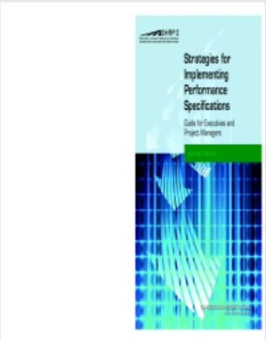

Strategies for Implementing Performance Specifications: Guide for Executives and Project Managers

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SHRP 2

STRATEGIC HIGHWAY RESEARCH PROGRAM

Accelerating solutions for highway safety, renewal, reliability, and capacity

Strategies for Implementing Performance Specifications

Guide for Executives and Project Managers

S2-R07-RR-2

TRANSPORTATION RESEARCH BOARD

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THE SECOND STRATEGIC HIGHWAY RESEARCH PROGRAM

Strategies for Implementing Performance Specifications:

Guide for Executives and Project Managers

SHRP 2 Report S2-R07-RR-2

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THE SECOND STRATEGIC HIGHWAY RESEARCH PROGRAM

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The need for SHRP 2 was identified in *TRB Special Report 260: Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life*, published in 2001 and based on a study sponsored by Congress through the Transportation Equity Act for the 21st Century (TEA-21). SHRP 2, modeled after the first Strategic Highway Research Program, is a focused, time-constrained, management-driven program designed to complement existing highway research programs. SHRP 2 focuses on applied research in four areas: Safety, to prevent or reduce the severity of highway crashes by understanding driver behavior; Renewal, to address the aging infrastructure through rapid design and construction methods that cause minimal disruptions and produce lasting facilities; Reliability, to reduce congestion through incident reduction, management, response, and mitigation; and Capacity, to integrate mobility, economic, environmental, and community needs in the planning and designing of new transportation capacity.

SHRP 2 was authorized in August 2005 as part of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). The program is managed by the Transportation Research Board (TRB) on behalf of the National Research Council (NRC). SHRP 2 is conducted under a memorandum of understanding among the American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), and the National Academy of Sciences, parent organization of TRB and NRC. The program provides for competitive, merit-based selection of research contractors; independent research project oversight; and dissemination of research results.

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The members of the technical committee selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical committee and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

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FOREWORD

James W. Bryant, Jr.
PhD, PE, *SHRP 2 Senior Program Officer, Renewal*

The majority of specifications used by state departments of transportation (DOTs) attempt to describe how a construction contractor should conduct certain operations using minimum standards of equipment and materials. These prescriptive specifications, commonly known as method specifications, have generally worked well in the past. However, with changes in the technology and the emphasis on providing more rapid solutions, more innovative specifications may be required in the future. Performance specifications can be used as a communication tool that translates the owner's performance requirements into language that will allow the contracting industry to understand, plan, and build the project to meet the requirements.

Over the past decades many transportation agencies have experienced workforce reductions, thus diminishing the level of experience and number of engineers and inspectors. These demands have caused some agencies to experiment with the use of performance specifications in an effort to meet both the initial quality and long-term durability needs of the constructed products. Performance specifications have been used successfully on a project-by-project basis, but a general framework is needed to help agencies use performance specifications systematically.

This report and the associated materials provide a framework that state DOTs can use to develop performance specifications; they include sample specifications language and implementation guidelines for both managers and specification writers.

The objective of this project was to develop performance specifications and strategies to accelerate construction, minimize disruption to traffic and community, and produce long-life facilities in the interest of rapid renewal. The final report documents the methodology used to create the products that were developed as part of the project. The products of the research include (1) guide performance specifications for different application areas and contracting mechanisms, which agencies can tailor to address project-specific requirements; (2) an implementation guide for executives and decision makers, which presents a broad overview of the benefits and challenges associated with implementing performance specifications; and (3) a step-by-step "how to" guide for specification writers for developing performance specifications and using the model performance specifications that were developed as part of this project.

The report, supporting guidelines, and model guide specifications will be useful to state DOTs, municipal agencies, consultants, and construction contractors. These products provide a starting point for an agency that wants to investigate the use of performance specifications as part of its routine operations.

CONTENTS

Online version of this report:
http://www.trb.org/Main/Blurbs/169108.aspx.

PREFACE

Transportation agencies are under increasing pressure to improve mobility while maintaining existing facilities with limited resources. In response to this pressure, agencies have begun experimenting with ways to accelerate construction and minimize disruption while improving mobility, safety, and long-term performance. To help advance such initiatives, Congress established the second Strategic Highway Research Program (SHRP 2) in 2006 to pursue research in four focus areas: Safety, Reliability, Renewal, and Capacity.

The Renewal area looks at improving the aging and increasingly congested transportation infrastructure through design and construction methods that will accelerate construction, cause minimal disruption to road users and the community, and produce long-lasting facilities. Recognizing that traditional method specifications can act as a barrier to the innovation often needed to achieve these objectives, SHRP 2 Project R07 was tasked with developing performance specifications that can motivate and empower the contracting industry to provide creative solutions to save time, minimize disruption, and enhance durability.

Despite the potential advantages offered by performance specifications, they will not emerge as a viable alternative to traditional method specifications overnight. For agency personnel, developing and implementing a scope of work in terms of user needs and end-result performance can be more challenging and resource intensive than simply adhering to the agency's standard specifications. For contractors, an initial investment may be needed to acquire the necessary knowledge, skills, and equipment to assume more responsibility for performance.

As an outgrowth of the SHRP 2 R07 research effort, this guidance document has been prepared to address the various cultural, organizational, and legal considerations that can affect the successful implementation of performance specifications.

An equally important component of an overall implementation strategy—specification development—is addressed in detail in *Framework for Developing Performance Specifications*: *Guide for Specification Writers*. Readers are encouraged to review that companion document for further information on how performance specifications can be developed and tailored to help achieve project goals.

EXECUTIVE SUMMARY

This volume, *Strategies for Implementing Performance Specifications: Guide for Executives and Project Managers*, provides a broad overview of the benefits and challenges associated with implementing performance specifications. The recommendations address the various cultural, organizational, and legal considerations that can affect the successful implementation of performance specifications. Project selection criteria and procurement and project delivery options are also addressed. The anticipated benefits of these guidelines are

- Improved decision making leading to more effective implementation of performance specifications;
- Improved understanding of the required changes in contract administration associated with performance specifications and alternative project delivery methods; and
- Smoother transition to a more performance-oriented business model.

In general, performance specifications have been demonstrated to be a powerful tool to motivate and empower the industry to improve project performance or value. One of the most significant benefits reported in the literature and confirmed by discussions with industry experts is the ability of performance specifications to promote construction innovation. The ability to innovate can provide contractors with a competitive advantage, which can ultimately lead to cost savings and greater returns. Benefits, or value added, from using performance specifications are more likely to be realized if the contractor becomes involved in a project early and assumes more responsibility for performance. This value added is contingent on owners selecting appropriate projects and defining key performance criteria and measures that align with project objectives. Value is also affected by the duration of the contractor's responsibility for performance.

Performance specifications will not immediately emerge as a viable alternative to traditional method specifications. Agencies and industry may find it easier to manage the changes in business practices required for performance specifications in steps or increments. The following guidelines have been developed to help agencies and industry with this transition. The key elements outlined in these guidelines include the following:

Organizational considerations. Agencies should communicate to internal agency staff the need for and advantages of transitioning to performance specifications and should develop an action plan for implementing performance specifications. The plan could include establishing a dedicated cross-functional internal team, developing criteria for screening and selecting projects, identifying changes in roles and responsibilities and standard administrative procedures, providing internal training, developing sample specifications, conducting trial projects, and evaluating lessons-learned.

Industry considerations. Agencies should engage industry early to highlight changes in roles, responsibilities, risks, and rewards related to performance specifications. Responsibilities may include design, construction quality management, and postconstruction performance (contingent on contracting method). Risks may include managing subcontractor and supplier relationships to meet performance requirements and providing bonds, insurance, or other guarantees of performance for long-term performance obligations. Rewards may include the ability to use innovative methods, materials, or technology or to earn incentives for improved performance. Collaborating with industry in the development of performance specifications will help balance the risks and lead to smoother implementation.

Deciding to use performance specifications. This guide includes a two-part decision process to determine whether performance specifications are appropriate for a given project. In the first step, the project selection process considers project characteristics, goals, and objectives; further, it looks at whether the objectives can be defined in terms of desired performance outcomes that can be measured and tested in the finished product or measured over a specified operational period. The decision will determine whether the project is a good candidate for method or performance specifications for specific project objectives (e.g., time, quality, service life). The second step evaluates whether the project is a candidate for alternative delivery methods that allow industry greater flexibility to achieve performance outcomes and that transfer more responsibility to industry for performance. Project delivery options range from traditional design-bid-build to design-build-operate-maintain.

Project delivery and procurement considerations. The decision to use performance specifications in conjunction with a project delivery system requires the agency to consider both the procurement process and how performance specifications will be implemented to meet performance objectives. The choice of delivery approach will result in different procurement approaches, performance parameters, and levels of performance risk assumed by industry. This guide considers how performance specifications will vary with project delivery method; it presents various alternatives to the traditional procurement process that align with project objectives and addresses how payment adjustment strategies can be used to motivate contractors to improve quality and performance.

1 INTRODUCTION TO PERFORMANCE SPECIFICATIONS

Chapter Objectives

This chapter

- Defines performance specifications and the role they play in an overall performance contracting strategy;
- Identifies the rationale for using performance specifications; and
- Compares the advantages and disadvantages of method and performance specifications.

PERFORMANCE SPECIFICATIONS: WHY NOW?

Societal changes and economic conditions suggest that the traditional way of delivering highway construction projects may no longer be sufficient to keep pace with the growing demands on our highway system to move people and goods safely and efficiently. Recent infrastructure report cards indicate that the system is deteriorating and facing increasing congestion. At the same time, state highway agencies are facing shrinking budgets and dramatic reductions in both the numbers and experience levels of inspectors and engineers. The complexity of high-speed construction, nighttime construction, and rehabilitation work under traffic—all of which the public demands—further stretches available agency resources.

In response to this widening gap between investment needs and available resources, several agencies have begun experimenting with alternative specifications and contracting strategies that place more responsibility for performance on the private sector.

The traditional way of doing business, using low-bid contracting and prescriptive requirements that tell the contractor how to perform the work, does not motivate the contractor to provide more than the prescribed minimum. The addition of performance specifications to an agency's toolbox would provide the means to motivate and empower contractors to find creative solutions to save time, minimize disruption, and enhance safety and quality in the interest of rapid renewal. The Federal Highway Administration (FHWA) put it this way in its 2004 *Performance Specifications Strategic Roadmap*:

> To attain our goals of quality, improved product performance, and a better environment for contractor innovation, we cannot simply identify and test those construction and materials factors that best determine product performance. We also must address roles, responsibilities, risks, and specification language, as well as determine how best to deliver that product. Freedom to innovate with accountability to deliver is the driving force behind the performance specification movement (FHWA 2004).

WHAT ARE PERFORMANCE SPECIFICATIONS?

As used in this document, the expression performance specifications serves as an umbrella term, encompassing various nontraditional specification types used or proposed for use in the highway construction industry, including end-result specifications, quality assurance (QA) specifications, performance-related specifications (PRS), performance-based specifications (PBS), and warranty and long-term maintenance provisions. (For more detail on these different specification types, refer to *Framework for Developing Performance Specifications: Guide for Specification Writers*, Chapter 1.)

In general, these specification types represent a progression toward increased use of higher-level acceptance parameters that are more indicative of how the finished product will perform over time. To varying degrees, they all attempt to shift performance risk to the contractor in exchange for limiting prescriptive requirements related to the selection of materials, techniques, and procedures. By relaxing such requirements, performance specifications have the potential to foster contractor innovation and improve the quality or economy, or both, of the end product.

Figure 1.1 places these specification types along a continuum of increasing contractor responsibility for performance. At one end of the continuum are the traditional method specifications through which the agency retains primary responsibility for end-product performance. Moving along the continuum, performance specifications that allow for quality–price adjustments based on end-result testing or predictive models begin to shift performance risk to the contractor. At the other end of the continuum are postconstruction performance provisions designed to monitor and hold the contractor accountable for actual performance over time.

As depicted in Figure 1.2 and discussed in greater detail in subsequent chapters, performance specifications can also be thought of as an integral component of an overall performance contracting system in which a project's specifications, contract

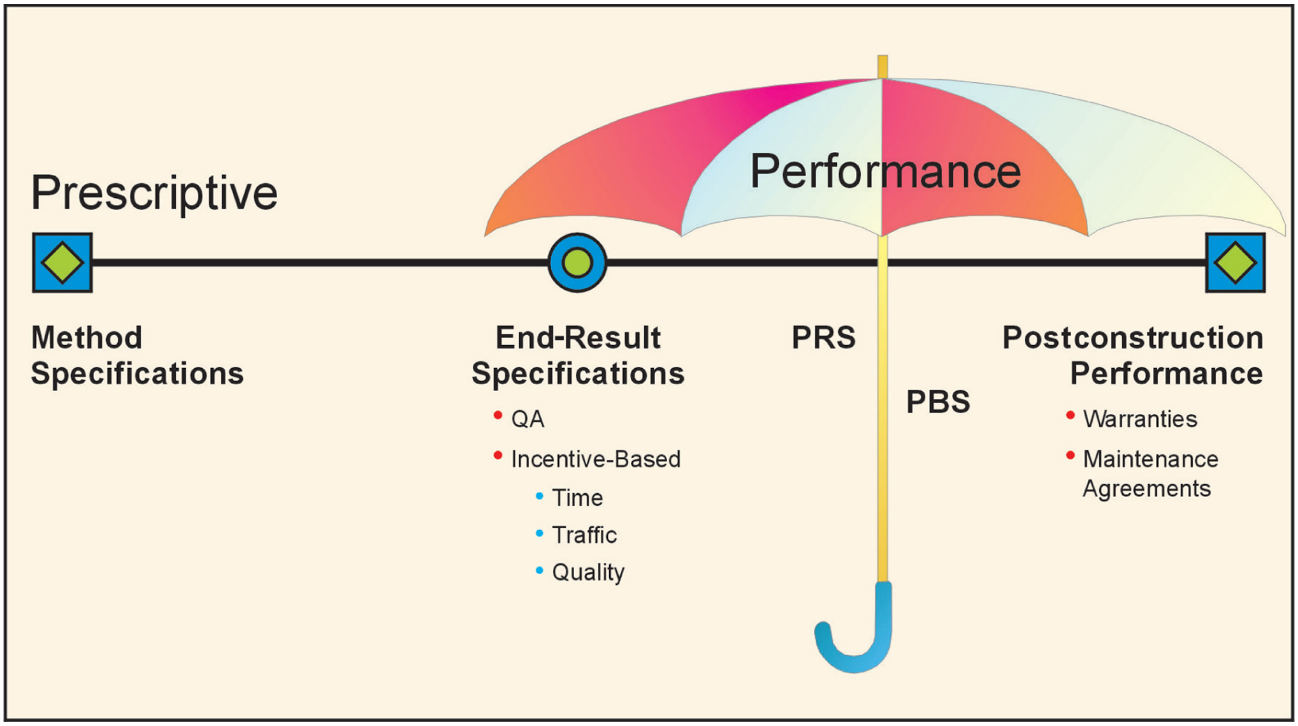

Figure 1.1. *Continuum of highway specifications.*

delivery method, and procurement approach are all tailored to one another and to achieving the project goals. The performance specification should translate user needs and project goals into measurable acceptance parameters. The chosen contract delivery method and its inherent conventions regarding design, construction, and post-construction maintenance responsibilities should be consistent with the risk allocated to the contractor in the specifications for achieving those goals. Likewise, the procurement approach should ensure the selection of a qualified contractor capable of meeting the performance objectives.

