



Arizona Department of Transportation

ROADWAY ENGINEERING GROUP MEMORANDUM

To: Roadway Design Personnel
ADOT and Consultants

Date: December 14, 2009

From: Mary Viparina
Assistant State Engineer
Roadway Engineering Group

Subject: Design Exception and Design
Variance Process Guide – Update of September
30, 2008 Guide

The subject Process Guide was developed to provide guidance and to set forth requirements and procedures for obtaining design exception approvals during the predesign and design stages of project development. This memorandum updates and supersedes previous memorandums. Design Exceptions are required for those elements considered to be controlling design criteria. Design Variances are for other essential design elements that are not controlling design criteria.

Please distribute the attached Process Guide to design engineers and project managers in your respective Groups and encourage them to become familiar with the updated guidelines. The new Guide shall be implemented in the Scoping Stage at the earliest timeframe determined practical by the Scoping Project Manager. If Design Exceptions or Design Variances are required during the Design Stage of an ongoing project, the Guide used in the Scoping Stage should be applied.

Please contact the Roadway Group for any questions or discussion on this update.

C:
Roadway Engineering Group
Statewide Project Management Group
Valley Project Management Group
Bridge Group
Traffic Engineering Group
Materials Group
Regional Traffic Engineers (4)
Contracts and Specifications Section
District Engineers (10)
Engineering Consultants Section
FHWA

DESIGN EXCEPTION AND DESIGN VARIANCE

PROCESS GUIDE

ARIZONA DEPARTMENT OF TRANSPORTATION

ROADWAY ENGINEERING GROUP

December 14, 2009

DESIGN EXCEPTION AND DESIGN VARIANCE

PROCESS GUIDE

SCOPE: In the geometric design of highway projects there are certain design values that are prescribed in the ADOT Roadway Engineering Group design manual *Roadway Design Guidelines* (RDG) and the AASHTO *A Policy for Geometric Design of Highways and Streets* (Green Book) that have been determined to be paramount to a properly designed highway. When it is determined that it is not practical for these design values to be met, documented justification must be submitted and approval must be obtained for inclusion in the design plans. The purpose of this guide is to specify a) the design guidelines applicable to various types of projects b) exception justification requirements and c) procedures required to obtain needed approvals.

DESIGN EXCEPTIONS: Design Exceptions (DE) are required when design values selected for design do not meet the design requirements of the basic “Controlling Design Criteria”. The AASHTO Green Book “Controlling Design Criteria” are identified in the document Guide for Review of the AASHTO Controlling Design Criteria on Existing ADOT Highways (Procedural Guide) and are listed herein on page 8. ADOT corresponding values for the “Controlling Design Criteria” are found in the RDG. The ADOT RDG values for the “Controlling Design Criteria” are equal to or more conservative than the design values specified in AASHTO.

Design Exceptions are required with project types as follows:

1. For new construction and major reconstruction, design elements shall conform to the requirements of the ADOT RDG. A list of the RDG Design Exception elements is listed in the Appendix.
2. For existing roadway design elements to remain, Design Exceptions are required for design values not meeting the AASHTO Controlling Design Criteria.

See the following Tables listing DE requirements for types of NHS and non-NHS projects.

DESIGN VARIANCES: Design Variances are required for utilization of design values for new construction that do not meet the design values prescribed in the RDG. These design values are separate from the basic controlling design criteria that require RDG Design Exceptions. The design values requiring Design Variances are listed in the Appendix. They are identified in the RDG and in supplemental design memorandums where the word “**shall**” is specified in the text.

PROJECT TYPES: The following Design Exception/Design Variance Tables provide guidance for determination of the need for Design Exceptions and/or Design Variances based on the scope of construction project:

National Highway System (NHS) Projects

Design Exception/ Design Variance Table

<u>Project Type</u>	<u>Design Exceptions Required AASHTO or ADOT RDG</u>	<u>Design Variance Required ADOT RDG + MEMOS</u>
1. New Construction (Major)		
a. New route or bypass	RDG	x
b. New divided highway		
1) New roadway	RDG	x
2) Existing roadway to remain	AASHTO	
2. Reconstruct Existing Roadway		
a. Total reconstruct	RDG	x
b. Partial reconstruct		
1) Existing roadway to remain	AASHTO	
2) Reconstruct roadway portion	RDG	x
3. Widen Existing Roadway (1)		
1) Existing roadway to remain	AASHTO (2)	
2) Widened roadway portion	RDG	x
4. Intersection Reconstruction	RDG (3)	x
5. Pavement Preservation		
a. Existing Roadway	AASHTO	
b. Roadway Reconstruction	RDG	x
6. Striping		
a. Change of lane width/shoulder width	AASHTO	
7. Spot Improvements	RDG (4) (5)	

