



# Intersection Design Vehicle

AASHTO design vehicles are typically used to design intersections. The turning characteristics of a design vehicle affect intersection features, such as pavement edge returns, channelization islands, and ultimately the size of the intersection.

## Design Vehicle Selection

The selected design vehicle should represent the largest vehicle to make frequent turns at an intersection. Using an incorrect design vehicle may result in either:

- A large intersection which requires additional right of way and increases pedestrian crossing times, or
- A small intersection area which may result in continuous maintenance from edge rutting and could restrict freight movements.

**Quick Tips:**

- Refer to Table 1 for the selection of intersection design vehicles.
- Oversized/overweight design vehicles should be considered on freight routes.
- Intersection geometry should not restrict vehicles for completing turning maneuvers.

The recommended design vehicles, based upon the functional classification of the intersecting roadways, are listed in Table 1. These design vehicles can be used for new or reconstructed intersections.

**Table 1: Guidance for the selection of intersection design vehicle.**

from	onto	design vehicle
freeway ramps	other facilities	WB-67 (Interstate semitrailer)
other facilities	freeway ramps	
state highways	state highways	WB-67
collectors ADT ≥ 400		WB-67
collectors ADT < 400		S-Bus-36 (conventional school bus)
local (gravel roads)		

Smaller design vehicles than those listed in Table 1 may be appropriate at some locations. Conditions that may justify a smaller design vehicle include:

- Right of way impacts.
- Turning truck traffic is minimal, e.g. intersections that do not serve businesses with large vehicles.
- Cross street traffic volumes are minimal (design year volumes < 400 vpd).
- Cross street is unlikely to be used as a detour route.

**Note:** If a smaller design is selected, the designer should still verify that the recommended design vehicle can still make the turn by encroaching onto other lanes if necessary.

Larger design vehicles (oversized/overweight vehicles) may also be appropriate at some locations. Conditions that may justify a larger design vehicle include:

- Intersections near industrial areas.
- Intersections near areas where freight is transferred from rail to truck.

The minimum design vehicle for intersections with state highways and local (county) rural roads should be a conventional school bus (S-BUS-36). A school bus is also appropriate for intersections with urban streets.

AASHTO recreational vehicles can be used for entrances to parks. Select a design vehicle that reflects the park's attractions (e.g. motor home sites, lakes, etc.).

Urban intersections that serve commercial and industrial areas where factories and businesses with frequent truck deliveries are located should be designed with a WB-67.

## Turning Radius

For intersection design, the most important attribute of a design vehicle is the turning radius. The turning radius affects turning characteristics, and ultimately the size of an intersection. The turning radius affects the speed of a turning maneuver. A tight turning radius will cause a slow turning maneuver and create the most off-tracking for a semi-truck.

### Definitions

**Centerline Turning Radius** – The turning radius of the centerline of the front axle of a vehicle with its steering wheels at the steering lock position.

**Note:** The center turning radius is the radius used in AUTOTURN for the vehicle path.

**Turning Radius** – The circular arc formed by the turning path radius of the front outside tire of a vehicle. The turning radius approximately equals the centerline turning radius plus one-half the design vehicle width.

**Off-tracking** - The difference in the paths of the front and rear wheels of a tractor/semitrailer as it negotiates a turn. The path of the rear tires of a turning truck does not coincide with that of the front tires.

(Reference: Section 2.1.2 AASHTO Greenbook, 2011)

### Center Turning Radius

Table 2 contains minimum center turning radii for several common design vehicles.

**Table 2: Minimum center turning radii for common design vehicles.**

design vehicle	minimum center turning radius (feet)
interstate semitrailer (WB-67)	41
single-unit truck (SU-30)	38
conventional school bus (S-Bus-36)	35
passenger car (P)	21
Reference: Table 2-2b AASHTO Greenbook, 2011	

### Urban Intersections

In urban areas, minimum center turning radii can be used for both left and right turns, since the turning speed is usually less than 10 mph. The minimum radius keeps the intersection geometry as tight as possible. Small intersections will reduce right-of-way impacts and shorten pedestrian crossing times.

