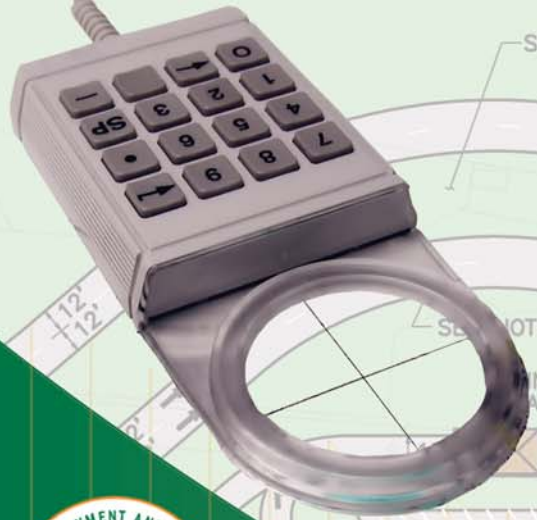

Traffic and Safety Engineering for Better Entry Control Facilities

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Military Surface Deployment and Distribution Command
Transportation Engineering Agency

2006

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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.

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FORWARD

Evolution of the Entry Control Facility (ECF)

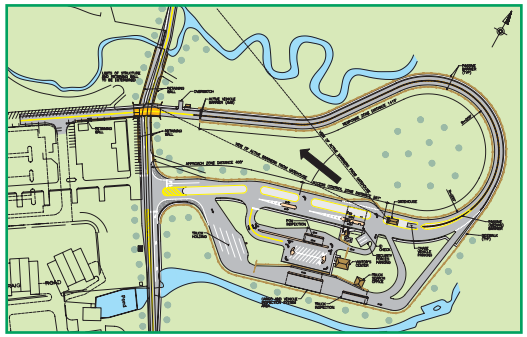
Prior to 2001, entry control varied by installation. While some installations had ECFs, most existing ECFs lacked the features and functionality required by current standards. Other installations had limited or no entry control. As a result, mandatory vehicle entry control became a Department of Defense (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* 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.

It is not totally clear what the long-term requirements of an ECF will be; however, a systematic assessment can help identify short-term and long-term needs that are required to address security, safety, and traffic flow.

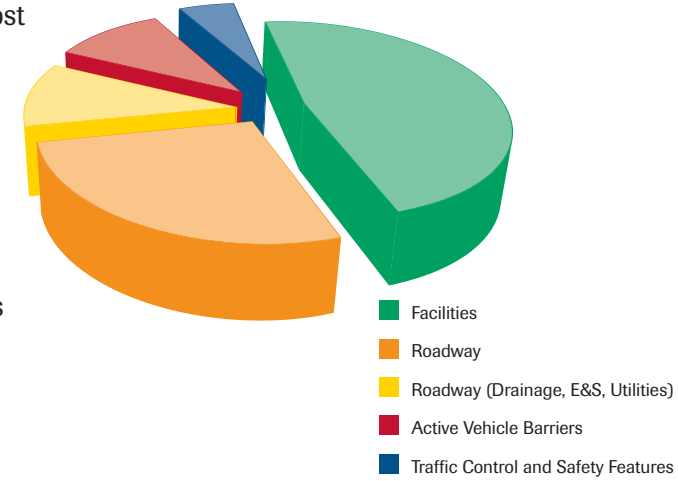
Why is Traffic Flow and Safety Important?



ECFs 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 active vehicle barriers, 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 . . . . . $75,000-$150,000
Active Vehicle Barriers . . . . . $100,000-$200,000
New ECF. . . . . $2,000,000-$5,000,000



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.

✓ $3 million for each fatality
✓ $63,000 for each injury
✓ $2,300 for each property damage only (PDO) crash
Source: Federal Highway Administration 2005

SDDCTEA

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 60 ECF engineering assessments at military installations all over the world.
✓ SDDCTEA assisted in the development of the Department of the Army, Army Access Control Points Standard Definitive Design and as such has a thorough understanding of how to apply these standards.
✓ SDDCTEA participated in the development of UFC 4-022-01 *Security Engineering: 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
✓ Aesthetics

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, and command group

Military Surface Deployment and Distribution Command – Transportation Engineering Agency (SDDCTEA)
was formerly known as Military Traffic Management Command – Transportation Engineering Agency (MTMCTEA)

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

Objective: 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

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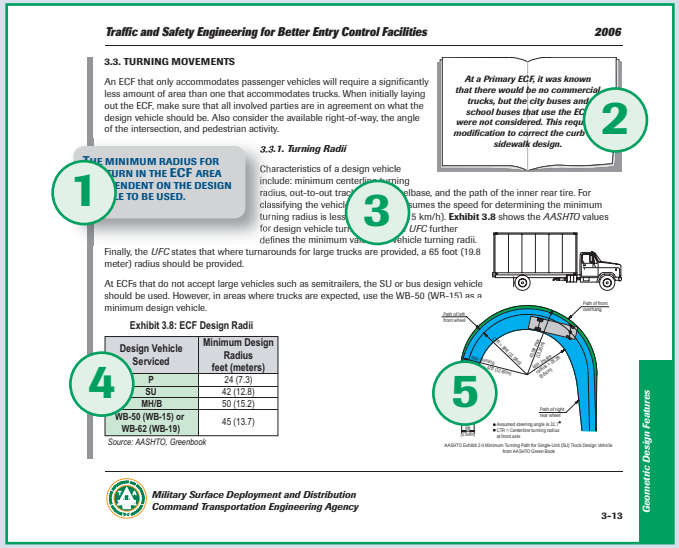
HOW TO USE THIS GUIDE

This pamphlet provides the traffic and safety related guidance necessary to plan and design an Entry Control Facility (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. **Lesson Learned** – Provides a specific example about the subject matter.
3. **Content** – Provides specific, detailed guidance.
4. **Tables** – Provides easy-to-use, look-up values for a particular subject.
5. **Graphics** – Illustrate the content or represent an applied condition.



Traffic and Safety Engineering for Better Entry Control Facilities 2006

3.3. 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.

At a Primary ECF, it was known that there would be no commercial trucks, but the city buses and school buses that use the ECF were not considered. This required modification to correct the curb sidewalk design.

3.3.1. Turning Radii

Characteristics of a design vehicle include: minimum centerline turning radius, out-to-out track, wheelbase, and the path of the inner rear tire. For classifying the vehicle, UFC assumes the speed for determining the minimum turning radius is less than 15 km/h). **Exhibit 3.8** shows the *AASHTO* values for design vehicle turning radii. The *UFC* further defines the minimum values for vehicle turning radii.

Finally, the *UFC* states that where turnarounds for large trucks are provided, a 65 foot (19.8 meter) radius should be provided.

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-50 (WB-15) as a minimum design vehicle.

Exhibit 3.8: 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-50 (WB-15) or WB-62 (WB-19)	45 (13.7)

Source: AASHTO, Greenbook

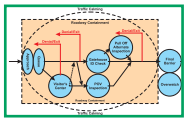
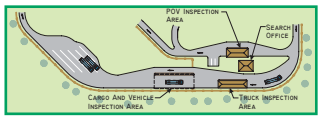
Military Surface Deployment and Distribution Command Transportation Engineering Agency

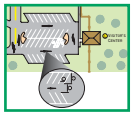
3-13

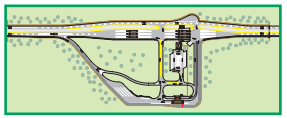
Geometric Design Features

COMMON ACRONYMS USED THROUGHOUT THIS PAMPHLET

AASHTO	American Association of State Highway and Transportation Officials
ACP	access control point
ADA	Americans with Disabilities Act
AT	antiterrorism
ATR	automated traffic recordings
AVB	active vehicle barrier
CCTV	closed circuit television
CMS	changeable message sign
COTS	commercial off-the-shelf
CRI	color rendition index
DoD	Department of Defense
DOT	Department of Transportation
ECF	entry control facility
FHWA	Federal Highway Administration
FPCON	force protection condition
HAR	highway advisory radio
IESNA	Illuminating Engineering Society of North America
ITE	Institute of Transportation Engineers
ITS	intelligent transportation system
MUTCD	*Manual on Uniform Traffic Control Devices*
O&D	origin and destination
POV	privately owned vehicle
PTZ	pan-tilt-zoom
R/W	right-of-way
RAM	random antiterrorism measure
RPM	raised pavement marker
SF	security forces
SDDCTEA	Surface Deployment and Distribution Command Transportation Engineering Agency
TMC	turning movement count
TRB	Transportation Research Board
UFC	*Unified Facilities Criteria*
vph	vehicles per hour
vphpl	vehicles per hour per lane





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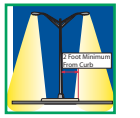
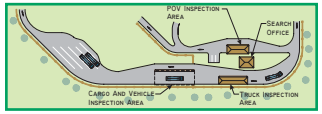




1. Introduction

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

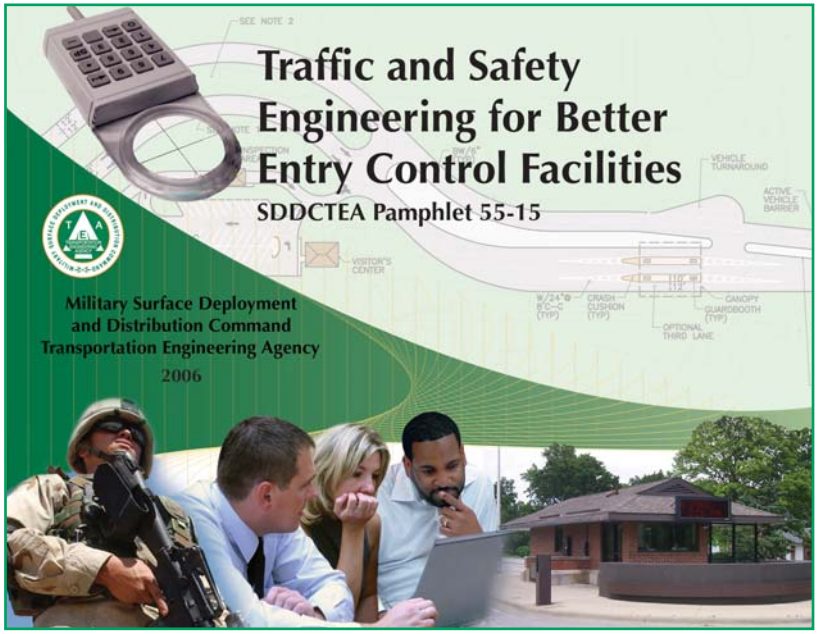
Mandatory vehicle access control to military installations is a Department of Defense (DoD) requirement (DoD Directives 5200.8 and 5200.8-R).

The purpose of this pamphlet is to provide guidance on methods to improve traffic flow and traffic safety while achieving force protection at Entry Control Facilities (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.

1.1. USE OF THIS GUIDANCE

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.



THE *UFC* PRESENTS A UNIFIED APPROACH TO THE DESIGN OF ENTRY CONTROL FACILITIES (ECF).

1.2. 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.

1.2.1. Unified Facilities Criteria

In May 2005, Unified Facilities Criteria (*UFC*) 4-022-01 on *Security Engineering: Entry Control Facilities/Access Control Points* (herein referred to as "the *UFC*") was released. The *UFC* 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.

The *UFC* provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and DoD Field Activities.

1.2.2. DoD Requirements

DoD 5200.8-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.

DoD 2000.12, is a directive for the DoD Antiterrorism Force Protection (ATFP) Program. DoD O-2000.12-H, *DoD Antiterrorism Handbook*, was issued under the authority of DoD 2000.12. DoD O-2000.12-H defines the DoD Force Protection Condition (FPCON) System (previously known as THREATCONs), 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.

DoD 2000.16, *DoD Antiterrorism Standards*, and service directives require the installation or the activity Commanding Officer to define the access control measures at installations. Additionally, DoD 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 DoD 2000.16, which required DoD Components to adopt and adhere to common criteria and minimum construction standards to mitigate antiterrorism vulnerabilities and terrorist threats. The minimum standards are based on the assumption that larger amounts of explosives will be detected and denied entry at the controlled perimeter of an installation. It is, therefore, critical that the infrastructure and operating procedures at the ECF are capable of that mission.

1.2.3. Service Requirements

Each service of the military has specific guidance regarding access to installations.

Exhibit 1.1: ECF Service Design References

Service	Design References
Department of Air Force	*Entry Control Facility Design Guide* but *UFC* governs
Department of Army	*Standard Definitive Design; Access Control Points for U.S. Army Installations*
Department of Navy	OPNAV 5530.14D, *Navy Physical Security Manual*
Department of Navy – Marine Corps	MCO P5530.14, *Marine Corps Physical Security Program*
Combatant Commander Requirements	Some combatant commanders have issued requirements for entry control procedures for installations within their area of responsibility. Ensure any such requirements are incorporated in addition to the requirements found in the *UFC*. Resolve any differences in the requirements for the design for and ECF by applying the most stringent requirement.

Source: The UFC

1.2.4. Design Guidance

Several publications 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. The *UFC* 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), *Security Engineering: Entry Control Facilities/ Access Control Points*, 2005	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*, 1999	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)*, 2003	This document provides guidance on the placement of signs, pavement markings, and the rules that govern their placement.	mutcd.fhwa.dot.gov available for download
Federal Highway Administration (FHWA), *Standard Highway Signs*, 2004	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* (Greenbook), 2004	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, 2002*	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*, 2000	This document provides guidance on methodologies for estimating capacity and determining level of service for transportation facilities.	gulliver.trb.org available for purchase
Illuminating Engineering Society of North America (IESNA), *Guidelines on Security Lighting for People, Property, and Public Spaces*, 2003	This document is intended to establish guidelines for the design and implementation of security lighting.	iesna.org available for purchase

GENERALLY, FPCON BRAVO+ IS THE DESIGN CONDITION FOR MOST NEW ECFS.

1.3. FORCE PROTECTION CONDITIONS (FPCONS)

The level of identification and inspection requirements at an ECF will vary depending on the FPCON level. In accordance with DoD O-2000.12-H, "the security measures employed during FPCON Bravo+ must be capable of being maintained indefinitely without causing undue hardship, affecting operational capability, or aggravating relations with local authorities." Therefore, an ECF must be capable of supporting the security measures employed during FPCON Bravo+, including any RAM employed in accordance with the installation AT Program.

Bravo+ represents a condition between Bravo and Charlie employed at many military installations. Generally, FPCON Bravo+ is the design condition for most new ECFs; however, it is important for the designers of an ECF to understand the anticipated operations, traffic volume, and flow during all FPCONs. At FPCONs Charlie and Delta, traffic congestion is expected and can be relieved by authorizing entry to mission-essential personnel only.

1.4. RANDOM ANTITERRORISM MEASURE (RAM)

Implementing RAM involves identifying at any FPCON a set of measures extracted from higher FPCONs that supplement the basic FPCON measures already in place. Therefore, the level of identification and inspection at the ECF will vary depending on the FPCON and the use of RAM. 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 when a general threat of possible terrorist activity exists but warrants only a routine security posture.	The baseline posture.	No direct checks; considered an open installation.
ALPHA	Applies when there is a general threat of possible terrorist activity against personnel and installations, the nature and extent of which are unpredictable.	The measures must be capable of being maintained indefinitely.	Vehicle identification only.
BRAVO (including BRAVO+ used at some installations)	Applies when an increased and more predictable threat of terrorist activity exists.	The measures must be capable of being maintained for weeks without causing undue hardship or extreme traffic delays, affecting operational capability, or aggravating relations with local authorities.	Vehicle and driver identification, random vehicle inspection.
CHARLIE	Applies when an incident occurs or intelligence is received indicating some form of terrorist action against personnel and installations is imminent.	Implementation of this measure for more than a short period may create hardship and affect the peacetime activities of the unit and its personnel.	Identification of vehicle and all vehicle occupants, more frequent random vehicle inspection.
DELTA	Applies in the immediate area where a terrorist attack has occurred or when intelligence has been received that terrorist action against a specific location is likely. Normally, FPCON DELTA is declared as a localized warning.	Measures to be implemented in response to local warning and not intended to be sustained for lengthy periods of time.	ID checks of all vehicle occupants and complete inspections of all vehicles. Generally, only mission-essential personnel report for duty.

Source: The UFC

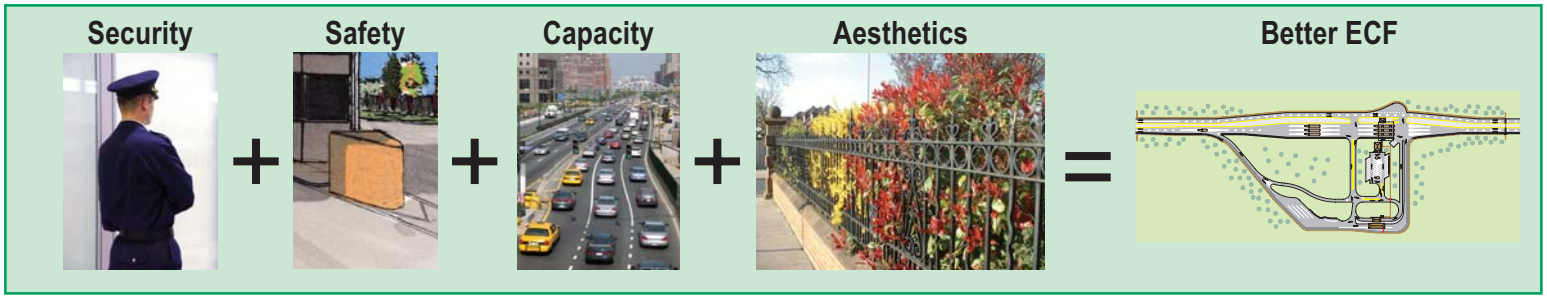
1.5. PURPOSE OF AN ECF

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 the priorities in **Exhibit 1.4** 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	The first objective of an ECF is to maintain perimeter security for the installation. An ECF must accommodate RAM and must be able to operate at all FPCONs.
Safety	Security Forces safety includes provisions for personnel protection against attack, errant drivers, and considerations for climate, location, and orientation. Safety measures such as reflectorization, impact attenuators, lighting, and properly placed pavement markings are an integral part of providing a safe approach for drivers entering or exiting the installation.
Capacity	The ECF needs to be capable of meeting the traffic demand with little or no delay under FPCON BRAVO+.
Aesthetics	The ECF should provide a sense of arrival for the approaching individual. At a minimum, the ECF should impart an immediate impression of professionalism and commitment to facilities excellence.



***UFC* ECF CLASSIFICATIONS:**

- ❑ **PRIMARY**
- ❑ **SECONDARY**
- ❑ **LIMITED USE**
- ❑ **PEDESTRIAN ACCESS**

1.6. ECF CLASSIFICATIONS

The *UFC* classifies ECFs into four "use classifications: primary, secondary, limited use, and pedestrian access." The *UFC's* ECF classifications are based on the intended function and anticipated usage of the ECF.

For the purpose of consistency, this pamphlet utilizes similar terminology as shown in **Exhibit 1.5**, but also discusses other classifications of note including a Main ECF, Truck-Only ECF, and Restricted Right-of-Way ECF, shown on pages 1-13 to 1-30.

Exhibit 1.5: ECF Classifications

Use Classification	Traffic Volumes	Typical Hours of Operation	Highest FPCON Operation	Services Provided	Visitor Passes	Random Inspection	Authorized Visitors	Truck Processing
Primary	High	24/7 – open continuously	Delta	Optional designation as truck and delivery ECF	✓	✓	✓	✓
Secondary	Moderate	Regular hours, but closed at times	Closed at or above Charlie	Optional designation as truck and delivery ECF		✓	✓	✓
Limited Use	Low	Open for special purposes	NA	Tactical vehicles, HAZMAT, special events, etc				
Pedestrian Access	Varies	Varies	Closed at or above Charlie	Personnel only, could be located near installation housing areas, near schools, or as part of a Main or Primary ECF	✓		✓	

Source: The UFC

1.7. ECF FUNCTIONS

An ECF can have many functions. 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.

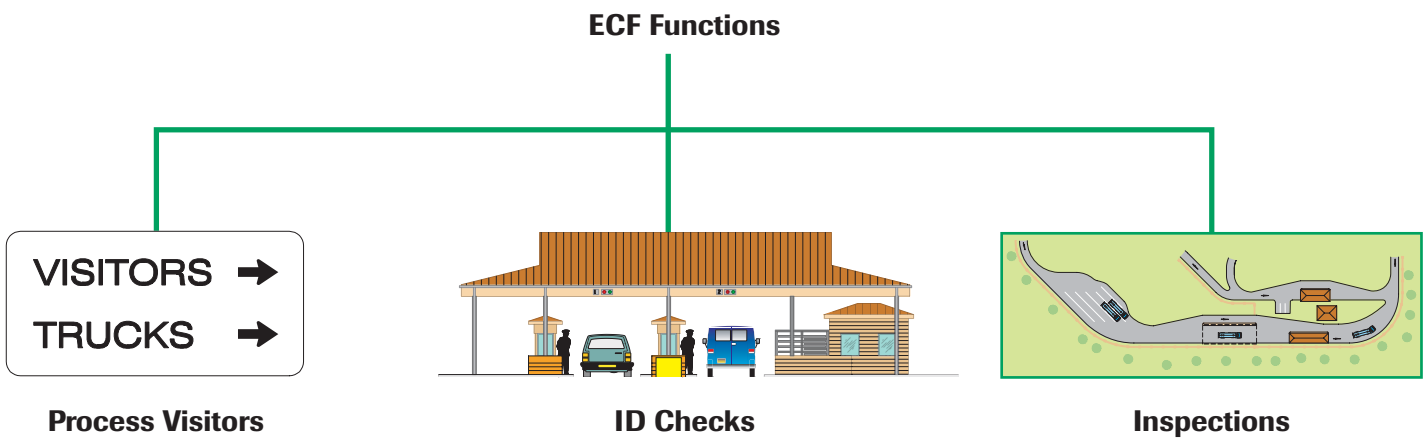
BASIC ECF FUNCTIONS:

- ❑ VISITOR PROCESSING
- ❑ VEHICLE REGISTRATION
- ❑ ID CHECKS
- ❑ PRIVATELY OWNED VEHICLE (POV) INSPECTIONS
- ❑ TRUCK INSPECTION

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.

The UFC illustrates three functional relationships:

✓ Condition 1 – ECF with visitor processing
✓ Condition 2 – ECF without visitor processing
✓ Condition 3 – Truck ECF processing



1.7.1. Condition 1 – ECF With Visitor Processing

Condition 1 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's center needs to be designed such that vehicles are removed from traffic prior to the ID checkpoint, and the following are provided:

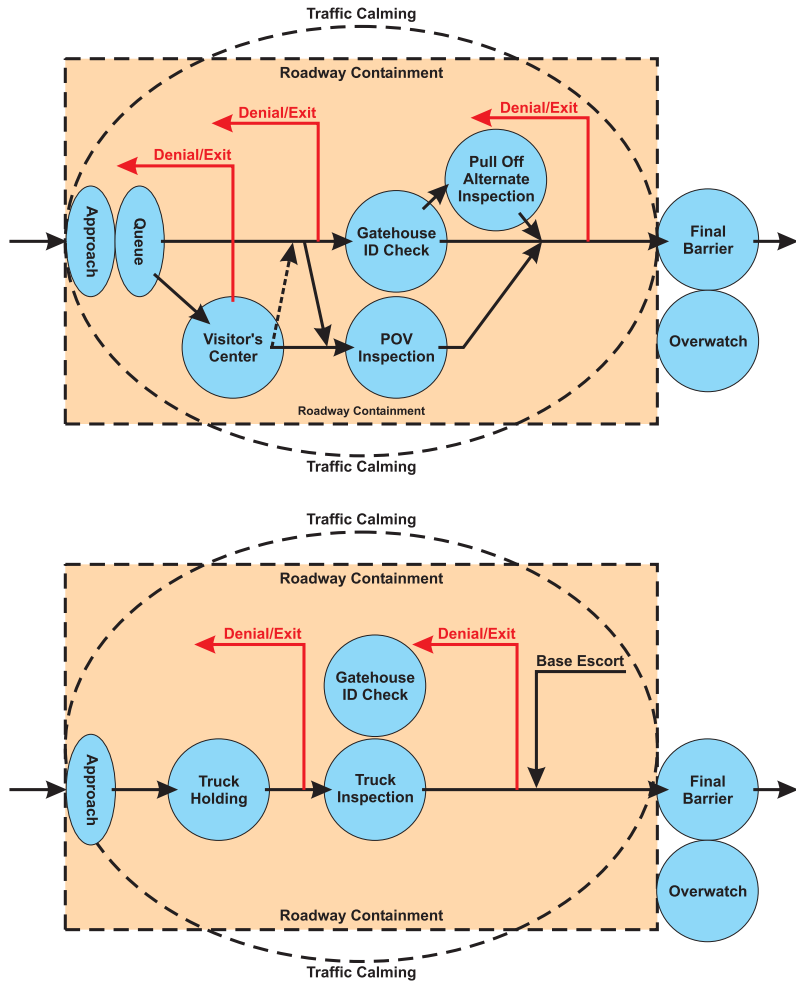
✓ Parking to meet the demand
✓ Entrance back into traffic prior to the ID checkpoint
✓ Rejection capabilities

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



1.7.2. Condition 2 – ECF Without Visitor Processing

Condition 2 provides the same components as Condition 1 without provisions for a visitor's center.

1.7.3. Condition 3 – Truck ECF Processing

Truck 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.

1.8. ECF ZONES

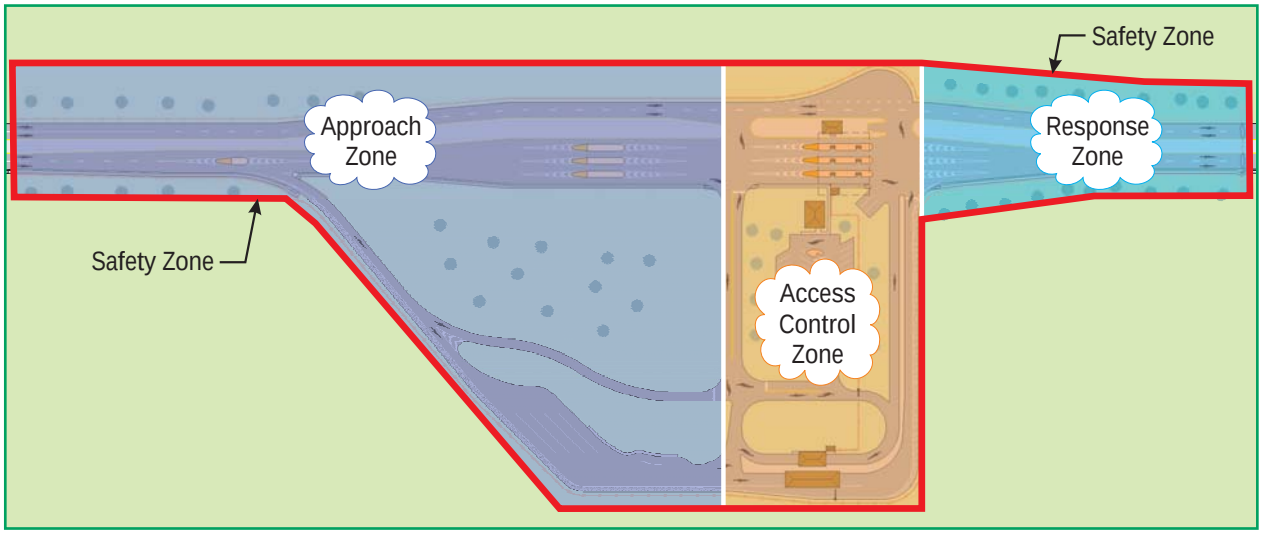
An ECF consists of four zones, each encompassing specific functions and operations. Beginning at the installation property boundary, the zones include the safety zone, approach zone, access control zone, and response zone.

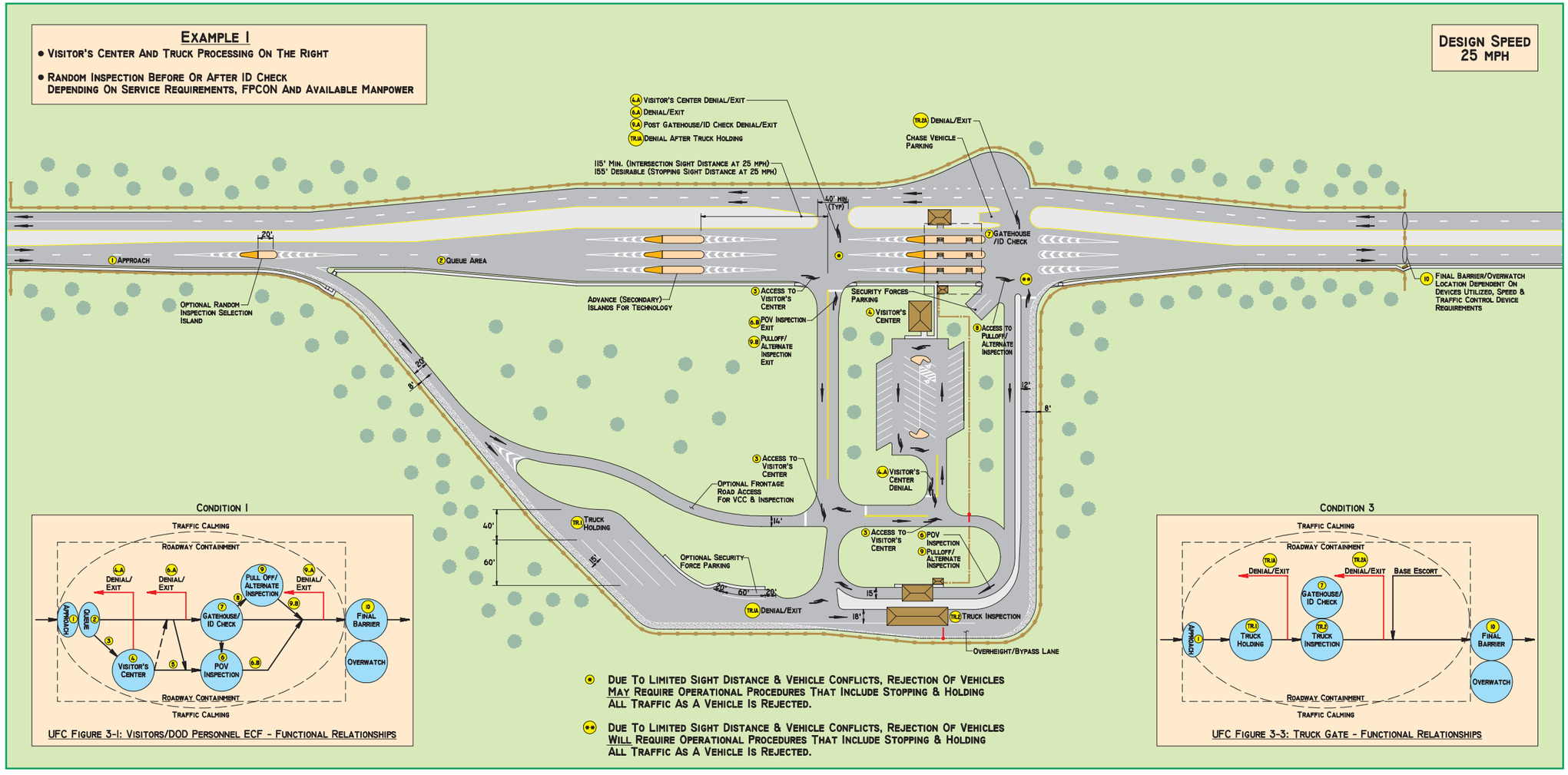
Pages 1-13 to 1-30 show examples of ECFs that conform to the criteria and incorporate the functional relationships and zones.

Exhibit 1.7: 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 check point to the active vehicle barriers	Provide measures to react to and resist a threat

Source: The UFC

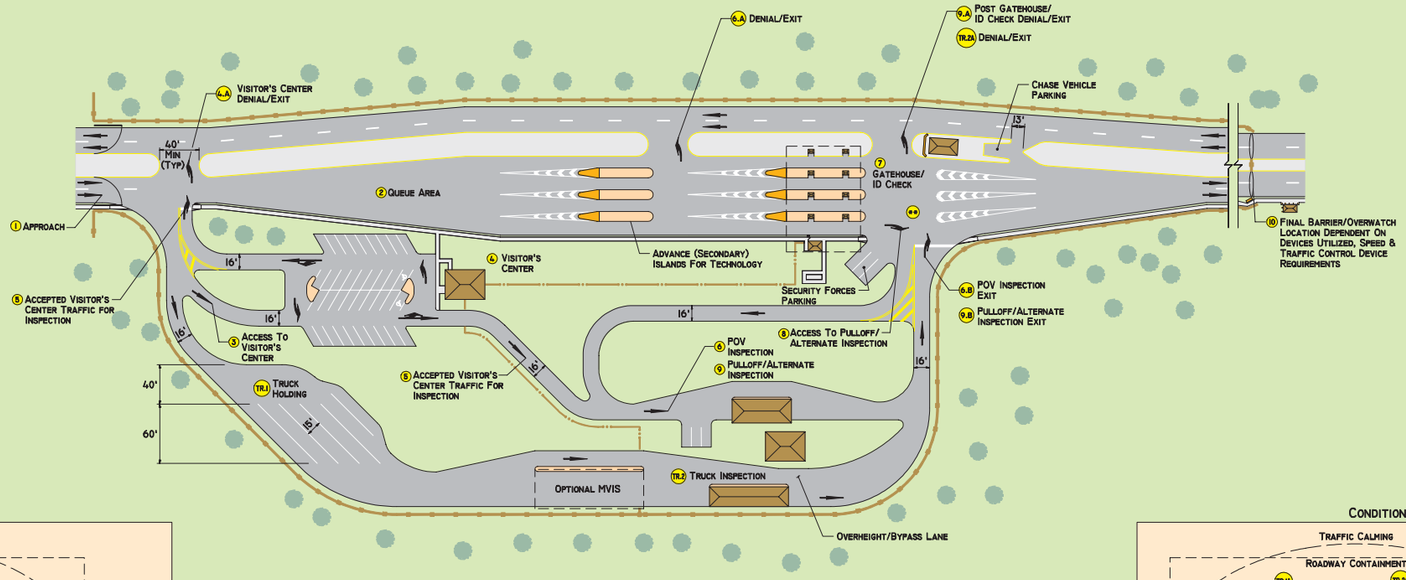



EXAMPLE 1
• VISITOR'S CENTER AND TRUCK PROCESSING ON THE RIGHT
• RANDOM INSPECTION BEFORE OR AFTER ID CHECK DEPENDING ON SERVICE REQUIREMENTS, FPCON AND AVAILABLE MANPOWER
DESIGN SPEED 25 MPH
4.A VISITOR'S CENTER DENIAL/EXIT
6.A DENIAL/EXIT
9.A POST GATEHOUSE/ID CHECK DENIAL/EXIT
TR.1A DENIAL AFTER TRUCK HOLDING
TR.2A DENIAL/EXIT
CHASE VEHICLE PARKING
115' MIN. (INTERSECTION SIGHT DISTANCE AT 25 MPH)
155' DESIRABLE (STOPPING SIGHT DISTANCE AT 25 MPH)
40' MIN. (TYP)
20'
1 APPROACH
2 QUEUE AREA
7 GATEHOUSE /ID CHECK
10 FINAL BARRIER/OVERWATCH LOCATION DEPENDENT ON DEVICES UTILIZED, SPEED & TRAFFIC CONTROL DEVICE REQUIREMENTS
OPTIONAL RANDOM INSPECTION SELECTION ISLAND
ADVANCE (SECONDARY) ISLANDS FOR TECHNOLOGY
3 ACCESS TO VISITOR'S CENTER
6.B POV INSPECTION EXIT
9.B PULLOFF/ ALTERNATE INSPECTION EXIT
SECURITY FORCES PARKING
4 VISITOR'S CENTER
8 ACCESS TO PULLOFF/ ALTERNATE INSPECTION
12'
8'
20'
8'
3 ACCESS TO VISITOR'S CENTER
OPTIONAL FRONTAGE ROAD ACCESS FOR VCC & INSPECTION
4.A VISITOR'S CENTER DENIAL
14'
40'
60'
TR.1 TRUCK HOLDING
OPTIONAL SECURITY FORCE PARKING
3 ACCESS TO VISITOR'S CENTER
6 POV INSPECTION
9 PULLOFF/ ALTERNATE INSPECTION
20'
60'
20'
15'
TR.1A DENIAL/EXIT
18'
TR.2 TRUCK INSPECTION
OVERHEIGHT/BYPASS LANE
CONDITION 1
TRAFFIC CALMING
ROADWAY CONTAINMENT
4.A DENIAL/ EXIT
6.A DENIAL/ EXIT
9 PULL OFF/ ALTERNATE INSPECTION
9.A DENIAL/ EXIT
APPROACH
QUEUE
7 GATEHOUSE/ ID CHECK
9.B
10 FINAL BARRIER
3
4 VISITOR'S CENTER
5
5 POV INSPECTION
6.B
OVERWATCH
ROADWAY CONTAINMENT
TRAFFIC CALMING
UFC FIGURE 3-1: VISITORS/DOD PERSONNEL ECF - FUNCTIONAL RELATIONSHIPS
CONDITION 3
TRAFFIC CALMING
ROADWAY CONTAINMENT
TR.1A DENIAL/EXIT
TR.2A DENIAL/EXIT
BASE ESCORT
7 GATEHOUSE/ ID CHECK
APPROACH
TR.1 TRUCK HOLDING
TR.2 TRUCK INSPECTION
10 FINAL BARRIER
OVERWATCH
ROADWAY CONTAINMENT
TRAFFIC CALMING
UFC FIGURE 3-3: TRUCK GATE - FUNCTIONAL RELATIONSHIPS
• DUE TO LIMITED SIGHT DISTANCE & VEHICLE CONFLICTS, REJECTION OF VEHICLES MAY REQUIRE OPERATIONAL PROCEDURES THAT INCLUDE STOPPING & HOLDING ALL TRAFFIC AS A VEHICLE IS REJECTED.
•• DUE TO LIMITED SIGHT DISTANCE & VEHICLE CONFLICTS, REJECTION OF VEHICLES WILL REQUIRE OPERATIONAL PROCEDURES THAT INCLUDE STOPPING & HOLDING ALL TRAFFIC AS A VEHICLE IS REJECTED.

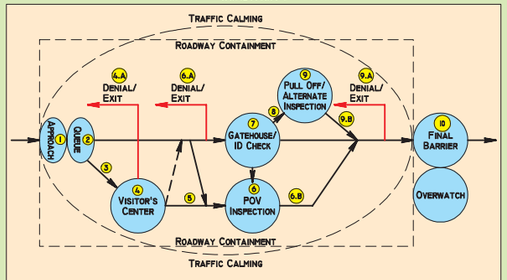
Example 2

- Visitor's Center And Truck Processing On The Right
- Random Inspection Before Or After Depending On Service Requirements, FPCON And Available Manpower

Design Speed 25 mph



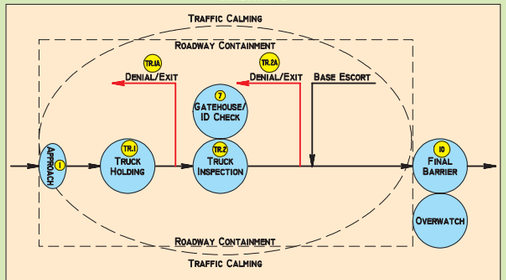
Condition I



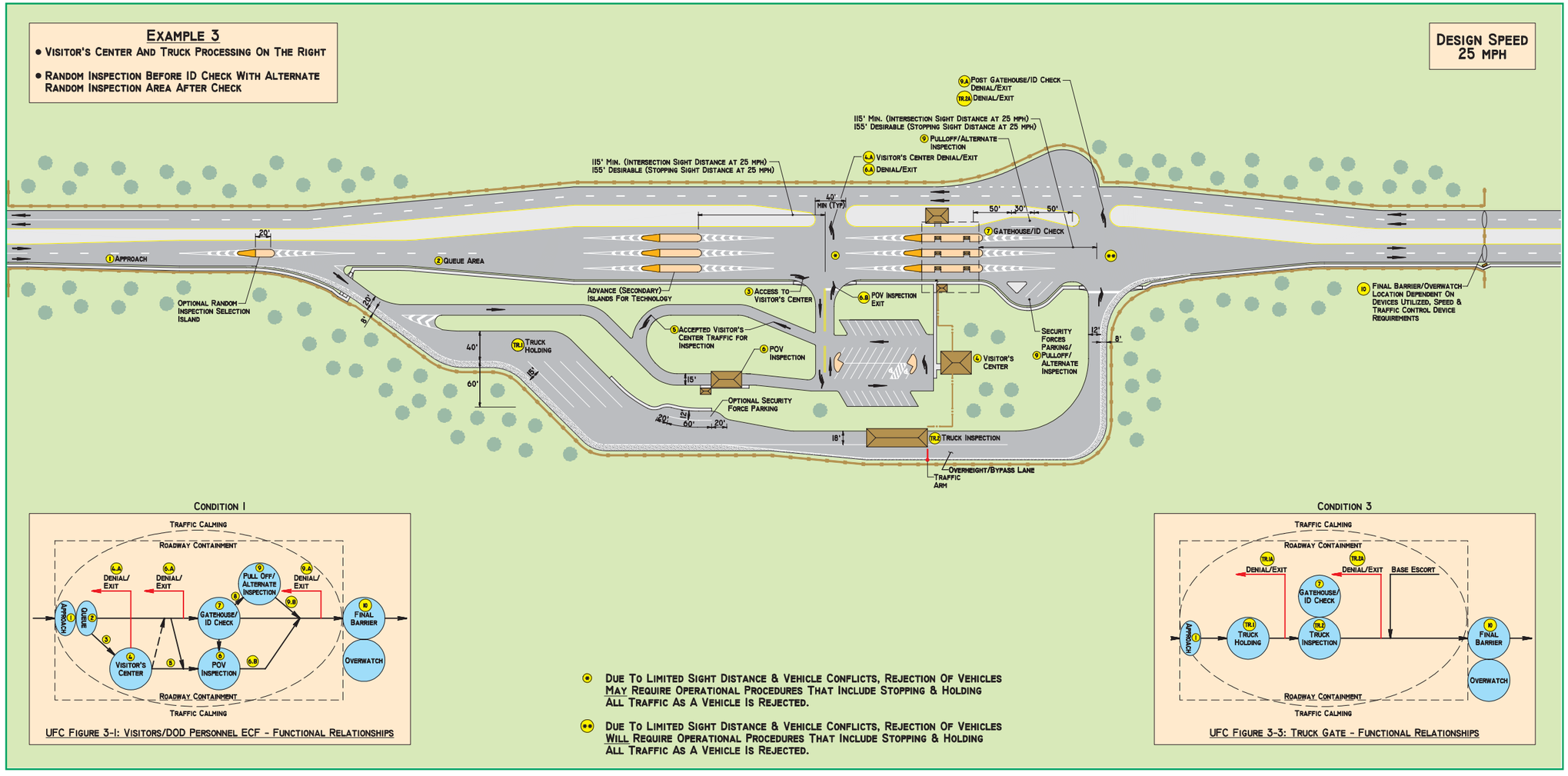
UFC Figure 3-1: Visitors/DOD Personnel ECF - Functional Relationships

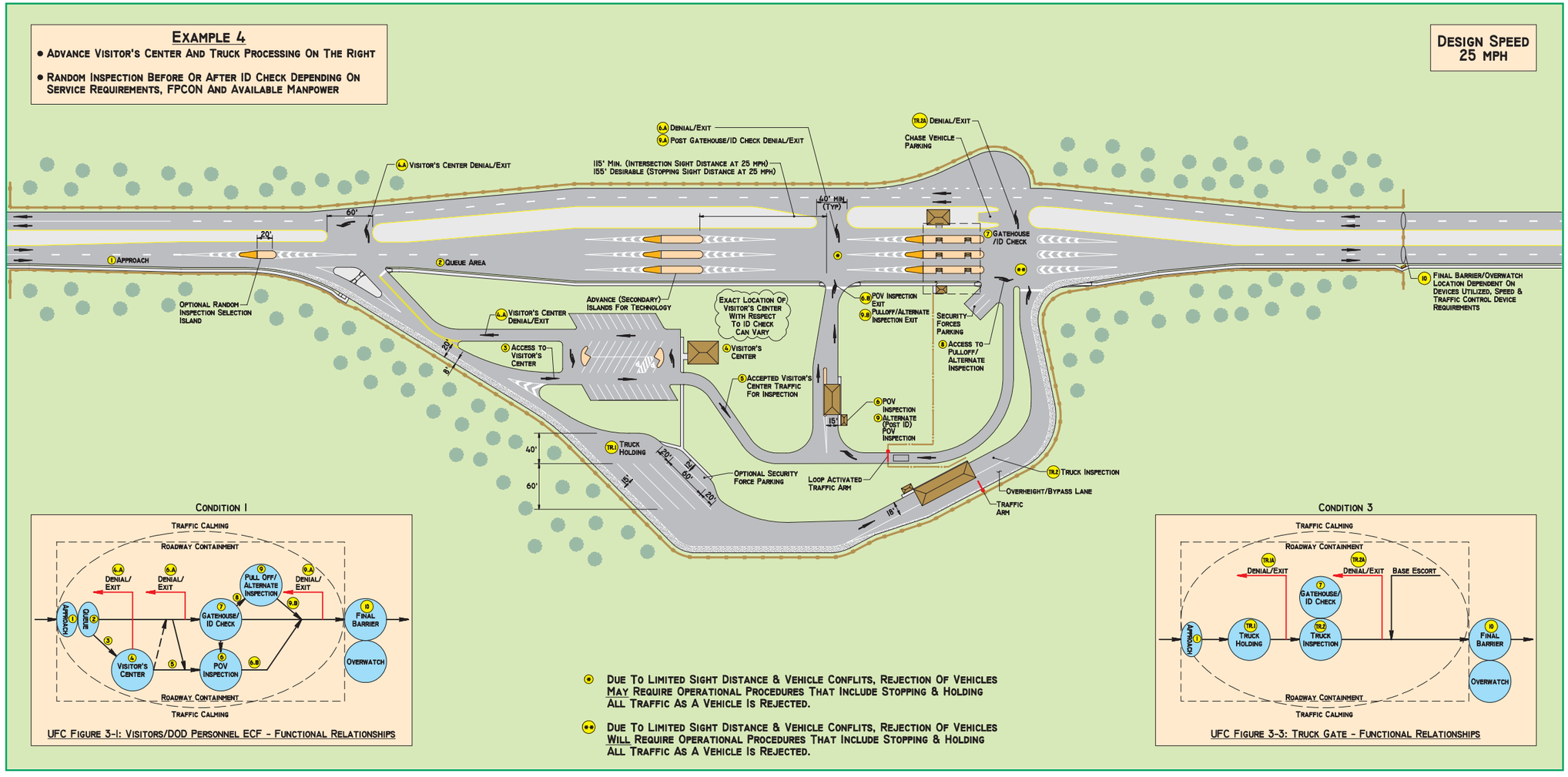
(**) Due To Limited Sight Distance & Vehicle Conflicts, Rejection Of Vehicles Will Require Operational Procedures That Include Stopping & Holding All Traffic As A Vehicle Is Rejected.

