Traffic Engineering and Highway Safety Bulletin 20-02
July 2020

# Design Vehicles and Truck Accommodations

In This Issue...



MILITARY SURFACE DEPLOYMENT AND DISTRIBUTION COMMAND, TRANSPORTATION ENGINEERING AGENCY (SDDCTEA)

1 Soldier Way
Scott Air Force Base, Illinois
62225-5006
http://www.sddc.army.mil/sites/TEA

Scan Here to Quickly Visit Us Online!

## Overview

**The design vehicle is defined as the largest vehicle that uses a roadway facility with considerable frequency.**

Selecting the proper design vehicle for a roadway facility, such as an entry control facility (ECF), roadway or intersection, is a crucial part of the preliminary design process. A design vehicle is defined as the largest vehicle that uses a roadway facility with considerable frequency. The American Association of State Highway and Transportation Officials (AASHTO) *Policy on Geometric Design of Highways and Streets* states the following regarding design vehicles: *Key controls in geometric highway design are the physical characteristics and the proportions of vehicles of various sizes using the highway. Therefore, it is appropriate to examine all vehicle types, establish general class groupings, and select vehicles of representative size within each class for design use. These selected vehicles, with representative weight, dimensions, and operating characteristics used to establish highway design controls for accommodating vehicles of designated classes, are known as design vehicles*.

AASHTO further identifies four general classes for design vehicles: passenger cars, buses, trucks, and recreational vehicles (RV). Note that within these groupings, there are different specific design vehicles. Buses include transit buses, school buses, and articulated buses which are different sizes and have different design requirements. Trucks include single unit (SU) trucks and combination trucks, or wheelbase (WB) trucks. These trucks also have different size design requirements which are denoted by symbols indicating the truck type and length (e.g., SU-30, WB-40, WB-67).

In the civilian world, roadway facilities are designed to a vehicle within these groupings. Freeway ramps and intersections are typically designed for trucks, as are industrial areas of cities, routes leading to commercial delivery points of shopping areas, and the roadways connecting these to freeways or highways into cities. In areas where truck traffic is much less common, such as residential areas, a bus may be an appropriate design vehicle since school buses are very common in residential areas.

Like the civilian world, military installations are comprised of different areas that may require different design vehicles. There can also be a distinction between designing a roadway system for a specific vehicle while also designing a system that allows for a larger vehicle to maneuver throughout the facility. Designing for a certain vehicle includes designing roadway curves and intersection corner radii such that there is no encroachment into adjacent lanes. As an alternative, if some level of encroachment is acceptable, a large vehicle that does not use the facility frequently can maneuver with encroachment. This may require a tractor trailer to use the entire width of an intersection.

As an example, in a housing area, the design vehicle may be a school bus. One or more school buses traveling through a housing area daily would be frequent enough to be considerable. A truck may also need to access the housing area; the most common example may be a moving truck. Residents moving would be much less frequent, so if a moving truck encroaches into adjacent lanes while maneuvering through the area, it would be considered acceptable. The driver would need to be cautious. Other vehicles, such as delivery vehicles, navigating a housing area designed for a school bus would have no issues since these types of vehicles are often no larger than a school bus.

The table below summarizes common design vehicles for various areas on a military installation. Note that where multiple design vehicles are shown, consider all and determine which is most appropriate as the design vehicle.

| Area | Vehicle | | | |
|---|---|---|---|---|
| | Passenger Car | Bus | Truck | RV |
| POV Gate | X | X | | X |
| POV Gate, Outbound | | | X | |
| Housing Area | | X | | X |
| Parking Lot | X | | | |
| Truck Gate | | | X | |
| Camping Area | | | | X |
| Arterials | | | X | |
| Collector Roadways | | X | X | X |
| Route to Loading Dock | | | X | |
| Warehouses | | | X | |
| Industrial Areas | | | X | |
| School Routes | | X | | |
| Residential Alleys | X | | | |
| Residential Driveways | X | | | |

Different areas require different design vehicles depending on the expected use of the area. Passenger cars are not often a design vehicle since designing to the smaller dimensions of cars can be a limitation to the facility. Turning movement conflicts and curb damage can occur when the facility is designed for too small of a vehicle. Buses, which includes transit buses and school buses, are common design vehicles since they often are a considerable part of the traffic composition. Trucks commonly use certain roadways on an installation, mainly between a truck gate and locations receiving deliveries on the installation. RVs are infrequently used as a design vehicle on installations since most do not have the recreational component that the civilian world has. However, if an installation has a camping area, the area and associated roadway routes should be designed for RVs, especially if trucks are not the design vehicle for the area.

