

Chapter Thirty-one
BASIC DESIGN CONTROLS

BUREAU OF DESIGN AND ENVIRONMENT MANUAL

Chapter Thirty-one
BASIC DESIGN CONTROLS

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Chapter Thirty-one

BASIC DESIGN CONTROLS

Road design is predicated on many basic controls that establish the overall objective of the highway facility and identify the basic purpose of the highway project. Chapter 31, in combination with Chapter 43, presents those basic controls that impact road design. Chapter 31 includes a discussion on speed, sight distance, traffic volume controls, non-highway controls (e.g., the driver), project scope of work, and the design exception process. The application of these items to a project will impact all elements of road design.

31-1 DEFINITIONS

31-1.01 Qualifying Words

Many qualifying words are used in road design and in this *Manual*. For consistency and uniformity in the application of various design criteria, the following definitions apply:

1. Shall, require, will, must. A mandatory condition. Designers are obligated to adhere to the criteria and applications presented in this context or to perform the evaluation indicated. For the application of geometric design criteria, this *Manual* limits the use of these words.
2. Should, recommend. An advisory condition. Designers are strongly encouraged to follow the criteria and guidance presented in this context, unless there is reasonable justification not to do so.
3. May, could, can, suggest, consider. A permissive condition. Designers are allowed to apply individual judgment and discretion to the criteria when presented in this context. The decision will be based on a case-by-case assessment.
4. Desirable, preferred. An indication that the designer should make every reasonable effort to meet the criteria and that the designer should only use a “lesser” design after due consideration of the “better” design.
5. Ideal. Indicating a standard of perfection (e.g., traffic capacity under “ideal” conditions).
6. Minimum, maximum, upper, lower (limits). Representative of generally accepted limits within the design community but not necessarily suggesting that these limits are inviolable. However, where the criteria presented in this context will not be met, the designer will in many cases need approval.
7. Practical, feasible, cost-effective, reasonable. Advising the designer that the decision to apply the design criteria should be based on a subjective analysis of the anticipated

- benefits and costs associated with the impacts of the decision. No formal analysis (e.g., cost-effectiveness analysis) is intended, unless otherwise stated.
8. Possible. Indicating that which can be accomplished. Because of its rather restrictive implication, this word is rarely used in this *Manual* for the application of design criteria.
 9. Significant, major. Indicating that the consequences from a given action are obvious to most observers and, in many cases, can be readily measured.
 10. Insignificant, minor. Indicating that the consequences from a given action are relatively small and not an important factor in the decision-making for road design.
 11. Warranted, justified. Indicating that some well-accepted threshold or set of conditions has been met. As used in this *Manual*, “warranted” or “justified” may apply to either objective or subjective evaluations. Note that, once the warranting threshold has been met, this is an indication that the design treatment should be considered and evaluated – not that the design treatment is automatically required.
 12. Standard. Indicating a design value that cannot be violated without severe consequences. This suggestion is generally inconsistent with geometric design criteria. Therefore, “standard” will not be used in this *Manual* to apply to geometric design criteria.
 13. Guideline. Indicating a design value that establishes an approximate threshold which should be met if considered practical.
 14. Criteria. A term typically used to apply to design values, usually with no suggestion on the criticality of the design value. Because of its basically neutral implication, this *Manual* frequently uses “criteria” to refer to the design values presented.
 15. Typical. Indicating a design practice that is most often used in application and which is likely to be the “best” treatment at a given site.
 16. Target. If practical, criteria the designer should be striving to meet. However, not meeting these criteria will typically not require a justification.
 17. Acceptable. Design criteria that may not meet desirable values, but yet is considered to be reasonable and safe for design purposes.
 18. Policy. Indicating IDOT practice which the Department generally expects the designer to follow, unless otherwise justified.

31-1.02 Acronyms

The following are acronyms for common terminology, agencies, and publications used in road design:

- AASHTO. American Association of State Highway and Transportation Officials.
- ADA. Americans with Disabilities Act.
- CFR. Code of Federal Regulations.
- FAHP. Federal-aid Highway Program.
- FAST. *Fixing America's Surface Transportation Act* of 2015.
- FEMA. Federal Emergency Management Agency.
- FHWA. Federal Highway Administration.
- HCM. *Highway Capacity Manual*.
- HSM. Highway Safety Manual.
- IDOT. Illinois Department of Transportation.
- ITE. Institute of Transportation Engineers.
- ISTEA. *Intermodal Surface Transportation Efficiency Act* of 1991.
- LOS. Level of Service.
- MAP – 21. *Moving Ahead for Progress in the 21st Century Act* of 2012.
- MASH. *Manual for Addressing Safety Hardware*.
- MUTCD. *Manual of Uniform Traffic Control Devices*.
- NCHRP. National Cooperative Highway Research Program.
- NHS. National Highway System.
- PS&E. Plans, Specifications & Estimates.
- SAFETEA-LU. *Safe, Accountable, Flexible, Efficient Transportation Equity Act — Legacy for Users* of 2005.
- STP. Surface Transportation Program.
- TEA-21. *Transportation Equity Act* for the 21st Century of 1998.

- TRB. Transportation Research Board.
- TRR. Transportation Research Record.
- USC. United States Code.
- USDOT. United States Department of Transportation.

31-2 SPEED

31-2.01 Definitions

1. Design Speed. Design speed is a selected speed used to determine the various geometric design features of the roadway. A design speed is selected for each project which will establish criteria for several design elements including horizontal and vertical curvature, superelevation, and sight distance. Section 31-2.02 discusses the selection of design speed.
2. Low Speed. For geometric design purposes, low speed is defined as 45 mph (70 km/h) or less.
3. High Speed. For geometric design purposes, high speed is defined as 50 mph (80 km/h) or greater.
4. Average Running Speed. Running speed is the average speed of a vehicle over a specified section of highway. It is equal to the distance traveled divided by the running time (the time the vehicle is in motion). The average running speed is the distance summation for all vehicles divided by the running time summation for all vehicles.
5. Average Travel Speed. Average travel speed is the distance summation for all vehicles divided by the total time summation for all vehicles. Note: Average running speed only includes the time the vehicle is in motion. Therefore, on uninterrupted flow facilities where travel is not congested, average running speed, and average travel speed are equal.
6. Operating Speed. Operating speed is the speed at which drivers are observed operating their vehicles during free-flow conditions. In practice, the term "operating speed" is commonly used to characterize prevailing vehicular speeds on a highway segment, either through field measurements of speed or through informal field observations. Although no precise percentile is used to define operating speed, it may be assumed to be between the 80th and 90th percentile of actual travel speeds.
7. 85th-Percentile Speed. The 85th-percentile speed is the speed below which 85 percent of vehicles travel on a given highway. The most common application of the value is its use as one of the factors for determining the posted, legal speed limit of a highway section. In most cases, field measurements for the 85th-percentile speed will be conducted during off-peak hours when drivers are free to select their desired speed.
8. Posted Speed Limit. The posted speed limit on State highways is typically based on traffic and engineering investigations, where statutory requirements do not apply. The district Bureau of Operations conducts traffic speed studies on the State highway system. The selection of a posted speed limit is based on several factors:

- the design speed used during project development;
- median type on multilane facilities;
- the 85th-percentile speed and pace speed;*
- highway functional classification and type of area;
- road surface characteristics, grade, alignment, and sight distance;
- type and density of roadside development;
- use of curb and gutter;
- the crash experience during the previous 12 months;
- the need for traffic signal progression; and
- parking practices and pedestrian and bicycle activity.

**Note: Pace speed is the specified increment of spot speed that includes the greatest number of speed measurements.*

9. Legal Speed Limit. Legal speed limits are those set by the Federal government or by the Illinois Statutes that will apply, for example, to those public roads that do not have a posted speed limit.

31-2.02 Design Speed Selection

A design speed is selected for each project, which will establish criteria for several geometric design elements including horizontal and vertical curvature, superelevation, cross sectional features, and sight distance. Part V, Highway Systems, presents the design speed criteria for new construction and reconstruction projects, 3R non-freeway projects, and 3R freeway projects. In general, the selected design speed is based on the following road design elements:

1. Functional Classification. The higher class facilities (i.e., arterials) are designed with a higher design speed than the lower class facilities (i.e., collectors and locals).
2. Urban/Rural. Design speeds in rural areas are generally higher than those in urban areas. This is consistent with the typically fewer constraints in rural areas (e.g., less development).
3. Terrain. The flatter the terrain, the higher the selected design speed can be. This is consistent with the typically higher construction costs associated with more rugged terrain.
4. Traffic Volumes. On some facilities (e.g., unmarked rural collectors), the design speed varies by traffic volumes; i.e., as traffic volumes increase, higher design speeds are used.

For geometric design application, the relationship between these road design elements and the selected design speed reflects general cost-effective considerations. For example, the higher the traffic volumes, the more benefits to the traveling public from a higher design speed.

In addition to the above, the selected design speed should equal or exceed the anticipated posted/regulatory speed limit of the facility after construction. This applies to all projects. For new construction/reconstruction projects, it is usually desirable practice to use a design speed 5 mph (10 km/h) over posted speed. For 3R, 3P, or SMART projects, the proposed design speed may be relaxed to equate the existing posted speed if practical. The posted speed limit on state highways will be determined based on actual operating speeds of the completed facility and on several factors not directly related to the project design speed. Therefore, to avoid a potential conflict, the designer should coordinate the design speed selection with the district Bureau of Operations early in project development to assist in predicting the posted speed limit of the completed facility. If the proposed design speed will be less than the predicted posted speed limit, the designer must choose one of the following approaches:

- increase the project design speed to equal the anticipated posted speed limit,
- post the project with a legal speed limit equal to the design speed, or
- seek a design exception.

In selecting a design speed, the designer should avoid artificially selecting a design speed low enough to eliminate any design exceptions. For example, if the IDOT criteria yield a design speed of 60 mph (100 km/h) and one or more geometric features are adequate only for 55 mph (90 km/h), the project design speed should be 60 mph (100 km/h) and not 55 mph (90 km/h). The designer will then be required to make project improvements to meet the specific geometric features for a 60 mph design speed or seek design exceptions for the specific 55 mph (90 km/h) geometric features, rather than requesting a single design exception for the 55 mph design speed.

31-3 SIGHT DISTANCE

31-3.01 Stopping Sight Distance

31-3.01(a) Theoretical Discussion (Passenger Cars)

Stopping sight distance (SSD) is the sum of the distance traveled during a driver's perception/reaction (or brake reaction) time and the distance traveled while decelerating to a stop. To calculate SSD, the following formulas are used:

$$\text{SSD} = 1.47 Vt + 1.075 \frac{V^2}{a} \quad (\text{US Customary}) \text{ Equation 31-3.1}$$

$$\text{SSD} = \frac{Vt}{3.6} + 0.039 \frac{V^2}{a} \quad (\text{Metric}) \text{ Equation 31-3.1}$$

where: SSD = stopping sight distance, ft (m)
 V = design speed, mph (km/h)
 t = brake reaction time, 2.5 seconds
 a = driver deceleration, ft/s² (m/s²)

For calculating adjusted SSD for downgrades, see Equation 31-3.2.

The following briefly discusses the theoretical rationale for each assumption within the SSD model for passenger cars:

1. Brake Reaction Time. This is the time interval between when the obstacle in the road can first be physically seen and when the driver first applies the brakes. Based on several studies of observed driver reactions, the assumed value is 2.5 seconds. This time is considered adequate for approximately 90% of drivers in simple to moderately complex highway environments.
2. Braking Action. The braking action is based on the driver's ability to decelerate the vehicle while staying within the travel lane and maintaining steering control during the braking maneuver. A deceleration rate of 11.2 ft/s² (3.4 m/s²) is considered comfortable for 90% of drivers for passenger cars.
3. Speed. The highway design speed is used to determine the initial driver speed.

AASHTO's *A Policy on Geometric Design of Highways and Streets* presents additional information on the assumptions used to develop the SSD model.