Condition 3



UFC Figure 3-3: Truck Gate - Functional Relationships


Example 3
• Visitor's Center And Truck Processing On The Right
• Random Inspection Before ID Check With Alternate Random Inspection Area After Check
Design Speed 25 mph
9.A Post Gatehouse/ID Check Denial/Exit
TR.2A Denial/Exit
115' Min. (Intersection Sight Distance at 25 mph)
155' Desirable (Stopping Sight Distance at 25 mph)
9 Pulloff/Alternate Inspection
4.A Visitor's Center Denial/Exit
6.A Denial/Exit
115' Min. (Intersection Sight Distance at 25 mph)
155' Desirable (Stopping Sight Distance at 25 mph)
40' Min (Typ)
50'
30'
50'
7 Gatehouse/ID Check
1 Approach
2 Queue Area
20'
Optional Random Inspection Selection Island
Advance (Secondary) Islands For Technology
3 Access To Visitor's Center
6.B POV Inspection Exit
5 Accepted Visitor's Center Traffic For Inspection
6 POV Inspection
TR.1 Truck Holding
40'
60'
15'
Optional Security Force Parking
20'
60'
20'
18'
TR.2 Truck Inspection
Overheight/Bypass Lane
Traffic Arm
4 Visitor's Center
Security Forces Parking/
9 Pulloff/ Alternate Inspection
12'
8'
10 Final Barrier/Overwatch Location Dependent On Devices Utilized, Speed & Traffic Control Device Requirements
Condition 1
Traffic Calming
Roadway Containment
4.A Denial/ Exit
6.A Denial/ Exit
9 Pull Off/ Alternate Inspection
9.A Denial/ Exit
Approach 1
Queue 2
3
4 Visitor's Center
5
7 Gatehouse/ ID Check
6 POV Inspection
6.B
9.B
10 Final Barrier
Overwatch
Roadway Containment
Traffic Calming
UFC Figure 3-1: Visitors/DOD Personnel ECF - Functional Relationships
Condition 3
Traffic Calming
Roadway Containment
TR.1A Denial/Exit
TR.2A Denial/Exit
Base Escort
7 Gatehouse/ ID Check
Approach 1
TR.1 Truck Holding
TR.2 Truck Inspection
10 Final Barrier
Overwatch
Roadway Containment
Traffic Calming
UFC Figure 3-3: Truck Gate - Functional Relationships
• Due To Limited Sight Distance & Vehicle Conflicts, Rejection Of Vehicles May Require Operational Procedures That Include Stopping & Holding All Traffic As A Vehicle Is Rejected.
•• Due To Limited Sight Distance & Vehicle Conflicts, Rejection Of Vehicles Will Require Operational Procedures That Include Stopping & Holding All Traffic As A Vehicle Is Rejected.



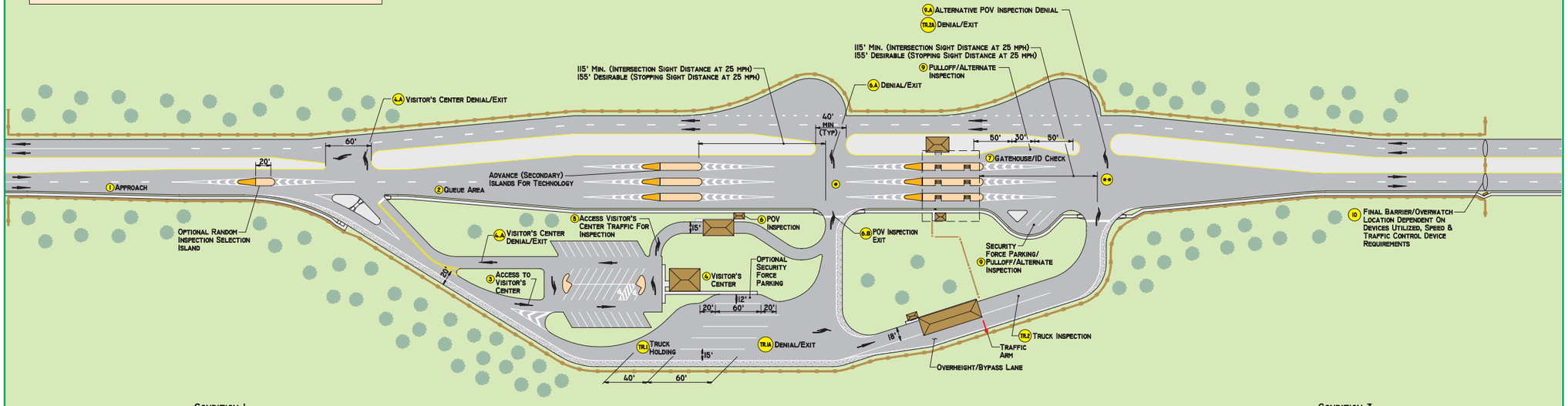
UFC Figure 3-1: Visitors/DOD Personnel ECF - Functional Relationships

UFC Figure 3-3: Truck Gate - Functional Relationships

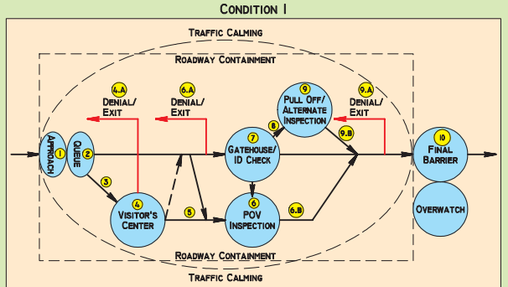
Example 5

- Advance Visitor's Center And Truck Processing On The Right
- Random Inspection Before ID Check With Alternate Inspection Area After ID Check

Design Speed 25 mph

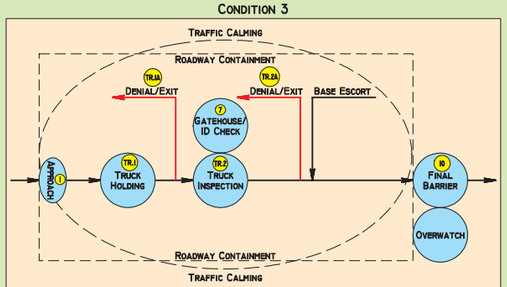


Condition 1



UFC Figure 3-1: Visitors/DOD Personnel ECF - Functional Relationships

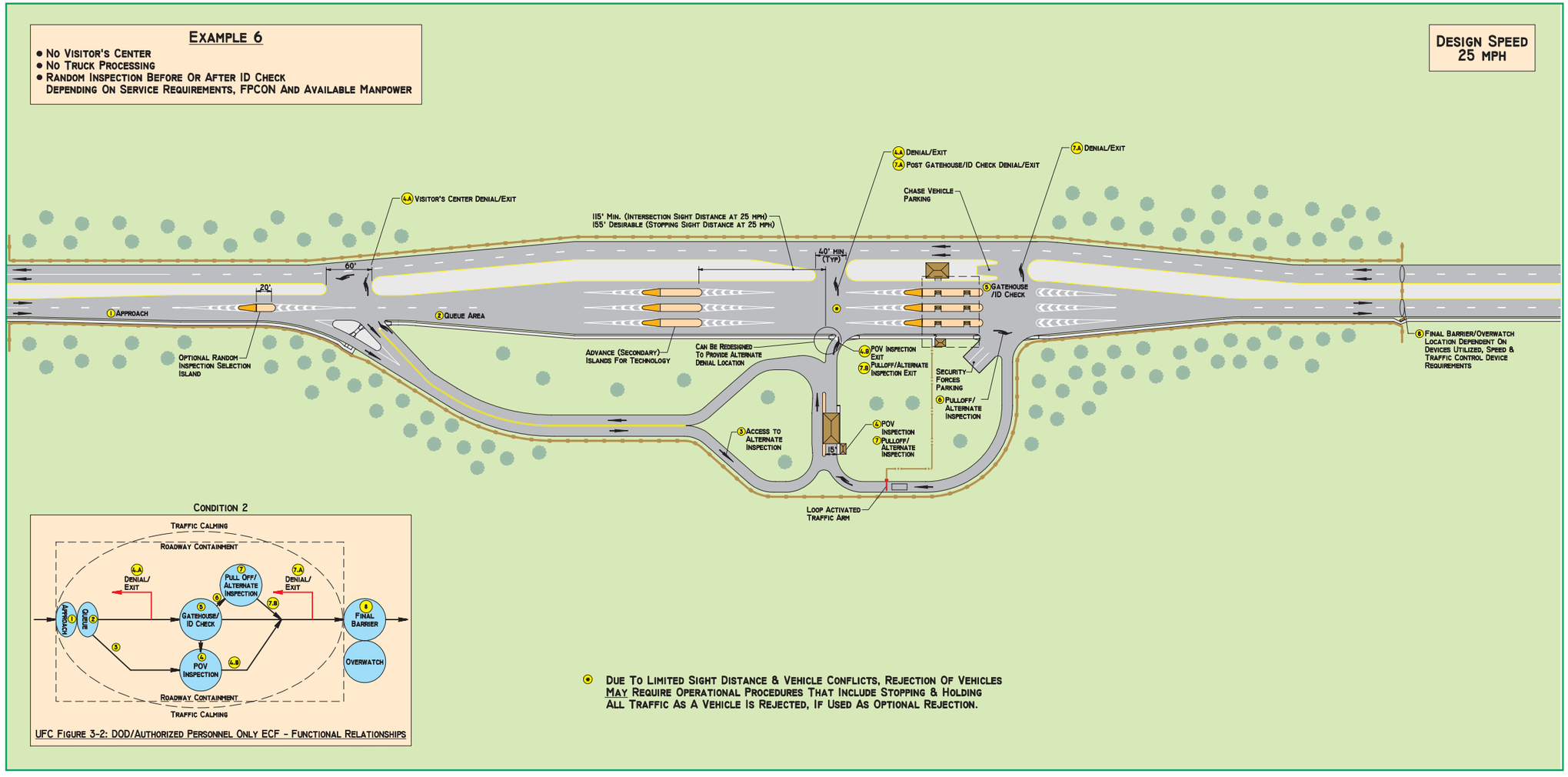
Condition 3



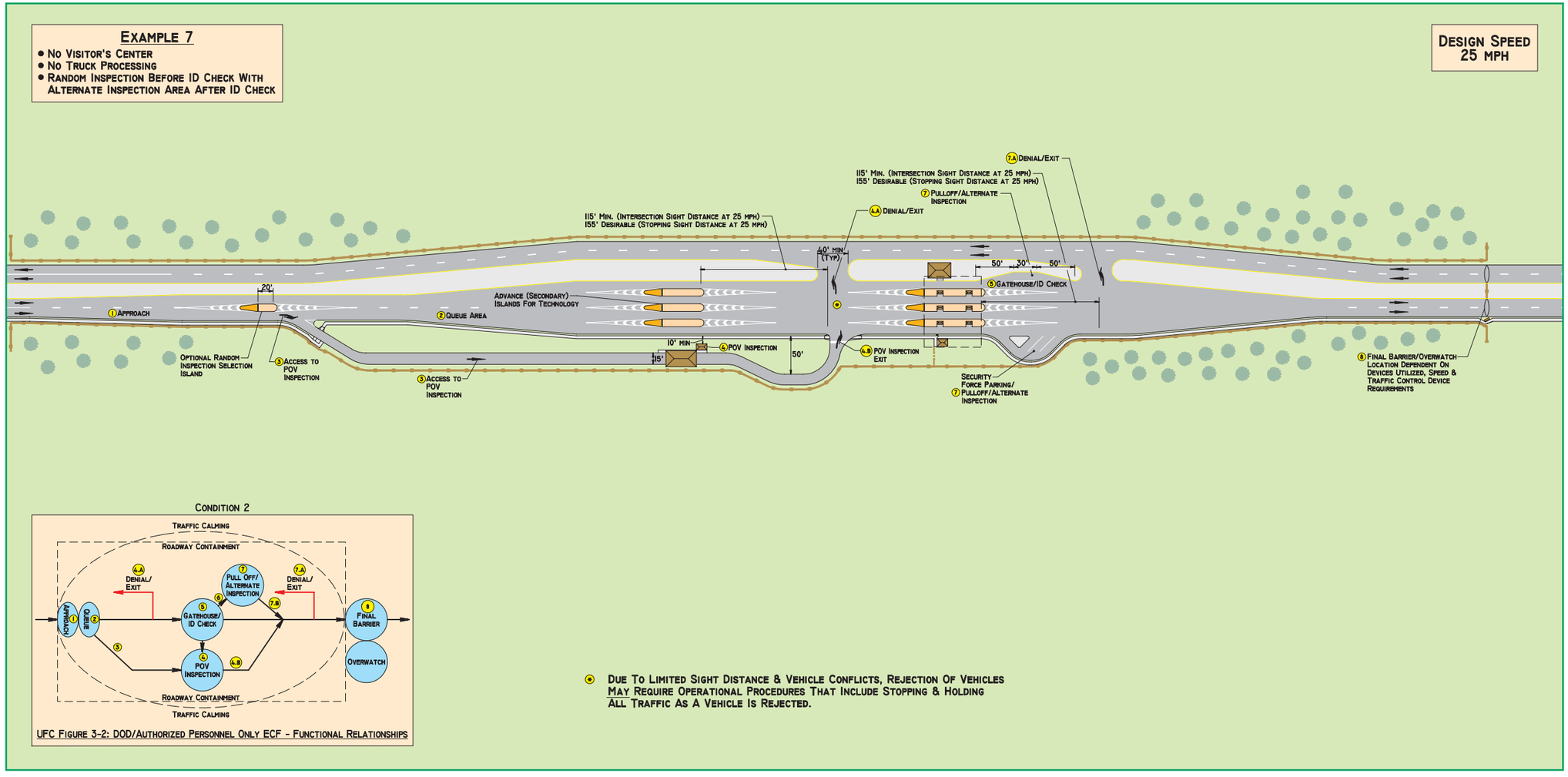
UFC Figure 3-3: Truck Gate - Functional Relationships

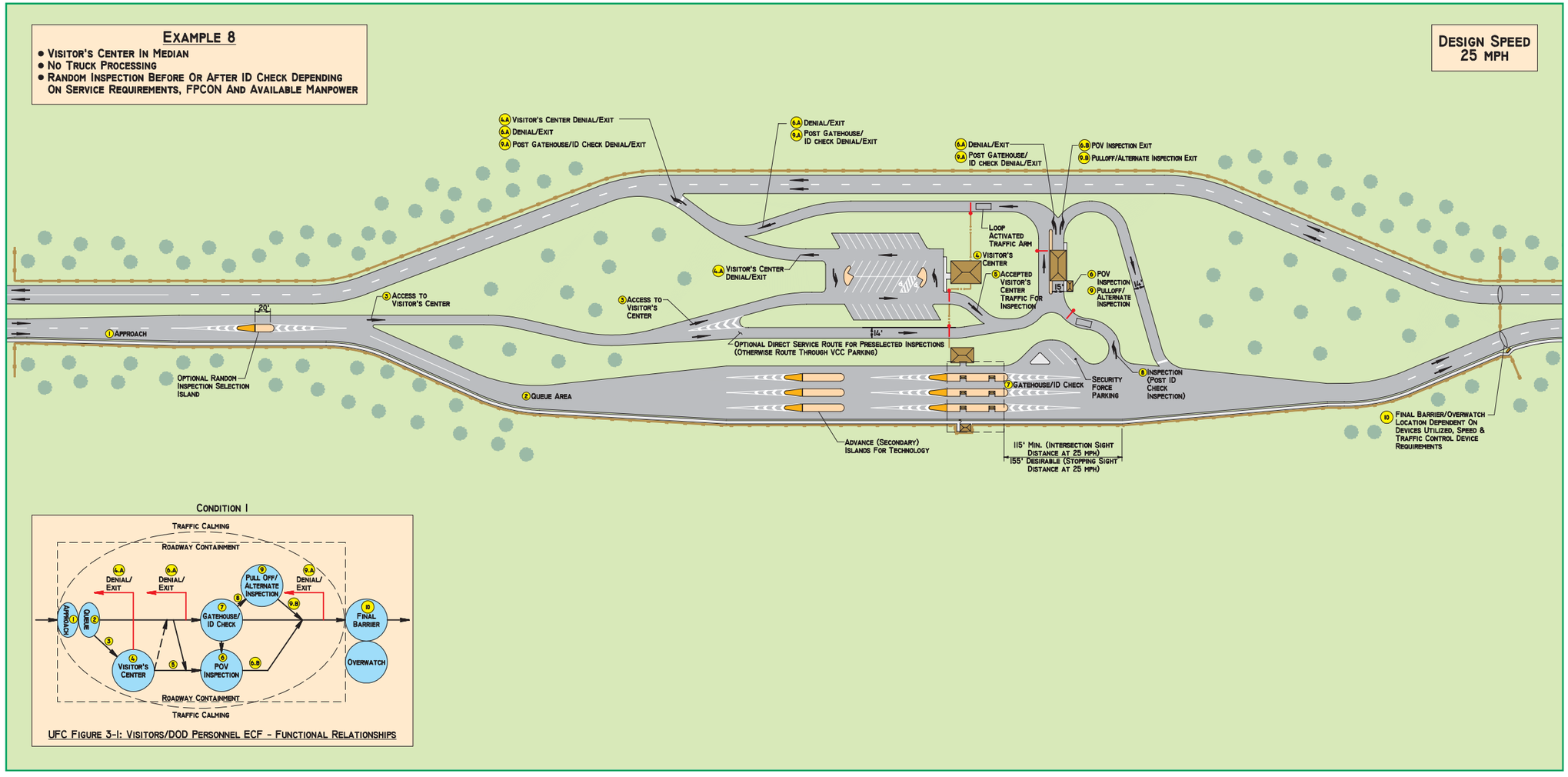
(•) Due To Limited Sight Distance & Vehicle Conflicts, Rejection Of Vehicles May Require Operational Procedures That Include Stopping & Holding All Traffic As A Vehicle Is Rejected.

(••) Due To Limited Sight Distance & Vehicle Conflicts, Rejection Of Vehicles Will Require Operational Procedures That Include Stopping & Holding All Traffic As A Vehicle Is Rejected.



UFC Figure 3-2: DOD/Authorized Personnel Only ECF - Functional Relationships


Example 7
• No Visitor's Center
• No Truck Processing
• Random Inspection Before ID Check With Alternate Inspection Area After ID Check
Design Speed 25 mph
7.A Denial/Exit
115' Min. (Intersection Sight Distance at 25 mph)
155' Desirable (Stopping Sight Distance at 25 mph)
7 Pulloff/Alternate Inspection
4.A Denial/Exit
115' Min. (Intersection Sight Distance at 25 mph)
155' Desirable (Stopping Sight Distance at 25 mph)
40' Min (Typ)
50'
30'
50'
5 Gatehouse/ID Check
20'
1 Approach
2 Queue Area
Advance (Secondary) Islands For Technology
10' Min
15'
4 POV Inspection
50'
4.B POV Inspection Exit
Optional Random Inspection Selection Island
3 Access to POV Inspection
3 Access to POV Inspection
Security Force Parking/
7 Pulloff/Alternate Inspection
8 Final Barrier/Overwatch Location Dependent On Devices Utilized, Speed & Traffic Control Device Requirements
Condition 2
Traffic Calming
Roadway Containment
4.A Denial/Exit
7 Pull Off/ Alternate Inspection
7.A Denial/Exit
6
7.B
Approach
1
Queue
2
5 Gatehouse/ ID Check
8 Final Barrier
3
4 POV Inspection
4.B
Overwatch
Roadway Containment
Traffic Calming
UFC Figure 3-2: DOD/Authorized Personnel Only ECF - Functional Relationships
Due To Limited Sight Distance & Vehicle Conflicts, Rejection Of Vehicles May Require Operational Procedures That Include Stopping & Holding All Traffic As A Vehicle Is Rejected.



UFC Figure 3-1: Visitors/DOD Personnel ECF - Functional Relationships

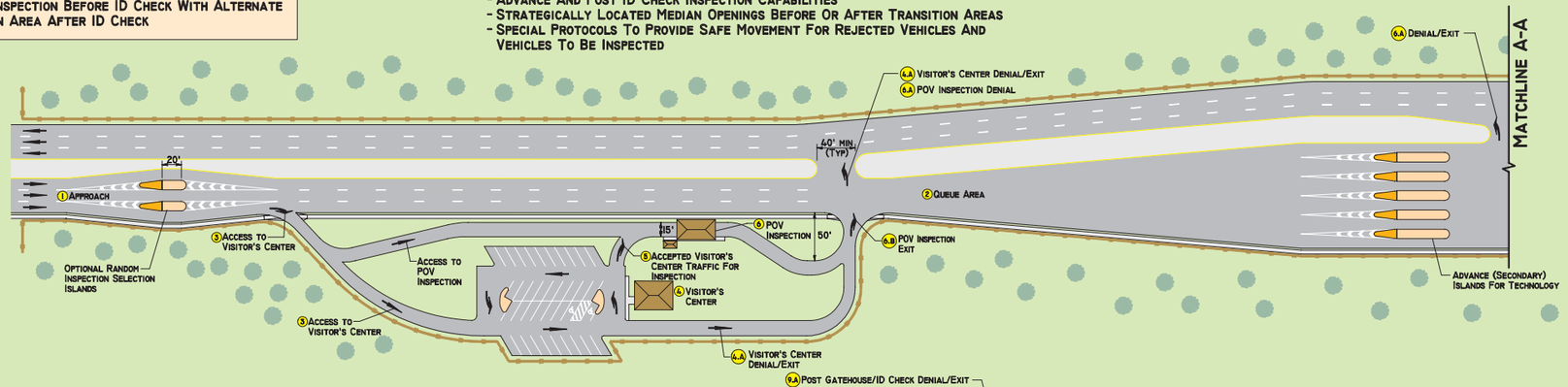
Example 9 - High Volume

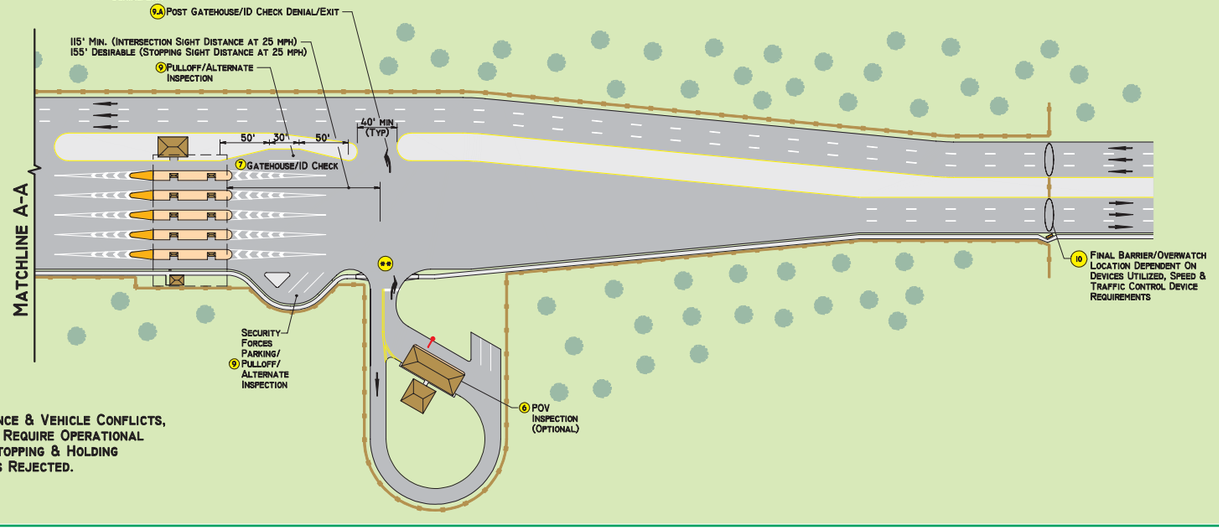
- Advance Visitor's Center
- No Truck Processing
- Random Inspection Before ID Check With Alternate Inspection Area After ID Check

Discussion Points

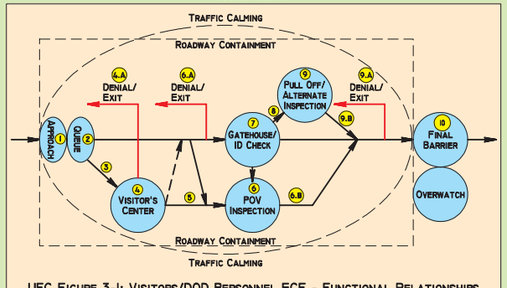
- A Few Installations Have Populations And Local Infrastructure That Warrant Primary ECFs With 5 Or More Processing Lanes
- Special Features May Be Needed To Safely Accommodate Traffic
  - Advance And Post ID Check Inspection Capabilities
  - Strategically Located Median Openings Before Or After Transition Areas
  - Special Protocols To Provide Safe Movement For Rejected Vehicles And Vehicles To Be Inspected

Design Speed 25 mph





Condition I



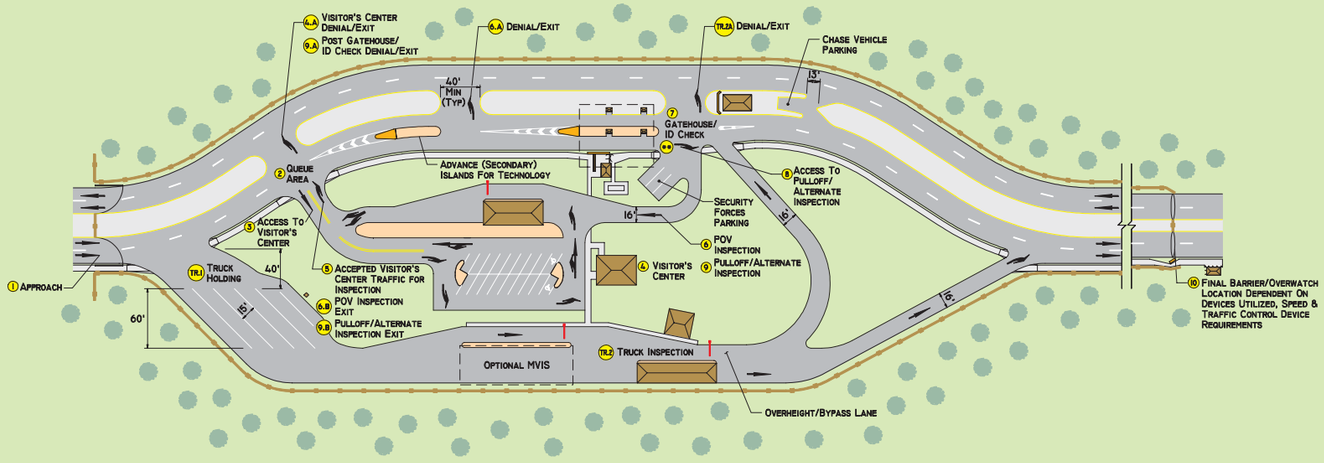
UFC Figure 3-1: Visitors/DOD Personnel ECF - Functional Relationships

●● Due To Limited Sight Distance & Vehicle Conflicts, Rejection Of Vehicles Will Require Operational Procedures That Include Stopping & Holding All Traffic As A Vehicle Is Rejected.

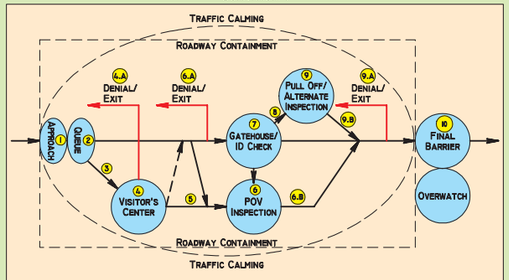
Example 10

- Visitor's Center And Truck Processing On The Right
- Random Inspection Before Or After ID Check Depending On Service Requirements, FPCON And Available Manpower

Design Speed 25 mph



Condition 1

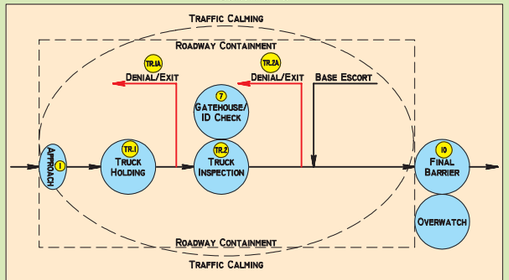


UFC Figure 3-1: Visitors/DOD Personnel ECF - Functional Relationships

(*) Due To Limited Sight Distance & Vehicle Conflicts, Rejection Of Vehicles May Require Operational Procedures That Include Stopping & Holding All Traffic As A Vehicle Is Rejected.

(**) Due To Limited Sight Distance & Vehicle Conflicts, Rejection Of Vehicles Will Require Operational Procedures That Include Stopping & Holding All Traffic As A Vehicle Is Rejected.

Condition 3

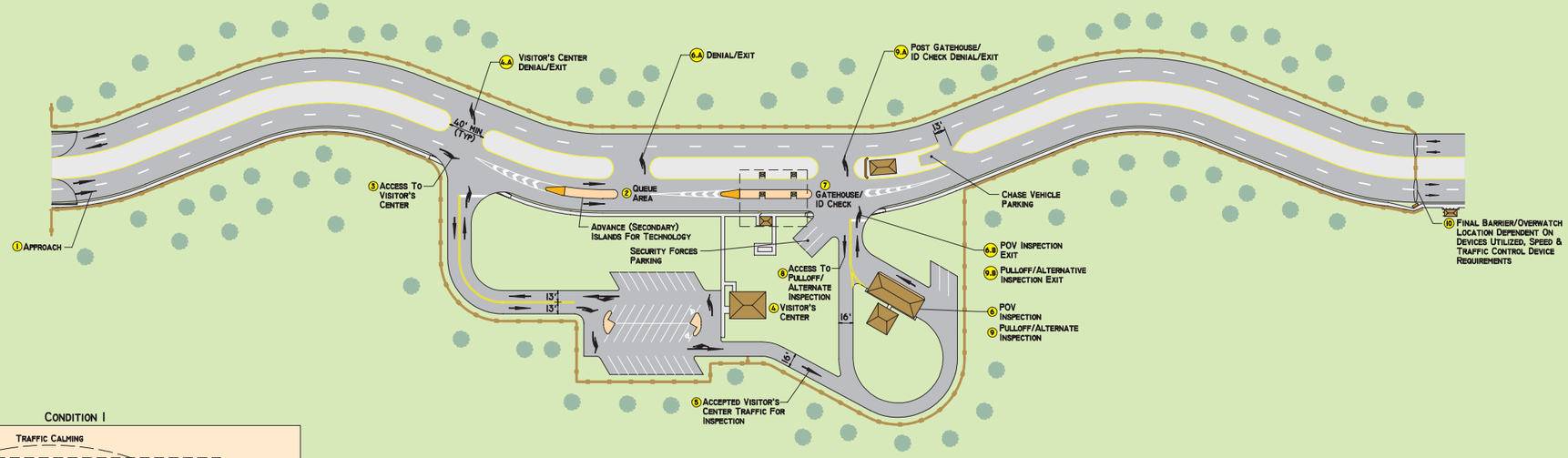


UFC Figure 3-3: Truck Gate - Functional Relationships

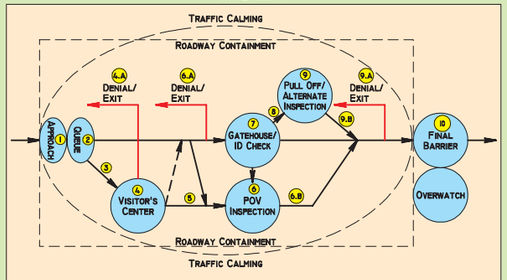
Example II

- Visitor's Center On The Right
- No Truck Processing
- Random Inspection Before Or After Depending On Service Requirements, FPCON And Available Manpower

Design Speed 25 mph



Condition I



UFC Figure 3-1: Visitors/DOD Personnel ECF - Functional Relationships

(**) Due To Limited Sight Distance & Vehicle Conflicts, Rejection Of Vehicles Will Require Operational Procedures That Include Stopping & Holding All Traffic As A Vehicle Is Rejected.

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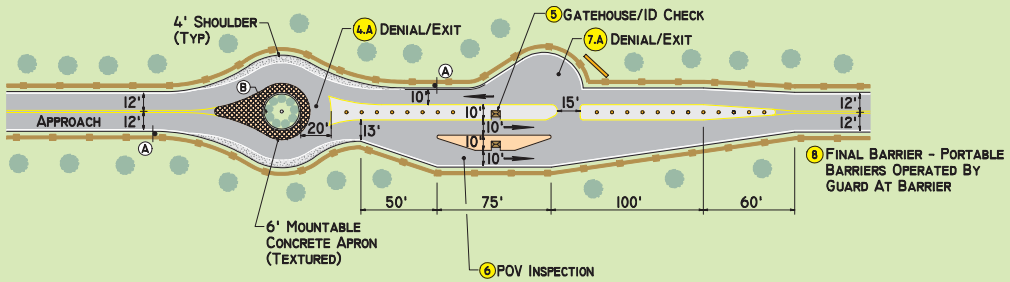
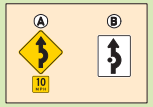
EXAMPLE 12 - LOW VOLUME

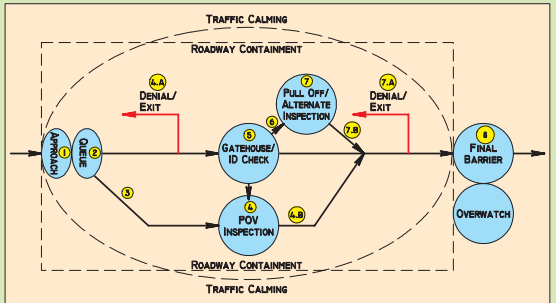
- NO VISITOR'S CENTER
- NO TRUCK PROCESSING
- GATEHOUSE IN CENTER

DESIGN SPEED 25 MPH





CONDITION 2



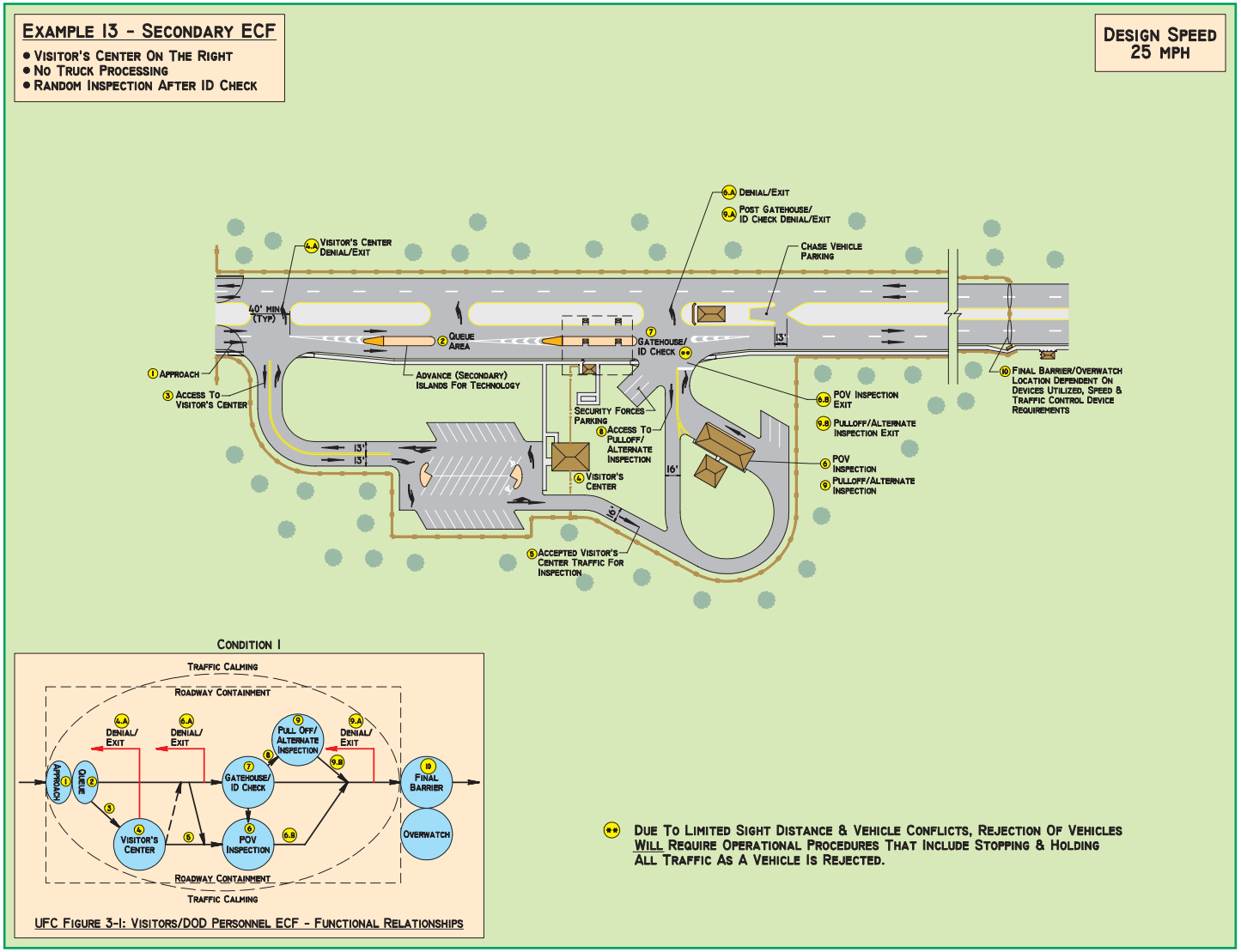
UFC FIGURE 3-2: DOD/AUTHORIZED PERSONNEL ONLY ECF - FUNCTIONAL RELATIONSHIPS

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:

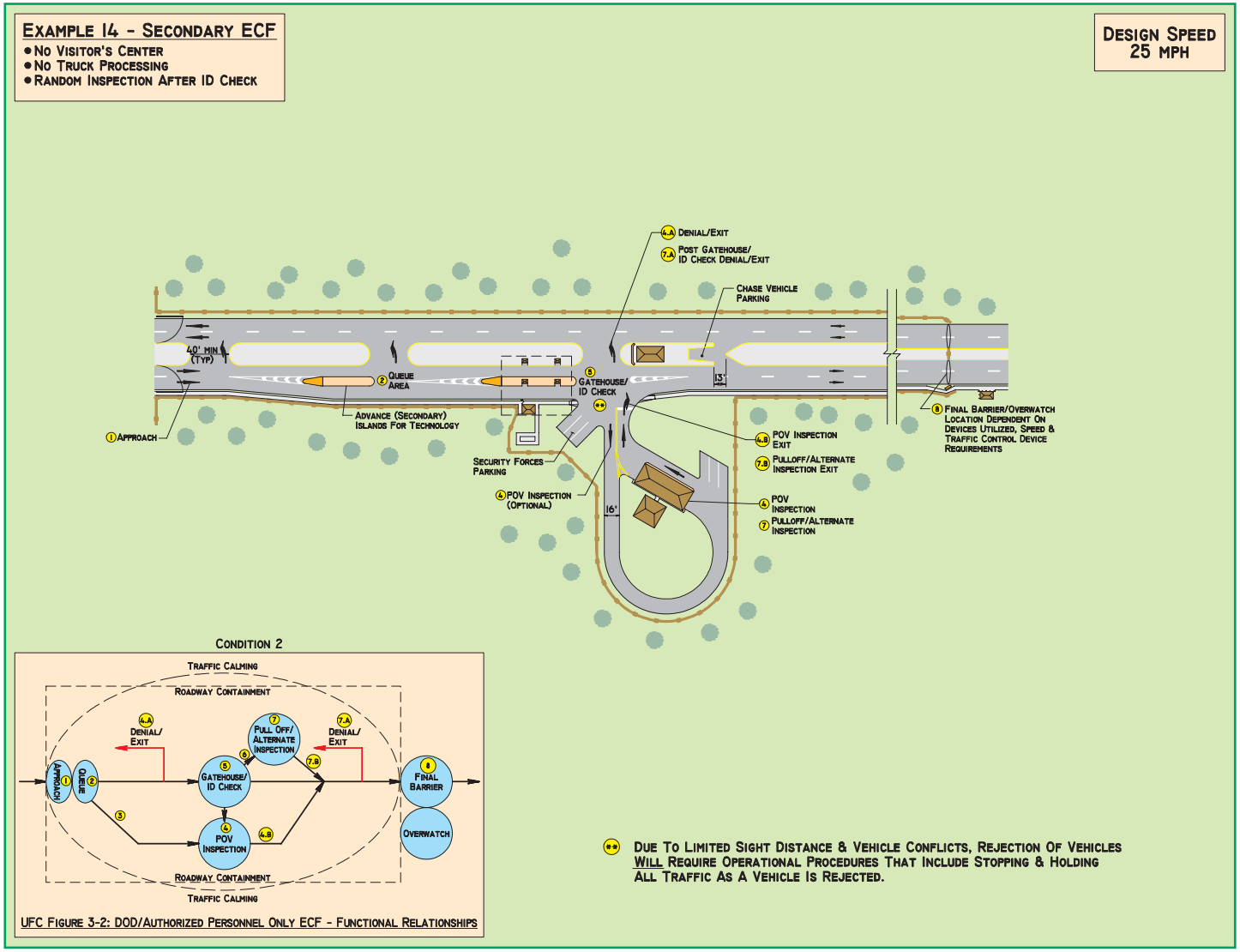
- SAFELY REDUCES VEHICLE SPEED TO BELOW 25 MPH.
- ACCOMMODATES TRUCK MOVEMENTS.
- SLOWS UNAUTHORIZED VEHICLES ATTEMPTING TO ENTER INSTALLATION VIA OUTBOUND LANES.
- ALLOWS FOR TURNAROUND OF PASSENGER CARS EITHER BEFORE OR AFTER GUARDHOUSE.

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

BARRIER CURB ON INSIDE AND OUTSIDE OF CIRCLE OFFERS PROTECTION FOR SECURITY FORCES AND ACTS AS A BARRIER TO ERRANT VEHICLES.