In locations where vehicles larger than passenger cars do not use the facility with considerable frequency, consider using a SU truck, i.e. delivery trucks, as a design vehicle. Even though a single unit truck is not one of the primary design vehicles, designing for a single unit truck gives a geometric buffer above a passenger car.

Many military vehicles are not included within these broad categories. However, most military vehicles do not exceed the size of tractor trailer trucks; so, if a facility is designed for a truck, it can accommodate most military vehicles.

When deciding on the appropriate design vehicle at an ECF, consult with the state or local DOT to determine what design vehicle is used for local roadways. The UFC 4-022-01 on ECFs states: *ECFs/ACPs must have the minimum ability for a WB-67 vehicle to be rejected prior to the identification (ID) check area for a POV only ECF/ACP. ECFs/ACPs that accept commercial vehicles (combined POV/truck gate or exclusive truck gate) must provide for a WB-67 vehicle to be rejected*. For other areas on the installation frequented by trucks, SDDCTEA recommends using a WB-67 truck as the design vehicle.

# Geometric Considerations

Larger arterial roadways through installations should accommodate trucks. The arterial should link gates with major truck destinations, such as the exchange, commissary, shoppettes, and more industrial areas of the installation. The features that should be incorporated into the roadway design to accommodate trucks include the following:

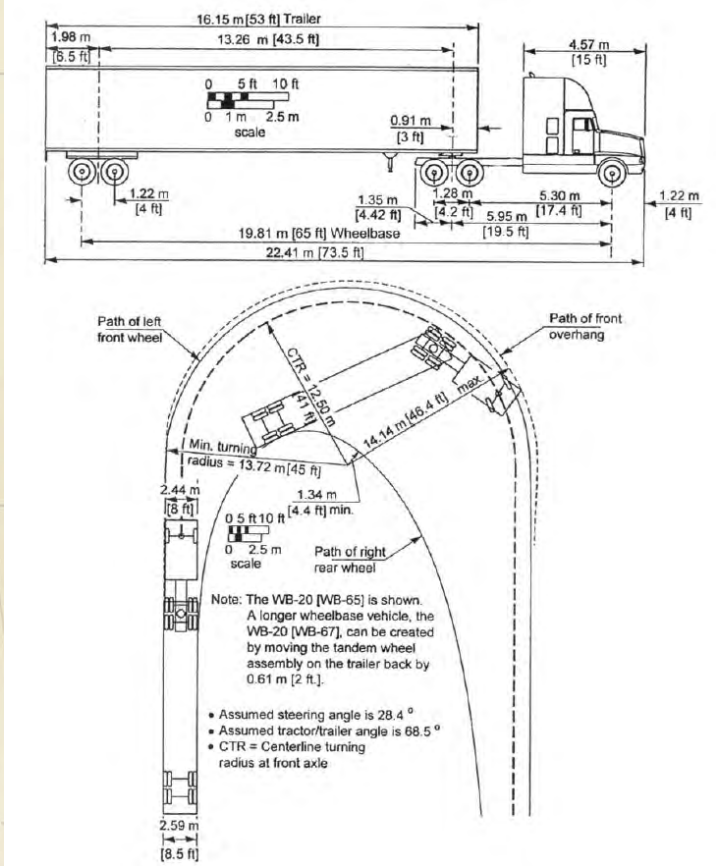
- ☑ Turning radii relating to horizontal curves, intersections, and entrances

- ☑ Lane widths through curves
- ☑ Vertical clearance
- ☑ Under-body clearance
- ☑ Climbing lanes on grades
- ☑ Sight distance considering different eye heights for design vehicles
- ☑ Noise considerations

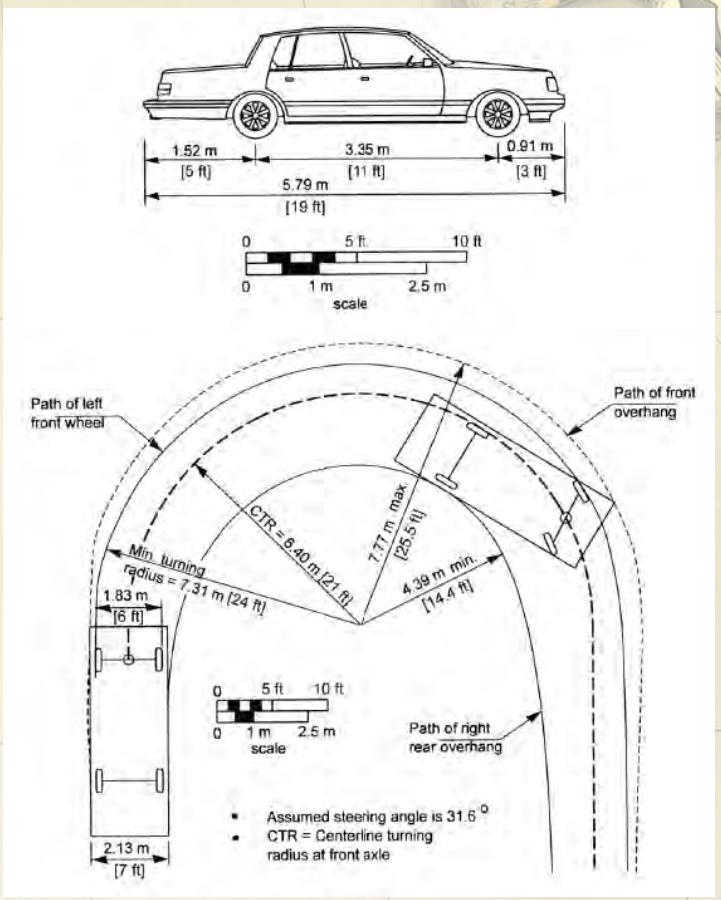
The turning radius for a design vehicle increases as the size of the design vehicle increases. Thus, a passenger car has a much smaller turning radius than a truck. The AASHTO Green Book shows turning radii for various design vehicles. In practice, CADD-based software such as AutoTurn, is often used for evaluating turning paths.

