the road.

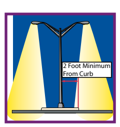
When light poles are in uncurbed areas, the pole should be located outside of the clear zone. In curbed areas, light poles shall be located at least 2 feet (0.6 meter) behind the face of the curb.



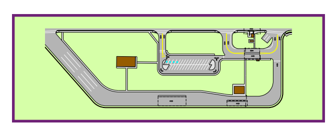






SECTION 12 - INTERIM ECF SOLUTIONS







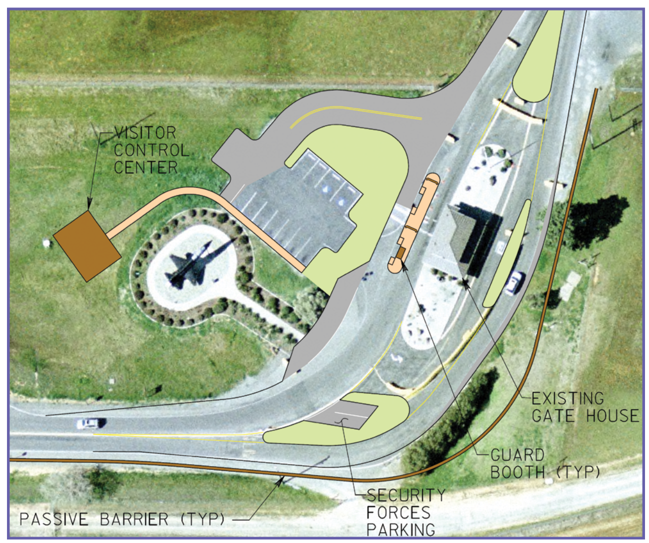

12. Interim ECF Solutions

An ECF is a unique facility which requires significant real estate and funding in order to construct to comply with standards. In today's financial climate, the ultimate design may not be feasible. While an ultimate design shall be considered for master planning and programming purposes; alternative, interim solutions should be implemented to improve security, safety, and capacity at existing ECFs in the near term.

This Chapter will identify interim ECF solutions that can be constructed in the near term to assist an installation with meeting some current design standards and maximizing available resources. The solutions discussed will bring an existing ECF closer to, or maybe into, full compliance with the UFC. If a fully compliant ECF cannot be achieved through interim solutions, then an ultimate design should be planned and programmed for non-compliant ECFs. Where appropriate, interim solutions should be designed and constructed so that they can be reused in the ultimate design.

12.1. SAFETY/SECURITY SOLUTIONS

Safety and security are important priorities of an ECF that typically work hand-in-hand. When the necessary infrastructure for security personnel to operate an ECF is provided, safety for ECF users increases and vice versa. A number of interim solutions can be provided in the near-term to improve safety for both motorist and security personnel, as well as enhance security and operations.



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12.1.1. Signing and Pavement Markings

One of the easiest and most cost effective improvements is to improve the signing and pavement markings throughout the ECF. Some installations provide too much signing which has nothing to do with the roadway elements or ECF operations. Over signing promotes negligence for all signs, creating a potential safety concern. Signs that do not pertain to the ECF should be removed and relocated outside the ECF corridor. Chapters 7 and 8 detail the minimum signing and pavement markings required in the approach and response zones to warn or alert motorist of changing conditions.

In addition to safety, advance signing may be able to reduce congestion by alerting motorist on where to go or what lane to be in. Congestion and delay can sometimes be attributed to poor signing especially if unfamiliar motorist (visitors, contractors, etc) frequently use the ECF.

12.1.2. ID Check Islands

Per UFC 4-022-01, ID check islands should be designed 10 feet wide by 50-75 feet in length. For existing ECFs, where islands do not exist or meet standards, the width at the ID Check area should be maximized to incorporate an ID check island. Providing an adequate refuge area for security personnel will assist with processing and improve safety at the ID check area.

Where 12 to 14 foot wide processing lanes are provided, lanes could be narrowed to 10 feet in order to provide width for an ID check island. However, the width of a processing lane shall be never less than 10 feet. At a minimum, an ID check island 4 feet wide by 25 feet in length should be provided. Although the island size is not ideal in the long term because it is not sufficient for a guard booth, the island does provide some protection for security personnel performing ID checks by defining a work area.