- (1) For passing lane/climbing lane additions, use "A Policy on the Design of Passing Lanes and Climbing Lanes" December, 1997.
- (2) AASHTO Review when determined necessary by Roadway Predesign
- (3) Exceptions needed as applied to portion being reconstructed - e.g. when adding turn lanes, exceptions would be required as applied to the design of the turn lane addition.
- (4) Exceptions required for spot improvement primary design element only – e.g. when spot widening a shoulder area, vertical and horizontal alignment do not require design exceptions.
- (5) HES funded projects do not require design exceptions.

Non-NHS Projects

Design Exception/ Design Variance Table

<u>Project Type</u>	<u>Design Exceptions Required</u> <u>ADOT RDG or AASHTO</u>	<u>Design Variance Required</u> <u>ADOT RDG + MEMOS</u>
1. New Construction (Major)		
a. New route or bypass	RDG	x
b. New divided highway		
1) New roadway	RDG	x
2) Existing roadway to remain	AASHTO (2)	
2. Reconstruct Existing Roadway		
a. Total reconstruct	RDG	x
b. Partial reconstruct		
1) Existing roadway to remain	AASHTO (2)	
2) Reconstruct roadway portion	RDG	x
3. Widen Existing Roadway (1)		
1) Existing roadway to remain	AASHTO (2)	
2) Widened roadway portion	RDG	x
4. Intersection Reconstruction	RDG (3)	x
5. Pavement Preservation		
a. Existing Roadway	(6) (2)	
b. Roadway Reconstruction	RDG	x
6. Striping		
a. Change of lane width/shoulder width	RDG	
7. Spot Improvements	RDG (4) (5)	

(1) For passing lane/climbing lane additions, use "A Policy on the Design of Passing Lanes and Climbing Lanes" December, 1997.

(2) AASHTO Review only when determined necessary by Roadway Predesign

(3) Exceptions needed as applied to portion being reconstructed.

(4) Exceptions required for spot improvement primary design element only – e.g. when spot widening a shoulder area, vertical and horizontal alignment do not require design exceptions.

(5) HES funded projects do not require design exceptions.

(6) No exceptions required but review vertical clearances affected by pavement treatment.

PROCESS:

Predesign Stage: Roadway projects are routinely scoped for programming with a Scoping Letter, Project Assessment (PA), Design Concept Report (DCR) or Location Design Concept Report (L/DCR). Roadway Predesign Guidelines for preparation of these documents describe the Design Exception process for each type of scoping document.

A justification letter requesting approval of the Design Exception or Design Variance is prepared by the design engineer and submitted to the Predesign Section Manager. The Predesign Section Manager reviews and sends all Design Exception and Design Variance requests to the Assistant State Engineer, Roadway Engineering Group for review and approval. The Assistant State Engineer, Roadway Group may require the concurrence of the Assistant State Engineer, Bridge Group for bridge related design exceptions.

For Design Exceptions requiring approval by FHWA, the Assistant State Engineer, Roadway Engineering Group first reviews and concurs as appropriate. Upon concurrence, the request for Design Exceptions is sent to FHWA for approval.

Design Exception and Design Variance requests for scoping documents prepared outside of Roadway Pre-design are to be submitted by the design engineer through the Project Manager to the Predesign Section Manager for processing.

FHWA Review and Approval: Design Exceptions

National Highway System (NHS): Design Exceptions on the NHS are approved by FHWA regardless of funding source.

FHWA Arizona Division Development Guidelines Number DG-44 "Design Exceptions and NEPA Compliance" contain NEPA requirements for Design Exceptions for projects on the Interstate and NHS.

Non-NHS: Design Exceptions, when required for non-NHS projects, are approved by ADOT regardless of funding source.

Disposition of Final Documents – Predesign Stage:

Design Exception and Design Variance requests and approvals (ADOT and FHWA) during the predesign stage are filed with the Scoping Documents for permanent record in Roadway Predesign.

