

Chapter 3

DESIGN CONSIDERATIONS AND CRITERIA

Introduction

The objective of highway design is to provide a safe, efficient, economical and environmentally compatible highway system. When good judgment and application of design considerations and design criteria are adopted, the planned level of service is reached.

This chapter explains general guidelines and those elements of highway design which must be addressed to ensure that highway facilities safely accommodate current and projected traffic volumes. These guidelines are divided into the two broad categories of general requirements and geometric requirements. General requirements are based on functional classification and relate to features of the cross section which influence safety, level of service, comfort, and convenience. Geometric requirements are a function of the design speed and relate to features of alignment which are controlled by the physical characteristics of motor vehicles and limitations of drivers.

In this chapter and subsequent chapters, references are made to guidelines, criteria, design controls, and design elements. In this manual, these meanings are:

- Guidelines — procedures for design adopted by the NHDOT and the way they are implemented,
- Criteria — standards which influence design,
- Controls — restraints affecting the application of guidelines or criteria, and,
- Design Elements — identifiable segments of the design objective.

Considerations

Design considerations are factors to be observed when practicing systematic design. The main ones are: safety, environmental, cost, constructability, maintenance, and highway function within the overall system.

Safety

Safety is the principal design consideration. All designs have maximum safety as their objective.

Emphasis on safety has also come from the Congress of the United States with passage of the Highway Safety Act of 1966, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), from the Federal Highway Administration (FHWA) by endorsement of the AASHTO *A Policy on Geometric Design of Highways and Streets* "Green Book" (5), the *Roadside Design Guide* (6) and from State and Local government.

In addition to highway design, consistency is an important safety consideration. High traffic volumes and operating speeds require quick driver response. Driver expectancy is a term

which relates the driver's anticipation to reaction time. If designs are consistent, there are no surprises to overload the driver's thought process, which may cause an accident. Reinforced expectancies help drivers respond quickly and correctly. Unusual situations that violate expectancies may cause longer response times, inappropriate responses, or errors of judgment.

Most design features are sufficiently similar to create expectancies related to common geometric, operational, and route characteristics. For example, because most freeway interchanges have right exits, drivers generally expect to exit from the right. This aids performance by enabling quick and correct responses when right exits are to be negotiated. There are, however, instances where expectancies are violated. For example, if an exit is on the left, then the right-exit expectancy is incorrect, and the decision sight distance may need to be lengthened to compensate for the additional reaction time.

Environmental

Traffic volume and speed are the basis for criteria which affect operation and safety. Preservation of the environmental status quo and/or environmental enhancement is an equally valid basis for design but the standards are not as well defined.

The Bureau of Environment and others monitor the development of projects and interject design elements or modifications as needed to comply with environmental concerns. Such concerns as air quality, water quality, or noise have standard tolerances to be followed. Wildlife, historic/archeological resources, wetlands, hazardous materials, floodplains, etc. are more subjective and are treated on a project-by-project basis.

In all environmental matters, the designer should coordinate with the Bureau of Environment and review the project files periodically to stay current with developments.

Cost

Economy of design without sacrificing other considerations is the designer's goal. Alternative designs should be studied as well as alternative locations. "Desirable" design criteria must be used whenever possible. Minimum design criteria are used only when dictated by overriding factors.

A Cost/benefit analysis may be used, when appropriate, to decide upon nearly equal designs.

Constructability

Constructability, i.e., limitations of construction methods and materials, is important. Consider the following:

- Traffic Control during construction must be carefully thought out early in the design process to provide for needs, e.g., temporary widenings that may require temporary construction easements;
- Plans must be clear to avoid misrepresentation or misinterpretation;
- Sufficient information must be shown for the design to be constructed as intended;

- Small-quantity bid items should be avoided, if possible. Combine similar work when appropriate;
- Check plans/sections, estimate and proposal to avoid conflicting information; and,
- Coordinate with the District Construction Engineer to resolve specific construction related design issues.

The designer should become familiar with construction practices and use the *Standard Specifications for Road and Bridge Construction (7)* as a design reference.

Frequently, the availability of funds does not permit the initial construction of the highway design ultimately required for traffic volumes within the design period. When current and short-term future traffic needs do not immediately require the ultimate design, the highway may undergo stage construction.

Construction may be categorized as follows:

- Relocation — construction of a new highway facility on new location. All facets of the guidelines shall be applicable with few exceptions. With improvements of this magnitude, a change in alignment, where feasible, is preferable to compromising the design.
- Reconstruction — rebuilding an existing highway to higher design standards with a substantial portion of the existing facility replaced or expanded. It will include all projects which provide for an increase in the number of traffic lanes. All facets of the design guidelines shall be applicable and deviations will be approved only where there is a substantial environmental or economic benefit, provided that the resulting level of safety is acceptable.
- Rehabilitation — the improvement of an existing highway utilizing a major portion of it, but correcting structural and functional deficiencies to bring most elements of the roadway and structure cross sections into conformance with the guidelines. All facets of the design guidelines shall be applicable except that existing horizontal and vertical alignments may remain in place, if appropriate. Projects which provide additional traffic lanes are not included in this type of construction with the exception that truck climbing lanes may be included.
- Resurfacing — a temporary improvement to extend the service of life of the existing pavement usually by pavement leveling and overlay and sometimes providing shoulder improvement, in order to keep a highway open to traffic with a tolerable riding surface without rehabilitation or reconstruction. This type of construction will not normally include pavement widening. The overlay may be placed on a continuous or intermittent basis as structurally required by the condition of the existing traveled way. The design guidelines are applicable to this type of construction as guides to aid in eliminating deficiencies. Where correction of deficiencies is necessary, such corrections should comply with design guidelines and be compatible with the remainder of the route.

There are many special projects which are constructed to fill specific needs such as bridges, traffic signals, street lighting, signing, pedestrian and bicycle facilities, landscaping and so on.

No set of guidelines, however comprehensive, can replace sound engineering judgment and experience. Each construction project must be considered individually with respect to the factors controlling its design, as well as collectively with other projects comprising the overall improvement.

Maintenance

Maintenance work begins after the construction is completed. Insufficient or inappropriate design causes additional maintenance effort or may require further construction to correct the design flaw.

More attention is now being given to maintenance responsibility. Suspected problem areas should be reviewed with the District Maintenance Engineer responsible for that area early in the design process.

Problems arise from drifting snow created by highway appurtenances, lack of snow storage space, lack of plow room, plow obstructions, and lack of drainage with snow melt. Drifting snow will typically occur where the surrounding area is higher than the road and has no obstruction to divert the wind. Avoid roadway cuts in open areas. Well placed landscape screening or fencing can reduce the incidence of drifting snow. Poorly placed screening, however, can cause snow to accumulate in the wrong places.

After snow has been plowed from the pavement, the snowbanks melt during the day, drain across superelevated pavements, freeze at night, block drainage, and cause icing problems. Areas on and adjacent to bridges should be carefully evaluated because bridge decks freeze before roadway pavement surfaces. A solution is to continue the shoulder break through the bridge area, allowing melting snow on the high side of superelevated curves to drain off, not across, the pavement. Any such considerations should be discussed early during the review process.

Sometimes sign posts, curbs, and other highway appurtenances make plowing difficult. Keep such obstructions back from the pavement to allow more area for snow storage or snow pickup especially in urban areas.

Consideration should also be given to designing cross sections and raised islands to contain or divert snow-melt from the pavement. (Refer to Sample Layouts in Volume 2.)

In addition to snow, other maintenance problems include washed out pipe ends, undercut headwalls, plugged culverts, clogged basin grates, washed out ditches, and slope and pavement failures. The experienced designer can include provisions to minimize premature deterioration requiring additional maintenance by being aware of these problems. Space should be provided when setting right-of-way lines and easement areas to allow access to structures and slopes, particularly around drainage and high fills. (This issue is further discussed in Chapter 10, "Right-of-Way.")

Highway Function

The highway functional concept is important to the designer. The relationship of function to administrative or legal classification is more fully explained in Chapter 2 but, for purposes of design, there are four (4) main functional highway classifications:

- Local Roads and Streets — primarily serve as access to residences, businesses or other abutting properties. Also included are Special Purpose Roads, which include recreational roads, resource development roads, and local service roads.
- Collector Roads and Streets (Rural and Urban) — collect traffic between local roads and arterial streets and provide access to abutting properties.
- Arterials (Rural and Urban) — provide a high speed, high volume network for travel.
- Freeways (Interstates and Turnpikes) — are not a functional class by themselves but rather principal arterials, are defined as expressways with fully controlled access. Freeways are considered separately because of their unique design.

The “Green Book” has specific information and design criteria pertaining to each classification. It is the intent of this Manual to emphasize the more common design guidelines and standards as a quick reference.

Designs vary between urban and rural highways and between highways with different functions. Rural highways are characterized by high-speed, low-density traffic with shoulders and open drainage channels as elements of the design. Conversely, urban highways are characterized by relatively low-speed, high-density traffic with curbs and underground drainage as elements of the design.

The distinction between rural and urban highways is quite apparent when comparing a highway in open farmland to one in the business district. The distinction is not quite so apparent, however, when a two-lane highway passes through the center of a relatively small community or a divided highway traverses the suburbs of a metropolitan area. For the purpose of applying the design guidelines, highways shall be considered as urban where it is desirable or necessary to construct or reconstruct an urban cross section.

Criteria

Design criteria help to establish levels of acceptable performance. They are tabulations of dimensions or values, usually given as a minimum figure. The designers’ approach should be flexible within the range of allowable criteria and not necessarily fixed at the “minimum” level.

Criteria are disseminated through publications, directives, or sometimes by verbal instructions. The record of basic criteria used on a project is indicated on the front sheet of most highway construction plans and is called “Design Data”. Major criteria are summarized in the Engineering Report and must be followed by the designer unless otherwise discussed with the Highway Design Administrator.

Design Data

The design data indicates the general conditions and controls for a specific project and is shown in the upper right area of the front sheet of the plans usually in the format indicated in Figure 3-1.

Average Daily Traffic (Year)_____	(the year of construction)
Average Daily Traffic (Year)_____	(the projected year, normally 20 years)
Percent of Trucks _____	percent of ADT
Design Speed _____	km/h
Length of Project _____	kilometers

Figure 3-1
DESIGN DATA

Guide Publications

In addition to this Manual, The NHDOT publishes a number of references frequently used in the design process:

- *Standard Specifications for Road and Bridge Construction* (7),
- *Manual on Drainage Design for Highways* ("Drainage Manual") (8),
- *Administrative Rules For The Permitting Of Driveways And Other Accesses To The State Highway System* (the "Driveway Manual") (9),
- *Work Zone Traffic Control Standards*,
- *Utility Accommodation Manual* (10),
- *NH Statewide Bicycle and Pedestrian Plan* (11).

The FHWA *Federal-Aid Policy Guide* (12) contains FHWA policies affecting the NHDOT. See Appendix 3-1 for a copy of the applicable pages of the Federal-Aid Policy Guide.

An important FHWA publication which designers should be familiar with is the *Manual on Uniform Traffic Control Devices* (MUTCD) (13).

The American Association of State Highway and Transportation Officials (AASHTO) produces numerous references endorsed by both the NHDOT and the FHWA. The NHDOT closely follows the criteria provided by the AASHTO series, primarily the "Green Book" and the *Roadside Design Guide*. In some cases, the NHDOT criteria are higher than that suggested by AASHTO.

All AASHTO publications relative to highway design are maintained in the Department's library which is located in the Bureau of Transportation Planning.

The National Cooperative Highway Research Program (NCHRP) Reports and various Transportation Research Board (TRB) Reports cover the field of highway and traffic engineering, most notably TRB Special Report 209: *Highway Capacity Manual*. (14).

Suppliers, manufacturers, and trade associations distribute books, pamphlets and sales information helpful to designers. Usually the items are "off-the shelf" products such as electrical apparatus, pumps, industrial fabrics, chemicals, etc. Manufacturers of patented retaining walls, gabions, slope stabilizing products, drainage pipe and structures, and other site applications employ sales engineers who can be helpful in developing designs which incorporate their product. Note that on Federally funded projects, the use of "proprietary items" (products) may only be used under certain circumstances and, furthermore, may require follow-up reporting by the Bureau of Materials and Research. (See Appendix 3-2 for additional information.)

Other References

Past projects are important and frequently used as references. (Refer to the proposal print file and hanging files located in Records Section.) Supervisors may recognize similar problem situations which were successfully resolved and suggest certain past projects to reference which illustrate the solution.

There are many other sources of information helpful to the designer, but the ones mentioned are the most common references.

Design Exceptions

Departure from criteria is sometimes allowed. If the criteria cannot be attained, except at great cost, find another solution or consider a "design exception." A design exception is a documented agreement to waive established criteria based upon valid reasons. Designers cannot use exceptions freely and never without the Assistant Commissioner's approval and FHWA approval on Federal overview projects.

These criteria relating to design speed, lane and shoulder widths, bridge widths, structural capacity, horizontal and vertical alignments, grades, stopping sight distances, cross slopes, superelevations and horizontal and vertical clearances contained or referenced in the functional chapters (VI, VII and VIII) of the "Green Book" are the controlling criteria and require formal design exception when not met. When a particular design element for a selected design speed will be less than the speed limit, a design exception for the element must be requested. In the absence of material covering controlling criteria in the functional chapters, material may be found in Chapters III and IV.

Formal documentation of a design exception request shall be in the form of a Conference Report or letter requesting waiver of design criteria. The following items shall be included when requesting a design exception:

1. Town/City.
2. Federal and State project numbers.
3. Route, street name, project limits.
4. Functional classification.

5. Nature of design exception.
6. Current standard (Reference established standard).
7. Traffic data including Average Daily Traffic (ADT), Design Hourly Volume (DHV), and percent trucks for the present and design year.
8. Type of project (relocation, reconstruction, etc.).
9. Accident record data base (consolidated file, number of years, etc.).
10. Accident data including numbers of fatals, injuries, which are Property Damage Only (PDO), and rates of each.
11. Accident analysis of roadway section including discussion of predominant accident types, predicted accident record with and without exception, and other issues stemming from the analysis.
12. Estimated cost savings with exception and mitigation of environmental impacts which may result.
13. Any other compelling reasons to reduce the current standard.

An example of a design exception request for both Federal overview and exempt projects is provided in Appendices 3-3 and 3-4.

Basic Factors Influencing Design

Design is based on a number of factors:

- Traffic volume,
- Design elements,
- Expected operating speed,
- Highway capacity,
- Highway system,
- Access control, and
- Environmental considerations.

The dominant factors are traffic volume, design elements and environmental considerations which are explained next.

Traffic Volume

Most of the criteria defining the geometric characteristics of highway cross section elements are related to traffic volumes. (Geometric criteria adopted for use are illustrated in Volume 2.)

Design Elements

Traveled Lanes

The required number of lanes depends primarily on traffic volume and the design level of service. Usually, the number of lanes will be determined during the preliminary design phase. Designers will also be concerned with analyzing the need for auxiliary lanes.

The traveled way designated for vehicle operation (excluding shoulders) normally consists of two or more paved traffic lanes. The lane width depends primarily on traffic volumes and ranges from 3.0 m for minor town roads to 3.6 m for most major highways.

Shoulders

Well-designed and maintained shoulders are necessary on rural highways with any appreciable traffic volume. A shoulder is the portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base course and pavement. Provision for bicycles is sometimes designated in shoulder areas. Shoulders intended for bicycle use should be a minimum of 1.2 m wide (uncurbed) or 1.5 m wide where adjacent to curbing.

Shoulder widths range from 1.2 m to 3.6 m (on major facilities) and may be less on minor local roads. All shoulders are paved unless otherwise approved.

Where roadside barriers are used on high speed facilities (divided highway), it is desirable to offset them an additional 0.6 m from the "useable" shoulder width, i.e., a 3.0 m shoulder becomes a 3.6 m shoulder.

On divided highways with greater than 2 travel lanes in each direction, median shoulder width is increased from 1.2 m to 3.0 m (3.6 m on Federal-Aid projects in guardrail areas.)

Medians

Medians on rural highways should be of sufficient width to provide freedom from interference by opposing traffic, minimize headlight glare, and assure safe operation of vehicles at intersections and crossovers.

Median width is the distance between edges of traveled ways of the separated roadways. The minimum desirable median width without a median barrier on rural multi-lane State highways is 15 m. Wider separation is desirable (27 m is recommended) where independent grade lines are used for each roadway.