UFC Figure 3-1: Visitors/DOD Personnel ECF - Functional Relationships

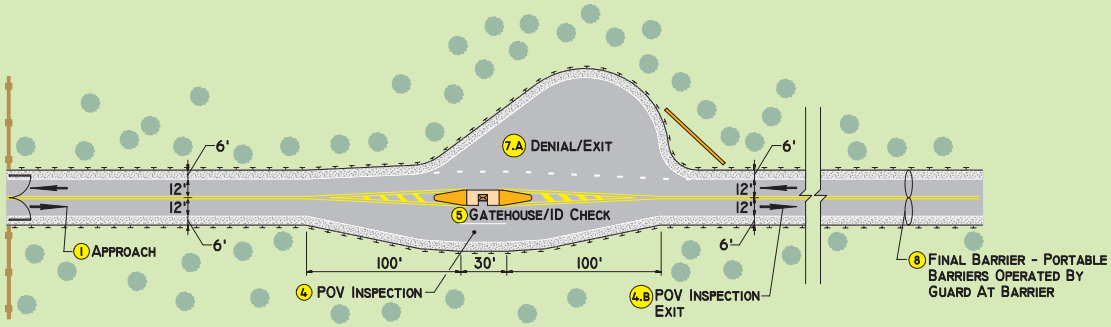


UFC Figure 3-2: DOD/Authorized Personnel Only ECF - Functional Relationships

EXAMPLE 15 - LIMITED USE ECF

- NO VISITOR'S CENTER
- NO TRUCK PROCESSING
- NO ADVANCE (SECONDARY) ISLAND FOR TECHNOLOGY

DESIGN SPEED 25 MPH



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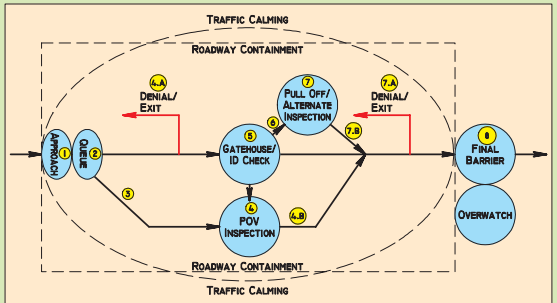
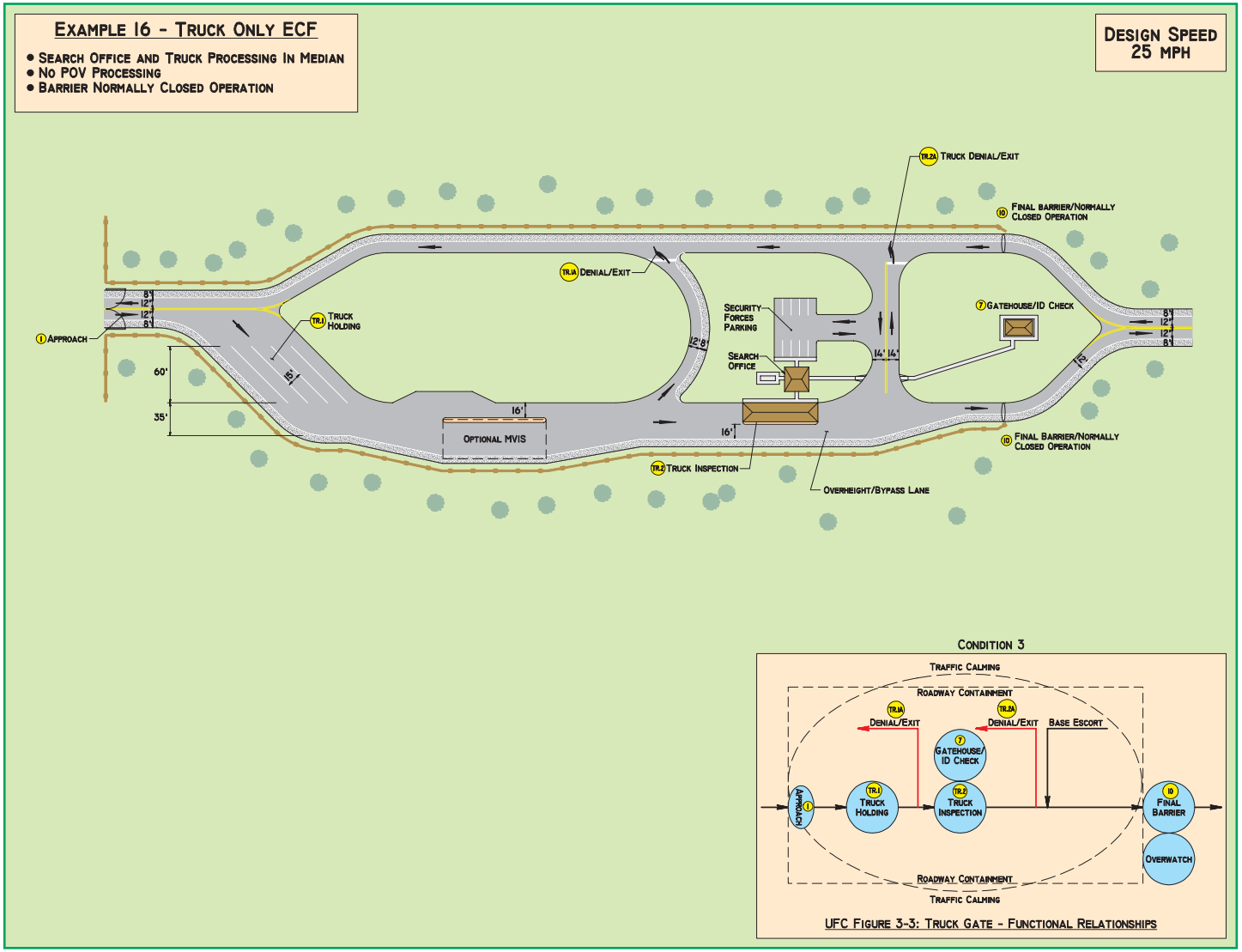
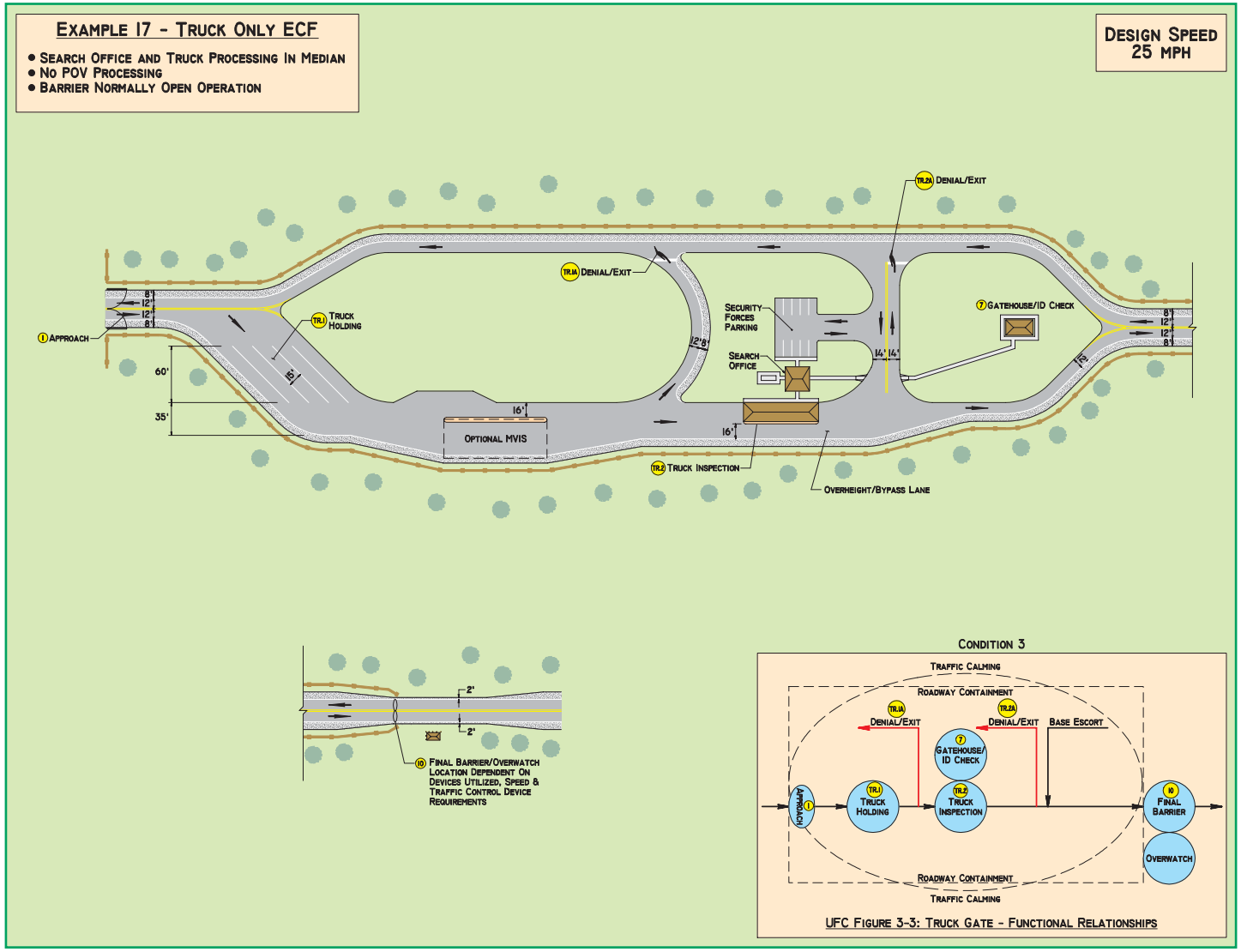


UFC FIGURE 3-2: DOD/AUTHORIZED PERSONNEL ONLY ECF - FUNCTIONAL RELATIONSHIPS



UFC FIGURE 3-3: TRUCK GATE - FUNCTIONAL RELATIONSHIPS



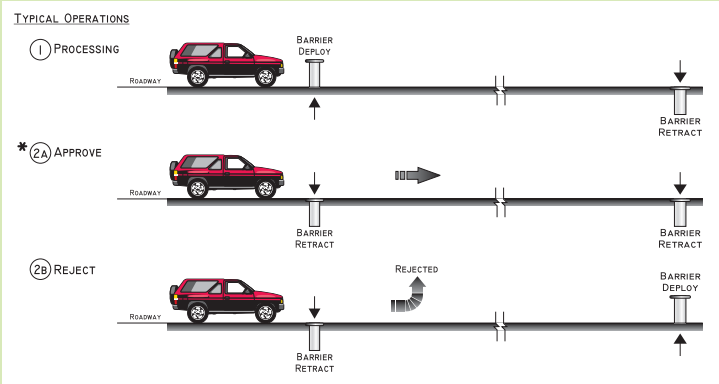
UFC FIGURE 3-3: TRUCK GATE - FUNCTIONAL RELATIONSHIPS

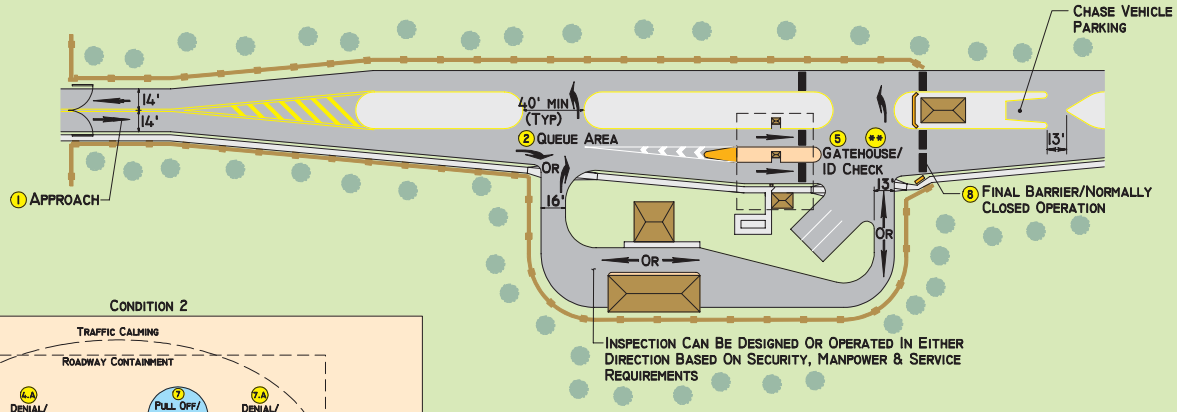
Example 18 - Restricted Real Estate ECF

- No Visitor's Center
- No Truck Processing
- Low Volume Applications Only
- Barrier Normally Closed Operation

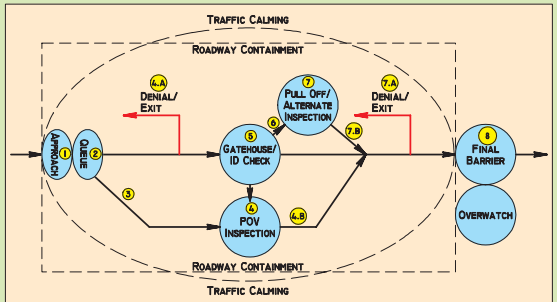
Design Speed 25 mph

* Note:
Could Sally Port Approvals At Higher FPCONs





Condition 2



UFC Figure 3-2: DOD/Authorized Personnel Only ECF - Functional Relationships

** Due To Limited Sight Distance & Vehicle Conflicts, Rejection Of Vehicles Will Require Operational Procedures That Include Stopping & Holding All Traffic As A Vehicle Is Rejected.

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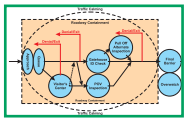
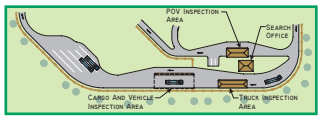

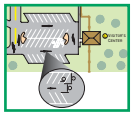

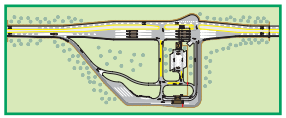

SECTION 2 – TRAFFIC ENGINEERING ASSESSMENTS AND ALTERNATIVES ANALYSIS

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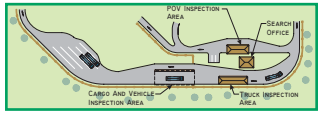


2. Traffic Engineering Assessments and Alternatives Analysis

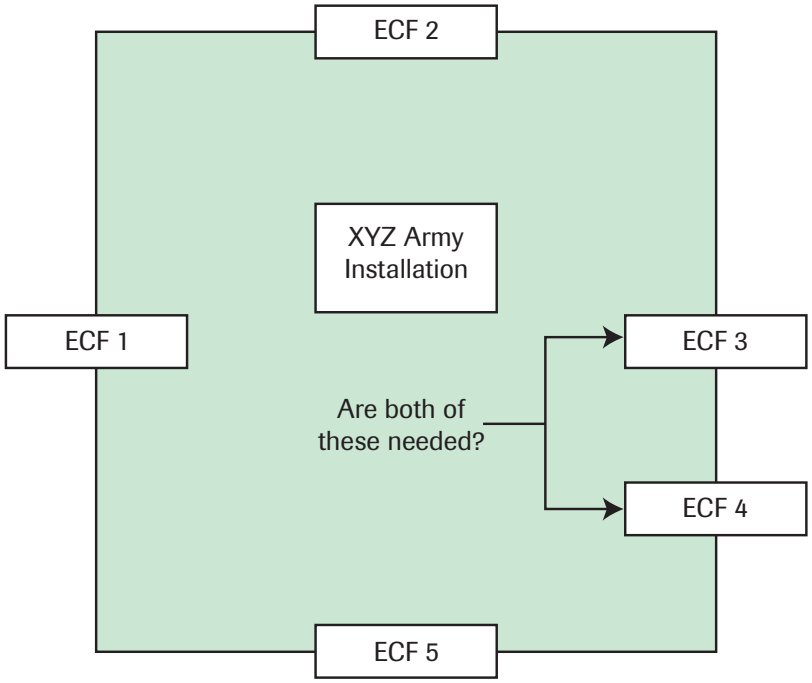
For alternatives analysis several questions should be asked and answered:

- ❑ **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.

The State Department of Transportation (DOT) was involved early in the design process at one installation. As a result of early communication, the state DOT assisted the installation by providing off-installation signing and electronic changeable message signs.

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

Installation Stakeholders

✓ Security Forces
✓ Engineering and Public Works
✓ Safety Offices
✓ Communication Offices
✓ Installation Command
✓ Housing Contacts

Other Military Stakeholders

✓ SDDCTEA
✓ Command Groups
✓ Major Commands
- Army Corps Engineers
- Naval Facilities Engineers

Other Stakeholders

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

2.2. TRAFFIC ENGINEERING AND SAFETY ASSESSMENT

In evaluating ECF conditions, several components should be considered:

✓ **Security and Functional Requirements** – Does the ECF satisfy the *UFC* functional requirements for ECFs?
✓ **Safety** – Is there a documented crash history or any documented safety deficiencies?
✓ **Service Requirements** – Does the ECF satisfy service standards and requirements?
✓ **Traffic Flow and Congestion** – Does the ECF accommodate existing and future traffic demands?
✓ **Aesthetics** – Can the ECF conform to architectural requirements?
✓ **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?

At one installation, three ECFs needed to be evaluated to see if they met current standards. All of the stakeholders for the project were contacted to attend a site view to discuss the existing ECFs; however when the site view occurred, there was no supporting data such as, master planning information, traffic counts and utility locations. The site view had to be rescheduled wasting both time and money.

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 two primary goals that need to be accomplished during the pre-site visit activities:

✓ 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 ✓Total number of staff at ECF during non-peak times
Staffing Levels	✓Total number of staff at ECF during peak times ✓Vehicle processing techniques (single, tandem, other) ✓Pedestrian and bicycle processing procedure ✓Personnel dedicated to inspections ✓Visitor's center staffing during peak times
Historical Traffic Volumes	✓Automated traffic recordings 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's center demands and processing ✓Inspection procedures and processing (POVs and Trucks)

2.2.2 Site Visit

During the site visit the ECF evaluation team should be focused on evaluating the different components of the ECF and how those components compare to current accepted applicable standards. **Exhibit 2.2** identifies eight categories that should be considered while performing the site visit and **Section 2.3** describes the traffic engineering assessment in depth.

An ECF was designed and constructed without a site visit by the designer. During construction conflicts between traffic control devices and roadway geometry were discovered resulting in additional costs due to modifications.

Exhibit 2.2: ECF Assessment Areas of Concern

Security	✓ Does the ECF satisfy installation security requirements and AT measures? ✓ Does the ECF satisfy functional requirements?
Crash History	✓ Is the ECF a high-crash location?
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?
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?
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 the 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?
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?
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 relocated to support land uses?
Aesthetics	✓ Does the ECF impart an immediate impression of professionalism and commitment to facilities excellence?

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
  - ✓ Command
  - ✓ Security forces
  - ✓ Department of public works
  - ✓ Safety officers
  - ✓ First responders
  - ✓ External stakeholders (county, external responders, state DOT)
  - ✓ Guards
  - ✓ 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 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's 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
- Inspection Procedures
  - ✓ Planning considerations
  - ✓ Master plan
  - ✓ BRAC
  - ✓ Deployment
  - ✓ Local growth
- ECF Sizing Analyses
  - ✓ Number of lanes (single vs tandem)
  - ✓ Visitor's 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
    - o Land use and development impacts
    - o Environmental constraints
    - o Utility constraints and needs
    - o Force protection constraints (stand-off, etc.)
    - o Wind, sun, weather etc
    - o Traffic constraints
    - o 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 Response Zone and 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 (CMS, CCTV)
- Special Events Overview (Evacuation, Housing Turnover, Public Event)
- Cost Estimates
  - ✓ By key areas (roadway, facilities, AVB, etc.)
  - ✓ Programmatic approach
  - ✓ Report

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.

FREQUENTLY ASKED QUESTIONS

Q: ***Are Traffic and Safety Engineering Studies required at ECFs?***

A: ***Yes, since traffic control devices are required and their justification needs to be documented.***

Per MUTCD, traffic signals and many other traffic control devices need to be justified by an engineering study. The MUTCD defines an "engineering study" as "the comprehensive analysis and evaluation of available pertinent information, and the application of appropriate principles, Standards, Guidance, and practices as contained in this Manual and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device. An engineering study shall be performed by an engineer, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer. An engineering study shall be documented." While many states have laws regarding engineering practice, the MUTCD's language provides conditions to minimize tort liability against government's "deep pockets."

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

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

PEAK HOUR – THE BUSIEST ONE 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 capability of the lane. ✓ During non-congested conditions, the counts represent the inbound vehicular demand.
Maximum Queue Assessment	✓ During congested conditions, the maximum queue should be recorded in vehicles as well as length. ✓ The length of the queue will assist planners and engineers in assessing impacts to local roadways and if corrective measures are required.
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 shoud be recorded. ✓ These counts assist engineers in determining the proper pedestrian and bicycle accommodations.
Automated Traffic Recordings (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 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.

2.3.2. Traffic Adjustments

2.3.2.1. 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 should consider future development plans and possible mission changes or base realignment and closure.

At a major Army installation, an ECF study was conducted, but over 25 percent of forces were deployed at the time. By adjusting traffic data collected, it was concluded that an additional lane would be required to accommodate the traffic associated with the deployment.

2.3.2.2. Local Development

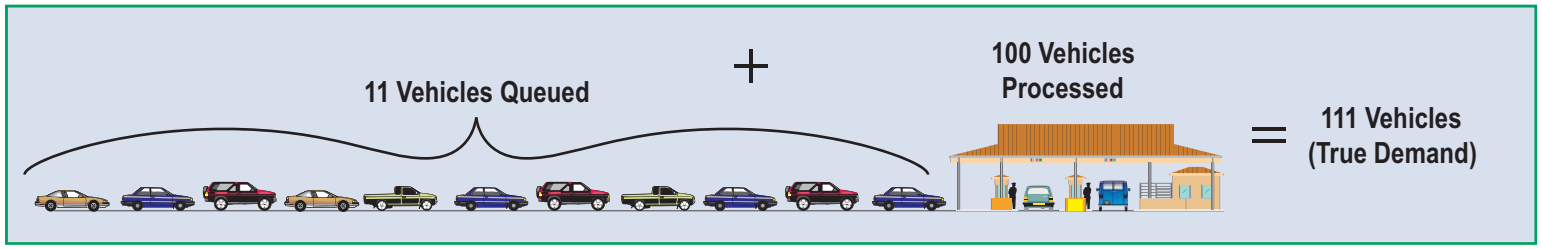
Planned commercial and residential development serving the installation should be considered in finalizing traffic forecasts. An example of this might be an off-installation residential community developed just outside a low-volume secondary ECF. Some of the residents may be employees of the installation who utilize that ECF and will therefore increase traffic through the ECF.

2.3.2.3. 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.

2.3.2.4. Calculating True Demand

Depending on the FPCON, the number of vehicles counted in each lane may not represent the true demand. The true demand under congested conditions is the number of vehicles processed plus the latent (queued) demand.



ECF CAPACITY IS DEPENDENT ON:

- ❑ NUMBER OF VEHICLES
- ❑ PERCENTAGE OF TRUCKS
- ❑ NUMBER AND WIDTH OF LANES
- ❑ FPCON LEVEL
- ❑ MANPOWER

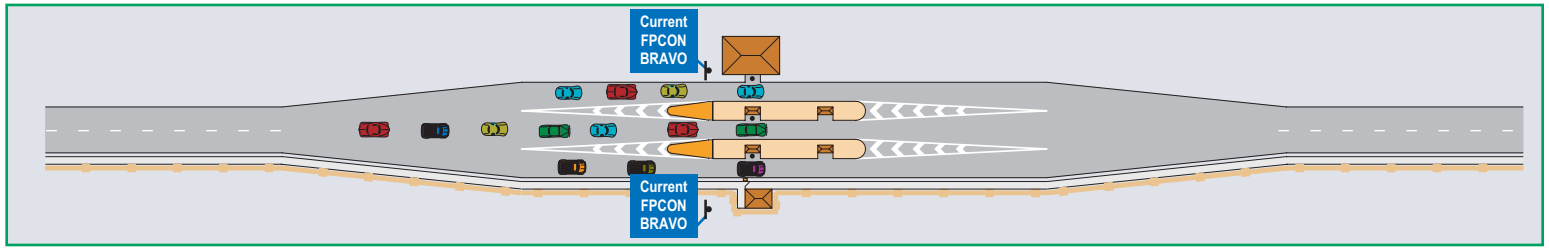
DESIGN CAPACITY – THE MAXIMUM VOLUME OF TRAFFIC OR THROUGHPUT THAT AN ECF NEEDS TO BE ABLE TO ACCOMMODATE DURING THE PEAK HOUR.

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. Additionally, the stopped vehicles become a target of opportunity themselves. The design of a modified or renovation of an existing ECF should improve the throughput of the ECF, and as 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 causes 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+ conditions. FPCON Charlie and FPCON Delta require greater amounts of vehicle inspection and personal identification—traffic volumes may be lowered by a reduction in workforce and visitors during these conditions.



2.4.2. Lane Processing Rates

To accurately size an ECF, a lane-processing rate must be assumed. SDDCTEA has performed over 60 ECF security, safety, and capacity traffic engineering assessments. During these assessments, SDDCTEA has collected significant data, which has been used to establish new criteria regarding capacity and processing rates at ECFs. The processing rate per lane with one ID checker ranges from 400 to 600 vehicles per hour for FPCON Alpha. For FPCON Bravo+, this rate drops to a range of 300 to 400 vehicles per hour per lane.

Exhibit 2.5: ECF Processing Rates

Check with SDDCTEA for updated rates

Processing Technique	Assumed FPCON	Single Processing (vphpl)	Tandem Processing (vphpl)	Automated Processing (vphpl)
No Direct Checks	NA	600-800 (1)	NA	NA
Vehicle Identification Only	Alpha	400-600	400-600 (2)	400-600 (5)
Vehicle and Driver Identification (4)	Bravo	200-400 (3)	300-600 (3)	200-400 (5)
Vehicle and Identification of All Occupants (4)	Bravo+ and Charlie	300-400	450-600	TBD (6)
Complete Inspection	Delta	20-120 (60 typ)	20-120 (60 typ) (7)	TBD (6)
Traffic Arm w/ Card Reader	NA	150-200(8)	NA	NA

(1) Processing at No Direct Checks dependent on roadway capacity. No increase for Tandem /Automated since no processing really occurs.
(2) Processing increase for Tandem at this level has not been studied. It is unlikely that a 50 percent increase will be achieved since processing is simplified.
(3) Based on data collected prior to 9/11/01.
(4) Bravo+ rates collected after 9/11/01 are more efficient than Bravo+ rates even though processing requires that all occupants be identified. The increase may be attributed to more efficient processing procedures implemented after 9/11/01.
(5) AF AETC automated ECF team noted that processing should be close to single lane processing rates.
(6) Unknown since how technology is utilized at higher FPCONs is unknown.
(7) Processing increase for Tandem at this level has not been studied. It is unlikely that a 50 percent increase will be achieved since long processing/ inspection times negate processing increases.
(8) 150 per *UFC* referenced study. 200 per vendor supplied data.
vphpl = vehicle per hour per lane

DOES ADDING GUARDS TO A LANE INCREASE ITS CAPACITY?

YES

IS THE LEVEL OF INCREASE WORTH THE EXTRA MANPOWER?

NO, NOT IF MORE THAN THREE ID CHECKERS ARE USED PER LANE.

2.4.3. Tandem Processing

To reduce congestion at ECFs, many installations use additional guards per lane. Some installations use as many as nine guards to process a single traffic lane. The *UFC* mandates that all ECFs be designed with tandem processing capabilities.

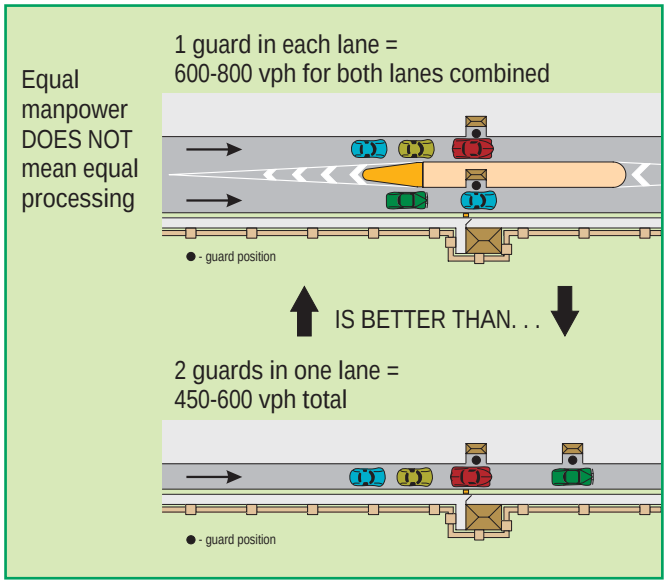
Leaders at a major Army installation reluctantly reduced the number of ID checkers per lane from nine to three, but found out that the level of congestion and delay remained the same despite reducing manpower by 67 percent.

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.

Exhibit 2.6: Bravo+ Processing Efficiency

ID Checkers per Lane	Vehicle Processing Rate per Lane
1	300-400
2	450-600
3	525-700
4	No significant increase; possible decrease

Source: SDDCTEA, Traffic Engineering and Highway Safety Bulletin, June 2003.



2.4.4. Calculating Lane Requirements

The number of lanes planned for an ECF shall be sufficient to handle the expected volume of traffic, especially 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.

One ECF in the planning and design process was initially planned to have two lanes, but once traffic volumes were analyzed it was concluded that the ECF needed four lanes. By determining the lane needs, the installation avoided building a facility that would have already been over capacity when opened.

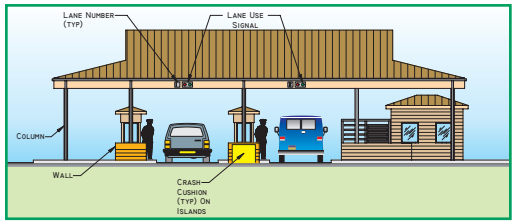
The incremental threshold for increasing the number of lanes at an ECF, under FPCON Bravo+, is 500 vehicles per hour (from 450 – 600 range on **Exhibit 2.5**), which represents the processing rate of one ID checker. It is assumed that manpower will be minimized under FPCON Bravo+ conditions and therefore 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 2.7** is a worksheet that can be used for calculating the required number of lanes at an ECF.

THE INCREMENTAL THRESHOLD FOR INCREASING THE NUMBER OF LANES AT AN ECF, UNDER FPCON BRAVO+, IS 500 VEHICLES PER HOUR.

CALCULATING THE NEEDED NUMBER OF LANES IS A FUNDAMENTAL STEP IN THE PLANNING AND DESIGN OF 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:

- ✓ Setting staggered work hours
- ✓ Encouraging carpooling
- ✓ Adding lanes
- ✓ Redirecting traffic to other ECFs
- ✓ Building new ECFs



It may also be possible to design lanes to be reversible such that outbound lanes can be used for incoming traffic during periods of peak volume. However, priority should be given to maximizing the number of lanes prior to utilizing reversible lanes.

Exhibit 2.7: ECF Lane Requirements Worksheet

Line	Field	Calculation	Value	*Example Calculation*	*Example Value*
1	Number of Vehicles Processed in Peak Hour (**section 2.3.2.4**)				*1200*
2	Number of Maximum Queued Vehicles in Peak Hour (**section 2.3.2.4**)				*150*
3	TOTAL EXISTING DEMAND	Line1 + Line2		*1200 + 150*	*1350*
4	Deployment Adjustment [DA] (**section 2.3.2.3**) *Percent of Total Base Population Deployed*	100% / (100% – DA%)		*100% / (100% – 10%)*	*10% deployment = 1.11*
5	TOTAL ADJUSTED EXISTING DEMAND	Line3 X Line4		*1350 X 1.11*	*1498*
6	Local Growth at ECF [LG] (**section 2.3.2.2**) *Percent of Estimated Local Growth*	(100% + LG%) / 100%		*(100% + 5%) / 100%*	*5% local growth = 1.05*
7	Future Growth [FG] (**section 2.3.2.1**) *Percent of Estimated Future Growth*	(100% + FG%) / 100%		*(100% + 8%) / 100%*	*8% future growth = 1.08*
8	DESIGN DEMAND	Line5 X Line6 X Line7		*1498 X 1.05 X 1.08*	*1699*
9	Design Processing Rate (**Exhibit 2.5**) *Default 500 veh per hour per lane*				*500*
10	CALCULATED LANE REQUIREMENTS	Line8 / Line9		*1699 / 500*	*3.4*
11	ROUNDED LANE REQUIREMENTS *Round to Next Highest Whole Number*				***4 lanes***

2.5. SIZING VISITOR'S CENTER PARKING

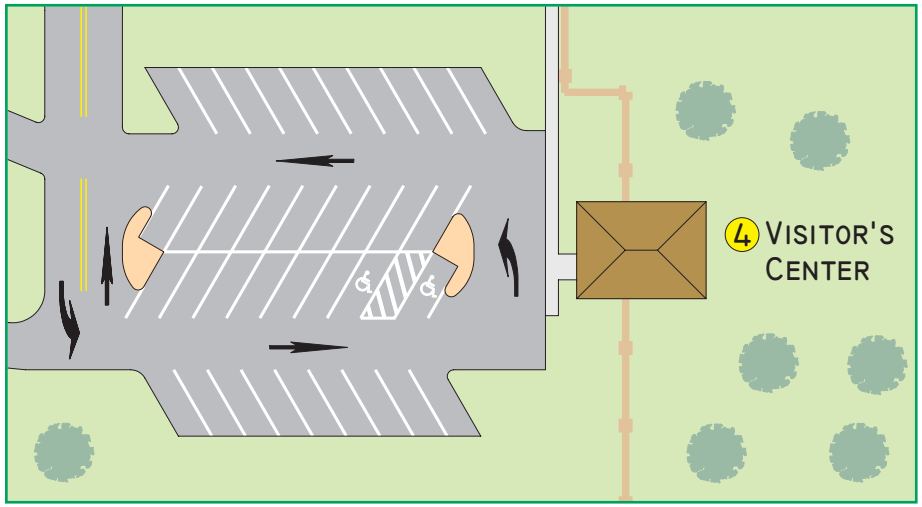
Primary ECFs include a visitor's center at most installations; there is usually one ECF that is the primary entrance for visitors. This ECF is commonly referred to as the Main Gate. The *UFC* states that the visitor's center should be able to process twelve to twenty visitors per hour per processor.

During the planning of a primary ECF, officials at one military installation were planning to have 10 parking spaces, but once they calculated their true needs, they determined that it would be appropriate to have 20 parking spaces.

The amount of parking needed at a visitor's center depends on three things:

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

As a general rule, size visitor's 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.



Provide sufficient accessible parking in accordance with the Americans with Disabilities Act (ADA). ADA requirements are one accessible space per one to 25 spaces and two accessible spaces per 26 to 50 spaces. However, SDDCTEA suggests two accessible spaces as a minimum. As a general rule, four percent of parking should be reserved for accessible parking. **Exhibit 2.8** is a worksheet that can be used for calculating the required number of parking spaces at an ECF that includes a visitor's center.

Exhibit 2.8: Required Visitor's Center Parking Spaces Worksheet

Line	Field	Calculation	Value	*Example Calculation*	*Example Value*
1	Estimated Visitor's Center Customers Processed in Peak Hour				*80*
2	Future Growth [FG] (**section 2.3.2.1**) *Percent of Estimated Future Growth*	(100%+FG%)/ 100%		*(100%+8%)/ 100%*	*8% future growth = 1.08*
3	ADJUSTED VISITOR'S CENTER DEMAND	Line1 X Line 2		*80 X 1.08*	*86*
4	Estimated Processing Rate Per Visitor (in minutes)				*15 min*
5	VISITOR'S CENTER CUSTOMER PARKING DEMAND	Line3 x (Line4 / 60)		*86 x (15 / 60)*	*21.6 ROUND TO 22*
6	Estimated Staff Parking Demand				*6*
7	NON-ADA PARKING DEMAND	Line5 + Line6		*22 + 6*	*28*
8	ADA Parking Requirement	1 if Line7 is <26 2 if Line7 is 26-50			*2*
9	TOTAL PARKING DEMAND	Line7 + Line8		*28 + 2*	***30 spaces***

2.6. SIZING INSPECTION AREAS

Removing inspection procedures from the 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's 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 three to five vehicles including the roadway leading to the area.

SDDCTEA studied one ECF that had a peak hour inbound demand of 1,300 vehicles. The ECF processed 320 vphpl in each of three inbound lanes during the peak hour and had substantial backups. Part of the low rate resulted from ID checkers performing random in-lane inspections of approximately one in 30 vehicles (32 total). These inspections consumed 27 minutes per lane per hour based on a typical inspection time of two to three minutes per vehicle.

When the inspections were removed from the roadway, the installation processed vehicles for the full hour, rather than for only 33 minutes, which equates to a processing rate of 580 vphpl. With this new processing rate, the true peak hour demand could be met with no queuing or delay.

At Limited Use ECFs, a turnout lane can be used if parking cannot be provided elsewhere due to geometric constraints and security requirements. It should be large enough to accommodate at least two vehicles and can be used for inspection activities.

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

One installation was planning to have a holding area for six trucks, but when they calculated a peak hour demand of 40 trucks with a processing rate of 20 trucks per hour (three minutes per truck); they concluded they needed a holding area for 20 trucks.

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, these rates are doubled. Once the number of vehicles not processed is known, that number represents the size of holding area needed.

Exhibit 2.9: Example Truck Processing Calculations

Hour	Arriving Trucks	Remaining Demand (Not Processed) from Previous Hour	Total Hourly Demand	Trucks Processed Per Hour	Trucks Not Processed (Holding Requirements)
0600-0700	15	NA	15	12	3
0700-0800	20	3	23	12	11
0800-0900	6	11	17	12	5
0900-1000	4	5	9	12	0

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 land uses. O&D Studies are especially useful if you are considering a new ECF and/or if you are considering significant land use changes.

> ***One installation was planning a new ECF at a location that was desirable from a site standpoint. When they evaluated O&D patterns, they found that most motorists would not use the new ECF at the planned location and the site was relocated to accommodate flow patterns.***

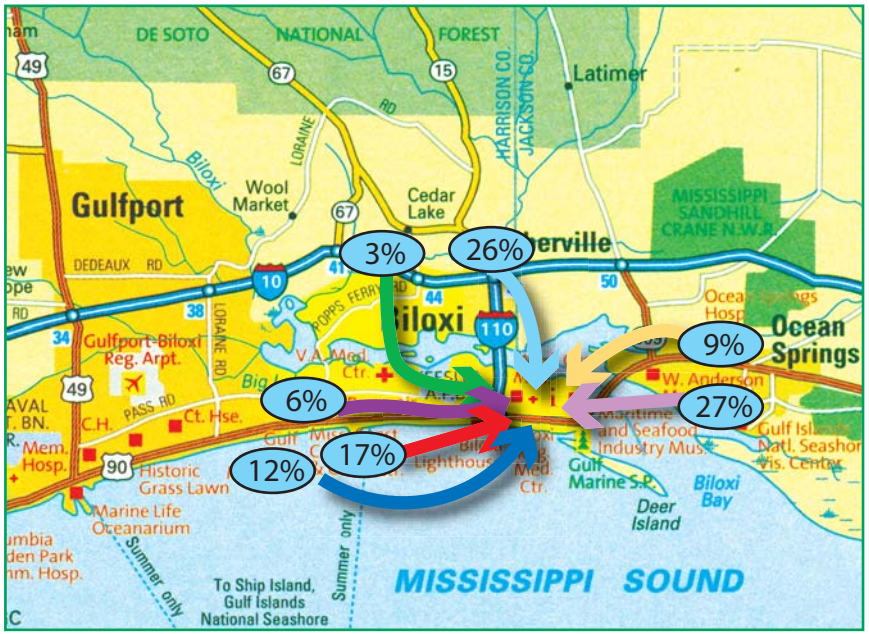
There are several methods to evaluate O&D patterns, which include:

- ✓ 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

The key questions to be asked include:

- ✓ 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.

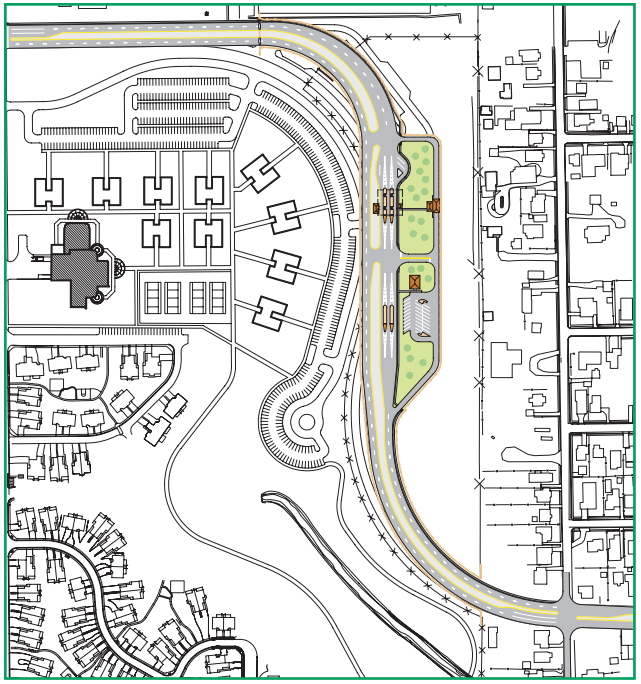


2.9. ALTERNATIVES EVALUATION

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, met 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.

A planning oversight occurred at an installation that selected a preferred site for an ECF using a concept that did not have the adequate number of lanes and geometric features. When the design progressed they had to move the ECF to another location.



2.10. OTHER ALTERNATIVES CONSIDERATIONS

In addition to traffic engineering studies, several considerations should be made while evaluating alternatives. The site should be capable of accommodating ECF process requirements.

Exhibit 2.10: Other Alternative Evaluation Considerations

Right-of-Way Impacts	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, *Security Engineering Entry Control Facility/Access Control Points* ✓ Service Requirements ✓ National design standards (*MUTCD*, *AASHTO*)
Cost	Consider versus: ✓ Quality ✓ Future needs ✓ Serviceability ✓ Sustainment
Other Considerations	✓ Flight line restrictions ✓ Intersection proximity ✓ Prevailing wind direction ✓ Angle of the sun

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 2.11: 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's Center ✓ Trucks	1600 (488)	400 (122)
Secondary	2 lanes per direction	2	✓ Inspection	1000 (305)	300 (91)
Limited Use	1 lane per direction	1	✓ Limited inspection	600 (177)	120 (37)

2.12. EVALUATION AND SELECTION

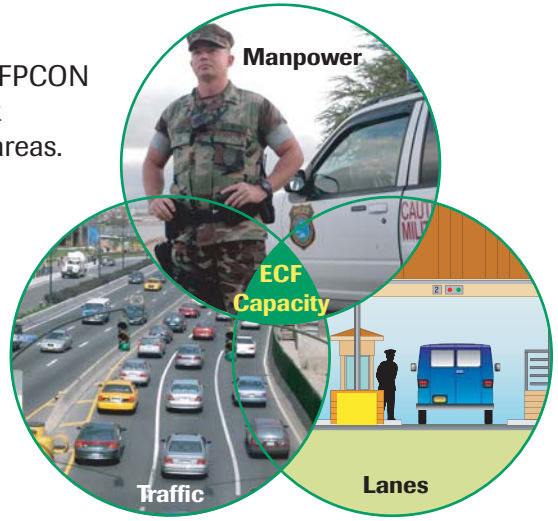
In the final evaluation, it is beneficial to quantify each consideration to the best level possible, but in the end the decision is usually partially subjective, based on planners, engineers, and stakeholders' assessment of the considerations. When comparing alternatives, it is useful to develop a matrix to be used by decision makers.

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.

Exhibit 2.12: Example ECF Alternatives Matrix

Category	Existing	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Satisfy ECF Needs	Yes	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 near by	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

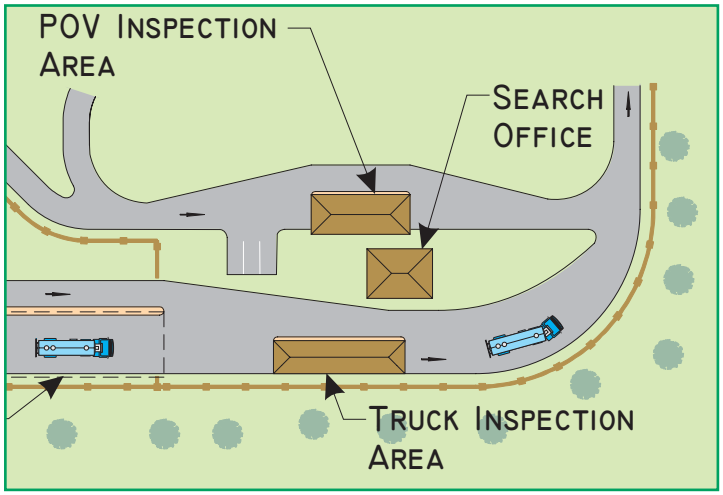


An ECF not only must have adequate lanes to accommodate traffic demands at FPCON Bravo+ (100% ID of all occupants), it must have adequate manpower to support efficient processing in those lanes as well as in visitor's centers and inspection areas.

At ID check areas, consider manpower needs over the entire day. Consider this simple methodology for determining manpower needs:

✓ For each hour, calculate the hourly "true demand" (**Section 2.3.2.4**)
✓ Divide the hourly demand, by the number of ID check lanes
- If the per lane volume exceeds 350, then provide two ID checkers for each lane
- If the per lane volume is between 175 and 350, 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

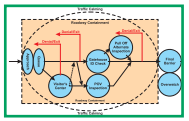
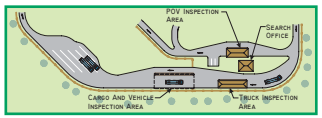
✓ If pedestrian activity exceeds ten in a 15-minute period, consider providing dedicated manpower to process pedestrians

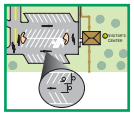


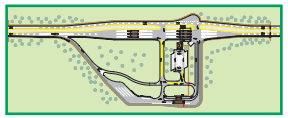
Gatehouse and overwatch needs will be dependent on FPCON and RAM and should be determined by security forces. The amount of support in visitor's centers will vary based on the demand and services provided. Inspection area requirements will vary based on the volume and classification of traffic as well 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 8**; 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's center processing and inspection activities may be reduced





SECTION 3 - GEOMETRIC DESIGN FEATURES

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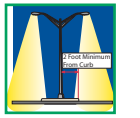
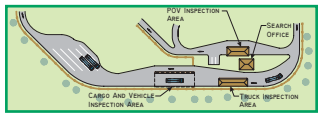




3. Geometric Design Features

3.1. DESIGN GUIDELINES AND CRITERIA

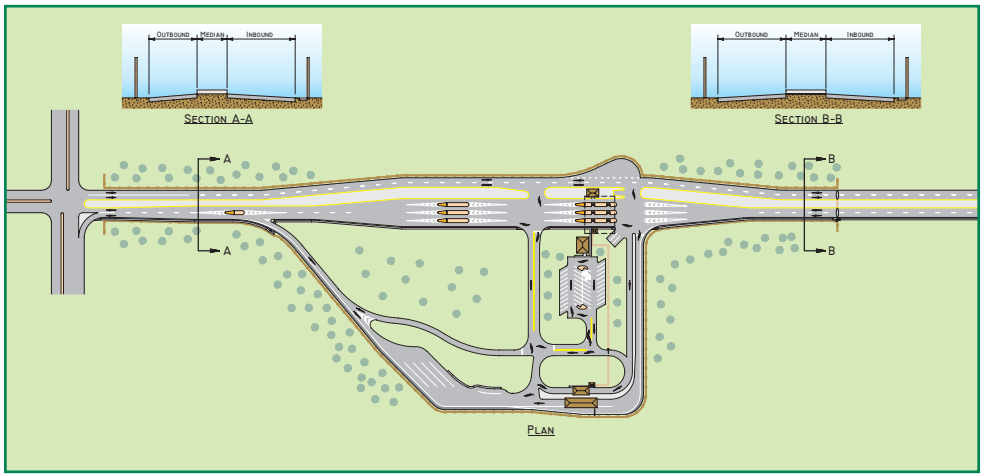
Geometric design is dependent on design speed, roadway classification, and design vehicle. Also, the type of ECF, space available, and traffic volume may impact design. This section is intended to provide basic guidance on general design features.