Following are two examples of design vehicle turning paths.

**Minimum Turning Path for WB-67 Design Vehicle (Source: AASHTO Green Book)**




**Minimum Turning Path for Passenger Car (P) Design Vehicle (Source: AASHTO Green Book)**




The table below shows minimum design turning radii for select design vehicles, from the AASHTO Green Book.

| Turning Feature | Design Vehicle Type | | | | |
|---|---|---|---|---|---|
| | Passenger Car | Single Unit Truck | Conventional School Bus | Interstate Semitrailer | Motor Home |
| *Symbol* | *P* | *SU* | *S-BUS 36* | *WB-67* | *MH* |
| Minimum Design Turning Radius (ft) | 24 | 42 | 38.9 | 45 | 40 |
| Centerline Turning Radius (ft) | 21 | 38 | 34.9 | 41 | 36 |
| Minimum Inside Radius (ft) | 14.4 | 28.3 | 23.8 | 4.4 | 25.9 |

As shown in the WB-67 turning path figure, the turning path of the trailer widens as the turning radius decreases. This is termed off-tracking and it requires more roadway width. With the combination of larger design vehicles and smaller turning radii, lanes must be widened. Lane widening is most common in intersection design where relatively tight turning radii require widening. Trucks turning right, for example, require significantly wider turning lanes. Channelized turning lanes, such as a pork chop style island, need to be wider since the truck has a defined path. The maximum turning radii available for turning vehicles at a given intersection depends on the intersection design and space available. A wider intersection typically provides for larger turning radii with less off-tracking, while a more constrained intersection would have smaller turning radii requiring more width for the truck. The truck would use more of the intersection to make the turn. In this case, a free right turn movement would not be appropriate. Chapter 2 of the AASHTO Green Book shows required radii and other geometric information for various design vehicles.

Vertical clearance varies by design vehicle. Typically, public arterials and freeways are designed with a minimum clearance of 16 feet (4.9 meters) plus an allowance for future resurfacing. Collector and local roads are designed with a minimum clearance of 14 feet (4.3 meters) plus an allowance for future resurfacing. Per the UFC, at an ECF that will allow commercial traffic: *The minimum desirable clear height (i.e., the vertical clearance from the highest point of the roadway to the lowest point on the canopy) must be 17.5 feet (5.3 meters*. ECF canopies, shoppette canopies, bridges, overpasses, traffic signals and utility crossings are examples where vertical clearance must be considered.

Climbing lanes can be provided on grades. Fully loaded trucks have slower acceleration rates, and when combined with grades, trucks often travel very slowly. A climbing lane allows cars and other vehicles with faster acceleration rates to pass trucks. Climbing lanes are not needed as often on military installations, but they may be needed on roadways with more rural characteristics and rolling or mountainous terrain.

Stopping sight distance must always be provided on roadway design. The AASHTO Green Book discusses that the higher driver eye height allows trucks drivers to see farther, which counterbalances the lower deceleration rates used when stopping trucks. Also, sight distance must be verified on horizontal curves, vertical curves, and intersections. Eye heights for trucks ranges from 5.9 to 7.9 feet, where the design eye height for passenger cars is 3.5 feet.

Noise can be a considerable detriment to quality of life. Trucks create noise by way of louder engines and engine brakes. In areas where roadways used by trucks are close to residential areas, consider noise barriers to help to reduce the noise and make for a more peaceful quality of life.