In locations where a canopy or sidewalk exists, a few options could be considered to provide ID check islands. If a sidewalk exists under the canopy, relocate the sidewalk outside the canopy and utilize the existing width to provide an ID check island between processing lanes. With the outer most travel lane shifting closer to the canopy columns, it may be desirable to decrease the width of the lanes to 10 feet to maximize the distance from the edge of pavement to the column, or the columns may require impact attenuators and concrete barrier flush with the face of the columns to protect motorists from striking them. If no sidewalk or insufficient width is provided under the canopy, an additional processing lane could be provided outside the canopy allowing adequate room to install an ID check island adjacent the canopy columns.

Exhibit 12.1: ID Check Island Dimensions

ID CHECK ISLAND DIMENSIONS FEET (METERS)	
Preferred	10 x 75 (3 x 23)
Minimum	10 x 50 (3 x 15)
Minimum without Guard Booth	4 x 25 (1.2 x 7.6)

Exhibit 12.2: Low Cost ID Check Island Enhancements

Before

After

Before

After

12.1.3. Canopies

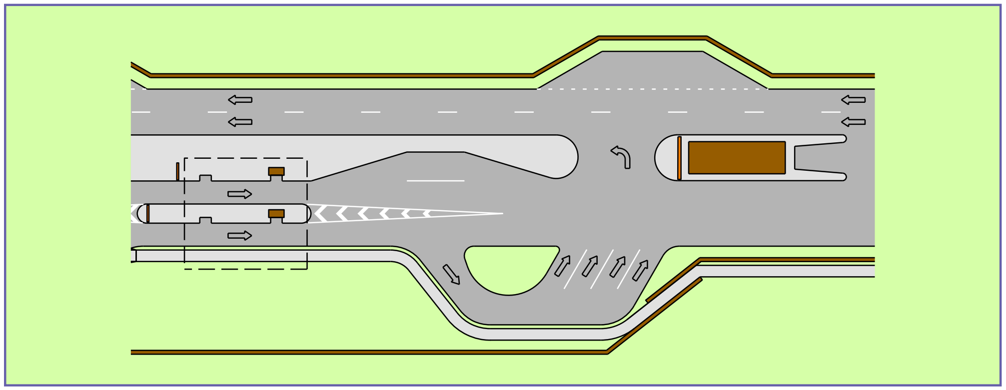
Canopies should be provided at the ID check and inspection areas. Canopies protect against inclement weather and facilitate processing/inspection. Canopies provide a location to mount security cameras and additional lighting to enhance operations. Where permanent canopies cannot be provided, temporary or more innovative solutions should be considered to minimize costs.

The picture in the bottom left is an example of an innovative canopy design utilized to enhance safety and security while minimizing costs.

12.1.4. Inspection Areas

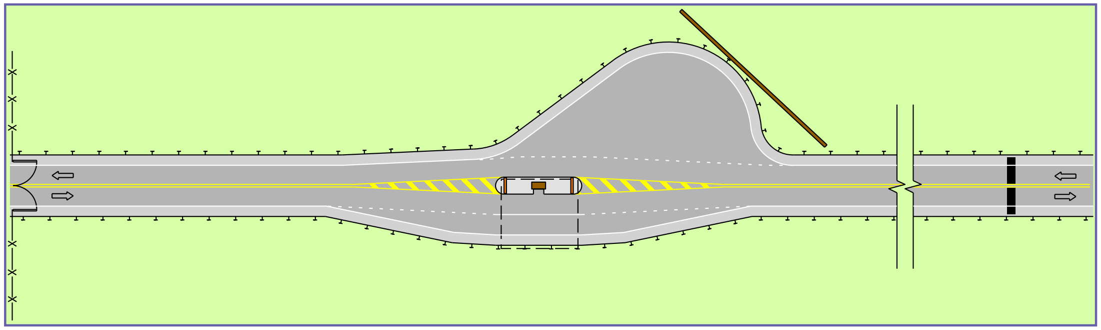
When the preferred inspection area layout cannot be provided, a pull-off alternative inspection area can be utilized instead. Pull-off areas can be provided before or after the ID check area to perform random inspections but should still be able to accommodate a minimum of two vehicles. A canopy or enclosure is preferred for all inspection areas but is not required for pull-off inspection areas. Design the alternative inspection area so that a canopy can be added at a later time as a different project.

Exhibit 12.3: Alternative Pull-off Inspection Area



Per the Army Standard for ACPs, when the inbound peak hour vehicle volumes fall below 290 vehicles per hour, a low-volume ECF design may be used whereby the vehicle search area may be incorporated into the ID check area as a second lane under the ID check area canopy.