Design criteria

- *DoD, Unified Facilities Criteria (UFC) on Entry Control Facilities*
- *Army Standard Definitive Design, Access Control Points for U.S. Army Installations*
- *AASHTO, A Policy on Geometric Design of Highways and Streets (Greenbook)*
- *AASHTO, Roadside Design Guide*
- *FHWA, Manual on Uniform Traffic Control Devices (MUTCD)*

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 curvature and alignment; and vertical curvature 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 considering the anticipated operating speed, adjacent land use and functional classification of the roadway. AASHTO defines the design speed as the maximum 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 selection of the ECF design speed should be based on the AASHTO definition of design speed. In most cases, the logical ECF design speed is 25 mph (40 km/h). The chosen ECF design speed should be maintained throughout the entire ECF area since motorists are likely to encounter maneuvers that they would not normally encounter. The design speed adjacent to the ECF may have a greater design speed than desired in the ECF. In those cases, a signing plan should encourage a transitional reduction in speed. Common practice is to avoid changes in design speed of more than 10 mph (16 km/h) from section to section. In no case should the posted speed limit exceed the design speed. When a reduction in speed is achieved through a transitional signing plan, the transition should be completed prior to entering the ECF.

Exhibit 3.1: ECF 25 MPH (40 km/h) Design Speed

- ✓ Uniform Vehicle Code states that a speed limit less than 25 mph (40 km/h) is not enforceable
- ✓ Normally established by the 85th percentile traveling speed

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.

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 (88km/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 signalize 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	✓ Low volumes ✓ Low speeds (25 mph (40km/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.

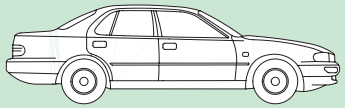
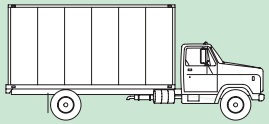
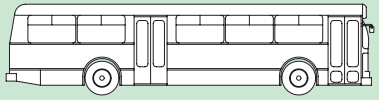
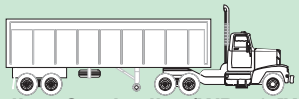
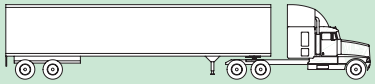
3.1.3. Design Vehicle

The ECF design team must determine what design vehicle is appropriate for designing an ECF. 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 an ECF, a concept was drawn by someone unfamiliar with design criteria. When the design progressed, changes had to be made to accommodate trucks.

For the purpose of ECFs, a design vehicle WB-50 (WB-15) to WB-62 (WB-19) 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.

Exhibit 3.3: ECF Design Vehicles

Design Vehicle	Minimum Design Turning Radius feet (meters)	Centerline 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 (7.8)
 Intermediate Semitrailer (WB-50 [WB-15])	45 (13.7)	41 (12.5)	17 (5.2)
 Interstate Semitrailer (WB-62 [WB-19])	45 (13.7)	41 (12.5)	8 (2.4)
Motor Home and Boat Trailer (MH/B) Note: Design for this vehicle will accommodate all AASHTO recreational variations	50 (15.2)	46 (14.0)	36 (10.7)

Source: AASHTO, Greenbook

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.

THE *UFC* STATES THAT THE MINIMUM LANE WIDTH IS 10 FEET (3.0 METERS) AND THAT THE PREFERRED LANE WIDTH IS 12 FEET (3.6 METERS).

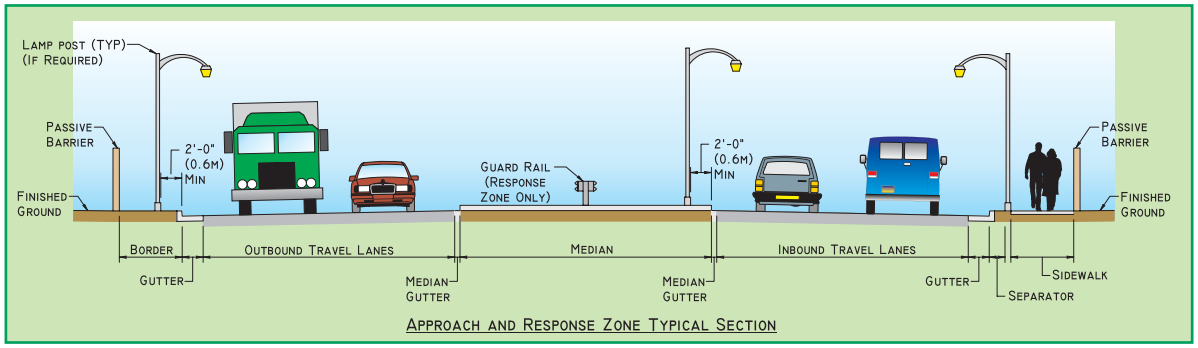
3.2.1. Travel Way and Lane Width

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.

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

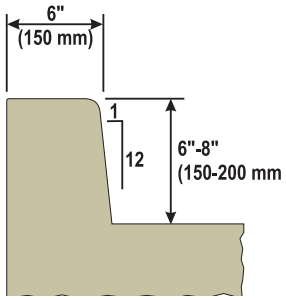
Snow removal requirements including the necessary width between ID check islands for snow removal equipment should be considered. If moderate-to-heavy bicycle traffic is expected, a 5 foot (1.5 meter) bike lane between the travel lane and gutter is recommended.



Approach and Response Zone Typical Section

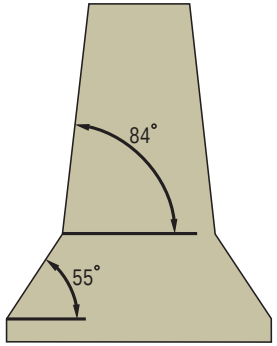
CURBS IN ASSOCIATION WITH GUTTER SECTIONS ARE USED TO CONTROL DRAINAGE AND CHANNEL IT LONGITUDINALLY TO DRAINAGE INLETS.

3.2.2. Curb and Gutter



Gutter sections vary from 1 foot (0.3 meter) to 6 feet (1.8 meters) in width. Collector roadways typically utilize a gutter section from 1 foot (0.3 meter) to 2 feet (0.6 meters) wide. For the purpose of ECF design, the *UFC* recommends 2 feet (0.6 meters) be used. If a gutter has a different color and texture than the road surface and has a longitudinal joint, it should not be considered part of the travel lane width.

Vertical curbs are primarily intended to contain vehicles within the roadway and to provide an elevated platform for personnel who must stand close to the moving vehicles. Where vertical curbs are used, they should not exceed 8 inches (200 millimeters) in height in normal applications. The *UFC* recommends that 6 inch (150 millimeter) vertical curbs be used approaching the checkpoint areas.



Curbing exceeding design limits warrants special consideration. Curbing greater than 12 inches (300 millimeters) is sometimes requested to be used as a passive barrier to control the movement of potential threats. Features of this nature should not be classified as “curb” and should be classified as “barriers.” Barriers have special design considerations to mitigate danger to motorists. The most common example of this is a Jersey-style barrier, which is sloped to lessen the severity of impact if struck. For specific design guidance on barriers of this nature refer to the AASHTO *Roadside Design Guide*.

Exhibit 3.4: 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, Greenbook

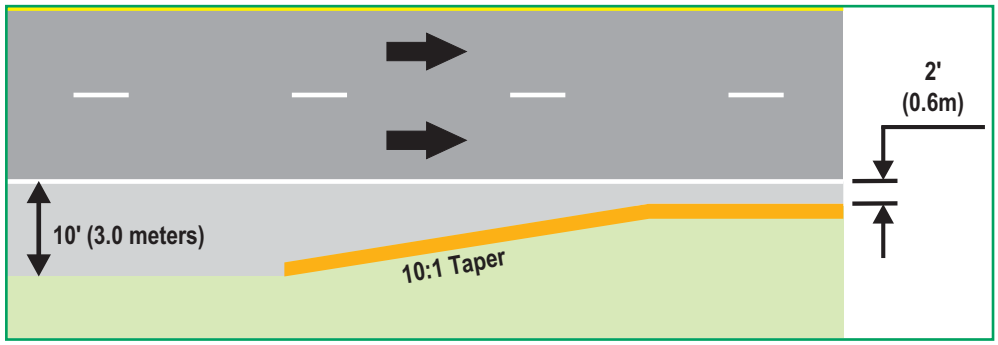
3.2.3. Shoulders

Curbs and gutters are preferable in areas where lane control is desired and to improve safety. Shoulders are discouraged near an ECF 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 ECF, so transitional sections may be needed from shouldered to unshouldered areas.

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. The *UFC* states that if used, shoulders should be 6-8 feet (1.8-2.4 meters) wide. As a minimum, when an uncurbed 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.

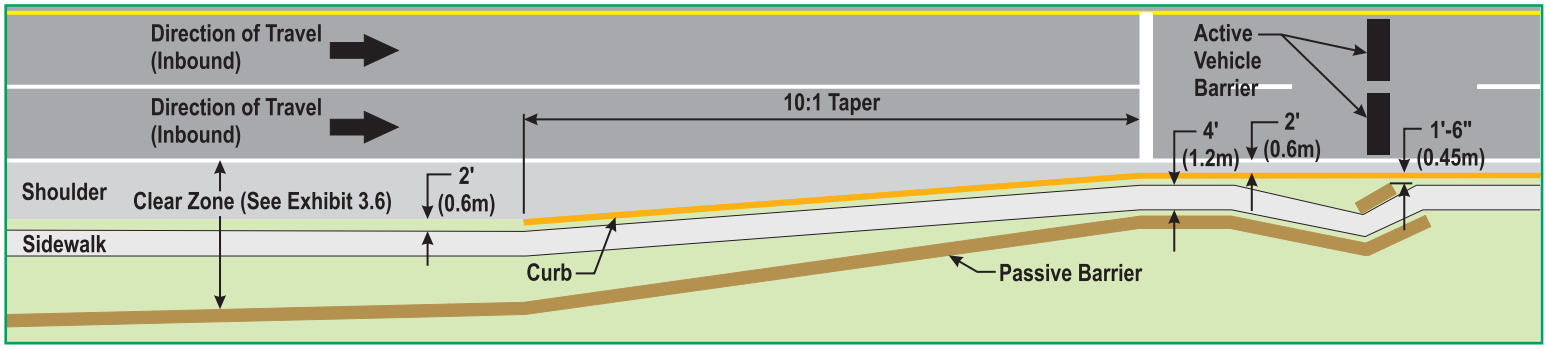
Shoulders should be pitched to drain away from the road surface, but not so much as to make their use hazardous. Their design should be a compromise between slope needs and drivability.

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 (1:10) 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. 2 feet (0.6 meters) should be maintained between the face-of-curb and the edge of the travel lane.



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.

At one installation, items were placed without meeting clear zone criteria. A crash occurred and the installation was liable for the injuries.

The required clear zone is a function of the design speed of the adjacent roadway, the average daily traffic (ADT) volumes, and roadside geometry. Often, meeting the distances outlined in **Exhibit 3.5** in the ECF area is not

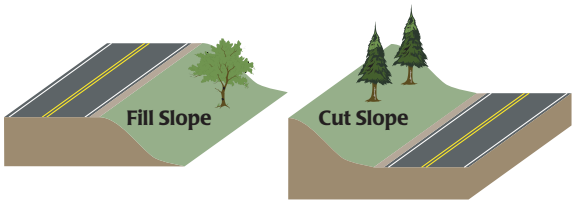
Exhibit 3.5: Clear Zone Requirements

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	12-14 (3.7-4.3)	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	18-20 (5.5-6.1)	24-28 (7.3-8.5)	*	14-16 (4.3-4.9)	19-20 (5.7-6.1)	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.

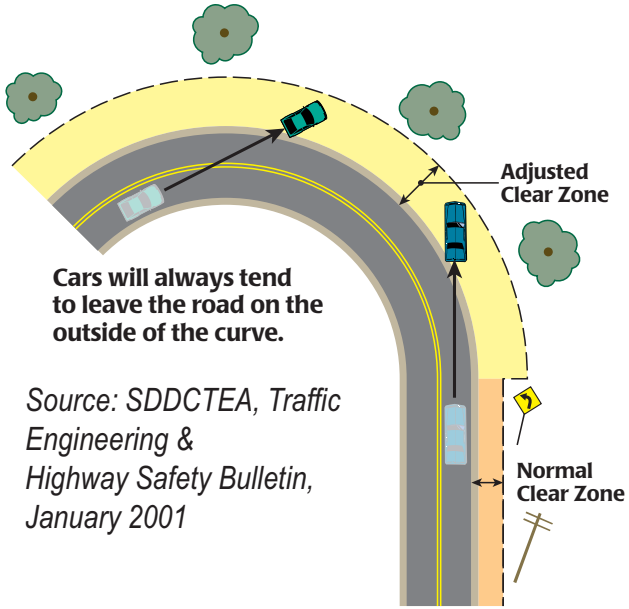
Source: SDDCTEA, Traffic Engineering & Highway Safety Bulletin, January, 2001

feasible due to geometric requirements. Nonvertical curbing is not acceptable for reducing the clear zone below the values presented in **Exhibit 3.5.** 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 3.5** should be used as the minimum and every other option should be exhausted before using values less than those presented.



The clear zones described in **Exhibit 3.5** are appropriate for tangent sections and the inside of horizontal curves. On the outside of horizontal curves, a correction factor from **Exhibit 3.6** should be applied to the value shown in **Exhibit 3.5**. 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.



Source: SDDCTEA, Traffic Engineering & Highway Safety Bulletin, January 2001

Exhibit 3.6: Clear Zone Curve Adjustments

Radius feet (meters)	Design Speed mph (km/h)		
	40 (64) or less	45 (72)	50 (81)
2,900 (884)	1.08	1.10	1.12
2,300 (701)	1.10	1.12	1.15
1,950 (594)	1.11	1.15	1.18
1,650 (503)	1.13	1.17	1.22
1,450 (442)	1.15	1.19	1.25
1,300 (396)	1.17	1.22	1.28
1,150 (351)	1.19	1.24	1.31
1,000 (305)	1.23	1.29	1.36
850 (259)	1.26	1.34	1.42
750 (229)	1.30	1.38	1.48
650 (198)	1.34	1.43	1.53
600 (183)	1.37	1.47	NA
400 (122)	1.54	NA	NA

Source: SDDCTEA, Traffic Engineering & Highway Safety Bulletin, January 2001

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. Medians typically provide green space between vertical faces, and wide medians provide a refuge area for pedestrians and left-turn traffic. 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.

Exhibit 3.7: 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 are asked to cross a distance that they may not be able to make in one signal cycle

Source: ITE, Traffic Engineering Handbook

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.

3.3. TURNING MOVEMENTS

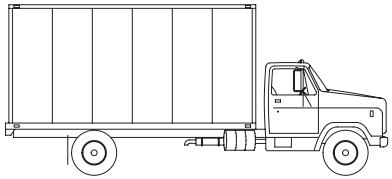
An ECF that only accommodates passenger vehicles will require a significantly less amount of area than one that accommodates trucks. When initially laying out the ECF, make sure that all involved parties are in agreement on what the design vehicle should be. Also consider the available right-of-way,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

At a Primary ECF, it was known that there would be no commercial trucks, but the city buses and school buses that use the ECF were not considered. This required modification to correct the curb and sidewalk design.

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

3.3.1. 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 3.8** shows the AASHTO values for design vehicle turning radii. The *UFC* further defines the minimum values for vehicle turning radii. Finally, the *UFC* states that where turnarounds for large trucks are provided, a 65 foot (19.8 meter) radius should be provided.

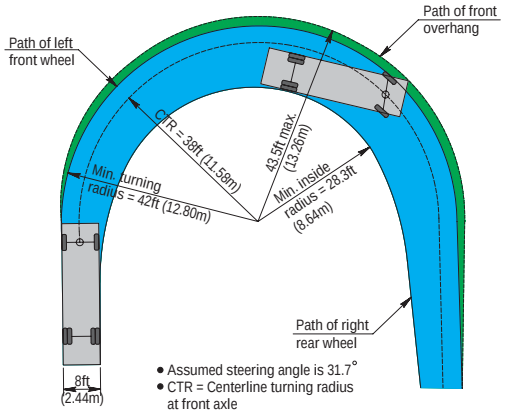


At ECFs that do not accept large vehicles such as semitrailers, the SU or bus design vehicle should be used. However, in areas where trucks are expected, use the WB-50 (WB-15) as a minimum design vehicle.

Exhibit 3.8: 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-50 (WB-15) or WB-62 (WB-19)	45 (13.7)

Source: AASHTO, Greenbook

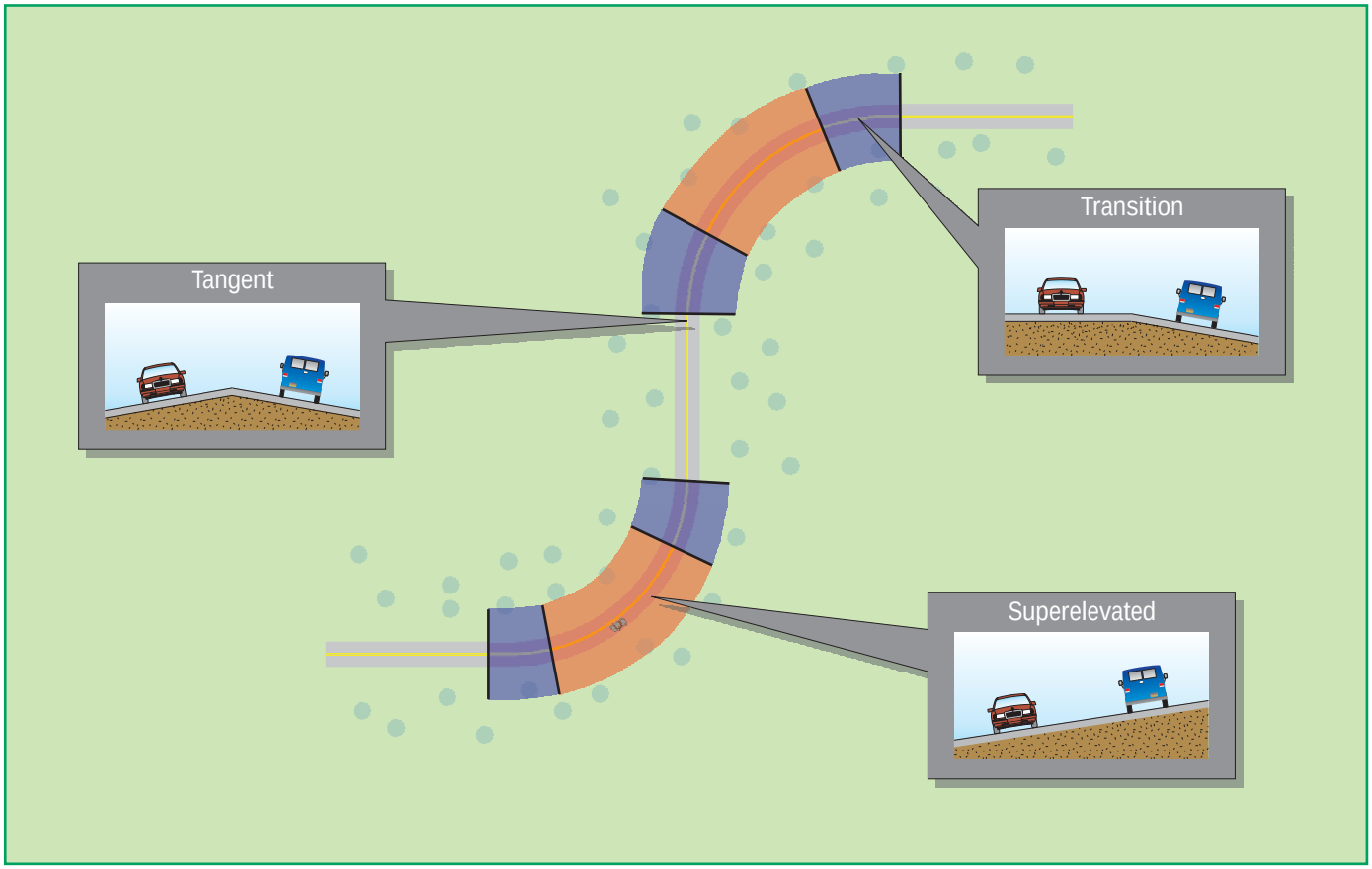


AASHTO Exhibit 2-4 Minimum Turning Path for Single-Unit (SU) Truck Design Vehicle from AASHTO Green Book

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

3.4. 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.



SUPERELEVATION REPRESENTS THE RISE AND RUN OF PAVEMENT ON A CURVE.

3.4.1. Horizontal Curves

For curves in the roadway where the design speed exceeds 15 mph (20 km/h) curves should be designed based on AASHTO criteria. Curves are designed according to design speed, the surrounding areas, and the climate. The design speed determines the sharpest curve allowable. The surrounding area dictates how much a curve can be superelevated.

Superelevation is most often represented as "e." Superelevation is important because it can increase the comfort for drivers traversing a curve and it can decrease the radius needed. The climate of the area can limit the acceptable amount of superelevation. If the curve is superelevated too much in cold weather climates, vehicles will have a tendency to slide off the curve. Four percent is the desirable superelevation at ECFs. **Exhibit 3.9** indicates what the minimum radius is for different design speeds at a superelevation rate of four percent.

In some instances, it may be desirable to use superelevation rates that exceed four percent; however, this should be carefully evaluated in ECF applications. **Exhibit 3.10** indicates where higher superelevation rates are appropriate and how the different rates affect the minimum allowable radius for a 25 mph (40 km/h) curve. It also illustrates the impact of superelevation on design curve radii.

Exhibit 3.9: Minimum Curve Radius at Superelevation of Four Percent

Maximum Superelevation	Design Speed mph (km/h)	Design Radius feet (meters)
4%	20 (30)	125 (35)
4%	25 (40)	205 (60)
4%	30 (50)	300 (100)
4%	35 (60)	420 (150)
4%	40 (70)	565 (215)
4%	45 (80)	730 (280)
4%	50 (90)	930 (375)

Source: AASHTO, Greenbook

Exhibit 3.10: 25 mph (40 km/h) Minimum Curve Radius

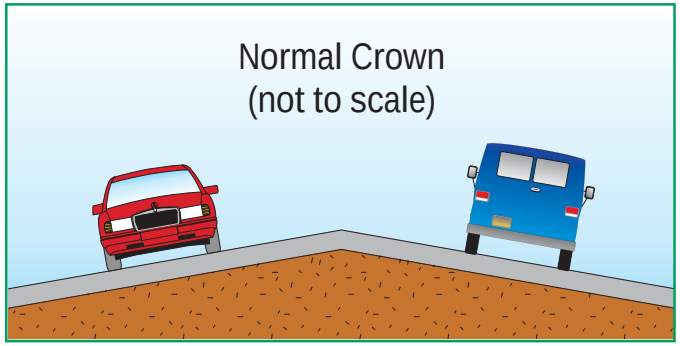
Superelevation Rate	Terrain	Road Class	Design Curve 25 mph (40 km/h)
0%	All	All	255 (75)
2%	All	All	225 (70)
4%	Urban	Limited Access, Arterials, Collectors, Local	205 (60)
6%	Suburban	Limited Access, Arterials, Collectors	185 (55)
8%	Rural	Limited Access, Arterials	170 (50)

Source: AASHTO, Greenbook

3.4.2. Horizontal Tangents and Transitions

In order for vehicles to safely negotiate a 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 3.11** shows the minimum tangent and transition lengths between reverse horizontal curves.

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*.



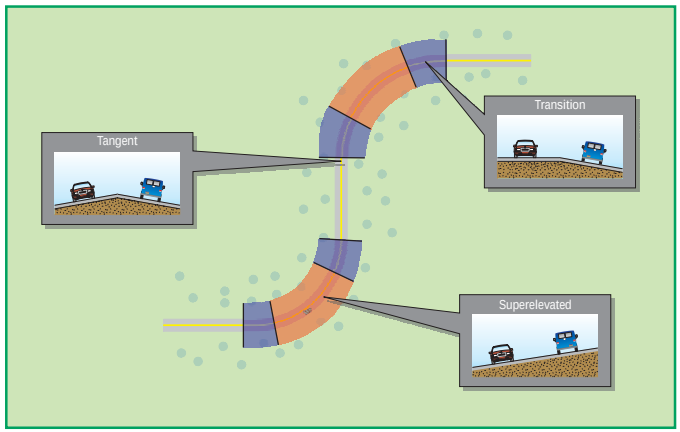


Exhibit 3.11: Minimum Tangent Distance at Superelevation of Four Percent

Maximum Superelevation	Design Speed mph (km/h)	Design Tangent feet (meters)(1)	Design Transition feet (meters)(1)
4%	25 (40)	34(10)	69(21)
4%	30 (50)	36(11)	73(22)
4%	35 (60)	39(12)	77(24)
4%	40 (70)	41(13)	83(26)
4%	45 (80)	44(14)	89(29)
4%	50 (90)	48(15)	96(31)

(1) Assumes one lane rotated
Source: AASHTO, Greenbook

3.4.3. Horizontal Sight Distance

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

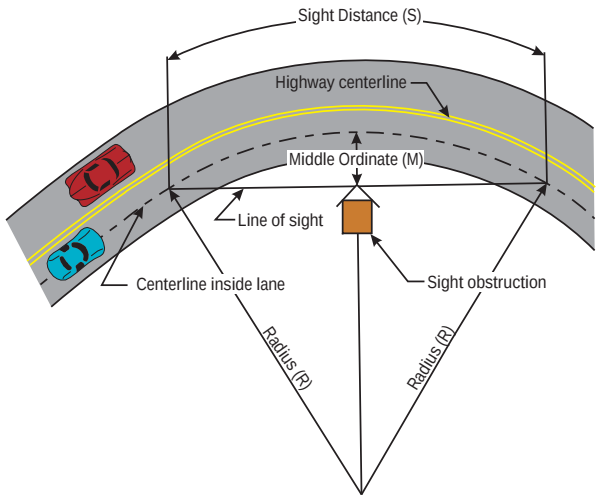
Providing appropriate sight distance for horizontal alignments addresses the need for the driver to be able to identify and react to an obstruction in the roadway ahead. This distance is based on an assumed eye height of 3.5 feet (1.1 meters) for the driver and an object 2 feet (0.6 meters) high. As **Exhibit 3.12** shows, the stopping sight distance is measured along the centerline of the inside travel lane. The middle ordinate is a distance from the centerline of the travel lane to a chord drawn between the driver's eye and the object ahead.

An ECF was constructed just beyond a horizontal curve; motorists had trouble seeing queued traffic approaching the ECF. To mitigate the problem, vegetation along the inside of the curve was removed to get the needed sight distance.

Exhibit 3.12: Horizontal Stopping Sight Distance at Superelevation of Four Percent

Maximum Superelevation	Design Radius feet (meters)	Middle Ordinate feet (meters)	Design Speed mph (km/h)	Stopping Sight Distance feet (meters)
4%	205 (60)	15 (5)	25 (40)	155 (50)
4%	300 (100)	17 (5)	30 (50)	200 (65)
4%	420 (150)	19 (6)	35 (60)	250 (85)
4%	565 (215)	21 (6)	40 (70)	305 (105)
4%	730 (280)	22 (8)	45 (80)	360 (130)
4%	930 (375)	24 (9)	50 (90)	425 (160)

Source: AASHTO, Greenbook



3.5. VERTICAL ALIGNMENTS

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

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

Initially one installation ignored clearance requirements because they didn't want their canopy to look like a "toll plaza," but when the importance of vertical clearance was explained, they corrected their design.

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.

3.5.1. Vertical Clearance

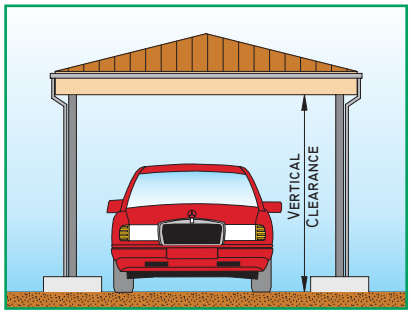
Ample vertical clearance must exist at ECFs to permit the safe passage of large trucks, heavy equipment transporters, and engineering maintenance equipment.

Exhibit 3.13: Average Design Vehicle Height

Design Vehicle	Average Height feet (meters)
P, Passenger Car	4.3 (1.3)
SU, Single Unit Truck	13.5 (4.1)
CITY-BUS, City Transit Bus	10.5 (3.2)
WB-50 (WB-15), Intermediate Semitrailer	13.5 (4.1)
WB-62 (WB-19), Interstate Semitrailer	13.5 (4.1)
MH, Motor Home	12.0 (3.7)

Source: AASHTO, Greenbook

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. At an ECF that will accommodate truck traffic, vertical clearance should be at least 17.5 feet (5.4 meters) from the highest point of the roadway to the lowest point on the canopy although 17 feet (5.2 meters) may be acceptable by some service branches. 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 14.5 feet (4.4 meters) is allowable. Emergency vehicles and buses should also be considered when planning an ECF; however, heights typically do not exceed those of the WB-50 (WB-15) or WB-62 (WB-19).



3.5.2. Vertical Curvature

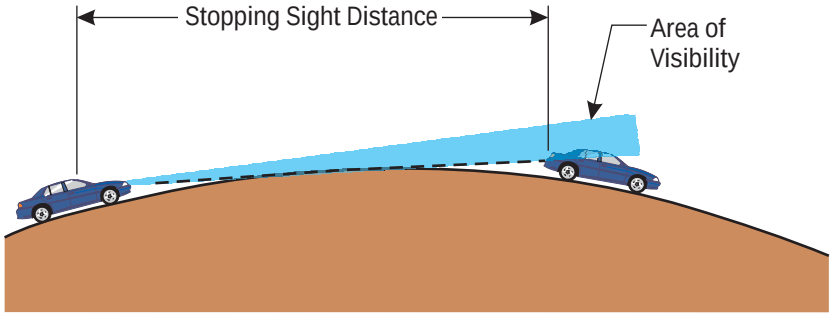
Like horizontal curves, acceptable vertical curvature is dependent on the design speed of the roadway and the sight distance needed to identify and react to an object in the roadway. The stopping sight distance for vertical curves is based on the height of the vehicle's headlights rather than direct line of sight. The design value for headlight height is 1.3 feet (0.4 meters). Any object that is within the shadow zone must extend into the headlight beam to be directly illuminated. Acceptable vertical curves are defined by the rate of vertical curvature, commonly known as the "K" value. For a complete discussion about the K values, see the AASHTO, *Greenbook*.

At one installation where the ECF was just over the crest of a hill, the vertical curve was not designed properly. This created a safety hazard for the guards because approach speeds were too fast and motorists could not see the ECF.

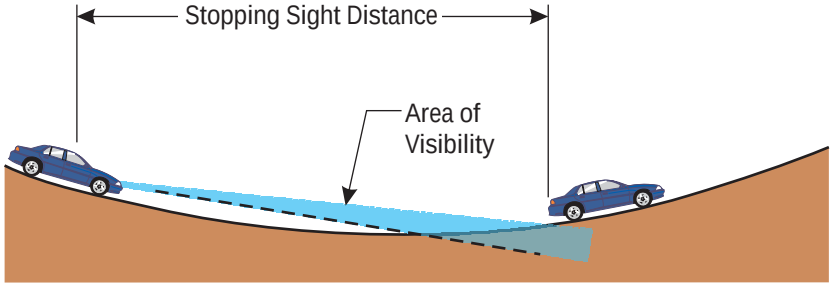
Exhibit 3.14: Vertical Stopping Sight Distance

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
Source: AASHTO, Greenbook



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.

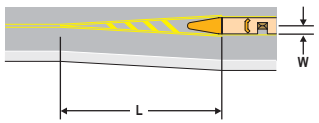
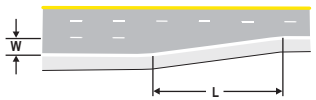
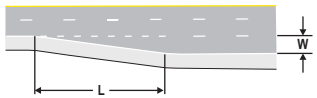
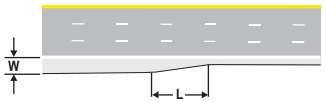
3.6. OTHER GEOMETRIC CONSIDERATIONS

3.6.1. 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) and the design speed (S). 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.

Exhibit 3.15: Transition Tapers

Type		Usage	Criteria
Lane Redirected		At an ECF to accommodate ID check islands	✓100 feet minimum ✓40 mph or less use $WS^2/60$ ✓Greater than 40 mph use W x S
Lane Dropped		After an ECF when reduction in lanes is needed	✓100 feet minimum ✓40 mph or less use $WS^2/60$ ✓Greater than 40 mph use W x S
Lane Added		Before an ECF when more processing lanes are needed	✓Minimum Length WS/3 or 10:1 ratio taper, whichever is greater
Shoulder-to-Curb Transition		Approaching an ECF when an uncurbed section of roadway is transitioned to a curbed section in order to control vehicle movements	✓10:1 Minimum taper for a transition from a shoulder section to a curb section $L_{min} = 0.33L$, where $L=WS^2/60$ (40 mph or less) or L=WS (>40 mph)

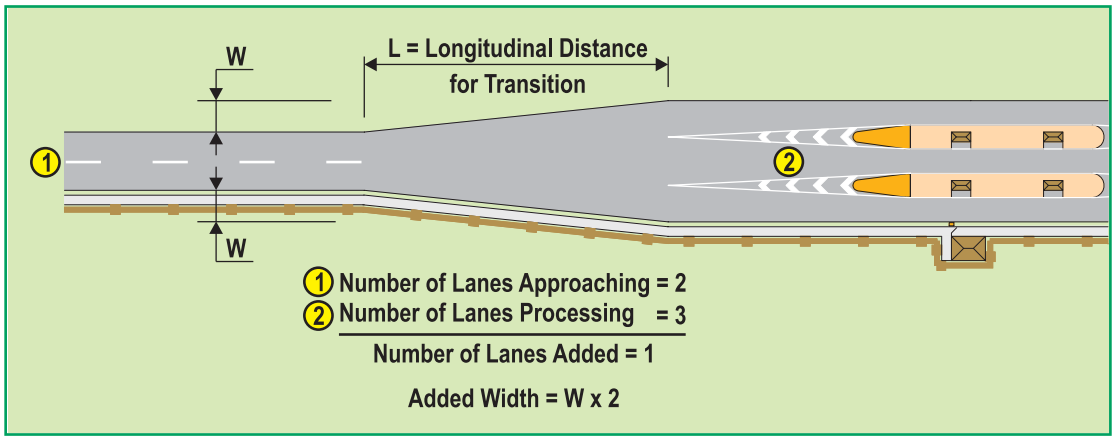
Source: SDDCTEA, Traffic Engineering & Highway Safety Bulletin, August 2001, Revised August 2004.

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. **Exhibit 3.16** shows an example of the required length of roadway for transitioning with a 25 mph (40 km/h) design speed.

Exhibit 3.16: Approach Zone Transition for 25 mph (40km/h) Design Speed

ID Check Lanes Added	Lateral Shift (W)	Total Width Added (Wx2)	Longitudinal Distance Required for Transition
1	10	20	105
2	20	40	210
3	30	60	315
4	40	80	420
5	50	100	520

(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) Asymmetrical (all lanes added to left or right) widening would require twice the transition since W is effectively doubled
(5) US Customary units only shown



3.6.2. 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.

Several stakeholders reiterated the point that the guard booth had to be protected from a high-speed attack and wanted to construct a concrete wall at the end of the island. After it was demonstrated that the proper type of crash cushion could provide similar protection as well as provide safety for motorists, stakeholders agreed to use crash cushions.

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

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.

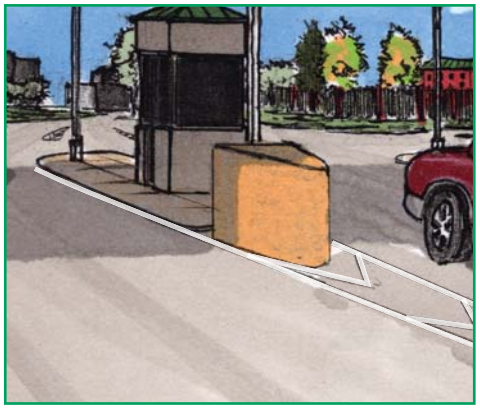
ID check islands are special cases. Although in most cases an adequate curb will protect the island and guard, the island is vulnerable at the nose and from the side. In normal practice, the decision on whether to provide attenuator protection is based on traffic volume and speed. Although not always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

Impact attenuators should conform to FHWA *National Cooperative Highway Research Program Report 350 (NCHRP 350)*. *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



PAVEMENT STRUCTURE AND PAVEMENT SURFACE PLAY A LARGE ROLE IN THE SAFETY, FUNCTIONALITY, AND LONGEVITY OF AN ECF.

3.6.3. Pavement Surface and Design

The type of pavement used is often based on material availability, costs of materials, and design. The pavement structure is dependent on the type of roadway and truck percentage. An under-designed pavement surface may appear acceptable in the short-term, but will soon experience cracking, spalling, and rutting.

In the ECF area there are a higher percentage of start and stop movements than drivers normally experience. To resist skidding:

✓ Provide a friction coefficient of at least 0.5
✓ Evaluate annually to ensure that the minimum friction coefficient is maintained

There are two types of pavements that are commonly used: flexible and rigid. Flexible pavement is generally placed in layers with a subbase (crushed stone), a base course (hot asphalt mix), and a wearing of surface course (hot asphalt mix). The hot asphalt mix is the most common type of material used for flexible pavement; however, check what is readily available and the most economical in the area. The subbase is normally 6 to 12 inches (150 to 300 millimeters) thick, the base course is normally 4 to 6 inches (100 to 150 millimeters) thick and the wearing course is normally 2 to 4 inches (50 to 100 millimeters) thick. Unlike flexible pavement, rigid pavement (such as concrete) is placed in one layer over the subbase and is normally 8 to 12 inches (200 to 300 millimeters) thick. Use **Exhibit 3.17** to determine the appropriate pavement structure for each ECF. Individual service should consult their applicable guidelines and *UFC* 3-250-0 on pavement design.

Exhibit 3.17: Typical Pavement Dimensions

ECF Type	Subbase Thickness inches (millimeters)	Flexible Pavement Base Course Thickness inches (millimeters)	Flexible Pavement Surface Course Thickness inches (millimeters)	Rigid Pavement Thickness inches (millimeters)
Primary	8 (200)	6 (150)	4 (100)	10 (250)
Secondary	8 (200)	6 (150)	4 (100)	10 (250)
Limited Use	6 (150)	4 (100)	2 (50)	8 (200)
Commercial	8 (200)	6 (150)	4 (100)	10 (250)

Source: AASHTO, Guide for Design of Pavement Structures

3.6.4. 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. 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 often dictates final alignment.

An ECF was designed at one location that met security needs, was safe for guards and motorists, accommodated traffic demands and was aesthetically pleasing; however, since drainage was not properly designed, the ECF had to be closed during periods of heavy rainfall.

Since the ECF will have curbs and gutters adjacent to all 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 municipality adjacent to the ECF 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*.

CARE SHOULD BE TAKEN THAT LANDSCAPING DOESN'T CONFLICT WITH SAFETY.

3.6.5. Landscaping

To integrate the ECF and approach highways 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. Properly designed landscaping can also substitute for or supplement passive barriers in the ECF. 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
- ✓ Screen opposing traffic from headlight glare
- ✓ Prevent driver distraction
- ✓ Improve aesthetics by blocking unsightly areas

Care should be taken that landscaping doesn't conflict with safety by becoming a hazard or causing sight distance restrictions. Trees in the clear zone should be limited to less than 4 inches (100 millimeters) in diameter.

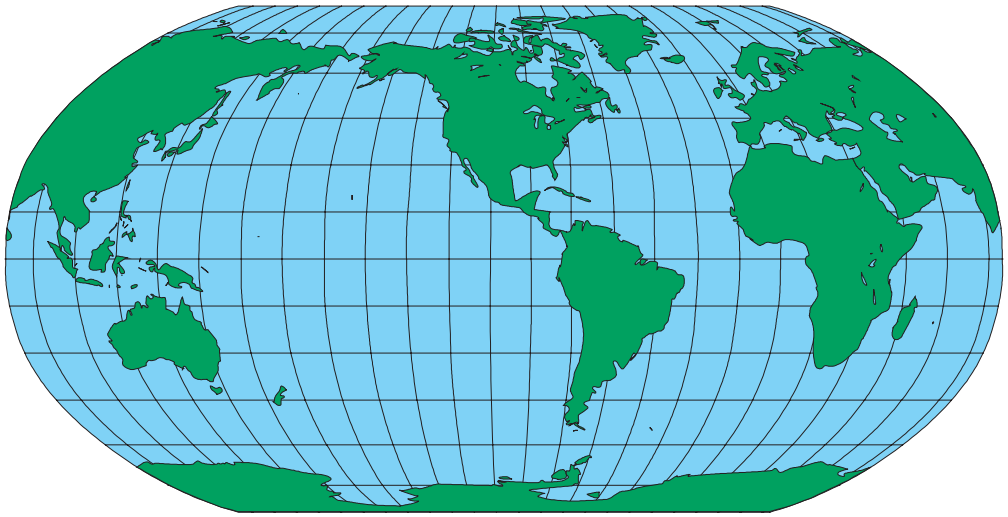
3.7. OUTSIDE CONTINENTAL UNITED STATES (OCONUS) CONSIDERATIONS

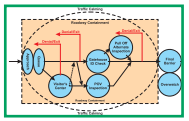
OCONUS installations require special considerations. Each location may have its own unique requirements due to:

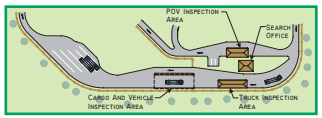
✓ Host country regulations
✓ Threat conditions
✓ Traffic volume
✓ Type of traffic

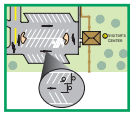
For example, many Japanese installations have significantly higher pedestrian volumes than most Continental United States (CONUS) locations.

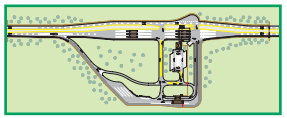
At one OCONUS installation, the ECF was not initially designed with special pedestrian facilities because a CONUS example ECF was being used. After the base had a traffic engineering study performed, they found that they had a significant pedestrian demand that warranted a dedicated facility.





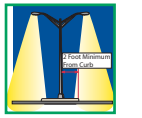


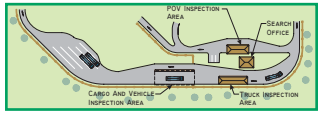




SECTION 4 - BUILDING AND FACILITY CONSIDERATIONS

4.1. VISITOR'S CENTER 4-2
4.2. GATEHOUSE 4-3
4.3. ID CHECK AREA 4-4
4.4. INSPECTION AREAS 4-6
4.5. TRUCK INSPECTION AREA 4-8
4.6. CANOPY 4-9
4.7. CLIMATE CONSIDERATIONS 4-10





4. Building and Facility Considerations

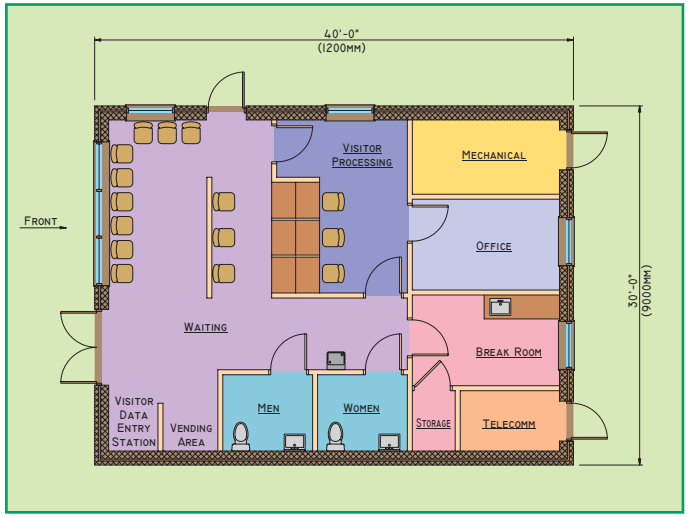
- ❑ Visitor's center
- ❑ Gatehouse
- ❑ Guard booth
- ❑ Canopies
- ❑ Inspection areas
- ❑ Truck inspection areas
- ❑ Overwatch

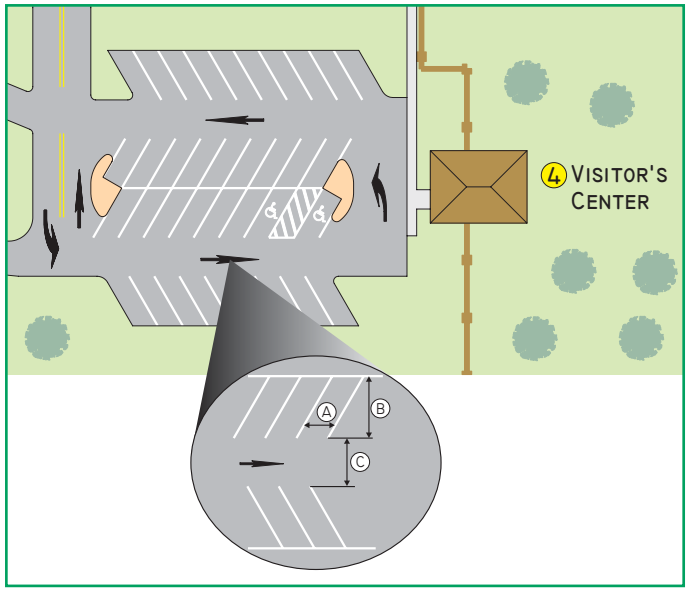
The *UFC* and other reference materials provide requirements and guidance on the design of buildings and facilities at ECFs. *UFC* 4-022-03, *Security Engineering: Design of Security Fencing, Gates, Barriers, and Guard Facilities,* provides guidance on the design of guard booths, gatehouses, and guard towers. The appearance of the facilities should be in accordance with the installation exterior architectural plan.

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





4.1. VISITOR'S CENTER

The visitor's center 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 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 visitor's center. 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 ADA and should include reserved accessible parking, curb ramps, and sidewalks.