### Rural Intersections

For rural intersections designed for semi-trucks, a larger center turning radius is needed to develop space for a stop sign island. A center turning radius of approximately 100 feet is usually sufficient to accommodate the dimensions of the island.

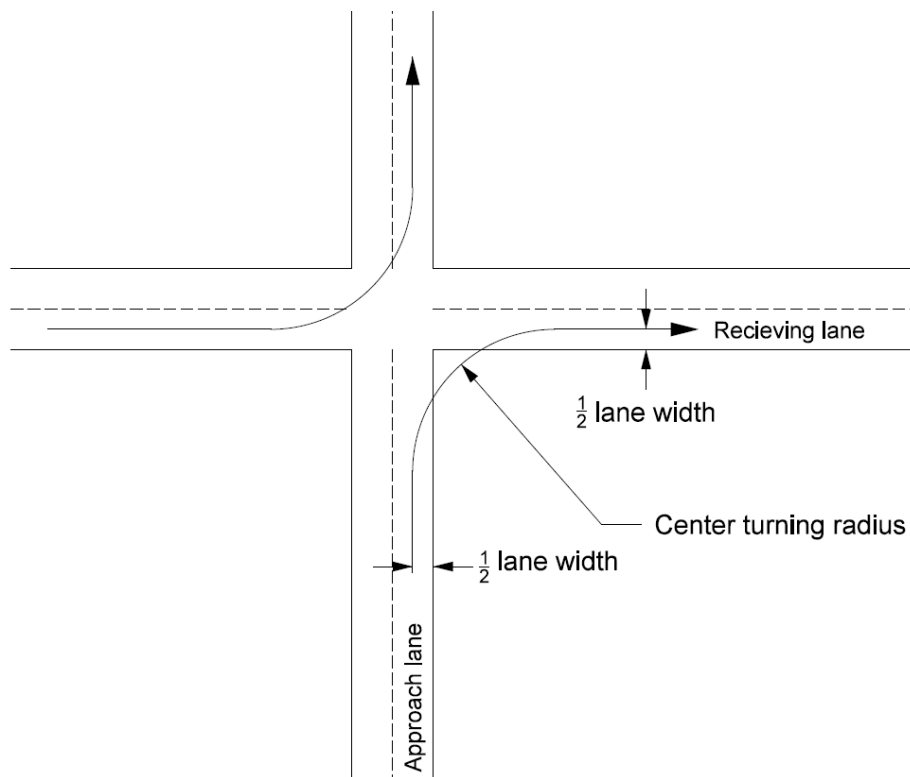
For rural intersection, a center turning radius of 50 feet is sufficient to provide intersection geometry that better reflects driver performance.

### Skewed Intersections

For skewed intersections, the center turning radius may need to be increased or decreased to develop a stop sign island.

## Turning Movements

Turning movements at most intersections are made from the approach lane into the near lane (receiving lane), see Figure 1. This turning movement is made without encroaching into other lanes. This type of movement is desirable because lane encroachments can increase operational delays or cause collisions.