In urban areas with severe right-of-way restrictions, the median width of State and other controlled access multi-lane highways may be less than the above dimensions if a median barrier is used. The minimum median width is 4.2 m (two 1.8 m shoulders and a 0.6 m barrier) for a facility with 2 travel lanes in each direction, and 7.8 m (two 3.6 m shoulders and a 0.6 m barrier) for a facility with greater than 2 travel lanes in each direction. Any median barrier will impose maintenance and safety concerns, therefore, wider medians (not requiring a barrier) are preferable.

Vertical Clearance

Vertical clearance is measured from overhead structures to the finished roadway surface or highest rail of the railroad. The designated clearance must be provided over the entire usable roadway width including shoulders. Figure 3-2 shows the established minimum vertical clearances:

Clearances must be shown on all profiles, both preliminary and final.

For additional information regarding coordination that is needed for vertical clearance design exceptions on the Interstate System, see Appendix 3-5.

Figure 3-2
MINIMUM VERTICAL CLEARANCES

Local road under Interstate with interchange	5.1 m
Local road under Interstate without interchange	4.5 m
Local road under all other roads	4.5 m
Local road under railroads	4.5 m
State Route under Interstate with interchange	5.1 m
State Route under Interstate without interchange	4.5 m
State Route under all other roads	4.5 m
State Route under railroads	4.5 m
Interstate Route under all roads	5.1 m
Interstate Route under railroads	5.1 m
Railroad under all roads	6.9 m *

* Minimum vertical clearance is measured from the top of high rail to the bottom of low edge of the bridge. The minimum vertical clearance by State Law is 6.7 m (22'-0"), however, railroads prefer a desirable minimum vertical clearance of 6.9 m (22'-6"). Clearances of less than 6.7 m have been approved in certain instances, such as replacement of an existing substandard clearance bridge with extreme roadway constraints near the structure.. If a clearance of 6.7 m is found to have impacts that are too severe, a vertical clearance of 6.4 m (21'-0") is acceptable with the railroad and should be investigated. If impacts are still too severe, review the situation with the Commissioner and present the limiting factors supporting the recommendation to reduce the vertical clearance lower than 6.4 m. For any variance under 6.9 m, the design of the bridge foundation will take into consideration future lowering of the tracks by the railroad.

Check with the Chief of Design Services to verify required clearances when railroads are involved.

Lateral Clearances

Adequate lateral clearance between the edge of traffic lanes and roadside obstructions is an important safety factor. Vehicles leaving the roadway should have reasonable opportunity to recover control and return to the roadway without overturning or colliding with trees, poles, headwalls or other objects. The *Roadside Design Guide* provides in-depth coverage of the clear zone issue.

In New Hampshire, the minimum lateral clearance from the traveled way for interstate highways and major arterials for the purpose of 4R work is 9.0 m. The minimum lateral clearance from the traveled way for ramps and most State highways with 2.4 m shoulders is 6.0 m. There may be instances where environmental or other considerations will dictate less offset, but for these instances, the approval of the Highway Design Administrator is needed.

Breakaway-type light poles and sign posts are permitted in the clear zone. Slopes in the clear zone should be as flat as practical, i.e., not steeper than 4:1 (H:V).

Lateral clearances for situations involving utility poles are described in the *Utility Accommodation Manual*.

In situations where guardrail is installed in areas that include roadside obstructions, the lateral clearance shall equal or exceed the full shoulder width plus the design deflection of the guardrail. (See the *Roadside Design Guide* for roadside and median guardrail deflection.) Allowance should also be considered for vehicle roll when impacting guardrail (typically an additional 0.6 m).

Bridge Width

- **New (Relocation or Reconstruction):** Bridge width dimensions refer to the clear width between bridge rails. This width should not be less than the approach width, i.e., traveled way plus paved shoulders. A reduction in this width can be made for “brush curb” which is inset from the face of bridge rail up to 150 mm; however, the minimum clear width between curbs should not be less than 7.2 m.
- **Existing (Reconstruction or Rehabilitation):** The minimum clear width should not be less than the approach traveled way and in no case less than 7.2 m between curbs.

AASHTO provides minimum clear roadway widths based on functional classification of roadways. Compare proposed bridge widths with the “Green Book” standards to ensure compliance.

Each existing structure should be evaluated by the Bureau of Bridge Design before widening of the existing road is planned. The expected service life of the bridge, condition, width, compatibility with the new road width, and the geometry of tapered roadways approaching the bridge should be evaluated.

There are three (3) pedestrian situations where guidelines have been established:

- Case I: Pedestrians are prohibited and/or where pedestrian traffic of sufficient volume is not anticipated for the design life of the structure.

Guideline: Structures will not be designed to accommodate pedestrians.

- Case II: There is not sufficient current pedestrian volume to warrant sidewalks on the roadway but sufficient pedestrian volumes may be anticipated during the design life of the structure which would require widening the roadway.

Guideline: Structures will be designed with sufficient width to provide for future sidewalk construction. This will be accomplished by widening the deck from curb to curb to include the width of a future sidewalk. These additional widths should be tapered on the approaches in a safe and logical manner.

- Case III: Current and/or future pedestrian traffic volumes are sufficient to warrant sidewalks on the roadway. In this case, the roadway will include barrier curbs at the outer edge of the shoulders.

Guideline: Structures will be designed with a raised sidewalk and barrier curb to match the approach roadway curbed section.

In no case shall bridges be designed with a raised sidewalk and curbs which do not match roadway approach curbs. All sidewalks shall be designed in accordance with current Americans with Disabilities Act (ADA) guidelines.

Right-of-Way Width

There is no fixed rule for setting right-of-way widths other than general guidelines found in the "Green Book". Each situation must be evaluated individually based on the width requirements for the proposed roadway improvements, economic factors and consideration of the existing right-of-way layout. The procedures for acquiring right-of-way are discussed in Chapter 10.

Pavement and Shoulder Slopes

The pavement surface must be sloped sufficiently to ensure proper drainage, yet not so steep as to adversely affect vehicle operation. Normally, paved traveled way slopes on tangent sections shall be 2 percent, and paved shoulder slopes 5 percent for rural highways but can be 2 percent in some curbed urban areas.

Design Speed

Speed reduces the visual field, restricts peripheral vision, and limits the time available for the driver to perceive and react. Highways built to high design standards help compensate for these limitations by simplifying control and guidance activities, by aiding drivers with appropriate information, by placing this information within the cone of clear vision, by eliminating much of the need for peripheral vision, and by simplifying the decisions required and spacing them further apart to decrease thinking demands.

Design speed is the principal factor that must be correlated with the physical features of design to achieve a roadway that will accommodate the traffic safely for the planned use. Once a design speed is selected, all geometric features should be related to it to obtain a

balanced design. Changes in terrain and other physical controls may dictate a change in design speed in certain sections. A decrease in design speed along the road should not be introduced abruptly, but extended over a sufficient distance to allow the driver to adjust and make the transition to the lower speed.

Design speed criteria are shown in Chapter 4, Alignment and Typical Sections, and Chapter 5, Geometrics.

Three (3) considerations are directly related to the selected design speed:

1. Horizontal curvature and superelevation
2. Vertical curvature and grade
3. Sight distance

The minimum guideline values for these design considerations should always be provided regardless of traffic volumes, highway classification or any other factors influencing design. These design considerations are closely related to traffic safety and should not be compromised.

Horizontal Curvature and Superelevation

In the design of highway curves, it is necessary to establish the proper relation between design speed and curvature and also their joint relations with superelevation and side friction. Although these relations stem from laws of physics, the actual values for use in design depend on practical limits and factors determined more or less empirically over the range of variables involved. These limits and factors are explained further in the *Elements of Design* chapter in the "Green Book".

The maximum permissible rate of superelevation is an example of practical limitations. Highways must serve vehicles traveling at a wide range of speeds. Slow-moving vehicles or stopped vehicles would be adversely affected with excessively steep superelevations, particularly in areas subject to ice and snow. The Department has adopted maximum superelevation rates of 8 percent for rural highways, 6 percent for ramps, and 4 percent for urban highways and for some rural intersections to minimize side slip and loss of control.

Complete tables of superelevation rates for various combinations of design speed and curvature are shown in Chapter 4, Alignment and Typical Sections. As a general rule, less superelevation is needed for flat (large radius) curves. As the radius decreases (sharper curve), the rate of superelevation must increase. When the required superelevation reaches 8 percent, the minimum permissible radius is established for that particular design speed. Correspondingly, minimum radii are established for all design speeds.

Vertical Curvature and Grades

Establishment of criteria for grades is not as objective as for other geometric elements of highways. The "Green Book" has established recommended maximum grades, based primarily on analysis of vehicle operating characteristics, design speeds, highway types and common practice among highway agencies. Refer to the "Green Book" for tables of maximum allowable grades based on the highway functional class (freeway, arterial, collector, local) in rural or urban areas.

More detailed guides and criteria for design of grades are presented in Chapter 4, Alignment and Typical Sections.

Sight Distance:

Sight distance is the length of roadway ahead visible to the driver. The minimum sight distance available must be sufficient to enable a vehicle traveling at the design speed to stop before reaching a stationary object in its path. Chapter 4, "Alignment and Typical Section", shows sight distance requirements for both stopping and passing sight distance conditions.

Refer to the "Green Book" for a thorough explanation of the concepts and procedures for defining required stopping sight distance. It is sufficient for this Manual to identify the sight-distance requirements for various design speeds, and to recognize those conditions which should be thoroughly investigated to ensure that adequate sight distance is provided.

Sight distance can be restricted by vertical curvature, horizontal curvature, roadside obstructions or any combination of these elements. Graphic procedures for checking sight distance are described in the "Green Book".

Stopping Sight Distance

Stopping sight distance allows the "average driver" to come to a stop if perception reaction time is 2.5 seconds and the vehicle can decelerate to a stop in a distance "d", where:

$$d = \frac{V^2}{254 f}$$

d = braking distance, m;

V = initial speed, km/h; and,

f = coefficient of friction between tires and roadway

Stopping sight distance is usually measured between the driver's eye and an object in the road whose respective heights are 1070 mm and 150 mm. Sometimes the sight distance should be measured to the road surface, sign or signal head, or other object to allow greater perception time for the driver. (Note "Decision Sight Distance" later in this chapter.)

Established minimum and desirable stopping sight distances are shown in Figure 3-3 of this chapter. Designers should always try to provide the desirable sight distance. Minimum values should be used only for unusually restrictive conditions.

Stopping sight distance should be adjusted for appreciable roadway grades (generally steeper than 3%). See the "Green Book" Table III-2 for adjusted values.

Decision Sight Distance

Decision sight distance allows the driver to perceive, react and perform a maneuver or adjust speed. The following are examples of critical locations where decision sight distance is important: interchange and intersection locations, changes in cross section such as toll plazas and lane drops; and areas of concentrated demand where there is apt to be "visual noise" whenever sources of information compete, as those from roadway elements, traffic, traffic control devices, and advertising signs.

Decision sight distances are given in Table III-3 of the "Green Book" for various avoidance maneuvers and roadway types. In computing and measuring decision sight distances, the 1070 mm eye height and 150 mm object height criteria used for stopping sight distance are typically used. Occasionally, other target objects, such as a signal head, are more appropriate. The designer should investigate the condition carefully at critical locations and use judgment in applying this criteria.

Intersection Sight Distance

Intersection sight distance is the sight distance at a crossroad or street looking along the predominant highway to provide clearance time for a vehicle starting to cross or turn onto the highway from a stop position.

Intersection sight distance varies with the type of intersection control (stop, yield, etc.) and with the type of turning movement. The required intersection sight distances are given in several graphs in Chapter IX of the "Green Book" and are further discussed in Chapter 4 of this Manual.

Passing Sight Distance

Consideration of passing sight distance is limited to two-lane, two-way highways on which vehicles frequently overtake slower-moving vehicles and the passing must be accomplished on a lane used by opposing traffic. Passing sight distance for use in design is determined on the basis of the length needed to safely complete a normal passing maneuver.

Passing sight distance is usually measured between the driver's eye and an on-coming passenger (P) vehicle, whose respective heights are 1070 mm and 1300 mm. Passing sight distances established on this basis are also considered adequate for night conditions, because the beams of the headlights of an opposing vehicle are generally seen from a greater distance than the top of the vehicle could be seen in the daytime.

Sight distance adequate for passing should be provided frequently on two-lane highways, and the length of each passing section should be as long as feasible.

There are no fixed criteria for the frequency of passing sections. However, experience shows that highway capacity is measurably reduced when a significant percentage of a particular section of highway is restricted to sight distances of less than 450 m. Highways with high traffic volumes will require a higher proportion of passing sight distances than those with low volumes.

Established minimum passing sight distances are shown in Figure 3-3. These distances for design should not be confused with other distances used as warrants for placing no-passing

zone pavement markings on completed highways. Values shown in the *MUTCD* are substantially less than design distances and are derived for traffic operating control needs which are based on assumptions different from those for design. (Refer to the Conference Report dated 4/4/91, Appendix 3-6.)

Figure 3-3
DESIGN CRITERIA BASED ON DESIGN SPEED

DESIGN CRITERIA	DESIGN SPEED - (km/h)						
	50	60	70	80	90	100	110
Minimum Radius of Curvature (m) *	80	125	175	230	305	395	500
Stopping Sight Distance (m) (level grade)							
Minimum	57.4	74.3	94.1	112.8	131.2	157.0	179.5
Desirable	62.8	84.6	110.8	139.4	168.7	205.0	246.4
Decision Sight Distance (m)	See the "Green Book" Table III-3						
Passing Sight Distance (m)	345	407	482	541	605	670	728

* Based on a maximum superelevation rate of 8 %. See the "Green Book" tables for rates of superelevation and runoff distances.

Environmental Considerations

Environmental considerations play a major role in developing projects. In response, the Department's Bureau of Environment evaluates the potential impacts of projects. These evaluations are conducted in accordance with pertinent Federal and State laws, including the National Environmental Policy Act (NEPA), the Clean Water Act, the National Historic Preservation Act, Section 4(f) of the Department of Transportation Act and New Hampshire RSA 482-A, Dredge and Fill in Wetlands, among others.

To initiate the evaluation process, the lead design Bureau must submit an Environmental Classification form (commonly referred to as the "green sheet" — see Appendix 2-7) to the Bureau of Environment. This form provides general information about the project and indicates the appropriate contact people for design data. It is normally accompanied by a project location map, as well as existing detail plans, if available.

Throughout project development, a close working relationship is needed between the Environmental and Design staff assigned to each project to identify potential environmental impacts, seek alternatives to avoid those impacts, adjust the design to minimize impacts to the extent practicable and develop appropriate mitigation measures, as necessary. Detailed design information is required to be included in the environmental documents and it is the responsibility of the design personnel to provide that information.

In preparing to advertise projects for bids, environmental commitments need to be incorporated into the contract documents. The specific details of the commitments will be provided by the Bureau of Environment to the appropriate Design personnel who are

responsible to incorporate this information as outlined in the Department's "Environmental Commitments Guidelines" — see Appendix 3-7.

Public participation is an essential component of the project development process and the environmental impact evaluation efforts in particular. To address this issue, the NHDOT has prepared a guide titled "*Public Involvement Procedures for New Hampshire Transportation Improvement Projects*" (15). This guide includes specific information about the environmental evaluation process.

Level of Service

Level of Service (LOS) is a term which denotes any one of a number of differing combinations of operating conditions that may occur on a lane when it is accommodating various traffic volumes. Level of service measures the effect of a number of factors, which include speed and travel time, traffic interruptions, freedom to maneuver, safety, driving comfort and convenience, and operating costs.

Arterials provide a higher degree of mobility for longer trips with higher operating speeds and improved levels of service. Since access to abutting property is not their major function, some degree of access control is desirable to enhance mobility. Collector roads serve a dual function in accommodating the shorter trip and feeding the arterials. They must provide some degree of mobility and also serve abutting property. Thus, an intermediate design speed and level of service is appropriate. Local roads and streets have relatively short trip lengths, and because property access is their main function, there is no need for high flow rates or high operating speeds.

The functional concept is related to level of service and it is important to the designer. Even though many of the geometric standards could be determined without reference to the functional classification, the designer must keep in mind the overall purpose that the street or highway is intended to serve. This concept is consistent with a systematic approach to highway planning and design.