PERFORMANCE SPECIFICATIONS AND OTHER PERFORMANCE MANAGEMENT INITIATIVES

Ideally, the implementation of performance specifications should be coordinated with other ongoing performance management initiatives. For example, the American Association of State Highway and Transportation Officials (AASHTO) strongly advocates the use of performance-based management within highway agencies as a means of advancing national interests related to system preservation and maintenance, mobility and connectivity, interstate commerce, safety, and the environment (AASHTO 2003, 2008). Similarly, a key aspect of the Moving Ahead for Progress in the 21st Century Act (MAP-21) is the transition to a performance- or outcome-based program. At the

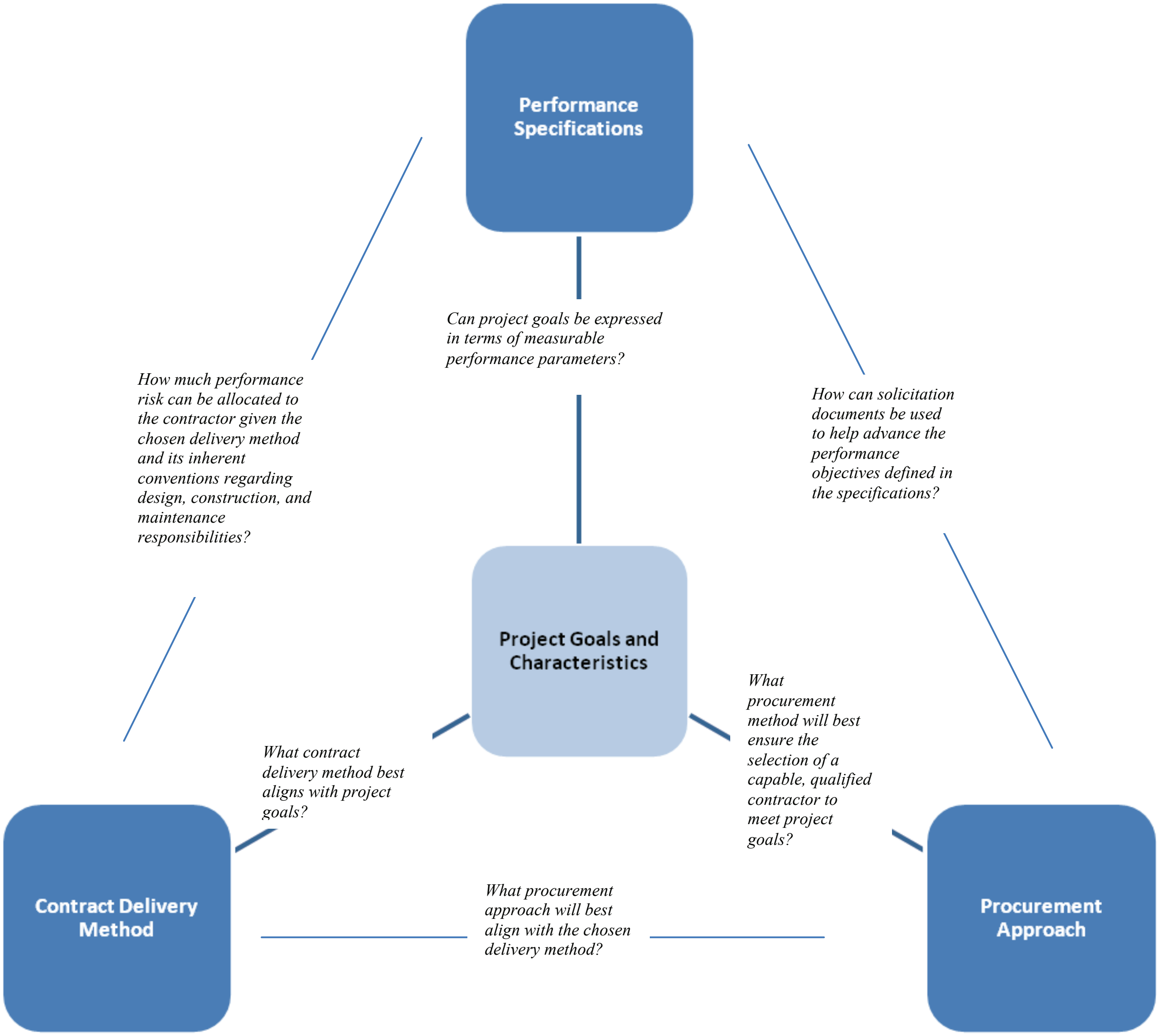

Figure 1.2. *Performance contracting system.*

federal level, performance management provides a means to more efficient investment of federal transportation funds by focusing on national transportation goals, increasing the accountability and transparency of federal highway programs, and improving transportation investment decision making through performance-based planning and programming. MAP-21 established the following national performance goals for federal highway programs:

- *Safety*. Achieve a significant reduction in traffic fatalities and serious injuries on all public roads.
- *Infrastructure condition*. Maintain the highway infrastructure asset system in a state of good repair.

- *Congestion reduction*. Achieve a significant reduction in congestion on the National Highway System (NHS).
- *System reliability*. Improve the efficiency of the surface transportation system.
- *Freight movement and economic vitality*. Improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.
- *Environmental sustainability*. Enhance the performance of the transportation system while protecting and enhancing the natural environment.
- *Reduced project delivery delays*. Reduce project costs and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices. (MAP-21 2012)

At the state level, agencies can invest resources in projects to achieve individual targets that collectively make progress toward national performance goals. The goals for performance specifications in a rapid renewal context (e.g., accelerated construction, minimized user impacts, and long-lasting facilities) generally align with these strategic goals. If an agency already has a performance management initiative under way, performance specifications can help translate an agency's broad policy goals and objectives down to the project level and instill organizationwide respect for measuring, testing, and evaluating performance. Some individuals within the organization may already understand performance metrics and how they can best be applied and implemented.

If project-level performance parameters align with overarching agency goals and performance measures (e.g., safety, congestion relief), the results of a particular project can provide a quick gauge of the organization's overall progress toward meeting its strategic performance objectives. The ongoing process of developing and monitoring performance requirements on a construction project can help accustom personnel to the broader objective of improving agencywide performance.

Performance specifications can also serve as a worthy adjunct to other management philosophies, such as lean construction, although this aspect is not specifically addressed in these guidelines. Consistent with lean principles, performance specifications aim to

- Eliminate unnecessary and non-value-added requirements;
- Result in continuous improvement;
- Align parties around the needs of the end user; and
- Place risk on the party best able to manage it.

Primary Objectives for Using Performance Specifications

- ✓ **Transfer performance risk to the contractor**
- ✓ **Motivate contractors to be more quality conscious**
- ✓ **Improve long-term durability**
- ✓ **Accelerate construction**
- ✓ **Encourage innovation**
- ✓ **Reduce agency inspection costs during construction**

RATIONALE FOR USING PERFORMANCE SPECIFICATIONS

While the motivation for using performance specifications will likely vary from agency to agency and from project to project, the literature and input from practitioners suggest that implementing performance specifications has the potential to improve quality and long-term durability. From this perspective, performance specifications better align design requirements with construction by focusing on characteristics that more directly relate to performance and promoting an improved understanding of performance among all parties. This improved understanding of performance further promotes the development and use of rational performance-based payment systems, replacing pass-fail or judgment calls. By being less prescriptive, performance specifications also encourage industry to innovate and take greater responsibility for performance outcomes, whether by improving quality, accelerating construction, or minimizing user impacts. Lastly, performance specifications can significantly reduce an owner's quality assurance burden during construction (particularly if the contractor has postconstruction responsibilities).

Such objectives (whether set internally by the agency or externally, as in a legislative mandate) will influence both the development and the use of performance specifications. Understanding the basic rationale for using performance specifications is therefore an important first step toward ensuring a successful implementation. Once identified, these objectives must be ranked and then communicated, understood, and accepted by all parties involved. In addition to agency personnel, the parties may include the public, legislators, industry, and sureties. The goals need to be understood and communicated at all levels within the agency and its industry partners, from top management down to field staff and subcontractors and suppliers.

ADVANTAGES AND DISADVANTAGES OF METHOD AND PERFORMANCE SPECIFICATIONS

Although the guidance presented in this volume is intended to help agencies implement performance specifications across a wide range of work and projects, this manual does not suggest that method specifications and an agency's standard processes be abandoned in their entirety. Such a move would not only be disruptive to internal and external stakeholders, but it could also lead to increased costs and reduced efficiency if performance specifications were not selectively applied to the appropriate projects.

As summarized in Tables 1.1 and 1.2, both method and performance specifications hold unique advantages and disadvantages that should be carefully weighed when considering how best to specify requirements for a particular project or project element. Chapter 5 provides additional details regarding the project scoping issues and key project characteristics that can influence the decision of whether performance specifications are an appropriate fit for a given project.

TABLE 1.1. ADVANTAGES AND DISADVANTAGES OF METHOD SPECIFICATIONS

Advantages	Disadvantages
• Method specifications are well established, easily understood, and applicable to a wide range of topic areas. • The agency can exert significant control over the work (although this may come at the expense of increased agency inspection efforts). • Requirements are based on materials and methods that have worked in the past, minimizing risk associated with newer or less proven methods or varying contractor performance.	• The contractor has little opportunity to deviate from the specifications and, provided that the specifications are met, is not responsible for performance deficiencies of the end product (i.e., the agency retains performance risk). • Method specifications lack built-in incentives for contractors to provide enhanced performance (e.g., cost, time, quality). • The prescribed procedures may prevent or discourage the contractor from using the most cost-effective or innovative procedures and equipment to perform the work. • Contractor payment is not tied to the performance or quality of the work. • Acceptance decisions based on test results of individual field samples can increase the potential for disputes.

Source: FHWA 2010.

TABLE 1.2. ADVANTAGES AND DISADVANTAGES OF PERFORMANCE SPECIFICATIONS

Advantages	Disadvantages
• Performance specifications promote contractor innovation. • The contractor assumes more performance risk. • Contractors have the flexibility to select materials, techniques, and procedures to improve the quality or economy, or both, of the end product. • A performance specification can provide a more rational mechanism for adjusting payment on the basis of the quality or performance of the as-constructed facility.	• The agency can exert less control over the work. • Opportunities for smaller, local construction firms may be reduced. • Identifying all of the parameters critical to performance and establishing related thresholds can be challenging. • Roles and responsibilities of the contractor and agency can become blurred if not adequately defined in the specifications or contract documents. • Staff may be reluctant to assume new responsibilities.

Source: FHWA 2010.

OVERVIEW AND ORGANIZATION OF MANUAL

Despite the potential advantages offered by performance specifications, they will not emerge as a viable alternative to traditional method specifications overnight. For agency personnel, developing and implementing a scope of work in terms of user needs and end-result performance is often much more challenging and resource intensive than simply adhering to the agency's standard specifications. For contractors, an initial investment may be needed to acquire the necessary knowledge, skills, and equipment to assume more responsibility for performance.

A concerted effort is therefore required on the part of senior leadership to foster a culture in which performance specifications will be embraced. To help agencies plan an effective strategy to achieve that goal, this guidance document addresses the various cultural, organizational, and legal considerations that can affect the successful implementation of performance specifications.

Chapter Contents

Chapter 2 traces how the decision to use performance specifications can affect traditional project development and delivery processes. Recognizing that such changes can have a significant effect on an agency's workforce, Chapter 2 also provides senior managers with a roadmap for successfully introducing performance specifications to their organization in a manner that will minimize staff resistance to change.

In addition to obtaining buy-in from internal staff members, agencies also need to engage local industry because performance specifications tend to yield the best results when agency and industry personnel work in partnership to achieve project goals. To help gain industry support, agencies should first recognize and appreciate the unique challenges that performance specifications pose to contractors. The most critical of these issues, including bonding concerns and flow-down of performance provisions to subcontractors, are discussed in Chapter 3.

Chapter 4 identifies various legal precedents of which agencies should be aware to help ensure that their actions do not unintentionally compromise the enforceability of performance specifications.

Although performance specifications have been applied to a wide range of transportation projects, experience indicates that certain conditions are more likely to yield favorable outcomes than others. Chapter 5 presents a selection process that project managers may use to assess whether performance specifying represents a viable option for a particular project or program.

In addition to the project scoping issues discussed in Chapter 5, the selected contract delivery method and procurement approach can also influence the decision on whether performance specifications are appropriate for a given project. Chapter 6 presents alternatives to the traditional process that can be used to help advance any project goals defined in performance specifications.

Companion Documents

An equally important component of an overall implementation strategy—specification development—is addressed in detail in *Framework for Developing Performance Specifications*. Readers are encouraged to review this companion document for further information on how performance specifications can be developed and tailored to help achieve project goals.

In addition, a series of guide performance specifications developed under SHRP 2 Project R07 is available to further assist agencies with the development of project-specific performance specifications. Given the difficulty in anticipating every project need, the guide specifications are limited to the following application areas, which have demonstrated the greatest potential for performance specifying:

- Portland cement concrete (PCC) pavement;
- Asphalt pavement;
- Concrete bridge decks;
- Earthworks construction and other geotechnical features; and
- Work zone traffic management.

2

ORGANIZATIONAL CONSIDERATIONS

Chapter Objectives

This chapter addresses the following questions:

- How will the decision to use performance specifications affect traditional project development phases?
- How can agencies help foster a culture in which performance specifications will be embraced by both internal staff members and industry?