31-3.01(b) Passenger Cars (Level Grade)

Figure 31-3.A provides stopping sight distances for passenger cars on grades less than 3%. When applying the SSD values for passenger cars, the height of eye is assumed to be 3.5 ft (1080 mm) and the height of object 2 ft (600 mm). Except as noted in the following subsections, the SSD values in Figure 31-3.A apply to all projects.

US Customary					Metric				
Design Speed (mph)	Brake ¹ Reaction Distance (ft)	Braking ² Distance On Level (ft)	Stopping Sight Distance		Design Speed (km/h)	Brake ¹ Reaction Distance (m)	Braking ² Distance On Level (m)	Stopping Sight Distance	
			Calculated (ft)	Design (ft)				Calculated (m)	Design (m)
30	110.3	86.4	196.7	200	50	34.8	28.7	63.5	65
35	128.6	117.6	246.2	250	60	41.7	41.3	83.0	85
40	147.0	153.6	300.6	305	70	48.7	56.2	104.9	105
45	165.4	194.4	359.8	360	80	55.6	73.4	129.0	130
50	183.8	240.0	423.8	425	90	62.6	92.9	155.5	160
55	202.1	290.3	492.4	495	100	69.5	114.7	184.2	185
60	220.5	345.5	566.0	570	110	76.5	138.8	215.3	220
65	238.9	405.5	644.4	645	120	83.4	165.2	248.6	250
70	257.3	470.3	727.6	730					
75	275.6	539.9	815.5	820					

Notes:

1. Brake reaction distance based on a time of 2.5 s.
2. Driver deceleration based on a rate of 11.2 ft/s² (3.4 m/s²).

STOPPING SIGHT DISTANCE (Passenger Cars – Level Grade)

Figure 31-3.A

31-3.01(c) Trucks

The passenger SSD in Figure 31-3.A are not designed for truck operations. In general, trucks require longer SSD for a given speed than passenger vehicles. However, truck's higher height of eye (7.6 ft (2330 mm)) and driver experience tends to balance the need for additional stopping lengths for trucks than those for passenger cars (e.g., the truck driver can generally see further beyond a crest vertical curve). Consequently, separate truck SSD are generally not used in highway design. However, the designer should still consider providing longer SSD at the following sites:

- weigh stations;
- rest areas;
- in the vicinity of truck terminals;
- industrial parks;

- coal mining and quarry areas;
- where horizontal sight restrictions occur on downgrades;
- highway/railroad grade crossings on high-volume truck routes (e.g., truck DDHV of 250 or greater);
- other facilities with high truck traffic (e.g., routes with truck DDHV of 250 or greater); and
- locations that have a high incidence of truck crashes.

31-3.01(d) Downgrade-Adjusted SSD

The longitudinal gradient of the roadway impacts the distance needed for vehicles to brake to a stop. IDOT practice is to only consider the grade adjustment for downgrades, which increases braking distances. Equation 31-3.1 is modified as follows to calculate the adjusted SSD for downgrades:

$$\text{SSD} = 1.47Vt + \frac{V^2}{30 \left[\frac{a}{32.2} \pm G \right]} \quad (\text{US Customary}) \text{ Equation 31-3.2}$$

$$\text{SSD} = \frac{Vt}{3.6} + \frac{V^2}{254 \left[\frac{a}{9.81} \pm G \right]} \quad (\text{Metric}) \text{ Equation 31-3.2}$$

where: SSD = stopping sight distance, ft (m)
 V = design speed, mph (km/h)
 t = brake reaction time, typically 2.5 seconds
 a = driver deceleration, typically 11.2 ft/s² (3.4 m/s²)
 G = grade expressed as a decimal. Downgrades are expressed as a negative.

Figure 31-3.B presents the downgrade SSDs for passenger cars. The designer should make a reasonable effort to meet these SSD values when downgrades are 3% or steeper. However, the grade-adjusted SSD values do not require a design exception when not met.

31-3.02 Decision Sight Distance

31-3.02(a) Theoretical Discussion

At some sites, drivers may be required to make decisions where the highway environment is difficult to perceive or where unexpected maneuvers are required. These are areas of concentrated demand where the roadway elements, traffic volumes, and traffic control devices

US Customary									
SSD for Downgrades (ft)									
Design Speed (mph)	(3%)	(4%)	(5%)	(6%)	(7%)	(8%)	(9%)	(10%)	
30	205	210	215	215	220	225	230	235	
35	260	265	270	275	280	285	290	295	
40	315	325	330	335	340	350	355	365	
45	380	385	395	400	410	420	430	440	
50	450	455	465	475	485	495	510	525	
55	520	530	545	555	570	580	595	610	
60	600	615	625	640	655	670	690	705	
65	685	700	715	730	750	765	790	810	
70	775	790	810	825	850	870	895	920	
75	870	885	906	930	955	980	1005	1035	
Metric									
SSD for Downgrades (m)									
Design Speed (km/h)	(3%)	(4%)	(5%)	(6%)	(7%)	(8%)	(9%)	(10%)	
50	66	67	68	70	71	72	74	75	
60	87	88	90	92	93	95	97	100	
70	110	112	114	116	119	122	124	127	
80	136	138	141	144	147	151	154	158	
90	164	167	171	174	178	183	187	192	
100	194	198	203	207	212	218	223	230	
110	227	232	238	243	249	256	263	270	
120	263	268	275	281	288	296	304	313	

1. Calculated SSDs are not shown. Values in table have been determined by using Equation 31-3.2 and rounding up to the next highest 5 ft (1 m) increment.
2. For grades less than 3%, no adjustment is necessary; i.e., use the level SSD values (Figure 31-3.A).
3. For grades intermediate between table values, use a straight-line interpolation to determine the SSD or use Equation 31-3.2 and round up to the next highest 5 ft (1 m) increment.

**STOPPING SIGHT DISTANCE
(Passenger Cars — Adjusted for Downgrades)**

Figure 31-3.B

may all compete for the driver's attention. This relatively complex environment may increase the required driver perception/reaction time beyond that provided by the SSD values (2.5 seconds) and, in some locations, the desired vehicular maneuver may be a speed/path/direction change rather than a stop. At these locations, the designer should consider providing decision sight distance to provide an additional margin of safety. The various avoidance maneuvers assumed in the development of Figure 31-3.C are:

1. Avoidance Maneuver A. Stop on rural road.
2. Avoidance Maneuver B. Stop on urban road.
3. Avoidance Maneuver C. Speed/path/direction change on rural road.
4. Avoidance Maneuver D. Speed/path/direction change on suburban road.
5. Avoidance Maneuver E. Speed/path/direction change on urban road.

31-3.02(b) Applications

In general, the designer should consider using decision sight distance at any relatively complex location where the driver perception/reaction time may exceed 2.5 seconds. Example locations where decision sight distance may be appropriate include:

- freeway exit/entrance gores;
- freeway lane drops;
- freeway left-side entrances or exits;
- intersections near a horizontal curve;
- highway/railroad grade crossings;
- approaches to detours and lane closures;
- along high-speed, high-volume urban arterials with considerable roadside friction; or
- isolated traffic signals on high-speed rural highways.

As with SSD, the driver height of eye is 3.5 ft (1080 mm) and the height of object is typically 2 ft (600 mm). However, candidate sites for decision sight distance may also be candidate sites for assuming that the "object" is the pavement surface (e.g., freeway exit gores). Therefore, the designer may assume a 0.0 in (0.0 mm) height of object for application at some sites.

31-3.03 Passing Sight Distance

Passing sight distance only applies to two-lane, two-way highways. Therefore, its theoretical derivation and application are discussed in Chapter 47.

31-3.04 Intersection Sight Distance

Intersection sight distance applies to the determination of the sight triangle in the corners of at-grade intersections. Therefore, its theoretical derivation and application are discussed in Chapter 36.

US Customary					
Design Speed (mph)	Decision Sight Distance for Avoidance Maneuver (ft)				
	A	B	C	D	E
30	220	490	450	535	620
35	275	590	525	625	720
40	330	690	600	715	825
45	395	800	675	800	930
50	465	910	750	890	1030
55	535	1030	865	980	1135
60	610	1150	990	1125	1280
65	695	1275	1050	1220	1365
70	780	1410	1105	1275	1445
75	875	1545	1180	1365	1545
Metric					
Design Speed (km/h)	Decision Sight Distance for Avoidance Maneuver (m)				
	A	B	C	D	E
50	70	155	145	170	195
60	95	195	170	205	235
70	115	235	200	235	275
80	140	280	230	270	315
90	170	325	270	315	360
100	200	370	315	355	400
110	235	420	330	380	430
120	265	470	360	415	470

Note:

Avoidance Maneuver A: Stop on rural road.

Avoidance Maneuver B: Stop on urban road.

Avoidance Maneuver C: Speed/path/direction change on rural road.

Avoidance Maneuver D: Speed/path/direction change on suburban road.

Avoidance Maneuver E: Speed/path/direction change on urban road.

DECISION SIGHT DISTANCE

Figure 31-3.C

31-4 CAPACITY METHODOLOGY

31-4.01 Definitions

1. Actuated Control. A defined phase sequence in which the presentation of each phase is on recall or the associated traffic movement has submitted a call for service through a detector.
2. Annual Average Daily Traffic (AADT). The total yearly volume in both directions of travel divided by the number of days in a year.
3. Average Daily Traffic (ADT). The calculation of average traffic volumes in both directions of travel in a time period greater than one day and less than one year and divided by the number of days in that time period. Although not precisely correct, ADT is often used interchangeably with AADT. The use of an ADT could produce a bias because of seasonal peaks and, therefore, the user should be aware of this.
4. Back of Queue. The maximum backward extent of queued vehicles during a typical cycle, as measured from the stop line to the last queued vehicle.
5. Capacity. The maximum number of vehicles that can reasonably be expected to traverse a point or uniform section of a lane or roadway during a given time period under prevailing roadway, traffic, and traffic control conditions. The time period most often used for analysis is 15 minutes. "Capacity" corresponds to Level of Service E.
6. Cycle. A complete sequence of signal indications.
7. D-Factor. The portion of traffic moving in the peak direction of travel on a given roadway during the peak hour.
8. Delay. Additional travel time experienced by a driver, passenger, bicyclist, or pedestrian beyond that required to travel at the desired speed. The primary performance measure on interrupted flow facilities
9. Demand Flow Rate. The count of vehicles arriving at the system element during the analysis period, converted to an hourly rate. This manual uses the term design hourly volume (defined below) in a similar manner as demand flow rate.
10. Density. The number of vehicles occupying a given length of lane, averaged over time. It is usually expressed as vehicles per mile (kilometer) per lane.
11. Design Hourly Volume (DHV). The one-hour volume in both directions of travel in the design year selected for determining the dimensions and configuration of the highway design elements. For capacity analyses, the DHV is typically converted to an hourly flow rate based on the maximum 15-minute flow rate during the DHV. The term DHV is not used in the *Highway Capacity Manual*, but its utility is similar to how demand flow rate (defined above) is used.

12. Directional Design Hourly Volume (DDHV). The traffic volume in the peak direction of flow during the design hour.
13. Directional Distribution (D). A characteristic of traffic that volume may be greater in one direction than in the other during any particular hour on a highway.
14. 85th Percentile Speed. A speed value that is exceeded by 15% of the vehicles in a traffic stream.
15. Flow Rate. The equivalent hourly rate at which vehicles or other roadway users pass over a given point or section of a lane or roadway during a given time interval of less than one hour, usually 15 minutes.
16. Free Flow. A flow of traffic unaffected by upstream or downstream conditions.
17. Green Time (g/c) Ratio. The ratio of the effective green time of a phase to the cycle length.
18. Heavy Vehicles. A vehicle with more than four wheels touching the pavement during normal operation.
19. K-Factor. The portion of AADT that occurs during the peak hour. (DHV/AADT)
20. Lane Group. A lane or set of lanes designated for separate analysis.
21. Level of Service (LOS). A quantitative stratification of a performance measure or measures that represent quality of service, measured on an A to F scale, with LOS A representing the best operating conditions from the traveler's perspective and LOS F the worst.
22. Passenger-Car Equivalent. The number of passenger cars that will result in the same operational conditions as a single heavy vehicle of a particular type under specified roadway, traffic, and control conditions.
23. Peak Hour. The hour of the day in which the maximum volume occurs.
24. Peak-Hour Factor (PHF). A ratio of the volume occurring during the peak hour to the maximum rate of flow during a given time period within the peak hour (typically 15 minutes).
25. Pedestrian. An individual traveling on foot.
26. Permitted Turn. A left or right turn at a signalized intersection that is made by a vehicle during a time in the cycle in which the vehicle does not have the right-of-way.
27. Phase. The part of the signal cycle allocated to any combination of traffic movements receiving the right-of-way simultaneously during one or more intervals. A phase includes the green, yellow, and red clearance intervals.