# Trucks at ECFs

Trucks at ECFs are an important consideration. Ideally, trucks should enter the installation at a different location than POVs. This may either be a separate inspection area at an ECF that also accommodates POVs, or it could be an entirely separate ECF only for trucks. This type of ECF should have a holding area sized for the truck demand, a search area with a canopy sized for a truck, and a turnaround both before and after the search area. When designating the location of a truck gate, engage local officials and other outside agencies. The external roadway system must be adequate to handle truck traffic, and local residents must not be opposed to any increase in truck traffic to arrive at the proposed truck ECF.

At a POV ECF that does not normally accommodate trucks, trucks still need special considerations.

- ☑ The ECF requires truck turnaround capabilities prior to the ID check area, in the event a truck erroneously turns into the POV ECF.
- ☑ Signing should be provided on the exterior route to inform and guide truck drivers to the correct ECF for truck processing.
- ☑ If special considerations are needed for off hours, such as the need for trucks to enter the installation through a POV gate at night when the truck gate is closed, the gate must be designed to include a truck rejection after the location where trucks are inspected.

Vehicular gates that normally do not accommodate trucks require a truck rejection. There may be many reasons a truck erroneously enters a POV ECF:

- ☑ General confusion related to unfamiliarity with the area.
- ☑ Poorly placed signing or unclear sign messages.
- ☑ Truck drivers following GPS-based driver directions that do not differentiate between routes for cars and trucks.

Turnarounds should be located so that the truck can turn around while not interfering with the ID check guards and can turn around if the gate is closed. Note that if the POV gate does not normally accommodate trucks, only an advance turnaround is necessary located before the ID check area. It is not necessary to design turnarounds after the ID check for

trucks. Figure 1 shows an example of a POV gate designed with an advance truck turnaround.

Signing must be in place directing trucks away from non-truck ECFs and to the truck ECF. The sign message should be clear and concise, and be located such that the truck driver can react in adequate time. Specifically, the signing should not be located on the approach zone for the ECF for which the truck restriction applies, since by the time a driver sees it, the driver cannot react to it and must turn around. Signing should be part of overall installation guide signing directing not only trucks, but also visitors, to the appropriate gate. If there is an ECF that can accommodate trucks at night when the primary truck ECF is closed, the applicable hours should be posted. To ensure proper placement, the installation may have to coordinate with local agencies to place signs off installation property. An example of undesirable truck signing is shown below.


This sign assembly has horizontal and vertical clearance signs mounted above a sign giving instructions for trucks. The signing above is not desirable for the following reasons:

- ☑ The top two vertical and horizontal clearance signs are not fabricated to MUTCD standards. The MUTCD standard for the top sign with the vertical clearance uses feet and inches, such as 16'-0". The horizontal clearance sign is not MUTCD compliant.
- ☑ Since the lower truck sign provides specific truck information, this sign should be mounted separate from the other two.
- ☑ The text on the lower sign panel giving directions is too small.
- ☑ The lower sign is mounted too low, and does not comply with MUTCD mounting height requirements. In this example with a two-lane approach, if a truck is in the left lane, a car can block the driver's line of sight to the sign.
- ☑ The sign is mounted in the approach zone, therefore requiring the truck to turn into the ECF before the driver sees the sign's message.

Figures 2 and 3 show examples of truck signing. Figure 2 shows preferred signing for a truck gate when the POV gate is not used for trucks, and figure 3 shows signing for a gate where the POV gate accommodates trucks at night. Signing off base should be coordinated with the local and/or state DOT, since off base roadways are often not owned and maintained by the installation.

# Off-Hour Truck ECF Considerations

There are two primary considerations for off-hour truck ECFs, or hours when the primary truck ECF is closed. This mainly includes nights and weekends, but may vary by installation. These include either using another ECF, or simply not allowing truck access to the installation.

If trucks are directed to another ECF at night, the receiving ECF must be geometrically capable of accommodating a truck. This includes:

- ☑ Canopy height
- ☑ Lane width
- ☑ Rejection capability

**FIGURE 1:** ECF With Advance Truck Turnaround

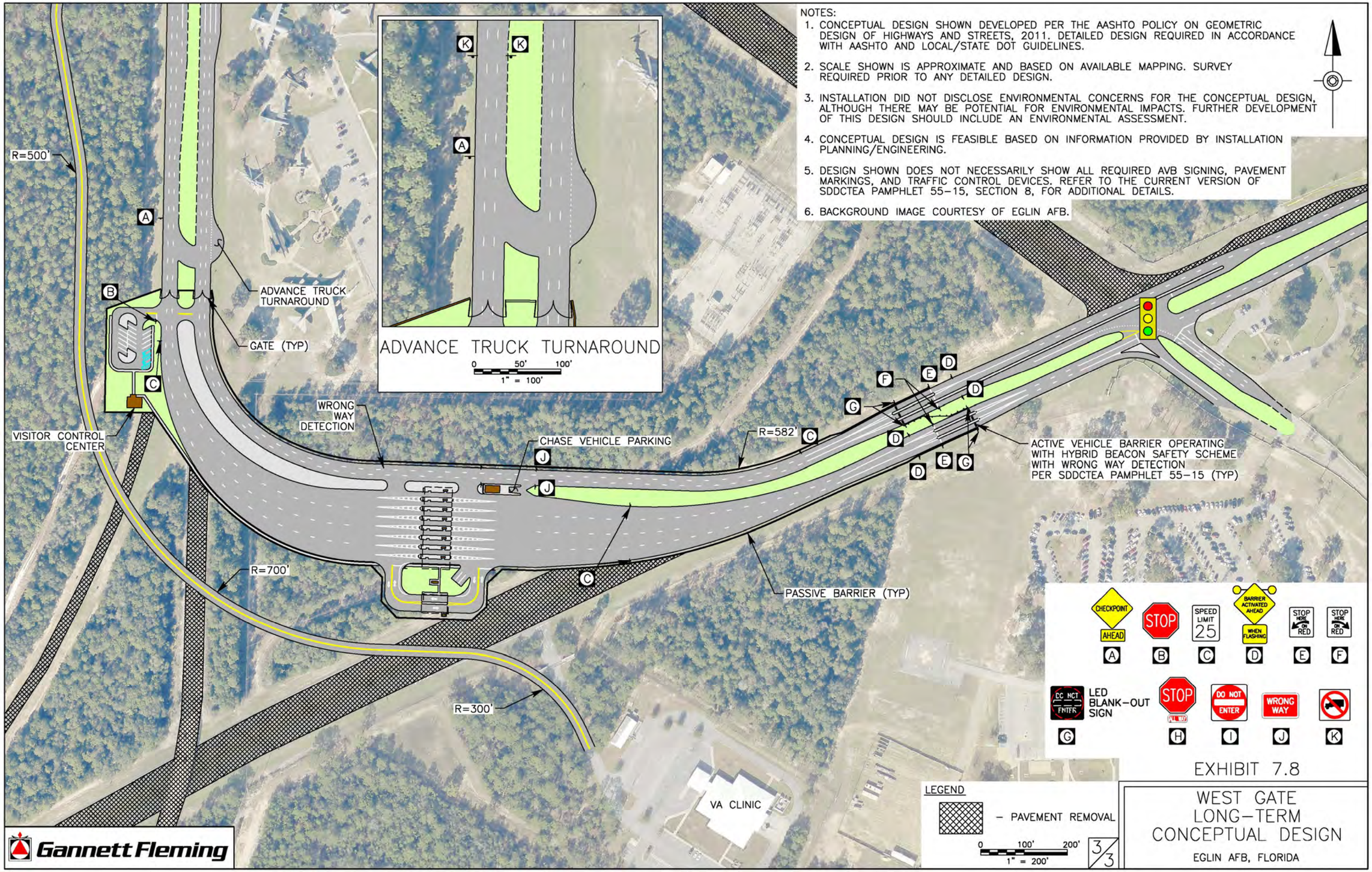


**FIGURE 2:** Example ECF Truck Signing for Truck Gate

**FIGURE 3:** Example ECF Truck Signing for Truck Restrictions During Certain Hours

Also, even though traffic volumes are significantly lower at night than during the day, truck inspections should not be conducted in the same lane as ID checks for POV traffic. This is so as not to unnecessarily delay POV traffic. The benefit to allowing trucks to be processed at night at another ECF is that trucks and deliveries are not delayed. If truck volumes are higher, such as exceeding 10 trucks per hour, the primary truck gate should be opened. If an alternate truck gate is in use, be sure that signing accurately represents where drivers are to go.

If truck access to the installation is not allowed when the truck gate is closed, there may be some latent demand. An installation should coordinate with their major carriers to minimize truck arrivals outside of gate operating hours. If trucks arrive during hours when the ECF is closed, they will often wait until the ECF is opened. There are several reasons why trucks may arrive during these hours:

- ☑ Traffic volumes are typically lighter during overnight hours.
- ☑ Long-haul truck drivers are limited with the number of hours they are able to drive and require periods of rest. They could arrive at the installation and then get some of their required rest.