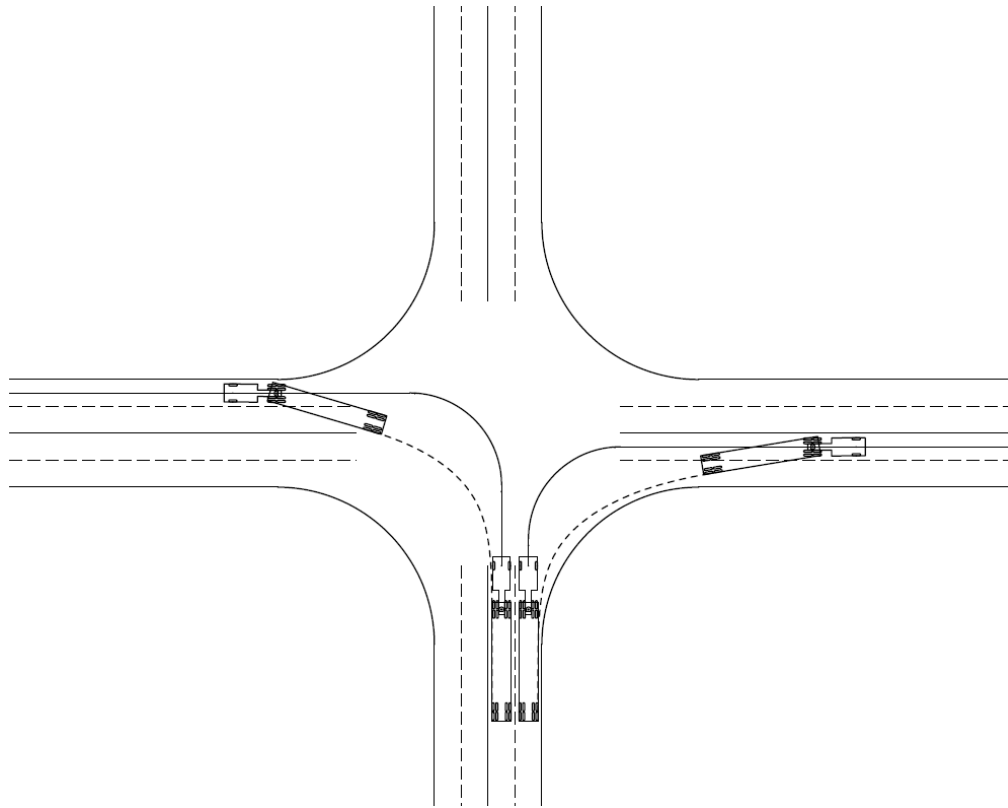


**Figure 1:** Illustration showing a typical turning movement for intersection design

Designers will need to test intersection geometry for intersections designed with a smaller design vehicle than listed in Table 1 to assure the geometry does not restrict turning movements of a semi-truck. To test the geometry, the turning movement will need to encroach into other lanes.

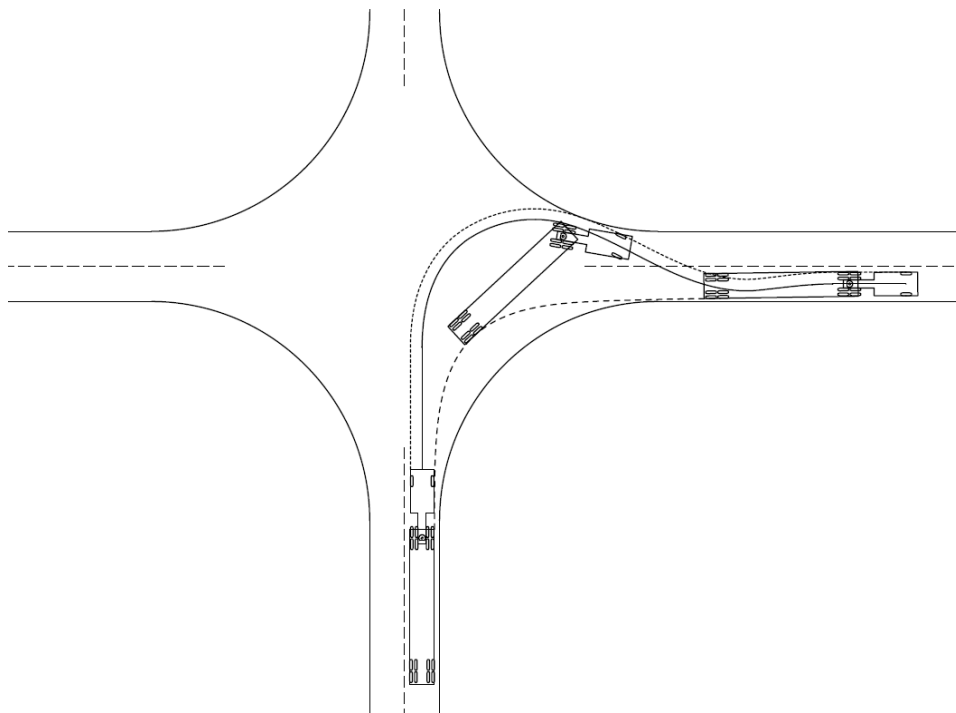
The designer should consider the following when designing an intersection that will need to have semi-trucks encroach into other lanes:

- Desirably, no encroachment should be allowed for a right turn from a road onto a state highway.
- At multilane lane signalized intersections, the semi-trailer can turn into the far lane, see Figure 2.