The first step in the design process is to define the function that the facility is to serve. The level of service required to fulfill this function for the anticipated volume and composition of traffic provides a cost-effective basis for the selection of criteria within the ranges of values available to the designer. The recognition of the functional classification as a design type should aid the highway planning and design process.

Appropriate levels of service are shown for various highway functional types and for various terrains, Figure 3-4. The levels of service identified with highway types are shown next in Figure 3-7.

Once a level of service has been selected, it is desirable that all elements of the roadway are consistently designed to this level. This consistency of design results in more uniform traffic movement and operating speed, and flow restrictions can be avoided.

The *Highway Capacity Manual* (HCM) supplies the analytical base for design calculations and decisions, but the designer must use judgment to select the proper level of service.

The effect that trucks and buses have in contributing to congestion of highways is discussed in the Highway Capacity Manual. Detailed procedures are outlined there for converting volumes of mixed traffic to equivalent volumes of passenger cars.

Figure 3-4

GUIDE FOR SELECTION OF DESIGN LEVELS OF SERVICE

Type of Area and appropriate Level of Service

<u>Highway Type</u>	Type of Area and appropriate Level of Service			
	<u>Rural</u>	<u>Rural</u>	<u>Rural</u>	<u>Urban and</u>
	<u>Level</u>	<u>Rolling</u>	<u>Mountainous</u>	<u>Suburban</u>
Freeway	B	B	B	C
Arterial	B	B	C	C
Collector	C	C	D	D
Local	D	D	D	D

General operating conditions for levels of service are defined as:

- A — free flow, with low volumes and high speeds.
- B — stable flow but speeds beginning to be restricted by traffic conditions.
- C — within stable flow zone but most drivers restricted in freedom to select their own speed.
- D — approaches unstable flow; however, drivers have little freedom to maneuver.
- E — flow is unstable, may be short stoppages.

Whether designing an intersection, an interchange, an arterial, or a freeway, the selection of the desired level of service must be carefully weighed, as the adequacy of the roadway is dependent on this choice.

Figure 3-5

LEVEL OF SERVICE CHARACTERISTICS BY HIGHWAY TYPE

Level of Service	Controlled Access Highways	Multilane Rural without Access Control	Two lanes	Urban and Suburban Arterials
A	Free flow. Average travel speed at or greater than 112 km/h. Service flow rate of 700 passenger cars per hour per lane, or 32% of capacity	Average travel speed 96 km/h or greater. Under ideal conditions, flow rate is limited to 720 passenger cars per lane per hour or 33% of capacity.	Average travel speed of 93 km/h or higher. Most passing maneuvers can be made with little or no delay. Under ideal conditions, a service flow rate of 420 passenger cars per hour, total two-way, can be achieved about 15% of capacity.	Average travel speed of about 90% of free flow speed. Stopped delay at signalized intersections is minimal.
B	Reasonably free flow conditions. Average travel speed at or greater than 112 km/h. Service flow rate not greater than 1,120 passenger cars per hour per lane, or 51% of capacity.	Reasonably free flow. Volume at which actions of preceding vehicle will have some influence on following vehicles. Flow rates will not exceed 55% of capacity or 1,200 passenger vehicles per lane per hour at 96 km/h average travel speed under ideal conditions.	Average travel speeds of 88 km/h or higher. Flow rates may reach 27% of capacity with continuous passing sight distance. Flow rates of 750 passenger cars per hour, total two-way, can be carried under ideal conditions.	Average travel speeds drop due to intersection delay and inter-vehicular conflicts, but remain at 70% of free flow speed. Delay is not unreasonable.
C	Operation stable, but becoming more critical. Average travel speed of 110 km/h. Service flow of 75% of capacity or not more than flow rate of 1,640 passenger cars per hour per lane.	Stable flow to a flow rate not exceeding 75% of capacity or 1,650 passenger cars per lane per hour, under ideal conditions maintaining at least a 95 km/h average travel speed.	Flow still stable. Average travel speeds of 84 km/h or above with total flow rate under ideal conditions equal to 43% of capacity with continuous passing sight distance or 1,200 passenger cars per hour total two-way.	Stable operations. Longer queues at signals result average travel speeds of about 50% of free flow speeds. Motorists will experience appreciable tension.
D	Lower speed range of stable flow. Operation approaches instability and is susceptible to changing conditions. Average travel speeds approximately 101 km/h. Service flow rates at 92% of capacity. Flow rate cannot exceed 2,015 passenger cars per hour per lane.	Approaching unstable flow at flow rates up to 89% of capacity or 1,940 passenger cars per hour at an average travel speed of about 92 km/h under ideal conditions.	Approaching unstable flow. Average travel speeds approximately 80 km/h. Flow rates, two-direction, at 64% of capacity with continuous passing opportunity, or 1,800 passenger cars per hour total two-way under ideal conditions.	Approaching unstable flow. Average travel speeds down to 40% of free flow speed. Delays at intersections may become extensive.
E	Unstable flow. Average travel speeds of 96 km/h. Flow rate at capacity or 2,200 passenger cars per hour per lane. Traffic stream cannot dissipate even minor disruptions. Any incident may produce a serious breakdown.	Flow at 100% of capacity or 2,200 passenger cars per lane per hour under ideal conditions. Average travel speeds of about 88 km/h.	Average travel speeds in neighborhood of 72 km/h. Flow rate under ideal conditions, total two-way, equal to 2,800 passenger cars per hour. Level E may never be attained. Operation may go directly from level D to level F.	Average travel speeds 33% of free flow speed. Unstable flow. Continuous backup on approaches to intersections.
F	Forced flow. Freeway acts as a storage for vehicles backed up from downstream bottleneck. Average travel speeds range from near 50 km/h to stop-and-go operations.	Forced flow, congested condition with widely volume characteristics. Average travel speeds of less than 50 km/h.	Forced, congested flow with varying unpredictable characteristics. Operating speeds less than 72 km/h.	Average travel speed between 25 and 33% of free flow speed. Vehicular backups, and high approach delays at signalized intersections.

Major Design Elements

The major design elements for which most criteria have been written are: pavement, typical section, horizontal and vertical alignment, lighting, traffic control and standard roadway items such as guardrail and drainage structures. These elements are more fully discussed in other chapters of the Manual.

There are less visible design elements, equally important, which are considered next.

Other Design Elements

Other design elements which must be considered and which may affect the overall operating characteristics of the facility are: pedestrian facilities, bicycle facilities, railroad crossings, drainage, utilities, airport clearances, and mitigating environmental impacts.

Individual chapters are devoted to utility involvement and drainage, therefore, their description in this chapter is brief.

Pedestrian/Bicycle Facilities

The designer should be particularly concerned with pedestrian conflicts on urban intersection projects. Safety should be the primary concern, with mobility secondary. Most conflicts occur at signalized high-volume intersections.

If it is decided to design special accommodations for pedestrians, refer to the "Green Book", *Highway Capacity Manual*, *Manual for Planning Pedestrian Facilities* (39), and the *MUTCD*.

Sidewalks, when warranted, are normally 1.5 m wide, unless a narrower width is approved by the Highway Design Administrator. It is desirable to separate the sidewalk from the roadway for increased pedestrian safety when the right-of-way width is available. Increased sidewalk width may be warranted in urban areas.

Safe and convenient movement of disabled persons, including those in wheelchairs, requires that accessible sidewalk ramps be provided at crosswalks, and driveways. A crosswalk is a marked crossing of a street or public way at the extension of a pathway used by pedestrians. For uniformity, the NHDOT standard for sidewalk ramps (pending approval) should be used unless a local standard acceptable to the FHWA is preferred by the municipality.

In establishing the location of the ramps, consideration should be given to drainage, access to pedestrian phase push-buttons at signalized intersections, and utility appurtenances. Normally, the ramp should align with the sidewalk and crosswalk. If offset ramps are necessary, the need for a properly located and highly visible stop line as a safety device is increased. Visually impaired persons have difficulty in detecting ramps, therefore, it may be advisable to provide textured surfaces different from the sidewalk surface. On all projects, the designer should confirm that current ADA requirements are met.

In order to ease pedestrian travel through curbed islands, certain modifications are normally required. In many cases, the crosswalk can be located directly in front of the island nose

without special design provisions or the island can be shortened sufficiently to permit such location without affecting turning vehicles. However, when an island does encroach on the location of a crosswalk, it is desirable to depress the entire crosswalk through the island, rather than construct ramps, particularly if the island is less than 4.8 m wide.

In areas of high traffic volumes or high speeds, underpass or overpass pedestrian facilities may be advisable and should be designed in such a way that promotes its use. Generally, pedestrians will avoid using steps or out-of-the-way ramps. Underpasses will be used if they are not too long and if they are maintained, lighted and secure.

Other modifications are useful such as the conversion from two-way to one-way traffic flow, elimination of turns, provisions for exclusive signal phases for pedestrians, and elimination of some crosswalks, (e.g., mid-block crosswalks). These and other pedestrian considerations should be evaluated before making design decisions.

Underpass construction for cattle, snowmobiles, skiers, or bicycles require the Highway Design Administrator's approval and, in most instances, the planning is prompted by users' requests, right-of-way considerations, or socio-economic considerations.

Bicycle facilities (separate or shared use within shoulders) should be considered. The designer, however, should be cautious when combining vehicles and bicycles. The suggested references are the *AASHTO Guide for Development of Bicycle Facilities* (16), *Selecting Roadway Design Treatments to Accommodate Bicycle* (40), and the NHDOT Bureau of Transportation Planning *New Hampshire Statewide Bicycle and Pedestrian Plan* (11) which shows the designated bike routes in the State. Projects on roadways designated as bike routes should be designed to accommodate bicycle travel, i.e., minimum 1.2 m wide shoulders (1.5 m wide curbed shoulder).

See Chapter 11 for additional information on Pedestrian/Bicycle Facilities.

Railroad Grade Crossing

If the design involves a railroad crossing, the facts must be assembled and the Chief of Design Services contacted. No contact will be made with the railroad except through the Chief of Design Services.

Appropriate grade crossing protection devices, pavement markings, and warning signs should be installed at all railroad grade crossings. Details are shown in the *MUTCD* and *Railroad-Highway Grade Crossing Handbook* (17). The final approval of the devices to be used is vested in the NHDOT Bureau of Rail Safety.

Sight distance is a major consideration at railroad grade crossings. There should be sufficient sight distance along the road for the driver to recognize the crossing, perceive the train, stop if necessary, and depart from a stopped position. See Figure IX-78 and Figure IX-79 of the "Green Book". The sight distances given are recommended but not always attainable. When costs, right-of-way, or environmental considerations prohibit achieving the recommended sight distances, some form of crossing protection should be provided. Decision and stopping sight distances for crossing protection must be assured. Refer to the "Green Book" for more detailed information.

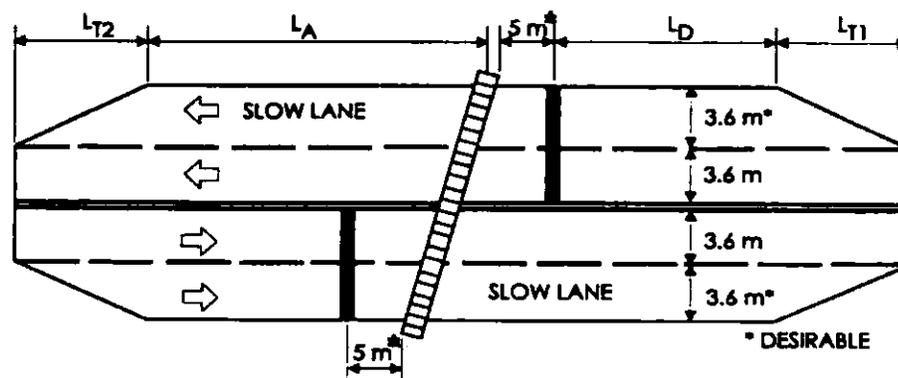
Crossings can be treated in various ways, including adequate signing, traffic signals, railroad signals with gates and grade separation. Judgment must be used in the selection process, which will involve the volume and speed of traffic on both the roadway and railroad and the available sight distance. Always provide the best device possible to protect the motorist and the pedestrian.

The roadway width at all railroad crossings should be the same as the width of the approach roadway, unless it is desirable to provide truck turnout lanes. The NHDOT uses truck turnout lanes at certain railroad crossings, to provide pavement width for vehicles that must stop by law (Figure 3-6). The length of full-width lanes "L", is determined on accel-decel requirements for the design speed.

If the crossing angle is less than approximately 45 degrees, consideration should be given to widening the outside lane, shoulder, or bicycle lane to allow bicyclists and/or motorcycles adequate room to cross the tracks at a more perpendicular angle. Additionally, compressible flangeway fillers can enhance bicycle and motorcycle crossing safety. In some cases, abandoned tracks can be removed or paved over.

Figure 3-6

RAILROAD CROSSING - - SLOW LANES



NOTES:

1. OTHER PERMANENT MARKINGS, IN ADDITION TO ABOVE, ARE REQUIRED.
2. ADDITIONAL WIDTH FOR SHOULDER(S) MAY BE APPROPRIATE.

LEGEND	
L _{T1}	20:1 Taper Desirable
L _{T2}	Merging Taper - English Design Speed:1
L _A	Accel length - Refer to "Green Book"
L _D	Decel length - Refer to "Green Book"
STOP LINES	Both directions, 5 m ² from near rail

Drainage

Drainage is a very important element for which criteria have been developed. The reference for drainage criteria is the NHDOT *Manual on Drainage Design for Highways* (the

“Drainage Manual”) (8). Chapter 6 of this Highway Design Manual provides additional drainage information.

Drainage items are estimated to cost 20 to 30 percent of the expenditure for highway construction and, from that viewpoint alone, drainage is an important design consideration.

Drainage facilities are provided through culverts, closed-system pipe, underdrain pipe, catch basins and open ditches. The designer should provide sufficient vehicle recovery area or protection from deep ditches and to keep basin grates and end sections flush with the ground.

Catch basin grates in paved areas create two problems. They may become loose or damaged if run over repeatedly by heavy loads, thereby creating a roadway deficiency and a maintenance problem. Also, bicyclists may be injured as a result of losing control while traversing a catch basin grate with parallel bars oriented in the direction of bicycle travel. This latter problem can be avoided by using a bicycle safe grate, recognizing, however, that it is less efficient hydraulically. Consult the “Drainage Manual” for the appropriate type of grate to be used. If there are questions regarding unique situations, discuss the issue with the Hydraulics Engineer.

One of the major considerations when designing highways (drainage in particular), is the extent to which land-use development will affect the area during the design period. It may be more economical to oversize a drainage facility to allow for increased runoff in the future than to rebuild the system before the design life of the road has expired. The issue of a private developer’s responsibility for impacts to the State highway drainage system is addressed in the “Driveway Manual”.

Drainage considerations are usually divided into hydraulic and structural requirements. Hydraulic design, procedure and criteria are covered generally in Chapter 6, and in detail in the Drainage Manual. Structural issues are covered in Chapter 7, “Highway Structures.”

The Hydraulics Engineer is responsible to review all major and “special” drainage design. The designer should refer pertinent drainage questions to the Hydraulics Engineer. Prints of the design along with well organized, legible computations must accompany all requests for review. Refer to Chapter 6 for procedures to follow.

Utilities

Although the geometric layout usually is unaffected by the utilities located within the project limits, utility relocation costs can be significant and should be seriously considered especially when designing the storm drainage system and other elements of the cross section. Time frames to relocate utilities (especially telephone — aerial or underground) can be substantial and commonly are a critical element to be included in the construction schedule.

Utility adjustments are coordinated by the Utilities Engineer who arranges for all work to be done prior to or during construction. (The utility may elect to perform the adjustment work with its own forces or to hire a contractor to do the work.)

The approved reference for utility issues is the *Utility Accommodation Manual* published by the NHDOT. Chapter 9, “Utilities”, of this Highway Design Manual, also deals with the subject.