28. Progression. The act of various controllers providing specific green indications in accordance with a time schedule to permit continuous operation of groups of vehicles along the street at a planned speed.
29. Protected Turn. The left or right turns at a signalized intersection that are made by a vehicle during a time in the cycle when the vehicle has the right-of-way.
30. Queue Storage Ratio. The maximum back of queue as a proportion of the available storage on the subject lane or link.
31. Red Clearance Interval. A brief period of time following the yellow indication during which the signal heads associated with the ending phase and all conflicting phases display a red indication.
32. Saturation Flow Rate. The equivalent hourly rate at which previously queued vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times are experienced.
33. Semi-Actuated Control. A signal control in which some approaches (typically on the minor street) have detectors and some approaches (typically on the major street) have no detectors.
34. Service Flow Rate. The maximum directional rate of flow that can be sustained in a given segment under prevailing roadway, traffic, and control conditions without violating the criteria for level of service.
35. Service Measure. A performance measure used to define LOS for a transportation system element.
36. Volume-to-Capacity (v/c) Ratio. The ratio of flow rate to capacity for a system element.
37. Weaving. The crossing of two or more traffic streams traveling in the same direction along a significant length of highway, without the aid of traffic control devices (except for guide signs).

31-4.02 Design Year Selection

31-4.02(a) Roadway Design

The geometric design of a highway should be developed to accommodate expected traffic volumes during the life of the facility assuming reasonable maintenance. This involves projecting the traffic volumes to a selected future year. Recommended design years are presented in Figure 31-4.A. The design year is measured from the expected construction completion date. Projected traffic volumes on State highways are provided by each district or from regional transportation studies with support from the OPP, Planning Services Section.

Project Scope Of Work	Typical
New Construction/Reconstruction	20 Years
3R Freeway Projects	Current*
3R Non-Freeway Projects	Current*

* *In general, current traffic volumes may be used. However, if a 3R project will introduce a new geometric design element (e.g., relocation of a horizontal curve), the element should be designed based on reconstruction policies.*

RECOMMENDED DESIGN YEAR SELECTION (Traffic Volumes for Road Design)

Figure 31-4.A

31-4.02(b) Other Highway Elements

The following presents the recommended criteria for selection of a design year for highway elements other than road design:

1. **Bridges.** The structural life of a bridge may be 75 years or more. For new bridges, bridge replacement, and bridge reconstruction, the clear roadway width of the bridge will be based on the 20-year traffic volume projection beyond the construction completion date. In addition, the designer may, on selected projects, evaluate if the bridge design will reasonably accommodate structural expansion to meet the clear roadway width across the bridge based on a traffic volume projection beyond 20 years.

For bridges within the limits of 3R projects, see Chapters 49 and 50.

2. **Underpasses.** The design year used for the geometric design of underpasses will be determined on a case-by-case basis.
3. **Right-of-Way/Grading.** The designer may consider potential right-of-way needs for the anticipated long-term corridor growth for a year considerably beyond that used for roadway design, especially in large metropolitan areas. No specific design year is recommended for use. For example, when selecting an initial median width on a divided highway, the designer may evaluate the potential need for future expansion of the facility to add through travel lanes. Other examples include potential future interchanges, potential reconstruction of a two-lane, two-way facility to a multilane highway, and the use of flatter side slopes to provide more future options.
4. **Drainage Design.** Drainage appurtenances are designed to accommodate a flow rate based on a specific design year (or frequency of occurrence). The selected design year or frequency will be based on the functional class of the facility, the ADT, and the

specific drainage appurtenance (e.g., culvert). The IDOT *Drainage Manual* presents the Department's criteria for selecting the frequency of occurrence. The design life of new drainage structures is typically 50 years.

5. Pavement Design. The pavement structure is designed to withstand the vehicular loads during the design analysis period without falling below a selected pavement serviceability rating. Chapter 54 presents the Department's criteria for selecting a design year for pavements.
6. Environmental Analyses. Some environmental analyses require the selection of a future year for design (e.g., noise analyses). BDE determines the specific criteria for environmental analyses.

31-4.03 Design Hourly Volume Selection

For most geometric design elements that are determined by traffic volumes, the peaking characteristics are most significant. The highway facility should be able to accommodate the design hourly volume (adjusted for the peak-hour factor) at the selected level of service. This design hourly volume (DHV) will affect many design elements including the number of through travel lanes, lane and shoulder widths, and intersection geometrics. The designer should also analyze the proposed design using the a.m. and p.m. DHV's separately. This could have an impact on the geometric design of the highway. The *Highway Capacity Manual* uses the term demand flow rate similarly as design hourly volume.

Traditionally, the 30th highest hourly volume in the selected design year has been used to determine the DHV for design purposes. This is still considered appropriate for rural facilities. However, at the discretion of the district, for urban facilities it may be more appropriate to base the DHV on the 10th to 20th highest hourly volume in the selected design year. Because the design of the project is significantly dependent upon the projected design hourly volumes, these projections must be carefully examined before using for design purposes.

31-4.04 Level of Service

Level of service (LOS) describes a quantitative stratification of a performance measure or measures that represent quality of service, measured on an A to F scale. A designated LOS is described in terms of service measures such as speed, density, delay, or percent time-spent-following.

Because drivers will accept different driving operational conditions, including lower travel speeds on different facilities, it is not practical to establish one level of service for application to every type of highway. Therefore, various levels of service have been established for the different types of highways facilities, location (i.e., rural or urban) and the scope of the improvement.

Part V, Highway Systems, presents LOS criteria for each highway type.

31-4.05 Capacity Analyses

31-4.05(a) Objective

The highway mainline, intersection, or interchange should be designed to accommodate the design hourly volume (DHV) at the selected level of service (LOS). The methodologies in the *Highway Capacity Manual* (HCM) uses the DHV, or demand flow rate, and the various highway factors which affect capacity to determine the LOS.

The maximum directional rate of flow that can be sustained in a given segment for a selected LOS, the definition for service flow rate, should be accommodated by adjusting the various highway factors which affect capacity until a suitable design is determined. The service flow rate of the facility is calculated by applying adjustments such as heavy vehicles and driver population to a base flow rate. By definition, the service flow rate for LOS E is synonymous with capacity for all uninterrupted-flow facilities and their components.

The HCM has established service measures to determine the level of service for various highway elements on different types of highway facilities. These are presented in Figure 31-4.B. For each service measure, the HCM will provide the analytical tools to calculate the numerical value. The designer should note that highway capacity service measures are segregated into two broad categories: (1) uninterrupted flow, or open highway conditions, which occurs on facilities that have no fixed causes of delay or interruption external to the traffic stream such as the influence of an intersection, and (2) interrupted flow which occur on facilities characterized by traffic signals, STOP signs, YIELD signs or other fixed causes of periodic delay or interruption to the traffic stream.

The following presents the simplified procedure for conducting a capacity analysis for the highway mainline:

1. Select the design year (Section 31-4.02).
2. Determine the DHV (Section 31-4.03).
3. Select the design LOS (see Part V, Highway Systems).
4. Document the proposed highway geometric design (lane width, length of weaving section, number and width of approach lanes at intersections, etc.).
5. Using the HCM, analyze the capacity of the highway element for the proposed design:
 - determine the maximum flow rate under ideal conditions;
 - adjust the maximum flow rate for prevailing roadway, traffic, and traffic control conditions; and
 - calculate the service flow rate for the selected level of service.

6. Compare the calculated service flow rate to the DHV. If the DHV is less than or equal to the service flow rate, the proposed design will meet the objectives of the capacity analysis. If the DHV exceeds the service flow rate, the proposed design may need further evaluation. The designer should either adjust the highway design or should adjust one of the capacity elements (e.g., the selected design year or the level-of-service goal).

Type of Facility	Service Measures
Vehicular	
Interrupted Flow Urban street segment Signalized intersection Two-way stop intersection All-way stop intersection Interchange ramp terminal Roundabout Uninterrupted Flow Two-lane highway Multilane highway Freeway Basic segment Ramp merge segment Ramp diverge segment Weaving segment	travel speed/Base FFS delay delay delay delay delay average travel speed, percent time-spent-following percent of free-flow speed density density density density density
Other Road Users	
Pedestrian Bicycle	space, delay, LOS score LOS score

SERVICE MEASURES FOR LEVEL OF SERVICE

Figure 31-4.B

31-4.05(b) Responsibility

For IDOT projects, the district Geometrics Engineer (or sometimes the project engineer) is responsible for performing all capacity analyses required by the project. The Policy and Procedures Section or the Project Development Unit is available as a resource to the district to assist in all capacity analyses. For consultant-designed projects, the consultant is responsible for performing capacity analyses. Consultants must use only highway capacity software that is approved by BDE.

31-4.06 Service Flow Rate

For general design purposes, IDOT uses a volume threshold designated as the service flow rate (SF) for the various highway classes. Service flow rate is taken from the *Highway Capacity Manual* (HCM) and is defined as the maximum volume that can be accommodated at a selected level of service (LOS) based on a typical set of operational assumptions for each facility.

As discussed in the HCM the base capacity of a facility at any LOS varies with the free-flow speed. For example, the base capacity for a basic freeway segment for LOS E ranges from 2250 at 55 mph (90 km/h) to 2400 at 75 mph (120 km/h) passenger cars per hour per lane under base conditions. The maximum service flow rate at LOS E, or MSF_E , is, also considered the capacity of a freeway, expressway, or arterial multilane highway. Base conditions include 12 foot lanes, a minimum of 6 foot right-side clearance, no heavy vehicles, no ramps, and a driver population composed primarily of regular users who are familiar with the facility.

The geometric design criteria tables in Part V, Highway Systems, present the service flow rate volumes for the applicable highway types at the design LOS. Factors which determine SF are the same as the base conditions above exclusive of lane width, lateral clearance and ramp density. Variances from the remaining base conditions causing operational constraints will cause a decrease to the SF. As discussed in the HCM these adjustments include the number of lanes (N), percent of heavy vehicles (f_{HV}), and driver population (f_p). To determine the SF_i at LOS i , use the MSF_i at the desired LOS i (e.g. see Exhibit 11-17 of the HCM). The equation for determining the SF_i for LOS i is:

$$SF_i = (MSF_i) (N) (f_{HV}) (f_p). \quad \text{Equation 31-4.1}$$

This equation is applicable for basic freeway segments (Chapter 44), expressways (Chapter 45), and arterial multilane highways (Chapter 47).

The SF's shown in the tables in Part V for multilane highways are one-way volumes derived from the above equation using appropriate HCM values and assume the following truck percentages for f_{HV} : freeways – 16%, expressways and arterial multilane highways– 8%. A PHF = 1.0 has been assumed, and the SF's found in the Part V tables for multilane highways must be multiplied by the actual PHF.

Capacity for a two lane rural highway (Chapter 47), which also exists at the boundary between LOS E and LOS F, is not determined by a measure of effectiveness. Under base conditions (12 foot or wider lanes, 6 foot or wider shoulders, no no-passing zones, all passenger cars, level

terrain, and no impediments to through traffic) the capacity of a two-lane rural highway (in one direction) is 1700 passenger cars per hour (pcph). The capacity of two-lane rural highway under base conditions is 3200 pcph total in both directions.

