

**VTrans Structures Section
QC/QA Program**



VERMONT AGENCY OF TRANSPORTATION

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Structures QC/QA Program

INTRODUCTION

This Structures Section Quality Control/Quality Assurance (QC/QA) program establishes the organizational procedures and practices for ensuring that requirements and expectations for structures projects are fully met. This QC/QA program provides checks and balances within Structures to assure quality in the design calculations, plans, and specifications. This (QC/QA) program applies to the in-house design, consultant design as well as design-build projects.

In-house designers, consultant designers and reviewers must recognize that quality is the result of several processes. It requires many individuals performing many appropriate activities at the right time during the plans development process. Quality does not solely consist of a review after a product is completed. It is an approach and a realization that Quality is something that occurs throughout the design and plan preparation process. Quality requires performing all activities in conformance with valid requirements, no matter how large or small their overall contribution to the design process. Good CADD techniques, attention to detail and ensuring the plans are correct and useful to the contractor are also essential to quality.

Consultants are agents for VTrans with the primary responsibility for preparation of contract plans. Consultants must ensure quality and adhere to established design policies, procedures, standards and guidelines in the preparation and review of all design products for compliance and good engineering practice.

Structures Section Management shall monitor and measure the Quality Control efforts used by Project Managers and their Consultants.

Structures shall identify and coordinate training needs of In-house staff engaged in the project management, design, review, and plan production for projects.

OBJECTIVE

The main objective of the Quality Control Program is to provide a mechanism by which all projects are subject to a deliberate and systematic review to reduce the risk of introducing errors and omissions into the design. The end product of the review is a quality set of design calculations and project plans.

The Quality Control Program must provide for a well documented "trail" of the design process, and will ultimately produce a properly documented project file. VTrans should be able to effectively substantiate its position from properly documented project files if any legal, social or procedural issues arise regarding the project.

A secondary objective of the Quality Control Program is to provide information feedback from reviews that will increase awareness in the Structures Section. Designers' improved expertise and general increase in knowledge from feedback should result in

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product improvement at early stages even before a project review is started. The Quality Control Program thus serves as a parallel training program.

This Program will be reviewed and updated periodically. At a minimum, the Program review and update will occur during a revision of the Structures Design Manual, and as necessary in the interim, to ensure compliance with changes to plans preparation requirements, processes and organizational structure.

DEFINITION OF TERMS

- a) **Quality:** Quality is a product and process that conforms to requirements; meets stakeholder needs; and strives for excellence in so doing.
- b) **Quality Control (QC):** Procedures of checking the accuracy of the calculations, consistency of the drawings and special provisions, by detecting and correcting design omissions and errors before the contract package is finalized.
- c) **Quality Assurance (QA):** Procedures of reviewing the work to ensure the quality control are in place and effective in preventing mistakes, and consistency in the development of bridge design plans and specifications.
- d) **Designer:** An individual directly responsible for the development of design calculations, drawings, specifications and contract documents and review of shop drawings related to a specific bridge design with a level of technical skills and experience commensurate with the complexity of the subject structure or structures being designed.
- e) **Checker:** An individual responsible for performing a full technical review of the structural design calculations, drawings, specifications and contract documents.
- f) **Reviewer:** An individual responsible for performing QA procedures for assuring that QC/QA procedures have been performed.
- g) **Engineer of Record (EOR):** An individual responsible for all bridge structural aspects of the design of the structure including the design of all of the bridge's systems and components and generally is a licensed professional engineer.
- h) **Online Shared Review (OLSR):** A project review process in which reviewers from multiple areas of expertise interactively evaluate project plans, specifications and estimates for completeness, clarity, consistency, correctness, and constructibility. This type of review takes place at multiple plan development milestones and is utilized for both Quality Control and Quality Assurance efforts. The OLSR also allows for efficient and effective shared review archives to be maintained and referenced.

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ORGANIZATION

Program Manager: The Structures Section Program Manager is responsible for creating, implementing, and updating this QC/QA Program Plan for the Structures Section. The Program Manager is responsible for monitoring the effectiveness with QA performance measures.

Structures Design Engineer: The Structures Design Engineer is responsible for filling the role of quality assurance manager. The Structures Design Engineer is a manager with significant experience in the area of highway structure design, and has the primary responsibility to develop VTrans design policies, procedures, standards and guidelines. The Structures Design Engineer also coordinates the in-house project plan review process. Additionally, in the role of quality assurance manager, this individual periodically performs unannounced QA reviews as required by the Program Manager to ensure the QC Program is being adhered to.