Design considerations include provisions for utilities, however, the designer should keep the following in mind:

- Utility information furnished with field surveys should be plotted and given to the Utility Coordinator as soon as possible for verification and to initiate utility coordination/relocation.
- The cost of utility adjustment may be substantial, regardless of who pays for it. Designers must consider utility adjustments as part of cost-effective design.
- Protection of existing underground utilities is important. For example, decreasing cover over existing waterlines below acceptable limits may result in their freezing and bursting. Decreasing cover over electric power lines may violate the National Electric Safety Code and create a potentially damaging situation. Sanitary sewer disruption caused by improperly designed protection can cause health problems and roadway damage. Substantial increase in cover over utilities can make it difficult to access for repair.

Airport Clearances

The highway designer, through the Chief of Design Services, shall contact the NHDOT Division of Aeronautics and provide the Division with the project location and a description of work to be completed if it's determined that an airport's proximity will be a design factor. It is extremely important that this information be provided as early due to the possibility that runway approach surfaces could be penetrated, affecting instrument approach procedures into the airport.

When transitional or approach surfaces might be penetrated, the highway designer shall provide a sketch indicating the runways with all pertinent vertical and horizontal data and clearances. This shall be included in the Engineering Report. A sample sketch along with control dimensions is shown in Figure 3-7, Air-Highway Clearances. Prior to the preparation of any sketch of this type, contact the Chief of Design Services for technical assistance and information required for the development of the airport layout plan. Once this is completed the Chief of Design Services will forward the sketch to the approving agency.

FHWA can act as intermediary in air-highway clearance approval negotiations with the Federal Aviation Administration (FAA) on Federally-funded projects. This is in compliance with the Highway/Utility Guide - FHWA SA-93-049. The Chief of Design Services shall assist in coordination with the NHDOT, Division of Aeronautics on all projects affected by airports.

Figure 3-7

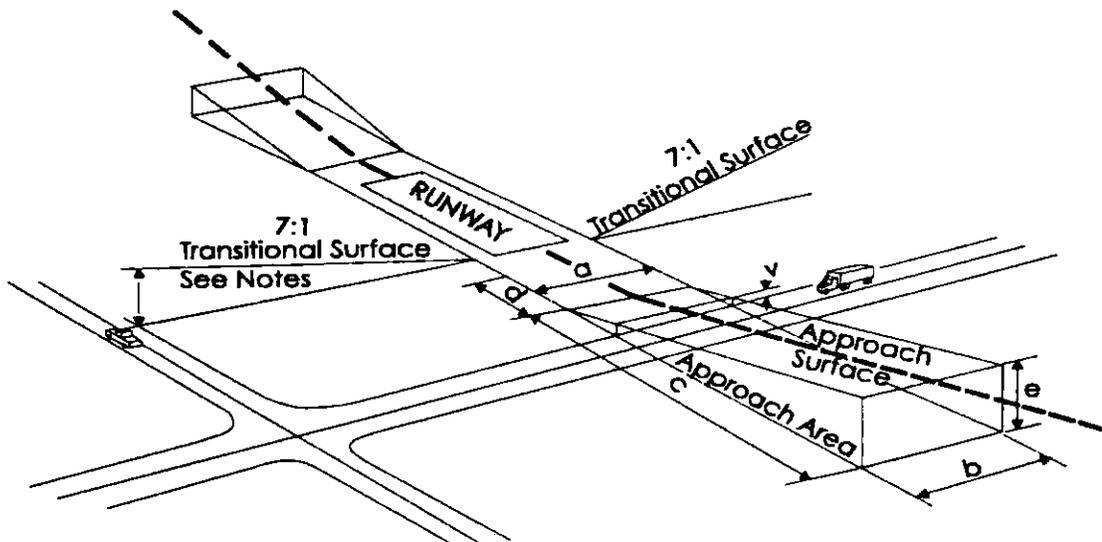
AIR-HIGHWAY CLEARANCES

TYPE OF AIRPORT	RUNWAY LENGTH AT SEA LEVEL (METERS)	a	b	c	e	c:e (Slope of Approach Surface)
VISUAL RUNWAY		60	150	900		
NON-PRECISION INSTRUMENT RUNWAY	960 OR LESS	75	675	3000	150	20:1
	961 - 1260	120	720	3000	75	40:1
	1261 - 1800	150	750	3000	75	40:1
	1801 - 2250	150	750	3000	75	40:1
PRECISION INSTRUMENT RUNWAY	OVER 2250					
PRECISION INSTRUMENT RUNWAY		300	4800	15000	360	50:1 ³

- a Width of approach area (and approach surface) at clear zone end.
 - b Width of approach area (and approach surface) at approach end.
 - c Length of approach area (and approach surface) measured horizontally beyond clear zone.
 - d Length of clear zone is 60 m, 30 m for VFR airports.
 - e Elevation of approach surface above end of runway and distance "c".
- V - Highway clearance, profile at pavement edge. Minimum vertical clearance is 4.6 m except for interstate highways which must have 5.2 m minimum clearance.

Notes:

1. All dimensions in meters. (Hard Conversion based on 30 m = 100').
2. Approach data conforms to Federal Aviation Regulations (FAR), Part 77 (MARCH 1993)
3. Precision Instrument Runways - Slope c:e = 50:1 for c = 3000 m; then 40:1 for 12000 m.
4. Transitional surfaces vertical for VFR airports.
5. For military airports, refer to FAR, Part 77.28.



APPENDIX LIST

- 3-1 Excerpts from FHWA Federal Aid Policy Guide relating to Design Standards
- 3-2 Patented/Proprietary Products
- 3-3 Design Exception - Overview Project
- 3-4 Design Exception - Exempt Project
- 3-5 Vertical Clearance, Interstate System
- 3-6 Conference Report - AASHTO vs. MUTCD Passing Sight Distance
- 3-7 Environmental Commitments Guidelines

PART 625—DESIGN STANDARDS FOR HIGHWAYS (EFF. 5-1-97)

Sec.

625.1 Purpose.

625.2 Policy.

625.3 Application.

625.4 Standards, policies, and standard specifications.

AUTHORITY: 23 U.S.C. 109, 315, and 402; Sec. 1073 of Pub. L. 102-240, 105 Stat. 1914, 2012; 49 CFR 1.44(b) and (n).

SOURCE: 62 FR 15397, Apr. 1, 1997, unless otherwise noted.

EFFECTIVE DATE NOTE: At 62 FR 15397, Apr. 1, 1997, part 625 was revised, effective May 1, 1997. For the convenience of the user, part 625 remaining in effect until May 1, 1997, follows the text of this part.

§625.1 Purpose.

To designate those standards, policies, and standard specifications that are acceptable to the Federal Highway Administration (FHWA) for application in the geometric and structural design of highways.

§625.2

23 CFR Ch. I (4-1-97 Edition)

§625.2 Policy.

(a) Plans and specifications for proposed National Highway System (NHS) projects shall provide for a facility that will—

(1) Adequately serve the existing and planned future traffic of the highway in a manner that is conducive to safety, durability, and economy of maintenance; and

(2) Be designed and constructed in accordance with criteria best suited to accomplish the objectives described in paragraph (a)(1) of this section and to conform to the particular needs of each locality.

(b) Resurfacing, restoration, and rehabilitation (RRR) projects, other than those on the Interstate system and other freeways, shall be constructed in accordance with standards which preserve and extend the service life of highways and enhance highway safety. Resurfacing, restoration, and rehabilitation work includes placement of additional surface material and/or other work necessary to return an existing roadway, including shoulders, bridges, the roadside, and appurtenances to a condition of structural or functional adequacy.

(c) An important goal of the FHWA is to provide the highest practical and feasible level of safety for people and property associated with the Nation's highway transportation systems and to reduce highway hazards and the resulting number and severity of accidents on all the Nation's highways.

§625.3 Application.

(a) *Applicable Standards.* (1) Design and construction standards for new construction, reconstruction, resurfacing (except for maintenance resurfacing), restoration, or rehabilitation of a highway on the NHS (other than a highway also on the Interstate System or other freeway) shall be those approved by the Secretary in cooperation with the State highway departments. These standards may take into account, in addition to the criteria described in §625.2(a), the following:

(i) The constructed and natural environment of the area;

(ii) The environmental, scenic, aesthetic, historic, community, and preservation impacts of the activity; and

(iii) Access for other modes of transportation.

(2) Federal-aid projects not on the NHS are to be designed, constructed, operated, and maintained in accordance with State laws, regulations, directives, safety standards, design standards, and construction standards.

(b) The standards, policies, and standard specifications cited in §625.4 of this part contain specific criteria and controls for the design of NHS projects. Deviations from specific minimum values therein are to be handled in accordance with procedures in paragraph (f) of this section. If there is a conflict between criteria in the documents enumerated in §625.4 of this part, the latest listed standard, policy, or standard specification will govern.

(c) Application of FHWA regulations, although cited in §625.4 of this part as standards, policies, and standard specifications, shall be as set forth therein.

(d) This regulation establishes Federal standards for work on the NHS regardless of funding source.

(e) The Division Administrator shall determine the applicability of the roadway geometric design standards to traffic engineering, safety, and preventive maintenance projects which include very minor or no roadway work. Formal findings of applicability are expected only as needed to resolve controversies.

(f) *Exceptions.* (1) Approval within the delegated authority provided by FHWA Order M1100.1A may be given on a project basis to designs which do not conform to the minimum criteria as set forth in the standards, policies, and standard specifications for:

(i) Experimental features on projects; and

(ii) Projects where conditions warrant that exceptions be made.

(2) The determination to approve a project design that does not conform to the minimum criteria is to be made only after due consideration is given to all project conditions such as maximum service and safety benefits for the dollar invested, compatibility with adjacent sections of roadway and the probable time before reconstruction of the section due to increased traffic demands or changed conditions.

Federal Highway Administration, DOT

§ 625.4

§ 625.4 Standards, policies, and standard specifications.

The documents listed in this section are incorporated by reference with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51 and are on file at the Office of the Federal Register in Washington, DC. They are available as noted in paragraph (d) of this section. The other CFR references listed in this section are included for cross-reference purposes only.

(a) *Roadway and appurtenances.* (1) A Policy on Geometric Design of Highways and Streets, AASHTO 1994. [See § 625.4(d)(1)]

(2) A Policy on Design Standards—Interstate System, AASHTO 1991. [See § 625.4(d)(1)]

(3) The geometric design standards for resurfacing, restoration, and rehabilitation (RRR) projects on NHS highways other than freeways shall be the procedures and the design or design criteria established for individual projects, groups of projects, or all non-freeway RRR projects in a State, and as approved by the FHWA. The other geometric design standards in this section do not apply to RRR projects on NHS highways other than freeways, except as adopted on an individual State basis. The RRR design standards shall reflect the consideration of the traffic, safety, economic, physical, community, and environmental needs of the projects.

(4) Erosion and Sediment Control on Highway Construction Projects, refer to 23 CFR part 650, subpart B.

(5) Location and Hydraulic Design of Encroachments on Flood Plains, refer to 23 CFR part 650, subpart A.

(6) Procedures for Abatement of Highway Traffic Noise and Construction Noise, refer to 23 CFR part 772.

(7) Accommodation of Utilities, refer to 23 CFR part 645, subpart B.

(8) Pavement Design, refer to 23 CFR part 625.

(b) *Bridges and structures.* (1) Standard Specifications for Highway Bridges, Fifteenth Edition, AASHTO 1992. [See § 625.4(d)(1)]

(2) Interim Specifications—Bridges, AASHTO 1993. [See § 625.4(d)(1)]

(3) Interim Specifications—Bridges, AASHTO 1994. [See § 625.4(d)(1)]

(4) Interim Specifications—Bridges, AASHTO 1995. [See § 625.4(d)(1)]

(5) AASHTO LRFD Bridge Design Specifications, First Edition, AASHTO 1994 (U.S. Units). [See § 625.4(d)(1)]

(6) AASHTO LRFD Bridge Design Specifications, First Edition, AASHTO 1994 (SI Units). [See § 625.4(d)(1)]

(7) Standard Specifications for Movable Highway Bridges, AASHTO 1988. [See § 625.4(d)(1)]

(8) Bridge Welding Code, ANSI/AASHTO/AWS D1.5-95, AASHTO. [See § 625.4(d)(1) and (2)]

(9) Structural Welding Code—Reinforcing Steel, ANSI/AWS D1.4-92, 1992. [See § 625.4(d)(2)]

(10) Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, AASHTO 1994. [See § 625.4(d)(1)]

(11) Navigational Clearances for Bridges, refer to 23 CFR part 650, subpart H.

(c) *Materials.* (1) General Materials Requirements, refer to 23 CFR part 635, subpart D.

(2) Standard Specifications for Transportation Materials and Methods of Sampling and Testing, parts I and II, AASHTO 1995. [See § 625.4(d)(1)]

(3) Sampling and Testing of Materials and Construction, refer to 23 CFR part 637, subpart B.

(d) Availability of documents incorporated by reference. The documents listed in § 625.4 are incorporated by reference and are on file and available for inspection at the Office of the Federal Register, 800 North Capitol Street, NW., Suite 700, Washington, DC. These documents may also be reviewed at the Department of Transportation Library, 400 Seventh Street, SW., Washington, DC, in Room 2200. These documents are also available for inspection and copying as provided in 49 CFR part 7, appendix D. Copies of these documents may be obtained from the following organizations:

(1) American Association of State Highway and Transportation Officials (AASHTO), Suite 249, 444 North Capitol Street, NW., Washington, DC 20001.

(2) American Welding Society (AWS), 2501 Northwest Seventh Street, Miami, FL 33125.

EFFECTIVE DATE NOTE: At 62 FR 15397, Apr. 1, 1997, part 625 was revised, effective May 1.

FEDERAL-AID POLICY GUIDE
July 21, 1995, Transmittal 13

23 CFR 625

NON-REGULATORY SUPPLEMENT

OPI: HNG-14

THIS SUPPLEMENT INCLUDES INFORMATION ON APPLICATION OF DESIGN STANDARDS, UNIFORM FEDERAL ACCESSIBILITY STANDARDS, AND BRIDGES

1. **NATIONAL HIGHWAY SYSTEM**. Section 109(c) of Title 23, United States Code (U.S.C.), provides that design and construction standards for new construction and reconstruction on the National Highway System (NHS), and for resurfacing, restoring, and rehabilitating multi-lane limited access highways on the NHS, shall be those approved by the Secretary in cooperation with the State highway departments. In a similar manner, 23 U.S.C. 109(b) provides standards for the Interstate system. The term "multi-lane limited access highway" in 23 U.S.C. 109(c) means Interstate or other freeway with full control of access. Standards for the design and construction of all projects on the NHS, including the Interstate system, are applicable to any proposed improvement regardless of the funding source (Federal, State, local or private). The standards are for the National Highway System, rather than for Federal-aid projects on that system. Deviations from the standards must have approved design exceptions.

a. **Interstate System Projects**. In accordance with 23 U.S.C. 109(b), the current AASHTO Interstate standards and policies as incorporated in 23 CFR 625 are applicable. Those standards apply whether or not the State has chosen to use the exemption provisions of 23 U.S.C. 106(b). Also, there is no authority under the ISTEA to develop FHWA approved individual State 3R standards for Interstate projects.

b. **Non-Interstate System Projects**

(1) **New construction and reconstruction**: In accordance with 23 U.S.C. 109(c), the current AASHTO standards and policies as incorporated in 23 CFR 625 are applicable to new construction and reconstruction. In addition to the Interstate system, the NHS consists of other principal arterials, including non-Interstate freeways. Therefore, those parts of the AASHTO Policy on Geometric Design of Highways and Streets (Green Book) applicable to highways classified as principal arterials, including non-Interstate freeways, must be used. Generally, the criteria in the Green Book functional chapters on local roads and streets and on collectors are not applicable to projects on the NHS. However, if highway segments functionally classified less than principal arterials are incorporated in the NHS because they connect to intermodal facilities or serve defense needs, the standards used may be those appropriate for the functional classification, including military requirements, of the segment taking into account the type of traffic using the segment.

(2) **For 3R projects**: All 3R projects, other than on the Interstate System or other freeways, may be constructed in accordance with FHWA-approved AASHTO standards for new and reconstruction projects or in accordance with FHWA-approved individual State standards developed pursuant to 23 U.S.C. 109(o) and 23 CFR 625.