The equation for determining the SF_i for LOS i for two-lane rural highways is:

$$SF_i = (2800) (v/c)_i (f_d) (f_w) (f_{HV}) \text{ where;} \quad \text{Equation 31-4.2}$$

v/c = the ratio of flow rate to an ideal capacity of 2800 pcph in both directions;

f_d = the adjustment factor for the directional distribution of traffic (assumed as 60%/40%);

f_w = the adjustment factor for narrow lanes and shoulders and;

f_{HV} = the adjustment factor for the presence of heavy vehicles.

This equation and method to determine SF are from Chapter 8 of the 1994 HCM. Service flow rates in the 2011 HCM are ancillary to the performance measures for two-lane rural highways; therefore, the method to determine SF for two-lane rural highways is complicated requiring an iterative process giving questionable results. The method to determine SF using the 1994 HCM is accurate enough for planning purposes. The volumes shown in Part V for rural two-lane highways assume 100% passing sight distance, a 60%/40% directional distribution, 6% heavy vehicle percentage, and a PHF = 1. On a project length basis, as much passing sight distance as practical should be provided with approximately 60% available as a minimum for level terrain and approximately 40% as a minimum for rolling terrain.

31-5 NON-HIGHWAY DESIGN CONTROLS

The characteristics of drivers and vehicles significantly influence the selected design criteria. When the driver and vehicle are properly accommodated, the safety and serviceability of the highway system are enhanced. When they are not accommodated, crashes and inefficient operation may result.

31-5.01 Driver

31-5.01(a) Typical Driver

The appropriate considerations for drivers are already built into the applicable geometric design values (stopping sight distance, horizontal curvature, superelevation, roadway widths, etc.). However, a brief discussion of the “typical” driver is warranted.

Drivers vary widely in their operating skills, experience, intelligence, and physical condition. The highway should be as forgiving as practical to minimize the adverse effects of driver errors. The following describes certain principles and driver traits that should be incorporated into the roadway design:

1. Information Processing. Drivers are limited in how quickly they can gather information, make a decision, and take action. They must process information related to lane placement, speed, traffic control devices, highway alignment, roadside conflicts, and weather. If the amount, complexity, or clarity of the information is inappropriate or excessive, driver error leading to a crash can result.
2. Primacy. Certain driving functions are more important than others. In order of importance they are:
 - Control — activities related to the physical control of the vehicle via the steering wheel, brake, or accelerator.
 - Guidance — activities related to selecting a safe speed and vehicular path on the highway.
 - Navigation — activities related to planning and executing a trip from point of origin to destination.

The roadway designer must be aware of the relative importance of these activities and ensure that the more important highway information is properly conveyed to the driver. This could result in the decision to remove or relocate lower priority information, if it were likely to interfere with the higher priority information.

3. Expectancy. Drivers are conditioned through experience and training to expect and anticipate what lies ahead on the highway. If this driver expectancy is violated, it will increase the time needed by the driver to assess the situation and make the correct

decision. These violations should be avoided. Where they are unavoidable, the designer should allow for increased warning time.

4. Speed. Speed must be considered when accommodating the driver. Higher speeds reduce the visual field and restrict peripheral vision.

A User's Guide to Positive Guidance (FHWA) contains more detailed information related to driver characteristics and highway design accommodations for the driver.

31-5.01(b) Elderly Driver

In general, the median age of drivers in the United States is increasing and, specifically, the age bracket of over 60 years is the fastest growing segment of the driver population. This reality greatly emphasizes the criticality of the relationship between the driver and the highway environment. Although the opinions are not unanimous, there is general agreement that advancing age has a deleterious effect on an individual's perceptual, mental, and motor skills — critical factors in vehicular operation.

The research community has conducted several studies of the elderly driver, including:

- “Older Driver Study of Traffic Control Devices in Illinois,” Illinois Department of Transportation, 1991;
- “Highway Design and Traffic Operation Needs of Older Drivers,” University of Illinois at Urbana - Champaign, January 1994;
- “Strategies for Improving the Safety of Elderly Drivers,” University of Nebraska/Midwest Transportation Center, 1991; and
- “Highway Design Handbook for Older Drivers and Pedestrians,” FHWA, 2001.

These four studies were primarily focused on the relationship between the elderly driver and traffic control devices where, arguably, a greater opportunity exists for cost-effective countermeasures than for roadway design. However, it is important for the road designer to be aware of the needs of the elderly driver and, where desirable, factor these needs into the roadway design. The following summarizes the more important observations from these studies:

1. Elderly Driving Characteristics. When compared to younger drivers, the elderly driver often exhibits the following operational deficiencies:
 - slower information processing;
 - slower reaction times;
 - slower decision making;
 - visual deterioration;
 - hearing deterioration;
 - decline in ability to judge time, speed, and depth perception;

- limitations on physical mobility; and
 - side effects from prescription drugs.
2. Crash Frequency. Predictably, elderly drivers are involved in a disproportionate number of crashes where there is a higher than average demand imposed on driving skills. The driving maneuvers that most often precipitate higher crash frequencies among older drivers include:
- making left turns across traffic,
 - merging with high-speed traffic,
 - changing lanes on congested streets,
 - crossing high-volume intersections,
 - stopping quickly for queued traffic,
 - attempting backing maneuvers, and
 - parking.
3. Countermeasures. The studies identified several countermeasures to alleviate the potential problems of the elderly driver. These included:
- increasing driver education;
 - increasing vehicular clearance times at signalized intersections;
 - increasing pedestrian phase times;
 - providing wider and brighter pavement markings;
 - providing larger and brighter signs;
 - reducing sign clutter;
 - providing more redundant information (e.g., advance guide signs);
 - installing grade separations;
 - revising warrants for traffic signals to increase their usage;
 - enforcing speed limits;
 - widening intersections;
 - increasing use of protected left-turn phases; and
 - increasing sight distance.

Most of the proposed countermeasures are related to traffic control devices. Perhaps the most practical measure related to road design is increasing sight distance. From an implementation perspective, this recommendation may be related to the warrants for the use of decision sight distance, as discussed in Section 31-3. The gradual aging of the driver population suggests that an increased use of decision sight distance may produce a commensurate reduction in the crash frequency for elderly drivers. These findings suggest that, where decision sight distance cannot physically be provided, an increased use of advance warning signs may be appropriate.

31-5.02 Vehicle

The physical and operational characteristics of vehicles using the highway are important controls in roadway design. Design criteria may vary according to the type of vehicle and the volume of each type of vehicle in the traffic stream.

Vehicular characteristics that impact design include:

1. Size. Vehicular sizes determine lane and shoulder widths, vertical clearances and, indirectly, highway capacity calculations.
2. Off-tracking. The design of intersection turning radii, traveled way widening for horizontal curves, and pavement widths for interchange ramps are usually controlled by the largest design vehicle likely to use the facility with some frequency.
3. Storage Requirements. Turn bay storage lengths, bus turnouts, and parking lot layouts are determined by the number and types of vehicles to be accommodated.
4. Sight Distance. Eye height and braking distances vary for passenger cars and trucks, which can impact sight distance considerations.
5. Acceleration and Deceleration. Acceleration and deceleration rates often govern the dimensioning of such design features as speed-change lanes at intersections and interchange ramps and climbing lanes.
6. Vehicular Stability. Certain vehicles with high centers of gravity may be prone to skidding or overturning, affecting design speed selection and superelevation design elements.

Figures 31-5.A and 31-5.B present vehicular dimensions and minimum turning radii for typical design vehicles. Figures 31-5.C and 31-5.D present two combination trucks to illustrate the application of the basic dimensions.

The selection of appropriate design vehicles for intersections and interchanges are discussed in Chapters 36 and 37, respectively.

31-5.03 Pedestrians

The pedestrian must be considered as an integral part of the highway environment, especially in urban areas. Except on fully access-controlled facilities, pedestrians are legally allowed to use the highway right-of-way consistent with the restrictions placed on pedestrian use. Therefore, the roadway design should provide for the safe and efficient movement of pedestrians, within practical limits, without compromising the accommodation of the vehicles using the highway facility.

Design Vehicle Type	Symbol	Dimensions (feet)											Typical Kingpin to Center of Rear Axle		
		Overall			Overhang		Wheelbases				T				
		Height	Width	Length	Front	Rear	WB ₁	WB ₂	S	WB ₃					
Passenger car	P	4.25	7	19	3	5	11	-	-	-	-	-	-	-	-
Single unit truck	SU	11-13.5	8.0	30	4	6	20	-	-	-	-	-	-	-	-
City transit bus	CITY-BUS	10.5	8.5	40	7	8	25	-	-	-	-	-	-	-	-
Articulated bus	A-BUS	11.0	8.5	60	8.6	10	22.0	19.4	6.2 ^a	13.2 ^a	-	-	-	-	-
School bus (84 passenger)	S-BUS	10.5	8.0	40	7	13	20	-	-	-	-	-	-	-	-
Combination trucks:															
Intermediate Semitrailer	WB-40	13.5	8.0	45.5	3	2.5 ^a	12.5	27.5	-	-	-	-	-	-	27.5
Large Semitrailer	WB-50	13.5	8.5	55	3	2 ^a	14.6	35.4	-	-	-	-	-	-	37.5
Large Semitrailer*	WB-55	13.5	8.5	66	3.5	7.5	14.6	40.4	-	-	-	-	-	-	42.5
Semitrailer - Full Trailer ("Double Bottom")	WB-67D	13.5	8.5	73.3	2.33	3	11.0	23.0	3.0 ^b	7.0 ^b	23.0	-	-	-	23.0
Interstate Semitrailer*	WB-65	13.5	8.5	73.5	4	4.5-2.5 ^a	21.6	43.4-45.4	-	-	-	-	-	-	45.5-47.5
Recreational vehicles:															
Motor home	MH	12	8	30	4	6	20	-	-	-	-	-	-	-	-
Car and camper trailer	P/T	10	8	48.7	3	10	11	-	5	19	-	-	-	-	-
Car and boat trailer	P/B	10	8	42	3	8	11	-	5	15	-	-	-	-	-
Motor home and boat trailer	MH/B	12	8	53	4	8	20	-	6	15	-	-	-	-	-

* On semitrailers longer than 48 ft, the maximum distance between the kingpin and the rear axle shall not exceed 45.5 ft.

a = Combined dimension of 19.4 ft is typical.

b = Combined dimension of 10.0 ft is typical.

WB₁, WB₂, WB₃ are effective vehicle wheelbases, starting at the front and moving towards the back of the vehicle.

S is the distance from the rear effective axle of a vehicle to the hitch point or, for A-BUS, the distance from second axle to articulating section.

T is the distance from the hitch point of a vehicle to the lead effective axle or axle set of the following unit or, for A-BUS, the distance from articulating section to rear axle.

**TYPICAL DESIGN VEHICLE DIMENSIONS
(US Customary)**

Figure 31-5.A

Design Vehicle Type	Symbol	Dimensions (meters)										Typical Kingpin to Center of Rear Axle			
		Overall		Overhang		Wheelbases									
		Height	Width	Length	Front	Rear	WB ₁	WB ₂	S	T	WB ₃				
Passenger car	P	1.3	2.1	5.8	0.9	1.5	3.4	-	-	-	-	-	-	-	-
Single unit truck	SU	3.4-4.1	2.4	9.2	1.2	1.8	6.1	-	-	-	-	-	-	-	-
City transit bus	CITY-BUS	3.2	2.6	12.2	2.1	2.4	7.6	-	-	-	-	-	-	-	-
Articulated bus	A-BUS	3.4	2.6	18.3	2.6	3.1	6.7	5.9	1.9 ^a	4.0 ^a	-	-	-	-	-
School bus (84 passenger)	S-BUS	3.2	2.4	12.2	2.1	4.0	6.1	-	-	-	-	-	-	-	-
Combination trucks:															
Intermediate Semitrailer	WB-12	4.1	2.4	13.9	0.9	0.8 ^a	3.8	8.4	-	-	-	-	-	-	8.4
Large Semitrailer	WB-15	4.1	2.6	16.8	0.9	0.6 ^a	4.5	10.8	-	-	-	-	-	-	11.4
Large Semitrailer*	WB-17	4.1	2.6	20.19	1.13	2.29	4.45	12.32	-	-	-	-	-	-	13.0
Semitrailer - Full Trailer ("Double Bottom")	WB-20D	4.1	2.6	22.4	0.7	0.9	3.4	7.0	0.9 ^b	2.1 ^b	7.0	-	-	-	7.0
Interstate Semitrailer*	WB-20	4.1	2.6	22.4	1.2	1.4-0.8 ^a	6.6	13.2-13.8	-	-	-	-	-	-	13.9-14.5
Recreational vehicles:															
Motor home	MH	3.7	2.4	9.2	1.2	1.8	6.1	-	-	-	-	-	-	-	-
Car and camper trailer	P/T	3.1	2.4	14.0	0.9	3.1	3.4	-	1.5	5.8	-	-	-	-	-
Car and boat trailer	P/B	3.1	2.4	12.8	0.9	2.4	3.4	-	1.5	4.6	-	-	-	-	-
Motor home and boat trailer	MH/B	3.7	2.4	16.2	1.2	2.4	6.1	-	1.8	4.6	-	-	-	-	-

* On semitrailers longer than 14.63 m, the maximum distance between the kingpin and the rear axle shall not exceed 13.87 m.

a = Combined dimension of 5.91 m is typical.

b = Combined dimension of 3.25 m is typical.