Exhibit 12.4: Low-volume ECF Design



IF REMOVABLE BOLLARD CHICANES ARE UTILIZED DURING OFF-PEAK HOURS, THE PROPER SPACING, SIGNS AND DELINEATION MUST BE UTILIZED PER SECTION 4.2.

KNOWING THAT SDDCTEA DOES NOT ENDORSE THE USE OF IN-ROADWAY BOLLARD SYSTEMS, THREAT CALCULATIONS SHOULD BE CONDUCTED TO VERIFY A REMOVABLE BOLLARD CHICANE PROVIDES A BENEFIT TO THE INTERIM DESIGN.

12.1.5. Response Zone Length Reduction

Almost all installations have some form of final denial barrier. Many of the older final denial barriers were installed before the development of the threat calculations described in this document and if still in place, they likely do not meet current standards. Where existing final denial barriers are short 2-3 seconds of the required minimum time, additional treatments may be applied to decrease the response times required. Refer to **Section 8.5 Other AVB Solutions** for information on possible solutions to reduce the required length of the response zone. In addition to the treatments identified in that section, another method of reducing the response zone is to use a different AVB safety scheme that requires a shorter response timeline. These schemes are presented in **Section 8.4.3**.

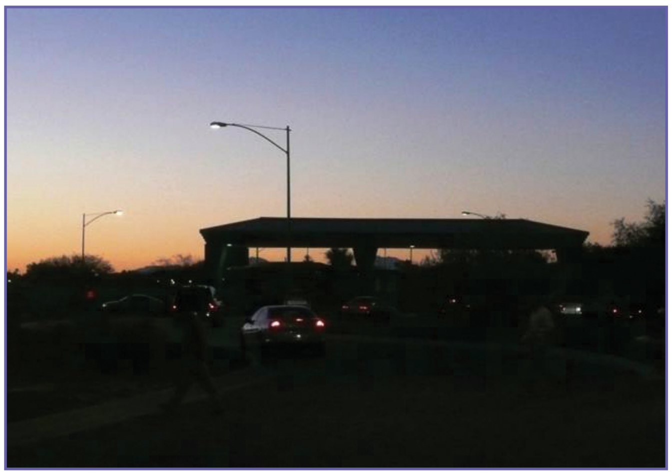
In addition to suggestions in **Section 8.5**, removable bollard chicanes may be utilized in the response zone to reduce the required response zone length by up to 40%. Removable bollard chicanes should only be used during off-peak hours when minimal congestion occurs at the ECF. During the peak hour, or periods of heavy traffic, bollard chicanes may not necessary since the queued traffic at the ID check limits the speed of a threat vehicle. **If removable bollard chicanes are utilized during off-peak hours, the proper spacing, signs and delineation must be utilized per Section 4.2. Knowing that SDDCTEA does not endorse the use of in-roadway bollard systems, threat calculations should be conducted to verify a removable bollard chicane provides a benefit to the interim design.**

If the required response zone time / length cannot be met through the use of the methods described above, the final denial barriers may have to be deactivated until the proper response time can be provided. Consult SDDCTEA for more guidance regarding response zone treatments.

12.1.6. ECF Lighting

Providing additional lighting at an ECF can be a relatively inexpensive way to substantially increase safety and security. At primary and secondary ECFs, a significant portion of operations occur between dawn and dusk. If the proper lighting is not provided, safety and security may be reduced. ECF lighting is important so that motorists and guards can see each other. ECFs should be designed with lighting features that support the operational requirements during dawn, dusk, or night time periods. Even if the ECF is intended to be used only during daylight hours, lighting should be considered in the event there is a change in usage.

Lighting should be complete and continuous. Specific areas of the ECF have their own lighting requirements governed by service and UFC 3-530-01. Lighting shall transition from the existing roadway lighting so that it does not blind the driver or backlight signs. Additional lighting may be required where pedestrian activity is anticipated. Refer to Chapter 11 for additional information regarding lighting.