(3) Certification acceptance projects: Standards for projects under certification acceptance procedures are those identified and approved in accordance with 23 CFR 640.

c. Certification. For projects on the NHS under the exemption provision of 23 U.S.C. 106(b)(1), the State certification that "...all work will meet or exceed the standards approved by the Secretary under section 109(c)" must be done on a project-by-project basis. Title 23 U.S.C. 109(c) applies to new construction, reconstruction and to multilane limited access (freeway including Interstate) 3R projects on the NHS. For non-freeway 3R projects the certification should be based on meeting the FHWA approved 3R standards developed under 23 U.S.C. 109(o) and 23 CFR 625. The form of the certification should be agreed upon between the Division office and the State.

2. NON-NATIONAL HIGHWAY SYSTEM. As provided in 23 U.S.C. 109(p), there will be no federally required or approved standards for Federal-aid projects off the NHS regardless of the funding source. Non-NHS projects are to be "designed, constructed, operated, and maintained in accordance with State laws, regulations, directives, safety standards, design standards, and construction standards." While there is no direct applicability of the safety provisions of 23 U.S.C. 109(o) or the historic and scenic values provisions of 23 U.S.C. 109(q) to non-NHS projects, the States are strongly encouraged to consider and apply these provisions in developing and applying their non-NHS standards.

3. PROJECTS WITH HISTORIC AND SCENIC IMPACTS OR VALUES. Title 23 U.S.C. 109(q) deals with the application of design standards on projects which involve or are located in areas of historic or scenic value. The intent is to emphasize that a great deal of flexibility can and should be used in design and construction of such projects. Because each scenic or historic site or area is unique, development of national standards for such projects is not appropriate. The intent of this section should be considered in the development of all Federally funded projects but is required to be considered in the design of NHS projects funded under 23 U.S.C. 103(e)(4), Interstate Substitute Program; 23 U.S.C. 133, Surface Transportation Program; or 23 U.S.C. 144, Highway Bridge Replacement and Rehabilitation Program.

4. SAFETY ENHANCEMENT

a. Title 23 U.S.C. 106(b)(3) provides that safety enhancement on 3R projects on the NHS and on any low cost (less than \$1 million estimated construction cost) projects on the NHS may be accomplished using phase construction. That is, those safety considerations that are reflected in an operative Safety Management System (established and implemented in accordance with 23 U.S.C. 303) and which do not present an immediate potential hazard as the result of the proposed improvement, may be met by phased construction. However, until such safety management system is in effect, the general safety requirement of existing 23 U.S.C. 109(a) and the safety enhancement provisions of 23 U.S.C. 109(o) are applicable to projects on the NHS.

b. Preventive maintenance projects (joint repair, pavement patching, crack sealing, bridge painting, etc.) using Federal-aid funds on Interstate highways and similar minor work on other NHS highways may be approved by FHWA without including safety or geometric enhancements. However, such approvals are to be given with the understanding that appropriate safety and geometric enhancements will be an integral part of future 3R/4R projects. Further, preventive maintenance or minor work items performed in this manner must not degrade any existing safety or geometric aspects of the facility.

5. DESIGN SPEED

a. For all new and reconstruction projects, and all Interstate System projects, the geometric design should be consistent with speed implied to the driver by the posted or regulatory speed. Therefore, the design speed chosen for such projects should equal or exceed the posted or regulatory speed in order to assure that drivers operating at the legal speed limit can do so without unwittingly exceeding the safe design speed of the facility.

b. For all non-freeway 3R projects the design speed for specific elements may be determined and selected as described in Technical Advisory (TA) T 5040.28, "Developing Geometric Design Criteria and Processes for Non-freeway RRR Projects", dated October 17, 1988. The TA provides for selecting a design speed that equals or exceeds the posted or regulatory speed limit or as an alternate, the use of specific, measured 85th percentile speeds for design of individual or series of horizontal and vertical curves as recommended in the Transportation Research Board 3R study. The alternative procedure may be used whether or not the State has FHWA approved special 3R criteria.

c. The intent of this policy is not to require speed limit posting or advisory speed signing to correspond to the actual design speed of the project or to an individual design element within a project. However, when the legal driving speed exceeds the design speed of a project element, the need for signs and markings should be based on recognized traffic engineering practice and accepted State policy, and be in accordance with the Manual on Uniform Traffic Control Devices.

6. BRIDGES

a. Bridge Widths. It is FHWA policy that the criteria contained in 23 CFR 625 apply in determining the width of all bridges to be constructed, reconstructed, or rehabilitated on the NHS. Exceptions may be provided on a project basis per 23 CFR 625 and within the delegated authority provided by FHWA Order M 1100.1. For rehabilitated bridges the provisions in 23 CFR 625 dealing with 3R projects may be applied. These provisions allow for flexibility in determining what geometric criteria are to be applied to 3R projects, including bridge widths other than full construction or reconstruction standards. Appropriate deck widths for rehabilitated bridges are to be determined on the basis that 3R projects must be designed and constructed in a manner that will enhance highway safety.

b. Treatment of Existing Bridges on 3R/4R, Bridge Replacement, and Bridge Rehabilitation Projects

(1) On each project, a determination must be made as to whether an existing bridge should remain in place, be rehabilitated, or replaced. This decision should be based on an assessment of the bridge's structural and functional adequacy for the type and volume of projected traffic over its design life.

(2) The AASHTO design standards list minimum clear roadway widths for existing bridges to remain in place. Any exception to these standards should take into consideration the accident history, future traffic use, and general physical features of the bridge approach roadway as permitted in 23 CFR 625. When a decision is made to retain a bridge, the bridge rail should be evaluated to determine if it can adequately contain and redirect vehicles without snagging, penetrating, or vaulting. Consideration should be given to upgrading structurally inadequate or functionally obsolete bridge rail. The evaluation should be based upon criteria similar to that shown in NCHRP Report 239, "Multiple-Service-Level Highway

Bridge Railing Selection Procedures." Guidance concerning width, rail and geometric criteria tradeoffs, and the effects on safety are contained in NCHRP's research Digest 98 and Report 203 both entitled, "Safety at Narrow Bridges." Appropriate traffic control devices should be installed where the clear roadway width is less than the approach roadway width.

(3) Rehabilitated bridges should be designed to at least the minimum AASHTO standards for new and reconstructed bridges. Exceptions to these standards may be approved based upon individual site evaluations; however, the rehabilitated bridges should, as a minimum, have at least an H15 load capacity and have an expected service life of 15 years or more. Bridges on the Interstate System, however, should have an HS-20 load capacity. Bridge rehabilitation projects must include correction of all major structural and safety defects. Substandard bridge rail should be upgraded to current standards and "safety" curbs which can cause vehicles to vault the rail should be eliminated. Exceptions may be considered on a case-by-case basis where safety can be adequately enhanced but cost-effective considerations prevent full widening or full upgrading of the bridge rail.

(4) Bridge replacement projects should meet the AASHTO standards for new bridges with very few exceptions. In the case of bridges on low volume roads and streets, exceptions may be appropriate if the existing road will not be upgraded in the foreseeable future (10 years or more).

(5) On all projects involving bridges, the approach guardrail should be evaluated and upgraded to current standards. Approach guardrail, if warranted, must be properly anchored to the bridge. The transition between the approach guardrail and the bridge rail should be smooth and of sufficient strength (i.e., reduced post spacing) to prevent snags and vehicle pocketing.

(6) Bridges which have been strengthened, replaced, or rehabilitated to eliminate deficiencies are to be reclassified as non-deficient in the bridge inventory. Those existing bridges for which FHWA has approved an exception to the AASHTO standards are also to be reclassified as non-deficient since it was determined that the bridge is adequate for the type and volume of projected traffic over its remaining design life. If exceptions were granted as a temporary measure because of a scheduled future replacement project, the bridge may remain classified as deficient.

c. Bridge Rails. Bridge railing designs used for new and reconstructed bridges on the NHS shall have been successfully crash tested in accordance with NCHRP 350 criteria (or equivalents).

7. VERTICAL CLEARANCE ON THE INTERSTATE SYSTEM

a. It must be emphasized that the integrity of the Interstate System for national defense purposes be maintained to meet the present AASHTO policy as stated in "A Policy on Design Standards - Interstate System," incorporated by reference in 23 CFR 625. The 16-foot vertical clearance standard must be maintained on all rural Interstate highway bridges. In addition, a 16-foot vertical clearance route shall also be maintained through or around each urban area. Interstate bridges in urban areas not on the 16-foot vertical clearance route must have a minimum of 14 feet of vertical clearance. Any exceptions to this policy must be approved by the FHWA.

b. At the time the 16-foot vertical clearance policy was established, FHWA in cooperation with the

Department of Defense (DOD) and States identified a 26,000-mile subset of the Interstate System that would meet the most urgent national defense needs. This is known as the "26,000 Mile Priority Network" and we have a commitment with DOD to maintain 16-foot vertical clearance on this network where it already exists and to correct deficient vertical clearance as rapidly as practical. Therefore, proposed design exceptions on the "26,000 Mile Priority Network" that reduce the existing adequate vertical clearance to below 16-feet (including proposed design exceptions for resurfacing projects), or do not provide for the correction of existing substandard vertical clearance, are to be coordinated with the Military Traffic Management Command (MTMC) before taking approval action on the exception request. In addition, copies of any other exceptions approved to the 16-foot vertical clearance requirement outside the 26,000-mile priority system should also be provided to MTMC for information.

c. Where the State highway agency has the approval authority for design exceptions under one of the 23 U.S.C. 106(b) exemption provisions, coordination with MTMC is still required and may be accomplished through FHWA or directly with MTMC.

8. DESIGN EXCEPTIONS

a. General. The 23 CFR 625 provides that exceptions may be given on a project basis to designs which do not conform to the minimum criteria as set forth in the standards, policies, and standard specifications for: experimental features on projects and projects where conditions warrant that exceptions be made.

(1) Some project conditions that may warrant exceptions could be the extreme difficulty or high cost of obtaining right-of-way, cost of construction, mitigation of environmental impacts, or the preservation of historic or scenic values of the location. The careful application of the flexibility provided in the design standards and policies, appropriate use of design exceptions, and coordination with transportation enhancement activities can result in projects that provide safe and efficient transportation facilities and are sensitive and responsive to scenic and historic resources.

(2) Although all exceptions from accepted standards and policies should be justified and documented in some manner, the FHWA has established 13 controlling criteria requiring formal approval. These criteria are design speed, lane and shoulder width, bridge width, structural capacity, horizontal and vertical alignment, grade, stopping sight distance, cross slope, superelevation, and vertical and horizontal clearance (other than the "clear zone"). Design exceptions to these controlling criteria can, in the most part, be easily identified and defined. However, two items, horizontal clearance and design speed, warrant some further explanation and discussion.

(a) **Horizontal Clearance:** A recovery area clear of unyielding objects should be established for all projects. Criteria from the AASHTO Roadside Design Guide should be treated as guidance for setting individual project or statewide criteria or policies, not as a national standard requiring a design exception if not met.

(b) **Design Speed:** Design speed is a concept by which coordination of the various physical design elements is achieved. Design speed has a significant effect on the operation and safety of a highway because it is used to determine various individual design elements with specific dimensions such as stopping sight distance or horizontal

curvature. Therefore, a "design speed exception" is necessarily an exception to individual physical design elements and accordingly must be justified on that basis.

(3) In a number of instances, a range of specific values of minimum, maximum, and desirable are contained in the AASHTO policies and guides. It is FHWA policy that the lowest or highest value of the range, whichever is appropriate, is to be considered as the minimum or maximum acceptable for design of NHS projects.

(4) For preventive maintenance projects, no exceptions are needed for the retention of existing substandard features. In effect, the State is maintaining the project as built, and as it was agreed upon in the project agreement. However, any new substandard features created, or existing ones made worse, must be covered by an exception since such actions in effect change the project as built.

b. Evaluating Exceptions

(1) When evaluating a request for a design exception, consideration must be given to the effect of the variance from the design standard on the safety and operation of the facility and its compatibility with adjacent sections of roadway. Since safety enhancement is an essential element of any project design, exceptions should not be approved if the exception would result in degrading the relative safety of the roadway. Such factors as the functional classification of the road, the amount and character of the traffic, the type of project (i.e., new construction, reconstruction, or 3R), and the accident history should be considered in the evaluation. The cost of attaining full standards and any resultant impacts on scenic, historic or other environmental features, as well as whether any other future improvements are programmed should also be taken into consideration.

(2) Depending on the nature of the variance from the design standard, it may not be necessary to look at all of the above factors. However, before an exception is approved there should be compelling reasons why the adopted criteria should not be used. Three issues should be considered in any analysis: (a) what is the degree to which a standard is being reduced; (b) will the exception affect other standards; and (c) are there any additional features being introduced, e.g., signing or delineation, that would mitigate the deviation?

(3) One of the factors that has a significant influence on the appropriate design criteria is design speed. Since design speed affects curvature, sight distance, and other speed related features, care must be taken in the selection of the most appropriate value. Any design which uses a design speed below the posted or regulatory speed limit should not be approved.

(4) The amount and character of the traffic actually using the route, or that can legally use it (including trucks with grandfathered lengths), should be determined and used in the design exception process whether or not the route is on the National Network. It is recommended that permanent Interstate lane widths less than 11 feet not be approved except in only the most extreme and special cases. If Interstate lane widths less than 11 feet are used, they should be on a temporary basis only.

c. Documentation. All exceptions to the design standards shall be identified and justified, taking into consideration the effect of any deviation from design standards on safety. The project files must include this information. Approved exceptions shall be identified either in project correspondence

or on the project plans. Separate lists or a file of exceptions is recommended in order that the division office remains fully informed on the nature and extent of design exceptions being approved for given categories of projects.

d. **Review and Approval.** If the FHWA is involved in reviewing and approving plans, specifications and estimates for any NHS project, then it also must review and approve design exceptions to standards applicable to that project. On those NHS projects on which the State has elected to apply one of the 23 U.S.C. 106(b) exemption provisions, which are administered under certification acceptance, or which are funded by other than Federal-aid funds, the State may approve design exceptions, but must evaluate and document the decision as if it were doing it for the FHWA. Design exceptions approved by the State for FHWA are still subject to FHWA oversight through periodic process reviews.

9. **UNIFORM FEDERAL ACCESSIBILITY STANDARDS (23 CFR 625)**. The Uniform Accessibility Standards (UFAS) adopted by the General Services Administration (GSA) are to be used for design of all future buildings (and facilities) for which Federal and Federal-aid funds are used.

a. The design of all new and altered rest area facilities must comply with the UFAS.

b. The design of all new parking facilities must comply with the UFAS.

c. The design of all pedestrian overpasses and underpasses must include ramps which do not exceed a 1:12 grade and platforms should be provided every 30 feet. Other features such as handrails and stairs (where stairs and ramps are used) should comply with UFAS. A 1979 agreement with the Architectural and Transportation Barriers Compliance Board (ATBCB) requires Washington Headquarters approval of all pedestrian overpasses and underpasses with grades that exceed a 1:12 slope or spacing of platforms of greater than 30 feet.

d. The design of all facilities such as sidewalks and curb cuts not located on a building site should comply with the UFAS unless there is some compelling reason such as very steep terrain which does not permit compliance. Curb ramps, sidewalks, etc., on building sites must conform to the UFAS.

e. A waiver may be obtained to the above accessibility design requirements on a case-by-case basis. Requests for waivers should be submitted together with a justification to the Washington Headquarters, HNG-14, for approval or submission to GSA.

10. **PRESTRESSING STRAND FOR PRETENSION APPLICATIONS DEVELOPMENT LENGTH REVISITED (23 CFR 625.3)**

a. As a result of evaluations and discussions, the criteria for strand development length in pretensioned applications is revised as follows:

(1) The use of 0.6 inch diameter strand in a pretensioned application shall not be allowed;

(2) Minimum strand spacing (center-to-center of strand) will be four times the nominal strand diameter;

(3) Development length for all strand sizes up to and including 9/16 special strand shall be

determined as 1.6 times AASHTO equation 9-32; and,

(4) Where strand is debonded (blanketed) at the end of a member, and tension at service load is allowed in the precompressed tensile zone, the development length shall be determined as 2.0 times AASHTO equation 9-32, as currently required by AASHTO article 9.27.3.

b. Exceptions to the above criteria are as follows:

(1) Development length for prestressed piling subjected to flexural loading shall be determined as indicated above. Development length foreembedded piling not subjected to flexural loading shall be determined as per AASHTO equation 9-32, and the use of 0.6 inch strand will be allowed.