WB₁, WB₂, WB₃ are effective vehicle wheelbases, starting at the front and moving towards the back of the vehicle.

S is the distance from the rear effective axle of a vehicle to the hitch point or, for A-BUS, the distance from second axle to articulating section.

T is the distance from the hitch point of a vehicle to the lead effective axle or axle set of the following unit or, for A-BUS, the distance from articulating section to rear axle.

**TYPICAL DESIGN VEHICLE DIMENSIONS
(Metric)**

Figure 31-5.A

Design Vehicle Type	Passenger Car	Single-Unit Truck	Intercity Bus (Motor Coach)		City Transit Bus	Conventional School Bus (65 pass.)	Large ² School Bus (84 pass)	Articulated Bus	Inter-mediate Semi-Trailer	Inter-mediate Semi-Trailer
			BUS-40	BUS-45						
Symbol	P	SU	BUS-40	BUS-45	CITY-BUS	S-BUS36	S-BUS40	A-BUS	WB-40	WB-50
Minimum Design Turning Radius (ft)	24	42	45	45	42.0	38.9	39.4	39.8	40	45
Centerline ¹ Turning Radius (CTR) (ft)	21	38	40.8	40.8	37.8	34.9	35.4	35.5	36	41
Minimum Inside Radius (ft)	14.4	28.3	27.6	25.5	24.5	23.8	25.4	21.3	19.3	17.0

Design Vehicle Type	Large Semi-trailer	Semitrailer Interstate		"Double Bottom" Combination	Semi-trailer/trailers	Turnpike Double Semi-trailer/trailer	Motor Home	Car with Camper Trailer	Car with Boat Trailer	Motor Home and Boat Trailer	Farm ³ Tractor w/One Wagon
		WB-62*	WB-65**or WB-67								
Symbol	WB-55	WB-62*	WB-65**or WB-67	WB67D	WB-100T	WB-109D*	MH	P/T	P/B	MH/B	TR/W
Minimum Design Turning Radius (ft)	45	45	45	45	45	60	40	33	24	50	18
Centerline ¹ Turning Radius (CTR) (ft)	41	41	41	41	41	56	36	30	21	46	14
Minimum Inside Radius (ft)	18.4	17.9	4.4	19.3	9.9	14.9	25.9	17.4	8.0	35.1	10.5

* Design vehicle with 48-ft trailer as adopted in 1982 *Surface Transportation Assistance Act (STAA)*.

** Design vehicle with 53-ft trailer as grandfathered in with 1982 *Surface Transportation Assistance Act (STAA)*.

- 1 The turning radius assumed by a designer when investigating possible turning paths and is set at the centerline of the front axle of a vehicle. If the minimum turning path is assumed, the CTR approximately equals the minimum design-turning radius minus one-half the front width of the vehicle.
- 2 School buses are manufactured from 42-passenger to 84-passenger sizes. This corresponds to wheel base lengths of 11.0 ft to 20.0 ft, respectively. For these different sizes, the minimum design turning radii vary from 28.8 ft to 39.4 ft and the minimum inside radii vary from 14.0 ft to 25.4 ft.
- 3 Turning radius is for 150-200 hp tractor with one 18.5-ft long wagon attached to hitch point. Front wheel drive is disengaged and without brakes being applied.

**MINIMUM TURNING RADII OF TYPICAL DESIGN VEHICLES
(US Customary)**

Figure 31-5.B

Design Vehicle Type	Passenger Car	Single-Unit Truck	Intercity Bus (Motor Coach)		City Transit Bus	Conventional School Bus (65 pass.)	Large ² School Bus (84 pass)	Articulated Bus	Inter-mediate Semi-Trailer	Inter-mediate Semi-Trailer
			BUS-12	BUS-14						
Symbol	P	SU	BUS-12	BUS-14	CITY-BUS	S-BUS11	S-BUS12	A-BUS	WB-12	WB-15
Minimum Design Turning Radius (m)	7.3	12.8	13.7	13.7	12.8	11.9	12.0	12.1	12.2	13.7
Centerline ¹ Turning Radius (CTR) (m)	6.4	11.6	12.4	12.4	11.5	10.6	10.8	10.8	11.0	12.5
Minimum Inside Radius (m)	4.4	8.6	8.4	7.8	7.5	7.3	7.7	6.5	5.9	5.2

Design Vehicle Type	Large Semi-trailer	Interstate Semitrailer		"Double Bottom" Combination	Semi-trailer/trailers	Semi-trailer/trailer	Motor Home	Car with Camper Trailer	Car with Boat Trailer	Motor Home and Boat Trailer	Farm ³ Tractor w/One Wagon
		WB-19*	WB-20**								
Symbol	WB-17	WB-19*	WB-20**	WB-20D	WB-30T	WB-33D*	MH	P/T	P/B	MH/B	TR/W
Minimum Design Turning Radius (m)	13.7	13.7	13.7	13.7	13.7	18.3	12.2	10.1	7.3	15.2	5.5
Centerline ¹ Turning Radius (CTR) (m)	12.5	12.5	12.5	12.5	12.5	17.1	11.0	9.1	6.4	14.0	4.3
Minimum Inside Radius (m)	5.6	2.4	1.3	5.9	3.0	4.5	7.9	5.3	2.4	10.7	3.2

Note: Numbers in table have been rounded to the nearest tenth of a meter.

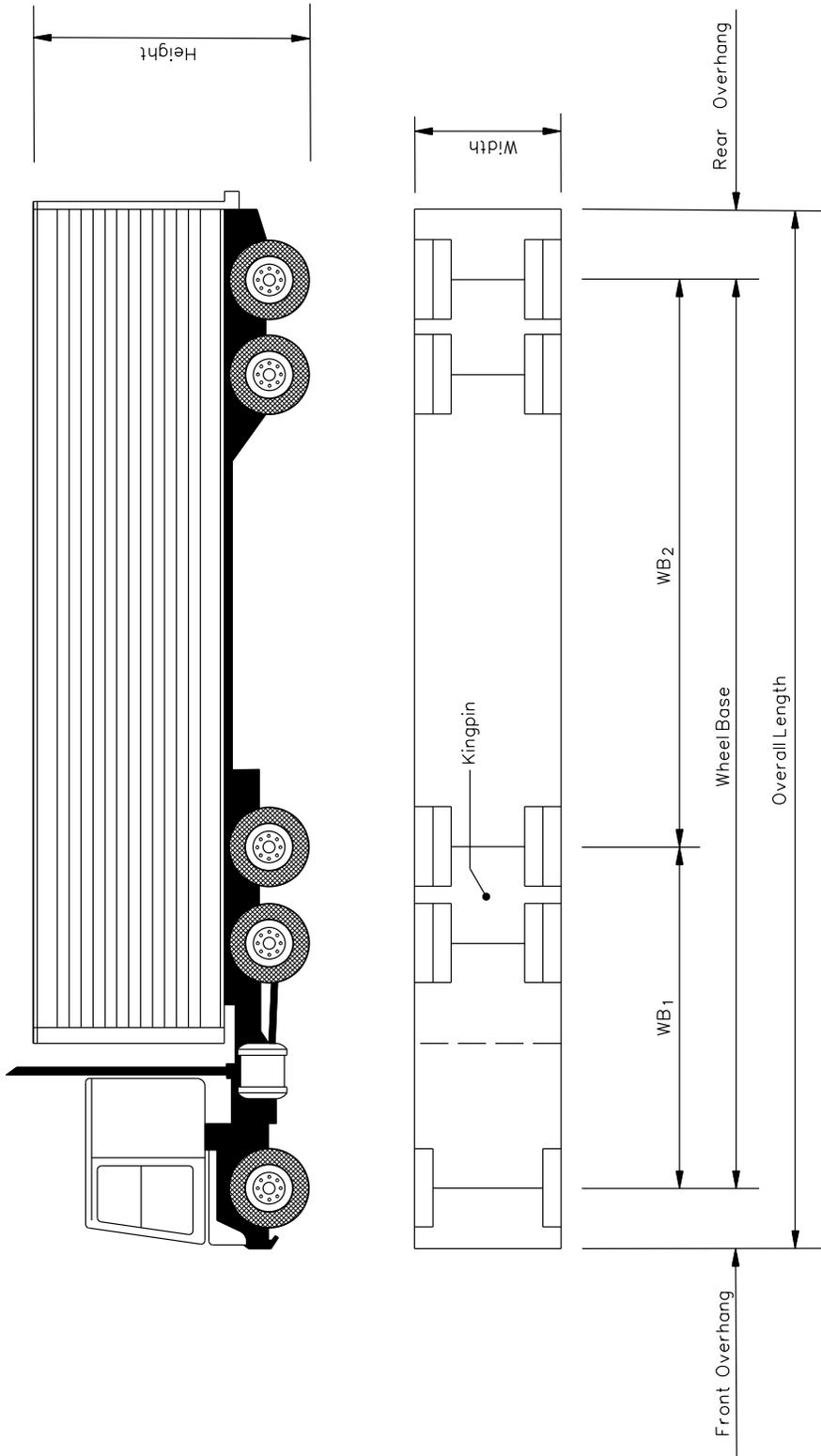
* Design vehicle with 14.63-m trailer as adopted in 1982 *Surface Transportation Assistance Act* (STAA).

** Design vehicle with 16.16-m trailer as grandfathered in with 1982 *Surface Transportation Assistance Act* (STAA).

- 1 The turning radius assumed by a designer when investigating possible turning paths and is set at the centerline of the front axle of a vehicle. If the minimum turning path is assumed, the CTR approximately equals the minimum design-turning radius minus one-half the front width of the vehicle.
- 2 School buses are manufactured from 42-passenger to 84-passenger sizes. This corresponds to wheel base lengths of 3.35 m to 6.1 m, respectively. For these different sizes, the minimum design turning radii vary from 8.78 m to 12.01 m and the minimum inside radii vary from 4.27 m to 7.74 m.
- 3 Turning radius is for 150-200 hp tractor with one 5.64-m long wagon attached to hitch point. Front wheel drive is disengaged and without brakes being applied.