Unless an agency actively uses alternative project delivery methods such as design-build, its policies, procedures, and organizational structure will likely bear the imprint of years of near-exclusive use of method specifications implemented under the traditional design-bid-build delivery system. Over the years, this approach has provided taxpayers with an adequate, safe, and efficient transportation facility at the lowest initial price that responsible, competitive bidders can offer. Accordingly, most agencies have structured their staff in a manner that will most effectively and efficiently support the needs of this system. Distinct departments have been created to nurture skills and transfer and preserve knowledge in specific functional areas such as design, materials, construction, and maintenance. Standards and manuals have been developed to promote consistency and facilitate the immersion of new or less-experienced employees into the organization. Standard specifications and standard details allow much of the engineering and design work to be performed by junior staff, just as materials and construction manuals allow less-experienced inspectors to adequately assume quality assurance functions during construction.

Much of the institutional knowledge that allows the traditional system to flourish will not directly transfer to the implementation of performance specifications. Performance specifications require different skills, processes, and management and coordination efforts for implementation to be successful. Fully integrating performance specifications into an agency's toolbox therefore requires the development of a new organizational context that imposes new roles, responsibilities, and relationships.

For such changes to take root, a concerted effort must be made to convince staff that a performance specifications initiative is worth pursuing. Otherwise, personnel may never truly commit to putting a performance specification strategy into action, and the implementation effort will likely fall flat.

Fortunately, change management has been the topic of numerous research studies over the years, and best practices and lessons learned are covered extensively in the literature related to management and organizational psychology. This chapter provides senior leadership with a roadmap for successfully introducing performance specifications to their organization in a manner that will minimize staff resistance to change.

HOW PERFORMANCE SPECIFICATIONS AFFECT PROJECT DEVELOPMENT PHASES

To appreciate the challenges (and potential benefits) associated with performance specifications, agencies must first understand how and why their implementation differs from that of method specifications. The following guidance traces how the decision to use performance specifications can affect various project development phases, from project planning and preliminary engineering through construction completion and possibly beyond to maintenance and asset management. First, the general process by which agencies have traditionally developed project plans and specifications is presented for comparison purposes.

Under the traditional system, an agency generally uses in-house design staff (or retains a consultant) to prepare 100% complete plans and specifications that fully define the contractor's scope of work and project requirements. These design documents are then used to procure contractors (typically on a low-bid basis) to build the project in strict accordance with the contract documents. The agency evaluates the bids received, awards the contract to the lowest responsible and responsive bidder, and, by virtue of the method specifications, retains significant responsibility for quality, cost, and time performance.

Developing a scope of work in terms of user needs and end-result performance is often much more challenging and resource intensive than simply adhering to the agency's standard specifications. Project staff must have the knowledge, skills, and experience to craft a realistic performance measurement system that ensures the needs of the agency and other stakeholders will be met, without materially compromising the intended risk allocation strategy, stifling creativity and innovation, affecting value for money, or otherwise detracting from project goals. The following guidance is intended to help agencies identify where the implementation of performance specifications will likely require a departure from their standard project development process.

Early Project Development

Deciding to Use Performance Specifications

Incorporating performance specifications into an agency's contracting toolbox requires modification of the agency's traditional project planning and scoping efforts to include an evaluation of whether or not to use performance specifications. To the extent possible, this decision should occur early enough in the project development process to preclude the need for a substantial de-engineering effort if performance specifications are to be used. While a decision as early as possible in project development provides greater potential for industry innovation under a performance specification to realize cost or time savings, performance specifications also have been successfully applied under a traditional contract delivery system or later in the project development process (e.g., using advanced measurement and testing methods, mechanistic properties).

Many considerations factor into the decision of whether or not to use performance specifications, including the choice of project delivery method. The step-by-step selection procedure presented in Chapter 5 can facilitate the decision-making process, but a cut-off score that automatically dictates or eliminates the use of performance specifications is difficult to define. Given specific project conditions or objectives, a single factor can override all others in determining the most appropriate choice for a specific project.

Assigning a Project Development Team

A multidisciplined team, including representatives from design, materials, construction, and maintenance, should be assigned early on in the project development process not only to help with the selection decision, but also to provide assistance thereafter during the specification development and performance monitoring efforts. Unlike the implementation of traditional method specifications, in which individual team members may not be active during all phases of a project's life cycle, projects on which performance specifications are used benefit greatly from the continued involvement of key personnel and information sharing across departmental lines.

For example, the field construction representative will ultimately oversee construction. That individual should participate in the specification development process to ensure that construction-phase issues (e.g., the quality management process, long-term maintenance considerations of possible design alternatives, maintenance and protection of traffic) are given appropriate attention in both the specification itself and in the accompanying solicitation package (particularly if a best-value procurement process is used).

Similarly, the engineers who participate in the preliminary design work and in the preparation of the specifications and solicitation package should remain involved after contract award to oversee and review any performance monitoring results—especially if performance parameters are intended to verify key design assumptions (e.g., pavement modulus). In addition to monitoring postconstruction performance, maintenance personnel should be consulted during specification development to help establish appropriate performance targets and thresholds given historical data from asset management systems.

Identifying Project Goals

Understanding user needs and communicating clear and concise project goals are critical to the success of any project. Given the nature of performance specifications, articulation of needs and goals takes on even greater importance because they set the foundation for the entire project development process. Decisions made with respect to performance measures, risk allocation, procurement approach, and project delivery method all stem from the goals established at project inception. For example, if a project goal is to enhance innovation, the performance specifications should provide the contractor enough freedom to incorporate creative solutions, just as the selected contract delivery method and procurement approach should also help advance this goal to the extent possible.

Early in the project development process, the project team, with input from other key stakeholders as necessary, should therefore develop and refine a list of project goals. Optimizing quality, time, and cost goals on a single project is rarely possible, so trade-offs may be necessary to ensure that the primary goal is achievable. Reaching a consensus on the relative importance of individual project goals will help the project team make informed decisions regarding the use of risk management and incentive strategies designed to increase the likelihood of achieving the primary project goal (e.g., enhanced quality), even if at the expense of secondary goals (e.g., cost).

Design Phase

Determining the Appropriate Level of Design

The level of agency design is an important consideration when implementing performance specifications. If contractor innovation is a primary goal, the agency should perform only the level of engineering and design necessary to support the environmental process; advance right-of-way acquisition; and identify the full scope, needs, and technical criteria for the project in accordance with the risks to be allocated to the contractor. In general, the agency's design effort should identify the project's needs and objectives but not necessarily prescribe solutions.

An appropriate parallel would be the level of design required for a design-build project. Agencies experienced in design-build contracting often report higher levels of project satisfaction with lower levels of preliminary design (with 30% often cited as a benchmark). However, that is not to say the same level of preliminary design should be applied to every project, or that every element within a single project should be taken to the same level of design. Each project, as well as each component of a single project, must be examined to determine the extent of preliminary or conceptual design needed to clearly convey the agency's performance expectations. For certain project elements, defining performance requirements could require close to 100% design, whereas for others, very little design may suffice.

Preparing Specifications and Solicitation Documents

Although preparing a 100% complete design package may not be necessary, the agency will have to redirect some of its previous design efforts to the development of an appropriate performance measurement strategy. This process is described in detail in *Framework for Developing Performance Specifications*. The effort will likely require dedicated resources, beyond those typically required to develop conventional specifications, to collect and analyze systemwide performance data for use in setting performance target values and thresholds.

Consideration will also have to be given to what contract documents need to accompany the performance specifications. The level of detail included in the plans and details should correspond to the flexibility extended to the contractor in the performance specifications. Inclusion or reference to an agency's standard details may therefore be inappropriate.

If a best-value or qualifications-based procurement process is contemplated, preparing the solicitation documents and evaluating the proposals received may also entail a significant effort beyond that traditionally performed by the agency. If the agency does not have the necessary expertise in-house, it may want to retain outside specialists. For example, if implementing performance specifications under some variation of a design-build-finance approach, the agency should consider seeking outside financial expertise to ensure the public's interests remain protected while it negotiates with a private entity that likely has significant experience in this area. Given the importance of the procurement step to successful implementation, Chapter 6 discusses various procurement issues and contract award considerations.

Design Quality Management

If performance specifications are implemented under the design-build approach, agency personnel will have to assume new design oversight responsibilities to ensure that the contractor's design meets the intent of the contract documents. The agency's oversight activities will generally include monitoring and auditing design progress and verifying compliance with contract requirements.

In reviewing design submittals, agency staff should be careful about recommending solutions to design problems. Any suggestions should be offered with the express provision that the contractor is not required to accept the suggestion. Requiring otherwise could result in the agency unintentionally assuming liability for aspects of the design that should remain with the contractor. Chapter 4 addresses the issue of owner interference in greater detail in the context of relevant case law.

To foster a collaborative project development process, the agency may wish to consider colocating its key personnel with those of the contractor. Colocation is intended to facilitate regular interaction and the free exchange of information between the parties in a manner that helps accommodate the fast-paced nature of design-build and rapid renewal.

Construction Quality Management

Managing quality has traditionally been an agency responsibility. However, performance specifications provide the opportunity to expand the contractor's role in construction quality management beyond conventional process control activities to include several of the quality assurance tasks traditionally performed by agency personnel. Although this approach may represent a departure from the traditional manner in which agencies allocate responsibility for quality management, it is consistent with the degree of risk assumed by the contractor for performance of the work. Too much oversight by agency personnel could shift significant risk back to the agency, as well as add time and inefficiency to the project—contradicting the goals of rapid renewal; too little oversight could compromise safety and performance.

With the contractor assuming a larger role for quality management under a performance specification, agency inspectors will transition from performing continuous on-site inspections of the quality, performance, and quantity of the work to assuming more of a verification role. The latter involves performing duties such as the following:

- Spot-check construction for compliance with design plans and project specifications;
- Evaluate construction at any "witness and hold" points stipulated in the contract;
- Verify that members of the contractor's quality management staff
  - — Have proper qualifications,
  - — Are present to observe and control the work, and
  - — Are carrying out the contractor's quality management plan;
- Perform verification sampling and testing of the contractor's test data for acceptance purposes;
- Determine if acceptance should be at full or adjusted payment;
- Verify progress and review payment requests;
- Audit safety records;
- Audit environmental compliance records; and
- Conduct and manage the review of as-built plans.

Although the contractor may assume a larger role for testing and inspection under a performance specification, responsibility for acceptance continues to reside with the agency. If contractor test data are used in the agency's acceptance decision, the agency, or its designated agent (i.e., consultant under direct contract with the agency), must perform some level of independent verification sampling and testing to meet the intent of Title 23, Code of Federal Regulations, Part 637. Use of a third-party testing and inspection firm hired by the contractor does not relieve the agency of its responsibility for verification. Likewise, splits of contractor-obtained samples cannot be used for verification purposes.

Similarly, even if the performance specification includes postconstruction requirements that effectively postpone final acceptance until the end of a warranty or maintenance term, the agency still should address initial acceptance at the end of construction to ensure that the contractor completed the basic scope of the work in accordance with the contract documents.

Best Practice in Construction QA: Michigan's Construction Quality Partnership

In 2004, the Michigan transportation construction industry, in partnership with the Michigan Department of Transportation (MDOT), Federal Highway Administration (FHWA), County Road Association of Michigan, and Michigan Municipal League, initiated the Construction Quality Partnership (CQP). The CQP is a comprehensive plan to improve quality by training and certifying all individuals, agencies, and companies that are involved in the design and construction of the transportation system in Michigan.

The initiative entails a joint training and certification program for both owner/agency and contractor personnel. Training is targeted to three organizational levels:

- Strategic—for corporate/executive management;
- Technical—for project engineers and managers; and
- Hands-on—for labor and inspection personnel.

The side-by-side nature of the training allows agency and industry personnel to gain appreciation for the contribution each entity makes to ensuring quality, facilitating subsequent interactions on the job.

The goal of the program is to change the way agency and industry personnel think about quality by expanding it beyond traditional materials testing. Construction practices must reflect the fact that operations such as mixing and placing materials have as great an effect on performance as does the quality of the individual materials. Through state-of-the-art personnel training in the areas of project development, construction processes, inspection, and equipment operation, the CQP aims to instill a focus on quality and continuous improvement in all individuals involved on transportation construction projects.

Once the training program is fully implemented, the plan is to develop corporate certification criteria that require contractors and consultants seeking work on MDOT projects to establish a corporate quality program.

The ultimate vision for the CQP is to include a postconstruction review process that provides a feedback loop to support continuous improvement efforts.

With time and the commitment of agency and industry leaders, the Michigan CQP initiative can be replicated in other locations to ensure that personnel are properly trained and equipped to deliver projects of the highest quality.

Postconstruction Performance Monitoring for Warranties and Operation-Maintenance Agreements

Implementing performance specifications that assign postconstruction responsibility to the contractor (e.g., through warranties or maintenance agreements) does not diminish the agency's responsibility to the public to provide a highway facility that performs to the desired level of service. Even if such agreements were to transfer all maintenance and repair activities to the contractor, agency personnel would still have to assume management and administrative duties to monitor and verify contractor performance during the operation and maintenance period. Depending on the length of the postconstruction period and the project goals, agency responsibilities may entail the following:

- Auditing and review of documentation, reports, self-appraisals, and performance data submitted by the contractor;
- Performance monitoring to ensure the facility continues to meet the specified performance requirements. Depending on the length of the postconstruction period, this could require formal condition surveys (ideally conducted using high-speed methods comparable to the agency's standard network-level asset management system), as well as more informal "windshield" surveys;
- Analysis and interpretation of performance data;
- Assessment of pay deductions (or penalty points) if the facility fails to meet performance standards and the contractor does not respond with the appropriate remedial action within the prescribed time frame (primarily for long-term maintenance agreements);
- Issuance of work permits and assessment of lane rental fees when the contractor needs to take lanes out of service to perform maintenance or repair work;
- Handback inspections before the end of the contract term (particularly for long-term operations and maintenance agreements); and
- Final acceptance and project closeout activities at the end of the warranty or maintenance term.

Given the administrative burden that accompanies these responsibilities, interested agencies should develop a performance monitoring plan and dedicate staff resources at the program level before applying postconstruction performance agreements on a widespread basis. A comprehensive monitoring program is essential to ensuring all performance objectives are continually met. For example, a computer-automated system to alert contract managers of the need to perform a monitoring event would alleviate some of the burden on individual contract managers to recall the timing of inspection events or other contract triggers. Such a system would be particularly helpful if the contractor's postconstruction responsibilities extended several years and overlapped with turnover in agency staff assignments. The implementation plan should also address which department (e.g., construction, materials, contract administration, maintenance, innovative delivery) has primary responsibility for postconstruction oversight and monitoring duties. Most likely, additional management and coordination across departments and field divisions would be needed to verify and manage contractor compliance throughout the contract period. To help streamline the collection and analysis of performance data, the agency should consider initially applying the same approach (e.g., similar performance parameters and data collection methods) it uses under its standard asset management system.