Structures Engineering Instructions (SEI's) and the Structures manual will be used to document the design policies, procedures, standards and guidelines.

Model example plans and checklists will be made available to be used as a guide for content and organization of a quality plan set.

Project Manager (PM): The PM has primary responsibility of project conformance to the QC/QA Program during the design and plan preparation of an assigned project.

For projects that are to be designed in-house the PM is responsible for determining the necessary technical knowledge and experience of the designer/checker for that specific design. Designers and checkers shall be assigned to bridge projects by matching experience to project complexity. The PM also has QA responsibility to verify that all QC activities have been performed by the assigned design team.

For consultant designed projects, the Engineer of Record (EOR) has the primary responsibility for QC and is responsible for determining the necessary technical knowledge and experience of the designer/checker for that specific design. The PM has the QA responsibility to verify that all QC activities have been performed by the assigned design team.

The PM directs technical staff and assigns quality control functions. The PM is responsible for identifying potential problem areas and resolving them in a timely manner to meet the needs of the project.

The PM allocates resources to various elements of work for the project within the constraints of the project schedule, project budget and the quality of the project. The constraints of Time, Cost, and Quality are always interrelated and exist in a state of equilibrium. If one of the constraints is changed then at least one other must be altered as well. An underlying assumption of the Quality Control Program is that Quality should be

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a fixed point around which the other constraints revolve, and a properly implemented QC Program will result a high quality product.

However, it is recognized by the Program Manager that the schedule and/or budget for a particular project may infrequently require that a reduced QA review process be utilized. Utilizing a reduced QA review process should not be taken lightly and the potential project risks of doing so should be analyzed and documented by the PM and communicated to the Structures Design Engineer. It is emphasized that a reduced QA review process shall not lead to reduced QC.

Federal Highway Administration (FHWA). The general role of the FHWA Division Office is to review the State's QC/QA Program and ensure the program is thorough, effective, documented, and followed. Further, it is the role of the FHWA Office of Bridge Technology to assure uniformity within Division Offices regarding implementation of the joint FHWA/AASHTO "Guidance on QC/QA in Bridge Design". The FHWA Division Office may perform periodic review of the program. Upon request, VTrans will provide project documents to the FHWA Division Office for review in accordance with the Federal-aid Stewardship and Oversight Agreement. The need for periodic reviews will depend on the complexity of the State's bridge projects.

QUALITY CONTROL PROCEDURE

In-House Engineering and Plan Preparation QC Checks

Checking Reports

This part of the QC plan applies to reports produced in the Structures Section such as scoping reports and structure type studies. Once the report writing has progressed to the final draft stage of development, it will be sent to the checker. The checker will be given a specific and reasonable deadline for completing the check.

Comments/corrections are marked on the review draft in red. Upon completion of the review, the checker will sign and date or place a dynamic stamp if utilizing OLSR (Online Shared Review) on the cover page of the draft and return the draft to its author.

The author then confirms or revises the corrections and comments, adds his/her own corrections/comments, and consults with the appropriate person(s) to resolve any conflicts. The author then makes the corrections to the text. The marked-up draft is placed in the project files after the document is finalized.

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Checking Calculations

Manual calculations will be prepared in pencil. A calculation may also include other forms, charts, graphs, data sheets, computer printouts, etc. The Designer must initial and date each computation sheet.

Assumptions, upon which calculations are based, shall be stated in the calculations. Assumptions with limited application should immediately precede the calculations to which they apply.

No Designer will check his or her own work. The checker shall be experienced in the discipline being checked and have a level of knowledge and qualifications sufficient to have performed the calculation that is being checked. cursory supervisory reviews do not satisfy the intent of this section.

The Designer determines the point at which design work has progressed sufficiently that checking can begin on a completed portion of work. The designer reviews the data and the scope of the work with the assigned checker. The Designer provides the checker with design criteria, copies of pertinent information, related drawings, and related calculations, if needed.

A design check includes verification of the introductory material on the calculation sheet, as well as the calculation itself. The checker verifies that all information is appropriate, correct, complete, consistent, legible, and reproducible. To do this, the checker needs to follow a logical method to make sure that he/she has not missed verifying any data. The standard policy is to check the major items of importance first.