**MINIMUM TURNING RADII OF TYPICAL DESIGN VEHICLES
(Metric)**

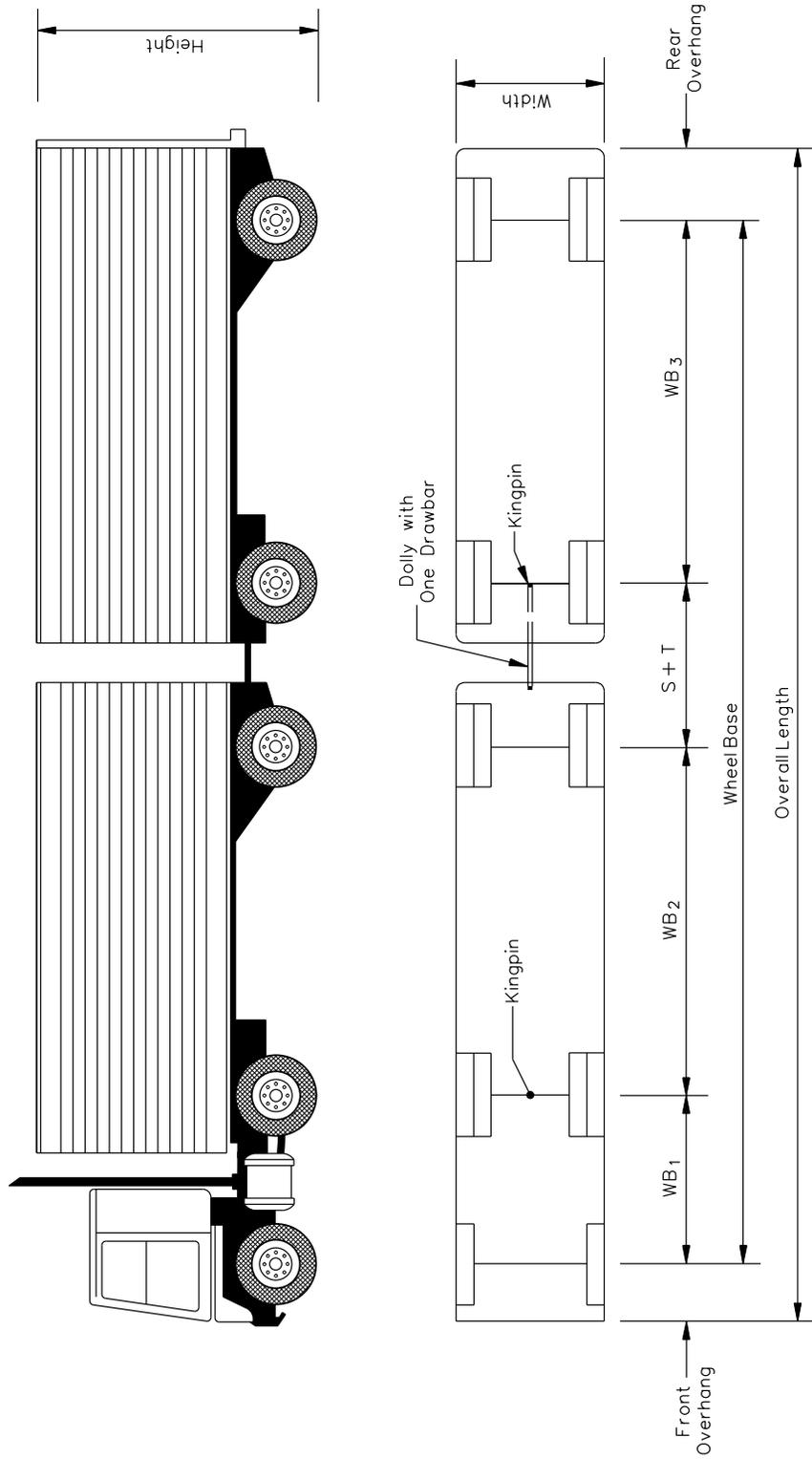
Figure 31-5.B



Note: For the legal dimensions of trucks allowed on Illinois highways, refer to information from the Central Bureau of Operations, Maintenance Operations Section.

BASIC DIMENSIONS OF TRACTOR-SEMITRAILER VEHICLE

Figure 31-5.C



Note: For the legal dimensions of trucks allowed on Illinois highways, refer to information from the Central Bureau of Operations, Maintenance Operations Section.

BASIC DIMENSIONS OF TRACTOR-SEMITRAILER/TRAILER VEHICLE

Figure 31-5.D

The *BDE Manual* presents many specific design criteria for the accommodation of pedestrians as follows:

- Chapter 17 discusses pedestrian accommodation warrants, sidewalk location considerations, pedestrian networks, accommodations on structures, and crosswalks at both intersections and midblock locations.
- Chapter 36 discusses pedestrian accommodation at intersections.
- Chapter 48 discusses sidewalks.
- Chapter 55 discusses the considerations involved in safely accommodating pedestrians through and around work zones.
- Chapter 56 discusses pedestrian accommodation with traffic signals.
- Chapter 58 discusses accessibility criteria.

31-5.04 Bicyclists

Similar to pedestrians, bicyclists are an important element of the highway environment. Chapter 17 discusses the detailed design criteria for bicycle accommodation.

31-6 PROJECT SCOPE OF WORK

The project scope of work will reflect the basic intent of the highway project and will determine the overall level of highway improvement. This decision, in combination with the highway functional classification (see Chapter 43), will determine which criteria in the *Manual* apply to the geometric design of the project. Selection of the scope of work for a project should not be an arbitrary decision, but may be based on such engineering factors including, but not limited to, safety, functional classification, traffic volume, pavement condition, project cost, available funding, funding sources, etc. Note that cost alone should not be the single factor driving project scope.

The following provides general definitions for the project scopes of work, and it references the applicable chapters for determining the related design criteria, which are found in *Part V, "Highway Systems"*, for new construction, reconstruction, or 3R projects, or *Part VI, "Other Highway Design Elements"*, for 3P and SMART projects.

31-6.01 New Construction

Generally, new construction is defined as horizontal and vertical alignment on a new location. Typically, the overall project will have a significant length and will connect major termini, but may be comprised of several smaller contracts due to funding constraints, optimization for type of work, etc. Where an existing two-lane, two-way facility becomes a multilane facility with a rural-type median, the new median and proposed roadway are considered new construction. In addition, new construction also includes any intersection or interchange that falls within the project limits of a new highway mainline or is relocated to a new point of intersection. Freeways, expressways, and bypasses are typical new construction projects.

Because of the significant level of work and the up-front costs associated with a project on new alignment, a 20-year design period is utilized at minimum, and the highest order of design criteria are typically applied.

Chapters 44 through 48 present IDOT criteria for new construction.

31-6.02 Reconstruction

Reconstruction of an existing highway will typically include the addition of travel lanes and/or reconstruction of the existing horizontal and vertical alignment, widening of the roadway, and flattening side slopes, but the highway will remain essentially within the existing highway corridor. These projects will usually require some right-of-way acquisitions. The primary reasons for reconstructing an existing highway are because the facility cannot accommodate its current or future traffic demands, because the existing alignment or cross section is deficient, and/or because the service life of the pavement has been exceeded. In addition, any intersection that falls within the limits of a reconstruction project will be reconstructed as needed to meet policy requirements.

Because of the significant level of work for reconstruction, the design of the project generally will be determined by the criteria for new construction and based on a 20-year design period. However, some existing cross section elements may be allowed to remain in place.

Chapters 44 through 48 will apply to reconstruction projects.

31-6.03 3R Projects (Non-Freeways)

3R projects (resurfacing, restoration, and/or rehabilitation) on non-freeways are primarily intended to extend the service life of the existing facility and to enhance highway safety. In addition, 3R projects should make cost-effective improvements to the existing geometrics, where practical and where existing crash data analyses point to a need. 3R work on the mainline or at an intersection is typically completed within the existing alignment. However, right-of-way acquisition is sometimes justified for flattening of side slopes, changes in horizontal alignment, changes in vertical profile, turn lane additions, intersection radii upgrades, and safety enhancements such as culvert extensions and guardrail length of need.

The overall objective of a 3R non-freeway project is to perform work necessary to return the highway to a condition of acceptable structural and/or functional adequacy. 3R projects may include any number of the following types of improvements:

- providing pavement resurfacing, rehabilitation, and/or short sections of pavement reconstruction;
- providing lane and/or shoulder widening (without adding through lanes);
- adding a two-way, left-turn lane (TWLTL);
- providing intersection improvements (e.g., adding or lengthening turn lanes, improving turning radii, channelization, corner sight distance improvements);
- flattening a horizontal or vertical curve;
- adding auxiliary lanes (e.g., truck-climbing lane);
- converting an existing uncurbed urban street into a curbed street;
- widening and/or resurfacing parking lanes;
- upgrading at-grade railroad crossings;
- rehabilitating and/or widening existing bridges;
- upgrading guardrail and other roadside safety appurtenances to meet current criteria;
- adjusting the roadside clear zone;

- flattening side slopes;
- providing drainage improvements, including pump stations; and/or
- implementing improvements to meet the Department's accessibility criteria (e.g., sidewalks, sidewalk curb ramps).

Any of the above may also be an element of work for a reconstruction project. Chapter 49 presents IDOT criteria for the design of 3R non-freeway projects, including criteria that may be allowed to remain in place.

31-6.04 3R Projects (Freeways)

3R projects (resurfacing, restoration, and/or rehabilitation) on existing freeways are primarily intended to extend the service life of the existing facility and to enhance highway safety. In addition, these projects should make cost-effective improvements to the existing geometrics, where practical. 3R freeway projects may include any number of the following types of improvements:

- providing pavement resurfacing, rehabilitation, and/or short sections of pavement reconstruction;
- realigning or widening an existing ramp or modifying an existing interchange;
- lengthening existing acceleration or deceleration lanes at freeway entrances and exits;
- flattening a horizontal or vertical curve;
- adding auxiliary lanes (e.g., a truck-climbing lane);
- rehabilitating and/or widening existing bridges;
- upgrading guardrail and other roadside safety appurtenances to meet current criteria;
- adjusting the roadside clear zone;
- flattening side slopes; and/or
- providing drainage improvements, including pump stations.

Chapter 50 presents IDOT criteria for the design of 3R freeway projects, including criteria that may be allowed to remain in place.

31-6.05 3P Projects

The Pavement Preservation Program (3P) is a category of projects consisting of repairing and resurfacing existing paved roadways on the State highway system (excluding Interstates). The

intent of the program is to cost effectively address specific pavement deficiencies. Besides marked non-interstate routes, unmarked roads including any urban minor arterials (without the need for a jurisdictional transfer) and collector and local roads (as part of a jurisdictional transfer) are eligible to be resurfaced under the program, given certain existing pavement condition criteria are met. The purpose of the 3P Program is to rehabilitate existing roadways and thus extend the roadway's service life. Typically the scope of a 3P project includes only ancillary items beyond resurfacing of the pavement and shoulder and does not include geometric improvements.

3P projects can sometimes provide a low-cost opportunity to reallocate the roadway width to better accommodate bicyclists. Bike lanes or shared lanes can be created by adjusting pavement marking. The possibility of removing traffic through lanes (a road diet) or parking lanes may also be investigated. Refer to Chapter 17 for further discussion.

Chapter 53 presents IDOT criteria for the selection and design of 3P projects.

31-6.06 SMART Projects

Surface Maintenance at the Right Time (SMART) is a category of projects with the intent of cost effectively extending the service life of the pavement without significantly increasing its structural capacity. If the SMART overlay is applied at the correct time, it can delay serious pavement distresses, thereby extending the life of the pavement, and decreasing overall life cycle costs. Typically the scope of a SMART project includes only ancillary items beyond resurfacing of the pavement lanes and does not include geometric improvements.

The selection criteria for SMART projects are presented in Figure 52-5.B. SMART overlays are not allowed on Interstate highways or bare PCC pavements. Four-lane routes, with the exception of Interstates, may be considered if the two-lane truck and patching directional criteria presented in Figure 52-5.B are met. Also, consider ramps and unmarked narrow pavements that do not have excessive rutting or shoving for SMART projects.

Considerations related to bicyclist accommodation may be applied as noted for 3P projects above.

Chapter 52 presents IDOT criteria for the selection and design of SMART projects.

31-7 ADHERENCE TO DESIGN CRITERIA

Parts IV, V, and VI of the *BDE Manual* (Roadway Design Elements, Highway Systems, and Other Highway Design Elements, respectively) present a vast amount of design criteria for application on individual projects. In general, the designer is responsible for making every reasonable effort to meet these criteria in the project design. However, it will not always be practical to meet the criteria. Therefore, this section presents IDOT's procedures for the appropriate action when the design criteria are not met.