Exhibit 4.1: Visitor's Center Parking Dimensions

	Parking Dimension	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)

Source: SDDCTEA, Traffic Engineering and Highway Safety Bulletin, October 2003

A GATEHOUSE IS THE CENTRAL CONTROL CENTER FOR AN ECF.

4.2. GATEHOUSE

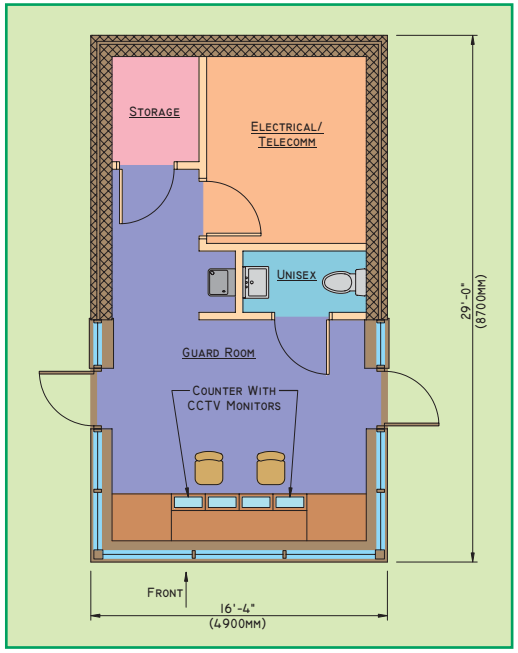
The gatehouse serves as the central control center for the ECF by providing shelter for security personnel and controls for the vehicle barriers, traffic control devices, access controls, lighting, and surveillance equipment.

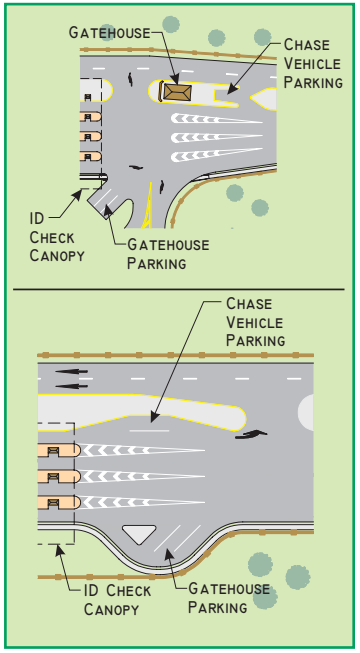
The gatehouse is typically located in the median or on the right shoulder.

✓ 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.





DESIGN THE ID CHECK AREA SO:

- ❑ **GUARDS CAN FUNCTION FREELY AND SAFELY**
- ❑ **PLATFORM SURFACES ARE MADE WITH ANTI-SKID PROPERTIES**
- ❑ **A MINIMUM PLATFORM WIDTH OF 3 FEET (0.9 METERS) IS PROVIDED BEHIND THE CURB**

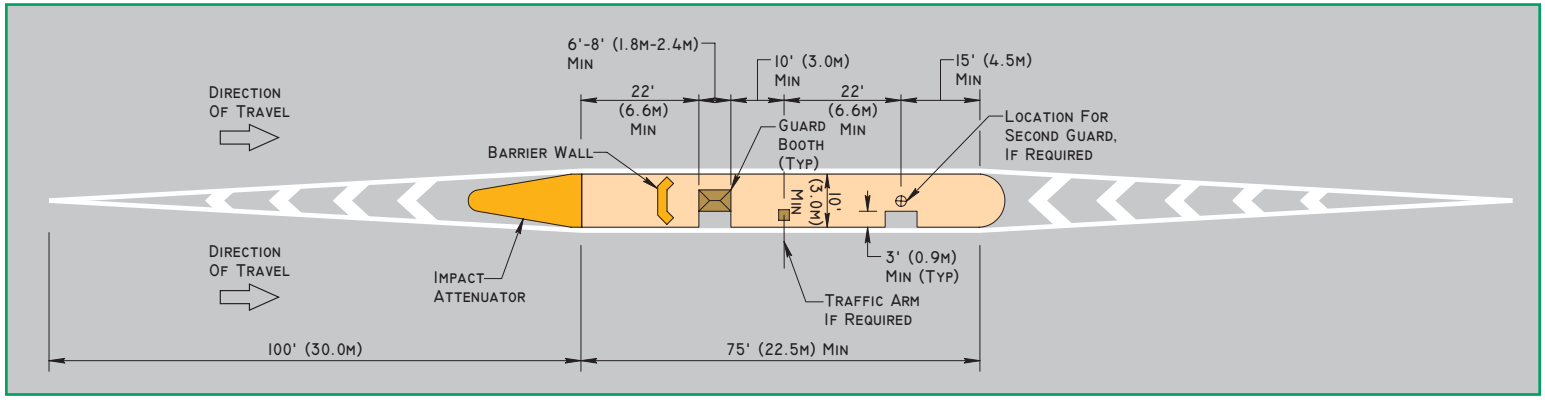
4.3. ID CHECK AREA

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 is recommended, 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 "notched" step down so that guards can process motorists at eye-level without having to bend over or step into traffic. The notched island should be designed to promote proper drainage so that it does not become an impediment to vehicular traffic. Typically, ID check areas should not be less than 10 feet (3.0 meters) wide and 75 feet (23 meters) long. Providing 75 feet (23 meters) of length will allow tandem checking of vehicles and room for future technology.



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

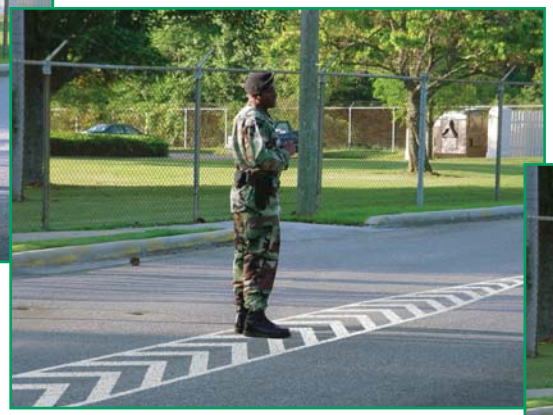
4.3.1. Short-Term Island Enhancements

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.

✓ Pavements 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 can also utilize temporary rubber curbing products if removal is possible.

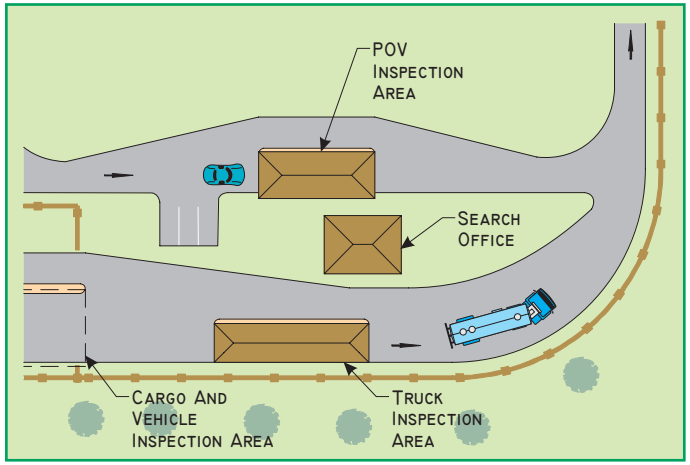
Where possible, a guard cut-out should be provided so that the guard is at road level.

No Delineation or Refuge



Delineation

Delineation and Refuge



4.4. 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

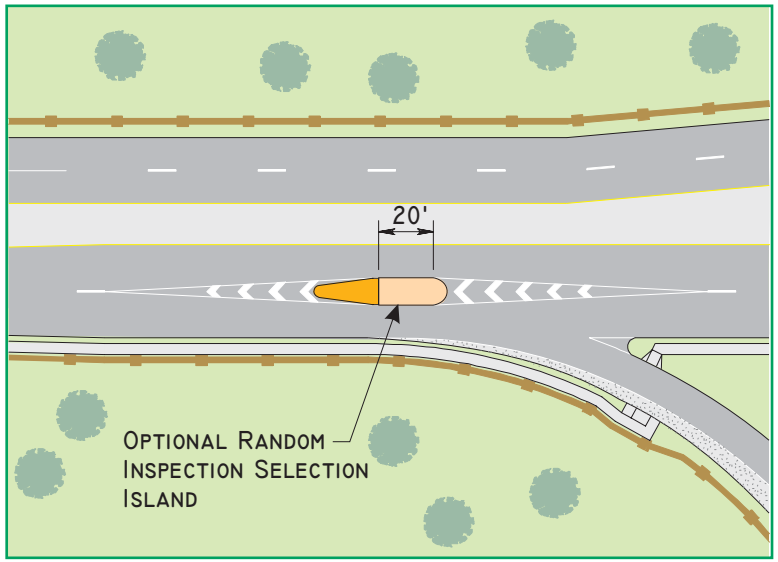
Some service branches perform random inspections prior to the ID check area in the approach zone, whereas other branches perform random inspection after the ID check area. Based on where and when random inspection activities occur, facilities and procedures should be developed to minimize the impact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

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.

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.

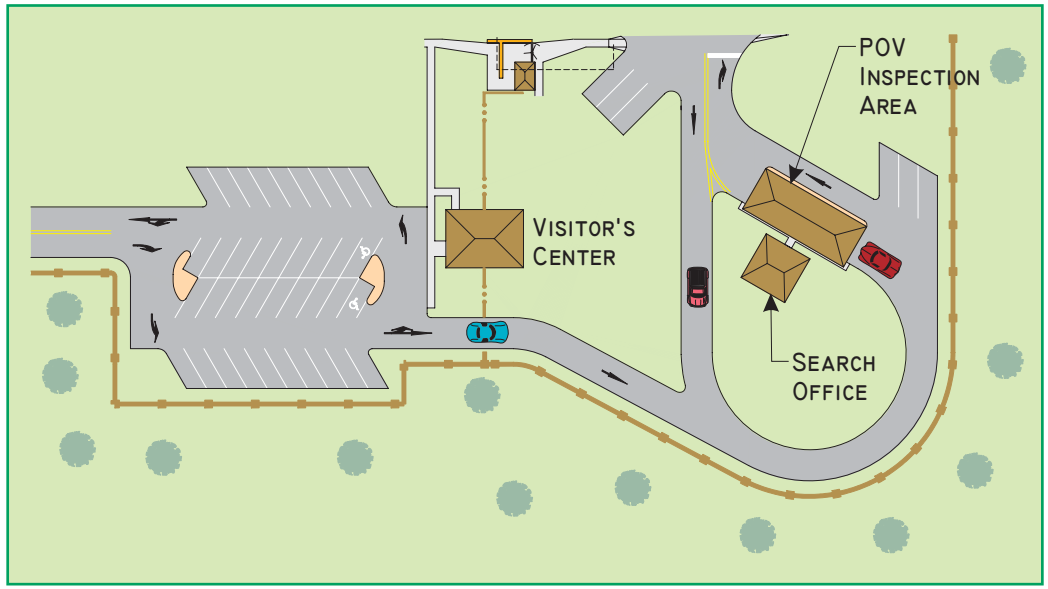
When inspections take place after the ID check area, the access to the inspection area needs be as close as geometrically possible and should be within the line of sight of the guard.

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.



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 visitor's centers, direct access from the visitor's center to the inspection area should be provided if practical.



TRUCK INSPECTIONS SHOULD BE SEGREGATED FROM POV INSPECTIONS SINCE:

- ALL TRUCKS SHOULD BE INSPECTED IN MANY SITUATIONS
- THERE ARE DIFFERENT INSPECTION PROCEDURES
- INSPECTIONS TAKE SIGNIFICANTLY LONGER THAN POV INSPECTIONS

4.5. TRUCK INSPECTION AREA

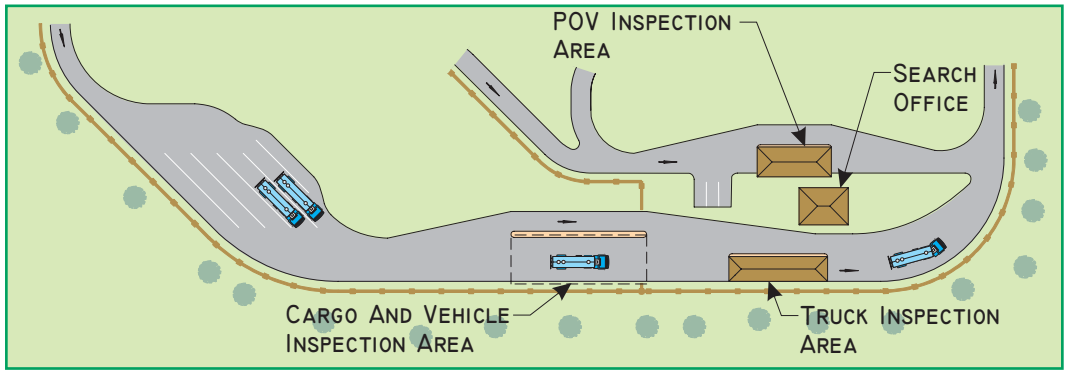
At installations with a significant truck demand, dedicated ECFs should be considered.

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. 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 ADA compliant.

At one installation, trucks were being inspected in the ID check lanes. In the time it took to inspect and process one truck, 30 POVs could be inspected. When the installation removed truck inspection and processing from the ID check lanes, processing rates went up by almost 25 percent.

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 may be a WB-50 (WB-15).

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 the *UFC*. In many cases radiation setbacks dictate geometric design requirements.



PROVIDING AN OVERHEAD CANOPY AT THE ID CHECK AREA CAN:

- ❑ IMPROVE LIGHTING
- ❑ PROTECT GUARDS AND DRIVERS FROM INCLEMENT WEATHER
- ❑ SERVE AS A PLATFORM FOR TRAFFIC CONTROL DEVICES, SIGNAGE, AND SECURITY EQUIPMENT

4.6. CANOPY

Canopies are used in three areas of an ECF:

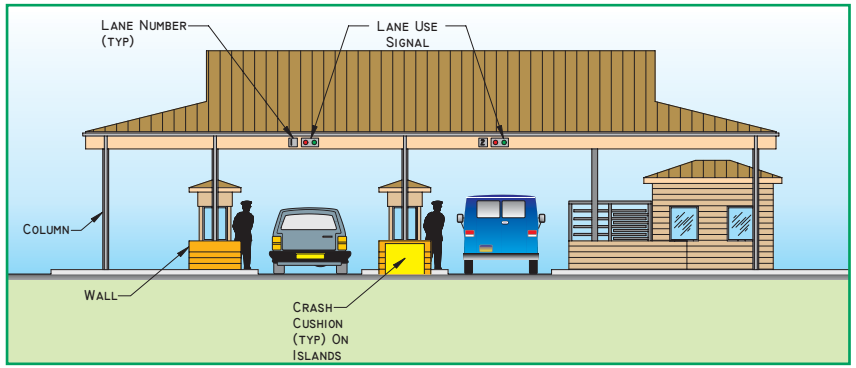
✓ ID check area
✓ POV inspection area
✓ Truck inspection area

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 (inbound and outbound), 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 (5.4 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. Some branches have designated 14.5 feet (4.4 meters) as the clear height if trucks will not use the ECF or if they have an alternate entry path such as through the inspection area. Additionally, some service branches allow a minimum clear height of 17.0 feet (5.2 meters) for truck inspection areas.



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 2 feet (0.6 meters) behind the face of curb.

4.7. CLIMATE CONSIDERATIONS

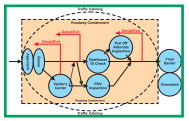
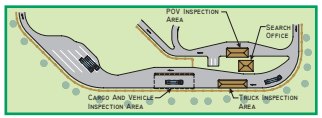
Consideration must be given to the effects of nature on the ECF and the personnel assigned to it. When possible, buildings and checkpoints should be orientated in a way that sunlight will not blind the approaching driver or the ID checker.

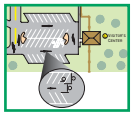
Hot and cold climates may affect the operation of the ECF in different ways. In cold climate locations, pavement warming devices and enclosed buildings should be provided to protect all control points in the ECF area, including the main ID check area, inspection areas and any other area where security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

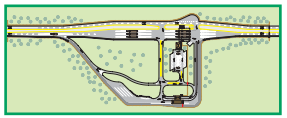
In warm weather climates that experience high levels of rainfall, proper precautions should be taken to protect all ID check and inspection areas from both windblown rain and vertical rain. The installations architectural compatibility plan should be consulted and all structures proposed for mitigating environmental effects in the ECF area should follow that plan.

Exhibit 4.2: 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 glare





SECTION 5 - TRAFFIC CONTROL DEVICES

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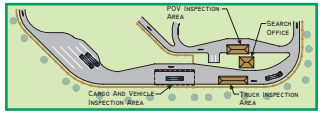
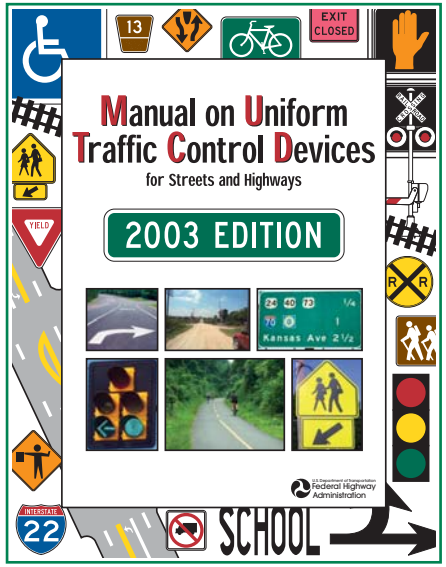


5. Traffic Control Devices

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.



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.

FREQUENTLY ASKED QUESTIONS

Q: Does the MUTCD apply to military reservations?

A: Yes, both national and military regulations dictate that the MUTCD be used.

National Requirement

"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 open to public travel*** *in accordance with 23 U.S.C. 109(d) and 402(a)."*

Military Requirement

Joint Regulation (AR 55-80, OPNAVINST 11210.2, AFMAN 32- 1017, MCO 11210.2D, and DLAR 4500.19) of the Department of Defense (DoD) Transportation Engineering Program identifies in 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 (see national requirement above), DODD 4510.11, and DoDI 6055.4."*
- 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.

FREQUENTLY ASKED QUESTIONS

Q: *Military roads are not "open to public travel" so why does MUTCD apply?*

A: *Per national and military regulations, the MUTCD does apply to military installations.*

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 reservation to be no different from those off the reservation.

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 Administrator."*

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

5.1. SIGNS

5.1.1. 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 150 feet (45 meters) from the other signs
- ✓ Clear obstructions and roadside features such as vegetation, utility poles, and pedestrian facilities
- ✓ Use reflective sheeting so that the sign will be visible at night

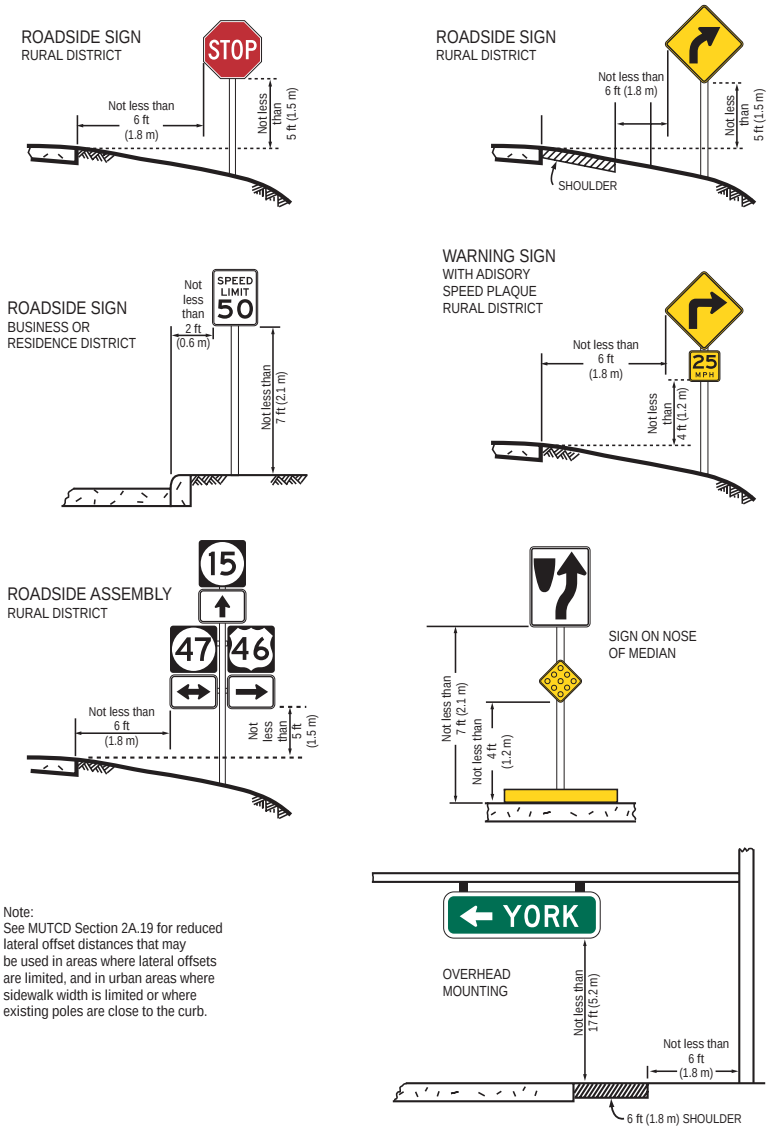
Placed Correctly:

- ✓ 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

5.1.2. Sign Types

Exhibit 5.1 shows some of the common sign types and shapes that may be found within and adjacent to an ECF and the graphic on page 5-5 (**Exhibit 5.2**) shows a typical sign layout at a primary ECF.

MUTCD Figure 2A-1. Examples of Heights and Lateral Locations of Signs for Typical Installations



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

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.

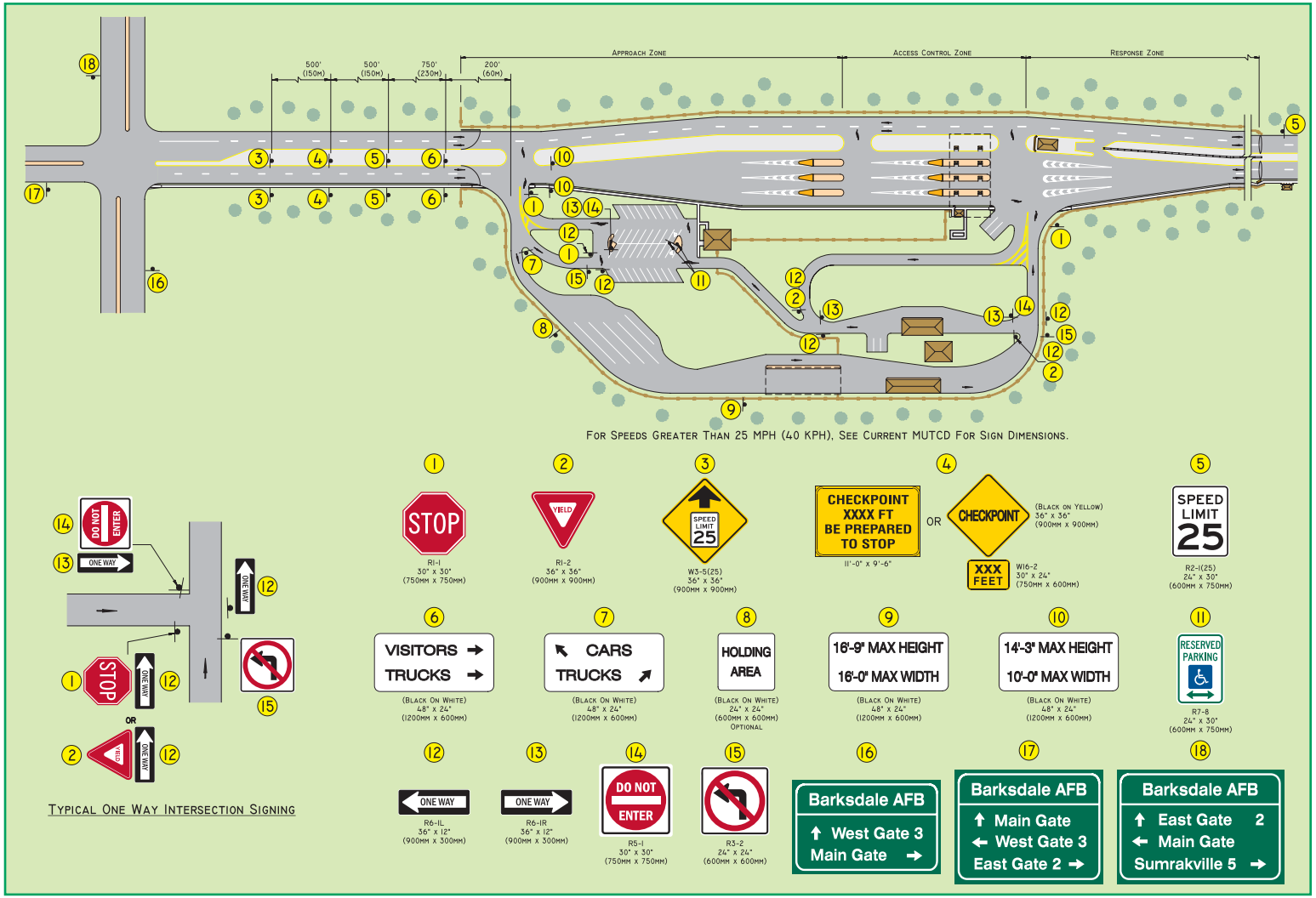
Guide signs are essential in directing motorists along roadways and streets. There is more information on guide signs as they relate to ECFs in subsequent sections.

Exhibit 5.1: Sign Shapes and Colors

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

Source: FHWA, MUTCD

Exhibit 5.2: Sample Sign Layout



5.1.3 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 50 feet (15.2 meters) away, 6 inch (150 millimeter) text can be seen 300 feet (91 meters) away and 12 inch (300 millimeter) text can be seen 600 feet (183 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 *SHS* 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.

5.1.4 Other 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.

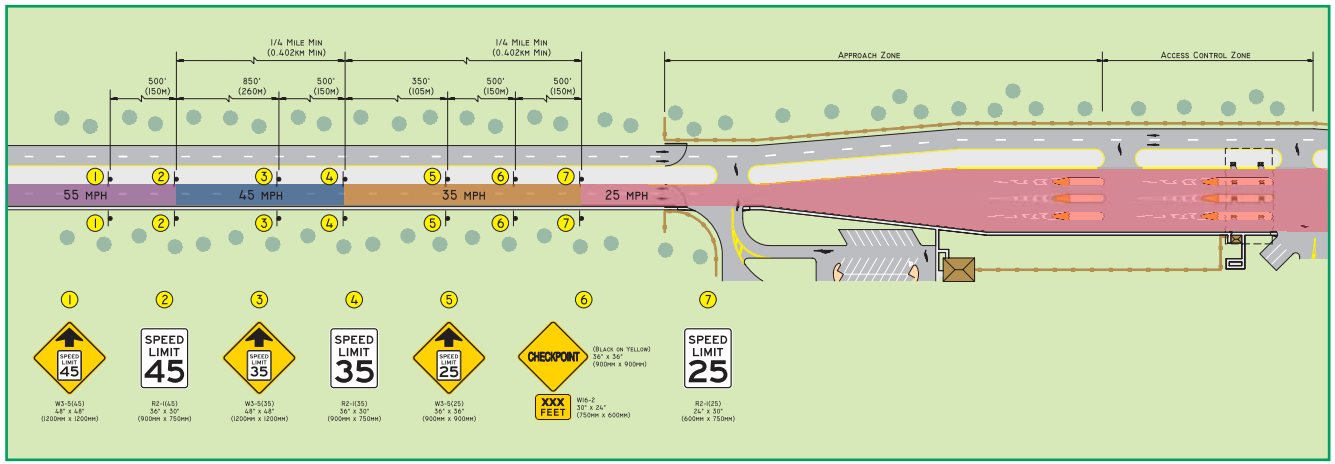
At an installation's Main Gate, the speed limit was reduced from 45 mph to 25 mph within 400 feet of the ID check even though there was an approach zone of nearly one mile. As a result, vehicles approached the ID check area at a higher speed than was preferred. When a transitional speed limit signing plan was introduced and enforced, speeds at the ID check area were lower.

5.1.4.1 Transitional Speed Limit Reductions

When the transition of posted speed limit is equal to or less than a 10 mph difference no additional signing is required; however, if the approaching speed limit is greater than 35 mph, (typically 10 mph greater than ECF posted speed limit) additional transitional signing may be required.

✓ Speed reductions of greater than 10 mph should be avoided.
✓ Speed zones of less than ¼ mile should be avoided.

At an ECF with an approach speed limit of 55 mph, a transitional speed reduction from 55 mph to 25 mph should occur in three zones (55-45; 45-35; 35-25) each being no less in length than ¼ mile (3/4 mile total). Each zone should be introduced with a W3-5 sign ideally placed at least 500 feet in advance of the zone. At an ECF with a 45 mph approach speed limit, two transitional zones (45-35, 35-25) should be used.



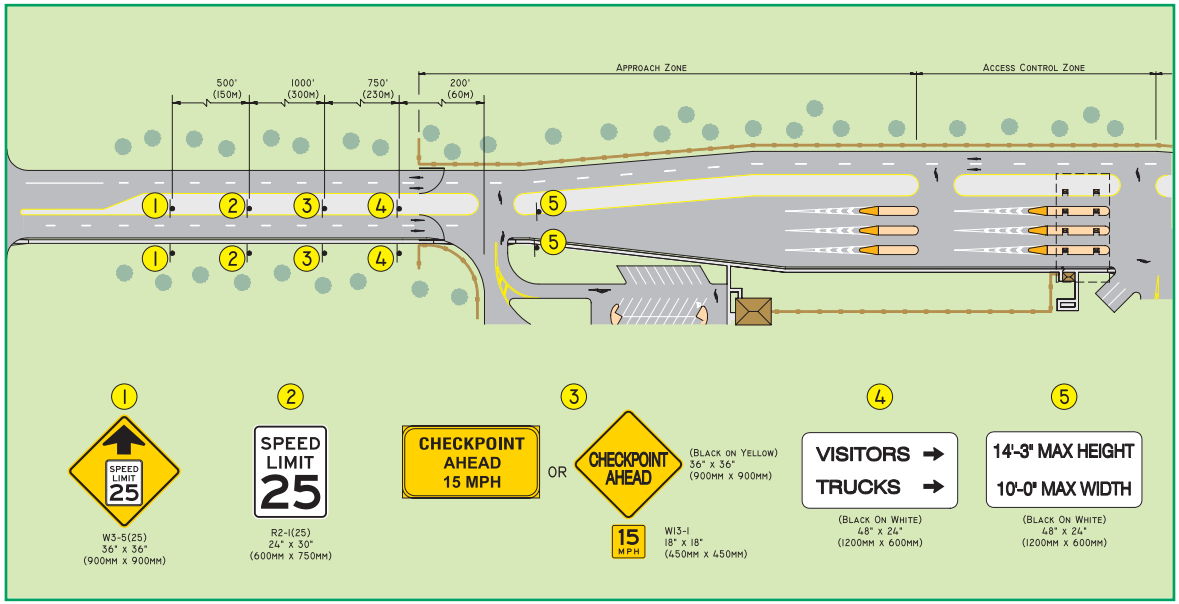
As a minimum, speed limit signs should be 24” x 30” (600 mm x 750 mm) when speeds are less than 40 mph. Where speeds equal or exceed 40 mph, a minimum speed limit sign size of 36” x 30” (900 mm x 750 mm) should be used. W3-5 signs are a minimum of 36” x 36” (900 mm x 90 mm) in size, but 48” x 48” (1200 mm x 1200 mm) signs should be used for speeds greater than or equal to 40 mph.

5.1.4.2 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.

5.1.4.3 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 Uniform Vehicle Codes (UVC) do not permit posted speed limits below 25 mph. Therefore, any posted regulatory speed limits below 25 mph may not be enforceable.



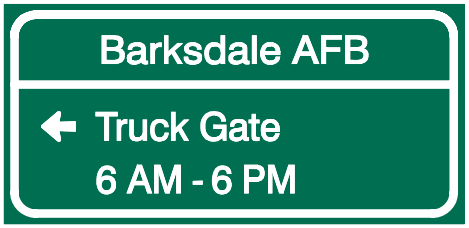
5.1.5. Guide Signs

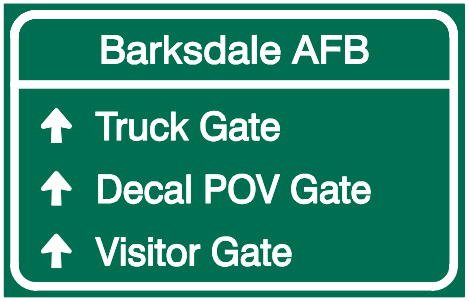
A comprehensive guide sign plan should be implemented at installations with two or more ECFs. One of the keys to an efficient ECF is sorting traffic and getting the motorists to the appropriate locations. A guide sign plan will most likely require coordination with local officials but will aid the processing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

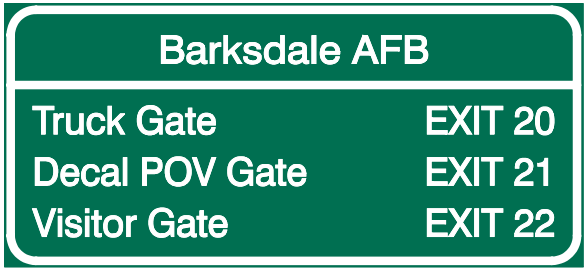
✓ Location
✓ Gate name
✓ Usage type (visitors, decal POVs, trucks)
✓ Hours of operation

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 visitor's centers, and provide printed copies of the map for drivers. Small maps can also be printed on the back of visitors' passes.







5.2. 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.

5.2.1. 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.

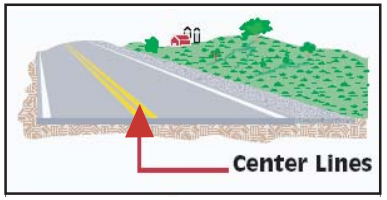
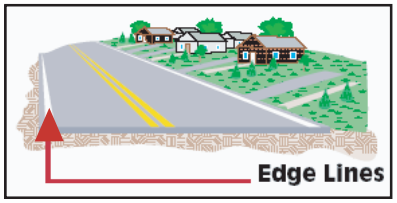
Exhibit 5.3: Primary Longitudinal Pavement Markings

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. Passing is prohibited on segments of roadway marked with double solid yellow lines.
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 may utilize the double solid white line to prevent passing.
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. Warrants for the use of pavement markings are contained in the *MUTCD* and are provided in **Exhibit 5.4** for centerlines and edgelines.

Exhibit 5.4: 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 (6.1 meters) or more and an Average Daily Traffic (ADT) of 6,000 or more Guidance: ✓ Should be placed on all urban arterials and collectors with a travel way of 20 feet (6.1 meters) or more and an ADT of 4,000 or more ✓ Should be placed on all paved rural arterials with a travel way width of 18 feet (5.5 meters) or more and an ADT of 3,000 or more ✓ Should be placed on other paved areas and travel ways less than 16 feet (4.9 meters) wide as a traffic engineering assessment indicates	✓ 30% reduction in head-on crashes
Edgelines		✓ 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 (6.1 meters) 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 (6.1 meters) or more and an ADT of 3,000 or more Options: ✓ May be placed where centerlines are not present ✓ May be used to minimize driving on shoulders	✓ 11 to 25% reduction in run-off-the-road crashes

Source: FHWA, MUTCD

5.2.2. Raised Pavement Markings (RPMs)

RPMs 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). RPMs can be used in snow zones through depressed mounting 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.

5.2.3. 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.

A new ECF was constructed without crosshatching in advance of the islands. Markings were added and the visibility of islands was enhanced for improved motorist and guard safety.

There are several types of transverse markings including stop lines, arrows, and word legends. The most common transverse marking used at ECFs is crosshatching. Crosshatch lines define an area, within defined boundaries, over which vehicular traffic should not travel. They should be used to better delineate ID check islands. 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 crosshatching and other transverse markings are shown in **Exhibit 5.5**. Typical ECF transverse and longitudinal pavement markings are shown in **Exhibit 5.6**.

Exhibit 5.5: Standard Pavement Marking Details

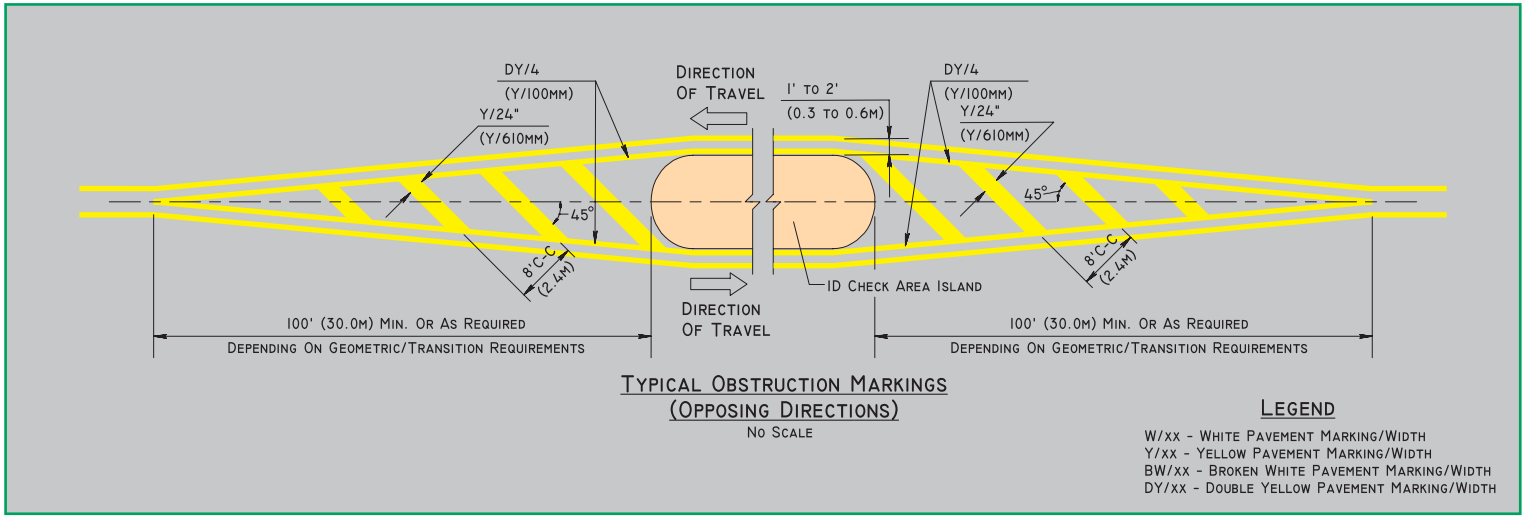
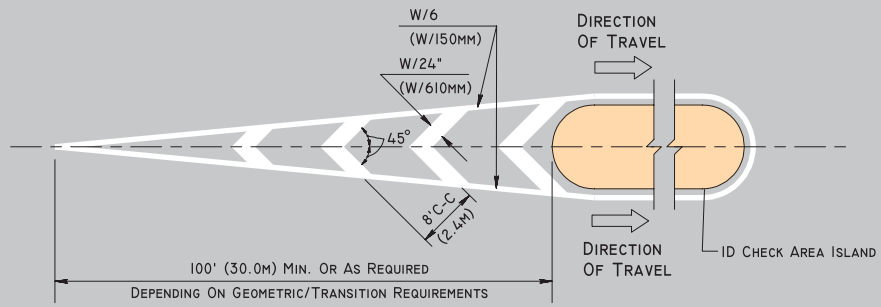
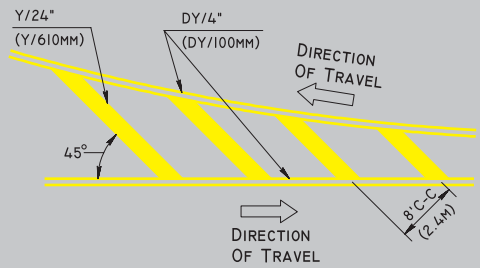


Exhibit 5.5 (cont.): Standard Pavement Marking Details



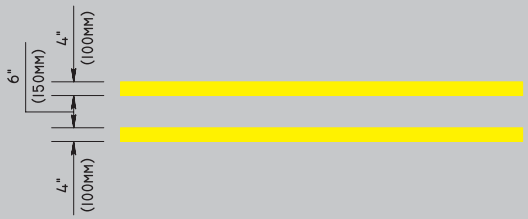
TYPICAL OBSTRUCTION MARKINGS
(SAME DIRECTION)
NO SCALE



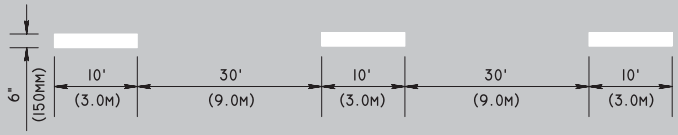
45° GORE HATCHING
NO SCALE

LEGEND

W/xx - WHITE PAVEMENT MARKING/WIDTH
Y/xx - YELLOW PAVEMENT MARKING/WIDTH
BW/xx - BROKEN WHITE PAVEMENT MARKING/WIDTH
DY/xx - DOUBLE YELLOW PAVEMENT MARKING/WIDTH



4" (100MM) DOUBLE YELLOW LINE
NO SCALE



6" (150MM) BROKEN LANE LINE
NO SCALE

LEGEND

W/xx - WHITE PAVEMENT MARKING/WIDTH
Y/xx - YELLOW PAVEMENT MARKING/WIDTH
BW/xx - BROKEN WHITE PAVEMENT MARKING/WIDTH
DY/xx - DOUBLE YELLOW PAVEMENT MARKING/WIDTH

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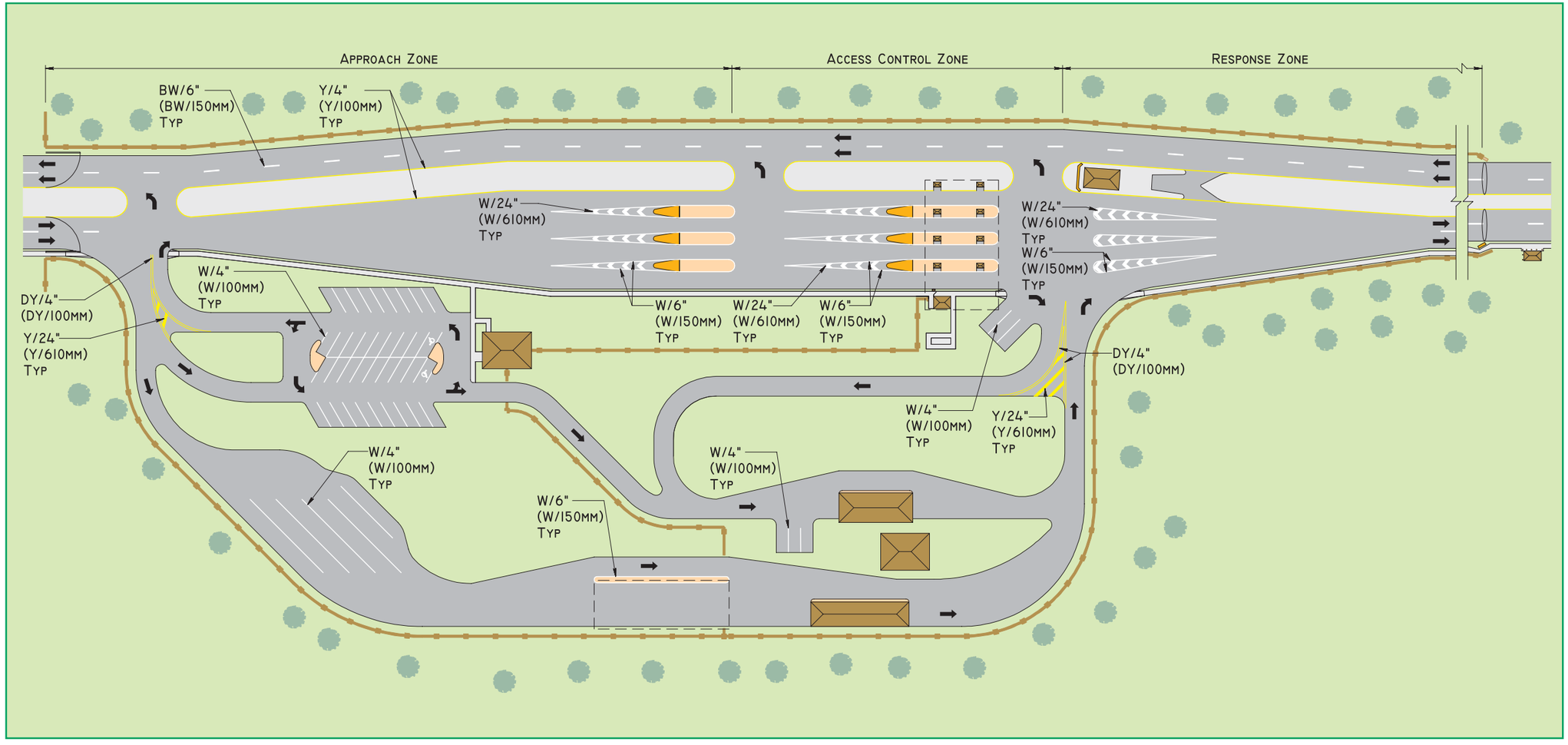
Exhibit 5.6: Sample Pavement Marking Plan



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

5.3. 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. Retroreflectivity is a measure of how bright the sign is at night.

5.3.1. Sign Retroreflectivity

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 many "cues" such as signs, pavement markings, guardrails and objects along the road. At night, signs may be one of the few driver cues. Install regulatory and warning signs with Type III or better sign sheeting in order to provide better visibility, especially at night. Although Type III signs cost more, the life cycle costs are lower than Type II or less. Type I signs should not be used. Generally, paint available from most sign shops that serve military installations does not have adequate, if any, retroreflective properties and should not be used. See **Exhibit 5.7** for grade types and characteristics.