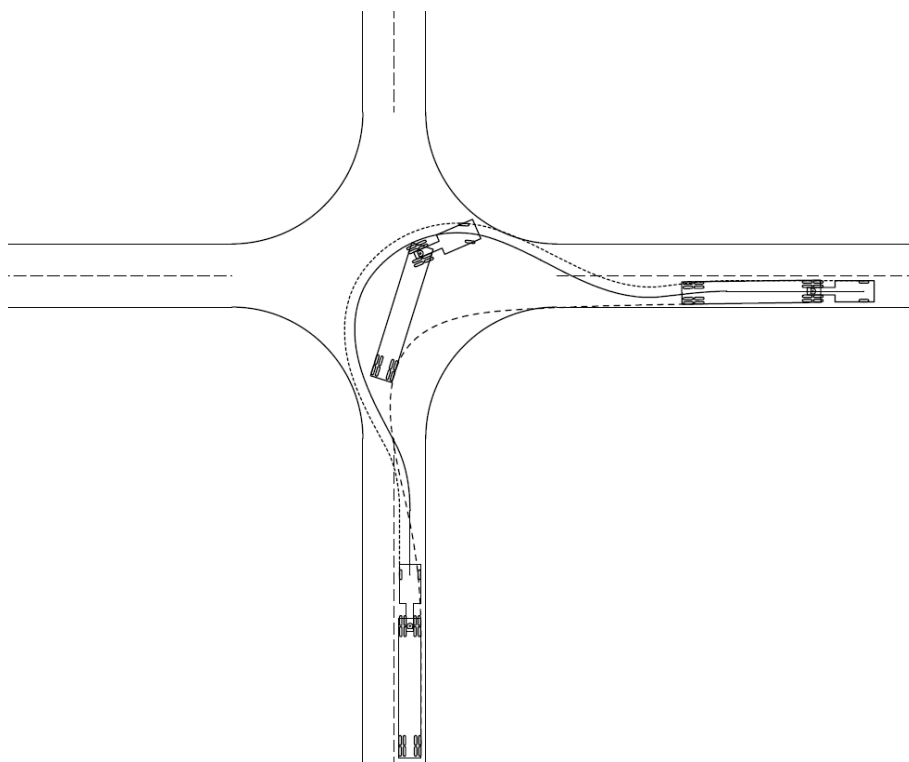
**Figure 2:** Illustration showing turning movements with encroachment into far lane.

- Right turns from a state highway onto to a local road or a roadway with minor truck volumes, the semi-trailer may encroach into the opposing lane on the receiving leg, see Figure 3.



**Figure 3:** Illustration showing turning movement with encroachment into opposing lane.

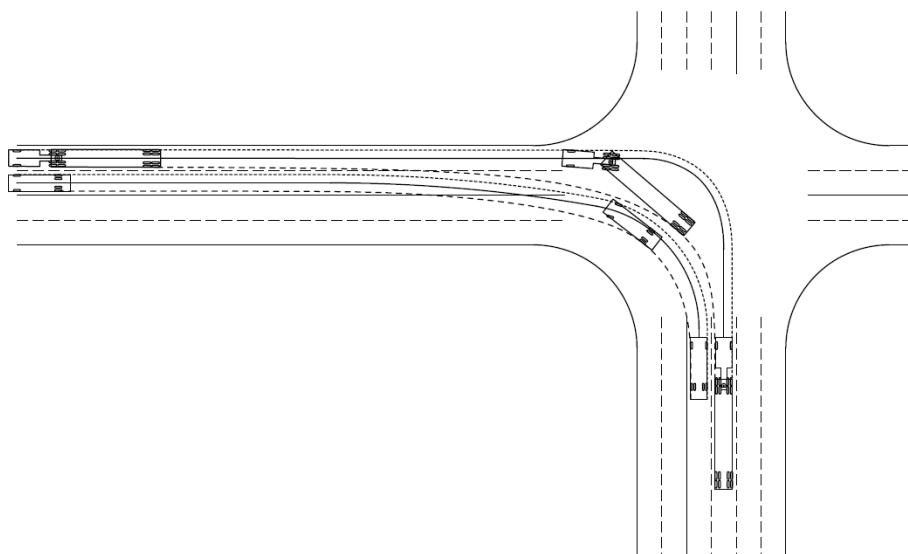
- On low volume roads in areas with restricted right of way, the semi-trailer may encroach into an opposing lane on the approach leg and into an opposing leg on the receiving leg, see Figure 4.