(2) Development length for pretensioned precast sub-deck panels or precast pretensioned voided deck plank, shall be determined as outlined above, or alternatively, by utilizing AASHTO equation 9-32 for development length and designing and tensioning on the basis of a guaranteed ultimate tensile strength (GUTS) of 250 ksi and release of prestress at 70 percent of GUTS regardless of the type of strand used (i.e., 250 or 270 ksi strand).

c. The above criteria and exceptions are an interim measure, until such time as the research indicates otherwise and AASHTO adopts the results.

11. EPOXY COATED REINFORCING STEEL FOR BRIDGE DECKS (23 CFR 625). As the result of recent laboratory and field studies, questions regarding the long-term performance and overall effectiveness of epoxy coated reinforcement (ECR) have been raised. The current policy of the FHWA is to continue to support the use of ECR as an alternative cost-effective means of combatting corrosion in bridge decks. However, the FHWA strongly recommends that the States:

a. Evaluate existing specifications and strengthen provisions where appropriate. In particular, minimum film thickness, holiday limits and testing, allowable bare areas and strong positive provisions for detecting and patching bare areas found at job-sites should be included.

b. Inspections of fabricating plants supplying ECR for State projects should be made. While the Concrete Reinforcing Steel Institute Certification Program is a significant step in the right direction, the States should not relinquish vigilance over coating operations and overall production of ECR.

c. Thoroughly inspect the coated steel delivered to the job-site and after installation in the forms to ensure that or is not damaged, and that when there is damage, it has been properly patched.

d. See that bars are stored properly, both at the coating plant and on the job-site. For example, it is known that the epoxy coating can suffer from ultraviolet light degradation if left exposed outdoors too long. (Some experts recommend limiting exposure to 3 months or less.) Extended outdoor storage of coated bars, either at the coating plant or the job-site, or the combination of the two, should be avoided. If the stored bars are subject to exposure to aggressive environments, e.g., salt laden air, the bars should be stored off of the ground either indoors or outdoors. If stored outdoors, the bars should be covered for protection against the elements and in such manner that condensation does not form on the bars.

e. Provide multiple corrosion protective systems in marine or harsh environments for bridge decks on critical high-volume traffic structures. In addition, multiple corrosion protective systems should also be used for other structural components that are subjected to marine or harsh, aggressive environments.

f. Use durable quality concrete and provide adequate cover over the reinforcing steel. These points cannot be emphasized enough for effective prevention of reinforcing steel corrosion.

g. Evaluate the corrosion performance and adhesion characteristics of ECR in existing bridge decks. The individual States may use SPR or other research funds to evaluate the integrity of the epoxy coating in existing decks after several years of service. These studies might also assist in determining if specification ECR is being placed into decks following normal construction practices.

12. CONSTRUCTION AND CONTRACT MANAGEMENT OF MAJOR AND UNUSUAL STRUCTURES (23 CFR 625). Previous information issued on this subject is clarified and amplified by this supplement as follows:

a. It is the sole responsibility of the contractor to construct and/or erect the structure in a safe and prudent manner and the contract documents should so indicate.

b. Current state-of-the-art type structures, more often than not, require that the designer assume a method of construction and/or erection (balanced cantilever, span-by-span incremental launching, strand tendons versus bar tendons, erection loads and/or equipment, etc.) in order to design the structure. Assumed construction loads and erection method loads should be indicated in the general notes of the drawings and clearly state that they were assumed for design purposes only.

c. In many instances the designer will provide schematic erection sequence drawings based upon the assumed method of construction/erection. These drawings should be placed in a clearly defined appendix to the contract drawings and clearly indicate that they are provided for information only and the if the contractor elects to use the methodology depicted, it is the contractor's responsibility to determine the appropriateness and adequacy of the method depicted.

d. Contractor options and/or limitations to options should be clearly delineated in the contract documents.

e. The contractor should be required to submit, for review by the Engineer, his or her construction/erection method, erection equipment drawings indicating loads imposed on the structure during all phases of erection falsework design and all supporting calculations as may be required to indicate the stress level resulting therefrom. All such documents are to be prepared and stamped by a registered Professional Engineer familiar with the particular methods and/or procedures being proposed.

f. It should be clearly stated in the contract documents that the Engineer's review does not in any way absolve the Contractor from responsibility for the structural adequacy of the construction /erection methods and/or the erection equipment. The Engineer's review is only to:

(1) determine that appropriate design specifications have been complied with; and

(2) that any temporary stresses imposed upon the structure or permanent (locked-in) stresses in the completed structure, resulting from the construction/erection method or construction equipment, are within allowable limits.

- g. Any modification to the structure from the contract documents resulting from construction/erection loads imposed on the structure in excess of that assumed in design is to be at the contractor's expense and be approved by the Engineer.
- h. The above notwithstanding, where there is a risk to the general public from construction/erection activities and/or falsework over or adjacent to travelled roadways, navigation or recreational waterways, existing operational, commercial or industrial facilities, etc., it should be the responsibility of the State or its consultant to do a sufficiently detailed in-depth review of the contractor's proposed methods and/or procedures to establish adequacy and safety.

13. TIED ARCH BRIDGES (23 CFR 625). Because tied arch bridges have only two main supporting members, there is little redundancy with regard to catastrophic failure. For this reason, any future preliminary plans for this type of structure should be submitted to the Washington Headquarters office at an early date for review and possible suggested use of an alternate structure type.

14. MARYLAND ROUTE 198 BRIDGE FALSEWORK FAILURE - BOARD OF REVIEW - FINAL REPORT (23 CFR 625). As the result of the August 31, 1989, falsework related bridge collapse of the Route 198 bridge over the Baltimore-Washington Parkway in Maryland, the Federal Highway Administration established a Board of Review to evaluate the failure and make recommendations to avoid future occurrences. The major recommendations of the Board of Review which were strongly endorsed and should be implemented include:

- a. Falsework specifications should be revised to better define the responsibilities of material suppliers, contractors, and engineers. To minimize the possibility that this type of situation occurs in the future, highway agencies should review their falsework specification and construction procedures and strengthen them, where needed.
- b. It is very important that every bridge on a project receive a separate falsework design analysis. On the subject project the same design analysis was used for two separate bridges even though the beam spacing differed slightly between the two. As a result, the falsework support beams were not directly under the webs of the second bridge which subsequently failed during concrete placement.
- c. In the event that falsework is moved from one bridge to another, the falsework should be thoroughly inspected for structural damage and plumbness to ensure that all members are in place and properly aligned and connected.
- d. Manufactured products that require certification by the manufacturer have been a problem on some highway construction projects. Contractors and engineers generally accept a certificate for specification compliance. In essence, manufactured shoring tower assemblies are considered to be certified through the contractor submitting catalog data to the engineer. This catalog information shows the shoring tower configurations, screw jack criteria, and other design information that is used in the design of the overall falsework system. For the subject bridge, the contractor did not construct the approved and certified shoring towers. Instead, the shoring tower assemblies that were furnished contained undersized jacks and consisted of components from several other manufacturers. The Board recommends that highway agencies should require:

(1) All falsework design submittals be formally signed and sealed by the contractor's registered Professional Engineer.

(2) The contractor's registered Professional Engineer certify that the falsework system has been assembled according to the approved falsework drawings, prior to placing loads on the falsework.

e. Each falsework system should be designed to handle all vertical and horizontal loading and to contain enough redundancy to prevent a failure in the entire system. Vertical loading and differential settlement forces, and horizontal lateral and longitudinal forces should be taken into account. Unbalanced temporary loading, caused by the placement sequence, should also be considered.

f. When falsework installations are to be placed adjacent to an open public road, special design considerations and protection should be taken to ensure that the falsework system is not disturbed by errant highway vehicles or from vibration forces caused by passing vehicles.

g. This post-failure investigation points out the importance of the highway agency moving quickly to preserve and document the in-place failure and to assign investigation responsibilities to qualified impartial parties.

15. METAL STAY-IN-PLACE BRIDGE DECK FORMS (23 CFR 625)

a. Virtually all States allow the use of metal stay-in-place bridge deck forms. The introduction of longer span forms, up to 4.8 meters (15 feet), suggest that a review of existing specifications and requirements is appropriate to insure that cost-effective designs are not being compromised.

b. To meet AASHTO Specifications, it is necessary to ensure that adequate cover is provided and that all dead loads are accounted for in the design. The limits of deflection suggested by at least one manufacturer ($L/240$ not to exceed $3/4"$) has been used successfully, with FHWA approval, in Pennsylvania. For design purposes, this appears to be a practical limit.

c. Designs should incorporate an allowance for the weight of the form and additional concrete (15psf), with the provision that if it is exceeded, the contractor is responsible to show that the effects on the rest of the bridge are acceptable, or, to provide additional strengthening if necessary, at no expense to the owner.

16. GUIDES AND REFERENCES

The following are citations to publications which are primarily informational or guidance in character and serve to assist the public in knowing those materials which are considered by FHWA to provide valuable information in attaining good design. The number in brackets following each citation indicates availability of the document as listed in the Appendix.

a. Roadway and appurtenances

(1) An Informational Guide for Roadway Lighting, AASHTO 1985.[2]

- (2) Highway Design and Operational Practices Related to Highway Safety, Report of the Special AASHTO Traffic Safety Committee, AASHTO 1974.[2]
- (3) Roadside Design Guide, AASHTO 1996.[2]
- (4) An Informational Guide on Fencing Controlled Access Highways, AASHTO 1990.[2]
- (5) Highway Capacity Manual, Special Report 209, Third Edition, Transportation Research Board 1994 Update.[4]
- (6) Guidelines on Pavement Management, AASHTO 1985. [2]
- (7) Handbook of Highway Safety Design and Operating Practices, FHWA 1978.[1]
- (8) Skid Accident Reduction Program, T 5040.17, FHWA December 23, 1980. [1]
- (9) Guidelines for Skid Resistant Pavement Design, AASHTO 1976.[2]
- (10) Special Report 214, Designing Safer Roads, Practices for Resurfacing, Restoration, and Rehabilitation, TRB 1987.[4]
- (11) AASHTO Guide for Design of Pavement Structures, AASHTO 1993. [2]
- (12) National Cooperative Highway Research Program Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features, TRB 1993. [4]
- (13) Guide for the Design of High Occupancy Vehicle Facilities, AASHTO 1992. [2]
- (14) AASHTO Guidelines on Pavement Management Systems, AASHTO 1990. [2]
- (15) A Guide for Transportation Landscape and Environmental Design, AASHTO 1991. [2]

b. Bridges and structures

- (1) Guidelines for Bridge Management Systems, AASHTO 1993. [2]
 - (2) Manual for Condition Evaluation of Bridges, AASHTO 1994. [2]
 - (3) A Guide for Protective Screening of Overpass Structures, AASHTO 1990.[2]
 - (4) Guide Specifications for Fracture Critical Non-Redundant Steel Bridge Members, AASHTO 1978, and amending Interim Specifications-Bridges, AASHTO 1981 through 1990. [2]
 - (5) Guide Specifications for Horizontally Curved Highway Bridges, AASHTO 1980, and amending Interim Specifications-Bridges, AASHTO 1981 through 1993. [2]
 - (6) Guide Specifications for Aluminum Highway Bridges, AASHTO 1991. [2]
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- (7) **Guide Specifications for Seismic Isolation Design, AASHTO 1991. [2]**
- (8) **Guide Specifications for the Design of Stress-Laminated Wood Decks, AASHTO 1991.[2]**
- (9) **Guide Specifications and Commentary for Vessel Collision of Highway Bridges, AASHTO 1991. [2]**
- (10) **Guide Specifications for Fatigue Evaluation of Existing Steel Bridges, AASHTO 1990, and Interim Specifications-Bridges, AASHTO 1993. [2]**
- (11) **AASHTO Guide Specifications - Thermal Effects in Concrete Bridge Structures, AASHTO 1989. [2]**
- (12) **Guide Specifications for Fatigue Design of Steel Bridges, AASHTO 1989, and Interim Specifications-Bridges, AASHTO 1993. [2]**
- (13) **Guide Specifications for Strength Evaluation of Existing Steel and Concrete Bridges, AASHTO 1989.[2]**
- (14) **Guide Specifications for Design and Construction of Segmental Concrete Bridges, AASHTO 1989, and Interim Specifications-Bridges, AASHTO 1994. [2]**
- (15) **Guide Specifications for Structural Design of Sound Barriers, AASHTO 1989, and Interim Specifications-Bridges, AASHTO 1992. [2]**
- (16) **Guide Specifications for Bridge Railings, AASHTO 1989, and Interim Specifications-Bridges, AASHTO 1990 through 1992. [2]**
- (17) **Guide Specifications for Alternate Load Factor Design Procedures for Steel Beam Bridges Using Braced Compact Sections, AASHTO 1991, and Interim Specifications-Bridges, AASHTO 1994. [2]**
- (18) **Guide Specifications for Strength Design of Truss Bridges (Load Factor Design), AASHTO 1986. [2]**
- (19) **Guide Specifications for Distribution of Loads for Highway Bridges, AASHTO 1994. [2]**
- (20) **Recommendations for Stay Cable Design, Testing and Installation, Post-Tensioning Institute 1993. [5]**
- (21) **Model Drainage Manual, AASHTO 1991. [2]**
- (22) **Highway Drainage Guidelines, Volumes I through X, AASHTO 1992 and Volume XI, 1994. [2]**
- (23) **Manual on Subsurface Investigations, AASHTO, 1988. [2]**

(24) Soils and Foundations Workshop Manual, FHWA 1994. [1]

c. Other

- (1) Transportation Glossary, AASHTO 1983.[2]
- (2) A Guide for Erecting Mailboxes on Highways,AASHTO 1994.[2]
- (3) A Guide on Safety Rest Areas for the National System of Interstate and Defense Highways, AASHTO 1968.[2]
- (4) Guide for the Development of Bicycle Facilities, AASHTO 1991.[2]
- (5) Guide Specifications for Highway Construction AASHTO 1993. [2]
- (6) Guide for the Design of Park-and-Ride Facilities, AASHTO 1992. [2]
- (7) Guide to Wetland Mitigation Issues for Transportation Designers, AASHTO 1996. [2]

Appendix A -- Document Availability

These documents may be reviewed at the following locations:

1. Department of Transportation Library, 400 7th Street, SW., Room 2200, Washington, DC 20590;
2. American Association of State Highway and Transportation Officials, Suite 249, 444 North Capitol Street, NW., Washington, DC 20001;
3. American Welding Society, 2501 Northwest 7th Street, Miami, FL 33125;
4. Transportation Research Board, 2101 Constitution Avenue, NW., Washington, DC 20418; and
5. Post-Tensioning Institute, 1717 W. Northern Avenue, Suite 114, Phoenix, Arizona 85021;

[Home](#) | [Directives](#) | [23 CFR TOC](#) | [Feedback](#)



United States Department of Transportation - Federal Highway Administration

Patented/Proprietary Products

References:

23 U.S.C. 112
23 CFR 635.411

Guidance:

It is the policy of the FHWA not to participate, directly or indirectly, in payment for any premium or royalty on any patented or proprietary material, specification, or process specifically set forth in the plans and specifications for a project, unless:

- the item is purchased or obtained through competitive bidding with equally suitable unpatented items,
- the SHA certifies either that the proprietary or patented item is essential for synchronization with the existing highway facilities or that no equally suitable alternative exists, or
- the item is used for research or for a special type of construction on relatively short sections of road for experimental purposes.

The primary purpose of the policy is to have competition in selection of materials and allow for development of new materials and products. The policy further permits:

- Materials and products that are judged equal may be bid under generic specifications. If only patented or proprietary products are acceptable, they shall be bid as alternatives with all, or at least a reasonable number of, acceptable materials or products listed; and
- The division administrator may approve a single source if it can be found that its utilization is in the public interest.

Trade names are generally the key to identifying patented or proprietary materials. Trade name examples include 3M, Corten, etc. Generally, products identified by their brand or trade name are not to be specified without an "or equal" phrase. If trade names are to be used, all, or at least a reasonable number of acceptable materials or products should be listed. The licensing of several suppliers to produce a product does not change the fact that it is a single product and should not be specified to the exclusion of other equally suitable products.

Scenarios:

Below are examples of conditions under which patented or proprietary materials may be approved on Federal-aid projects.

Case I. The item is identified by the contract specifications along with a listing of other acceptable products, and the list includes a reasonable number of acceptable products. The FHWA may then participate in the cost of a patented or proprietary item since it is acquired competitively.