5.3.2. 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 needed enhancements. Adding glass beads is one method to reflectorize pavement markings. Some manufacturers offer thermoplastic markings or inlaid markings with similar properties.

Daytime

Night (Non-retroreflective)

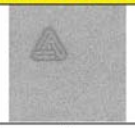
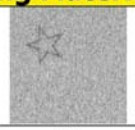
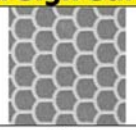
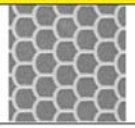
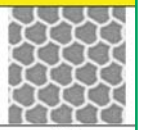
Night (Retroreflective)

Exhibit 5.7: Retroreflective Sheeting Standards

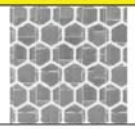
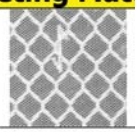
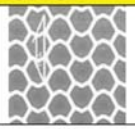
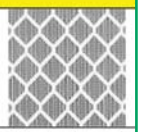
FHWA Retroreflective Sheeting Identification Guide – September 2005

Notes: ASTM Types are shown as stated by the manufacturers using ASTM D4956-04 "type" designations.
Agencies should verify that the sheeting they use complies with their specifications or ASTM D4956.
FHWA does not endorse or approve any material nor does it determine type category(s) for materials.
This side of the Sheeting ID Guide is for rigid surfaces only. The other side is for flexible surfaces and non-signing applications.

Retroreflective Sheeting Materials for Rigid Sign Surfaces Made with Glass Beads

Example of Sheeting (Shown to scale)									
ASTM Type	I	II	II	III	III	III	III	III	III
Manufacturer	See note A	Avery Dennison®	Nippon Carbide	3M™	ATSM, Inc.	Avery Dennison®	Kiwalite®	LG Lite	Nippon Carbide
Brand Name	Engineer Grade	Super Engineer Grade	Super Engineer Grade	High Intensity	High Intensity	High Intensity	High Intensity	High Intensity	High Intensity
Series Number	Several	T-2000	15000 17000 18000	2800 3800	ASTM HI	T-5500	22000	LH8000 LH8100	N500 N800
NOTES:	A								

Retroreflective Sheeting Materials for Rigid Sign Surfaces Made with Prisms

Example of Sheeting (Shown to scale)									
ASTM Type	III, IV	III, IV, X	VII, VIII, X	VIII	IV, VIII	IX	IX	X	Unassigned
Manufacturer	Avery Dennison®	3M™	3M™	Avery Dennison®	Nippon Carbide	3M™	Avery Dennison®	Nippon Carbide	3M™
Brand Name	High Intensity Prismatic	High Intensity Prismatic	Diamond Grade™ LDP	MVP Prismatic	Crystal Grade	Diamond Grade™ VIP	Omni-View™	Crystal Grade	Diamond Grade™ DG3
Series Number	T-6500	3930	3970	T-7500	94000 (IV) 92000 (VIII)	3990	T-9500	93000	4000
NOTES:	B	B	B,D		B,C			C	

A – All the manufacturers listed on the other side of this guide (except Reflexite) provide Engineer Grade sheeting. Engineer Grade sheeting is uniform without any patterns or identifying marks. Visually, it is indistinguishable from lower quality grades (i.e., utility and commercial grades).
B – These materials can be classified as different ASTM Types.
C – These materials are visually indistinguishable from one another.
D – The arrow or "water mark" on this product is no longer included with new productions.

Source: FHWA

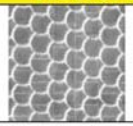
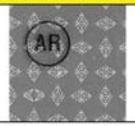
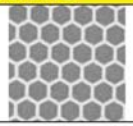
Exhibit 5.7 (cont.): Retroreflective Sheeting Standards

FHWA Retroreflective Sheeting Identification Guide – September 2005

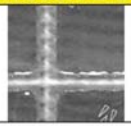
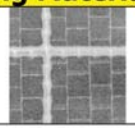
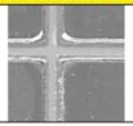
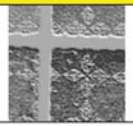
Notes: ASTM Types are shown as stated by the manufacturers using ASTM D4956-04 "type" designations.
Agencies should verify that the sheeting they use complies with their specifications or ASTM D4956.
FHWA does not endorse or approve any material nor does it determine type category(s) for materials.
This side of the Sheeting ID Guide is for flexible and non-signing applications. The other side is for rigid surfaces.
Below are symbols that have been used to indicate special applications for sheeting on this side of the Sheeting ID Guide:

Cone Drums Temporary Tubes Sign

Retroreflective Sheeting Materials for Non-Signing Applications

Example of Sheeting (Shown to scale)						
ASTM Type	III	III	V	V	III	VI
Manufacturer	Avery Dennison®	Reflexite	Reflexite	Reflexite	3M™	Reflexite
Brand Name	High Intensity Prismatic Work Zone	High Impact Channelizer Tape	Barrier Delineator	Barrier Delineator	High Intensity Flexible	Traffic Cone Collar
Series Number	WR-6100	n/a	AR1000	AP1000	3840	n/a
Typical Use	Reboundable Device	Reboundable Device	Rigid Non-Signing Surface	Rigid Non-Signing Surface	Reboundable Device	Traffic Cone

Retroreflective Sheeting Materials for Flexible Signs

Example of Sheeting (Shown to scale)						
ASTM Type	VI	VI	VI	VI	VI	VI
Manufacturer	3M™	3M™	Avery Dennison®	Reflexite	Reflexite	Reflexite
Brand Name	Diamond Grade™ Roll-Up Sign	Vinyl Roll-Up Sign	Flexible Roll-Up Sign	Flagging Material	High Performance Marathon	Super Bright Fluorescent
Series Number	RS20	RS30	WU-6014	n/a	n/a	n/a
Typical Use	Roll-Up Sign	Roll-Up Sign	Roll-Up Sign	Roll-Up Sign	Roll-Up Sign	Roll-Up Sign

Contact Information

3M - www.3M.com/tcm	Kiwalite - www.kiwa-lite.com	Reflexite - www.reflexite.com
ATSM, Inc. - www.atsminc.com	LG Lite - www.lgchem.com	Nippon Carbide - www.nikkalite.com
Avery Dennison - www.reflectives.averydennison.com		FHWA - www.fhwa.dot.gov/retro

Source: FHWA

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.

5.4. 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.

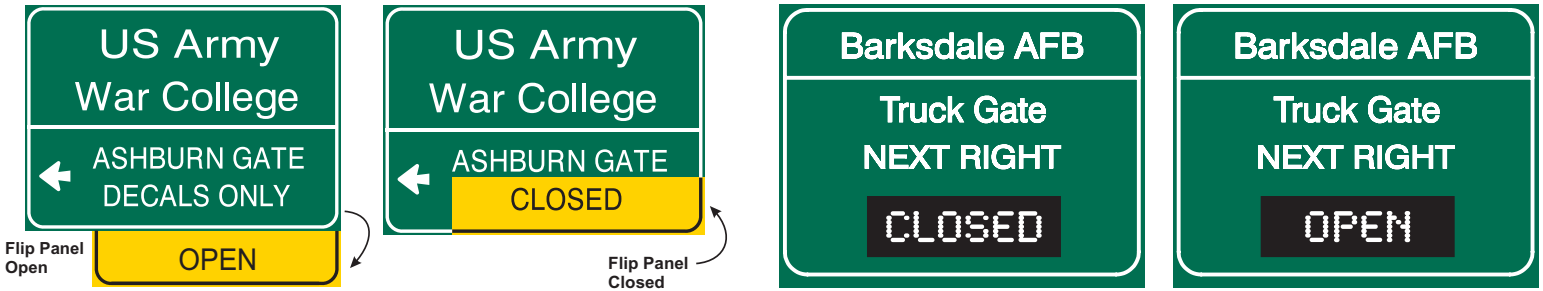
In the access control zone, movable barriers may be used if only the ID check lane is reversible and to control vehicle movements.

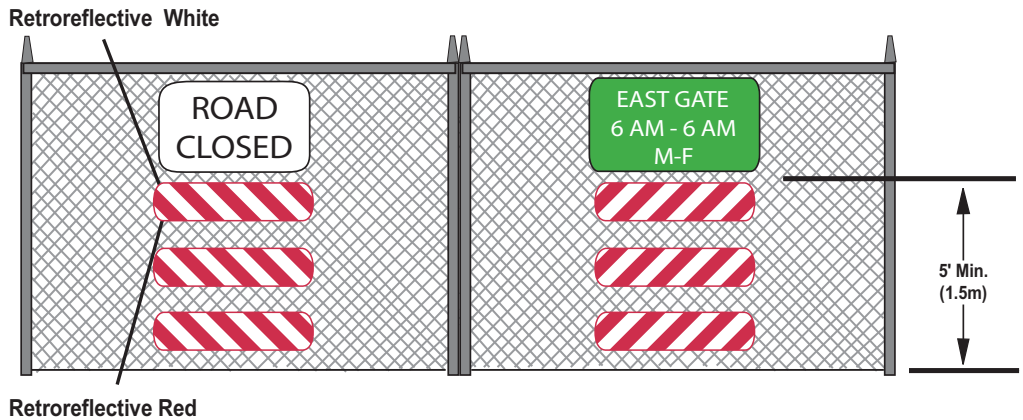
5.5. CLOSURES

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.

Type III barricades should be used during the times when the ECF is closed to traffic. A GATE CLOSED sign listing the hours of operation should be installed prior to the barricade, and on the barricade as well.

At a Navy installation, there is an ECF that is opened only when demands necessitate its use; however, there were no signs in advance of the ECF to inform drivers of the ECF's status. A sign with a remote electronic insert was constructed so that guards at the ECF could flip a switch to let drivers know the ECF's status. This improved traffic flow on local roadways and at the ECF.





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

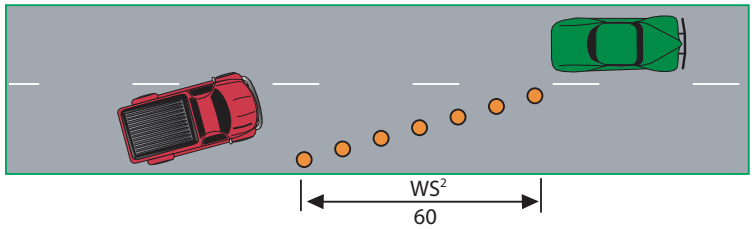
5.6. TRAFFIC CONES AND MARKERS

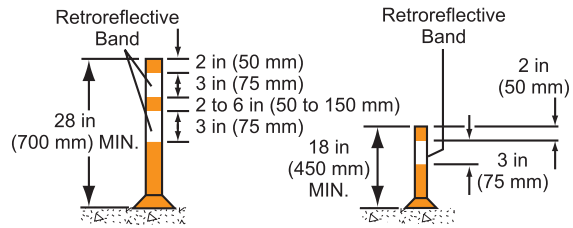
Traffic cones and markers can be used effectively for temporary channelization of traffic during lane reversal and lane closures. These devices are convenient since, unlike steel drums, they can be quickly placed and removed and, if struck, will not damage vehicles. Orange traffic cones indicate a construction zone while red traffic cones indicate a lane closure.

When traffic cones are used in the ECF area they should be:

✓ 18 inches (450 millimeters) high, minimum
✓ Reflectorized

As a general rule, 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 $WS^2/60$ (where W is the width of the shift and S is the posted speed in miles per hour) or 100 feet (30.5 meters), whichever is greater.



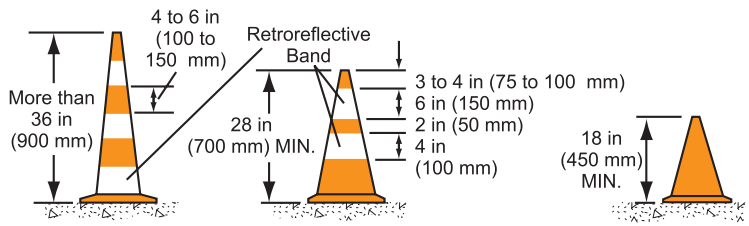


Night and/or Freeway High-Speed Roadway (≥ 45 mph) (≥ 70 km/h)

Day and Low-Speed Roadway (≤ 40 mph) (≤ 60 km/h)

*SDDCTEA recommended marker

TUBULAR MARKERS

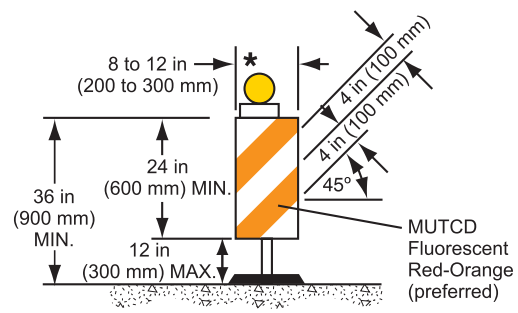


Night and/or Freeway High-Speed Roadway (≥ 45 mph) (≥ 70 km/h)

Day and Low-Speed Roadway (≤ 40 mph) (≤ 60 km/h)

*SDDCTEA recommended cone

CONES



VERTICAL PANEL

* Warning lights (optional)

EXPOSED BLUNT ENDS OF BARRIERS PRESENT A HAZARD TO MOTORISTS. ALSO, EMPTY WATER-FILLED BARRIERS CAN BECOME MOVING HAZARDS IF STRUCK BY VEHICLES.

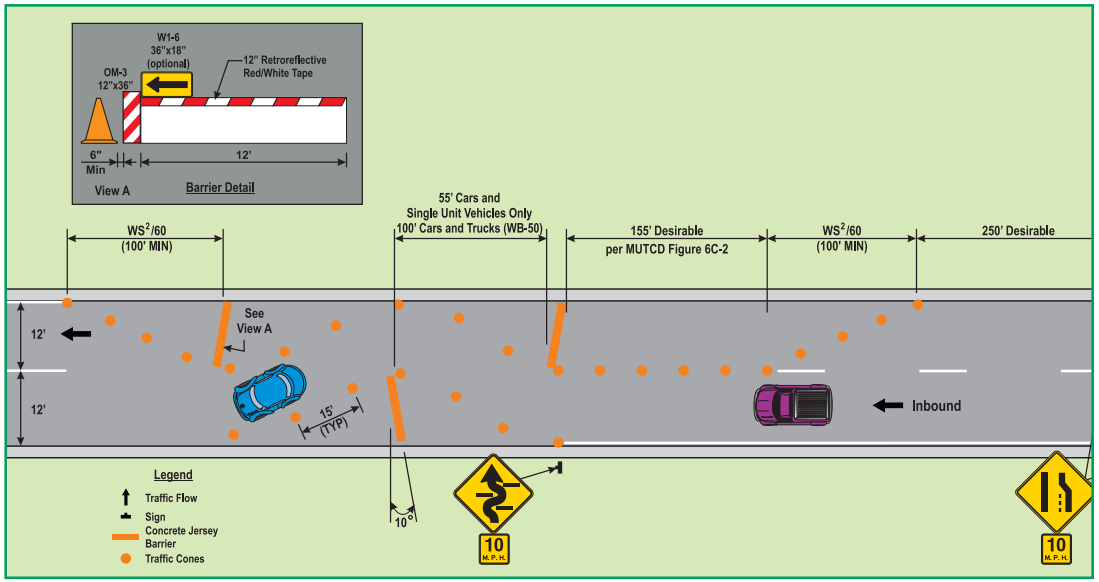
5.7. IN-ROADWAY BARRIER PLACEMENT AND TRAFFIC CONTROL

Concrete or water-filled barrier placements are discouraged on approaches to ECFs. However, installations often see it as the only temporary means of controlling traffic before a permanent fix can be installed. To date, there has been little guidance on the suitability, layout, spacing, and delineation of barrier placements resulting in potential traffic safety and operational conflicts.

Common problems encountered at many military installations include:

✓ No warning signs of approaching speed reduction
✓ Exposed barrier blunt ends
✓ Barrier openings permitting a “straight-line” path
✓ Barriers spaced too close resulting in conflicts with larger vehicle turning paths
✓ Little or no delineation of the travel paths

Proper barrier spacing and orientation will accommodate a WB-50 (WB-15) while still providing the desired level of speed reduction. Delineation of a barrier is often nonexistent, making it particularly difficult to negotiate a vehicle through the configuration at night. Red and white retroreflective tape should be installed, as shown, to improve barrier delineation.



SDDCTEA DOES NOT ENDORSE THE USE OF IN-ROADWAY BOLLARDS DUE TO THE HAZARDS ASSOCIATED WITH THESE DEVICES. HOWEVER, IF THEY ARE IN USE THEY SHOULD HAVE DELINEATION COMPLIANT WITH THE *MUTCD*.

5.8. IN-ROADWAY BOLLARD SYSTEMS AND TRAFFIC CONTROL

In-roadway bollard systems have been deployed at several military installations in order to provide security benefits by limiting vehicular speeds and movements. SDDCTEA does not endorse the use of bollard systems and encourages other design options to address security concerns.

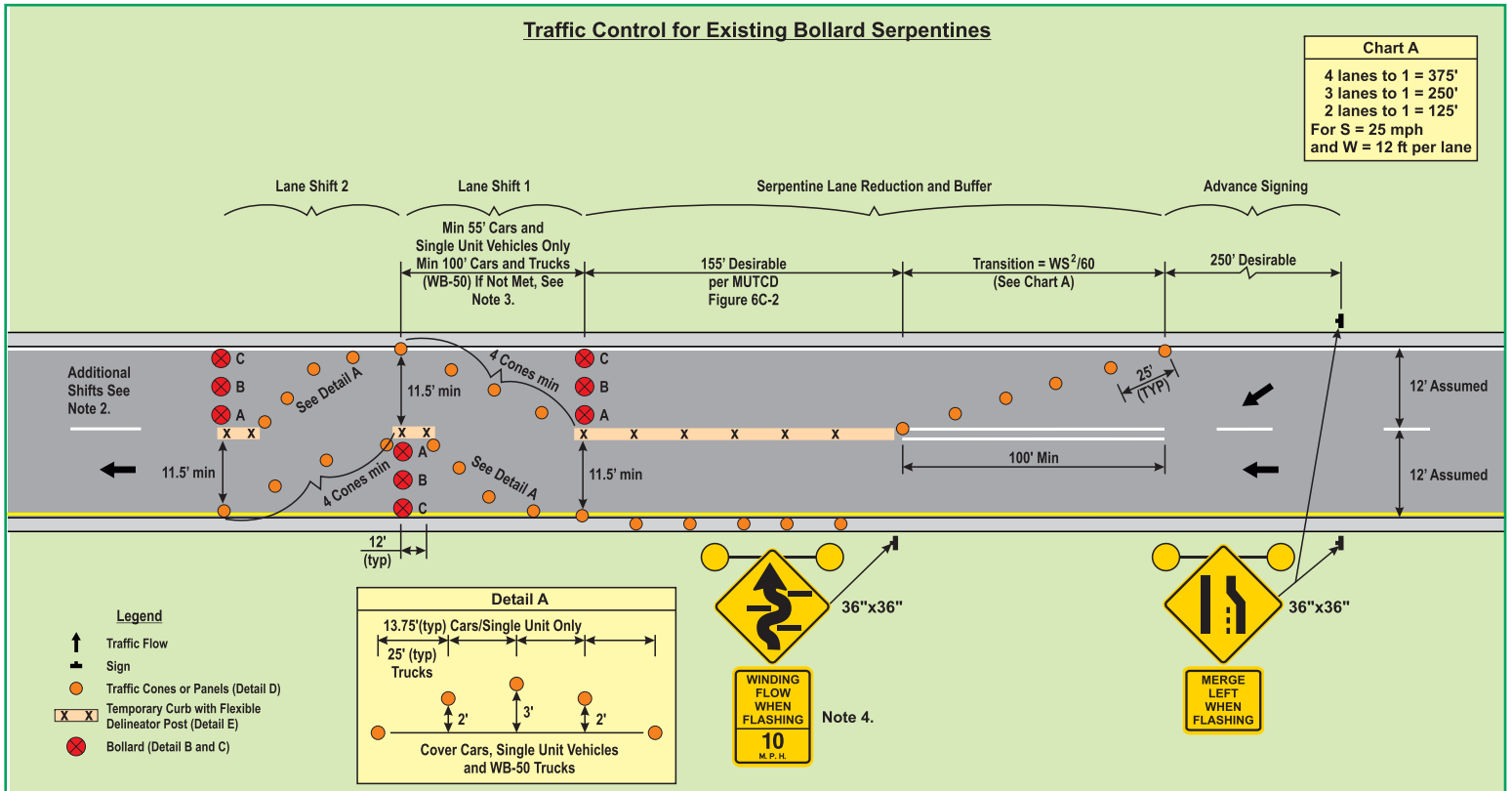
Since a bollard is a fixed object like a tree or utility pole, existing standards such as the *MUTCD* and AASHTO *Roadside Design Guide* discourage their use. Also, bollards are not continuous like other barrier systems. Vehicular impacts may result in significant penetration increasing the potential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

If existing systems are in use and must remain in use, they should be delineated. The bollards themselves should have retroreflective red and white markings and the roadway alignment should be delineated using signs, traffic cones and panels. To satisfy AASHTO requirements, use temporary curbing to shield bollards from vehicles in the travel way. Proper spacing is critical to allow vehicles to navigate the system safely.

When systems are not used for all time periods, flashers can be used to advise motorists of when serpentine bollards are in place. When bollard are removed for a short-term period, temporary curbing can remain provided it is delineated and does not impede the travel way. When bollards are removed for longer periods, temporary curbing should be removed as well.

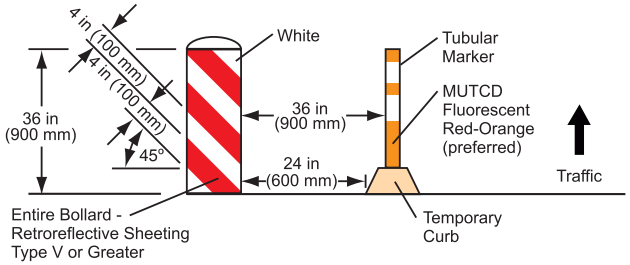
SDDCTEA does not endorse or recommend roadway bollards; however, we are available provide guidance regarding existing systems in order to make their operation safer to the road user.

Traffic Control for Existing Bollard Serpentines

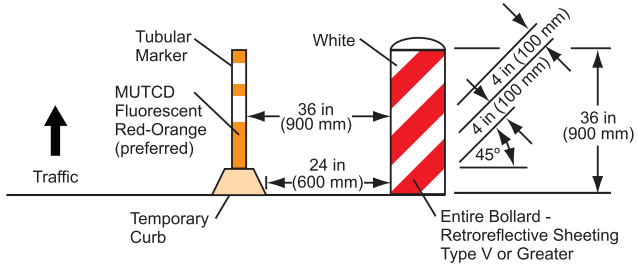


Notes:

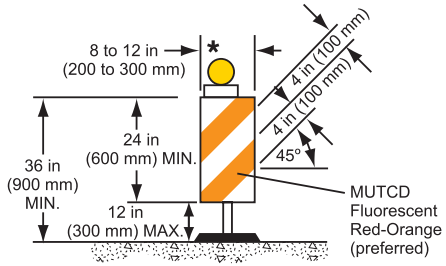
1. SDDCTEA does not recommend placement of in-roadway bollards due to fixed-object safety hazards and engineering standards. If bollards are currently in place they must be signed and delineated in accordance with the Manual on Uniform Traffic Control Devices and reviewed by SDDCTEA traffic safety engineers to minimize vehicle crashes, serious injuries and service's/installation's liability.
2. Additional lanes shifts delineated as shown in lane shift 1 and lane shift 2.
3. If spacing requirements cannot be satisfied, design vehicle may not be able to navigate. Retract "A" bollards and shift traffic control to accommodate turning radii. SDDCTEA can assist in assessing specific systems in place.
4. Suggested speed to be determined based on site geometry and design vehicle.



Detail B BOLLARDS TO LEFT OF TRAFFIC

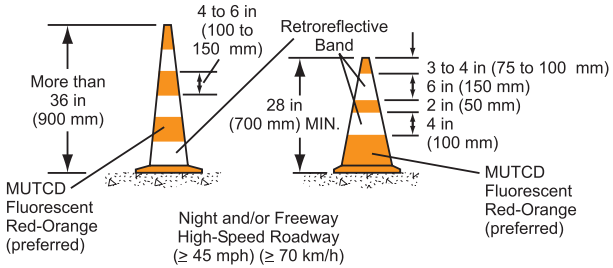


Detail C BOLLARDS TO RIGHT OF TRAFFIC



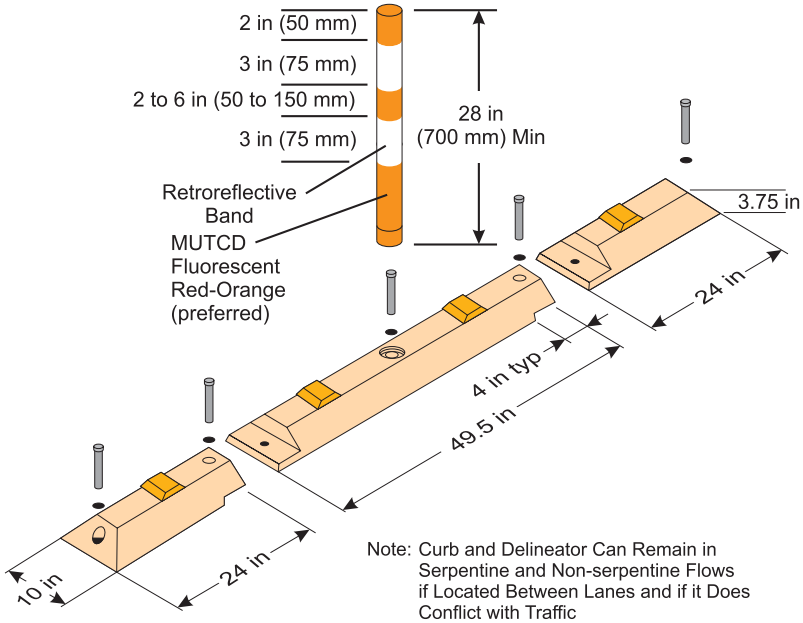
VERTICAL PANEL

* Warning lights (optional)



CONES

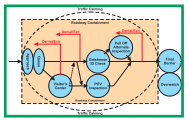
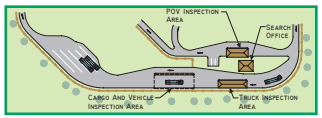
Detail D

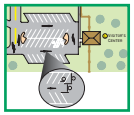


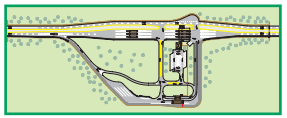
Note: Curb and Delineator Can Remain in Serpentine and Non-serpentine Flows if Located Between Lanes and if it Does Conflict with Traffic

CURB AND FLEXIBLE DELINEATOR DETAIL

Detail E



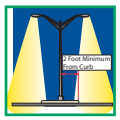


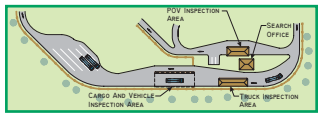
SECTION 6 - LIGHTING CONSIDERATIONS

6.1. ILLUMINATION REQUIREMENTS 6-2

6.2. TRANSITIONAL LIGHTING 6-5

6.3. PLACEMENT OF LUMINAIRES. 6-6





6. Lighting Considerations

The Illuminating Engineering Society of North America (IESNA) [www.iesna.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.

At a temporary ECF, portable floodlights were used for ECF lighting, but were placed on the outbound side of the road and pointed towards the guards. The flood lights blinded the guards and the drivers, making it hard to see their faces. When the floodlights were relocated to the inbound side, guards could better perform their functions.

Lighting should be complete and continuous. Specific areas of the ECF require their own lighting requirements. These requirements are governed by service and the *UFC*. 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.

6.1. 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 standardized candle burning at one foot from a given surface. Lux is the SI unit of luminance. One lux is one lumen per square meter.

Exhibit 6.1: Typical Illumination Values

Lighting Source	Luminance footcandles (lux)
Moon	0.01 (0.01)
Gas Station Canopy	10-20 (100-200)
Office Building	20-50 (200-500)
NFL Football Stadium	300 (3000)
Sun	10,000 (100 kilolux)

Source: IESNA

6.1.1. Luminance Levels

The level of illumination is dependent on the task being performed and the needed visibility to perform those tasks.

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.

Exhibit 6.2: ECF Luminance Levels

Zone or Feature	Minimum Luminance footcandles (lux)
Approach and Response Zone	✓ 4 (43) at Primary ECFs (Air Force requirement) ✓ 3 (32) at Primary & Secondary ECFs ✓ Portable lights or as determined by lighting specialists at Limited-Use ECFs
Access Control Zone (general areas)	✓ 5 (54) in general areas
Identification and Inspection Areas	✓ 10 (108) or twice the immediate surrounding areas
Under ID Check and Inspection Canopies	✓ 10 (108) ✓ 20 (216) (Air Force requirement)
At ID Check Station	✓ 10 (108) ✓ 30 (324) (Air Force requirement)

Source: The UFC

THE COLOR RENDITION INDEX (CRI) IS A MEASURE OF THE ABILITY TO DISTINGUISH BETWEEN COLORS.

6.1.2. Color Rendition 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.

6.1.3. 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. The type of lamps that should be used at ECFs are High Intensity Discharge (HID) lamps, which conserve more energy than incandescent lamps; however, the restrike time is longer. 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.

Image provided courtesy of the International Dark-Sky Association (http://www.darksky.org)

6.1.4. Luminaire Selection

A qualified lighting engineer should develop a lighting plan that meets lighting requirements within the site constraints.

Exhibit 6.3: Types of Luminaires

Lamp Type	Time Required for Lamp to Cool Down and Re-strike (Minutes)	Time to 60% Light Output After Re-strike (Minutes)	Light Color	Color Rendition Index	Recommended ECF		Notes
					Application	Lighting Level*	
Metal Halide (Standard Lamp)	10-15	3	White	65 or greater	✓ Approach zone ✓ Access control zone ✓ Under canopy ✓ Search area ✓ Response zone	✓ Approach zone and response zone: 3 fc (32 lux) to 4fc (43 lux) or greater ✓ Access control zone and search area: 5 fc (54 lux) or greater ✓ Under canopy: 10fc (108 lux) or greater	✓ Lower lumen output and life
Pulse Start Metal Halide	4	2	White	65 or greater			✓ Improved lumen output and life ✓ **Recommended as best to use**
High Pressure Sodium (Color Improved Lamp)	1	3	White	65 or greater			✓ Lower lumen output and life ✓ Has best re-strike time
High Pressure Sodium (Standard Clear Lamp)	1	3	Yellow	20 or greater	✓ Lighting transition (before approach zone and after response zone)	✓ Taper lighting level from 3 fc (32 lux) to 1 fc (11 lux)	✓ CRI under 65 (transition and blend with any existing lighting)
Backup Quartz-Halogen	N/A	N/A	White	97-100	Secondary "spotlight" usage only		✓ Plug-in and hand-carry with stand
	(Automatically switched on when outage occurs and has back-up power)	(Remains on until main lamp re-strikes and reaches 60% output)	White	97-100	Provides emergency lighting during outages with approximately 1/7th the normal lighting level for specified areas		✓ Some manufacturers offer a combination metal halide or HPS with Quartz backup built in for automatic switchover

Note: low pressure sodium lamps not recommended due to CRI of 0 and no quartz back-up built into luminaire.
* Average Maintained Lux (footcandles)

Metal Halide are HID lamps that satisfy CRI requirements, but must be supplemented by a back-up lighting source such as Quartz lights due to their long restrike time after power has been restored or a back-up power source has been connected.

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.

6.2. 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 18.2 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 3 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 (18.2 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.

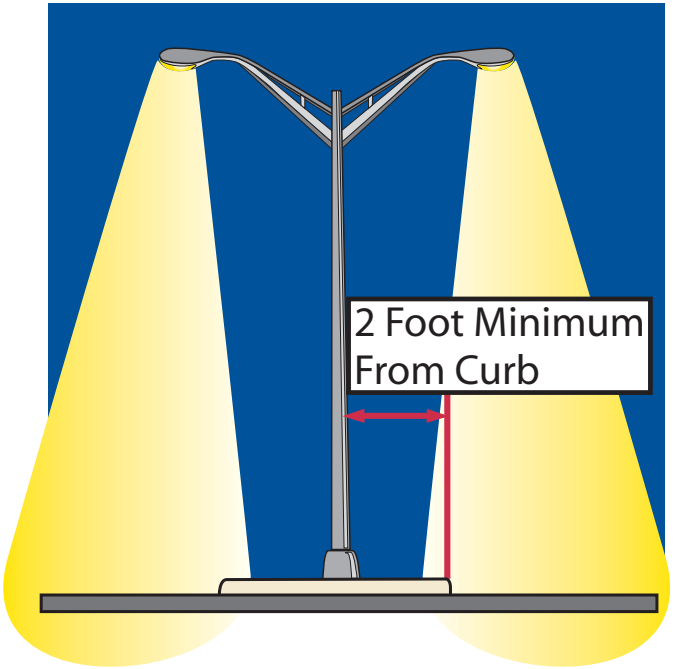
High mast lighting in the range of 120 to 180 feet (36.6 to 54.9 meters) high does not require transitional lighting since it provides its own transition through distance; however high mast lighting exceeding 120 feet typically requires stronger luminaries of 1,000 watts and may create light pollution on neighboring properties.

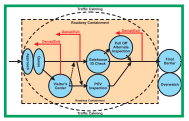
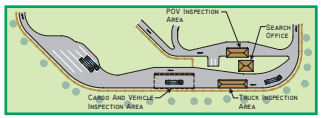
The final determination of the lighting type selected should consider the life-cycle cost of each system. Although one high mast light can often replace six conventional lights, the cost of high mast lights are often five times more than conventional lights not including power requirements.

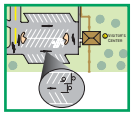
6.3. PLACEMENT OF LUMINAIRES

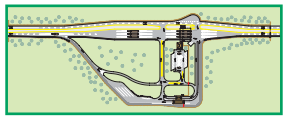
Light poles can be placed along the roadway or in the median. In some cases, light poles in the median may limit the number of poles needed. However, at wider ECFs with numerous lanes the needed illumination may not be achievable with median light poles; therefore, light poles should be placed on both sides of the road.

When light poles are in uncurbed areas the pole should be located outside of the clear zone. In curbed areas, at least a 2 foot (0.6 meter) clearance from the curb face to the pole is required.







SECTION 7 - FORCE PROTECTION ISSUES

7.1. STANDOFF DISTANCES 7-1
7.2. SCREENING 7-2
7.3. THREAT SCENARIOS 7-3
7.4. VEHICLE BARRIERS 7-4
7.5. PASSIVE BARRIERS 7-5
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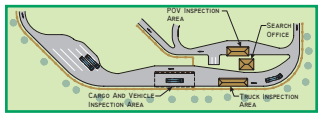


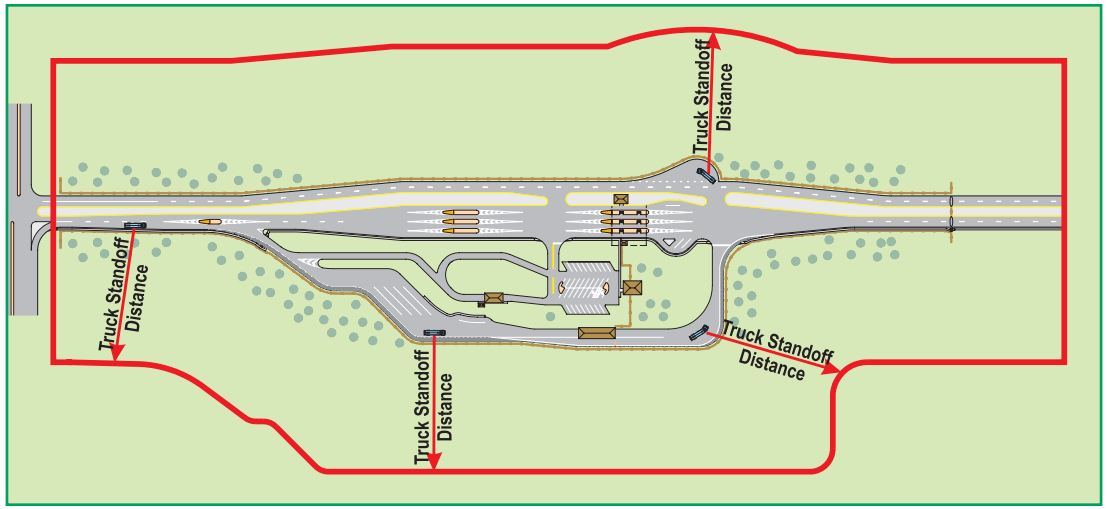
7. Force Protection Issues

7.1. 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 is the point on passive and active barriers closest to the structure. 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

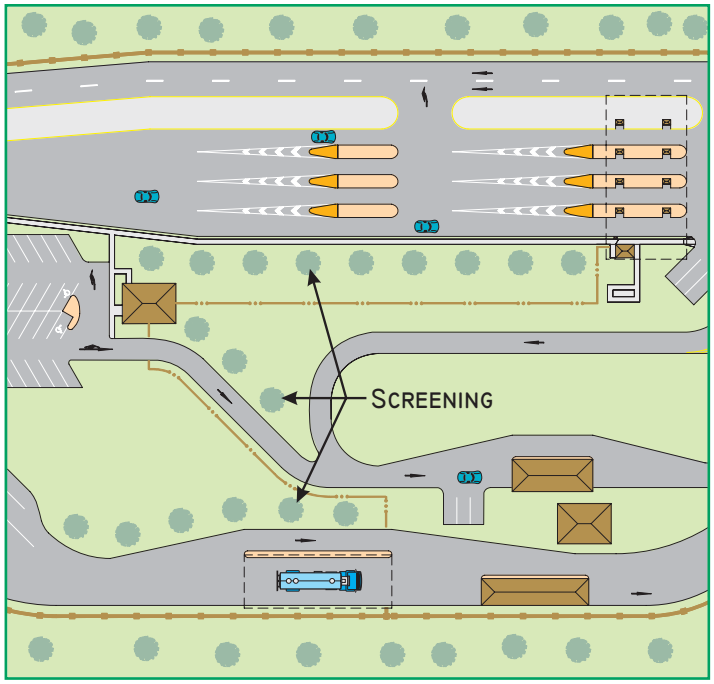
In general, an ECF design should maximize the standoff distance to all adjacent protected structures. For planning purposes, the level of protection for buildings in proximity to the ECF is based on a specific explosive threat and required or achievable level of protection for adjacent structures.



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

7.2. 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 visitor's center, 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.



7.3. 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 three threat scenarios detailed in **Exhibit 7.1** as a minimum. The Army has two types of high speed threats depending on where the threat is initiated.

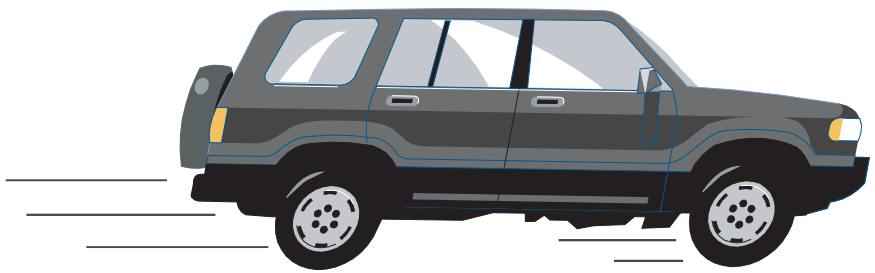
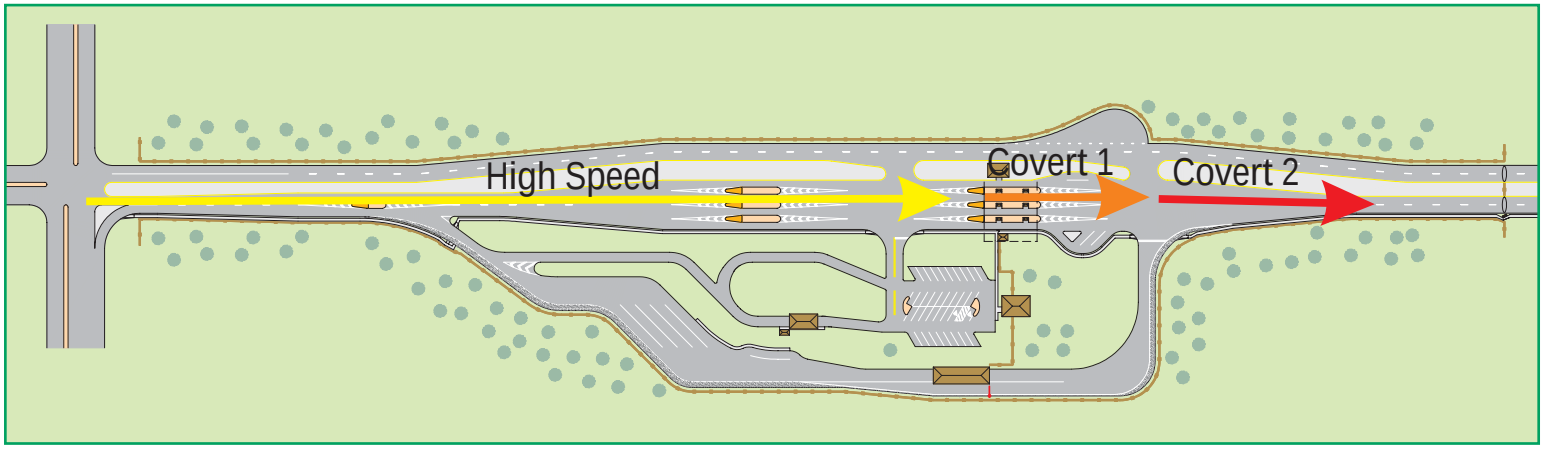


Exhibit 7.1: Threat Scenarios

Scenario	Action
High Speed	Vehicle approaches the ECF at a moderate or high rate of speed
Covert 1	Vehicle appears legitimate until the ID check area
Covert 2	Vehicle is rejected or directed to proceed to the inspection area, however, once away from the guard attempts to enter the installation

Source: The UFC



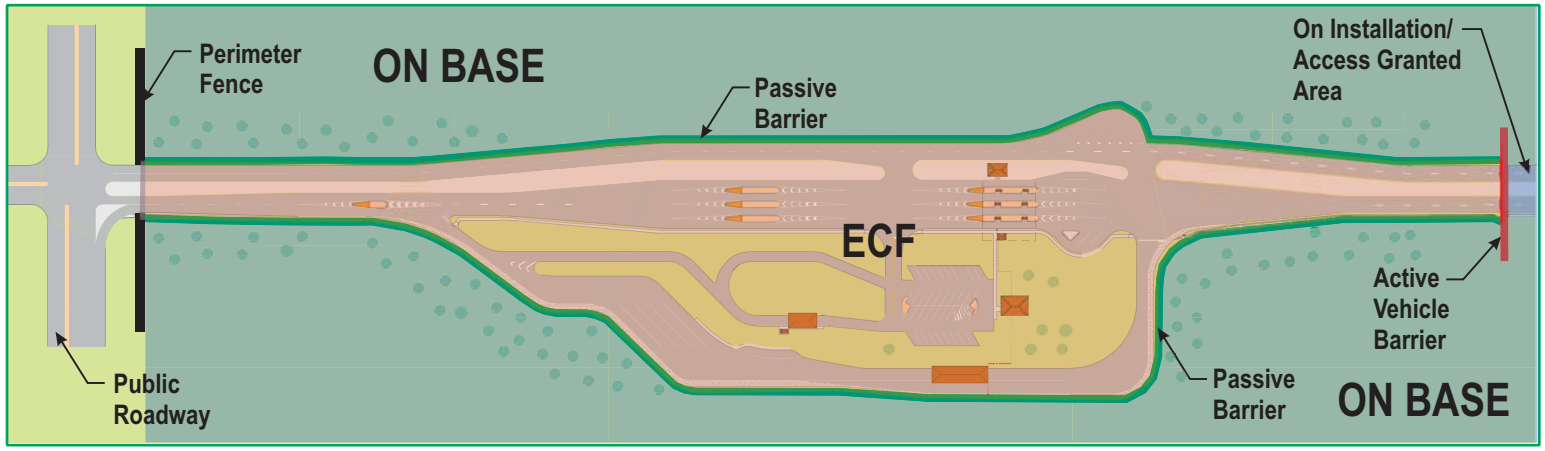
WHEN SELECTING BARRIERS, THE MOST CRASHWORTHY BARRIERS THAT ALSO SATISFY SECURITY REQUIREMENTS SHOULD BE USED. BARRIERS NOT ON THE ROADWAY SHOULD BE LOCATED OUTSIDE THE CLEAR ZONE. BARRIERS WITHIN THE ROADWAY SHOULD BE DESIGNED FOR SAFETY CONSISTENT WITH THE *MUTCD*.

7.4. 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** – Relies on bulk, mass, and/or position to contain vehicles with no moving parts
- ✓ **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 encompass 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. The *UFC* provides additional discussion of the selection and application of active and passive vehicle barriers.



7.5 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 visitor's center and inspection areas. Passive barriers may include a variety of natural or man-made features. Examples of passive barriers are shown in **Exhibit 7.2**.

Eighteen-inch high curbing was installed as a passive barrier to contain vehicles. Since the barrier was not sloped (similar to a Jersey barrier), several vehicles have had blown out tires or minor damage to the bottom of their vehicles.

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) and at least two feet (610 millimeters) behind the face-of-curb. 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.