FOSTERING A PERFORMANCE-BASED CULTURE

The most critical element of implementing anything new—performance specifications included—is the ability to manage the change within the organization to ensure that personnel understand both the need for the change and the benefits it will provide.

As already discussed, successful implementation of performance specifications will likely require a departure from traditional project development and delivery processes. To foster a culture in which such changes will be embraced requires, at a minimum, acknowledgment from senior management that performance specifications could have a significant effect on the agency's workforce.

Figure 2.1 adapts the process presented in John Kotter's seminal work on change management, *Leading Change*, to the steps needed to integrate performance specifications into an agency's standard operating procedures (Kotter 1996). The actions needed to progress through each step are summarized in Table 2.1, as are the potential pitfalls that could hinder the initiative. While designed as a sequential process, flexibility in how it is implemented is clearly possible. The first and last steps—"establish the need" and "institutionalize change"—would not change, but interim steps (e.g., "communicate a vision" and "form the right team") might be accomplished concurrently or in a different order. Each step is further described in the narrative that follows.

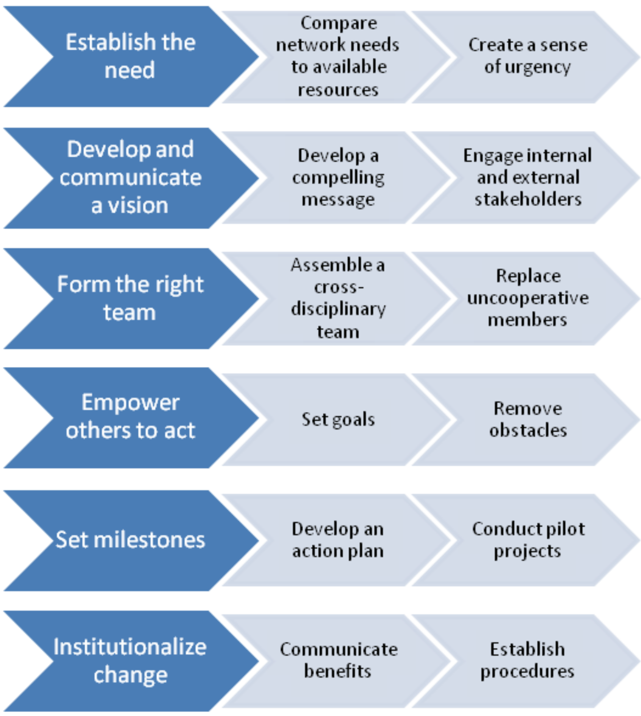

Figure 2.1
Steps to integrate performance specifications into an agency's operating procedures.

Establish the Need

Strong endorsement from upper management can help garner broad employee support for the changes needed to fully deploy performance specifications on a programmatic level. To gain such support, best practice suggests first establishing the specific rationale as to why performance specifications represent a necessary addition to an agency's contracting toolbox. For example, the literature suggests that implementing performance specifications has the potential to improve quality and long-term durability, encourage innovation, accelerate construction, and reduce an owner's quality assurance burden during construction (particularly if the contractor has postconstruction responsibilities). If a comparison of network needs to available resources suggests that performance specifications would provide a better means of achieving an agency's strategic goals than traditional method specifications, a greater sense of urgency can be created regarding the implementation effort.

Without such an underlying rationale for change, people may not be inclined to alter their habits to implement what they may otherwise perceive to be an executive whim to experiment with new processes. Creating a sense of urgency regarding why a change initiative provides the right solution for a particular problem tends to be more motivating than simply issuing a top-down command.

Develop and Communicate a Vision for Using Performance Specifications

People are generally reluctant to alter their habits. In the absence of a compelling reason to change, staff will continue to do what they've always done and will strive to retain the processes that are familiar to them. Once the need for performance specifications is established, the agency should communicate this need through a clear and concise vision statement.

The vision statement should serve to both motivate individuals and ensure everyone is working toward a common goal. For example, an agency with minimal resources to devote to construction inspection may wish to communicate that performance specifications will allow the agency to do more with less by empowering industry to assume more responsibility for quality and performance. Similarly, an agency that is more interested in innovation may wish to focus on the idea of capitalizing on the expertise of the private sector.

Achieving buy-in from industry also is critical to the successful implementation of performance specifications. Although performance specifications impose greater risk on contractors, they also offer the opportunity for increased profit margins should contractor-initiated design, process, or technology innovations yield improved efficiencies or cost savings. This concept may require tailoring a message to focus on the benefits that performance specifications can bring to industry while also offering assurances that opportunities for smaller or local firms will not disappear.

Form the Right Team

Assembling a multidisciplined team of individuals who are willing to move past traditional silos of responsibility is a key element of a successful implementation strategy. One approach used by several agencies is to set up a special projects group (or

TABLE 2.1. NECESSARY ACTIONS AND POTENTIAL PITFALLS IN IMPLEMENTING PERFORMANCE SPECIFICATIONS

Step	Actions	Potential Pitfalls
Establish the need.	• Compare network needs to available resources to determine if performance specifications would provide a better means of achieving organizational goals than would traditional method specifications. • Continually champion the development and use of performance specifications for appropriate projects.	• Lack of executive involvement
Develop and communicate a vision for using performance specifications.	• Engage internal and external stakeholders with a compelling message as to how performance specifications would add value to an agency's contracting "toolbox."	• Lack of a simple and concise vision as to how performance specifications can help fulfill an agency's need(s) • Inability to communicate the vision • Failure to achieve industry buy-in • Behavior contrary to the vision (e.g., using performance specifications indiscriminately, not allowing industry sufficient flexibility)
Form the right team.	• Assemble a cross-disciplinary team that is willing to modify the agency's traditional processes to accommodate the use of performance specifications.	• Failure to get past traditional silos of responsibility (e.g., between design and construction, pavement and geotech) • Failure to tap the right people to develop and implement performance specifications
Empower others to act on the vision.	• Remove obstacles that would undermine efforts to implement performance specifications. • Recognize that traditional project development phases may require modifications to realize the benefits of performance specifications.	• Failure of senior leadership to remain involved in the performance specification initiative and to remove obstacles to its successful implementation • Underestimating how the use of performance specifications can affect an agency's workforce and standard project delivery processes • Underestimating organizational inertia and the difficulty of pushing people out of their comfort zones
Develop an action plan and include milestones for short-term achievements.	• Identify goals and objectives of the implementation effort. • Conduct trial projects or demonstrations.	• Failure to set realistic expectations • Failure to adequately account for the learning curve that people (both internal staff and industry) must navigate before understanding and mastering a new process or technology
Institutionalize performance contracting.	• Identify and communicate benefits of using performance specifications. • Add performance specifications to the agency's contracting "toolbox."	• Failure to formalize new procedures • Lack of patience related to realizing the benefits of performance specifications

Establishing a Sense of Need: United Kingdom Highways Agency

Today, the United Kingdom (UK) Highways Agency is a leader in the use of performance specifications and alternative contracting strategies that place more responsibility for quality and performance on industry.

This development came largely in response to a series of targeted government initiatives aimed at addressing perceived problems with the UK's construction industry as a whole. In the mid-1990s, government leaders—encouraged by productivity gains achieved in the manufacturing industry through the introduction of lean production techniques—sought ways to attain similar results in the construction industry.

At the time, the construction industry was generally viewed as underperforming with respect to customer satisfaction, capital investment, research and development, training, and commitment to safety and quality. These failings often led to adversarial relationships with owners, cost overruns, and extended project durations.

To identify how to best fix those problems and modernize its construction industry, the UK first focused on identifying what was broken. Key findings from early government-sponsored research included the following (Egan 1998, 2001):

- The rate of profitability in construction was too low and unreliable to induce contractors to make sustainable investments in capital improvements, research and development, and training; quality and innovation often suffered as a result.
- Owners equated price with cost and did not differentiate between best value and lowest price. Furthermore, competing all work, instead of creating longer-term relationships with industry partners, inhibited learning, innovation, and development of skilled and experienced teams.
- Too many independent construction firms and subcontractors had fragmented the industry, hindering team continuity and performance improvement.
- Contractors had no stake in the long-term success of the project and were not accountable to the end user. Instead, contractors focused on the next client and the next job.

Recommended solutions to address the perceived deficiencies included the following:

- Create a culture of partnership—both between owners and contractors and among designers, subcontractors, and the supply chain—to enable the team to learn and make incremental improvements over time to improve long-term efficiency.
- Focus on the end products and the needs of the end user.
- Set targets for performance and continual improvement.
- Select partners on the basis of best value, not lowest price.

Such findings and recommendations laid the groundwork for the UK's plans to improve the quality and efficiency of its construction industry. The Highways Agency, which by the late 1990s was already outsourcing a significant portion of its design, construction, and maintenance work (albeit to separate entities), was receptive to the recommendations.

alternative delivery office) to develop staff experience and provide leadership and support related to nontraditional contracting practices. Training and continued support from senior managers can also help reinforce any changes in traditional roles and responsibilities and standard operating procedures needed to accommodate performance specifications.

Empower Others to Act on the Vision

Once a vision for performance specifications has been communicated and a team has been established to act on the vision, senior managers should remain engaged to ensure that the initiative moves ahead with minimal obstacles. For example, management needs to remain actively involved to determine whether the chosen team has the necessary knowledge, skills, and resources to implement performance specifications as intended.

As addressed earlier, some modifications to traditional processes may be necessary to realize the benefits of performance specifications. Likewise, organizational structure may need to change to eliminate barriers to successful implementation of performance specifications. Narrow divisions of work can reinforce traditional silos and undermine efforts to develop comprehensive performance specifications that have the road user in mind.

Another obstacle may be related to equipment and technology. Advances in nondestructive testing techniques may ultimately allow agencies to incorporate acceptance parameters that better reflect the future performance and design life of the facility. However, new technologies are often difficult to absorb into daily practice. To ensure an adequate return on investment, agencies should develop an implementation and rollout plan to shepherd new technology into routine use. Such a plan may require new information technology infrastructure to manage large quantities of electronic data and a learning curve for staff before the full potential of the new technology can be realized.

Develop an Action Plan and Include Milestones for Short-Term Achievements

To avoid discouragement, agencies should acknowledge that successful implementation of performance specifications will not occur overnight. Agencies may have to devote considerable time and resources to collecting the historical data needed to establish reasonable performance targets and tolerances. Investment in new technologies and information systems also may be necessary to support all of the performance parameters that the agency wishes to implement.

Likewise, agencies need to appreciate the impact that performance specifications will have on industry. Agencies should collaborate with industry during the specification development process and encourage contractors to invest in state-of-the-art equipment and construction process control. Quite often contractors need to make an initial investment to acquire the necessary knowledge, skills, and equipment to assume more responsibility for performance. One way to ease this transition is to gradually phase in the use of performance specifications over time, starting with demonstrations and pilot projects before expanding to a more widespread programmatic level.

Time also may be needed for the benefits of performance specifying to become apparent. Initially, the agency may receive higher bid pricing because of contractor uncertainty regarding the risks involved. As industry grows more familiar with performance specifications and comfortable with its ability to manage the risks, some contractors may actually see a competitive advantage to using performance specifications—an advantage that can be passed onto the agency in the form of lower bid pricing.

Institutionalize Performance Contracting

As with any new process, internal and external stakeholders must be educated about the potential benefits of performance specifications. A powerful way to communicate this message is through the successes and lessons learned from demonstration projects. In relating this information, agencies should make a conscious attempt to convey exactly how the use of the new specifications helped improve performance. If people are left to draw their own conclusions, they may not make the right associations. For example, people might think a project succeeded because it was performed by a contractor's "A" team working together with the agency's most seasoned resident engineer, and not because the project's performance specifications helped promote innovation and quality-conscious behavior.

Project successes and lessons learned should then be translated into formal procedures that provide agency-specific guidance related to the development and implementation of performance specifications.

3 INDUSTRY CONSIDERATIONS

Chapter Objectives

This chapter addresses the following questions:

- What challenges and risks do performance specifications pose to prime contractors?
- What concerns does the surety industry have regarding long-term bonds?
- What are the alternatives to traditional performance or warranty bonds?
- What can be done to garner industry support for performance specifications?

The preceding chapter focused on the implementation of performance specifications from the agency's perspective. However, performance specifications, particularly those including warranties or other postconstruction responsibilities, will also present unique risks and challenges to the construction industry. Convincing industry to take on new roles and responsibilities is crucial to the successful implementation of performance specifications. Quite often the industry's risk appetite determines the success of implementation. Contractors and sureties with limited experience may decline to compete or may price the risk into their bids. New specifications or contracting methods that shift responsibility to industry may have to be introduced in a gradual or stepped process for industry to gain the required skills and experience. From a risk perspective, contractors must consider two important issues: managing subcontractor and supplier relationships and meeting bonding requirements. These issues are discussed in the following sections.

MANAGING SUBCONTRACTOR RELATIONSHIPS RELATIVE TO PERFORMANCE REQUIREMENTS

Subcontractors and suppliers play a major role in the successful implementation of performance requirements. Prime construction contractors assume the contractual responsibility for meeting performance guarantees. However, the parties that typically have the skills to achieve those guarantees are specialty subcontractors and suppliers. These specialists may have proprietary technology or products, or they may have built their businesses into "centers of expertise" in a given area of performance. This arrangement can create several pragmatic challenges in how to "flow-down" contractual performance requirements to subcontractors and suppliers.

Limitation of Liability

Perhaps the biggest challenge is that suppliers of technology or products are not willing to take major commercial risks that could result in liability far in excess of their contract price. Suppliers commonly condition their willingness to furnish goods or technology on a particular project to an agreement by the prime contractor that the supplier will have a contractual limitation of liability (frequently capped at 100% of their contract price) for any deficiency attributable to the supplier. Such conditions create potential gaps in liability, which can cause problems in obtaining recourse for a performance failure.

On industrial projects such as power and petrochemical plants, limitations of liability are an accepted part of the contracting landscape between owners and contractors. However, the public sector has not widely adopted limitations of liability for prime contractors (the exception being a handful of megaprojects on which limitations of liability were required to obtain adequate price competition). Therefore, on highway rapid renewal projects, the prime contractor will likely have to assume the risk for the gap between the supplier's limited liability and the liability incurred if the supplier fails to meet the performance guarantee. This gap risk is significant because of the large difference in the contract price of a purchase order vis-à-vis a prime construction contract.

In theory, a trade subcontractor is justified in requiring an overall contractual limitation of liability. To date, however, most subcontractors have not made overall liability caps part of their contracting philosophies. Subcontractors are nevertheless very sensitive to how much liability they are willing to incur for delay damages, or other discrete damages, associated with their performance on a given project. They pay particular attention to delay-related liquidated damages amounts in the prime contract, and they generally expect to negotiate a lower value for liquidated damages exposure than the prime contractor has assumed in its contract with the owner. This is especially important for large projects where the liquidated damages may be a large daily value.