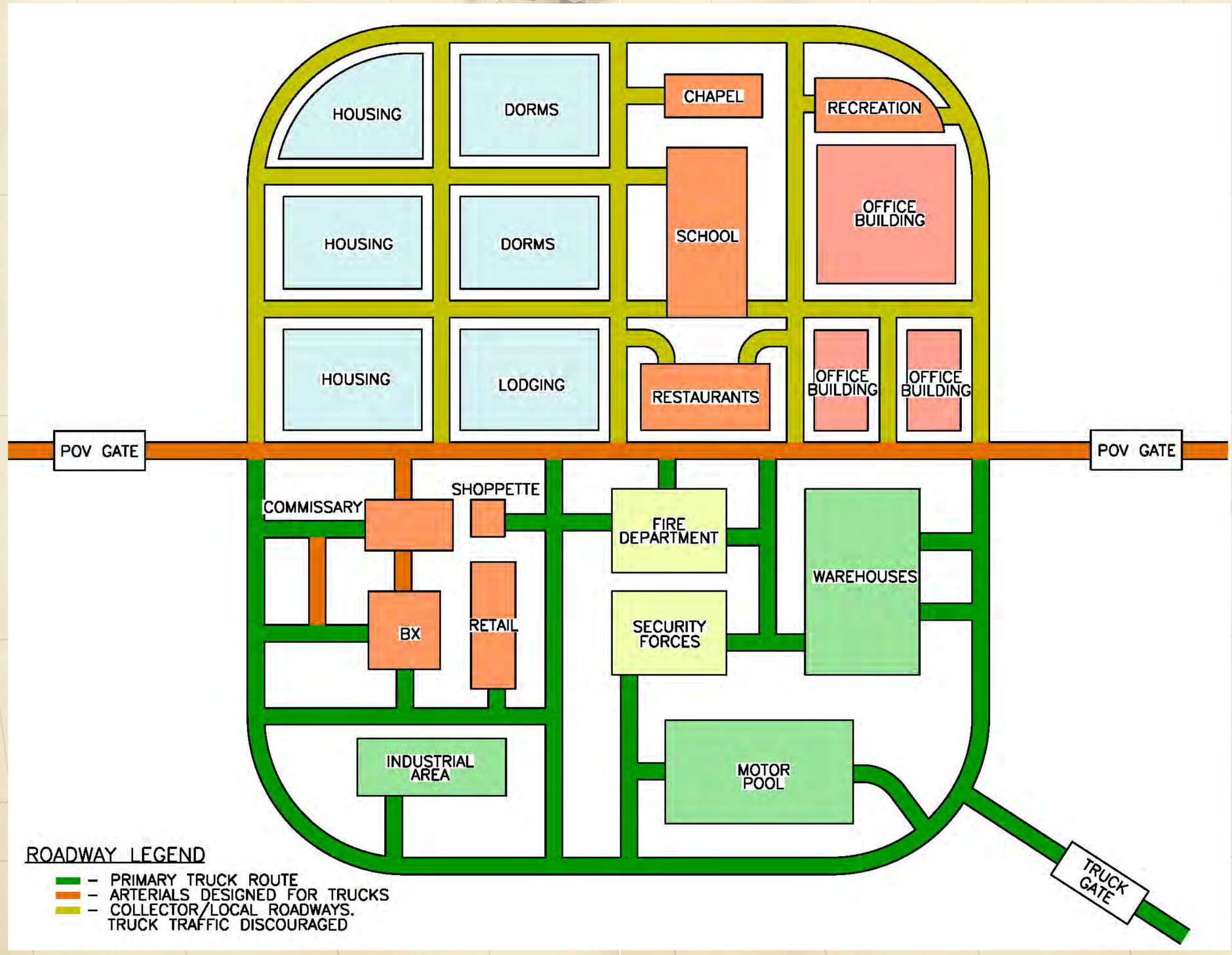
If trucks arrive during hours when the ECF is closed, they must wait somewhere. Queuing on public roadways is both a safety and security concern. With no designated queuing waiting area, trucks will stack up along the approach zone to the ECF. This may be sufficient in some cases, but if the queue extends to and beyond the intersection with the public roadway, other measures should be done to mitigate this condition. These may include:

- ☑ Adjusting the operating hours of the ECF to accommodate the demand. Simply opening the ECF earlier would accommodate the demand and minimize the queue by simply letting the trucks on the installation after processing.
- ☑ Relocate the fenceline to a location between the truck holding area and the truck inspection area. This would open the regular holding area up to be available to queuing during closed periods. There may be security concerns associated with moving the secured perimeter so close to the ECF, but this is a local assessment and decision.
- ☑ Building a holding area outside of the approach zone. If space allows, a holding area outside of the ECF area is desirable since it keeps queued trucks separate from the ECF area.
- ☑ Building a pull-off or turning lane adjacent to the public roadway. This lane would be located on the public roadway, next to the through lane. It would be preferred that this be a right-turn lane versus a left-turn lane to avoid trucks waiting in a median. If the roadway is owned by a state or local agency, they would likely need to take the lead on construction. This option is not as desirable since the trucks are not on installation property and are adjacent to through traffic travelling on the public roadway.
- ☑ Work with local officials to provide a truck holding somewhere in the community, perhaps between the installation and an adjacent interstate or other primary access route.