Copies of Design Exception approvals are sent to ADOT Contracts and Specifications Section for documentation.

Design Stage:

The need for Design Exceptions and Design Variances during the roadway design stage of a project should be minimized with a thorough analysis during the scoping or pre-design stage. It is however, not uncommon in the refinement of design elements during the design stage and after obtaining more precise design data that the need for design exceptions or variances becomes evident. It is important that the design engineer address these changes from the scoping document early and in an expedient manner. By addressing the potential exceptions or variances in the early stage of design, impacts on schedule and project cost can be minimized. All of the controlling design elements requiring Design Exceptions should be refined and identified by completion of the Stage II plans development.

Stage III design, prior to submittal of plans for review, is the final time that a Design Exception or Design Variance may be submitted for consideration. Identification of the need for Design Exceptions and Design Variances after Stage III is an indication that the designer has not thoroughly reviewed the design for compliance with the applicable standards. Only rarely and with strong justification will requests for Design Exceptions or Design Variances after the Stage III design be considered. Design Exceptions and Design Variances will not be granted based upon a lack of adequate time to make changes to meet the project schedule.

Design Exception and Design Variance requests with appropriate justification will be sent from the design engineer to the Assistant State Engineer, Roadway Engineering Group through the Project Manager. Following review and concurrence by the Assistant State Engineer, Design Exception requests on the NHS are to be submitted by the Project Manager to the FHWA for review and approval in accordance with the **ADOT/FHWA Operating Partnership**.

Disposition of Final Documents - Design Stage:

The design engineer shall keep all Design Exception and Design Variance requests and approvals in the design project file and send copies to the Assistant State Engineer, Roadway Engineering Group for permanent file. The Assistant State Engineer will keep on permanent file copies of all Design Exceptions and Design Variance approvals during the design stage.

Copies of Design Exception approvals are sent by the Project Manager to Contracts and Specifications Section.

EVALUATION AND JUSTIFICATION FOR DESIGN EXCEPTIONS and DESIGN VARIANCES:

Requests for Design Exceptions and Design Variances must be accompanied by appropriate justification. Approval of a Design Exception or Design Variance requires **compelling** reasons to justify why the established standard cannot or should not be used.

Consideration must be given for the effects of the variance from the design standard on the **safety and operation** of the facility and the **compatibility with adjacent sections of highway**. Consideration must also be given to the functional classification of the highway, the type of project (e.g. new or reconstruct, 3R), and the amount and character of traffic. **Accident history** may be a factor when evaluating an existing roadway. The cost of obtaining current applicable standards should be weighed with any resultant impacts upon **scenic, historic, and other environmental** features. **Future planned improvements** to the roadway or corridor must be considered.

Issues to be considered in any analysis should **include a) what is the degree to which the standard is being reduced? b) what impacts, if any, will the exception have on other standards?, c) does a reduction in the standard significantly impact the safety in the specific area or the overall project? and d) are there any other additional features (such as signing, delineation, rumble strips) that would mitigate the impacts of the deviation from standard?**

The FHWA *“Mitigation Strategies for Design Exceptions”* July 2007 should be reviewed to consider mitigation measures that are outlined for potential implementation with approvals for design exceptions.

ELEMENTS REQUIRING DESIGN EXCEPTIONS:

A. **For Existing Highway Elements to Remain In-Place:** For projects identified as determined in accordance with the Design Exception/Design Variance Tables, an AASHTO Controlling Design Criteria Report is prepared utilizing the Guide for Review of the AASHTO Controlling Design Criteria on ADOT Roadways. Design elements that are required to be addressed are:

- * **Design Speed**
- * **Lane Width**
- * **Shoulder Width**
- * **Bridge Width**
- * **Horizontal Alignment**
- * **Superelevation**
- * **Vertical Alignment**
- * **Grade**
- * **Stopping Sight Distance**
- * **Cross Slope**
- * **Vertical Clearance**
- * **Horizontal Clearance**
- * **Bridge Structural Capacity /Bridge Barrier**

Note: For Interstate Highways see also “A Policy on Design Standards- Interstate System” pamphlet for design values requiring exceptions.