Flow-Down of Contractual Provisions

Another challenge that prime contractors experience in obtaining subcontractor/supplier compliance with performance specifications is the flow-down of contracting terms. Prime contractors often handle flow-down responsibilities with simple language saying, in effect, the subcontractor is bound to provide to the contractor whatever the contractor is obligated to provide to the owner. A performance specification can be so simple as to require only one trade to accomplish it. However, far more often a number of players (including both designers and trade contractors) need to coordinate to achieve the performance specification. This arrangement raises the following questions:

- Who is truly contractually responsible to meet the specifications?
- How will the coordination efforts take place to ensure compliance?
- How much leeway does one party have in its performance when it could affect another's performance?

Consider, for example, the tolerances that apply to each party's work. If a performance specification is tied to steel and concrete operations, are normal industry tolerances sufficient to achieve the specification, or should one of the trades be subject to tighter tolerances? Using simple flow-down language does not allow these issues to be carefully thought through and considered, creating a gap in responsibility.

Incentives and Disincentives

A reciprocal issue is how to handle incentives and disincentives when they relate to subcontractors and supplier performance. The prime contractor may simply flow-down verbatim whatever is in its prime contract (subject to the limitations of liability already discussed). That approach does not work well when achievement of the performance requirement can occur only through the cooperation of a number of players. The better practice is to have a meaningful discussion with the party that is most capable of achieving the performance requirement about what can be done to ensure that it is accomplished, and then to select an appropriate contracting method for achieving this result.

Warranties

Another challenge relates to how to handle warranties on performance specifications that flow from subcontractors and suppliers. Depending on the length of the warranty and the type of performance specification, the question arises of how the owner and prime contractor gain access to the subcontractor and supplier. Two common best practices address this issue. One is to specifically discuss the warranties with the subcontractor and supplier and determine how they will be administered after construction completion. The other is to give the owner the contractual right to deal directly with the subcontractor and supplier after construction completion, during the warranty period, through an assignment of the warranty provision in the prime contract and the relevant subcontracts.

Managing Performance Specifications

The final major challenge relates to how prime contractors manage the process of evaluating and achieving performance specifications. Those who think carefully about the process, and identify which of their subcontractors and suppliers are vital to achieving the specification, will generally do well. They will have coordination meetings and develop specific contractual language and execution plans with this interdisciplinary process in mind. Those who treat the specification trivially, leaving the subcontractors and suppliers to figure out compliance and coordination, will often find themselves struggling to determine how to meet their contractual requirements to the owner, likely without any recourse of going back to the subcontractor or supplier.

BONDS, GUARANTEES, AND OTHER MECHANISMS

Agencies have faced challenges finding bonds and other forms of guarantees to support programs that use a combination of performance specifications and warranties. Typically, agencies have required a warranty bond to guarantee that contractors will perform their warranty obligations during the warranty period. The bonds are secured through a surety, which guarantees that if the contractor fails to perform during the warranty term, it will be responsible for the cost of remedial work to the limits of the warranty bond. How the bond limits are determined varies from agency to agency, and the methodology may vary depending on the component being warranted. For example, bond values may be set in the following ways:

- Total dollar value of the warranted work (i.e., full value of the contractor's contract);
- A percentage of the total dollar value;
- The lower value between a percentage of the contract value and a set dollar amount (i.e., 5% or $2,000,000); or
- The estimated cost to perform a repair.

Contractors, however, have found it difficult to obtain such bonds or other suitable guarantees of performance for long-term obligations. Little research has been published on this issue. But a combination of information from the existing literature and information from subject matter experts in the surety and insurance industry supports the conclusion that this challenge stems from two primary factors:

- *Unique risks in using performance specifications*. Performance specifications on highway projects present unique risks to the industry, regardless of the scope or duration of the contractor's performance responsibilities. Depending on the way the contract is structured, these risks have the effect of limiting the pool of contractors who are willing or able to enter into contracts with the agency. These risks also have a pragmatic impact on the willingness of an entity—such as a contractor, manufacturer, or corporate parent—to provide financial security that backstops the contractor's obligations.
- *Bond and insurance marketplace*. The surety and insurance marketplace currently has a limited appetite for providing security vehicles to support the long-term performance obligations desired by agencies, particularly when those vehicles are tied to the performance of assets over their design life. The surety market has historically been unwilling to underwrite long-term exposure unless the contractor is large and well capitalized. Moreover, entities that have created alternatives to performance and warranty bonds, such as subcontractor default insurers, have been unwilling as yet to expand their product lines to cover long-term warranties based on performance specifications.

Unique Risks in Using Performance Specifications and Long-Term Warranties

Regardless of whether the contractor's performance obligations are secured through a bond, corporate guarantee, letter of credit, or some other financial instrument, the first question to consider is the nature of the risk associated with providing such financial backstop. The factors used to assess the risks of performance specifications and long-term warranties include a determination by the contractor, and those providing financial backstops, of the following:

- The ability to achieve the performance standards by objective means and measurable standards;
- The impact on performance by factors outside their control;
- An objective historical baseline to assess the ability to meet the performance standards;
- Expectations and criteria clearly set forth by the agency in the contract;
- The ability to demonstrate and validate the efficacy of the contractor's work years after the work is performed; and
- The balance between risk and reward opportunities.

The risks associated with performance specifications can heavily influence the ability of a contractor to provide a suitable guarantee of its performance, particularly when the guarantor is providing financial support for a long-term warranty. The primary risk areas are as follows:

- *Measurement technology and sampling*. The inability to ensure that the contractor's performance can be precisely tested, measured, and sampled—either because technology does not allow it or because the agency has yet to implement available technology—means that the contractor and its guarantors face the uncertainty of meeting the agency's expectations. A related concern is whether the samples taken will be consistent and representative of overall performance.
- *Factors outside of industry control affecting long-term performance*. The inability of the contractor to predict or control how the facility will perform or be used can have a significant impact on long-term warranties. For example, if the warranty does not have exclusions for preexisting conditions (e.g., pavement base, drainage systems), extreme events, inaccurate traffic predictions, or inadequate design by others, the contractor and its guarantors will be reluctant to provide suitable long-term guarantees.
- *Combination of performance and prescriptive specifications*. When performance and prescriptive requirements are combined, contractors are in effect being asked to provide guarantees that the constructed facility will perform as expected when they have not fully controlled the design. This lack of control affects appetite for risk assumption.
- *Inability of small contractors to assume risks*. As projects and programs become more complicated, particularly in terms of providing financial backstops of

performance, smaller contractors may be unable to participate in any meaningful capacity, particularly if their bonding companies resist.

- *Inability to predict performance based on engineering properties or other parameters measured at the time of production or installation*. The relationship between engineering properties and performance can be tenuous. The risk is that the predictions will not remain valid over the life of a warranty, particularly if the warranty is expected to approach a design life of multiple decades.

The combination of these risks creates a high level of uncertainty for third parties in the business of providing financial support for contractor's performance obligations. This is particularly true when the overall duration of the performance obligation is extended beyond the normal construction period to assume risks for warranty or maintenance obligations.

Bond and Insurance Marketplace

The public-sector construction industry in the United States has long relied on performance bonds to secure the faithful performance of a contractor's obligations. Performance bonds and warranty bonds are three-party agreements in which the surety guarantees to the owner (the obligee) that the contractor (the principal) is capable of performing the contract and protecting the obligee from financial loss if the principal does not perform. Bonds are credit instruments and are underwritten in a manner similar to bank loans. Underwriters generally consider three factors:

- *Capacity*. This factor considers the ability of the contractor to perform the obligations of the contract. Evaluation criteria include the contractor's technical skill, management, qualifications of personnel, employee retention, and exposure and progress on other contracts.
- *Capital*. This factor considers the financial strength of the contractor as it relates to its ability to fulfill the terms of the contract. Evaluation criteria include the contractor's financial condition, working capital, debt structure, liquidity, and leverage.
- *Character*. This factor considers the historical performance of the contractor. Evaluation criteria include experience and reputation, industry niche, length in business, and relationships with subcontractors.

These underwriting factors can influence a surety's decision to provide either performance or warranty bonds on projects that use performance specifications. The Surety & Fidelity Association of America (SFAA) issued a white paper titled *Statement Concerning Bonding Long-Term Warranties*, which framed the issue as follows:

> Some public owners have proposed special warranty requirements in excess of the standard one year warranty of the entire work. Under these warranties, the contractor is responsible for correcting defects in its work that are due to faulty materials and workmanship (materials and workmanship warranty) or correcting any shortfall from established specifications (performance warranties). It is often difficult to determine where the line is between faulty

workmanship and materials versus inadequate design, use beyond expectations or maintenance issues (SFAA 2003).

While noting that the surety industry understood the desire for quality assurance, SFAA concluded that bonded long-term warranty requirements limit bond availability, thus limiting competition for construction contracts and ultimately increasing costs. SFAA highlighted the pragmatic issues associated with a surety's underwriting process and how that process does not align with long-term bonds. According to SFAA, "As the duration of the bonded obligation becomes longer, and the surety must assess the contractor's operation for periods of time well into the future, the certainty of the judgment will be lessened" (SFAA 2003). After examining the risks, as well as assessing capacity, capital, and character, the surety industry has major concerns about the overall uncertainty of the contractor's financial situation.

SFAA representatives noted during an interview with the authors that the time periods within which bonds are underwritten can also create major underwriting challenges, regardless of the amount of coverage applied over and above the normal 1-year warranty and bond period. Surety commitments (and underwriting decisions) are made at the time of bid. On a reasonably large project, that can mean that the overall commitment (with only a 1-year warranty) may be 2 to 3 years. The surety takes on the risk of the financial condition of the contractor during that procurement and contract execution time period. If an agency adds on an additional warranty obligation of, say, 5 years after completion of the project, then the surety is at risk for the contractor's financial condition for potentially 7 to 8 years. The surety is likely to have difficulty underwriting and assessing such arrangements.

In addition to the underwriting uncertainties, the SFAA paper expressed surety concerns over the method of payment for the work under long-term performance-based warranties. The paper noted that under most contracts, the contractor is paid fully on final completion, leaving no contract balance to fund any warranty work. If a surety is obligated to step in and complete the warranty work, then it cannot avail itself of contract funds to mitigate its losses as it would if the default took place during contract performance and before final payment.

The SFAA paper noted that to compensate for the increased risk due to the diminished certainty of underwriting and the method of payment, sureties typically raise their underwriting standards and provide long-term bonds only to the largest and most financially sound contractors. As a result, smaller contractors who are otherwise qualified to do the work are sometimes shut out from bidding on these projects.

To mitigate these issues, the SFAA paper recommended the following:

- Warranties should be limited to 1 year.
- Any warranty of more than 1 year should be only from the supplier of the equipment or material and explicitly excluded from the prime contractor's bond.
- Warranties from the prime contractor in excess of 1 year should not be backstopped by a performance bond. Instead they should come from a specific warranty bond required at final acceptance of the construction project. That would enable the bonding company to underwrite the financial condition of the contrac-

tor at the time the warranty bond is placed and not years earlier. The amount of a warranty bond should be commensurate with the long-term warranty and not the entire project (i.e., the value of the warranty should correspond to the reasonable, expected cost of implementing the warranty work).

The interview with SFAA also confirmed that sureties have major issues with warranty bonds. The SFAA representatives noted that the amount of the bond (and the underwriting associated with it) is commercially challenging. Not enough money can be made in the premium for the level of effort required. The general view of sureties is that they generally are willing to provide warranty bonds as a service to their existing clients in good standing, but they do not view it as a separate market focus.

The conclusions of the SFAA white paper are supported by a survey of several bonding companies (Bayraktar et al. 2006). The survey confirmed the reluctance of sureties to provide long-term warranty bonds because of the detailed underwriting reviews needed, and also when the length of the warranty is extended. Interviewees noted a concern that warranty work is funded by contractors out of working capital and that this can jeopardize the contractor's financial status. They also expressed concern that the reasoning for providing warranty bonds is not based on sound underwriting practices; instead they cited "responses to competition," "holding on to market share," and "fear of losing large premium producers." The survey also noted a high probability that small companies will be eliminated from warranty projects because of risk and underwriting concerns. The recommendations from this survey include the following:

- Decreasing the warranty period to a maximum of 3 years;
- Having a renewable annual warranty bond after 3 years; and
- Treating warranty requirements as a separate line item on the project, which would help fund the warranty expense and be an additional incentive to the contractor.

Regardless of whether an agency is considering performance bonds that cover warranty obligations or separate warranty bonds, the effect on contractors is another issue to consider. Carrying a bond reduces the contractor's overall bonding capacity, and many contractors have expressed concern that warranty projects will reduce their capacity to take on future work. In some cases these bonding concerns have precluded contractors from bidding or have contributed to lower numbers of bidders on warranty projects.

Alternatives to Bonds and Insurance

Surety bonds are not extensively used outside of North America. Elsewhere, contract obligations are secured by letters of credit or similar demand instruments that function like letters of credit. These instruments are irrevocable commitments by the issuing bank to a third-party beneficiary (the agency) on behalf of a customer of the bank (the contractor) to meet demands for payment. These instruments are for smaller percentages of the contract price (5% to 10%) than a typical performance bond (100%) and are generally tied to a date specific (generally 1 year, subject to renewal on a yearly basis), payable on demand of the owner. Unlike surety bonds, which are three-party agreements in which the surety is obligated to the owner and the contractor, letters of credit run only to the benefit of the owner. As a result, letters of credit can generally be drawn on quickly and easily, since a contractor can validly raise few defenses to stop a draw.

Letters of credit are a viable way of guaranteeing long-term obligations and warranties and have been used in large public-private partnerships to secure operations and maintenance commitments by developers. However, several challenges with their use remain:

- *Collateral requirements*. Because these instruments are not written on the basis of leveraging assets, the contractor may need to have substantial collateral in place to secure the letter of credit. Consequently, a $2,000,000 letter of credit can, in effect, tie up $2,000,000 in operating capital for the length of the warranty. As a result, only the largest contractors will likely be capable of supporting multiple long-term warranties or maintenance agreements with collateral committed for a lengthy time.
- *Risks of the letter of credit being drawn on*. With surety bonds the contractor has the right to argue that it is not in default of a warranty or maintenance obligation. However, the demand feature of a letter of credit generally means that the agency has the right to draw on the letter of credit if it believes in good faith that it is correct in its position; the contractor will have to argue about its rights later. This places substantial emphasis on the underlying risks associated with performance specifications, as already discussed.