Case II. The SHA certifies that the product is essential for synchronization. This is particularly appropriate when upgrading or expanding existing traffic signal systems. The existing controller(s) is part of an existing system which is not compatible with any system hardware. To convert the overall system would be more expensive than to add to what is already there. Thus, it is in the public interest to require the compatible proprietary item, and upon the division administrator's concurrence, the item may be specified.

Case III. The SHA certifies that there is no equally suitable alternate. This situation should be reasonably verified by the division office. Based on a public interest finding with the division administrator's concurrence, the item may be specified.

Case IV. Products appear from time to time that are new and innovative, i.e., research item or experimental feature. Based on the developer's claim, manufacturer's claims, or because of certain local conditions, there may be sufficient justification to evaluate the product in actual highway usage. The SHA may then elect to submit a detailed plan of research and evaluation (work plan) for the product. The work plan may also be used to develop specifications in order to provide a basis for future competition with other materials. The work plan should be approved with or prior to PS&E approval, and the specifications may then require the proprietary item.



STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

Highway Design Manual
February 1999
APPENDIX 3-3

CHARLES P. O'LEARY, JR.
COMMISSIONER

WINDHAM-DERRY
IM-DR-T-93-1(193)8
12158
(I-93 over Kendall Pond Rd. & Fordway Extension)

Bureau of Highway Design
Room 207
Tel: (603)271-2171
Fax: (603)271-7025

January 30, 1996

Ms. Kathleen O. Laffey
Division Administrator
Federal Highway Administration
279 Pleasant Street, Room 204
Concord, NH 03301-2509

Dear Ms. Laffey:

Enclosed please find a copy of a design exception for the above noted project. The design exception is to allow for retaining the existing superelevation on unimproved sections of the alignments in the immediate vicinity of the bridge work. This design exception is being submitted for your concurrence.

If you need any further clarification, please let us know.

Sincerely,


Craig A. Green, P.E.
Chief of Preliminary Design

CAG:ljw

Enclosure

cc: W. Husband

S:\WINDAM\12158\LETTERS\LAF13096.DOC

STATE OF NEW HAMPSHIRE

INTER-DEPARTMENT COMMUNICATION

Highway Design Manual
February 1999

DATE January 16, 1996

AT (OFFICE)

Department of Transportation
Bureau of Highway Design

To:
~~FROM~~ Craig A. Green, P.E.
Chief of Preliminary Design

SUBJECT WINDHAM-DERRY
IM-IDR-T-93-1(193)8
12158

from
Leon S. Benson, P.E.
Assistant Commissioner

Thru: *Greg E. Placy*
Greg E. Placy, P.E.
Administrator
Highway Design

DR 1/25/96
Gilbert S. Rogers, P.E.
Ass't. Commissioner
Project Development

RWG 1-25-96
Robert W. Greer, P.E.
Director
Project Development

*FHWA should
also be asked.*

MEMORANDUM

It is requested that a design exception be approved for this project to allow for the existing superelevations on I-93 to remain on a portion of the existing curves that are not within the limits of the approach work of the bridges. The I-93 bridges and roadways in the area of Kendall Pond Road and Fordway Extension currently have superelevations that do not meet modern day standards. As part of the proposal, the superelevation on the bridges and on the roadway will be corrected (in the area of work), however, the entire length of the curves which have the superelevation inadequacies is not proposed to be corrected. The areas felt to need a design exception are the I-93 NB and SB alignment in the area of Fordway Extension and the I-93 NB alignment over Kendall Pond Road, since these are the locations where traffic will be delivered into a substandard superelevated section. (The I-93 SB alignment superelevation will be corrected to the end of the curve where traffic is delivered to a tangent alignment).

Background:

- * Project includes:
 - Replacement and widening of the I-93 NB & SB bridge decks over Kendall Pond Road and Fordway Extension.
- * Interstate 93 is a rural freeway.
- * Posted Speed - 65 mph.

• The traffic for I-93:

1993 DHV 6,100
2013 DHV 9,050
1993 ADT 58,400
2013 ADT 95,700

5% Truck DHV east of intersection.
7% Truck ADT west of intersection.

- There have been 86 accidents within the project limits over a 5 year period (from Exit 4 to a point 2.1 miles southerly).
- Existing roadway width for I-93 is 24' with 4' and 10' shoulders (38' total).
- Existing bridge width is 38' curb to curb.
- The I-93 NB bridge over Kendall Pond Road is located on an approximate 1° - 20' curve. The I-93 NB & SB bridges over Fordway Extension are located on an approximate 1° curve.
- The approximate existing superelevation on the 1° - 20' curve is 3.8%, and on the 1° curves is 2.8%.
- Existing length of curves:
 - 1° - 20' I-93 NB over Kendall Pond Road = 0.8 mile
 - 1° - 30' I-93 SB over Kendall Pond Road = 0.7 mile
 - 1° I-93 NB over Fordway Extension = 0.7 mile
 - 1° I-93 SB over Fordway Extension = 0.8 mile
- AASHTO, Policy on Geometric Design of Highway and Streets (1990), in Table III-10 on page 168 indicates a recommended rate of 4.6% for a 1° - 20' curve and 3.6% for a 1° curve.

Reason for exception:

- The difference in the modern day standard superelevation and the existing superelevation for the 1° - 20' curve and for the 1° curve (for 70 mph design) is 0.8%. However, the existing superelevations are within 0.5% of the modern day standards for 65 mph (1° curve superelevation 2.8% existing versus 3.2% required @ 65 mph; 1° - 20' curve superelevation 3.8% existing versus 4.1% required @ 65 mph).

- The accident history is inconclusive as to the causes of the accidents since the exact locations and exact cause of the accidents are not identified.
- The purpose of this project is to address five bridges which have deteriorated deck conditions. These bridges are on the Department's "Red List." There is a project in the Ten-Year State Transportation Improvement Program to improve Interstate 93 from Salem to Manchester (10418) (FY 2004-5) which would include these bridges and curves. Due to the deteriorated conditions of the bridge decks, it was felt that the rehabilitation could not wait for this project. To bring the superelevation rates up to modern day standards for the entire lengths of the curves is felt to be beyond the scope of work of the bridge deck replacements, and the remaining unimproved portions of the curves will be addressed as part of the Interstate 93 improvements from Salem to Manchester.
- The lengths of curve to be addressed by the project:

NB over Kendall Pond Road, 0.2 mi (out of 0.8 mi).

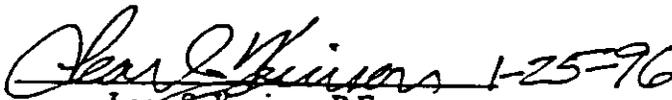
SB over Kendall Pond Road, 0.2 mi (out of 0.7 mi).

NB over Fordway Extension, 0.4 mi (out of 0.7 mi).

SB over Fordway Extension, 0.4 mi (out of 0.8 mi).

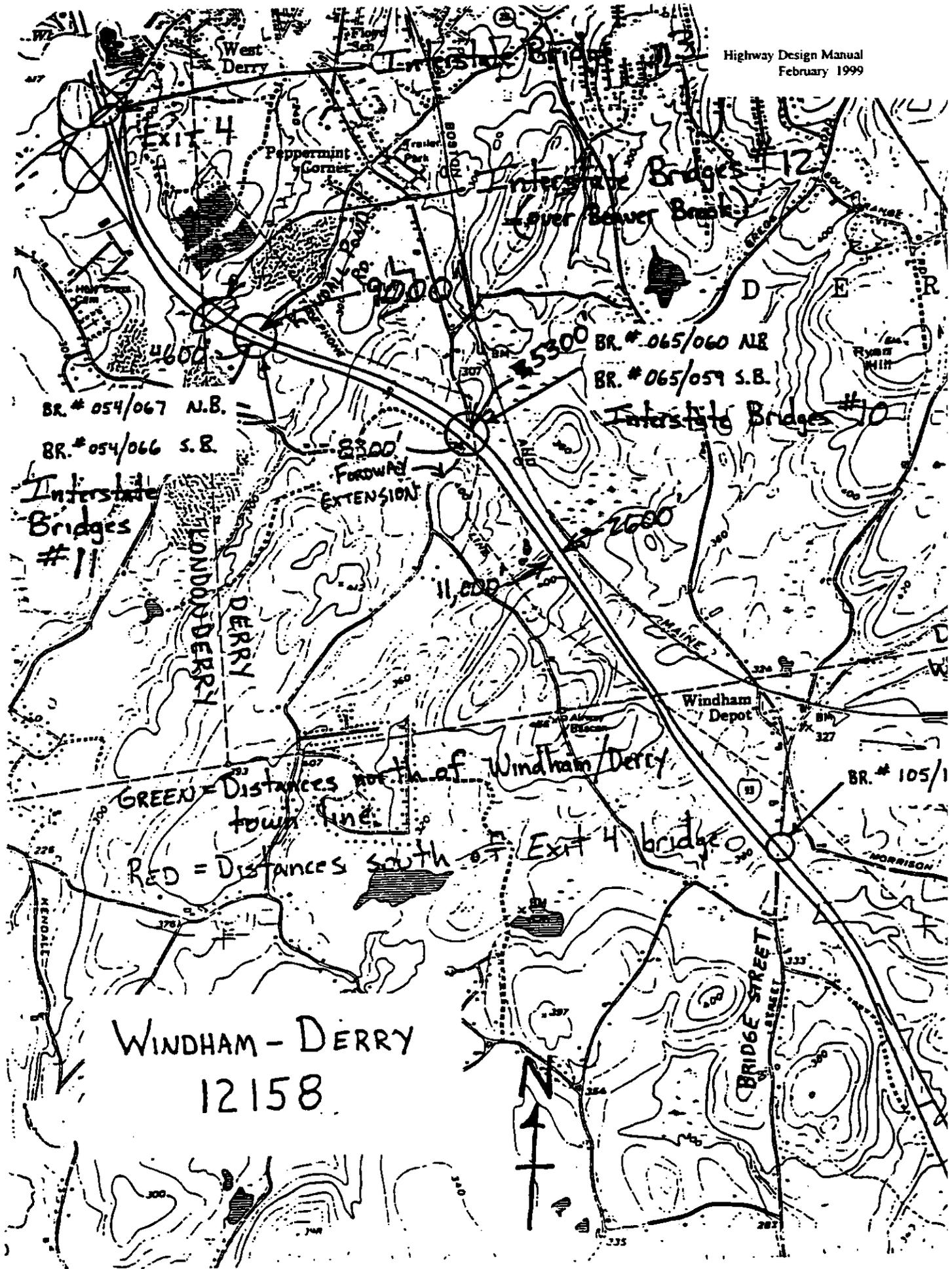
DESIGN APPROVED  _____

NOT APPROVED _____



Leon S. Kenison, P.E.
Assistant Commissioner

CAG/pab



BR. # 054/067 N.B.

BR. # 054/066 S.B.

Interstate
Bridges
11

BR. # 065/060 N.R.

BR. # 065/059 S.B.

Interstate Bridges # 10

8300'
FORWARD
EXTENSION

2600'

11,000'

GREEN = Distances north of Windham/Derry town line

RED = Distances south of Exit 4 bridge

WINDHAM - DERRY
12158



STATE OF NEW HAMPSHIRE
INTER-DEPARTMENT COMMUNICATION

Highway Design Manual
February 1999
APPENDIX 3-4

CA
FROM: *CA* Craig A. Green, P.E. **DATE:** May 5, 1997
Chief of Preliminary Design **AT (OFFICE):** Bureau of Highway Design

SUBJECT: STODDARD
BRF-X-T-012-1(37)
10666
NH Route 9 over North Branch of the Contoocook River

TO: *CA* Carol A. Murray, P.E.
Assistant Commissioner

THRU: *6/10* *5/7/97* *Recommend Pub 5-8-97*
CA Greg E. Plagy, P.E. *GR* Gilbert S. Rogers, P.E. *RW* Robert W. Greer
Administrator Assistant Director Director
Highway Design Project Development Project Development *CA*

MEMO

It is requested that a design exception be approved to allow 1.2 meter shoulder construction.

Background:

- Project includes:
 - Replacement of the NH Route 9 bridge over the North Branch of the Contoocook River.
 - Realignment of approximately 570m (0.3 mile) of NH Route 9.
- NH Route 9 is a rural arterial.
- Posted Speed 55 mph.
- Traffic for NH Route 9

1997 DVH	550
2017 DVH	840
1997 ADT	3930
2017 ADT	6440

6% trucks in DHV
11% trucks in ADT
- There have been six accidents in the vicinity of the bridge in a 6 year period. One of the accidents was a fatal. In three of the accidents, weather was an apparent contributory factor.

- Existing roadway width within the project limits is 7.5± meters with 1.2m ± shoulders.
- Existing bridge width is 7.2 meters (24') curb to curb.
- AASHTO, Policy on Geometric Design of Highways and Street (1994) in table VII-2 on page 488 indicates a recommended shoulder width (for a DHV over 200) as 2.4 meters.

Reason for exception:

- NH Route 9 is a rural, low volume highway along this section. This roadway has a large area of wetlands on the north side of NH Route 9 (on the easterly approach), and a historic stone arch bridge on the southerly side of the roadway. Using 1.2 meter shoulders will help reduce impacts into the wetlands and avoid impacts to the historic stone arch bridge.
- The westerly approach to the bridge has a steep hillside on the north side of the roadway and steep fill to the North Branch of the Contoocook River on the south side of the roadway. Using 1.2 meter shoulders reduces impacts into private property and avoids impacts into the river.
- The shoulders approaching this project are very narrow. There are no improvements in close proximity to this project that widened the shoulders, and there are no proposed projects for improvements to widen the shoulders in the State's Ten Year Transportation Improvement Program.
- This project will be paid with 80% Federal funds and 20% State funds. A reduced shoulder width will provide a cost savings to these funds. The construction cost savings will be the 8' total width over the length of the project (0.3 of a mile). It is estimated the savings will be approximately \$90,000 in construction costs, which includes the roadway and bridge work.

Design Approved 5/8/97

Not Approved _____



Carol A. Murray, P.E.
Assistant Commissioner

CAG/fmm

S:\ADMIN\CONSULT\MEMOS\10666\10804287.DOC



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION ONE

279 Pleasant Street, Suite 204
Concord, New Hampshire 03301-2509

Highway Design Manual
February 1999

APPENDIX 3-5

October 9, 1997

- ___ BRIDGE DESIGN
- ___ CONSTRUCTION
- ___ ENVIRONMENT
- ___ HIGHWAY DESIGN
- ___ MAT. & PAV.
- ___ MUNIC. HWYS.
- ___ R.O.W.
- ___ TRANS. PLANNING
- ___ BUDGET & FINANCE

Mr. Leon S. Kenison
Commissioner
The State of New Hampshire
Department of Transportation
Concord, New Hampshire 03302

Subject: Vertical Clearance, Interstate System
Coordination of Design Exceptions

Dear Mr. Kenison:

For your information, enclosed is Associate Administrator for Program Development Thomas J. Ptak's August 15 memorandum (HNG-14) concerning the coordination that is needed for vertical-clearance design exceptions on the Interstate System. Its main focus is upon satisfying the needs of the Military Traffic Management Command Transportation Engineering Agency (MTMCTEA).

As summarized in Mr. Ptak's memorandum, FHWA has adopted standards for vertical clearance on the Interstate System that require:

1. For the rural Interstate, a clear vertical height of 4.9 meters for structures over the entire roadway width, including useable shoulder width, and ^{16' ±}
2. For the urban Interstate, a clear vertical height of 4.9 meters must be provided, for the entire roadway width, including useable shoulders, through or around that particular urban area, on at least one route. Having met this requirement, other Interstate routes in that urban area are to provide at least a vertical clearance of 4.3 meters. ^{14' ±}

Also, please note on the second page of Mr. Ptak's memorandum that ".....the FHWA and MTMCTEA have agreed that all exceptions to the 4.9-meter vertical clearance standard for the rural Interstate and the single routing in urban areas, 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, will be coordinated with MTMCTEA beginning upon receipt of this memorandum. This agreement extends to the full roadway width including shoulders for the through lanes, as well as ramps and collector-distributor roadways in Interstate-to-Interstate interchanges."