BEFORE

AFTER

12.2. CAPACITY SOLUTIONS

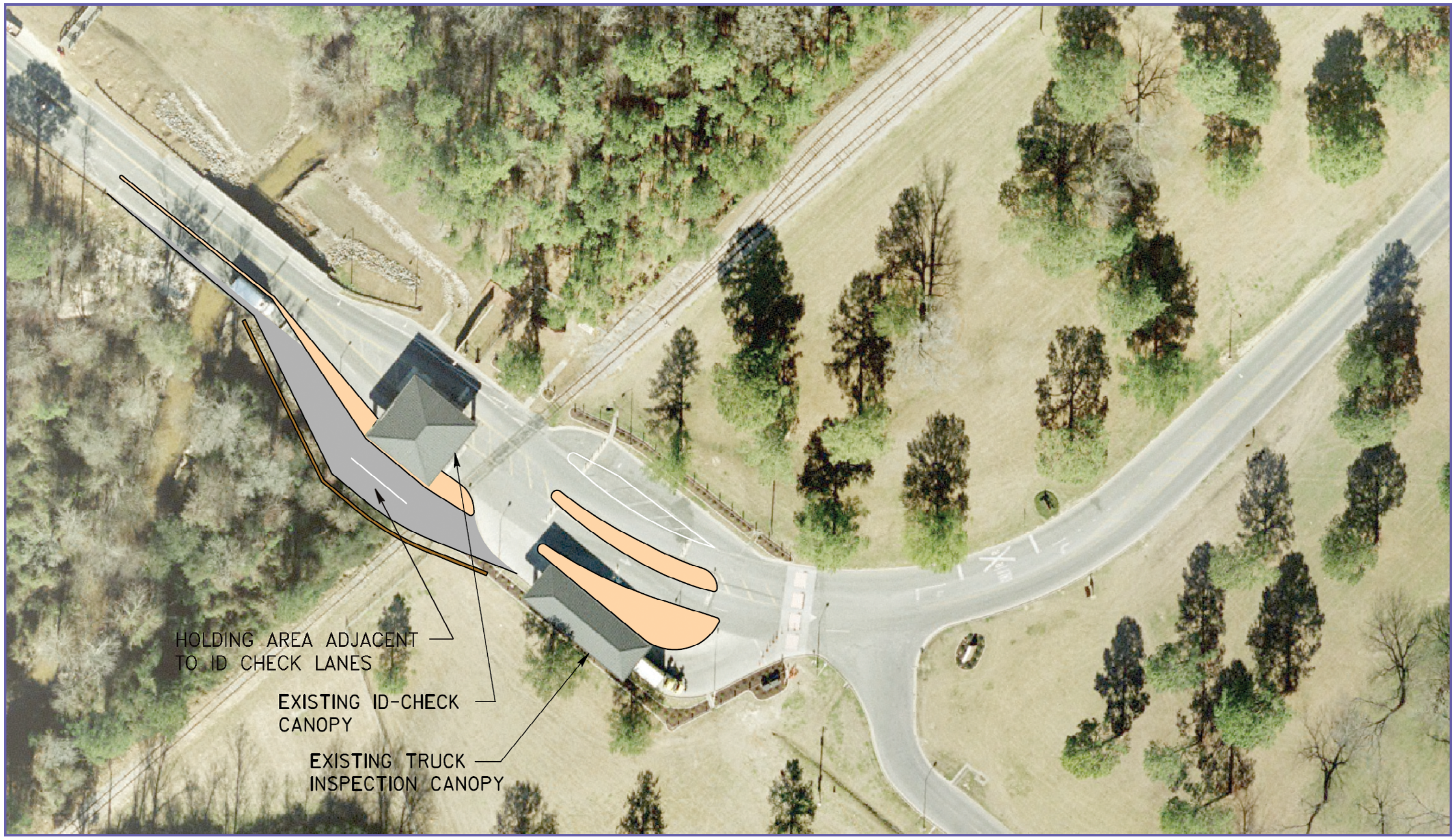
Next to response zone length, lack of capacity is another primary problem often experienced at ECFs. Adding capacity to an existing ECF can be a significant undertaking and very costly. Fortunately, there are a few lower cost options to increase capacity. The solutions provided are for capacity issues occurring only in the ECF and not at adjacent intersections or bottlenecks.

12.2.1. Commercial/Contractor Vehicle Processing

At ECFs where commercial and contractor vehicles are processed along with installation personnel, a reduction in capacity may be experienced because of the additional time required to process commercial vehicles and the lack of holding area. The queue from the commercial vehicle inspection area may be so long that it actually blocks lanes in the approach zone reducing the throughput of the ECF before the ID check area, creating a safety concern.

Two infrastructure alternatives should be considered to alleviate this problem. One alternative is to increase the processing capacity at the commercial vehicle inspection area by providing an additional lane to perform inspections. If manpower shortfalls or cost prohibit the additional processing lane, a larger holding area should be considered. The commercial vehicle holding area should be able to accommodate the maximum commercial vehicle queue length experienced on a typical busy day. If pavement costs are too high to implement this alternative in the near term, consider providing a gravel lot or roadway with signing depicting how commercial vehicles should park until a paved lot or road can be provided. **Exhibit 12.5** is an example of providing a segregated roadway and small holding area for commercial vehicle processing.