B. **For New Construction and Reconstruction: See Design Exception/Design Variance Tables**

The current edition of the Roadway Design Guidelines (RDG) including any updates, revisions and design memoranda is the basis for Design Exceptions. RDG design values equal or exceed the corresponding AASHTO values for design exceptions. Therefore, AASHTO design criteria **will not be used** as the basis for Design Exceptions unless specifically stated in the RDG.

Section 3.1 of the RDG states “To promote uniformity throughout the state, the use of design values lower than the mandatory standards presented in this manual shall require the written approval of the Roadway Group Manager or authorized designee.” The mandatory standards are those presented using the word “shall”.

See the Appendix for a listing of design elements requiring Design Exceptions.

ELEMENTS REQUIRING DESIGN VARIANCES:

A. For New Construction and Reconstruction: See Design Exception/Design Variance Tables

The current edition of the Roadway Design Guidelines (RDG) including current updates, revisions and design memoranda is the basis for Design Variances. Design Variances are needed for all other design values proposed lower than the mandatory standards as stated in the RDG Section 3.1. These are in addition to and are separate from the RDG Design Exception controlling criteria elements.

See the Appendix for a listing of design elements requiring Design Variances.

Reference List:

1. ADOT Roadway Design Guidelines (RDG), January 2007 and current updates
2. A Policy On Geometric Design of Highways and Streets – 2004 AASHTO Green Book
3. A Policy on Design Standards, Interstate System, 2005.
4. Guide for the Review of the AASHTO Controlling Design Criteria, 2009
5. FHWA Development Guideline Number DG-44
6. ADOT/FHWA Operating Partnership- 2008 (See Table 1: Summary of Responsibilities)
6. Roadway Predesign Guidelines for Preparation of Scoping Documents:
http://www.azdot.gov/Highways/Roadway_Engineering/Roadway_Predesign/index.asp
7. FHWA *Mitigation Strategies for Design Exceptions* July 2007

APPENDIX

This List Updated 3/21/11

DESIGN EXCEPTION/ DESIGN VARIANCE PROCESS GUIDE

This appendix is intended to summarize the key design elements at the time of issue. The items will change with the issuance of new and revised design criteria. The designer may stay abreast of the current design updates by visiting the roadway design website at:

http://www.azdot.gov/Highways/Roadway_Engineering/Roadway_Design/Design/Memos/index.asp

The following list summarizes the RDG design elements requiring Design Exceptions and Design Variances:

*Items identified with ** require Design Exceptions. All others require Design Variances. Items identified as **ABSOLUTE** will not be considered for an Exception or a Variance.*

CHAPTER 100 – Design and Criteria

**** Design Speed** - Section 101.3

- Change of Traffic Design Data after Final Scoping - Section 102.2
- Level of Service – Section 103.2

CHAPTER 200 – Elements of Design

**** Stopping Sight Distance** - Section 201.2

**** Superelevation** - Section 202.1

- Superelevation Transition Length - Section 202.3
- Ramp and Lane Taper Cross Slope - Section 202.3
- Horizontal Alignment Control Coincident with Axis of Superelevation Rotation – Section 203.1

**** Horizontal Sight Distance** – Figure 203.2

- Use of Spiral Curves - Section 203.3
- Profile gradeline coincides with axis of rotation for superelevation - Section 204.2

**** Vertical Alignment Stopping Sight Distance** - Section 204.2

- Minimum Highway Grade over 4000 ft - Section 204.3

- **** Maximum Grades** - Section 204.3
- Maximum Grade Break Without Vertical Curve - Section 204.4
- Separate Grade Lines for Divided Highways - Section 204.6
- ** Vertical Clearance to Structures** - Section 206.4 (See Bridge Design Guidelines, Section 2)
- Falsework clearance – (See Bridge Design Guidelines, Section 16)

CHAPTER 300 - Cross Section Elements

- ** Cross Slope** - Section 301.2
- ** Lane Width and Pavement Width** - Section 301.3
- ** Minimum shoulder width** - Section 302.4
- ** Horizontal clearance to obstructions** - behind curb or curb and gutter - Section 303.2
- Shoulder wedge steeper than 6:1 – Section 303.3
- Minimum Median Width Without Barrier for Rural Highways - Section 304.1
- Median Barrier Warrants - Section 304.4
- Median Curb Types for Urban Highways – Section 304.5
- Guard Rail at Embankment Curbs - Section 305.7
- Longitudinal Barrier End Treatment – Section 305.10
- Rural Cross Section - Section RA to address ultimate design - Section 306.2
- Fringe Urban Section - median width and address ultimate design - Section 306.3
- Sidewalk Ramps conform to ADA – Section 310
- Right of Way Fence- Section 313
- Detour Horizontal Alignment - Section 316.4
- Detour Stopping Sight Distance - Section 316.6
- Detour Sidewalks have Temporary Concrete Barrier - Section 316.8