The checker will mark items to indicate either his/her agreement or disagreement. The following is the color code to be used for making calculations.

- Yellow: Use for agreement
- RED: Use for corrections

When satisfied, the checker will place his/her name/initials and date each original calculation sheet.

At the completion of the Contract Plans, the design calculations, check calculations, all design-assumption documentation, Load Rating Calculations, and other design-related information shall be retained in a permanent bridge design file.

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Checking Drawings

Drawings are prepared under the direction of the Designer. They are developed progressively by an interactive process using sources of information such as survey data, reports, record data, preliminary sketches, samples, official maps, etc, in conformance with the requirements, design criteria, and standards and guidelines required by VTrans. Before a drawing is considered final, it will be independently checked for:

- Conformance with the design criteria, project requirements including graphic standards (CADD Standards)
- Completeness and clarity
- Coordination with other aspects of the project, i.e., structural, civil, traffic, right-of-way, etc., and with other associated project documents
- Compatibility with standards and good plans preparation practice
- Coordination with project elements being developed or planned development on adjacent projects including environmental, utility and ROW constraints

All primary structural components of bridge design drawings should be checked in detail. The checker will review a drawing to determine if it meets the objectives of the task and is complete, accurate, and suitable for the intended use. All items must be marked by the checker to indicate either his/her agreement or disagreement.

- Yellow: Checker agrees with drawing
- RED: Area requiring correction, with appropriate comments noted by the checker adjacent to the area

The Designer then inspects the check print, confirms or revises the corrections and comments, adds his/her own corrections/comments, consolidates and coordinates comments, and consults with the checker and others as appropriate to resolve any conflicts.

Once the corrections from the compiled check print are made to the original the CADD operator will plot a revised check print. Both the original and revised check prints are then returned to the Designer. The Designer then back checks the revised check print against the original check print.

In cases where the designer is not the drawing checker, the designer must at least review the drawings to ensure that they are in conformance with the design.

Checking Special Provisions

Special Provisions for VTrans projects are typically created under the direction of Contract Administration. When Draft Special Provisions are supplied for review,

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the Designer shall check them to verify that they are in conformance with the design requirements for the project. In addition, the Designer should also verify that the Special Provisions are in conformance with the environmental, utility and ROW constraints for the project.

Resolution of Checking Disputes

During the review and checking process, if the checker does not agree with the results of the design task being checked, the checker will first discuss the matter with the Designer. If the difference cannot be resolved between the checker and the Designer, the PM will be consulted to assist in the resolution of the dispute. As needed the Structures Design Engineer may also be consulted to arbitrate questions of design policy and standards.

Consultant Design Engineering and Plan Preparation QC Checks

The EOR shall have the primary responsibility for all QC activities for consultant designed projects. All design consultants associated with a VTrans Structures project will have a documented QC/QA program for its design including QC procedures that shall meet or exceed the Program used for In-House projects. Consultant Quality Control Plans are required for all projects and will be submitted to the PM in advance of any design work and shall include, but not be limited to, the following areas:

- Organization personnel that are involved in QC/QA activities
- Quality Control Review of Plans, Reports, Calculations & Correspondence
- Proposed Method of Documentation of Comments, Coordination, Response and QC Records
- QC/QA of Sub-Consultants and Vendors
- Proposed method for monitoring and measuring efficiency of production.
- Quality Assurance Certification

Strong emphasis will be placed on coordination with all of the sub-consultants throughout the project. Particular attention will be placed on critical path activities and on the sub-consultant's needs for information required for participating in these and other activities in a timely manner. Regular meetings and teleconferences will take place in order to facilitate this coordination. All sub-consultants shall be required to conform to the Consultant Quality Control Plan and provide their supplement where they are performing a specialized service.

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QUALITY ASSURANCE REVIEW PROCEEDURE

PM Review

At the conclusion of the QC process, and prior to external review of plans, the plans shall be forwarded to the PM for QA Review. The PM will perform the QA review and will verify that all of the necessary QC checks were completed. The PM will review the plans for conformance with VTrans standards and all of the owner requirements for each project. At the conclusion of the review, the PM will communicate any QC process concerns and/or review comments to the Designer to be addressed.