Exhibit 12.5: Example of Segregating Truck Holding Area from Roadway



Background Image Source: Google Earth

Other non-infrastructure related alternatives could be considered as well:

✓ Increase manpower during commercial vehicle peak hour to improve processing capacity
✓ Stagger commercial vehicle arrival times
✓ Adjust the commercial vehicle gate hours to avoid the POV peak hour

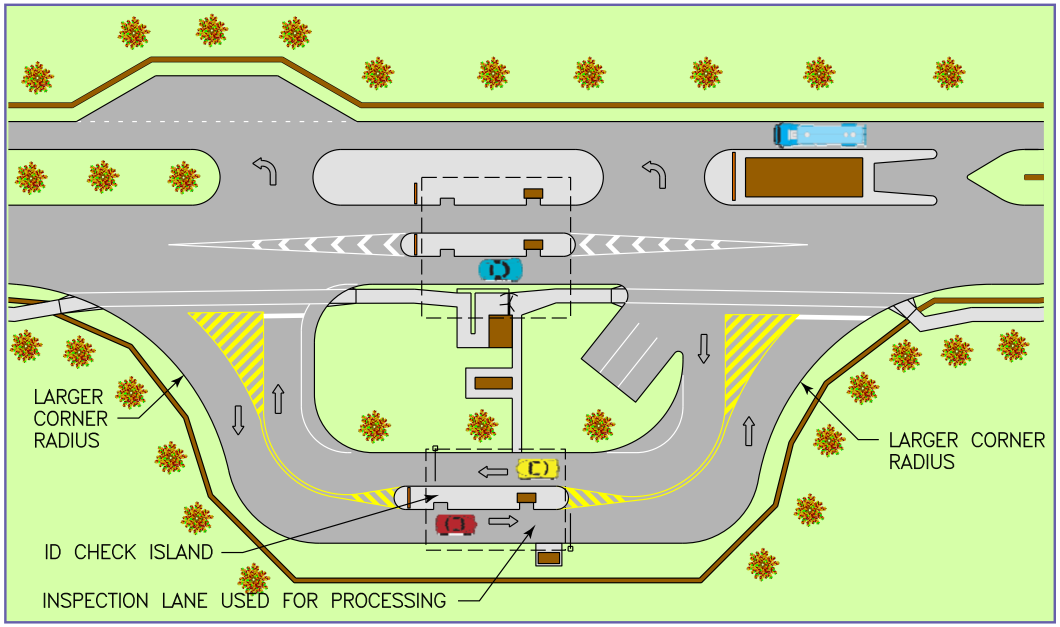
12.2.2. Processing Vehicles in Inspection Areas

While it is not preferred, vehicles could be processed in the POV or truck inspection area during the peak hour to reduce congestion at the ECF. POV inspection areas should only be used for processing under the following circumstances:

- ✓ FPCON level of Charlie or lower
- ✓ Vehicles arrive in platoons
- ✓ Significant or consistent queuing during the peak hour
- ✓ Alternative vehicle inspection area provided (NO in-lane inspections)
- ✓ National Guard bases, where drill weekend traffic is much higher than the typical weekday traffic and consists of primarily all military personnel; or
- ✓ Trucks do not arrive during hours used for vehicular processing (if truck inspection lane is used)

Bi-directional POV inspection areas are preferred because two lanes are available in the inspection area. One lane can be used for POV processing, and the other can be used for inspections. If the POV inspection area is to be utilized for processing on a regular basis, the entrance and exit lanes into the inspection area should be modified to with larger corner radii for traffic turning in and out of the inspection area. This will promote traffic flow through the area. An ID check island shall be provided for security personnel in the POV inspection area if vehicle processing is to be conducted. Consult SDDCTEA for more information. A POV inspection area used for POV processing is shown in **Exhibit 12.6**.

Exhibit 12.6: POV Inspection Area for Vehicle Processing



12.2.3. Reversible Lanes

An innovative way to increase capacity at an existing ECF is the utilization of reversible lanes during the peak hours. Reversible lanes can be utilized strictly in the access control zone or throughout the length of the ECF as discussed in Section 7.4. Lane reversal should be only used after a traffic engineering study shows it to be practical and safe.