CHAPTER 400 – At-Grade Intersections

- Use RODEL software model for design of modern roundabouts – Section 403.2
- Skewed intersections exceeding 20 degrees – Section 403.4
- Access Openings on Freeways - Section 405.1 **ABSOLUTE**
- Crossovers - Section 405.1
- Private Road Connections - Section 405.2
- ** **Intersection Stopping Sight Distance** - Section 408.3
- ** **Intersection Sight Distance** - Section 408.4
- Intersection Grades - Section 408.8
- Free Right Turns - Section 408.11

CHAPTER 500 - Traffic Interchanges

- Crossroad Grade at Ramp Termini - Section 503.5
- Paved Gore Crossover Rates - Section 504.1
- Loop Ramp Minimum Radius – Section 504.2
- Ramp Taper and Ramp Gore Crossover Rates - Section 504.3
- Ramp Width - Section 504.5
- Parallel exit ramps in urban areas – Section 504.7
- No curbed gores – Section 504.7
- Parallel entrance ramps in urban areas – Section 504.7
- No curbed gores – Section 504.8
- Maximum ramp/crossroad intersection angle – Section 504.1
- Access control limits – Section 506

CHAPTER 600 - Highway Drainage

- Federal and State Statutes - Section 602.1
- Design Frequency Changes - Section 603.1
- Bridges and Culverts at Flood Channels or Detention Basins – Section 602.2B
- Pavement Drainage Frequencies - Section 603.2D
- Pavement Drainage Allowable Spread – Section 603.2D
- Pavement Drainage – Sump – Section 603.2D
- Ditches, Channel and Detention Basin Frequency - Section 603.2E
- Capture ratio for Inlets – Section 606.2A
- Bicycle and Pedestrian Safe Grates - Section 606.2B **ABSOLUTE**
- No Curb Opening Inlets for Pump Station Collection - Section 606.2B
- Pipe Material and Pipe Size – Section 607.1
- Use of Pipe Selection Guidelines and Procedures - Section 607.5
- Channel Side Slopes – Section 608.1A
- Channel Velocity and Flow Depth – Section 608.2
- Freeboard for Open Channel - Section 608.4
- Channel Height for Outside Wall in Bend – Section 608.5
- Channel Linings – Section 608.6
- Channel Inflows – Section 608.9
- Maintenance Width for Channels – Section 608.11
- Detention Basin Outflow and Standing Water Retention Period - Section 609.1
- Detention Basin Maximum Depth and Water Level – Section 609.2
- Detention Basins - No Dams - Section 609.2
- Detention Basins – Use of Dry Wells - Section 609.2

- Detention Basin Emergency Spillways – Section 609.4
- Bridge Backwater Requirements – Section 610.1
- Bridge Hydraulic Calculations – USACE HEC-RAS program – Section 610.2E
- Skew and Scour at Bridge Foundations- Section 610.2F
- Culverts Having Earth Inverts – Section 611.1
- Box Culvert Minimum Size- Section 611.3A
- Hydraulic Design of Closed Invert Culverts – Section 611.3B
- Culvert Backwater – Section 611.3C
- Culvert Concrete Headwall Requirement and Attachment to Culvert – Section 611.3G
- Culvert Combination Stock/Vehicle/Equestrian Pass Limitation – Section 611.3K
- Structural Plate Pipe – Paved Invert and Headwall Requirement – Section 611.3K
- Erosion and Sediment Control Design Requirements - Section 612.1
- Erosion Control Linings – Section 612.2A
- Grade Control Structures – Section 612.2B
- Bank Protection – Section 613.1 & Section 613.2
- Pump Station Design – Section 614.1
- Pump Station Storage Reservoirs – Section 614.2
- Pump Station Site Layout and Access – Section 614.5

CHAPTER 700 – EARTHWORK DESIGN

- Ground Compaction Application to Embankment Areas – Section 701.4