

specific needs of each project. Creating a specific policy requirement to address the required quality activities at this fundamental policy level articulates the importance to the owner's project managers of considering project design quality from the very inception of the project. It also creates a mechanism to map the conceptual design quality requirements identified in the early stages of project development directly into the DB project procurement documents. This will not only furnish much-needed guidance to the owner's project managers but also promote consistency in a given owner's DB projects, making estimating the cost of these activities easier for the competing design-builders.

Design-Build Design Submittal Process

One of the traditional ways that owners have ensured quality design is by being able to fully review the design before it is advertised for bids. In DB, owners do not have this same opportunity. One of the major advantages of DB is schedule compression, which happens by being able to start construction before the full design is finalized. In fact, in a recent research project on QM in DB for transportation projects, 85% of surveyed state DOT respondents (hereafter referred to as "our DB QA study") (Gransberg et al. 2008) indicated this as a reason for implementing DB. Another advantage of DB is the transfer of risk from the owner to the design-builder, and that study found that 53% of the state DOT respondents also indicated this as a reason for implementing DB. In a DB contract, the design-builder is responsible for the adequacy of the design in relation to the contract documents. Owners must be aware that "increased control over project design might not only reduce potential design-build benefits but might also carry with it the risk of liability for the entire project" (Wichern 2004). Arkansas clearly states this in its *Design-Build Guidelines and Procedures*:

With Design-build contracting, the design risk is placed with the Design-build firm, and the Department's review will determine if the proposed design meets the objectives of the Contract Provisions. (AHTD 2006)

Thus, many owners that do place the responsibility for design QA and QC on the design-builder use specified design review checkpoints—a design PQA activity—to ensure that the design is proceeding according to contract requirements. This also fulfills the owner's responsibility to the public to deliver projects that have been designed and built in accordance with public law and good engineering practice. These checkpoints exist so that the design-builder's final design is acceptable to the owner and is in accordance with the performance criteria contained in the contract documents.

Design Review Checkpoints

The RFP content analysis found in our DB QA study that there are two general ways in which design review checkpoints are determined. These are summarized in

Table 4-4. The first method, defined reviews, specifically articulates them in the RFP. The owner specifies in the RFP which reviews it will conduct and what must be included in the reviews. The design-builder must then account for the required reviews in its proposal and in the project schedule.

The following example comes from a Mississippi DOT (MDOT) RFP and outlines the design review requirements for a project:

Preliminary Design Phase (Minimum 30% Plans): The *Contractor* will prepare and submit a single preliminary design submittal for the entire project. . . . Final Design Review Phase (100% Plans): Final Design may be broken down into packages (i.e., Roadway, portions of Bridges, Drainage, etc.) as determined by the *Contractor*. Following completion of the design for each submittal for the Project, the *Contractor* shall prepare and submit a Final Design Submittal for review by MDOT. . . . Released for Construction Documents: Following the incorporation of MDOT’s comments from the Final Design Review Phase, the *Contractor* shall prepare and submit a Release for Construction submittal to MDOT for MDOT’s final review and Released for Construction stamp. (MDOT 2005; emphasis added)

This is by far the most common way to identify the required reviews. In our DB QA study’s solicitation document analysis, 41 projects had design reviews as a requirement of the contract. Of these 41 projects, 83% told the design-builder at what point the design would be reviewed.

The second approach, proposed reviews, is to allow the design-builder to propose the schedule of design reviews in their response to the RFP or during negotiations after the award of the contract. This is the stated policy of the Arkansas DOT: “There will be no pre-defined reviews scheduled by the Department. The selected firm and the Department will decide on the appropriate timing of reviews

Table 4-4 General Design-Build Design Review Categories

Type	Design-Builder Responsibility	Owner Responsibility	Comments	Percent of Projects in DB QA Study Content Analysis
Defined Reviews	To be responsive, must follow defined reviews in contract documents	Defines reviews in the RFP	Reviews may be performed by design-builder, DOT, or 3rd party	83%
Proposed Reviews	Propose design reviews for project as part of proposal or after award of contract	Accepts or rejects proposed design reviews	Reviews may be performed by design-builder, DOT, or 3rd party	17%

Source: Gransberg et al. (2008), Table 10, with permission from the Transportation Research Board of the National Academies.

during execution of the contract” (AHTD 2006). The Washington State DOT (WSDOT) used this approach for its Thurston Way Interchange project:

For any designs for which early construction reviews will not be conducted, at least one design review shall be conducted before completion of 100 percent design. The percentage of design will be mutually agreed upon between the *Design-Builder* and WSDOT, but should be near the mid-point of design. (WSDOT 2000; emphasis added)

In our DB QA study’s solicitation document content analysis, DOTs employed this approach in only 17% of the projects reviewed.