Exhibit 7.2: Passive Barriers

Passive Barrier	Requirements
Dense Trees	✓ Must be spaced according to *UFC* criteria ✓ Must be large enough to stop threat vehicle, min 4 inch (100 millimeter) diameter ✓ Aesthetically pleasing and environmentally friendly solution ✓ Not addressed in the *UFC*
Boulders	✓ Must be spaced according to *UFC* criteria ✓ Must be large enough to stop threat vehicle, minimum Department of the Army size is five feet (1.52 meters to 11 feet (3.35 meters) in length, 3 feet (0.91 meters) in width, and 3 feet (0.91 meters) in height. ✓ Aesthetically pleasing ✓ May not be cost effective unless material is readily available
Earthen Berms	✓ Careful design is required to contain threat vehicle and to limit ramping ✓ May help control ECF and limit view of ECF and installation from exterior areas
Ditches	✓ May serve dual purposes: contain threat and drainage for roadway
Reinforced Fencing	✓ Must be reinforced to stop threat vehicle ✓ Can be aesthetically pleasing
Bollard	✓ Must be spaced according to *UFC* criteria ✓ Must be large enough to stop threat vehicle ✓ Can be aesthetically pleasing
Jersey Barrier or High Slope-faced Curb	✓ Can be located within clear zone consistent with AASHTO ✓ If greater than 8 inches (200 millimeters), cannot be traditional curbing
Walls	✓ Must be designed to stop threat vehicle ✓ Can be aesthetically pleasing
Guardrail System	✓ Can be located in clear zone if crashworthy but should be located outside clear zone, if possible ✓ May not prevent head-on penetration ✓ May not immobilize larger vehicles

Source: The UFC

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

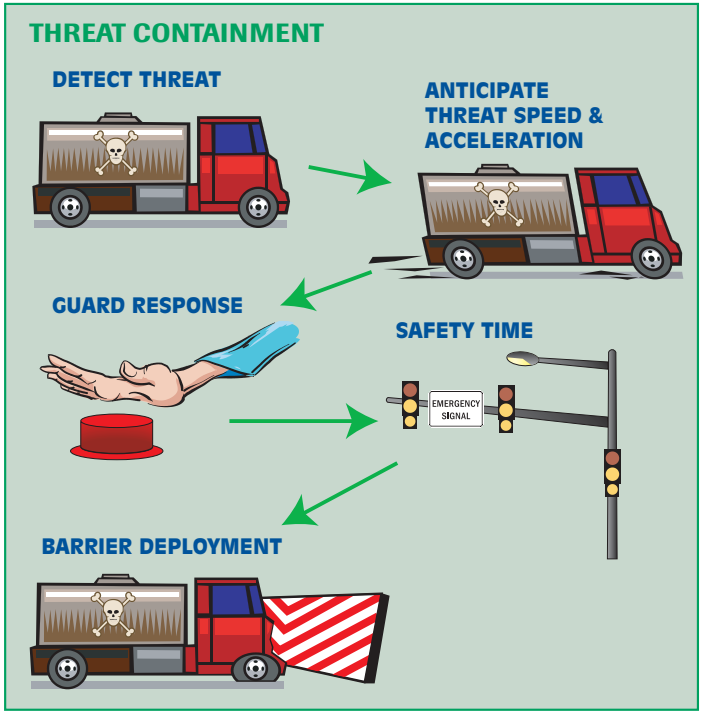
7.6 ACTIVE VEHICLE BARRIERS

Many installations require AVBs at the end of the threat response zone as 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 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:

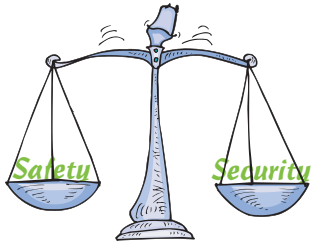
✓ **Velocity** and location of the threat vehicle when it is detected
✓ Rate of threat vehicle **acceleration**
✓ **Guard response**, **safety**, and **deployment time**

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



Overwatch

The overwatch is a position that is designed to oversee the entire ECF. The overwatch should have 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.



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.**

✓ **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. At one installation, a retiree drove over the curb and through the grass instead of following the signage when directed to the visitor's center.
- **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 wanted to prove 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.

7.6.1. Active Vehicle Barrier Markings and Delineation

Active vehicle barriers are often improperly delineated. The use of red and white stripes is appropriate because of the stop condition that is required for the impact hazard (AASHTO *Roadside Design Guide*). Additionally, since these devices are typically centered within the travel way, the diagonal striping should point up and outward from the center of the device. If located only on one side of moving traffic, the striping should point downward toward the traffic.

In addition to the front face of barriers, the backside of barriers should be delineated to the extent possible. Delineation should match the same "V" 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 sheet barriers with markings that satisfy FHWA retroreflective requirements for warning signs and will maintain retroreflectivity based on expected traffic for a minimum of two years.

A list of some manufacturers to contact includes:

- ✓ www.reflexite.com – inquire about series number AR1000 (abrasion resistant)
- ✓ www.flinttrading.com - inquire about their durable thermoplastic line
- ✓ www.3m.com/tcm - inquire about Type IX Diamond Grade sheeting

Improper colors

Correct orientation and colors

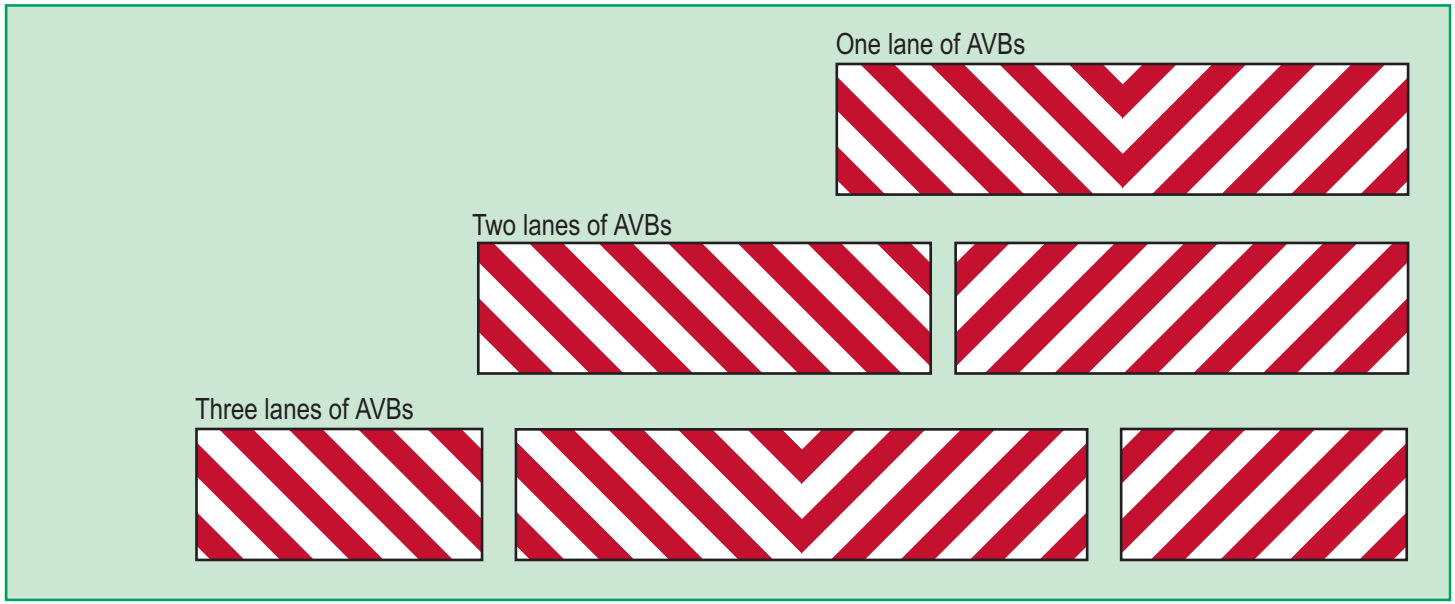
✓ www.reflectives.averydennsion.com
✓ www.nikkalite.com
✓ www.kiwa-lite.com
✓ www.lgchem.com

It should be noted that this list is not an endorsement of any manufacturer and may not be all inclusive of qualified suppliers.

For added delineation, 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. As discussed in upcoming sections, lights should be light emitting diodes to maximize visibility and operational efficiency.



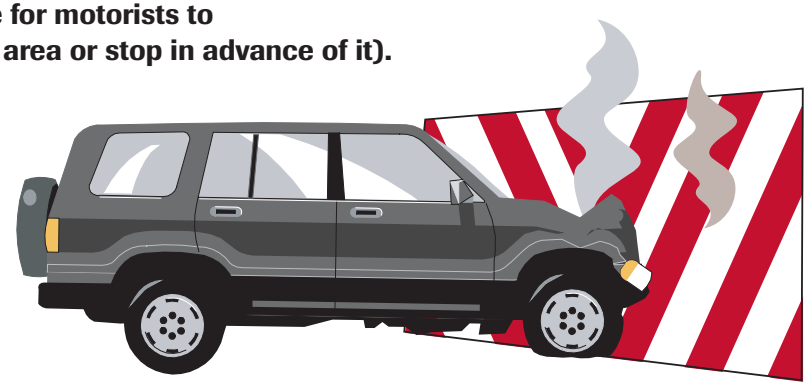
7.6.2. Existing Guidance on AVB Systems

UFC Guidance on Deployment of AVBs

The *UFC* 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. The *UFC* 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, the *UFC* states what is continued in the box to the right.

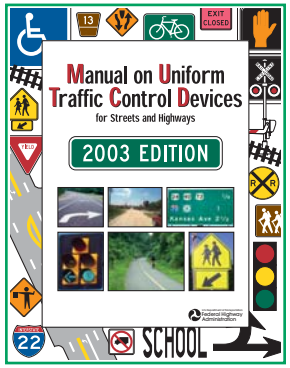
> *"…the purpose of the final denial barrier is to stop unauthorized vehicles from entering the installation. Some individuals who attempt to enter the installation without authorization are lost, confused, or inattentive, but there are also those whose intent is to "run the gate." A properly designed final denial barrier will take into account both groups, minimizing the risk to individuals who have made an honest mistake and providing a properly designed barrier (based on the specified threat) to stop those with hostile intentions…* ***The design and operation of the ECF should include provisions to protect innocent users of the ECF from operation of the final denial barrier whether deployment is accidental, during a test, or during an actual response to a threat.*** *Where possible, incorporate an appropriate delay time (minimum of 4 seconds) into the barrier control sequence to allow sequencing of traffic signals and lights at the final denial barrier to allow vehicles approaching the barrier to either clear it or stop safely in front of it before it deploys. Automatic detection loops embedded in the pavement around the active vehicle barrier system can be used to avoid deployment of the vehicle barrier when an authorized vehicle is within the loop detection zone and the barrier is activated…"*

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).



7.6.3. Safety and the Role of the MUTCD

In order to satisfy the necessary safety requirements in deploying AVBs, **AVBs must be designed, implemented, and operated in accordance with the FHWA's *MUTCD.*** Thus, 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 traffic signalization = 4 seconds minimum
- ✓ Deployment time = 2 seconds minimum
- ✓ TOTAL = 9 seconds minimum

The 4 seconds minimum safety time includes time for traffic control signals to sequence to alert motorists of pending AVB deployment. 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 wet stopping sight distance is needed for a driver to react and stop the vehicle. If a vehicle is 110 to 149 feet (33.5 to 45.4 meters) from the barrier, it will take the driver 4 seconds to safely traverse the barrier since it must be assumed that the driver cannot safely stop the vehicle. This time may be more dependent on operational procedures and site conditions such as grade.

You Need to Follow the *MUTCD*!

National Requirement

"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 open to public travel in accordance with 23 U.S.C. 109(d) and 402(a)."

Military Requirement

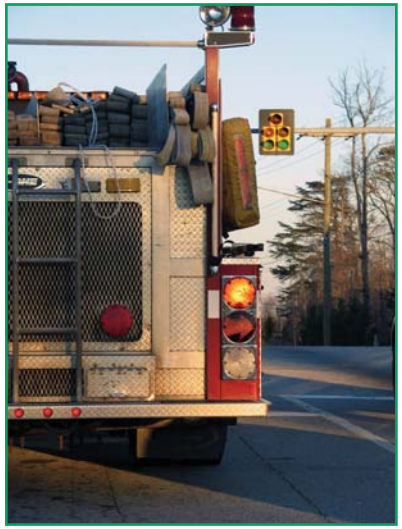
Joint Regulation (AR 55-80, OPNAVINST 11210.2, AFMAN 32-1017, MCO 11210.2D, and DLAR 4500.19) of the Department of Defense (DoD) Transportation Engineering Program identifies in Section 3-11 the Military's Highway Safety Program requirements:

- Under General: *"This section prescribes the policies and procedures related to DoD highway safety needs. It implements 23 USC 402 (see national requirement above), DODD 4510.11, and DoDI 6055.4."*
- 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."***

Other supporting regulations include:

✓ DoDD 4510.11 on DoD Transportation Engineering
✓ DoDD 4715.1 on Environmental Security
✓ DoDI 6055.4 on DoD Traffic Safety Program

Some may question if the 4 seconds 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 > 20 mph. Requires at least 3 seconds of flashing red signals prior to start of arm's downward movement and 5 seconds of arm deployment prior to 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 clearance (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 clearance (3 to 6 seconds) and red clearance (not exceeding 6 seconds) depending on traffic speeds and engineering judgment.

Most active vehicle barrier 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. Due to the dangers associated with activation of an active vehicle barrier system and the potential for false alarms, in no case shall activation of the active vehicle barrier system be triggered through automatic detection and response. 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 the *UFC* guidance.

Ultimately, although security and safety considerations should be at the forefront of ECF designs including AVBs, installation officials must be mindful of the potential tort liability that exists if AVBs are not properly designed for safety that road users are accustomed too and required by the national *MUTCD*.

FREQUENTLY ASKED QUESTIONS

Q: ***Is the AVB a traffic control device?***

A: ***No.***

A traffic control device is a sign, signal, marking, or other device used to regulate, warn, or guide traffic, placed on, over, or adjacent to a street, highway, pedestrian facility, or shared-use path by authority of a public agency having jurisdiction. An AVB is a design feature used to combat forced entry by threat vehicle(s) along a travel way.

FREQUENTLY ASKED QUESTIONS

Q: ***If the AVB is not a traffic control device, why does the MUTCD apply?***

A: ***Other standards and precedence.***

AVBs are a physical deterrent to terrorists and innocent road users just as resistance gates are a physical deterrent to road users at movable highway bridges and some highway-railroad crossings. Requirements for resistance gates are a design feature contained in AASHTO's, *Standard Specifications for Movable Highway Bridges*.

National Requirement

AASHTO states ***"Warning signs, hazard identification beacons, traffic signals, signal bells and gongs, gates and barriers, and other safety devices shall be provided for the protection of pedestrian and vehicular traffic. These shall be designed to be operative prior to the opening of the movable span and until the span has again been completely closed.*** The devices shall conform to the requirements for "Traffic Control at Movable Bridges," in the *MUTCD*. These safety devices are required to warn and regulate innocent road users at AVBs.

Military Requirement

Section 6-8 (page 6-21) of the *UFC* states, ***"Signs, markings and signals are necessary to perform traffic control and satisfy regulatory requirements and should be provided in accordance with Service guidance and the MUTCD."***

7.6.4. 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. The *UFC* as well as most service branches have specific guidance on these calculations. The Army's detailed methodology is available as part of their *Army Access Points, Standard Definitive Design*. 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.

One installation did not calculate response zone requirements and initially placed AVB at locations that "seemed" appropriate. As part of an installation development project, the installation has reviewed their AVB placement and will be relocating their AVBs at locations nearly twice the calculated minimum response zone length in order to maximize response. Also, they can collocate AVBs at intersections controlled by a traffic signal where a stop condition will be more expected.

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. If a high-speed attack can be detected through manual or automated means in the approach zone, the response zone (on straight alignments) may still need to exceed 670 feet to accommodate covert threats (assuming acceleration of 11.3 ft/sec2 and velocity initial of 35 mph) and to accommodate guard response and safe barrier deployment. If there is 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.

Exhibit 7.3: Design Vehicle Acceleration Rate

Design Vehicle	Acceleration Rate feet per second squared (meter per second squared)
P	11.3 (3.44)

Source: The UFC

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. In many cases, one can locate AVBs at the first major intersection beyond the ID check area, provided that minimum response zone requirements are met. When collocated 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

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

7.6.5. Preferred AVB Traffic and Safety Control

The preferred, conventional traffic and safety control system for AVBs is shown on the subsequent concept. The goal of traffic control devices associated with the AVBs is to provide a quick response to a potential threat while still protecting innocent ECF users in the area.

Proper signing and delineation are required on the approach to the AVBs for the inbound and outbound lanes as illustrated in **Exhibit 7.4**.

- ✓ A mast arm assembly with three signal heads, an emergency R10-13 sign (EMERGENCY SIGNAL), and a luminaire must be provided at the active vehicle barrier device.
- ✓ The signals at the active vehicle barrier must always be 8-inch flashing yellow until the barrier deployment sequence has been initiated. Once the barrier initiation sequence has been started, the flashing yellow signal indications change to steady 12-inch yellow signal indications (clearance) before changing to 12-inch solid red signal indications.
- ✓ A R10-6A sign (STOP HERE ON RED) must be installed 40 feet (12.2 meters) prior to the mast arm assembly.
- ✓ A W3-3 sign (SIGNAL AHEAD) supplemented by a W11-12P modified sign (BARRIER ACTIVATED WHEN FLASHING) and two flashing yellow beacons must be installed 140 feet (42.7 meters) prior to the mast arm.
- ✓ A W3-3A MODIFIED sign (ACTIVE BARRIER) supplemented by a W16-2 (XX FEET) sign must be installed in advance at a location determined by a qualified traffic engineer.

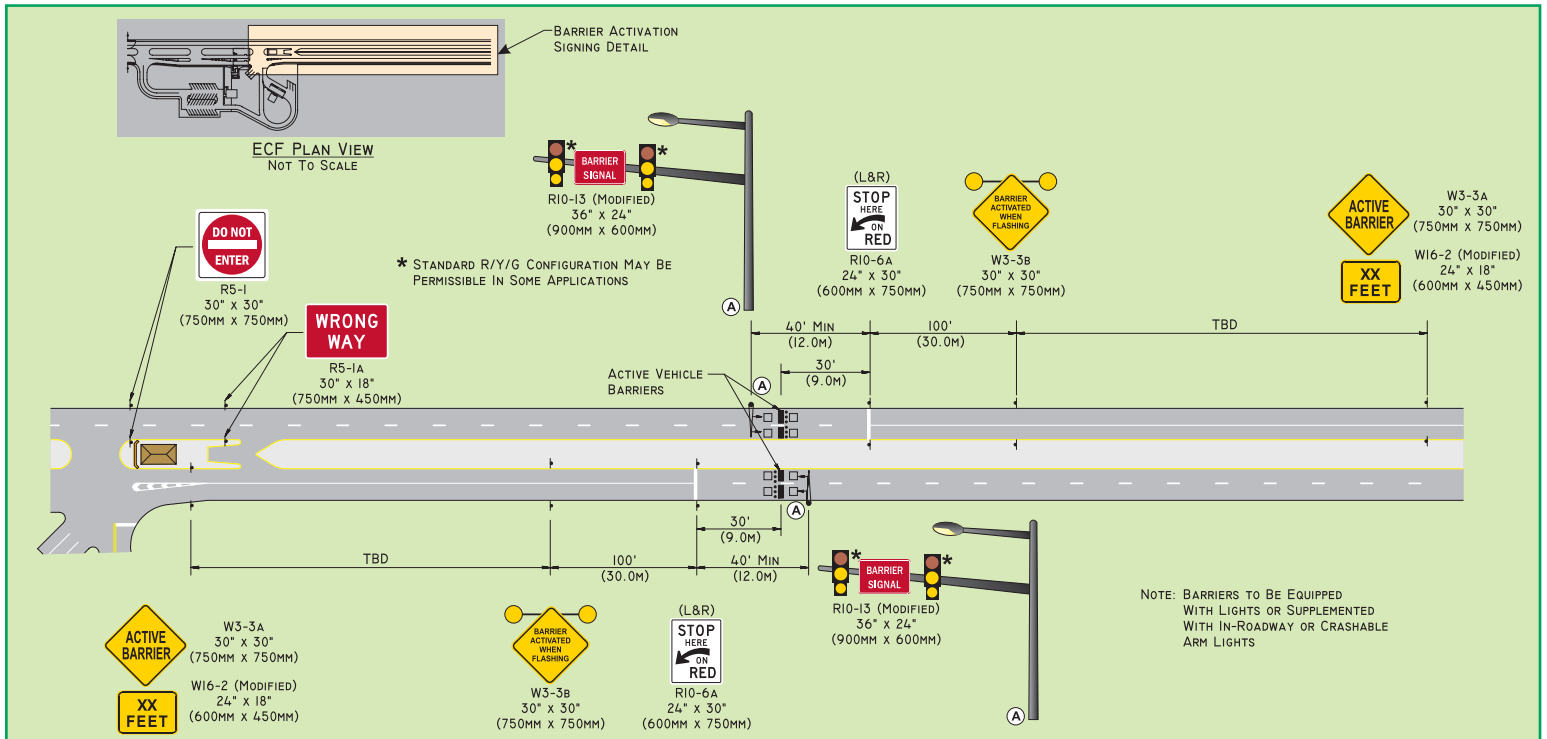
Indications not compliant with the MUTCD were placed at an AVB scheme at one installation on the east coast. The non-compliant scheme included only one indication which was post mounted with indications only 8-inches in size. The traffic control scheme was not apparent to motorists and as a result several near misses and one crash occurred during deployments addressing non-threat conditions. The installation is in the process of designing and constructing a traffic control system compliant with the MUTCD.

WARNING!

- Currently installed AVB systems controlled by guards without any advance warning and control lights/signs prior to deployment do not meet Military Safety Standards and the *MUTCD*.
- Currently installed AVB systems with barrier control lights that flash or go steady red from a flashing yellow beacon upon activation violate the clearance Standards of *MUTCD* Sections 4D.12 and 4D.13, “Flashing Operations of Traffic Control Signals” and “Preemption and Priority Control of Traffic Control Signals,” respectively.

AVB deployment should be triggered through programmable logic associated with the traffic signal controller. In other words, barrier controls should be dependent on the signaling (and safety) sequencing of the traffic controller. For more guidance on the deployment of active vehicle barriers and the components/logic involved, contact SDDCTEA.

Exhibit 7.4: Preferred Traffic and Safety Control System for Active Vehicle Barriers



Barrier Activation Signing Detail

* Standard R/Y/G Configuration May Be Permissible In Some Applications

Traffic Control and Safety at Active Barriers	Operational Sequence Per Second (Min for Safety - 25 MPH (40 KPH) Design Speed)											
	Traffic Control	-	1	2	3	4	5	6	7	8	9	10
		Normal Ops	Guard Perception and Reaction Time to Threat (Button)			Yellow Clearance (MUTCD Minimum)			All Red	Deploying Barrier		Threat Contained
Sign and Signal Warning System	Warning Sign with Beacons	BLANK	BLANK	BLANK	BLANK	ALT FY	ALT FY	ALT FY	ALT FY	ALT FY	ALT FY	ALT FY
	Traffic Signal	FY	FY	FY	FY	Y	Y	Y	R	R	R	R
	In-Roadway Lights or Barrier	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	FR	FR	FR	FR
	Active Barrier	DOWN	DOWN	DOWN	DOWN	DOWN	DOWN	DOWN	DOWN	ACTIVATED	ACTIVATED	DEPLOYED

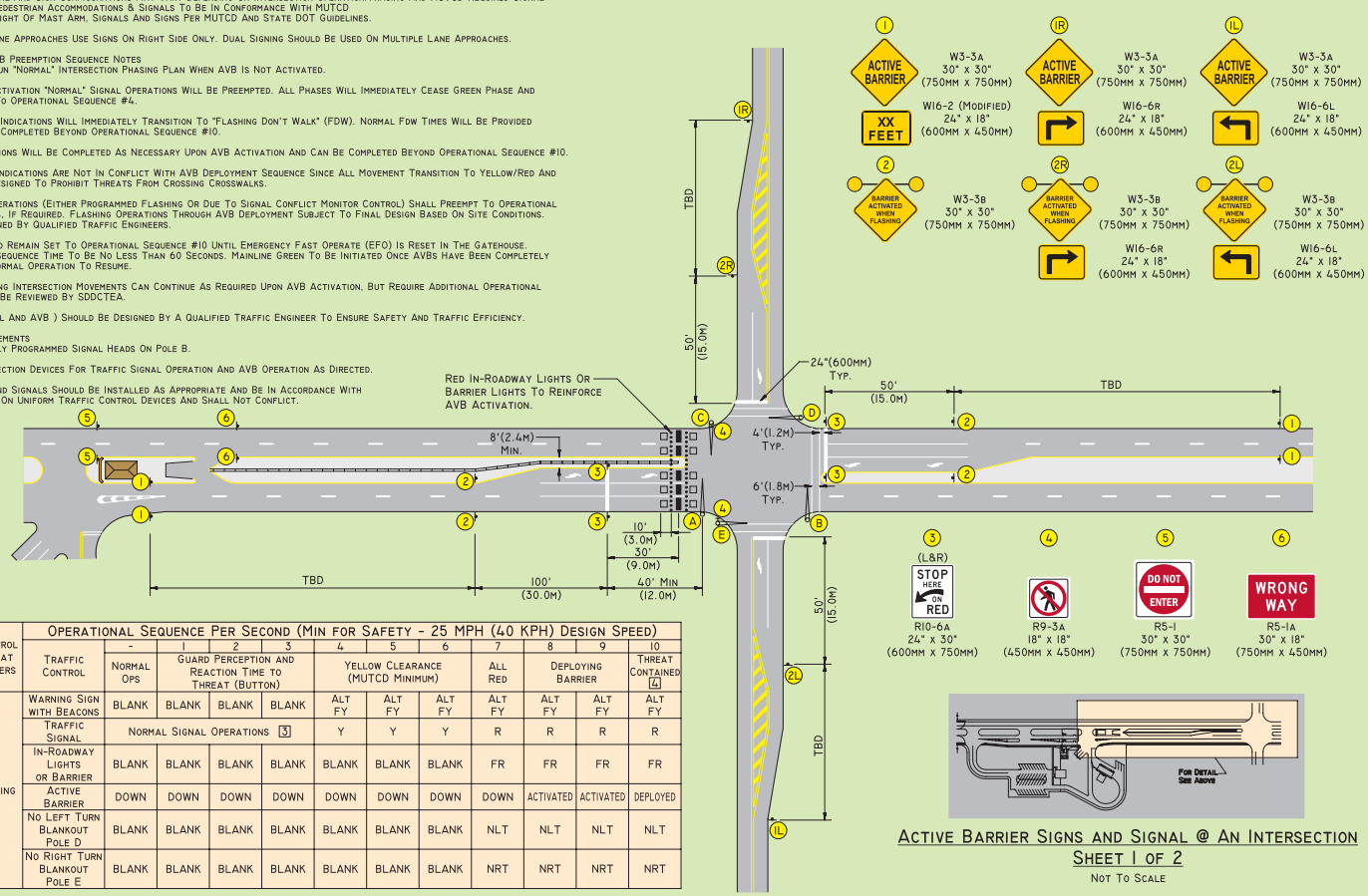
When practical, AVBs should be collocated to downstream intersections in order to maximize response zone length and have stopping conditions at an “expected” location. At a minimum, conventional traffic control schemes should be collocated to downstream intersections if they are within 500 feet of the neighboring intersection; otherwise, driver confusion may occur from closely spaced traffic control. FHWA suggests that in no cases, should AVB systems be installed less than 300 feet from a neighboring intersection. **Exhibit 7.5** illustrates an AVB system collocated at an intersection.

When an AVB system is collocated to an intersection, the intersection must be signalized on all approaches and should operate a normal phasing sequence unless preempted by barrier deployment. The design of the intersection should be conducted by a qualified traffic engineer who has an understanding of operational analysis. In most cases, collocation of an AVB system to a downstream intersection will result in a minimal increase in overall deployment costs and may result in decreased operational costs.

Exhibit 7.5: AVB System Collocated at an Intersection

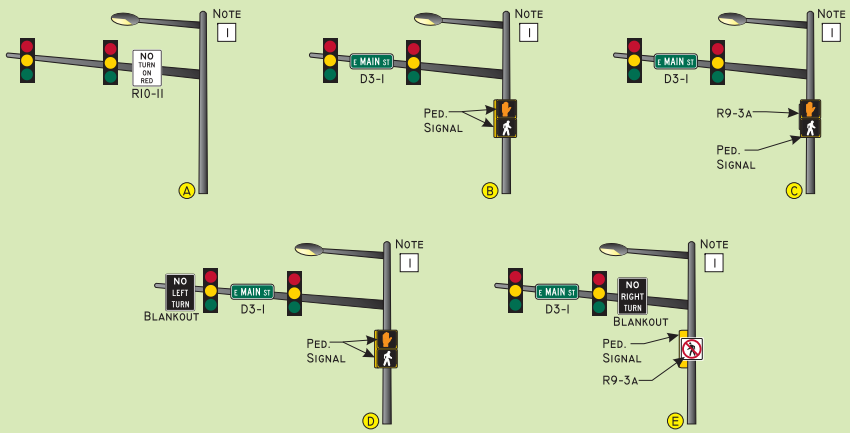
Notes:

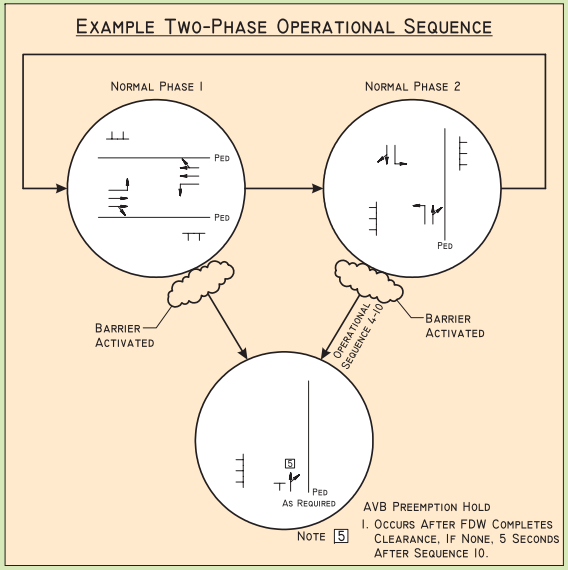
1. Pole A-E Signal And Sign Configurations May Vary Depending On Intersection Operation/phasing And MUTCD Required Signal Indications. Pedestrian Accommodations & Signals To Be In Conformance With MUTCD
   - Mounting Height Of Mast Arm, Signals And Signs Per MUTCD And State DOT Guidelines.
2. For Single Lane Approaches Use Signs On Right Side Only. Dual Signing Should Be Used On Multiple Lane Approaches.
3. Normal To AVB Preemption Sequence Notes
   - Signal To Run "Normal" Intersection Phasing Plan When AVB Is Not Activated.
   - Upon AVB Activation "Normal" Signal Operations Will Be Preempted. All Phases Will Immediately Cease Green Phase And Transition To Operational Sequence #4.
   - All "Walk " Indications Will Immediately Transition To "Flashing Don't Walk" (FDW). Normal Fdw Times Will Be Provided And May Be Completed Beyond Operational Sequence #10.
   - FDW Indications Will Be Completed As Necessary Upon AVB Activation And Can Be Completed Beyond Operational Sequence #10.
   - Pedestrian Indications Are Not In Conflict With AVB Deployment Sequence Since All Movement Transition To Yellow/Red And AVBs Are Designed To Prohibit Threats From Crossing Crosswalks.
   - Flashing Operations (Either Programmed Flashing Or Due To Signal Conflict Monitor Control) Shall Preempt To Operational Sequence #4, If Required. Flashing Operations Through AVB Deployment Subject To Final Design Based On Site Conditions. To Be Designed By Qualified Traffic Engineers.
4. All Devices To Remain Set To Operational Sequence #10 Until Emergency Fast Operate (EFO) Is Reset In The Gatehouse. Minimum AVB Sequence Time To Be No Less Than 60 Seconds. Mainline Green To Be Initiated Once AVBs Have Been Completely Retracted. Normal Operation To Resume.
5. Non-Conflicting Intersection Movements Can Continue As Required Upon AVB Activation, But Require Additional Operational Provisions To Be Reviewed By SDDCTEA.
6. System (Signal And AVB) Should Be Designed By A Qualified Traffic Engineer To Ensure Safety And Traffic Efficiency.
7. Signal Requirements
   - Use Optically Programmed Signal Heads On Pole B.
   - Install Detection Devices For Traffic Signal Operation And AVB Operation As Directed.
   - All Signs And Signals Should Be Installed As Appropriate And Be In Accordance With The Manual On Uniform Traffic Control Devices And Shall Not Conflict.



Traffic Control and Safety at Active Barriers	Operational Sequence Per Second (Min for Safety - 25 MPH (40 KPH) Design Speed)										
	-	1	2	3	4	5	6	7	8	9	10
	Traffic Control	Normal Ops	Guard Perception and Reaction Time to Threat (Button)			Yellow Clearance (MUTCD Minimum)			All Red	Deploying Barrier		Threat Contained [4]
Sign and Signal Warning System	Warning Sign with Beacons	BLANK	BLANK	BLANK	BLANK	ALT FY	ALT FY	ALT FY	ALT FY	ALT FY	ALT FY	ALT FY
	Traffic Signal	Normal Signal Operations [3]				Y	Y	Y	R	R	R	R
	In-Roadway Lights or Barrier	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	FR	FR	FR	FR
	Active Barrier	DOWN	DOWN	DOWN	DOWN	DOWN	DOWN	DOWN	DOWN	ACTIVATED	ACTIVATED	DEPLOYED
	No Left Turn Blankout Pole D	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	NLT	NLT	NLT	NLT
	No Right Turn Blankout Pole E	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	BLANK	NRT	NRT	NRT	NRT

Exhibit 7.5 (cont.): AVB System Collocated at an Intersection





ACTIVE BARRIER SIGNS AND SIGNAL @ AN INTERSECTION
SHEET 2 OF 2
NOT TO SCALE

7.6.6. 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:

✓ **Manage Threat Speed** - The length of the response zone can be minimized, or the available response time increased, by using passive barriers or roadway layout to control the velocity of threat vehicles as they travel through the ECF zones.

✓ **Manage Time** - Change the operational features through technology so that the time can be managed. Manage time includes alternatives to better manage response and safety time. 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. In all cases, they still must include traffic and safety control in conformance with the *MUTCD*.

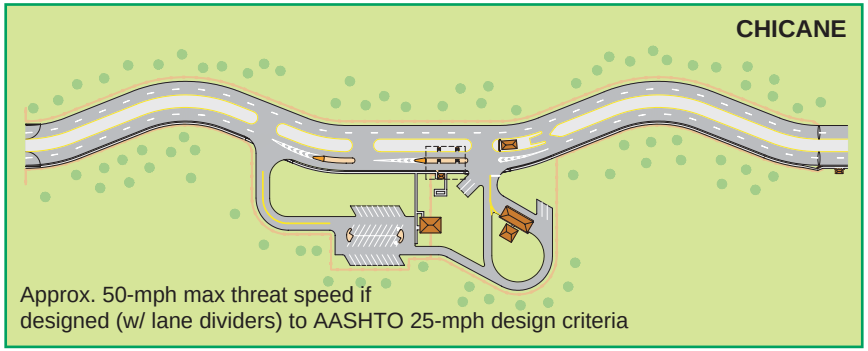
Exhibit 7.6: Threat Speed Management

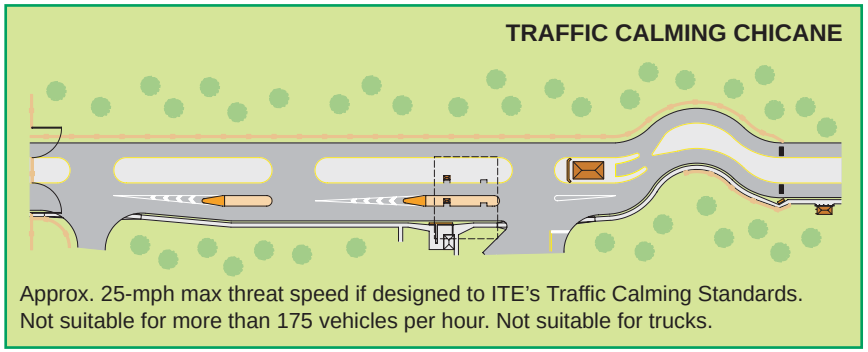
Category and Treatment	Threat Speed Management Chicanes, Traffic Calming, Curves/Turns
Pros	✓ Utilizes geometric constraints to physically limit both "normal" and "threat" speeds ✓ Can be designed to compliment aesthetic attributes
Cons	✓ May cause some minor reductions in roadway capacity due to controlled 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 *MUTCD*

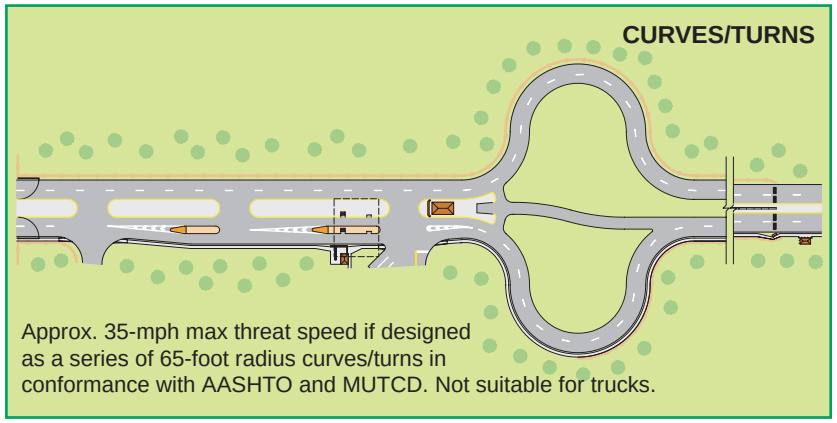
7.6.6.1. Threat Speed Management

Threat speed management uses geometric constraints to physically limit the maximum attainable threat speed. By limiting threat speed, distances needed to accommodate response and safety time can be decreased.

In many cases, the existing topography or alignment of the roadway offers benefits of speed management provided threat vehicles can be contained to the roadway through the use of passive barriers.







- "BEST OPERATIONAL ALTERNATIVE FOR TRAFFIC FLOW"
- "POSSIBLE OPERATIONAL AND MAINTENANCE ISSUES"
- "POTENTIAL THREAT VULNERABILITIES DEPENDING ON DESIGN CHARACTERISTICS"

7.6.6.2. Vehicle Presence

The Vehicle Presence operational strategy is a unique and complex approach to reducing the minimum response zone length. Basically, the system functions as a means of flow control inside the threat response zone:

✓ Each authorized vehicle must individually stop (red signal indication) just prior to the AVB.

✓ If no AVB activation takes place at that time, the vehicle receives a green signal indication. Only one vehicle can proceed on the short green signal as posted by a regulatory sign stating "ONE VEHICLE PER GREEN."

✓ If AVB activation takes place with a vehicle stopped on a red signal indication:
- The lane signal indication remains red (preemption hold).
- A traffic arm is deployed with flashing lights supplemented by a post mounted sign reading, "BARRIER ACTIVATED WHEN FLASHING."
- Traffic signal controller scans multiple sensor inputs in each lane for vehicle presence (of prior released vehicles, disabled vehicles, defective detectors, etc.) prior to and after the barrier before the AVB deploys.

The system in its normal operation works in a similar fashion to ramp metering configurations in many metropolitan areas. Effectively, the system permits the reduction of time associated with vehicle braking and stopping since every vehicle is required to stop regardless of activation.

If utilized, the Vehicle Presence scheme shall be designed, installed, and operated with several safeguards:

✓ **Vehicle Detection at AVBs** – Detectors/sensors shall detect vehicles prior to and just after the AVB in order to suppress activations until the traversing vehicle has cleared.

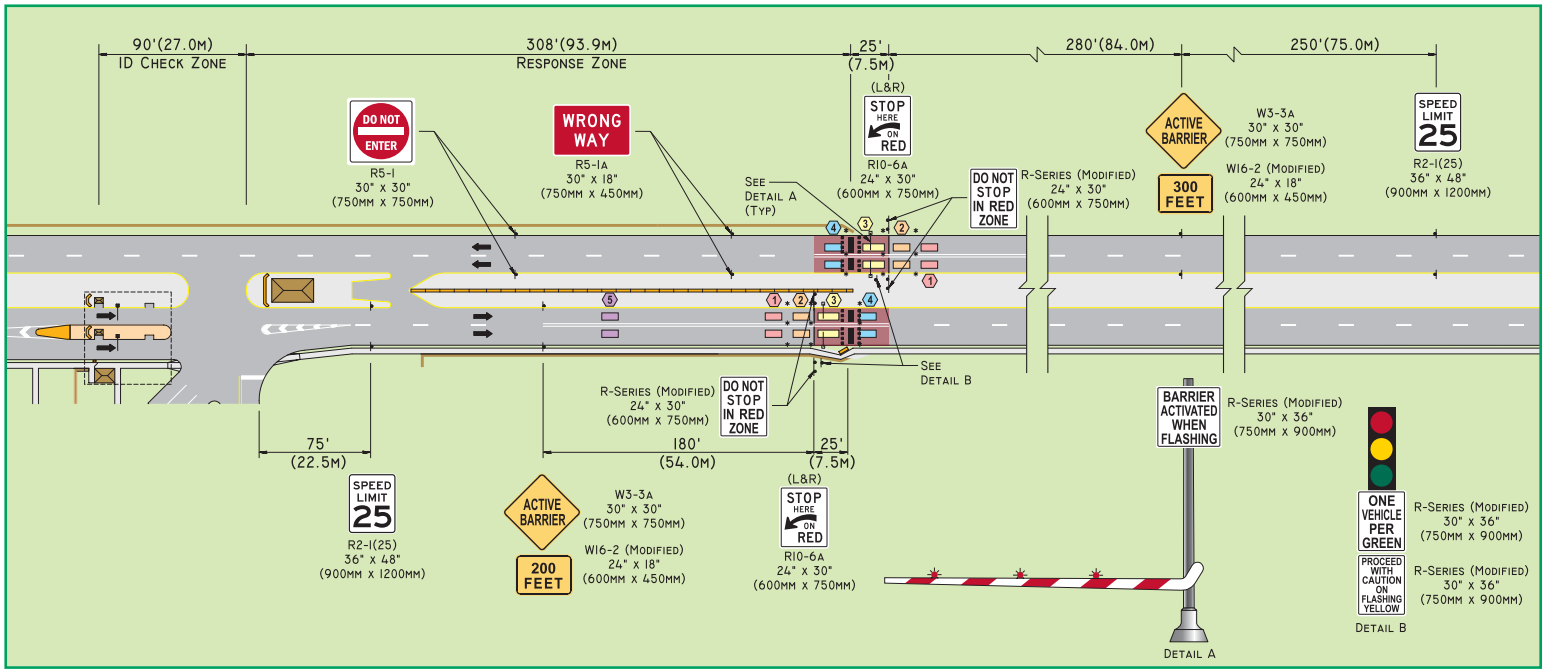
✓ **Detection of Bicycles and Motorcycles** – Detectors/sensors shall detect bicycles and motorcycles.

✓ **System Safety Check** – The microprocessor controller shall check both operational status and detection status prior to its "Start Up" deployment. Under no circumstance will the AVB deploy when one or more detectors is (are) not operational, is (are) offline with system, or have a call.

✓ **Queue Preemption Phase** – The system shall allow for vehicle queue preemption in case of back-ups associated with the AVB system.

✓ **Emergency Fast Operate** - If guards initiate the "Emergency Fast Operate" command during queue preemption, the lane control signal shall change from flashing "Yellow" to solid "Yellow" for 3 seconds and then to solid "Red" for 2 seconds.

Although the vehicle presence scheme is a viable alternative, it places more reliance on system operations. Additionally, there is a greater likelihood of driver confusion due to the unique application and the number of signs required. Finally, there is some level of vulnerability depending on design conditions that should be explored prior to implementation.



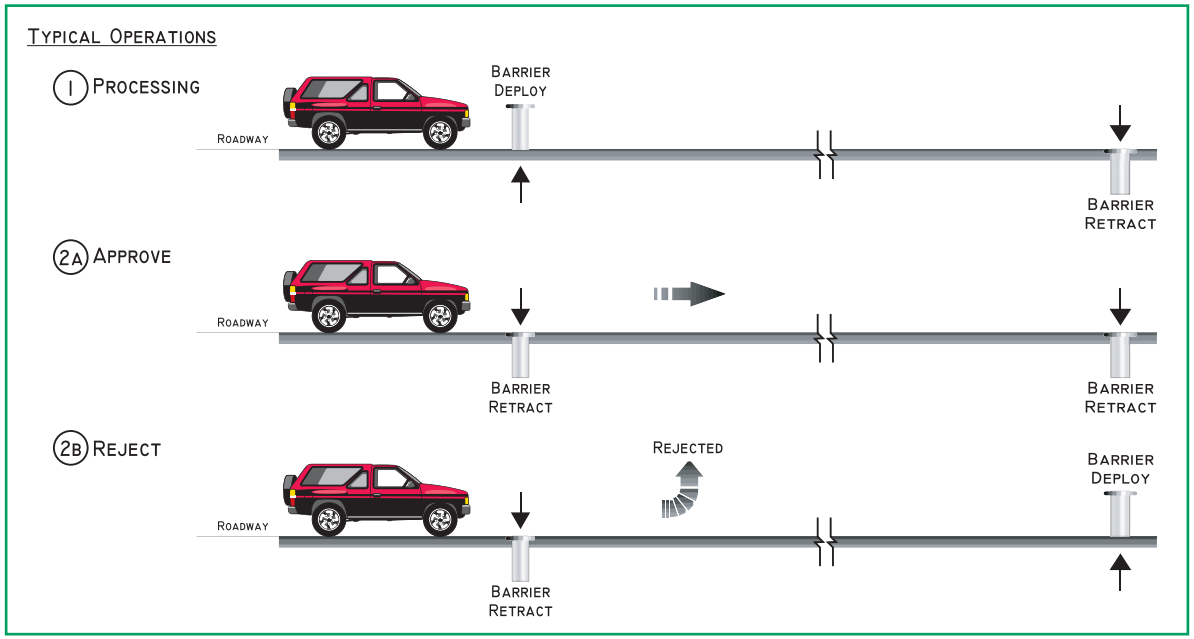
- "SIGNIFICANT DECREASE IN TRAFFIC EFFICIENCY VERSUS CONVENTIONAL OPERATIONS - ACCEPTABLE AT LOW-VOLUME LOCATIONS ONLY"
- "BARRIER MAINTENANCE ISSUES DUE TO CONSTANT CYCLING"
- "COMPLETE CONTAINMENT VERSUS THREATS"

7.6.6.4. Barrier-Up Operations

Barrier-up or barrier normally closed operations are often used at low-volume locations where there is limited conventional operations, or where security requirements necessitate complete and continual containment.