Default Insurance and Efficacy Insurance

Subcontractor default insurance (SDI) emerged about 15 years ago in response to perceived deficiencies with subcontractor performance bonds. The default of a major subcontractor can affect the overall project schedule, expose the general contractor to liquidated damages or other delay-related damages, and affect the work of other subcontractors. Faced with an imminent default by a subcontractor, a general contractor typically makes a demand on the subcontractor's performance bond. Ideally, the surety should be ready, willing, and able to step in and remedy the default. But criticisms have emerged that the surety's response time is too slow given the urgency of the project schedule. Addressing these perceived shortcomings of surety bonds, Zurich Insurance Group created an SDI policy known as Subguard. It works as a two-party agreement between the contractor and insurance company, with the contractor procuring the policy as the named insured. The general contractor is responsible for prequalifying the individual subcontractors and suppliers and bringing them into the agreement. Coverage commences on a formal declaration of default, but the general contractor is not required to terminate the subcontract.

This type of product is a hybrid of insurance and surety. It gives an owner the right to access an insurance policy in cases of a predetermined default, with fewer procedural defenses available to the contractor than in a surety situation. Subject matter experts were consulted to assess the suitability of SDI for long-term warranties or maintenance agreements on highway projects using performance specifications. At present, no such product exists, and concerns remain as to whether such products would be viable given the nature of the risks.

In other industry sectors, power generation in particular, insurance products have been created based on efficacy (i.e., insuring the performance of a system or project). These products have been used by extremely sophisticated contractors who are well established financially and can absorb large financial risks. Such insurance products are not known to be available for the highway sector yet. Given the nature of the contracting community, this type of product will not likely be available for smaller contractors.

Current Practices

Information derived from the NCHRP 10-68 study on pavement warranties demonstrates an evolving process among the states for warranties and securing the obligations of the contractor (Scott et al. 2011). Some current practices are as follows:

- *Prequalification of future work*. Instead of using a separate financial instrument to secure performance, Florida ties performance during the warranty to prequalification for future work through the use of a guarantee. If the contractor fails to perform the required remedial work, the contractor is precluded from bidding on future state work for a period of 6 months or until the remedial work is completed, whichever is longer. Several agencies in other states have considered using this program as well, but it does not work in every case. In Florida, most contractors work only in-state; thus they are motivated to work things out with the state. States that contract heavily with out-of-state contractors, or where in-state contractors have alternatives in other states, may not find this guarantee as compelling.
- *Pay-for-performance*. Minnesota has used a pay-for-performance specification: the contractor is paid a portion of the costs at the time the item is placed and then is paid on a graduated scale over time if the item performs to expectation. Minnesota implemented this alternative for warranties on its I-494 design-build project.
- *Retainage*. North Dakota has, for some of its projects, held a 1% retainage for the duration of the warranty in lieu of any bonds or other security.
- *Use of extended performance bonds*. Some state agencies, including those in California and North Carolina, have extended performance bond coverage to warranties of 1 year or less. The challenge with this approach is that the penal sum of the performance bond may be substantially more than the value of any potential warranty work; having this bond outstanding ties up bonding capacity.

Recommendations for Addressing Risks Related to Long-Term Performance Guarantees

Several issues relate to the use of bonds, insurance, guarantees, and other mechanisms with contracts based on performance specifications, particularly those containing long-term warranty or maintenance obligations. Given the current state of the surety and insurance markets and availability of products, the risks associated with performance specifications on highway projects, and the risk of using long-term warranties or maintenance obligations in conjunction with performance specifications, the long-range viability of bonds, insurance, guarantees, and other mechanisms cannot be ascertained with any certainty. Agencies should not simply mandate long-term security instruments without trying to balance the interests of the contracting and the surety/insurance industries. To develop an implementation program that is workable and viable, agencies should consider doing the following:

- Reach out to the surety and insurance markets and determine how best to create sustainable products that will meet the agency's performance goals.
- Balance the qualifications required from builders/operators to obtain favorable terms for long-term performance guarantees (insurance or other instruments) with the need to generate adequate local competition for these services. Insurers value the track record of experienced highway builders and operators (as European-based banks do) and welcome this business, particularly for long-term maintenance and operation commitments under a public-private partnership (P3).
- Consult with states that have more sophisticated transportation department contract offices with mature P3 and long-term operating experience. Those agencies will lead the way for other agencies in determining the best approach to guaranteeing long-term performance obligations.
- Give sureties the means to reevaluate and reprice their commitment to long-term obligations. One option may be to allow the surety to be alleviated from its obligation if the principal's financial condition erodes to a predetermined level or if the surety no longer underwrites the principal.
- Adopt some of the recommendations in the SFAA report. For example, use shorter-term warranty (rather than performance) bonds and structure payment of the warranty obligations as a line item. This is similar to the North Dakota approach with retainage.
- Decide whether Florida's prequalification and guarantee model is appropriate within the state to secure financial performance.
- Work with manufacturers who are willing to provide product guarantees of performance.

GARNERING INDUSTRY SUPPORT

Traditionally, agencies retain the risk associated with the performance of a project through the use of standard method specifications under a low-bid contract, and they achieve minimum performance through process control, material testing, and inspection of the work during construction. Performance specifications move away from this traditional model for ensuring performance by transferring performance risk to the industry. The transition from method to performance requirements has been evident in pavement construction. For example, standard quality assurance (QA) specifications for pavements require contractors to produce mix designs on the basis of criteria and tolerances specified by the agency. The specifications allocate responsibility for quality control and testing to the contractor and establish targets for construction quality characteristics with incentives (disincentives) for achieving higher (reduced) quality compared with the target values. Pavement warranty provisions also shift greater responsibility for postconstruction performance to the contractor by providing greater latitude in design and construction; in turn, they require that pavement meet or exceed specified performance targets during the life of the warranty.

Highway agencies and industry are continually looking for ways to innovate to improve performance. Performance specifications can provide a platform for agency- or industry-initiated innovation. At the lowest level, a performance specification can prescribe new materials, processes, or technology (e.g., mechanistic mix designs for pavement, rapid nondestructive testing methods) to enhance performance, with the agency retaining the majority of performance risk. As the industry gains experience, the agency can gradually eliminate prescriptive requirements and shift performance responsibility to industry.

At the highest level, performance specifications eliminate prescription, expressing requirements in terms of end-user or functional end-result requirements and allowing industry the greatest latitude to innovate. This chapter has addressed the obvious risks related to shifting performance responsibility to industry. To successfully implement performance specifications, agencies must collaborate with industry (and suppliers) in setting goals and identifying realistic performance parameters and targets to meet goals. Quite often both agencies and industry need to make initial investments to change roles and responsibilities, develop knowledge and skills, modify standard procedures, and perhaps acquire new equipment or technology. To ease the transition and spread out the initial costs, performance specifications can be phased in over time. For example, as described in *Framework for Developing Performance Specifications*, an agency may approach the implementation of performance specifications for pavements using a phased or tiered approach that starts with a minimal departure from current practice, then transitions to a substantial shift in technology and business practices to improve performance. The guide further addresses the development and use of incentive strategies and payment mechanisms as reward mechanisms in performance specifications to motivate industry to enhance performance.

4 LEGAL PERSPECTIVE OF PERFORMANCE SPECIFICATIONS

Chapter Objectives

This chapter

- Presents an overview of key court decisions addressing the enforceability of performance specifications;
- Discusses the application of the Spearin doctrine to performance specifications; and
- Addresses possible lines of defense for failing to meet performance specifications.

The guidance and recommendations in this document primarily stem from best practices and lessons learned. They are based on a review of published reports, guidance documents, and contracts and specifications, as well as discussions with subject matter experts from agencies and industry. However, in implementing performance specifications, users should also be aware of the legal precedents that may affect their enforceability. This section provides an additional view of performance specifications—that of the courts.

A substantial number of reported decisions address the enforceability of performance specifications. Most of the cases are based on disputes involving federal government contracts and have been reported in decisions by various agency Boards of Contract Appeals (BCAs) and the U.S. Court of Federal Claims. The following is an overview of the most common topics discussed in the cases.

DESIGN VERSUS PERFORMANCE SPECIFICATIONS

Whether a contractor's performance is governed by a design (i.e., prescriptive or method) or by a performance specification is critical to determining liability for project defects. When an owner specifies the material and character of the work by using design (or method) specifications, the warranty by the owner that as long as the contractor performs the work as specified, the contractor will not be responsible for the consequences of design defects is implied (*United States v. Spearin*). This long-standing principle, called the *Spearin* doctrine, has been a cornerstone of construction law in the United States for almost a century and has helped shape current practices in construction contracts and project management.

As the construction industry has moved to performance specifying, much discussion has ensued over the application of the *Spearin* doctrine to performance specifications and the consequent liability of the owner. Many of the cases before the BCAs and the Court of Federal Claims evaluate whether the particular specification in dispute is a design specification, performance specification, or a mixture of the two.

Generally speaking, a design specification is one that describes in precise detail the manner and method of the construction work to be performed and from which the contractor is not allowed to deviate (*J. L. Simmons Co., Inc. v. United States*). Courts and BCAs refer to these specifications as road maps, cookbooks, and similar adjectives. In essence, they mean that a design specification dictates how the contractor is to do the work. In contrast to design specifications, a performance specification sets forth an objective, result, or standard, and the contractor has discretion as to the means of achieving it (*Kiewit Construction Co. v. United States*). In classic performance specifying, the owner does not state design, measurements, or other specific details and simply states the expected result.

Also, commonly, a particular specification can have a mixture of design and performance elements. For example, if a bridge project involves the driving of concrete cylinder piles, a performance specification might say, "Drive the 50-ft diameter piles to a minimum tip elevation of –55 ft and to a bearing capacity of 650 tons." A mixed design and performance specification might add requirements such as hammer size, cushion replacement, jetting limitations, maximum stress levels in driving the piles, and similar restrictions.

The distinction between a design and performance specification is critical in assessing liability. If a contractor complies with a design specification that does not work, then, under the *Spearin* doctrine, the contractor is given cost and time relief. However, if the specification is considered a performance specification, then the contractor is responsible for achieving it, regardless of cost. Although this would seem to be a relatively simple concept, the problems come when an owner prescribes a mixed design and performance specification and then performance cannot be achieved under the design constraints established by the owner.

For example, consider the bridge scenario. Assume that the specification precludes any type of prejetting. When the contractor starts driving the piles, it finds that it is exceeding the maximum stress levels and the piles are starting to crack at elevations well above the minimum tip elevation. Assume that the owner and contractor agree that the solution is to prejet to within 5 ft of the minimum tip elevation. That operation costs the contractor more money and time. The contractor would argue that the owner's specifications were defective in that the design requirements led the contractor to believe it should not price prejetting operations. If the owner believed that it had drafted a performance specification, then it would disagree with the contractor's claim for money and time. Ultimately, because the owner constrained the contractor's ability to do the work by establishing some "cookbook" requirements, the owner's argument would likely fail.

Numerous reported cases evaluate this type of issue. A recent design-build case, *White v. Edsall Construction Company, Inc.*, explains the principle (see, generally, Loulakis 2002). The contract involved the construction of an aviation support facility for the U.S. Army, and the issue was the design of the storage hanger tilt-up canopy doors and truss. The specification required the design-builder to use a three-pick-point system to lift the doors. The design-builder eventually concluded that the three-point system was deficient and made a claim for its costs in modifying the lifting system. The Army argued that the specification was a performance specification and specifically argued that liability for the deficient three-pick-point system was to be borne by the design-builder through the following note, which was on the canopy door drawings:

> Canopy door details, arrangements, loads, attachments, supports, brackets, hardware, etc. must be verified by Contractor prior to bidding. Any conditions that require changes from the plans must be communicated to the Architect for his approval prior to bidding and all costs of the changes must be included in the bid price.

The Armed Services Board of Contract Appeals (ASBCA) found the three-pick design system to be a defective design specification and rejected the disclaimer language. The ASBCA found that the Army had warranted that the door load could be evenly distributed to the specified three pick points and that the disclaimers could not be read to eliminate this warranty. It said that if the number of picks was not a design specification, then "bidders would have been free to select the method of performance, and it would not have been necessary for them to seek the architect's permission to make changes from the plans." Importantly, the ASBCA stated that the design-builder had no prebid obligation "to ferret out if the Government's three-pick point design would provide the proper load distribution."

Given the number of cases that have considered this issue, the owner clearly bears the risk of a mixed design and performance specification that does not work. Efforts by owners to avoid this risk by using creative labels have not been successful. These efforts include (a) calling a design specification "performance specification requirements," (b) stating that the design specification is "discretionary," (c) using disclaimers of liability, and (d) saying that the design specification is "for guidance purposes only." Stated simply, the BCAs and Court of Federal Claims—as well as state courts—view the *Spearin* doctrine as an important right for contractors, and they have been reluctant to accept the arguments of owners that would compromise this right.

These cases involved design-build delivery, an approach that commonly assumes that control and liability for design is shifted from the owner to the contractor. In reality, design-build or design-bid-build performance specifications may contain a mix of design requirements (or constraints) and end-result performance requirements. The design constraints may restrict the contractor's ability to provide a preferred or lowest-cost solution but should not prevent the contractor from meeting the required performance. A simple example of a design constraint is prohibiting the use of steel construction for a bridge to reduce future maintenance cost. As a best practice, when drafting specifications containing design constraints and end-result performance requirements, the drafter should clearly define roles and responsibilities and performance requirements and should ensure that design requirements or restrictions do not prevent a contractor from reasonably meeting the required performance.

DEFENSES TO MEETING A PERFORMANCE SPECIFICATION

In numerous cases pure performance specifications have cost contractors more money than expected, and they have sought relief. The cases are clear: when a contract is properly written in terms of a clear performance specification with end-result requirements, courts will not hesitate to find the contractor liable for failing to meet such specifications. Consider *Utility Contractor, Inc. v. United States*, in which a contractor was to design and build a flood control system to collect rainwater along a creek in Oklahoma and prevent the construction area from flooding. Rainstorms caused the creek to overflow temporary cofferdams installed to keep the construction area dry. The contractor alleged that the government had failed to identify detailed procedures in the contract for protecting the permanent work during the construction phase. The court rejected the claim based on its reading of the contract, taken as a whole, as requiring the contractor to possess sufficient hydrological expertise and construction skills to protect its unfinished work.

Despite this general principle, questions remain as to how far this obligation will actually extend when the contractor is confronted with factors beyond its reasonable control. In the few cases on this subject, two lines of defense have surfaced: impossibility or impracticability of performance and owner interference.

Impossibility and Impracticability of Performance

If an owner creates a performance specification that is, for technological or financial reasons, impossible or impracticable to perform, courts may excuse the contractor's nonperformance. The factors to be considered in establishing impossibility are (a) whether any other contractor was able to comply with the specifications, (b) whether the specifications require performance beyond the state of the art, (c) the extent of the contractor's efforts to meet the specifications, and (d) whether the contractor assumed the risk that the specifications might be defective (*Oak Adec, Inc. v. United States*). Commercial impracticability is a subset of the legal doctrine of impossibility; it excuses a party's delay or nonperformance when the "attendant costs become excessive and unreasonable by an unforeseen supervening event not within the contemplation of the parties at the time the contract was formed" (*L.W. Matteson, Inc. v. United States*).