31-7.01 Department Intent

The general intent of the Illinois Department of Transportation is that all design criteria in Parts IV, V, and VI be met and that, wherever practical, the proposed design should exceed the lower criteria. In addition, where a range of values is presented, the designer should make every reasonable effort to provide a design that is near the desirable or preferred value. Also, the designer should pay special attention regarding the possible cumulative effects of using more than one minimum design criteria within a particular project's limits; analyze the effects the proposed design has on safety performance; and, when necessary, provide additional design features, if feasible, to mitigate a potential reduction in safety. The overall intent is to ensure that the Department will provide a highway system that meets the transportation needs of the State and provides a reasonable level of safety, comfort, and convenience for the traveling public.

31-7.02 Hierarchy of Design Criteria

The Department, in concert with 23 CFR 625, FHWA's May 5, 2016 policy memorandum on controlling criteria, and the FHWA/IDOT Stewardship and Oversight (S&O) Agreement, has established the following hierarchy of design criteria as they pertain to the potential for design exceptions (see Section 31-7.04 for information on the design exception submittal and approval process):

31-7.02(a) Level One Design Exceptions

Level One design exceptions involve the controlling design criteria established by FHWA, but only on the interstate system, pursuant to the S&O Agreement. When not met, Level One design exceptions require documentation and justification by the district, concurrence by BDE, and formal approval by FHWA. These criteria are judged to be those design elements that are the most critical indicators of an interstate highway's safety and overall serviceability. There are 10 controlling design criteria for interstate routes, per FHWA's May 5, 2016 policy memorandum on controlling criteria and the S&O Agreement. These 10 Level One criteria are listed in form BDE 3107, "Level One Design Criteria Checklist." The appropriate reference chapter of the BDE Manual has been listed along with each criterion on form BDE 3107.

31-7.02(b) Level Two Design Exceptions

Level Two design exceptions involve two distinct sub-sets, per the S&O Agreement. In addition to FHWA controlling design criteria for projects off the interstate system, Level Two design criteria are also additional design criteria identified by IDOT, over and above the FHWA controlling criteria, on both interstate and non-interstate projects. When not met, Level Two design exceptions require documentation and justification by the district and formal approval by BDE only. The additional IDOT criteria are other important indicators of a highway's safety and serviceability. The FHWA controlling design criteria and additional IDOT criteria have been integrated and listed in form BDE 3108, "Level Two Design Criteria Checklist." The appropriate reference chapter of the BDE Manual has been listed along with each criterion on form BDE 3108.

31-7.02(c) ADA Accessibility Criteria – Maximum Extent Practicable

Chapter 58 presents most of the accessibility criteria applicable to an IDOT project and references their sources, which include: the 2010 ADA Standards for Accessible Design, the Public Rights-of-Way Accessibility Guidelines, and the Illinois Accessibility Code. These codified standards and guidelines have the effect of law and as such, design exceptions in the traditional sense, are not possible. That being said, the standards do recognize that in certain situations (e.g. alterations of existing facilities) full compliance will not always be possible within the scope of the project. Where accessibility requirements cannot be fully met, the barriers to full compliance must be well documented as well as the measures taken to comply with the standards to the maximum extent practicable. See Section 31-7.04(b) for more information.

31-7.03 Design Criteria Checklists

The "Level One Design Criteria Checklist" (form BDE 3107) and "Level Two Design Criteria Checklist" (form BDE 3108) were created to ensure designers have considered the relevant design criteria and evaluated the need for design exceptions. The appropriate checklist must be completed for each new construction, reconstruction, or 3R project. The checklist is then included in the Phase I engineering report and becomes a part of the permanent project file. The results from the checklists should also be discussed at the district coordination meetings.

31-7.04 Design Exception Process

31-7.04(a) General Procedures

The design exception process applies to all capital improvement projects considered new construction, reconstruction, 3R, 3P, SMART, HSIP, etc.

Design exceptions are discussed at project coordination meetings held in each district. These meetings are scheduled monthly or bi-monthly, are attended by representatives from FHWA and BDE, and allow for a timely approval process. With sufficient notice in advance of the coordination meeting and with adequate justification, BDE and FHWA can typically inform the

district during the meeting if a design exception is denied or granted. In addition to presentation at a coordination meeting, design exceptions require the completion of form BDE 3100 "Design Exception Request – Project Identification" with attachments if needed. The approved Design Exception Request form then becomes part of the permanent project file. As an aide in filling out form BDE 3100, see Figure 31-7.A, "Guidelines for Completion of Design Exception Request – Project Identification."

The documentation for design exceptions shall be included with the coordination meeting agenda and submitted to BDE two weeks prior to the scheduled meeting. During coordination meetings, the district discusses the design details for each project; and, provides justification as to the need for design exceptions to the design criteria, when necessary. For projects on the interstate highway system that involve FHWA's controlling criteria, design exceptions (i.e., Level One) are evaluated for a determination by FHWA and BDE in accordance with the FHWA/IDOT Stewardship and Oversight Agreement. For projects on the interstate highway system that do not involve FHWA's controlling criteria, or for projects off the interstate highway system, design exceptions (i.e., Level Two) are evaluated for a determination by BDE.

The reason for design exceptions shall be clearly justified and documented. The justification may be presented by a combination of crash analysis, safety analysis, cost comparisons, level of social, environmental, and economic impacts, capacity analysis, and other relevant information as to the rationale and basis for the design exception. A benefit/cost analysis may also be included if it will help with the decision making process. Level One design exceptions may require the preparation of a report and a formal request to the FHWA for determination, or submittal of form BDE 3107, in addition to the completion of form BDE 3100.

All discussions and agreements reached at the coordination meeting and relevant to any Level One or Level Two design exception shall be documented by both minutes prepared each time the project is presented and the completed form BDE 3100. The documentation within the meeting minutes, or as an attachment to the minutes, and form BDE 3100 shall include the individual listing of each design exception, the location, the justification, and whether the design exception was approved or denied by BDE and, if necessary, FHWA. The minutes and form BDE 3100, in addition to form BDE 3107 and/or BDE 3108 on all new construction, reconstruction, or 3R projects, shall be included in the Phase I engineering report. Note that safety cannot be compromised through the design exception process to meet scope/schedule/budget.

If the district determines that a design change involving a design exception is required after the Phase I engineering report process is complete, the proposed design change and exception must be coordinated with BDE. In order for the Regional Field Engineer to make an informed determination, the district must prepare either a memo with attachments discussing the design change and exception, or discuss the proposed issue at a District coordination meeting. To expedite the process, if the issue is to be discussed at a coordination meeting, submit a short report addressing the change to the BDE Regional Field Engineer in advance of the meeting.

31-7.04(b) Procedures for Meeting ADA Accessibility Criteria to the Maximum Extent Practicable

The ADA accessibility criteria presented in Chapter 58 and the various Federal and State ADA standards are applicable whenever pedestrian access, circulation, or use is affected, or could be affected, by the project. As described in Section 58-1.01(b), newly constructed facilities and elements added to existing facilities must be fully compliant with the criteria. However, existing elements that are altered must comply with the criteria to the maximum extent practicable within the scope of the project. This typically means that alterations must also be fully compliant unless there are existing physical constraints or qualified historic facilities which make full compliance impracticable. The following steps are the procedure to go by when a feature does not fully meet accessibility guidelines, but will be built to the maximum extent practicable.

1. District Coordination Meetings. Any proposed element not able to be made fully compliant within the scope of the project shall be discussed at the district coordination meetings. The district shall complete form BDE 3101 "Maximum Extent Practicable" and attach any supporting documentation. This documentation shall be included with the coordination meeting agenda and submitted to BDE two weeks prior to the scheduled meeting. The BDE representative should be able to determine, following the presentation at the coordination meeting, whether or not the element is designed to the maximum extent practicable.
2. Documentation. In addition to the general procedures for documentation listed in Section 38-7.04(a), the district shall fully document its evaluation of the non-compliant element and must clearly demonstrate that compliance is not feasible. Furthermore, the district shall document what will be otherwise done to apply the ADA standards to the maximum extent practicable. The documentation in the maximum extent practicable request will vary on a case-by-case basis; however, cost is not a factor. The completed form BDE 3101 and any supporting documentation shall become part of the permanent project file. Include a copy of the completed form BDE 3101 with the District's inventory until the non-compliant element is improved to full compliance and removed from the transition plan.

Accessibility criteria must be fully considered in the initial scope of a project. As such, most, if not all, of the features in an alteration type of project should be able to be fully compliant and this is the Department's goal. In other words, if too many requests for a Maximum Extent Practicable determination are being sought for a project, it is likely the project's scope is too narrow and the scope must be re-evaluated.

31-7.04(c) Vertical Clearances Exceptions on the Interstate System

The integrity of the Interstate System for national defense purposes shall be maintained to meet AASHTO Policy as stated in A Policy on Design Standards - Interstate System. IDOT requires vertical clearances on new construction/reconstruction Interstate sections in rural areas and single routing through or around urban areas to be no less than 16 ft 09 in (5.1 m). The clear height of structures over other urban interstate routes shall not be less than 15 ft 00 in (4.5

meters). This clearance is required over the full roadway width (travel lanes and usable shoulders), including ramps and collector-distributor roadways within Interstate-to-Interstate interchanges.

The FHWA allows a minimum 16 ft 00 in (4.9 m) in rural areas and along the single routing in urban areas. The minimum vertical clearance in other urban areas shall be no less than 14 ft 00 in (4.3 m). The extra clearance IDOT requires allows for future overlays. The urban areas in Illinois where single routing occurs are:

- Peoria,
- Quad Cities,
- Metro-east St. Louis area, and
- the Chicago metropolitan area.

Maps of the single interstate route for these urban areas are shown in the figures in Section 44-6.

Design exceptions must be approved whenever the criteria are not met. These criteria apply whether it is a new construction project, a project that does not provide for correction of an existing substandard condition, or a project which creates a substandard condition at an existing structure.

There is a distinction between FHWA criteria and IDOT criteria for the vertical clearance over the Interstate. If the minimum clearances exceed those required by the FHWA, but are less than that required by IDOT, a design exception shall be presented as in Section 31-7.03(a) as a Level One design exception.

If the minimums required by the FHWA are not met, form BDE 3102 must be used to request approval for substandard vertical clearances over interstate routes. Form BDE 3102 will be filled out by the District and submitted to the Illinois Division of the FHWA. The FHWA will complete the "Date to SDDCTEA," "Response Requested by," and FHWA contact information and forward the completed form to the Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA) prior to taking any action on the design exception. If the SDDCTEA does not respond within 10 working days (after receipt by SDDCTEA), it can be concluded that the SDDCTEA does not have any concerns with the proposed exception. If comments are forthcoming, the FHWA and IDOT will consider mitigation to the extent feasible.

Coordination with SDDCTEA, as discussed above, is not required for interstates in urban areas with a minimum vertical clearance of 14 ft 00 in (4.3 m) and also served by a single interstate route, however IDOT policy must be considered.

PROJECT IDENTIFICATION FIELDS

Key Route: This should be the key route number for the facility, if it has one. Typically, this will be an FAI, FAP, FAU, or FAS number, e.g. FAP 341.

Marked Route/Road Name: This should be the interstate, state or U.S. route marking, if the route has one, e.g. Illinois Route 72, followed by the name the route is known as locally, if one exists. Typically, this will be a street, road, avenue or such, e.g. Higgins Road, Main Street.

Contract #: This should be state contract number associated with the project, if any, e.g. 60166.

State Job #: This should be a P-, D- or C- number assigned to the project, e.g. C-91-367-10.

Section: This should be a section number assigned to the project, e.g. 177-2-1A, 177-2B-1, 177-2VB-1.

County(ies): This should be any counties in which the project is located, e.g. Cook, Pike.

Municipality: This should be any municipalities in which the project located, e.g. Schaumburg, Moline.

Local Agency: This should be any local public agency, if it is a primary lead on the project, e.g. Village of Schaumburg.

LRS Section #: This should be the section number assigned to the project by the Bureau of Local Roads and Streets, e.g. 11-00237-10-WR.