Sincerely yours,

Thomas D. Myers
Assistant Division Administrator

RECEIVED
OCT 10 1997

OCT 10 1997

Enclosure



U.S. Department
of Transportation
Federal Highway
Administration

Memorandum

Highway Design Manual
February 1999

APPENDIX 3-5

ACTION: Vertical Clearance, Interstate
Subject: System Coordination of Design
Exceptions
Date: August 15, 1997

From: Associate Administrator for
Program Development
**Reply to
Attn. of:** HNG-14

To: Regional Administrators
Federal Lands Highway Program Administrator

For almost 30 years, the Federal Highway Administration (FHWA) and the Military Traffic Management Command Transportation Engineering Agency (MTMCTEA) of the Department of Defense (DOD) have cooperated to meet the demands of military traffic on the Interstate System, particularly in the area of vertical clearances. This need has been met with the adoption of standards by FHWA for vertical clearance on the Interstate that require a clear height of structures over the entire roadway width, including the useable width of shoulder, of 4.9 meters for the rural Interstate. In urban areas, the 4.9-meter clearance is applied to a single route, with other Interstate routings in the urban area having at least a 4.3-meter vertical clearance.

In 1960, at the request of the DOD, and with the cooperation of the States, the above standards were established to accommodate military traffic on the Interstate. At that time, a large number of structures on the Interstate, constructed under previous criteria, existed which did not conform to the new minimum standard. The correction of all these deficiencies could not be economically justified. Consequently, in 1969, the MTMCTEA, the American Association of State Highway and Transportation Officials (AASHTO) (then AASHO) and the FHWA agreed to concentrate on a subset of the Interstate judged to be priority routes. The subset contained a significantly smaller number of deficient structures on 41 842 kilometers of the Interstate. The 41 842-kilometer priority network served about 95 percent of the major military installations.

Since then, the MTMCTEA has developed and continues to refine the Strategic Highway Network (STRAHNET). The STRAHNET report dated January 1991 was distributed to Regional Federal Highway Administrators by memorandum from the Director, Office of Environment and Planning dated March 22, 1991. Since 1991,

there have been a few changes made to STRAHNET. These changes have been coordinated with the States and the field offices. Maps delineating the changes were distributed to the affected regional offices by HEP-10. The STRAHNET is a system of highways that provides defense access, continuity and emergency capabilities for movements of personnel and equipment in both peacetime and wartime. The STRAHNET was based on quantifiable DOD requirements, addressing their peacetime, wartime, strategic, and oversize/overweight highway demands. The network consists of approximately 96 000 kilometers of highway. The STRAHNET has been incorporated into the National Highway System (NHS). Almost 75 percent of the system in the continental United States (about 70 000 kilometers) consists of roadways on the Dwight D. Eisenhower National System of Interstate and Defense Highways.

The currently established procedures require the FHWA to coordinate with the MTMCTEA when a clear height of structures of less than 4.9 meters is created as the result of a construction project or the project does not provide for the correction of existing substandard vertical clearance on the 41 842-kilometer priority network prior to approving the exception. For routes not on the priority network, coordination is not required although the FHWA policy provides that the MTMCTEA be notified of all exceptions to vertical clearance on the remainder of the Interstate System. The approval action for exceptions to vertical clearance has been delegated to the field offices, which can contact the MTMCTEA directly. When the State highway agency (SHA) has approval authority for design exceptions under one of the 23 U.S.C. 106(b) exemption provisions, coordination with the MTMCTEA is still required and may be accomplished through the FHWA or directly with the MTMCTEA.

The development of the STRAHNET, the establishment of Power Projection Platforms, base realignments, and the evolving role of the military have created a need to revise coordination procedures between the MTMCTEA and the FHWA, concerning exceptions to the vertical clearance requirements on the Interstate System. Therefore, the FHWA and the MTMCTEA have agreed that all exceptions to the 4.9-meter vertical clearance standard for the rural Interstate and the single routing in urban areas, 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, will be coordinated with the MTMCTEA beginning upon receipt of this memorandum. This agreement

extends to the full roadway width including shoulders for the through lanes, as well as ramps and collector-distributor roadways in Interstate-to-Interstate interchanges. This change in effect eliminates the 41 842-kilometer priority network as a separate subset of the Interstate System. The revised coordination procedures do not change the standards adopted for the Interstate enumerated in "A Policy on Design Standards - Interstate System," AASHTO, July 1991, or the delegations of authority in FHWA Order M1100.1A.

A number of toll roads are part of STRAHNET by virtue of being incorporated into the Interstate System under the former provisions of Section 129(b) of Title 23, United States Code. While the FHWA does not have any particular "leverage" on the toll authorities to comply with Federal standards on non-federally funded projects, it is expected that the SHA's have established appropriate procedures to assure that proposed changes or alterations of the toll road will meet applicable policies established for the Interstate System. The working relationship should ensure the needs of the military are considered and that necessary coordination occurs.

A request for coordination may be forwarded to the MTMCTEA at any time during project development prior to taking any action on the design exception. It should include a time period of 10 working days (after receipt) for action on the request. The office initiating a request for coordination to the MTMCTEA should verify receipt of the request by telephone or fax. If the MTMCTEA does not respond within the time frame, the FHWA should conclude that the MTMCTEA does not have any concerns with the proposed exception. If comments are forthcoming, the FHWA and the SHA will consider mitigation to the extent feasible.

A request for coordination should be addressed to:

Director
Military Traffic Management Command
Transportation Engineering Agency (MTMCTEA)
ATTN: MTTE-SA
720 Thimble Shoals Boulevard, Suite 130
Newport News, VA 23606-2574
(Telephone: 757-599-1117, Fax: 757-599-1560)

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAY DESIGN

Highway Design Manual
February 1999

APPENDIX 3-6
April 4, 1991

CONFERENCE REPORT

PROJECT: FILE: AASHTO

DATE OF CONFERENCE: March 28, 1991

LOCATION OF CONFERENCE: Small Design Conference Room

ATTENDED BY: DEPARTMENT OF TRANSPORTATION

G. S. Rogers	Caleb Dobbins
J. S. Colburn	D. A. Lyford
Doug Graham	Craig Green

SUBJECT: AASHTO Vs. MUTCD Passing Sight Distance

NOTES ON CONFERENCE:

This meeting was held to discuss the difference between the passing sight distance values in the MUTCD Manual and the AASHTO Policy on Geometric Design of Highways and Streets (Green Book). The AASHTO Manual values for passing sight distance were considerably higher than the MUTCD. The concern was a result of (1) designer liability and (2) the requirement for including an estimate of pavement marking for contractors to bid on.

The following is a result of this meeting:

1. The MUTCD will be used when estimating the quantity for pavement marking. A note will be put on the plans indicating the passing lane locations and will be approved by the Traffic Bureau before permanent markings are placed. The quantity for pavement markings will be backed up by a sketch kept in the file with a copy to Traffic for their later use in field adjustment as necessary.
2. The AASHTO Manual (Green Book) values will be used if/when actually designing a passing zone.

Submitted by,


Craig A. Green, P. E.
Chief of Preliminary Design

CAG/mkr

Noted by G. Rogers

cc: L. Kenison	M. Fudala	J. Colburn	All Team Leaders
R. Greer	R. Davis	D. Graham	
G. Rogers	C. Green	D. Lyford	

STATE OF NEW HAMPSHIRE
INTER-DEPARTMENT COMMUNICATION

*RWG
7-30-96*

FROM Robert W. Greer, Director
Project Development

DATE July 30, 1996

AT (OFFICE) Department of
Transportation

SUBJECT Environmental Commitments Guidelines
Commissioner's
Office

TO Bureau Administrators *Bill Hauser*
District Engineers
Project Managers

Enclosed for your information and implementation is the newly adopted "Environmental Commitments Guidelines," which supersedes the former "Monitoring Environmental Commitments - Steps in Process." The revised guidelines are a product of the joint NHDOT/FHWA Process Review on Environmental Commitments, which has recently been finalized.

As stated in the process review report, "the frequency and magnitude of environmental commitments as mitigation for anticipated impacts have increased dramatically over the last several years. These commitments are critical in securing approvals to advance projects in compliance with the provisions of the National Environmental Policy Act It is important that these commitments are properly implemented, that they are successful in accomplishing their purpose and that they are cost effective. It is equally important that the Construction Bureau staff understand the significance of these commitments and the laws/regulations that require them."

The enclosed guidelines should be followed to assure that appropriate Department personnel are involved in the development of environmental commitments, and that the commitments are implemented with conviction. As a monitoring tool, a new "Environmental Field Report" has been developed (enclosed), replacing the outdated "Environmental Mitigation Field Data" form. This report will be used by the Bureau of Construction's contract administrators to indicate the status of environmental commitments implementation.

The cooperation of you and your staff is needed to ensure the integrity of the project development process with respect to environmental considerations. Successful implementation of environmental commitments is necessary to maintain the Department's credibility with the resource agencies, government officials, special interest groups and the general public.

If you have any questions or need clarification about the guidelines, please contact Bill Hauser, Administrator, Bureau of Environment at 271-3226.

RWG:jaa
Encl.
cc J. Clement, w/encl.
FHWA

RECEIVED
BUREAU OF ENVIRONMENT

AUG 02 1996

N. H. DEPARTMENT OF
TRANSPORTATION

**THE STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION**

ENVIRONMENTAL COMMITMENTS GUIDELINES

These guidelines are intended to direct the development and implementation of environmental commitments (including mitigation) proposed in response to impacts on the natural, social, economic and cultural environment caused by NHDOT transportation projects. The frequency and magnitude of environmental commitments have increased dramatically in recent years. These commitments are critical in securing approvals to advance projects, therefore, the importance of their successful implementation cannot be overstated.

Communication and coordination among the Department's bureaus and between the Department and outside agencies is essential to ensure that environmental commitments are reasonable and implemented with conviction. In general, it is the responsibility of the Bureau of Environment to initiate this coordination and to facilitate communication throughout project development. The process of identifying commitments may continue through the final design and right-of-way acquisition phases. All appropriate bureaus, e.g., Highway Design, Bridge Design, Municipal Highways, Maintenance, Turnpikes, Right-of-Way, Construction, etc. must be involved in the review of the proposed commitments to assure they are consistent with design, safety and construction criteria, achieve the desired results, and are implemented cost-effectively.

A list of environmental commitments will be compiled by the Bureau of Environment, revised as necessary throughout project development and distributed to all appropriate bureaus and the Federal Highway Administration (FHWA).

The specific steps involved in the development and implementation of environmental commitments are outlined below.

I. Development of Environmental Commitments

- A. As environmental documents are being developed, a listing of potential environmental commitments (natural, social, economic and cultural) will be prepared by the Bureau of Environment. The list should be distributed to all appropriate Department personnel (Design, Construction, Maintenance, Right-of-Way, etc.) and the FHWA at key project development junctures. This would precede the traditional "commitments memo" normally distributed at the conclusion of the environmental documentation process. The list of commitments is dynamic and will be revised throughout the life of the project to reflect changes, deletions and additions. The Project Manager has the ultimate responsibility to assure that the mitigation measures are carried out, but individual staff may be assigned specific tasks. The list should also identify the party responsible for the implementation of each commitment. The Project Manager will determine the need for a special meeting of

bureau representatives, to address controversial commitments.

- B. Appropriate Department representatives, including Construction personnel where needed, will attend meetings with the natural resources agencies, as these are often the forum where commitments are first discussed. The Bureau of Environment will provide the appropriate notification of these meetings.
- C. At the project turnover meeting with Final Design personnel, the environmental commitments will be discussed by the Bureau of Environment and introduced to the project management team.
- D. The environmental documents will include a summary of environmental commitments, for easy reference. Commitments made subsequent to the completion of the documents will be appended.
- E. At the conclusion of the environmental documentation process, the Bureau of Environment will distribute a memorandum to the project manager or other project personnel, transmitting the environmental document with specific reference to the environmental commitments. This memorandum will include conditions from permits, MOAs, etc., if available. Where additional conditions are imposed or commitments are made following the NEPA process, a follow-up memo will be issued by the Bureau of Environment transmitting a supplement to be appended to the summary of environmental commitments. Copies of these commitments memos will be distributed by the Bureau of Environment to FHWA, the lead design bureau, Construction, Right-of-Way, Transportation Planning, Maintenance, Bridge Maintenance and other bureaus as appropriate.
- F. At the 60% Preliminary Plan Coordination Meeting, the environmental commitments will be reviewed and their implementation discussed.
- G. The lead design bureau will draft the Environmental Commitments text for the Prosecution of Work section in the Proposal/Contract, and distribute it to the Bureau of Environment, Construction, Right-of-Way and Maintenance Bureaus for review. Permits should be included in the Bid Proposal and Contract. Other referenced documents (i.e., MOAs etc.) will be available to the contractor through the Bureau of Environment.
- H. At the Issues Meeting (90%), the environmental commitments will be reviewed again. The construction coordinators should be present.
- I. Commitments made late in the project development process, including permit conditions, will be coordinated with the appropriate bureaus by the Bureau of Environment. Where unreasonable or confusing permit conditions are proposed or issued, they should be challenged through the appropriate channels for modification or clarification.
- J. The finalized Environmental Commitments text in the Prosecution of Work of the Proposal/Contract, with the attached referenced documents, will be provided by the lead

design bureau to the Bureau of Environment for appending to the project environmental documents.

- K. Unique environmental commitments will be presented by the Bureau of Environment to prospective bidders at a pre-bid conference, if such a conference is determined appropriate by the Project Manager or other lead project personnel.
- L. Where major utility work is necessary on a project in areas of known environmental sensitivity, the commitments will be clearly presented to the utility companies by the Utilities Section and assurances received that these commitments will be respected by their work forces. Project construction personnel need to be advised by the Utilities Section of this coordination and the utilities' responsibilities to comply with the commitments.

II. Implementation of Environmental Commitments

- A. Upon assignment to a project, the Contract Administrator will review the Bureau of Construction's files relative to correspondence/documents addressing environmental commitments. Comments and questions should be directed to the appropriate bureaus for response.
- B. Copies of the commitments list, all supporting documents (environmental studies, permits, MOAs, etc.) and plans of record, will be retained at the project site by the Contract Administrator.
- C. At the preconstruction conference, an opportunity to review environmental commitments with the Department and the contractor's construction personnel, as well as utility personnel when appropriate, will be provided. All appropriate Department personnel should attend this conference, and an invitation extended to appropriate representatives of resource agencies (ACOE, EPA, FWS, NHWB, NHFGD, etc.). If environmental commitments are of a magnitude or sensitivity to warrant special attention, a separate preconstruction conference will be held at the direction of the Project Manager or other lead project personnel to emphasize the importance of these commitments.
- D. As required by permit conditions, or for other purposes, the Contract Administrator will monitor, or facilitate monitoring by others, the implementation of environmental commitments. The Department's Environmental Field Report form (copy attached) will be used to make interim reports of the progress and effectiveness of such implementation.
- E. Prior to the final construction inspection, the Contract Administrator will submit a completed final Environmental Field Report form to the Bureau of Environment. The Bureau of Environment will review the form to note the disposition of commitments.
- F. Appropriate members of the Department (Environment, Design, Maintenance, etc.) and the resource agencies (ACOE, EPA, FWS, NHWB, NHFGD, etc.) will be invited by the Bureau of Construction to attend a final inspection to review the status and effectiveness of environmental commitments.

**NEW HAMPSHIRE DEPARTMENT OF TRANSPORTATION
ENVIRONMENTAL FIELD REPORT**

Project _____ Date _____
 State & Federal No. _____
 Project Contract Administrator _____
 Contractor _____
 Project Environmental Coordinator _____
 Bureau of Environment Representative _____
 Contract Amount _____ Percent Complete _____

A. Erosion Control Plan Yes No
 Erosion Control Designer _____
 Did the Design Work ? Yes No
 Comments _____

B. Soil Erosion Control

Soil Erosion Control Measures	Effective Y/N	Ease of Maintenance 1-5 (Hardest)	Will you use it again on like project ? Y/N (If no - explain)
1. Hay Bales			
a. Toe Slope			
b. CB's & DI's			
c. Inlets of Pipes			
d. Slope			
e. Other			
2. Silt Fence			
a. Toe Slope			
b. CB's & DI's			
c. With Wire Fence			
d. Ditch Check Dams			
e. Other -			
3. Dust Control			
a. Water Truck			
b. Calcium Chloride			
c. Tire Scrubber			