The argument is that by accepting a performance specification, the contractor has represented to the owner that the specifications are attainable and subject to neither defense. However, courts have considered this matter more precisely and have evaluated (a) the precise contract terms agreed on by the contractor and (b) the relative knowledge of the owner and contractor regarding the "impossible specification."

In *Colorado-Ute Electric Association v. Envirotech Corp.*, the design-builder (Envirotech) agreed to meet certain performance requirements in its contract to provide the owner (Colorado-Ute) with a hot-side electrostatic precipitator at a coal-fired electric power plant. Specifically, Envirotech agreed to comply with state air quality standards requiring that emissions opacity not exceed 20% and warranted that it would bear the cost of all corrective measures and field tests until continuous compliance could be achieved. Envirotech failed to achieve continuous compliance with the performance requirements and claimed that such compliance was impossible to accomplish. The court held that Envirotech had expressly warranted that it could provide Colorado-Ute with a satisfactory precipitator and thus assumed the risk of impossibility. The court stated, "[Envirotech's] impossibility defense is inconsistent with its express warranties and cannot be employed to avoid liability."

Similarly, in *Aleutian Constructors v. United States*, the Court of Federal Claims held that by altering the owner's initial design specifications for the design features at issue, the assumption by the contractor of the risk that performance under its proposed specifications may be impossible is implied. In this case, the contractor (Aleutian) agreed to construct an airplane hangar and dormitory building for the U.S. Air Force's optical aircraft measurement program at Shemya Air Force Base, Alaska. The area is known for its extreme weather conditions and high winds.

During construction, Aleutian obtained the government's approval to change the design of the roofing system provided that it warrant the materials and workmanship for a 5-year period and verify that the proposed design would withstand a wind uplift pressure of 80 psf. Soon after installation, the roofing system failed and Aleutian was forced to make substantial repairs and modifications to the roofing system. Aleutian filed a claim to recover the repair costs, alleging defective specifications and impossibility. The court rejected the claim and reasoned that when a contractor persuades an owner to change its design to one proposed by the contractor, the contractor assumes the risk that performance under its proposed design may be impossible. Accordingly, by assuming responsibility for the design, the contractor assumes liability for all damages and losses arising from the inability of the design to meet the owner's performance goals.

Another instructive case in this area is *J. C. Penney Company, Inc. v. Davis & Davis, Inc.* The issue involved the quality of workmanship of certain sheet metal and coping work. The project specifications provided that the work must "be true to line, without buckling, creasing, warp or wind in finished surfaces." The owner refused to accept the work because it did not comply with the specifications. The design-builder did not dispute the assertion that the work did not comply with the specifications but instead claimed that it was impossible to comply with the specifications. The court found that impossibility is not a basis to allow the design-builder to recover its additional costs from the owner for attempting to comply with the specifications. The court reasoned that the specifications, although impossible to meet, were negotiated by the parties at arm's length. Therefore, the owner was totally within its rights in refusing a product that did not meet all of its bargained-for specifications.

As evident from these cases, one of the biggest hurdles that contractors face relative to these defenses is the argument that they have assumed the risk of meeting the performance specification. This is particularly true in a design-build context because the contractor may actually have participated in the development and writing of the specification. Therefore, while these defenses are theoretically available to a contractor, few tribunals have accepted the arguments.

Owner Involvement and Interference

An owner can potentially jeopardize its right to shift the risk of achieving performance specifications to the contractor by interfering with the design or construction process. Consider, for example, *Armour & Company v. Scott*, which arose out of a design-build contract for the construction of a meat packing plant. The court found that the owner became so actively involved in the design process by modifying the electrical and mechanical systems and ultimately increasing the facility size that the owner assumed the role of a de facto partner of the design-builder. The substantial interferences constituted a breach of contract by the owner.

Sometimes, despite the best efforts of the owner to develop a performance specification and enable the design-builder to meet it, circumstances related to owner involvement can affect the single point of responsibility. Consider, for example, *Allen Steel Co. v. Crossroads Plaza Associates*, which involved a commercial facility in Salt Lake City, Utah. In response to an owner's solicitation of design-build proposals for structural steel work, a contractor submitted in its proposal three structural design alternatives. However, the proposal specifically stated the following:

> This proposal is offered for the design, fabrication, and erection of the Structural Elements only for the tower and mall. . . . Owner's engineer is to check this design and make changes if necessary to enable him to accept overall responsibility for the design. Changes that effect [sic] quantity, weight, or complexity of structural members will require an adjustment in price.

The proposal was accepted, and the contractor was directed to prepare detailed plans for steel fabrication on the basis of its plans.

During the course of performance, however, inspectors from Salt Lake City stopped construction because of what they perceived as structural defects. The owner retained its own engineer to correct the defect. Steel had to be torn down to remedy the problem, resulting in delays to the project and substantial cost overruns. The owner charged the contractor for the added costs, prompting litigation between the parties.

The sole issue in the case was whether the contractor had effectively disclaimed responsibility for design defects by placing responsibility for the design within the control of the owner through its proposal. The court found that although the owner had only provided general design parameters for the structural steel, the contractor had effectively disclaimed its responsibility because it had provided a design for purposes of the bid and transferred the risk of verifying adequacy of the design to the owner.

5

DECIDING TO USE PERFORMANCE SPECIFICATIONS

Chapter Objectives

This chapter addresses the following questions:

- Under what conditions should performance specifications be used instead of traditional method specifications?
- How does the project delivery approach affect the decision to use performance specifications?

Performance specifications are not ideal for every construction contract. However, they may hold significant advantages over traditional method specifications when certain criteria or conditions are met. To help agencies identify and understand these conditions, this chapter presents a two-part decision process for evaluating when to use or not to use performance specifications. Part 1 of this decision process, outlined in Figure 5.1, is based on a project's scope and goals. Part 2, summarized in Figure 5.2, addresses the project delivery considerations that can also affect the decision. A more detailed discussion of the decision process follows the figures.

The decision to use method or performance specifications is often a matter of degree (how much and at what level). Different approaches to specifying may be appropriate to specific elements within a project. Therefore, a project may include both method and performance requirements, though that is unlikely. To develop and write effective performance specifications, the screening process described in this chapter should be followed by a more in-depth evaluation of the type and level of performance

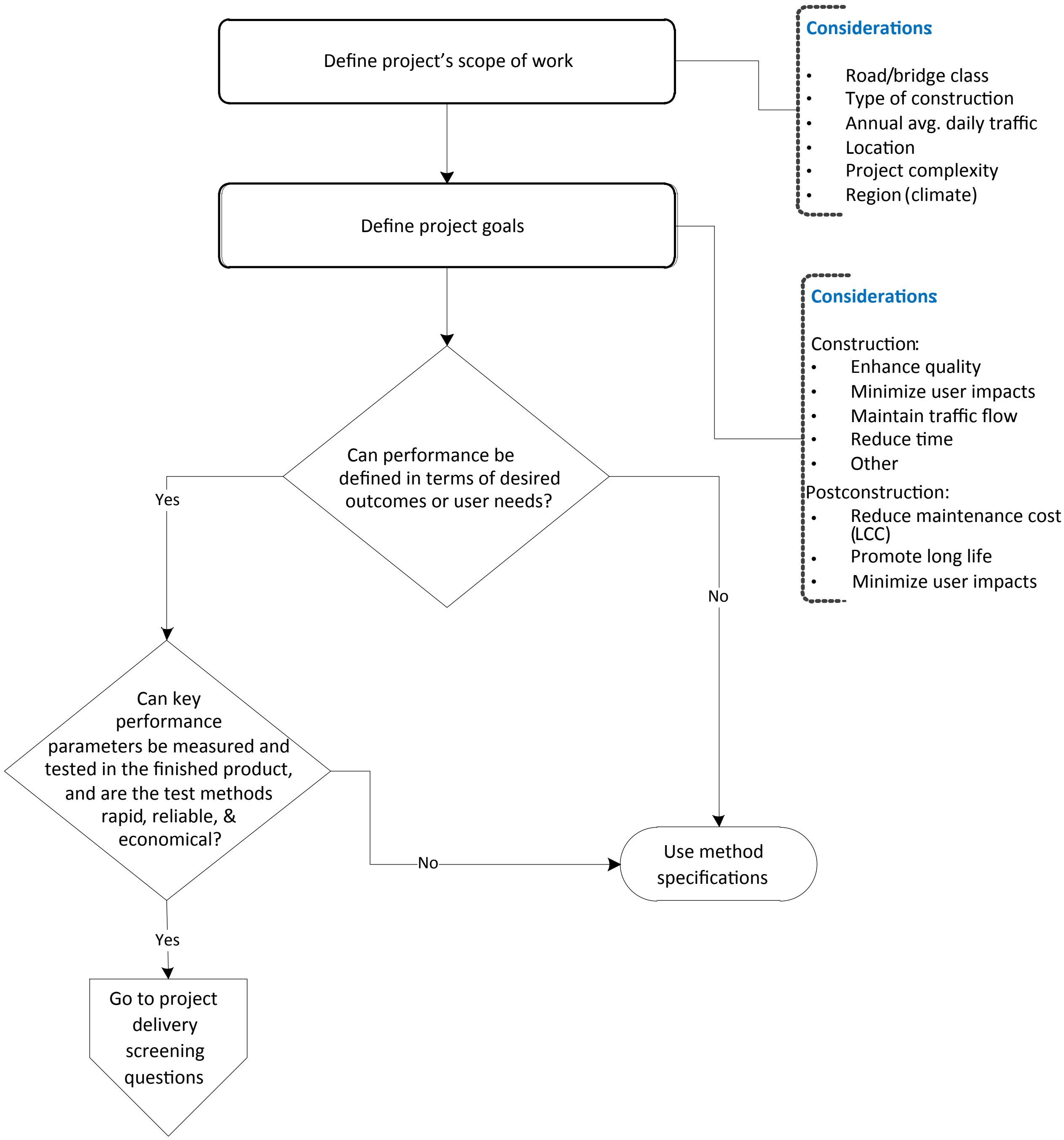

Figure 5.1. *Decision process Part 1: Project-level considerations.*

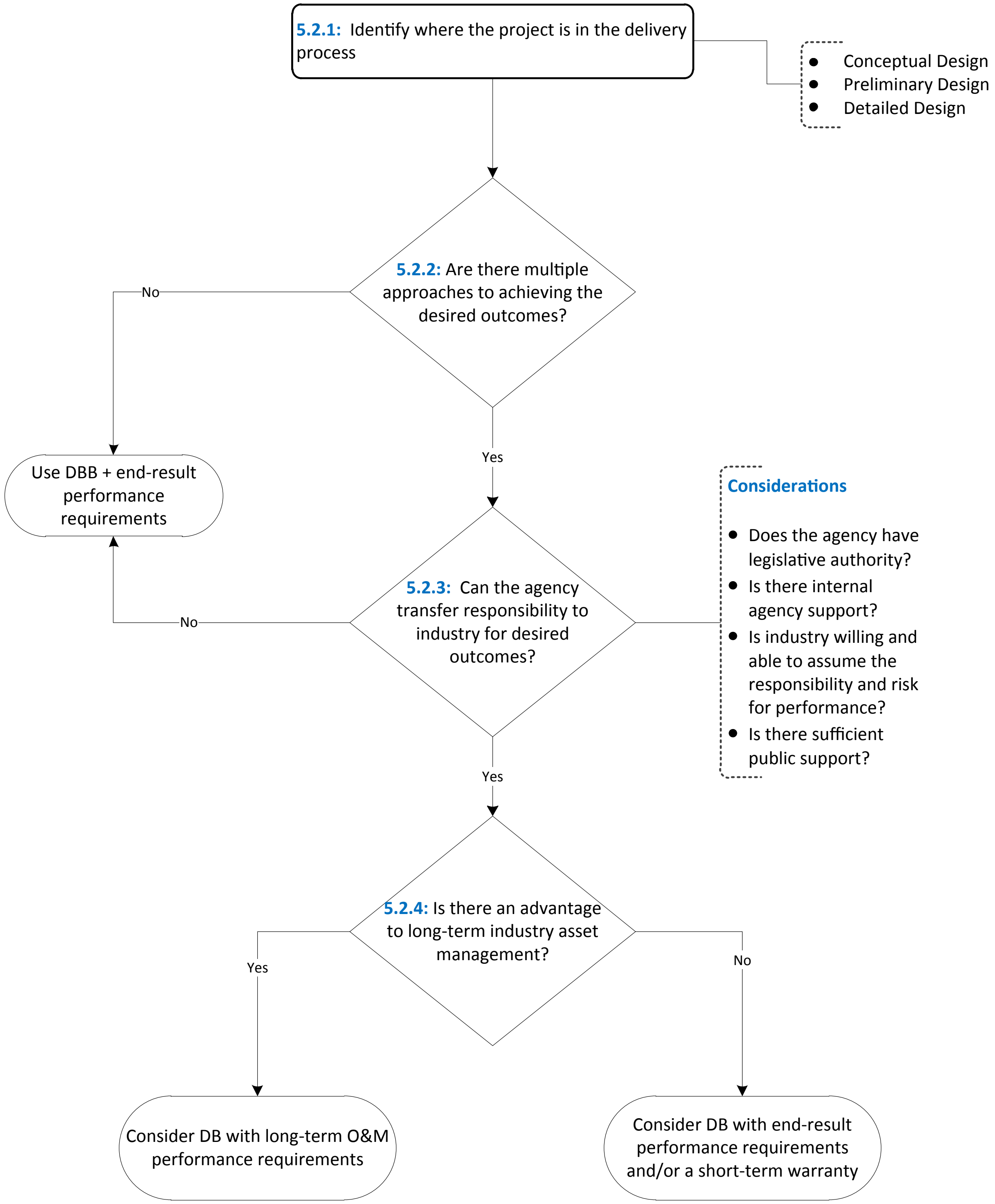

Figure 5.2. *Decision process Part 2: Project delivery considerations.*

requirements appropriate for the project characteristics and contracting type (see also *Framework for Developing Performance Specifications*, Chapter 2).

Although a single person can perform this evaluation, a multidisciplined team should be assembled to provide for a more balanced and accurate selection process. Personnel for a selection team may include planners, designers, and construction and maintenance personnel. Representatives from local industry also can be consulted to obtain their perspective on performance specifications.

PROJECT-LEVEL CONSIDERATIONS

Scope of Work

Project scope is a key issue when deciding whether or not to use performance specifications. Although performance specifications have been applied to a wide range of transportation project types, experience indicates that certain conditions are more likely to yield a successful outcome than others.