# On-Installation Truck Routes

Ideally, the route that trucks take through an installation to their destination should be through industrial areas of the installation, away from residential housing areas and school crossings. The truck gate could be located to support these ideals, but it is more important that it be located to provide proper access control away from busy areas of the installation. Figure 4 shows a notional figure for roadway hierarchy, and the designation for truck routes versus roadways not designated for trucks on an installation. The roadways are intended to separate truck traffic from primary POV traffic roadways.

**FIGURE 4:** Roadway Hierarchy Example

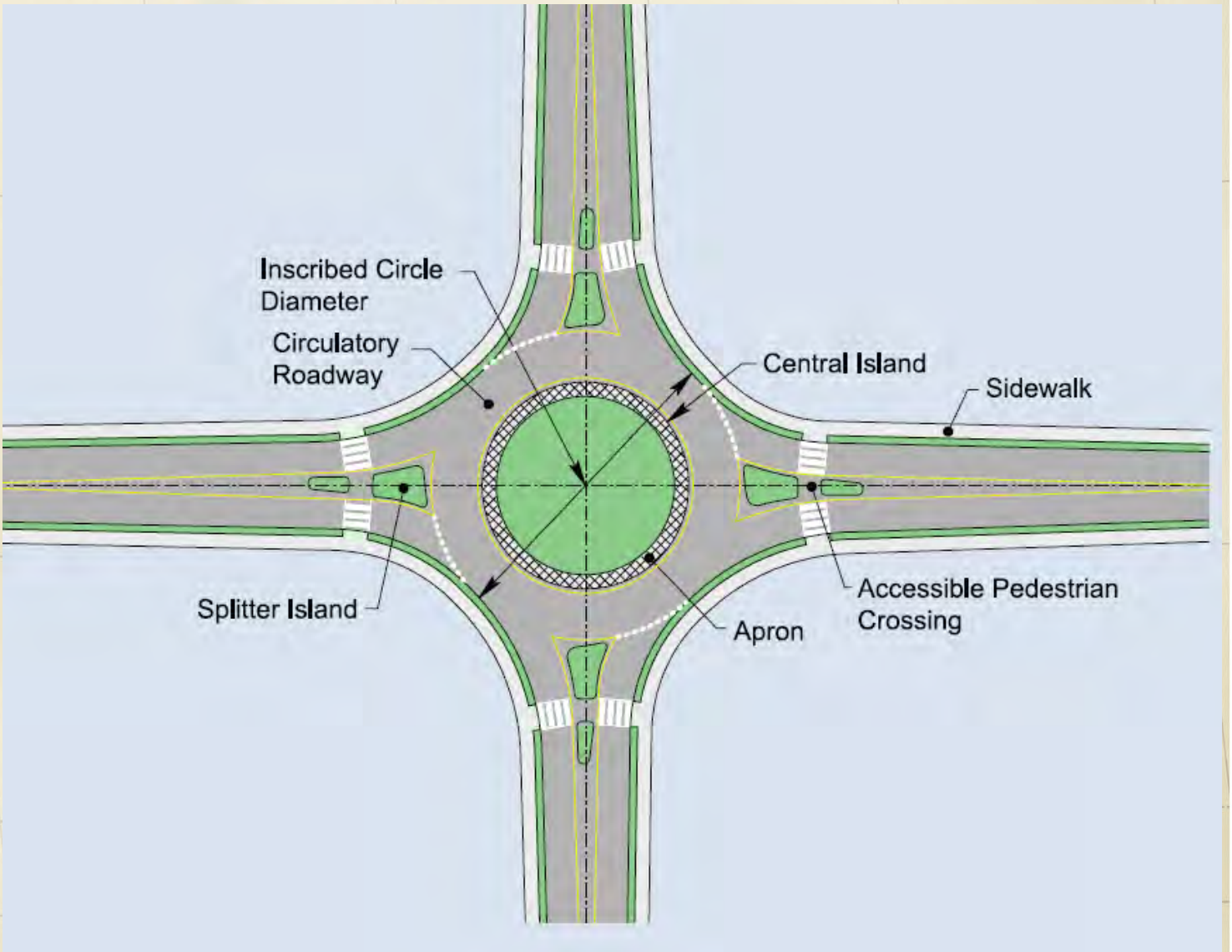


# Trucks at Roundabouts

The appropriate design vehicle for a roundabout is a critical design decision. In a roundabout design, trucks can be accommodated by using an apron on the outer portion of the central island. The apron is the outer portion of the central island that is designed for off-tracking of the rear wheels of trucks, buses and tractor trailers. While it must be able to physically accommodate these large vehicles, it should also be raised above the roadway and have a rough texture to discourage other vehicles from using it.