If the following conditions are met, lane reversal may be considered:

✓ Roadway cannot be widened because of physical or monetary constraints
✓ At least 65 percent, or preferably 75 percent, of the traffic is traveling in one direction during peak periods
✓ Cyclic congestion is evident
✓ Opposite direction capacity is adequate during reversal
✓ Roadway is at least three lanes
✓ Route and width are continuous

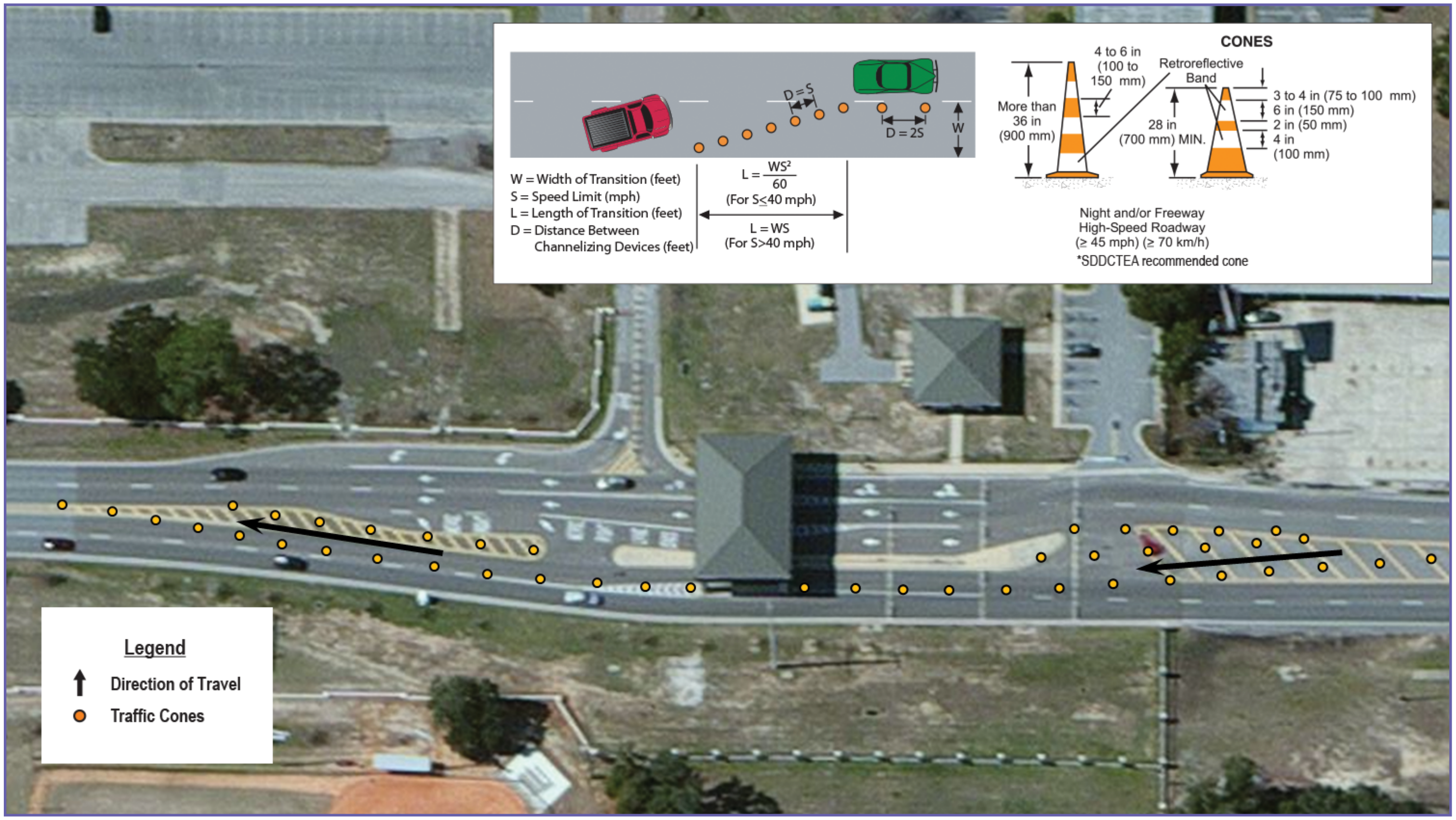
When modifying an ECF to accommodate reversible lane(s), an ID check island shall be provided between each reversible lane designed to process vehicles. In addition, consider providing a canopy over the reversible lanes to assist security personnel performing ID checks. Reversible lanes are not preferred because of potential crash increases, but when correctly implemented can increase capacity during the peak hour. Note that even if there is no outbound capacity in the peak hour, at least one outbound lane must remain open to allow for accommodating rejected vehicles. Therefore this is not a viable option where there is only one outbound lane.