In practice, the AVBs are normally closed (1) until the vehicle is authorized for entry (2A). If the vehicle is to be rejected and the rejection turnaround is beyond the checkpoint (2B), a second set of AVBs can be deployed to prevent unauthorized entry by the rejected vehicle.

In normal applications, barrier-up operations cannot process more than 150 vehicles per hour. Additionally, the constant cycling of barriers can increase maintenance and operational costs.



- "40-50% DECREASE IN TRAFFIC EFFICIENCY VERSUS CONVENTIONAL OPERATIONS"
- "BARRIER MAINTENANCE ISSUES DUE TO CONSTANT CYCLING"
- "COMPLETE CONTAINMENT VERSUS THREATS"

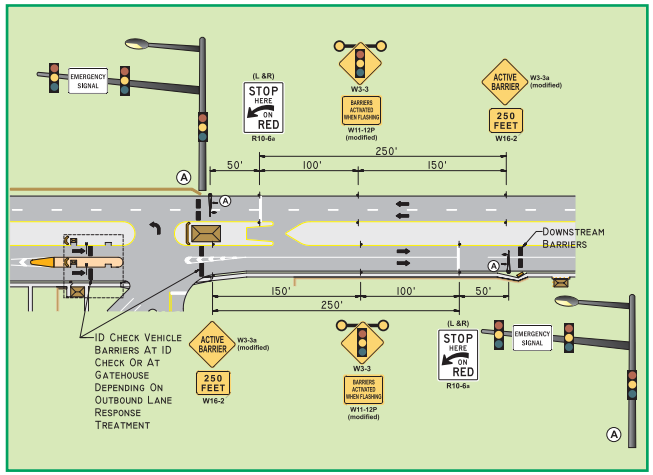
7.6.6.3. Barrier-Up Vehicle Platooning Operations

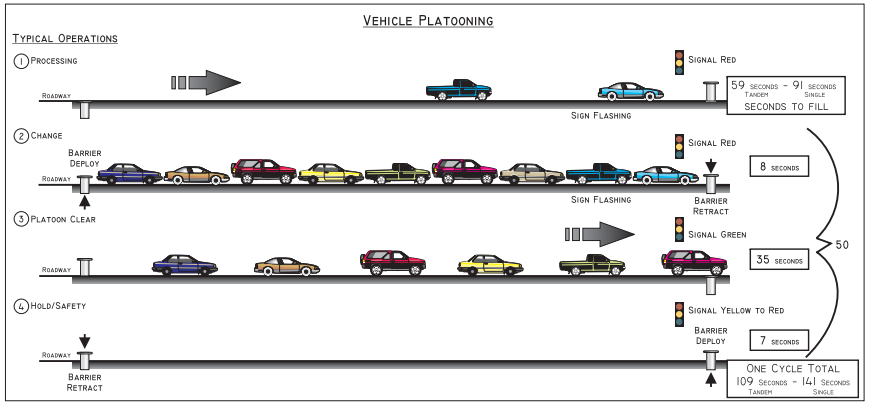
Vehicle platooning is similar to barrier-up operations, except checkpoint guards process several motorists and vehicles prior to authorizing final entry as a group.

As guards process traffic, (1) Vehicles enter and queue at the approach to the second set of deployed AVBs. (2) Once the platoon or "sally port" area is filled, guards deploy AVBs at the ID check area and retract barriers at the second set of AVBs. (3) Once the AVBs have been changed, the platoon discharges, and (4) guards reverse the AVBs, and the process starts again.

Barrier-up vehicle platooning can be sized to fit many situations, but typically AVBs should be around 300 feet apart to maximize operations. With this configuration, motorists' delays will increase and throughput capacity (processing capability) will decrease by approximately 40 to 50 percent versus conventional operations.

The traffic and safety control requirements are similar to conventional operations; however, some sign messages and signal indications are slightly different.



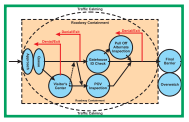
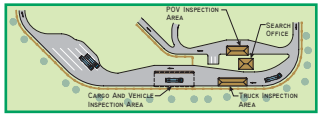


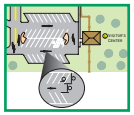
7.6.6.5. Other Solutions

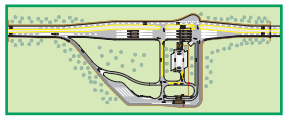
Ultimately, innovation is needed in addressing safety and security. In some cases, "out-of-the-box" ideas are needed. In other cases, more costly solutions must be considered. Other potential solutions to address safety and security may include:

- ✓ **Deploying multiple barrier systems** – consider deploying multiple sets of AVBs if the response zone is constrained by a downstream intersection.
- ✓ **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 tire spikes to gauge the intent of violators before deploying more active systems.

SDDCTEA is continuing to work with ECF stakeholders in developing alternatives; however, any solution must be consistent with FHWA's *MUTCD*.





SECTION 8 – INTELLIGENT TRANSPORTATION SYSTEMS

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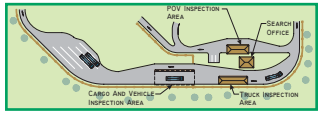


8. Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) involve the application of technologies and innovative practices to improve all aspects of transportation service.

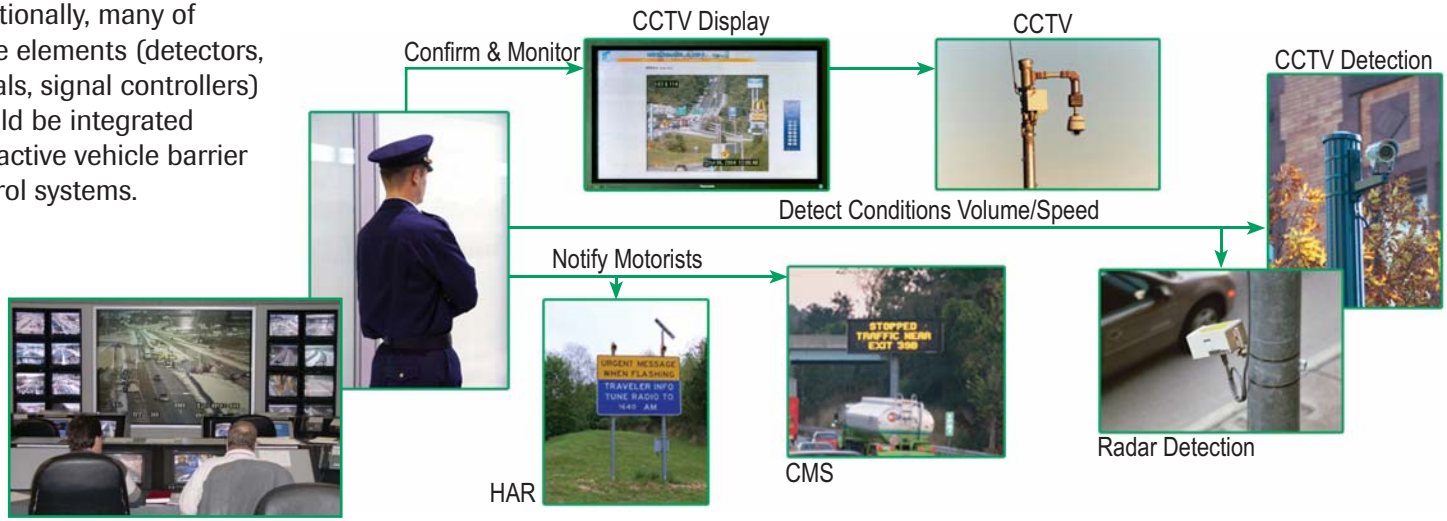
Intelligent Transportation Systems (ITS) involve the application of technologies and innovative practices to improve all aspects of transportation service.

Better-known examples of ITS technologies that may be applicable to ECFs include:

- ✓ Detection devices
- ✓ Changeable Message Signs (CMS)
- ✓ Closed Circuit Television (CCTV)
- ✓ Highway Advisory Radio (HAR)
- ✓ Automated ECF technologies
- ✓ 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.

8.1. DETECTION DEVICES

There are a variety of detection devices that can be used for transportation projects.

Exhibit 8.1: 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 ✓ Designed 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 8.1 (cont.): Detection Devices

Type		Description	Considerations	ECF Applications
Passive Infrared		✓ Passive Infrared Detectors are able to discern slight changes in thermal radiation such as those caused by a vehicle moving into or through their field of view	✓ Passive infrared detectors are marketed as low voltage, non-intrusive alternates to inductive loops ✓ Passive infrared detectors have been combined with microwave Doppler radar and ultrasonic sound wave detection sensing to create triple-technology traffic detectors	✓ Wrong-way detection ✓ Point overspeed detection ✓ Vehicle presence/AVB safety
Video	 	✓ Uses zones "painted" on the fixed video image to recognize if the image changes ✓ When zones recognize a change, algorithms can determine vehicle type and speed	✓ Systems have improved but there are still some issues with snow, fog, and nighttime conditions ✓ Most applications permit as many as 99 point detections or multiple detection intervals of variable length which can be used to provide continuous detection ✓ 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/phototransitor	✓ 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 include:

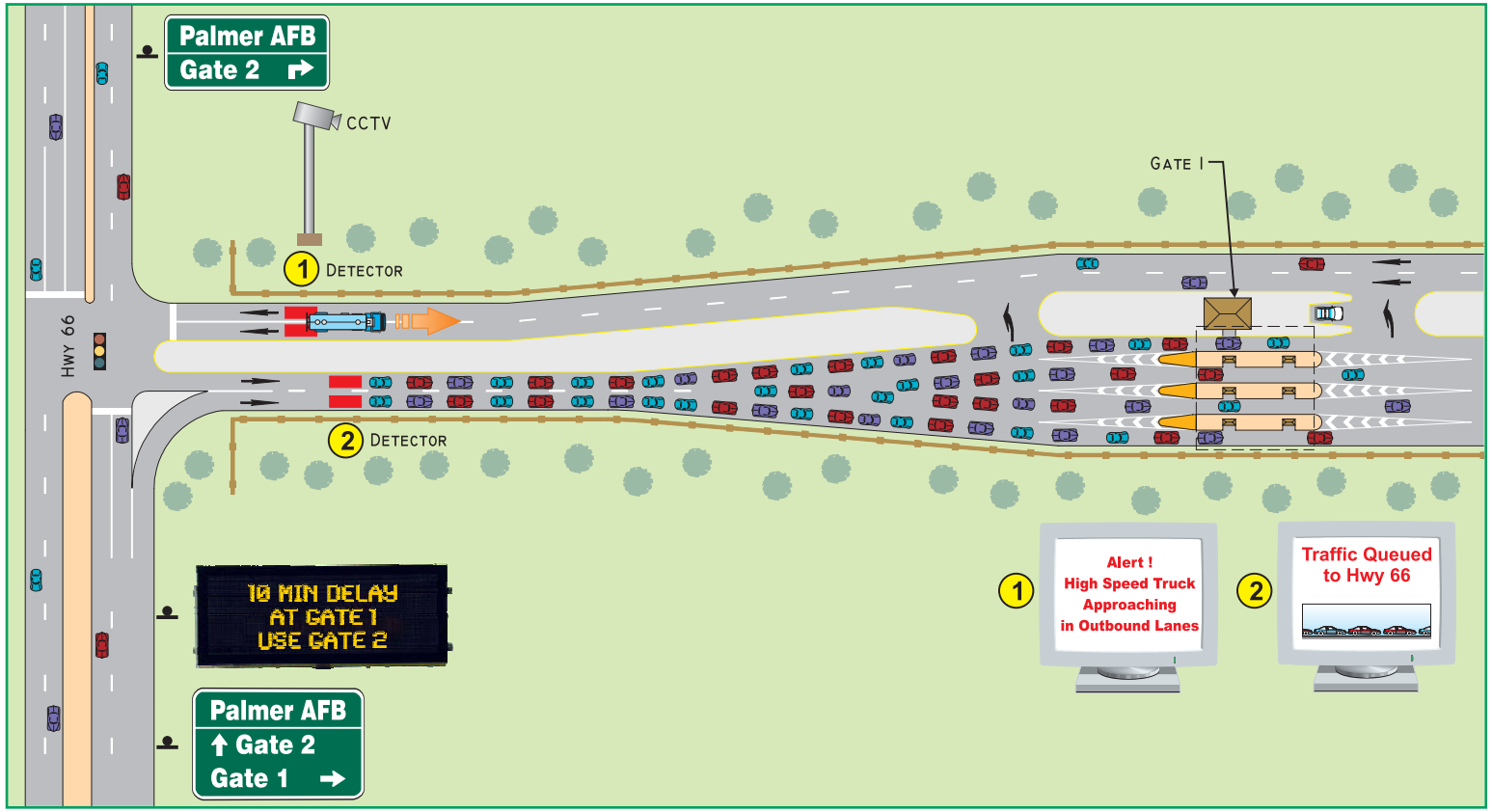
✓ **Wrong Way Detection** - Wrong way sensors can be deployed in all outbound lanes at the ECF entrance and after each turn-around to monitor for illegal outbound entry.

✓ **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 HAR or CMS so that they can use an alternate ECF, if appropriate.

✓ **Overheight vehicles** - Break beam technologies can be used to monitor for overheight vehicles.


Palmer AFB
Gate 2
CCTV
GATE 1
1 DETECTOR
HWY 66
2 DETECTOR
10 MIN DELAY
AT GATE 1
USE GATE 2
1
Alert !
High Speed Truck
Approaching
in Outbound Lanes
2
Traffic Queued
to Hwy 66
Palmer AFB
Gate 2
Gate 1

CHANGEABLE MESSAGE SIGNS (CMS) OFFER THE ABILITY TO CHANGE THE INFORMATION BEING PROVIDED TO MOTORISTS.

Near one Army installation, a major highway provides access to seven ECFs. CMS are being deployed along the highway to the north and south of the installation and will be used to inform motorists of ECF conditions so that alternate routes can be used.

8.2. CHANGEABLE MESSAGE SIGNS (CMS)

When used, CMS should be located where the driver has an opportunity to react and take an alternate route if appropriate. CMS placed in the approach zone provide little benefit if alternate routes are not easily accessible. When deployed, 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
- RENSEL 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

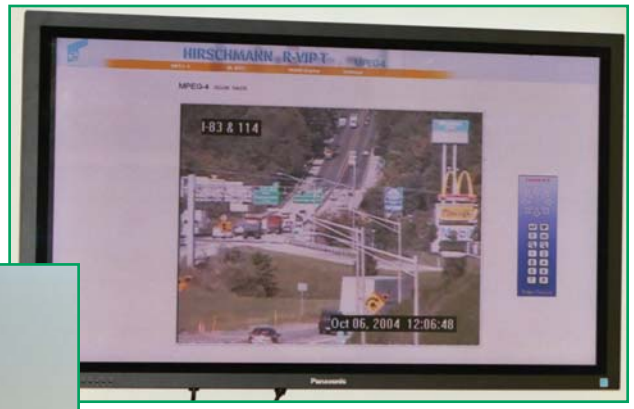
CLOSED CIRCUIT TELEVISION (CCTV) SYSTEMS PROVIDE SECURITY BENEFITS AND PROVIDE A MECHANISM TO MONITOR TRAFFIC CONDITIONS.

One Air Force base had someone stand at a neighboring intersection that could not be seen from the ECF to let guards know when traffic would backup from the ECF through the intersection. In discussions with the local city, it was determined that the city was planning to deploy a CCTV near this intersection to monitor traffic operations on the local arterial. As a result of the discussion, the base and city are exploring sharing the CCTV so that the base can better utilize their manpower, but still oversee and respond to traffic backups.

8.3. 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's 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.

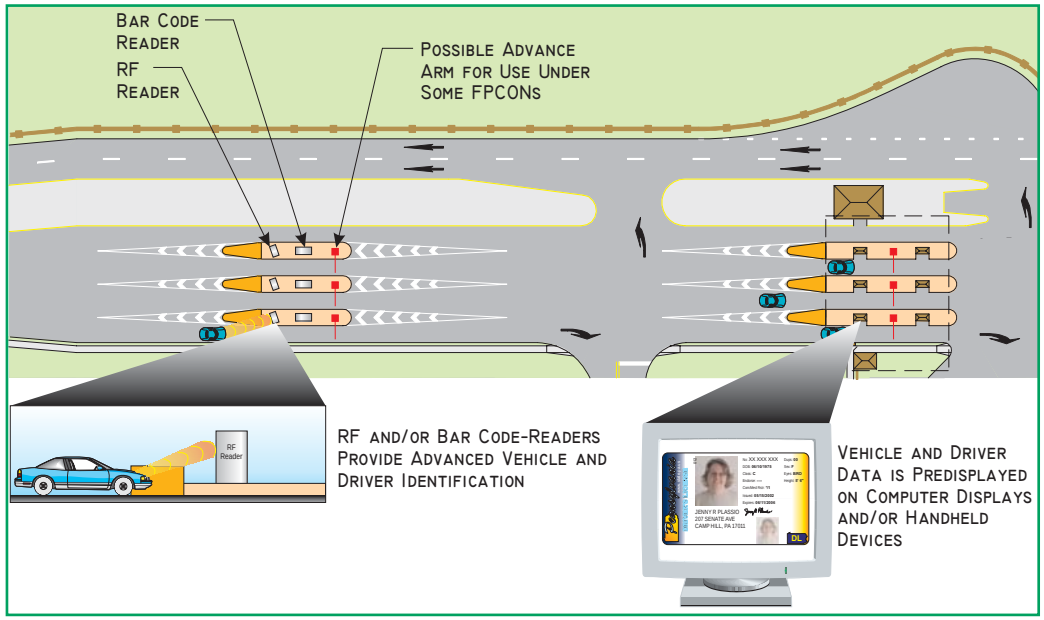
AUTOMATED ECF CONFIGURATIONS VARY, BUT THE GENERAL SEQUENCE IS A DEVICE RECOGNIZES THE VEHICLE AND/OR THE DRIVER IS IDENTIFIED USING DEVICE READERS; THE DRIVER'S INFORMATION IS DISPLAYED ON A READER; THE PERSON IS EITHER ACCEPTED OR REJECTED.

One Air Force base calculated lane requirements based on tandem processing capabilities and determined they needed three lanes. Before the ECF was constructed, "Smart Gate" was provided to the installation for their use. Fortunately, processing was discussed and they plan to construct four processing lanes. Two lanes will utilize "Smart Gate" and two will be dedicated for manual processing including multiple occupant vehicles.

8.4. AUTOMATED ECF TECHNOLOGIES

Most service branches have developed or are developing some type of automated ECF technology. The purpose of most automated ECF concepts is to improve the reliability of ID checks while maintaining or minimizing manpower.

The configurations of device readers can include radio frequency (RF) tags that identify a vehicle, and depending on how the system is configured, potentially identify drivers. Device readers may also include bar code 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.



When evaluating the applicability and efficiency of installing automated ECF technologies, there are several questions that should be asked before deployment at an ECF.

Will the use of automated ECF technology impact traffic operations? At Bravo+, conventional processing (two guards per lane) can accommodate 450-600 vehicles per hour per lane. By way of comparison, initial estimates for some automated ECF technology indicate that the technology can process 300-400 vehicles per hour per lane. At some locations, if automated ECFs are used, one or more additional lanes may be warranted.

How will automated ECF technology be utilized at various FPCONS? The best application of automated ECFs is when only the driver must be identified. As FPCONS are raised and additional identification and searches are required, the benefits of automated ECFs may depreciate.

When automated ECFs are utilized and security requires identification of all occupants, how is this accomplished? When security levels necessitate the identification of all occupants, the benefits of automated ECFs may not be applicable to multiple occupant vehicles but only single occupant vehicles. In those cases, multiple occupant vehicles need to be adequately signed to a dedicated manual lane or to another ECF, if appropriate. This should be evaluated carefully because such measures may discourage car pooling and result in more traffic.

When planning and designing ECFs with planned or possible future automation, the design team should ask the following questions:

Will the configuration of automation require advance islands for preprocessing and advance rejection? Early automation deployments have utilized a variety of configurations. Some systems have all automation occur on the ID check island; while, other configurations have utilized advance (secondary) islands for automated preprocessing. Preprocessing provides an opportunity to screen and reject prior to the ID check area. Consult with your service branch for guidance prior to design.

What will the typical queue of conventional processing be? 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. A similar practice should be employed at ECFs with planned automated and conventional processing.

Will special signing be needed? When automated and conventional processing is planned, signing needs should also be considered. Advance signing should instruct automated users to keep left. As vehicles approach the ID check area, lane use signing should designate usage type similar to a toll plaza. At the ID check there may be a need for automated lane signs, conventional lane signs and high-occupant vehicle lane signs. Consult with SDDCTEA regarding signing needs for your planned ECF.

HIGHWAY ADVISORY RADIO (HAR) INFORMS MOTORISTS OF TRAFFIC CONDITIONS.

OVERHEIGHT DETECTION IS APPROPRIATE AT LOCATIONS WHERE THE VERTICAL CLEARANCE OF THE CANOPY OR OTHER ROADWAY FEATURES ARE OF CONCERN.

8.5. HIGHWAY ADVISORY RADIO (HAR)

For ECF applications, HAR can be used to:

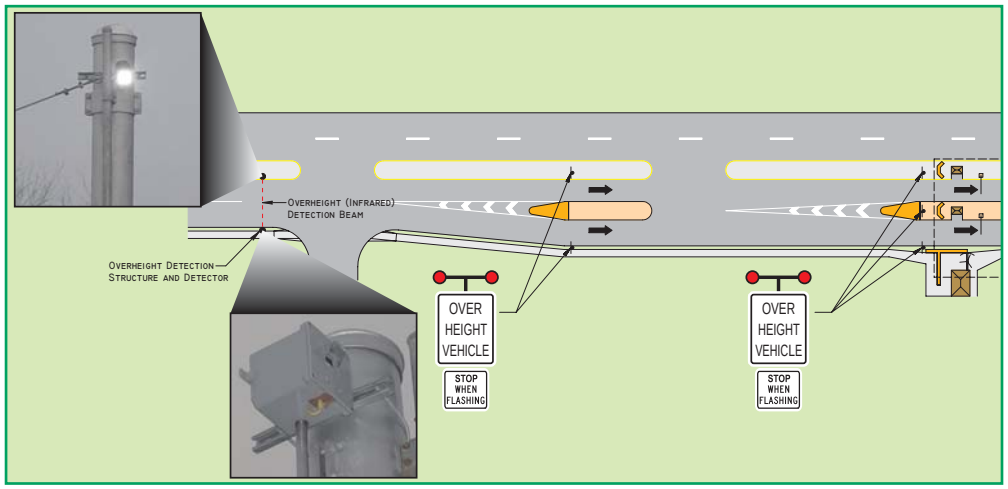
- ✓ Inform motorists which ECFs are open or closed
- ✓ Inform visitors and commercial vehicles which ECF to use

Most HAR systems employ software that translates typed text to radio broadcast so that a dedicated broadcaster is not needed.

8.6. 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 at a location far enough in advance that the driver can be warned and take corrective action.



8.7. 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.

8.7.1. Signal Indications

There are two nominal sizes for signals indications: 8-inch and 12-inch. SDDCTEA suggests using 12-inch lenses in most cases including at active vehicle barrier locations except for the flashing yellow indication which can be 8 inches.

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 40 percent
- ✓ Lower life-cycle costs

8.7.2. 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.

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 CALTRANS 2070 controller for active vehicle barrier control systems since a 2070 controller has more flexibility in communicating with and controlling other devices. Controllers should be installed by local or state DOT approved installers or by someone with International Municipal Signal Association (IMSA) certification.

8.7.3. Active Vehicle Barrier Control System

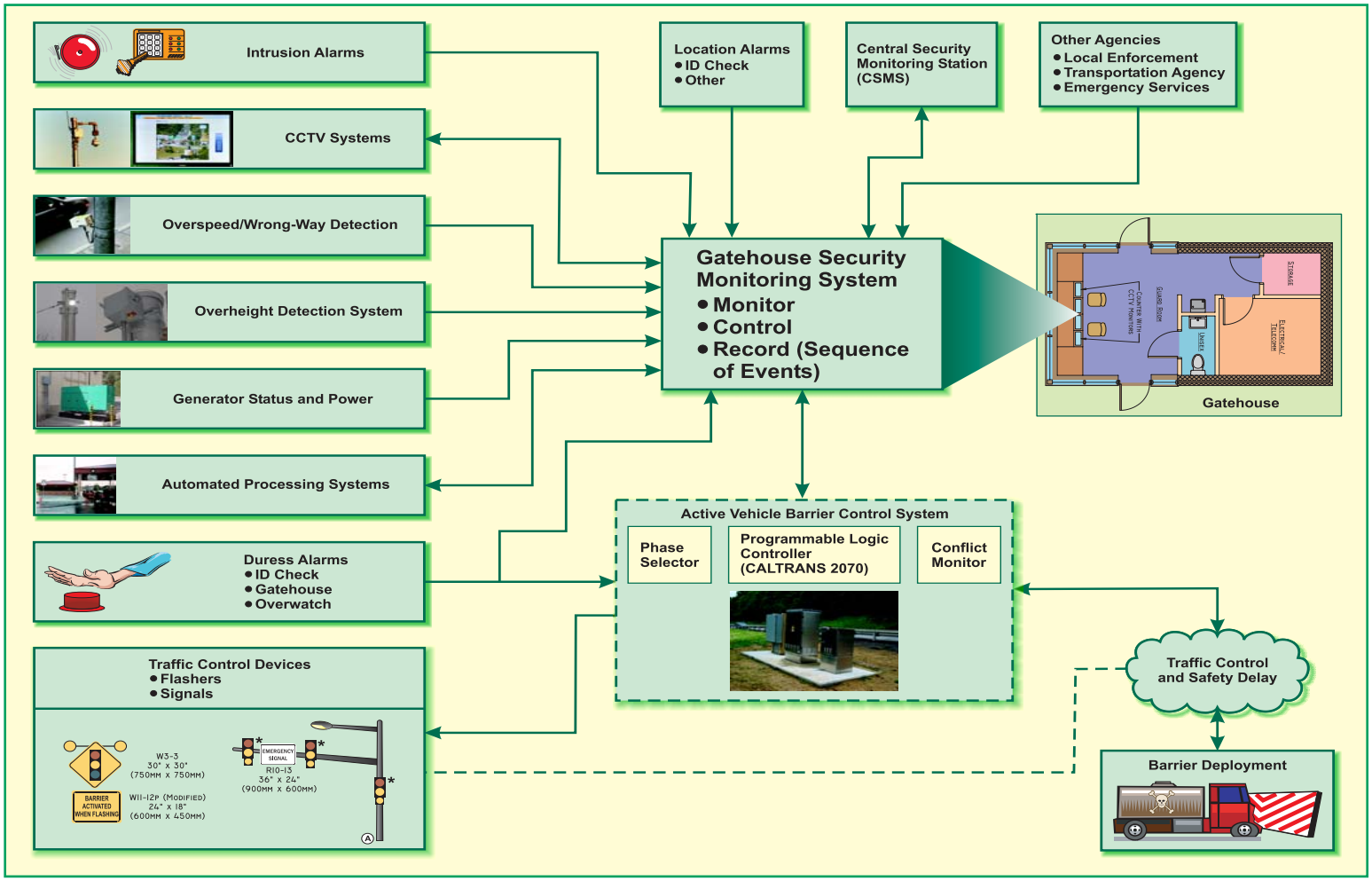
Active vehicle barrier control systems discussed in **Section 7** should be controlled by an approved programmable logic controller for traffic control such as a CALTRANS 2070 controller. Active vehicle barrier deployment should be triggered through the traffic signal controller and should be dependent on the signaling (and safety) sequence. Active vehicle barriers and their associated traffic control should not be controlled independently by barrier controllers.

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, active vehicle barrier 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 Engineer's Protective Design Center is in development of a guide specification for active vehicle barrier control systems. For more on active vehicle barrier control systems, contact SDDCTEA.


Intrusion Alarms
CCTV Systems
Overspeed/Wrong-Way Detection
Overheight Detection System
Generator Status and Power
Automated Processing Systems
Duress Alarms
• ID Check
• Gatehouse
• Overwatch
Traffic Control Devices
• Flashers
• Signals
W3-3
30" x 30"
(750MM x 750MM)
BARRIER ACTIVATED WHEN FLASHING
W11-12P (MODIFIED)
24" x 18"
(600MM x 450MM)
EMERGENCY SIGNAL
R10-13
36" x 24"
(900MM x 600MM)
Location Alarms
• ID Check
• Other
Central Security Monitoring Station (CSMS)
Other Agencies
• Local Enforcement
• Transportation Agency
• Emergency Services
Gatehouse Security Monitoring System
• Monitor
• Control
• Record (Sequence of Events)
STORAGE
ELECTRICAL/ TELECOMM
COUNTER WITH CCTV MONITORS
GUARD ROOM
DESKS
Gatehouse
Active Vehicle Barrier Control System
Phase Selector
Programmable Logic Controller (CALTRANS 2070)
Conflict Monitor
Traffic Control and Safety Delay
Barrier Deployment

8.8. 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 2070 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.

8.9. 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 CMS alone. The location of some devices may make physical connections cost-prohibitive.

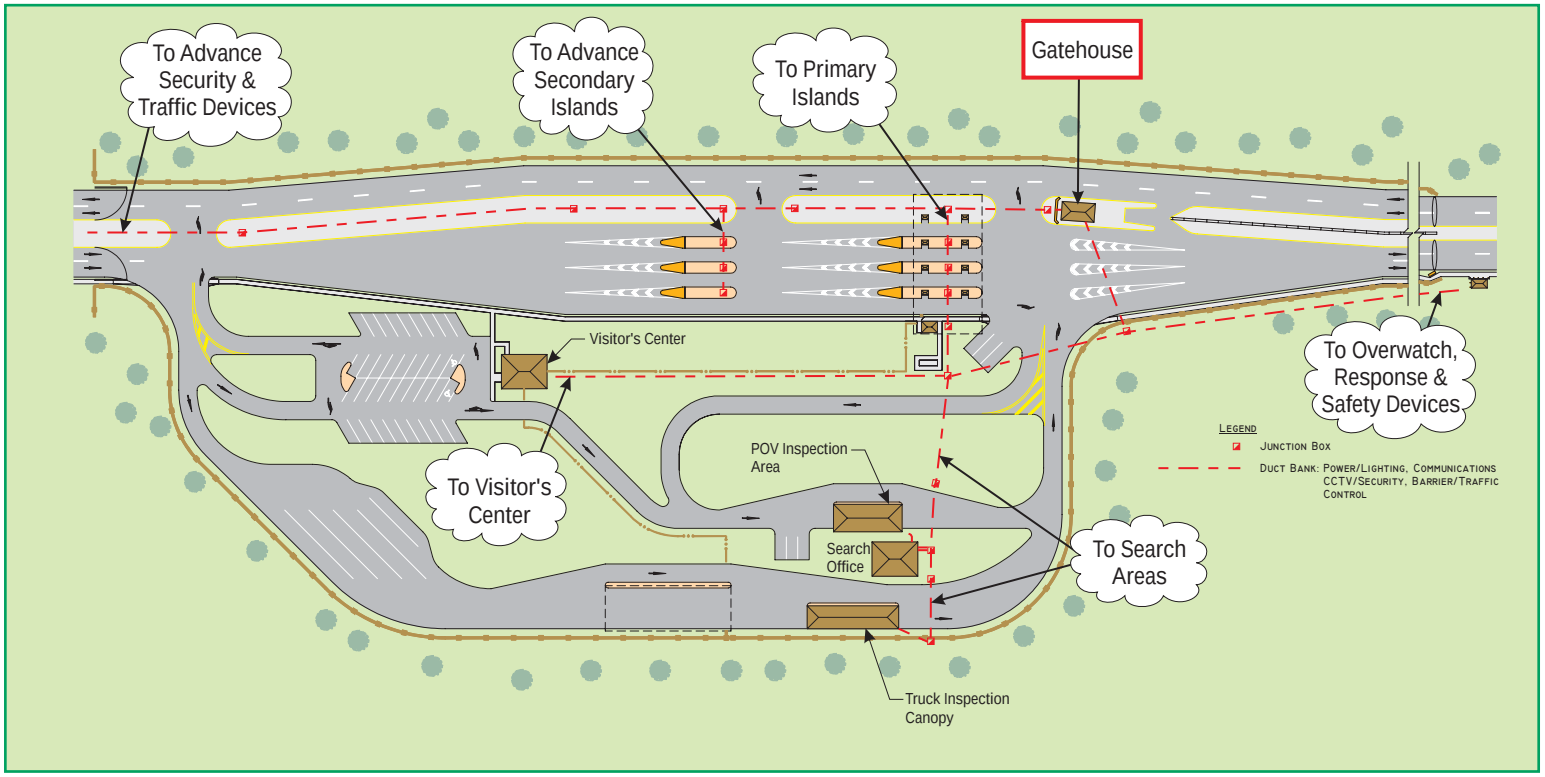
Exhibit 8.2: Types of Communication

Communication Type	Key Features	Support Detection Devices?	Support CMS?	Support CCTV?
Hardwire (Fiberoptic or Copper)	This communication technique includes physically connecting equipment using either fiberoptic 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

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 visitor's center.

An ECF was designed without spare conduit connecting the key features. When CCTV was added to the ECF, the roadway had to be trenched to add the conduit.

At ECFs, communication is also needed to link all the facilities to and from the gatehouse to a central monitoring point. The *UFC* 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.



8.10. 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.

8.10.1. 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.

8.10.2. 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

THE FOLLOWING SHOULD BE CONSIDERATIONS WHEN PLANNING FOR UTILITIES WITHIN AN ECF:

- ❑ **WHAT IS NEEDED NOW AND**
- ❑ **WHAT WILL BE NEEDED IN THE FUTURE**

8.11. POWER AND COMMUNICATIONS REQUIREMENTS

In the ECF area, utilities should be buried for several reasons: vulnerability, clear zone obstructions, visibility, and aesthetics. The *UFC* states that "Electrical design shall 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)

Future technological advances should be anticipated and provisions should be included with underground conduit and duct banks. Layouts similar to the ones shown in the *UFC* "Figure 6-7 Typical Locations for Provision of Future Power/Control Connections" should be used for accommodating future technology.

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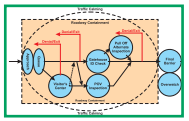
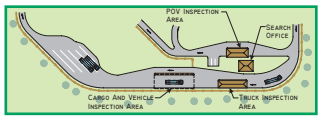
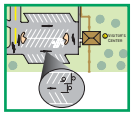
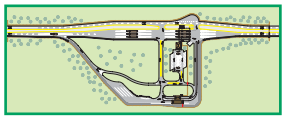
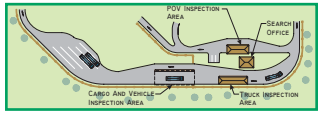







SECTION 9 - MULTIMODAL CONSIDERATIONS

9.1. PEDESTRIANS AND BICYCLES 9-1
9.2. TRANSIT AND PARK-N-RIDE SERVICES 9-2



9. Multimodal Considerations

Under FPCON Bravo+ conditions, provide dedicated personnel and facilities when the pedestrian and/or bicycle traffic exceeds ten users per 15-minute period during the peak one hour of vehicular traffic.

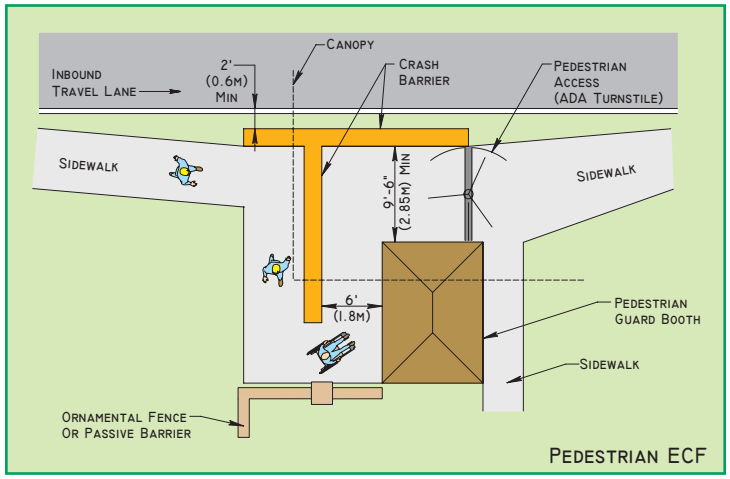
The use of transit as well as pedestrian and bicycle activity should be considered while analyzing the conditions at an existing ECF or developing a new ECF. All modes should be accommodated to the appropriate level at ECFs. Accommodating alternate modes of transportation can help reduce the demand of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

9.1. Pedestrians and Bicycles

It is important to accommodate alternative modes of transportation at the ECF. Pedestrian and bicycle 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 and/or bicycle activity is present, consider conducting a study to determine if the erection of a dedicated pedestrian ECF could better accommodate the demand. The O&D study would primarily identify if the users are being forced far from their straight-line path, and if the erection of the ECF could potentially increase the user demand.

When providing any pedestrian accommodations, compliance with the ADA is required, including curb ramps, wheelchair friendly ECFs, adequate crossing width, and other provisions as outlined in the act.



TRANSIT IS A DIRECT MEASURE FOR REDUCING THE CONGESTION AND DEMAND AT AN ECF.

9.2. TRANSIT AND PARK-N-RIDE SERVICES

At military installations, the majority of the population is younger and may depend on transit as their transportation on and off base. Below are two types of transit arrangements to consider.

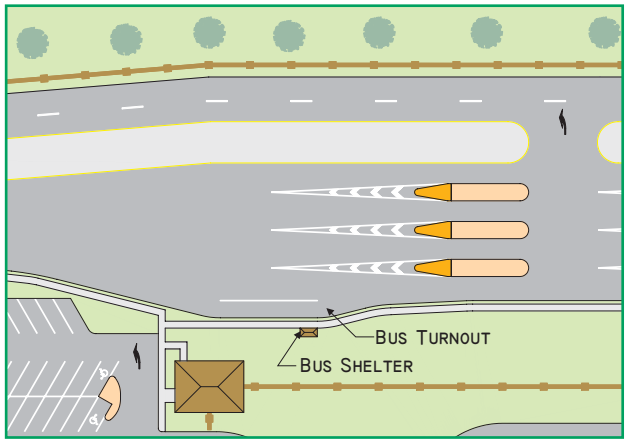
A major military installation had two transit routes serving the base. After September 11th, the base discontinued the service, resulting in lost ridership of 13,000 patrons per month. The base and transit agency have explored new mechanisms to accommodate lost ridership while maintaining security.

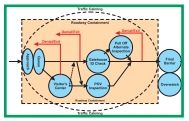
✓ External service provided on installation (with guard at higher FPCONs)
- Most efficient
- Guard can help minimize security risks, but security may still be an issue since some passengers are not destined to the installation

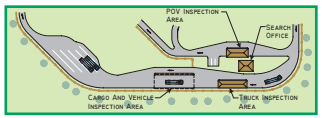
✓ External/internal services meet at transit center
- Requires dedicated on-installation service—may get transit to provide or share service
- Requires transit center
- Allows for park-n-ride opportunities at transit center

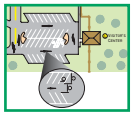
Park-n-ride is an external parking lot where motorists can leave their vehicles and be picked up by transit vehicles to be taken to their final destination. If a park-n-ride area is provided, consider offering incentives for usage such as, time off or discounts at stores on the installation. The cost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

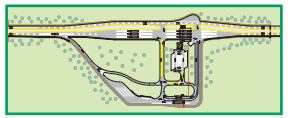
If transit service currently exists, discontinuing that service should be viewed as a last resort if security concerns cannot be accommodated. Before any decision to eliminate or restrict transit service is made, the ridership's impact on the ECF processing capability should be considered. If a new ECF 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.







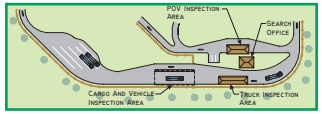




SECTION 10 – SPEED MANAGEMENT ISSUES

10.1. SPEED MANAGEMENT TECHNIQUES 10-1

10.2. OTHER SPEED MANAGEMENT CONSIDERATIONS 10-4



10. Speed Management Issues

There are three reasons to reduce speeds in the ECF area:

- ❑ **Safety of guards and motorists**
- ❑ **Clearer distinction between threats and speeders**
- ❑ **To physically control the maximum threat speed**

The control of vehicle speeds at ECFs is a common concern. To control the speed of threats, the geometry must limit the maximum attainable speed as discussed in **Section 7**. To control the speed of average motorists, other options, such as traffic calming and signing, can be considered.

The use of traffic calming devices such as speed humps may be appropriate at low-volume residential ECFs but must be evaluated by an engineering assessment. The *UFC* also states that rumble strips should be installed at the boundaries of the ECF. However, where traffic is adjacent to residential areas, rumble strips can precipitate noise problems that will need to be mitigated by sound walls or other means.

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. One of the most common mistakes is the use of residential traffic calming measures that are installed in the ECF area. Generally, many of these measures are not appropriate for use at the ECF.

10.1. SPEED MANAGEMENT TECHNIQUES

The installation of most traffic calming devices are governed by volume thresholds. Generally, traffic calming measures should not be used for streets that have an average daily traffic volume above 6,500 vehicles. Horizontal alignment changes as described earlier can be used to manage traffic along with the ones shown in **Exhibit 10.1**.

Exhibit 10.1: Speed Management Techniques

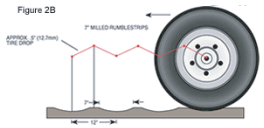
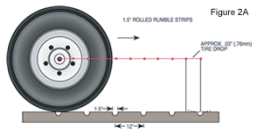
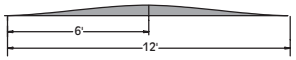
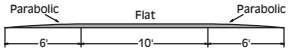
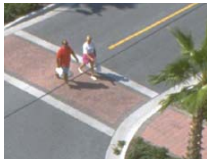
Category		Application Restrictions	Installation Requirements	Benefits	Graphic	Other Issues
Rumble Strips	Milled Style	✓ Consider use when housing is not adjacent to the ECF ✓ Place far enough in advance so the sound created does not interfere with the guards ability to communicate	✓ Longitudinal width of 7 inches (180 millimeters) ✓ Transverse width of 16 inches (400 millimeters) ✓ Depth of 0.5 inches (12 millimeters)	✓ 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		✓ Noise ✓ Snow removal ✓ Bicycles
	Rolled or Formed Style		✓ Longitudinal width of 1.5 inches (38 millimeters) ✓ Spaced 8 inches (200 millimeters) apart ✓ Depth of 1.25 inches (32 millimeters)			
Speed Humps	Watts Profile Style	✓ Recommended only for local streets having an ADT of less than 3,500 vehicles and a posted speed limit of 30 mph (48kph) or less ✓ *UFC* approved for installation at ECFs ✓ Army Regulation 420-72 Section 2-17 prohibits use on Army installations	✓ 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
	Seminole Style	✓ Appropriate for streets with an ADT of up to 6,500 vehicles ✓ *UFC* approved for installation at ECFs ✓ Army Regulation 420-72 Section 2-17 prohibits use on Army installations	✓ 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		

Exhibit 10.1 (cont.): Speed Management Techniques

Category	Application Restrictions	Installation Requirements	Benefits	Graphic	Other Issues
Speed Bumps (NOT RECOMMENDED)	✓ *UFC* prohibits installation ✓ Army regulation 420-72 Section 20-17 prohibits installation on Army installations	✓ Longitudinal width of 1-3 feet (0.3-0.9 meters)	✓ Questionable benefits ✓ Some vehicles can traverse more easily at higher speeds		✓ Low clearance vehicles may get hung up ✓ Emergency vehicle response times ✓ Drainage ✓ Bicycles ✓ Proximity to intersections ✓ Grade ✓ Curves ✓ Increased liability
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
Flashing Warning Devices	✓ Locate outside clear zone	✓ Must be *MUTCD* compliant	✓ Can increase awareness and recognition of ECF features thus encouraging lower speeds		✓ Maintenance
Advanced Speed Detection and Signing	✓ 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

10.2. OTHER SPEED MANAGEMENT CONSIDERATIONS

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

✓ Engineering
✓ Education
✓ Enforcement

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.

NOTES:

NOTES:

- Early Coordination with Stakeholders
  - ✓ Command
  - ✓ Security forces
  - ✓ Department of public works
  - ✓ Safety officers
  - ✓ First responders
  - ✓ External stakeholders (county, external responders, state DOT)
  - ✓ Guards
  - ✓ 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 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's 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
- Inspection Procedures
  - ✓ Planning considerations
  - ✓ Master plan
  - ✓ BRAC
  - ✓ Deployment
  - ✓ Local growth
- ECF Sizing Analyses
  - ✓ Number of lanes (single vs tandem)
  - ✓ Visitor's 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
    - o Land use and development impacts
    - o Environmental constraints
    - o Utility constraints and needs
    - o Force protection constraints (stand-off, etc.)
    - o Wind, sun, weather etc
    - o Traffic constraints
    - o 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 Response Zone and 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 (CMS, 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