Appropriate Number of Design Reviews

In addition to how the design reviews are defined, the number of required design reviews by the owners varies across the nation. However, our DB QA study’s content analysis identified three main approaches:

- No formal review prior to final (release-for-construction) design review.
- One review prior to the final design being released for construction.
- Multiple reviews prior to the final design review.

Also, in many instances the design-builder is encouraged to request informal reviews that are not required but allow the owner to provide more frequent input to ensure that the final design will meet the contract requirements. These reviews are often called “over-the-shoulder” or “oversight” reviews to indicate that the design process will not stop proceeding to wait for comments that result from these informal reviews. Table 4-5 provides a summary of the different categories of the

Table 4-5 Required Number of Design Reviews

	Percent of Projects in DB QA Study Content Analysis	Comments
No review prior to final	15%	Owner still provides oversight and comments informally
One review prior to final	56%	Can be anywhere from preliminary design until just before the final design review
Multiple reviews prior to final	29%	The exact number of reviews can range from one to two for every major feature of work

Source: Gransberg et al. (2008), Table 11, with permission from the Transportation Research Board of the National Academies.

required number of design reviews and the corresponding percentage of occurrences in our RFP analysis.

No Mandated Reviews When there is no owner-mandated design review check-point required before the final design is released for construction, the burden of design compliance is fully placed on the design-builder. In theory, this is one of the benefits of utilizing DB project delivery. However, the owner must still provide assurance that the contract will be completed with all the requirements met in a timely manner. In the RFPs analyzed in our DB QA study, 41 mentioned the design review requirements. 15% used the approach of no owner-mandated design review checkpoints before the release-for-construction design review. The Minnesota DOT detailed its design PQA approach in one RFP as follows:

The Department will participate in oversight reviews and reviews of early construction as part of its due diligence responsibilities. If the Department, in its review, observes that the Design-Builder is not complying with contract requirements and/or that the QC/QA checks are not complete, it will notify the Design-Builder in writing that construction may not proceed until the noted items are corrected. The Department's oversight review and comments will not constitute approval or acceptance of the design or subsequent construction. (MnDOT 2001)

This PQA activity (sometimes termed "due diligence") must be accomplished through an oversight approach, as stated in the MnDOT RFP referenced above, or by an audit approach referenced in the Utah RFP below, which describes the design-builder's review procedures. The Utah RFP also shows that although the owner does not conduct a progress design review, the design-builder must do so with oversight from the owner:

The *Design-Builder* will review all designs to ensure the development of the plans and specifications are in accordance with the requirements of the Contract. . . . The Department will audit, as needed, the *Design-Builder* processes and Design Documents to verify compliance with the Contract Documents. The Department will be invited to attend all reviews. . . . The *Design-Builder* shall conduct oversight reviews, and the Department may participate in these reviews and comment as requested or as it otherwise deems necessary. . . . The *Design-Builder* shall determine the materials to be compiled for each review. Formal assembly and submittal of drawings or other documents will not be required, but the Design-Builder is encouraged to provide informal submittals to facilitate reviews. The review may be of progress prints, computer images, draft documents, working calculations, draft specifications or reports, or other design documents. . . . The *Design-Builder* will conduct informal milestone reviews at approximately the 60% stage of project elements to determine whether the Contract requirements and design are being

followed. The Department will be invited to attend these reviews. (UDOT 2005; emphasis added)

The Utah RFP goes on to discuss the design review process for the final design deliverable.