Permit Applicant: This should be the name of any entity named as applicant for the Highway Permit associated with the work of the project. This can be a local agency or a private property owner, e.g. City of Rockford or Rubloff Development Group.

Permit #: This should be the number assigned to any associated Highway Permit by district staff, e.g. C-050658.

Project Limits: This should be the specific limits of the project for which an exception is being requested.

Project Length: This should be expressed in miles and feet, if possible.

Estimate of Cost: This should be the construction cost of the entire project for which the exception is being requested.

GUIDELINES FOR COMPLETION OF FORM BDE 3100, "DESIGN EXCEPTION REQUEST- PROJECT IDENTIFICATION"

Figure 31-7.A
(1 of 6)

Design Year: This is the year of the conditions for which the project is being designed. For instance, the design year and construction year is typically 20 years in advance of the construction year for new construction/reconstruction projects.

Functional Classification: This should be the functional classification as described in BDE Manual Chapter 43 and shown on the Getting Around Illinois website at <http://www.gettingaroundillinois.com/gai.htm?mt=fc> - interstate, non-interstate freeway or expressway, other principal arterial, minor arterial, major collector, minor collector and local road or street. Please note that Strategic Regional Arterial (SRA) is not a functional classification, but a highway type.

Design Traffic: ADT: This should be the average daily traffic for the design year which appears in the field directly above.

Design Traffic: DHV: This should be the design hour traffic for the design year shown above for both the a.m. and p.m. weekday peaks. Non-weekday peak hour design volumes can be added, if appropriate.

Current Posted Speed: This should be the posted speed limit in the vicinity of the requested exception.

On the NHS System? This should indicate the route's presence, or lack thereof, on the National Highway System (NHS). Check applicable box. NHS status can be verified at <http://www.gettingaroundillinois.com/gai.htm?mt=fc#>.

Structure Numbers: Include the number of any structures included in the project.

Type of Project (Construction, Reconstruction, 3R, 3P, SMART, HSIP): This should be project categories as described in the BDE Manual Chapters 44 through 50, 52, and 53; and Safety Policy 1-06.

Brief Project Description: This should be a brief and concise, yet comprehensive, synopsis of the work to be undertaken for the project.

EXCEPTION DOCUMENTATION FIELDS

Level of Exception: Level One exceptions are the 13 controlling design criteria established by FHWA on the interstate system only, and noted on the "Level One Design Criteria Checklist" form BDE 3107. Exceptions to all other design criteria on the interstate and non-interstate system are considered to be Level Two, and noted on the "Level Two Design Criteria Checklist" form BDE 3108. Check the applicable box.

GUIDELINES FOR COMPLETION OF FORM BDE 3100, "DESIGN EXCEPTION REQUEST- PROJECT IDENTIFICATION"

Figure 31-7.A
(2 of 6)

Design Element for Which an Exception Is Requested: This should be the specific criterion for which the designer is requesting an exception. This should also not typically contain the location of that exception. Each form should have only one design criterion for which an exception is being requested, e.g. guardrail length of need; turn lane taper length; level-of-service. Examples of what this should NOT be: encroachment; RT movements; painted median; isolated ditch cleaning; outside roadway ditch. If there is more than one location which requires the exception, this should be noted in the field, e.g. level-of-service (5).

Design Element Policy Value: This should be the specific value of the criterion noted in the field above from the appropriate design document. For instance, the criterion for which an exception could be requested is turn lane storage at a signalized intersection. The BDE Manual Section 36-3.02.b dictates such minimum storage based on a red-time equation, as an example, say 400 feet. Also, the specific design document for the policy value should also be noted in this field to facilitate review of the form and its associated exception. The proper entry for this field in this case would be: 400 feet, BDE Manual Section 36-3.02.b.

Proposed Design Element Value: This should be the proposed value of the design feature for which the exception is being requested. The designer should arrive at this value by weighing all the project constraints, impacts and costs to optimize the feature's value. For the example in the field above, the entry could be "300 feet". Each form should have only one value of a design feature for which an exception is being requested.

Location(s) of Exception: This should include any and all locations of the specific exception noted above.

Crash History and Potential of Exception Location(s): This should be a very brief summary, and should always include the presence of any Five Percent Report Location, or lack thereof. Also, note any specific incidents which might directly affect the design feature for which an exception is being requested.

Cost of Using Policy Value: This should be the cost which would be required if the policy-stipulated design feature value would be used on all locations noted above.

Cost of Using Proposed Exception Value: This should be the cost if the design feature value for which the exception is being requested would be used on all locations noted above on the project. The purpose of this field and the one directly above is to determine both the difference in cost between the two design feature values, as well as that cost compared to the total construction cost of the project.

Impacts Other Than Cost, of Using Policy Value: This should comprise any considerations other than strictly monetary which compelled the designer to choose the excepted design feature value. Typically, this includes impacts to historic or recreational properties or the requirement to increase project scope to accommodate the policy-stipulated design feature value. If there are none, the appropriate response is N/A.

**GUIDELINES FOR COMPLETION OF FORM BDE 3100,
"DESIGN EXCEPTION REQUEST- PROJECT IDENTIFICATION"**

Figure 31-7.A
(3 of 6)

Proposed Mitigation to Address Exception: This should include any measures added to the project to alleviate the potential effects of the use of the excepted design value. This typically includes augmented traffic control, street lighting or other relatively low cost improvements. If there are none, the appropriate response is N/A.

Geometric Compatibility with Adjacent Sections: This is to ensure that the cross-section of the project containing the excepted design feature is consistent with those into which it will match at its termini. The appropriate text for this field is “Compatible.” If this is not the case, the designer should re-evaluate the project’s proposed design choices.

Potential Effects on Other Design Elements: This should contain any conceivable impacts to other project design features resulting from the choice of the policy-stipulated design feature value versus the excepted feature value. For instance, there are cases where the choice of a compliant policy value for a turn lane taper would require reducing the needed storage for that lane. Or, establishing both full storage and taper lengths at that location might require relocation of the intersection with consequent effects on the storage and taper lengths of the opposing approach. If there are none, the appropriate response is N/A.

Potential Impacts on Mobility or Traffic Operations: This should contain any possible effects the choice of the excepted value might have on facility safety, capacity or level-of-service. For instance, the choice of an excepted value for turn lane storage could increase queues sufficiently on that approach such that traffic regularly does not clear during a single traffic signal cycle, with consequent reduction in capacity and level-of-service. This excepted value could also possibly increase the likelihood of rear-end crashes on that approach. If there are none, the appropriate response is N/A.

Summary of Justification for Exception: This should be a brief and concise synopsis of why the excepted value would be the best choice given the totality of the pertinent circumstances.

Coordination Meeting Date: This should be the date of the meeting at which the exception was presented to BDE/FHWA representatives and at which the exception was approved or denied. Alternatively, if the exception was processed by e-mail or phone, this should be the date the exception was requested.

Prepared By: This should be the name of the individual who actually filled out the form and did the requisite analysis for the exception. If the person is employed by an outside entity, such as a consulting firm or local agency, that should also be noted in this field, e.g. John Doe, ABC Consulting.

Date: This should be the date the form was completed or revised for final approval or denial.

**GUIDELINES FOR COMPLETION OF FORM BDE 3100,
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Figure 31-7.A
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PAVEMENT/RESURFACING EXCEPTIONS FIELDS

New Pavement, Pavement Widening, Resurfacing: The appropriate box should be checked, based on the scope of the project in question. All Pavement/Resurfacing Exceptions fields should be blank or contain N/A, unless the exception requested is pavement-related only.

Design Period/Expected Service Life: This should be the result from the design procedures outlined in the BDE Manual Chapters 52, 53, and 54.

Design Year: This should be the result of the design procedures outlined in the BDE Manual Chapters 52, 53, and 54.

Structural Design Traffic: This should be the result of the design procedures outlined in the BDE Manual Chapters 52, 53, and 54.

%PV, %SU, and %MU: This should be the result of the design procedures outlined in the BDE Manual Chapters 52, 53, and 54.

Design Element Policy Value: This should be the specific criterion for which the designer is requesting an exception, from the BDE Manual Chapters 52, 53, and 54.

Proposed Design Element Value: This should be the result of the design procedures outlined in the BDE Manual Chapters 52, 53, and 54.

Location(s) of Exception: This should include any and all locations of the specific exception.

Cost of Using Policy Value: This should be the cost which would be required if the policy-stipulated design feature value would be used on all locations noted above.

Cost of Using Proposed Exception Value: This should be the cost which would be required if the design feature value for which the exception is being requested would be used on all locations noted above on the project. The purpose of this field and the one directly above is to determine both the difference in cost between the two design feature values, as well as that cost compared to the total construction cost of the project.

Summary of Justification: This should be a brief and concise synopsis of why the excepted value would be the best choice given the totality of the pertinent circumstances.

Prepared By: This should be the name of the individual who actually filled out the form and did the requisite analysis for the exception. If the person is employed by an outside entity, such as a consulting firm or local agency, that should also be noted in this field, e.g. John Doe, ABC Consulting.

Date: This should be the date the form was completed or revised for final approval or denial.

GUIDELINES FOR COMPLETION OF FORM BDE 3100, “DESIGN EXCEPTION REQUEST- PROJECT IDENTIFICATION”

Figure 31-7.A
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APPROVAL FIELDS

BDE Approval Date: This is the date on which the BDE staff approves the exception. This date may or may not coincide with a date in the Coordination Meeting Date field, from above on the form.

FHWA Approval Date: This is the date on which the FHWA staff approves the exception. Such exceptions are granted pursuant to the BDE Manual Section 31-7.04 and the department's stewardship and oversight agreement with FHWA. This date may or may not coincide with a date in the Coordination Meeting Date field, from above on the form.

GENERAL

Separate forms should be completed for each specific exception. For instance, say the level-of-service criterion for a given location on the project is "C". If the designer determines the best choice for actual design for the project is "D" at the same location, or for the entire project. This will require completion of a single BDE 3100 form. If it happens that precisely the same exception to precisely the same design criterion occurs on other places on the project, those exceptions may be added to this form. This should then be duly noted in the Location(s) of Exception and Design Element for Which an Exception Is Requested fields as previously discussed.

Conversely, say a designer requests an exception for a Turn Lane Storage value of 100 feet. The BDE Manual dictates a minimum value of 135 feet. This exception will require one BDE 3100 form. Say the designer has a similar exception to the 135 feet criterion, but it is 90 feet, not 100 feet as in the first exception. This second exception would require a second BDE 3100 form because the exception is not precisely the same as that requested in the first exception form.

If a request is for an exception to a geometric or drainage design criterion, all fields in the areas of Project Identification and Exception Documentation should be filled. If a specific field does not apply, it should be completed with N/A. In such cases, all fields in the area of Pavement/Resurfacing Exceptions should be left blank.

If a request is for an exception to a pavement or resurfacing design criterion, all fields in the area of Pavement/Resurfacing Exceptions should be filled. If a specific field does not apply, it should be completed with N/A. In such cases, all fields in the area of Exception Documentation should be left blank. Also in such cases, all fields in the areas of Project Identification should be filled. If one of those specific fields does not apply, it should be completed with N/A.

GUIDELINES FOR COMPLETION OF FORM BDE 3100, "DESIGN EXCEPTION REQUEST- PROJECT IDENTIFICATION"

Figure 31-7.A
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31-8 REFERENCES

1. *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2011.
2. *Highway Capacity Manual 2010*, Transportation Research Board, 2010.
3. NCHRP Report 400, *Determination of Stopping Sight Distances*, Transportation Research Board, 1997.
4. *Stopping Sight Distance for Large Trucks*, TRR 1208, Transportation Research Board, 1989.
5. Report No. FHWA-TO-81-1, *A User's Guide to Positive Guidance* (2nd Edition), FHWA, 1981.
6. *Manual on Uniform Traffic Control Devices*, FHWA, ATSSA, AASHTO, and ITE, 2009.
7. Martin, S.F.J., *Design Exceptions: Legal Aspects*, TRR 1445, Transportation Research Board, 1994.
8. *A Policy on Design Standards – Interstate System*, AASHTO, 2005.