**Figure 4:** Illustration showing turning movement with encroachment into an opposing lane on the approach leg and on the receiving lane.

### Dual Turning Movements

A well-designed dual turn movement provides adequate space for vehicles to turn side by side. A poorly designed dual movement does not provide adequate space and vehicles on the inside of the turn become trapped, see Figure 5.



**Figure 5:** Illustration showing dual turning movements.

The following guidance can be used to design dual turning movements.

- Use a semi-trailer for the outside turn.
- Use a single unit design vehicle for the inside turn.

- Use the minimum center turning radius for the semi-trailer.
- To develop the turning the path of the vehicle on the inside:
  - Use the rear wheel path of the semi-trailer.
  - Offset the rear wheel path by 7 feet. Seven feet comes from providing 3 feet of clearance between the turning vehicles plus 4 feet to account for one-half the width of a single unit design vehicle.

## Oversized Vehicles

By definition, an oversized vehicle is a vehicle, or load on a vehicle, which exceeds an applicable length, height, width, or weight limit, and which cannot be reasonably separated into smaller loads.

The operator of an oversized vehicle must acquire a permit which limits their activity to an approved haul route. Permits for oversized loads are issued by the Department of Motor Vehicles (DMV) for the primary highway system, and by local agencies for other highways in Iowa.

## Designing for Oversized Vehicles

It is best to identify any needs for oversized vehicles during the planning phases of a project. This would be during the planning study for corridor projects, or during the concept development phase for other projects. District Offices review applications for oversize vehicle permits and often have a good working knowledge of which routes are frequently used by oversized vehicles. If necessary, the DMV can provide information about routes which are frequently used by oversized vehicles.

Checking into oversized vehicles is a significant step that is often overlooked on projects. Most projects have little need to accommodate oversized vehicles; however, some projects have a severe impact on hauling large loads through a region of our state. Many routes cannot be used by oversized vehicles because of pavement or bridge embargos, clearance issues, or restrictive geometry. Understanding how we are impacting these users of the highway system is imperative. A project that makes it difficult to route oversized vehicles is possible, but may require improvements on other parts of the system to lift restrictions and make the routes accessible.

Design intersections frequently used by oversized vehicles to allow them to navigate the intersection. The corner radii should be designed to allow an oversized vehicle to use all of the available roadway width on the approach and receiving legs of the intersection. Oversized vehicles are permitted to use lanes in the opposing travel direction and off-track onto a full depth paved shoulder to complete a turn. Shoulders other than full depth paved are not recommended to be used frequently by an oversized vehicle.

Other physical features of an intersection such as light poles, signs, and especially curbs and raised islands create problems for a turning an oversized vehicle. These intersections should be designed with painted islands and smaller curbs (3 inch curbs are recommended). Designers should work with the Office of Traffic and Safety and the District office to locate other vertical objects near the intersection.

Contact the Geometrics Engineer for information regarding oversized design vehicles.

## Analyzing Existing Routes for Oversize Vehicle Permits

As part of the oversized vehicle permitting process, a District Office may contact the Office of Design to develop turning paths at intersections along the haul route. The intent is to determine if any physical features need to be modified, adjusted or relocated to allow the load move through the intersections.

The designer should request a copy of the Heavy Load Permit application or a detailed sketch of the oversized vehicle, from the District Office. The detailed sketch needs to include the distance between each axle, the location of the pivot point from an axle, the width of the component, and the width of the tire group.

The intersection geometry can be provided by the District Office, or recreated from as-built plans. All the physical features of the intersection need to be shown to accurately identify any potential conflicts. District field staff will need to provide the Designer locations of the physical features near the intersection.

# Chronology of Changes to Design Manual Section:

## 006A-002 Intersection Design Vehicle

1/15/2014	NEW
	New