When the *Designer* has completed a design package to 100%, and the package has been checked and audited, a formal design submittal is assembled and distributed for review, including plan sheets, calculations, specifications, and other pertinent data. The Designer shall prepare for these reviews a full set of drawings and other documents stamped “Checked and Ready for Review.” . . . After the 100% comments have been addressed and the design documents have been checked and audited, a “ready to be released for construction” submittal package is assembled and distributed to the *Design-Builder* and the Department for release for construction. (UDOT 2005; emphasis added)

To preserve the definition of design liability, Utah also requires the design-builder to complete a certification process on the final design package, and specifies the time limit to which the owner must adhere to furnish timely acceptance:

When a design package is ready to be released for construction, the *Design-Builder* shall certify all of the following related to the Work:

- The design is in accordance with the Contract requirements.
- The design has been checked in accordance with UDOT accepted quality procedures.
- No design exceptions exist that have not previously been approved by the Department.
- The Department will conduct its review and accept or reject the final design package within seven (7) Working Days of receipt of the final design documents. (UDOT 2005; emphasis added)

Single Design Review The second category of DB design review is where the owner requires a single official review of the design before the review of the final design deliverable. This gives the owner an intermediate point at which to verify that the design development is proceeding in accordance with the contract requirements and is progressing according to the schedule. The Mississippi DOT uses this type of design review for their DB projects. An example is:

The *Contractor* will prepare and submit a single preliminary design submittal for the entire project. Preliminary design shall include roadway plan and profile, bridge type, selection layout, drainage, erosion control, signing, architectural and traffic control plans. MDOT will review Preliminary Design Submittals within 21 Days of the submittal. (MDOT 2005; emphasis added)

MDOT also provides for an “optional design review” with the following RFP clause:

At the request of the *Contractor*, MDOT will provide optional design reviews on design packages as requested by the *Contractor*. MDOT as appropriate will review optional design Submittals within 14 Days. (MDOT 2005; emphasis added)

This RFP goes on to define the final design review process as follows:

Final Design may be broken down into packages (i.e., Roadway, portions of Bridges, Drainage, etc.) as determined by the *Contractor*. Following completion of the design for each submittal for the Project, the *Contractor* shall prepare and submit a Final Design submittal for review by MDOT. . . . Following the incorporation of MDOT’s comments from the Final Design Review Phase, the *Contractor* shall prepare and submit a Release for Construction submittal to MDOT for MDOT’s final review and Released for Construction stamp. (MDOT 2005; emphasis added)

Another example comes from the Washington State DOT in the RFP for its Thurston Way Interchange project. The exact point of the design review is not listed, but it is left to be decided upon execution of the contract:

For any designs for which early construction reviews will not be conducted, at least one design review shall be conducted before completion of 100 percent design. The percentage of design will be mutually agreed upon between the *Design-Builder* and WSDOT, but should be near the mid-point of design. (WSDOT 2000; emphasis added)

The requirement of only one official review by the owner is, by far, the most popular design review process currently used, as found in our RFP analysis. 56% of the RFPs analyzed in our study used this type of design review process.

Multiple Design Reviews In the final category of design reviews, the owner requires more than one official owner review before the design can be released for construction. This was the process found in 29% of our DB QA study’s RFPs that included information about design reviews. The Maine DOT required in one RFP that “formal design package submittals shall be made . . . at the 50% and 80% design development stage of any design package intended to be RFC [released-for-construction]” (MaineDOT 2003). The EFLHD also requires more than one design review before the design is released for construction. In an RFP they state the reasons for the reviews:

Initial submittals are intended to provide the *Contractor* a means of proposing and obtaining acceptance for horizontal and vertical alignment deviations from the Government preliminary design plans; deviations from the

Government preliminary bridge Type, Size, and Location (TS&L) plan; and changes in basic parameters of the project. . . . Intermediate Design Submittal. The purpose of this submittal is to ascertain that the design is progressing in accordance with the requirements of the project, that existing field conditions have been properly identified and dealt with, and that the *Contractor* has coordinated the design with EFLHD, NPS, the permitting agencies, and the utility companies. (EFLHD 2001; emphasis added)

We found two variations of this category that require mention in this section. The first is when the owner requires an independent design quality assurance firm to do the design reviews, with the owner only providing limited oversight. This was the situation with the S.H. 130 project in Texas. The Texas Turnpike Authority's RFP stated:

DQAM [design quality assurance manager] will conduct a formal over-the-shoulder review presentation to the TTA [Texas Turnpike Authority] at the TTA's office. The over-the-shoulder review presentation will be held, following the DQAF's [design quality assurance firm's] approval of: the Corridor Structure Type Study Report; the Preliminary (30%) Design Submittal; the Intermediate (65%) Design Submittal; and the Final (100%) Design Submittal. . . . Developer's designer shall furnish to the DQAF at least five (5) mandatory design submittals, and if necessary, any resubmittals. (TTA 2001)

The second variation is when the owner requires certain design review, and attends the reviews, but is not the party responsible for the review. In the following example from Washington State, the DB firm was responsible for the formal design reviews with the DOT in attendance:

The DQA [design quality assurance] Manager will conduct formal milestone reviews at the 30%, 60%, and 90% (or as otherwise agreed by the WSDOT and Design-Builder) stage of project elements to determine whether the Contract requirements and design are being followed and that QC/QA activities are following the approved QMP. . . . The DQA Manager shall compile and maintain documentation of the review. The Department will be invited to attend these reviews. (WSDOT 2004)

In the vein of deciding the appropriate number of owner design reviews for a given project, it is interesting to note that the U.S. Army Corps of Engineers (USACE) changed its DB design reviews policy in 2007, reducing the number of reviews from four (30%, 60%, 90%, and final) to two (intermediate and final) (USACE 2006). The reason for the change was to reduce the potential for delays due to waiting for government reviews. In a personal communication with the author, Joel Hoffman of USACE explained the rationale as: "The philosophy is that once the designer of record approves construction and extension of design submittals, the builder can proceed—don't wait on us, unless there is a specific

government approval required.” Thus, one critical issue in determining the appropriate number of design reviews is the need for the design-builder to maintain an aggressive schedule. If the project is not schedule-constrained, the DB design reviews can afford to inject more design review points. Conversely, design reviews can be minimized on a fast-track project.

Over-the-Shoulder Reviews In addition to the design reviews outlined above, another notable trend is the inclusion in the RFP of a statement inviting the design-builder to request informal over-the-shoulder reviews to ensure that the design is progressing according to the contract requirements without the need to prepare a specific design submittal package, and to provide owner input to the design where it will be both desired and helpful. These reviews fall into the owner PQA category. These statements are included in RFPs regardless of the number of required design reviews. Almost always, however, a statement is also included that removes liability from the owner for any comments that may be incorporated into the design from the informal reviews. The following extract comes from the EFLHD RFP referenced above:

Over-the-Shoulder reviews may be scheduled by the Contractor or EFLHD. Over-the-Shoulder reviews are strongly encouraged to enhance the partnering efforts between the Contractor and the Government. . . . The number and timing of the reviews will be discussed at the Start-up Conference. . . . Over-the-Shoulder reviews will be conducted for informal review of designs. The intent of Over-the-Shoulder reviews is to provide guidance to the Contractor during the course of the project. Over-the-Shoulder reviews do not take the place of the Overall Project Submittals. (EFLHD 2001)

The Washington State DOT included this in one RFP:

Throughout the design process, the Design-Builder may request additional oversight visits by WSDOT to discuss and verify design progress and to assist the Design-Builder and/or its designer(s) in resolving design questions and issues. (WSDOT 2000)

Design reviews are an integral part of any design QA program. They ensure the constructability of the project as well as that the design meets the contract requirements. Even though the design-builder is responsible for both of these elements in DB, the owners must assure itself that the design-builder is carrying out its responsibility. This is done by owner design reviews using one of the three approaches outlined above.

Design Review Responsibility

Communicating who is responsible for the design reviews is also essential to the smooth execution of these quality activities. This can be done in a variety of ways,

including lists, charts, diagrams, or designating responsibility in contract clauses. Table 4-6 is an example from a Louisiana DOT DB RFP that provides a good example of how to effectively communicate design review responsibility.