Figure 5 shows an example of a roundabout with the truck apron in the central island. Note that the apron size within the central island is determined by the design vehicle and size of the overall island.

**Figure 5: Key Roundabout Features**



# Loading Docks

Loading docks are provided for trucks to offload easily into a building that receives frequent shipments, which are often the common truck destinations on an installation. Loading docks typically are built at the same level as the truck trailer's floor such that a forklift or other equipment can pass between the truck and the building while loading or unloading. Loading docks are typically used at exchanges, commissaries, and warehouses on installations.

When designing loading docks, consider the following:

- ☑ Trucks should be permitted to drive in rather than back in. Straight-through, "Y" or angle approaches should be considered depending on traffic volume estimates. Service roads for one-way truck traffic should be a minimum of 14-feet wide, or for two-way traffic no less than 26-feet wide. If pedestrians are to be accommodated, there should be an additional 5-foot wide sidewalk or 10-foot wide shared-use path separated from the roadway as far as practical.
- ☑ The design of approach roadways should also allow for counterclockwise traffic circulation since it is easier for drivers to make left-hand turns and to back trailers into a dock from this position.
- ☑ The configuration of the area required to maneuver and position trailers from the approach roadway to the dock is called the apron space. Consider the trailer movement and the amount of room it takes for the trailer to maneuver when planning apron space. Traffic flow and vehicle length are key factors for consideration. As an example, a truck with an overall length of 65 feet requires a minimum apron space of 135 feet.
- ☑ If the area is to be surfaced with asphalt, a concrete landing strip, or parking space for the truck at the dock, must be provided. In warm temperatures, the landing strip will prevent the trailer's landing gear from sinking into the asphalt when parked at the dock. The typical position of semi-truck landing gear is 120 inches behind the nose of the trailer. Gravel-covered apron space should be avoided because it creates uneven and unsafe conditions.
- ☑ Unless docks are designed to handle peak loads, provisions must be made for a truck waiting area. This should be placed so that the trucks in this area do not interfere with trucks maneuvering into or pulling away from the dock.
- ☑ To the extent possible, it is preferable to separate driveways for trucks from vehicular traffic. This eliminates conflicts between trucks that often travel slowly and require more space to navigate and cars which can maneuver faster and often have frequent travel.
- ☑ Route trucks such that they do not travel between the parking lot for patrons and the front doorway to the building. This eliminates unnecessary pedestrian conflicts with trucks.

Shoppettes also receive frequent truck deliveries. Fuel trucks and normal deliveries of goods are common. Larger shoppettes could have a loading dock, but it may be more practical to design the building without one. In this case, the truck would be offloaded using a ramp from the back and brought in the building by a back door. Fuel deliveries must be provided to the location where the underground fuel tanks are located. These are frequently underground in front of the building, near the fuel pumps. Locations are often in conflict with vehicular access to the fuel pumps. Therefore, fuel truck deliveries conflicting with automobile traffic are unavoidable.

Mr. Bruce A. Busler, SES
Director, Transportation Engineering Agency

# Contact Us


**MILITARY SURFACE DEPLOYMENT AND DISTRIBUTION COMMAND**
**TRANSPORTATION ENGINEERING AGENCY (SDDCTEA)**
1 Soldier Way
Scott Air Force Base, Illinois
62225-5006

**DSN:** 770-5218

**FAX:** 618-220-5125

**EMAIL:** army.sddc.safb.traffic@mail.mil

**WEBSITE:** http://www.sddc.army.mil/sites/tea
for pamphlets, bulletins and studies


# Reference List


- ☑ TEA Home: http://www.sddc.army.mil/sites/tea
- ☑ SDDCTEA Pamphlet 55-15: *Traffic and Safety Engineering for Better Entry Control Facilities*: https://www.sddc.army.mil/sites/TEA/Functions/SpecialAssistant/TrafficEngineeringBranch/Pages/default.aspx, 2019
- ☑ SDDCTEA Pamphlet 55-17: *Better Military Traffic Engineering*: https://www.sddc.army.mil/sites/TEA/Functions/SpecialAssistant/TrafficEngineeringBranch/Pages/default.aspx, 2016
- ☑ AASHTO Policy for the Geometric Design of Highways and Streets, 2011
- ☑ Roundabouts: An Informational Guide, Second Edition [published as TRB's National Cooperative Highway Research Program (NCHRP) Report 672], 2010.
- ☑ Unified Facilities Criteria 4-022-01: *Entry Control Facilities/Access Control Points.* https://www.wbdg.org/ffc/dod/unified-facilities-criteria-ufc
- ☑ https://www.beatonindustrial.com/loading-dock-equipment/loading-dock-planning-and-design/