Structures Review

Plans or reports will be submitted by the Project Manager for QA review to the Structures Design Engineer. The Structures Design Engineer will coordinate the review in the Section by assigning the project to a primary reviewer (typically a third party PM) and make copies available to other Project Managers and to Bridge Management for review and comment. At the conclusion of the review period, the Structures Design Engineer will schedule a plan review meeting with the Project Manager, primary reviewer, Bridge Management and other interested Project Managers to discuss the review results. Three to four weeks should normally be allowed for the review. Lesser time frames will be allowed if required to meet a project schedule.

The Project Manager will consider and address the review comments and make appropriate revisions to the project. The Structures Design Engineer will be notified by the Project Manager when and why a significant review comment is not being addressed.

Internal plan reviews will occur at the following project milestones:

- a) Scoping Report/ Alignment Study or Conceptual Plans
- b) Preliminary Plans
- c) Final Plans (Draft Special Provision and Estimate review)

The Project Manager, depending on the complexity of the project may elect to skip milestones in the Project Development Process and the subsequent review. A project manager may request review of a project at additional project milestones if desired.

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External Review

Plans or reports will be submitted by the Project Manager for review to identified parties. The distribution list for the plan review shall be that used in the standard distribution memos that are used in the Structures Section. It shall be the responsibility of the Structures management to ensure that the lists are maintained.

External plan reviews will occur at the following project milestones:

- a) Scoping Report/ Alignment Study or Conceptual Plans
- b) Preliminary Plans
- c) Final Plans
- d) Pre-Contract Plans (Special Provision and Estimate review)

The Project Manager, depending on the complexity of the project may elect to skip milestones in the Project Development Process and the subsequent review. A project manager may request review of a project at additional project milestones if desired.

At the conclusion of the review, the Project Manager will address all review comments in a similar manner as with internally-generated reviews. The Structures Design Engineer will be notified by the Project Manager when a significant review comment is not being addressed.

In some instances, review comments will be made that are not addressed to the satisfaction of the reviewer. Every effort should be made by the PM to communicate with the reviewer as to why the comment was not addressed. In those cases where there is no resolution the decision of the PM will be final. As noted above, the PM has primary management responsibility for QA during the development of a project and as such they have the authority to determine how comments are addressed.

The decision of the PM may be appealed through the management of the commenting section to the Structures Design Engineer.

Communication between the PM and external reviewers for comments and responses will primarily be through the use of OLSR. In the event that comments are received through meetings with reviewers, there shall be minutes prepared that summarize the comments received. The PM shall respond to all significant comments. The response shall be made in the OLSR review or in memo form if appropriate. The PM will be responsible for submittal of comment/responses to the reviewing entity.

Where it is necessary and prudent to discuss the comments with the reviewer(s) prior to making a response, the PM shall arrange for the meeting.

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Consultant designed projects shall follow the same QA process as noted above. However, where appropriate the PM may designate the Consultant to prepare responses to review comments.

Project Constructibility Review

Project Managers are encouraged to conduct constructibility reviews on projects or complex project components at appropriate stages of the project design. These reviews can be conducted internally to include knowledgeable VTrans participants and are typically organized and facilitated by the VTrans Quality Assurance Unit (QAU). External constructability reviews utilizing outside expertise of contractor or fabricator organizations may also be requested by the PM. Examples of these organizations are Associated General Contractors (AGC), National Steel Bridge Alliance (NSBA), Precast/Prestressed Concrete Institute (PCI) and The International Association of Foundation Drilling (ADSC).

Constructibility reviews are often most useful before the final design is fully completed and prior to final detailing. Constructibility reviewers need enough detail to evaluate the level of difficulty for construction or fabrication of the design intent.

Project Specific Peer Review

For major projects involving unusual, complex, and innovative features, a peer review may be desirable to raise the level of confidence in the quality of the design, plans and specifications. A peer review is generally a high-level QA review by a special panel of professionals specifically appointed by the Program Manager to meet the demands for quality and accuracy, recognizing the complexity of the design. Peer review is an effective way to improve quality and to reduce the risk of errors and omissions.

At the request of the Program Manager, this Project Specific Peer Review may be utilized to perform a value engineering analysis of the project.

DESIGN SOFTWARE VERIFICATION/STANDARDIZATION

The use of computer software for the design of bridges and other transportation structures is fully integrated in the process in the Structures Section. It is critical that the output and results that are obtained from the software that is used in the design are accurate and repeatable. It is equally important that the Structures Section adopt standard computer programs for use. Verified and standardized software applications are an important component in producing Quality designs.