For long lane-reversal sections, overhead lane use control signs or signals are necessary (and signals are recommended). These signals have 12-inch (300 millimeters) rectangular faces displaying a RED X, YELLOW X or a DOWNWARD GREEN ARROW. A YELLOW X indication means that a road user is to prepare to vacate the lane over which the signal indication is located because a lane control change is being made to a steady RED X signal indication; generally, this is not necessary for ECF applications. Overhead signals should be spaced so that a driver always has at least one in view, with a maximum spacing of ¼ mile (0.4 kilometers).

For short lane-reversal sections, such as through the access control zone, cones and signing are adequate for control. In the access control zone, movable barriers may be used if only the ID check lane is reversible and to control vehicle movements. Another alternative is to modify the median islands before and after the ID check area to negate the need for moveable barriers. With this configuration, signing and traffic cones are still required. In most situations, the ECF itself is the bottleneck therefore the reversible lane is only necessary through the access control zone.

Exhibit 12.7 is an example of a short-lane reversal through the access control zone to increase processing capacity during the peak hour of an existing ECF. Proper traffic cones spacing and tapers shall be utilized when implementing a reversible lane.

Exhibit 12.7: Short-lane Reversal Using Traffic Cones



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12.2.4. Maximizing Manpower

If available, increasing manpower during peak hour conditions is an easy way to increase capacity. Additional ID checkers would only be necessary for the peak hour or until traffic reduces. If single processing is currently being used, increasing to tandem processing can increase capacity by approximately 30-40% per lane. However, adding additional ID checkers beyond tandem processing provides little benefit. Where resources are available, increase or relocate manpower to ECFs that experience significant congestion during the peak hour.

If tandem processing is to be implemented, ID check islands may need to be modified to accommodate the additional ID checker.

12.2.5. Travel Demand Management

Demand management programs attempt to address congestion at the root of the problem by reducing the number of vehicles on the road. These initiatives work to modify driver behavior by encouraging people to make fewer single-occupancy trips, travel in off-peak hours when possible, and support land-use policies that reduce the demand for vehicular travel. **Exhibit 12.8** shows six typical demand management strategies used to reduce congestion. Of the six strategies, only the first four have typical applications on military installations. For more information, refer to SDDCTEA's *Travel Demand Management* bulletin dated March 2011.

Exhibit 12.8: Demand Management Strategies

Strategy	Examples
Travel Alternatives	✓ Telework ✓ Flexible work hours/alternate work schedules ✓ Pedestrian/bicycle travel
HOV	✓ Carpooling ✓ Guaranteed ride home program ✓ Parking pricing and cash-out programs ✓ Instant ridesharing program
Transit	✓ Enhanced bus quality and transit stops ✓ Internal shuttle service ✓ Guaranteed ride home program ✓ Subsidized fares
Land Use	✓ "Smart Growth" policies ✓ Pedestrian/bicycle/transit connections
Freight	✓ Truck-only toll lanes (TOT) ✓ Lane restrictions ✓ Delivery restrictions ✓ Availability on rail or barge
Pricing	✓ High occupancy toll lanes (HOT) ✓ Time-of-day pricing ✓ Activity center pricing

As discussed at the beginning of this chapter, the solutions presented are for existing ECFs that do not meet current standards. These improvements are considered interim until an ultimate design can be constructed. An ultimate design should be planned and programmed for non-compliant ECFs.

Exhibit 12.9: Interim Improvement Checklist

LOW COST ENHANCEMENT CHECKLIST	
SAFETY/SECURITY	**CAPACITY**
✓ Provide/improve signing/pavement markings	✓ Increase manpower during peak hour
✓ Provide/modify ID check islands • Preferred 10’x75’ • Standard 10’x50’ • Minimum 4’x25’ (no guardbooth)	✓ Utilize POV inspection area for processing
✓ Provide alternative POV inspection area	✓ Utilize reversible lanes
✓ Reduce response zone length • Overspeed/wrong way detection • Alternative AVB strategies • Removable bollard chicane	✓ Increase commercial/contractor vehicle processing capacity • Add processing lane • Expand holding area
✓ Improve lighting • Approach zone • Access control zone • Response zone	✓ Travel demand management
✓ Install canopies • ID check area • POV inspection area • Commercial inspection area	