In addition to deciding which reviews will be conducted and when, deciding who will perform the reviews is just as critical to the success of DB projects. Since the owner is not performing the design with its own designers, design QA and QC responsibilities will shift in DB. One can see in Table 4-6 that the Louisiana DOT has assigned virtually all the design QA and QC responsibility to its design-builder, only entering the process to verify the as-built plans. Remembering that the design phase defines the standard of quality for the constructed project, it is imperative that the design documents are professionally reviewed and checked to ensure a quality project. Our DB QA study sought to identify the trend in design quality responsibilities by asking the respondents to indicate which entity was primarily assigned the responsibility for a list of common design QM tasks. However, a large number of the respondents did not confine themselves to furnishing a single answer to each question. Many indicated that the responsibility for the tasks was indeed shared among some combination of the agency, the design-builder, and the agency's consultants. This response yielded valuable information regarding the distribution of design QM responsibility among the parties to a DB contract. Table 4-7 summarizes the survey responses to the question of assigned responsibility for design QM tasks.

Table 4-7 shows that the design-builder or a third-party consultant is often given more responsibility than is seen in traditional DBB in performing design

Table 4-6 Communicating Design Review Responsibilities: Louisiana Department of Transportation and Development

Stage of Design Development	Design Check and Certification to Design-Builder	Design Review
Definitive Design	Designer and DQCM	DQCM
Interim Review	Designer and DQCM	DQCM
Readiness for Construction Design	Designer and DQCM	DQCM
Final Design	Designer and DQCM	DQCM
Working Plans and Related Documents	Designer and DQCM	DQCM
As-Built Plans	Designer and DQCM	LADOTD's designated representative
Major Temporary Components	Designer and DQCM	DQCM
Temporary Components	Designer and Checker	Not applicable

DQCM, design quality control manager; LADOTD, Louisiana Department of Transportation and Development.

Source: LADOTD (2005).

Table 4-7 Survey Responses for Design Quality Management Task Responsibility

Who performs the following design quality management tasks?	Agency Personnel	Agency-Hired Consultant	Design-Builder's Design Staff	Design-Builder's Construction Staff
Checking of design calculations (QC)	15.4%	15.2%	68.7%	0.8%
Checking of quantities (QC)	13.8%	11.2%	53.1%	21.8%
Review of specifications (QC)	32.9%	25.0%	38.9%	3.2%
Technical review of design deliverables (QC)	30.9%	28.6%	40.0%	0.6%
Acceptance of design deliverables (QA)	57.9%	15.8%	22.9%	3.3%
Approval of final construction plans and other design documents (QA)	82.0%	5.2%	9.9%	2.9%
Approval of progress payments for design progress (QA)	81.8%	9.1%	2.0%	7.1%
Approval of post-award design QM/QA/QC plans (QA)	84.4%	9.7%	5.9%	0.0%

Letters in parentheses indicate type of task: QC, quality control; QA, quality assurance, QM, quality management. Source: Gransberg et al. (2008), Table 13, with permission from the Transportation Research Board of the National Academies.

QM tasks that lead up to the final acceptance of the design. Public agencies are assigning the design-builder the responsibility for design QC tasks, such as checking design calculations, checking quantities, technical review of design deliverables, and review of specifications. Because these tasks are primarily associated with the production of design deliverables, the owner is facilitating the overall schedule by stepping back from these tasks and giving the design-builder control. Additionally, it effectively prevents the owner's unintentional assumption of design liability through directive design review comments (Gransberg et al. 2006). When it comes to the design QA tasks of accepting and approving *final* construction plans and design documents, owners have, by and large, retained the responsibility. This makes sense since owners still have ultimate responsibility for the design, construction, and final quality of each project. Public owners cannot contractually assign their public duty to another party. They can have design-builders and third-party consultants help achieve an assurance of quality, but at the end of the day they must be able to affirm that each project has been constructed to the requisite quality level.

Our DB QA study asked each respondent to cite the number of DB projects in which its agency had been involved. This allowed the responses to be divided by experience level. The responses from agencies with more than five DB projects were assembled as a single group to compare to the responses of the total population. The idea was to capture the potential differences between agencies whose QM system had been able to benefit from lessons learned in early DB projects and those agencies that were embarking on their first series of DB projects. Intuitively, those with more DB QM experience should have had a better knowledge of how