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Software verification is a process that provides objective evidence that the design outputs of particular software meet all of the required outputs, provide consistent output, correct and accurate output and that the results are well documented.

Commercial “off the shelf” software before it is provided for general use will be verified by experienced engineers. The verification shall be done by testing and comparing output with known designs or output from previously verified software.

MathCAD and spreadsheets are used extensively in-house during the design process and many applications for these tools have become standard sheets. These applications are typically developed by using them as electronic calculation sheets. As these are checked, refined, and used on multiple projects the verification process is satisfied for them to become standard sheets.

A list of verified computer programs and applications will be maintained by the Structures Design Engineer

PROGRAM QUALITY ASSURANCE

Program QA is a process to ensure compliance with the QC/QA plan. It will include periodic reviews of projects and review of established processes used to deliver projects. The Structures Design Engineer will work to ensure that an appropriate level of review (and cooperation in the review process) have occurred for:

- (a) Design
- (b) Constructibility
- (c) Bid ability
- (d) Value Engineering

This will also incorporate a general review of personnel to ensure an acceptable level of expertise is maintained for quality design products. As communication is a vital element in all processes, the QA will also review documentation concerning the level and quality of communications accomplished during various processes.

At least annually, the Structures Design Engineer shall meet with customers of the Structures Section (Operations, Construction and Contract Administration) to discuss issues and quality of plans and shall use the information to improve processes and Quality.

The Structures Design Engineer may perform QA reviews of projects in an unannounced fashion. He/she may perform the review or delegate this duty. For consultant projects, he/she may direct the PM to perform the QA review.

On June 30th of each year, the Structures Design Engineer shall deliver to the Structures Program Manager, with a copy to the Program Development Director, the Chief of

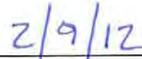
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Quality Assurance, and the FHWA VT Division Bridge Engineer, an annual QA report documenting the results of the previous year's QA investigation.

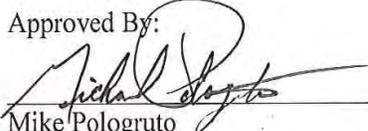
The report shall include an overall summary of the effectiveness of Structures QC/QA Program and recommend any changes necessary to improve quality. The effectiveness will be determined and measured against specific performance measures and available qualitative measures. These performance measures will be developed and reviewed annually by the Program Manager.

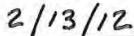
Approved By:


Wm. Michael Hedges
Structures Program Manager

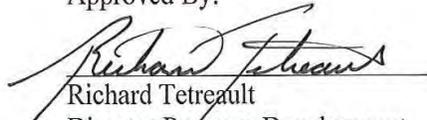

Date

Approved By:


Mike Pologruto
Chief of Quality Assurance


Date

Approved By:


Richard Tetreault
Director Program Development


Date

Appendix A: Clarification of the Process for Responding to OLSR Comments

The OLSR Process is an important part of the Structures Division QA. As such, the Project Manager and/or Lead Designer should carefully review all comments made during the OLSR and provide responses to the reviewers as indicated below:

- 1) All comments shall be reviewed by the Project Manager and/or Lead Designer.
- 2) Typos and CADD QC issues shall be addressed, if necessary, but do not require a response back to the reviewer.
- 3) All other comments require some form of response back to the reviewer by the Project Manager and/or Lead Designer. The method of response may be as simple as a check mark to indicate that the Document will be revised to address the reviewer's comment. If the comment is not going to trigger a revision in the Document, then the Project Manager and/or Lead Designer shall give a brief explanation of why the comment does not require a revision.
- 4) Comments of such complexity that a back and forth discussion may be required between the Reviewer and the Project Manager and/or Lead Designer shall be done via some other collaboration (phone call, email, meeting) so as not to bog down and clutter the Shared Review with numerous comments on the same topic.
- 5) In-House personnel may comment during the OLSR Period.
- 6) Consultants should provide their responses after the OLSR Period has ended utilizing the FDF Process.

FDF Process

Within two weeks of the deadline for the OLSR, the Project Manager and/or Lead Designer shall address any comments which do not yet have a response per the above guidance. The responses shall be made in a copy of the OLSR PDF file and exported to an FDF file. The FDF file shall be sent to the OLSR facilitator so that the archived copy of the OLSR PDF file on the Sharepoint site may be updated with all of the responses.