12.2.6. National Guard Installations

National Guard installations have unique needs that differ from larger active duty installations. National Guard bases often are open most, if not all weekdays, and typically have a light amount of traffic, requiring only one lane at the ECF. On drill weekends, there is a significant increase to the traffic demand. Smaller installations may only have one gate with one or two lanes and a truck inspection lane. It may also have a POV inspection lane. Drill weekend morning peak periods may require 2, 3, or 4 inbound lanes at the ECF. Fortunately, truck demand is mostly limited to weekdays and not part of weekend traffic demand. In this case, all available lanes should be used for ID checking / POV processing - to include the truck processing lane and the POV inspection lane. Even though drill weekends are recurring events, their frequency is limited. As a result, using the inspection lanes for POV processing is considered acceptable for these occasions.

Guard bases also could use special treatments with response zones. Guard bases frequently have limited real estate available for an ECF. In this case, the Stop Control AVB Safety Scheme may be appropriate, in order to limit the length of the response zone. The Stop Control scheme has a shortened response zone length, but requires all traffic (inbound and outbound) to stop at the AVB. Because of this stop, the roadway capacity is lessened. Capacity at the stopping point may be adequate for normal weekday traffic, but inadequate for the drill weekend peak periods. To alleviate this, a guard could be located at the barrier to wave traffic on, thereby avoiding the stop condition at the barrier. If a threat were to be detected, the guard would function as the traffic control and stop traffic at the barrier.

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ECF Evaluation Checklist

✓ Early Coordination with Stakeholders
- Installation Command
- Security forces
- Department of public works
- Safety officers
- First responders
- External stakeholders (county, external responders, state DOT)
- Guards
- SDDCTEA
- Others

✓ Information Gathering
- Previous studies
- Planning data
- Electronic mapping
- Force protection information
- Signalized intersection data
- Crash data
- Staffing levels

✓ Traffic Data Gathering and Collection
- Automated traffic recordings of inbound and outbound traffic volumes
- Peak hour ECF volumes
- Peak hour queue observations
- Peak hour turning movement counts at adjacent intersections
- 24-hour and peak hour truck volumes
- 24-hour and peak hour pedestrian and bicycle volumes
- Visitor control center demands and processing
- Inspection procedures and processing (POVs and Trucks)

✓ Safety Review
- Guard
- Motorists
- Hazards/fixed objects
- Sight distance
- Conflicts
- Signing and markings (layout/retroreflectivity)
- Lighting review

✓ Operational and Manpower Review
- Interaction with signals (retiming opportunities)
- Queue mitigation strategies
- Processing procedures and manpower usage

✓ Future Traffic Projections
- Inspection Procedures
- Planning considerations
- Master plan
- BRAC
- Deployment
- Local growth

✓ ECF Sizing Analyses
- Number of lanes (single vs tandem)
- Visitor control center parking
- Truck holding

✓ Installation-wide Review
- By ECF (lanes, ingress vs egress)
- Consolidation scenarios to maximize resources
- Total needs

✓ Short-term, Low-cost Solutions
- Guard safety
- Motorist safety
- Speed management
- Operations and processing
- Low-cost facility needs

✓ Alternatives Development
- Possible charrette
- Pros/cons matrix
    - ◆ Land use and development impacts
    - ◆ Environmental constraints
    - ◆ Utility constraints and needs
    - ◆ Force protection constraints (stand-off, etc.)
    - ◆ Wind, sun, weather, etc.
    - ◆ Traffic constraints
    - ◆ Flight line restrictions
- Preliminary active vehicle barrier assessments
- Preliminary costs
- Rationale for dismissal

✓ Refined, Preferred Alternative
- Standards compliance review and rationale
- Functions/feature review

✓ Active Vehicle Barrier (AVB) Response Zone and Safety Scheme Assessment
- Threat scenarios and response calculations
- Stand-off issues
- Scheme alternatives and selection
- Traffic and safety layout
- Intersection design, if applicable

✓ Technology Assessment
- Role of automation
- Overheight detection
- ITS opportunities (DMS, CCTV)

✓ Special Events Overview (Evacuation, Housing Turnover, Public Event)

✓ Cost Estimates
- By key areas (roadway, facilities, AVB, etc.)
- Programmatic approach
- Report

Military Surface Deployment and Distribution Command
Transportation Engineering Agency