Project Characteristics

Table 5.1 summarizes the typical conditions under which method and performance specifications can best be applied.

The likelihood of realizing the advantages of each specification type tends to correlate with project complexity. Performance specifications are typically most advantageous when the project provides ample opportunity for industry to innovate and

TABLE 5.1. APPROPRIATE CONDITIONS FOR USING METHOD VERSUS PERFORMANCE SPECIFICATIONS

Method Specifications	Performance Specifications
• End-product performance cannot be easily defined. • End-product performance cannot be easily or economically measured and verified. • Limited methods exist that would satisfy the agency's minimum requirements. • The agency must retain performance risk because of permit requirements, maintenance considerations, the need to tie into existing or adjacent construction, and similar issues. • Removing and replacing defective work would be impractical. • Preexisting conditions would compromise the transfer of performance risk to the contractor.	• End-product performance can be defined in terms of desired outcomes or user needs. • Key performance parameters can be measured and tested, and the test methods are rapid, reliable, and economical. • Multiple approaches can achieve the desired results. • Industry is willing to assume performance risk. • The agency is willing to relinquish control over some aspects of the work.

influence performance outcomes. This is often the case on complex projects involving major reconstruction or new capacity, multiphased work zone management, major or nonstandard structures, and high traffic volumes requiring accelerated design and construction.

In contrast, less complex projects involving only minor resurfacing or restoration of the pavement surface or the use of standard structural components to match existing facilities are less likely to benefit from a performance specification. An exception would be projects in which the agency allows significant latitude through the selection of alternate designs, materials, or construction methods.

Scoping Issues

Preexisting conditions can significantly limit the ability of performance specifications to shift performance risk to the contractor, particularly on project elements with an extended warranty or maintenance period. In those situations, the contractor's scope of work should include activities to correct any preexisting conditions that could potentially affect performance. Alternatively, if the scope of work does not address underlying deficiencies, the specification should identify exclusions relieving the contractor of responsibility for performance problems stemming from preexisting deficiencies.

If the risk associated with underlying conditions cannot be allocated to the contractor in an equitable manner, the scope of the performance specification may have to be modified to exclude certain sections of the work or to eliminate certain performance requirements all together. These scoping considerations should be factored into decisions regarding whether and how to use performance specifications for specific project elements.

Also, many projects involve reconstruction of facilities while maintaining traffic flow. Agencies traditionally provide prescriptive requirements for maintenance of traffic and project phasing in the construction plans. The agency must decide whether retaining control is too restrictive when specifying time-based and/or quality-based performance requirements for a project. For example, on more complex projects with higher traffic volumes, shifting control of work zone management and phasing to the contractor may be beneficial, particularly when using alternate procurement methods or a design-build contract. This shift would allow the contractor to plan and phase the work in a manner that best suits its design and construction operations.

Project Goals and Desired Outcomes

In addition to project scoping, the agency should identify and prioritize the key goals or specific outcomes desired for a project. As shown in Figure 5.3, outcomes may focus on construction or may extend to postconstruction performance.

As an initial task, the project team should identify desired goals and rank the objectives in order of importance. One approach for determining rankings is to rate or score the relative importance of project goals in a committee forum on a scale of, say, 1 to 10 (with 1 being minimally important and 10 being extremely important to project success). The ratings can then be compiled and averaged to determine the relative ranking of goals.

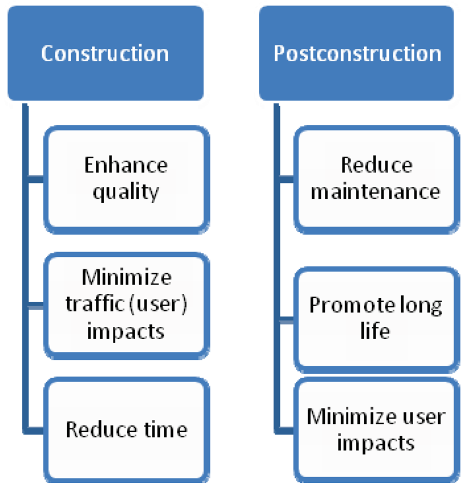

Figure 5.3. *Project goals during construction and postconstruction.*

To the extent possible, the goals should be based on definitive criteria (e.g., time savings in days or annual maintenance cost in dollars). More subjective goals will benefit from a group discussion to determine their relative importance.

Achieving multiple goals in a rapid renewal context may be possible. But first the project team must assess whether performance specifications are the best way to achieve the desired outcomes. To this end, the next steps in the decision process are designed to help determine whether goals can be described, measured, and tested in terms of end-product performance.

Defining Performance by Desired Outcomes or User Needs

Once project characteristics and desired outcomes have been identified, some basic issues have to be considered to determine the feasibility and practicality of using performance specifications. As a first step, the project team must determine whether project goals or desired outcomes can be defined in terms of key end-result performance parameters that are within the contractor's control. Such parameters may relate to the operational or end-result performance of the finished product (e.g., pavement ride quality) or to functional parameters that are more indicative of actual product performance over time (e.g., surface distresses such as rutting or cracking as in a pavement warranty provision). Desired outcomes may also include time performance in terms of construction time or traffic delays in the work zone.

Measuring and Monitoring Performance over Time

Given the existence of valid performance parameters, the next step is to determine whether the parameters can be measured and tested rapidly, reliably, and economically. For example, nondestructive testing techniques may be able to reduce some of the delay associated with quality assurance and acceptance activities, especially if results are available in real time or within a matter of days. Similarly, techniques that minimize traffic disruption (e.g., by ensuring timely opening of roadways after a construction project or by eliminating the need for lane restrictions during warranty or maintenance periods) would be preferable to those that impair mobility.

If the measurement strategy is difficult to achieve in a rapid renewal context, or if potential gaps exist (see Table 5.2), the extent to which a performance measurement strategy can be based solely on end-result or functional requirements is limited. For this reason, performance specifications must often incorporate some more prescriptive materials and construction-related properties to act as surrogates. (For example, density and moisture content are commonly used as surrogate properties in acceptance plans and payment schedules for soils even though they do not provide as direct an indication of future performance as would a modulus value.)

In the absence of surrogate measures, a gap may also have the wider effect of eliminating the use of performance specifications to achieve project goals, in which case traditional method specifications may provide the best option.

TABLE 5.2. POTENTIAL GAPS ASSOCIATED WITH PERFORMANCE SPECIFICATIONS

Gap	Considerations
Technology gap	• Can a particular parameter be measured and evaluated using existing technology? • Are standardized tests available? • Do the tests provide repeatable results? • Will both the agency and contractor have confidence in the ability of the measurement strategy to yield reliable results? • Are “referee” tests available if the agency or contractor disputes the results of the initial testing? • Is the approach quantitative? If not, is it possible to minimize the subjectivity of qualitative measures by requiring the parties to reach agreement as to what constitutes acceptable performance before construction (e.g., through the use of trial sections)?
Sampling and testing gap	• Can the data be collected, processed, and analyzed in a timely manner to influence and improve contractor operations? • Can sampling and testing be conducted in a manner that has minimal impact on traffic and lane closure? • Compared with other testing techniques (or the use of method specifications), is the measurement and testing economical? Is a major capital investment required? • Do the measurement techniques require a high skill level from technicians? Are special certifications necessary? • Is specialized equipment necessary? If so, should the contractor provide this equipment or should the agency? • Does sampling provide continuous coverage?
Knowledge gap	• Are the main factors affecting performance for a particular parameter known and understood? • Would a typical contractor know how to control its materials and processes to meet a particular performance standard? • Is there sufficient experience or historical data to properly calibrate design or predictive models?

PROJECT-DELIVERY CONSIDERATIONS

If Part 1 of the decision process demonstrates significant advantages to using a performance specification to achieve project goals, an additional set of decisions should be made to address project delivery. The project delivery approach affects the extent to which the agency can or should transfer responsibility for design, materials, construction, and possibly postconstruction maintenance and operation to the private sector. (This decision will also be driven by the degree of flexibility inherent in the project scope.) In this context, project delivery refers to the overall contracting and procurement process for a project, inclusive of design, construction, and maintenance and operation phases. Figure 5.4 compares the range of delivery systems applicable to performance specifications. Note that for the case of construction manager at risk (CMR), the performance specifications would be similar to those implemented under design-bid-build.

The choice of delivery method affects the level of control and risk that can be shifted to the contractor. To help select a delivery system that is compatible with a given project's characteristics and goals, the project team should consider the issues that follow.

Stage of Development

The first step in selecting a project delivery approach is to identify where the project is in the overall development process. Are the elements of the work in the conceptual design stage or in the detailed or final design stages? The stages are defined differently by various highway agencies, but, in essence, they relate to the extent that the project design has been defined with regard to geometry, alignment, materials selection, right-of-way, environmental clearances, traffic phasing, and other key project elements.

In general, a project with greater design definition (more detailed or final design) offers fewer opportunities for a contractor to innovate or provide alternative design or construction solutions under performance specifications. This situation would drive the decision toward using a traditional design-bid-build (DBB) delivery system with some level of end-result specifications.

Possible Delivery Approaches

If the project is in the preliminary or conceptual design phase but still requires the use of a standard design or a specific component to match existing facilities, or if the project scope is not complex and allows for little flexibility or innovation, then traditional DBB delivery with some end-result requirements is appropriate.

If the project is larger, more complex and multifaceted, has a relatively low level of design definition, and allows multiple solutions to achieve the desired outcomes through alternate designs, materials, or construction methods, then design-build (DB) and its variations may provide a better means of achieving the project goals.

	Design-Bid-Build	Design-Build	Warranties	Design-Build-Operate-Maintain
Contractual Roles	• Design responsibility retained by agency • Quality management by contractor • Verification testing by agency • Acceptance at end of construction by agency • Postconstruction maintenance and asset management by agency	• Design criteria by agency • Final design by contractor • Quality management by contractor • Verification testing by agency • Acceptance at end of construction by agency • Postconstruction maintenance and asset management by agency	• Design by agency (if DBB) • Quality management by contractor • Verification testing by agency • Acceptance at end of construction by agency • Asset management by agency • Warranty by contractor	• Performance criteria by agency • Design by contractor • Quality management by contractor • Verification testing by agency • Postconstruction maintenance and asset management by contractor • Performance monitoring by contractor and agency
Specification Strategy	• Construction acceptance criteria based on surrogate or end-result properties	• Construction acceptance criteria based on surrogate or end-result properties	• Construction acceptance criteria based on surrogate or end-result properties • Postconstruction performance based on functional properties	• Performance criteria based on functional and high-level operational parameters
Procurement Approach	• Procurement likely by low bid (cost only), but may incorporate additional cost factors related to time or bid alternatives in the selection process	• Procurement based on low bid (cost only) or best value, incorporating cost and other factors related to performance in the selection process	• Procurement based on low bid (cost only) or best value, incorporating cost and other factors related to performance in the selection process	• Procurement likely by best value, incorporating cost and other factors related to performance, or a qualifications-based negotiation

Figure 5.4. *Alternative delivery systems.*

Transfer of Responsibility to Industry

The choice of delivery method affects the extent to which control and risk can be shifted to the contractor. Under traditional DBB delivery, the agency retains the majority of the performance risk related to design; the contractor assumes responsibility for the aspects of performance related to materials and construction workmanship.

If moving to design-build (DB) and/or postconstruction warranty or maintenance agreements, the responsibility for design, materials, construction, traffic, and asset management can be shifted in varying degrees to the industry. The questions that follow can be used to determine the feasibility of transferring some of these responsibilities.

Does the agency have the legal authority to use alternative project delivery methods (e.g., DB, with or without warranty, or long-term maintenance agreements)? If the agency faces legal barriers to implementing alternative delivery and procurement methods, then application of performance specifications may be possible only under a DBB approach by specifying performance-related or end-result construction requirements. Also, if legal barriers exist—related to the use of DB, warranty provisions, or best-value procurement—then the agency may need to obtain special legal authority to test the alternative delivery methods under an experimental or pilot program before gaining support for broader legislative authority.

Does the public support alternative delivery? Performance specifications may require a higher initial investment. The agency must consider whether the public and legislators are receptive to the higher initial cost, particularly if benefits will not be realized until far in the future.

Does the agency have internal support for using alternative delivery? As discussed in Chapter 2, performance specifications change the traditional roles and responsibilities of agency and contractor personnel, potentially affecting the way a project is administered and inspected. Agency personnel must be willing to relinquish control in some areas in exchange for the contractor accepting more performance risk. The agency may find it beneficial to provide training and support for its staff to ensure that any changes in traditional roles and responsibilities are adequately and consistently communicated and enforced. For example, if the agency is not going to perform the same level of inspection, personnel have to be aware of the quality management, testing, and record keeping required of the contractor to ensure adequate performance. One approach used successfully by several agencies is to set up a special projects group (or innovative contracting office) dedicated to alternative delivery to develop internal support and staff experience.

Is industry able to assume the performance risks? Quite often the industry's appetite for risk determines whether a performance specification is feasible. Under performance specifications, contractors that traditionally rely on owners to specify materials and construction processes have to take on greater responsibility for keeping up with the state of practice. If the local contracting community has limited resources and expertise or is averse to being held responsible for performance outcomes, then performance specifications may not provide the best option. The agency must carefully gauge the interest and ability of industry to respond to alternative delivery and procurement requests. If industry is not prepared or is unable to assume performance risk, the result of implementing a performance specification may be less competition and potentially higher costs.

For projects involving a warranty or postconstruction maintenance agreement, cooperation from the surety industry is also important. Sureties may be reluctant to participate in a project subject to a performance warranty (e.g., 5 to 10 years for pavements). For sureties, unwillingness to offer a bond often boils down to the uncertainty regarding risks associated with long-term performance specifications. Sureties may either not offer a bond or increase the premiums on the bond to cover perceived risk, which translates to higher bids.

If the answers to these questions are generally positive and support the transfer of responsibility for performance to the private sector, then DB with or without a short-term warranty is an appropriate delivery option for the agency. The last step to consider is whether or not private-sector asset management should be included in the alternative delivery system.

Private-Sector Asset Management

Some agencies may perceive a need to outsource the long-term asset management of a facility. This may be accomplished through a long-term operation and maintenance (O&M) agreement or a public-private partnership agreement. From the agency's perspective, private-sector asset management may fill a gap in the agency's resources, reduce its cost of inspection and maintenance, or allow the project to be constructed sooner than available public funds would allow. Industry may perceive the potential for a higher rate of return through innovation or performance incentives and the opportunity for a long-term return on investment.

Typically, the private sector incurs significantly more risk for performance under such long-term agreements. The payment terms often require industry to finance certain front-end costs of the project (e.g., planning, design, construction) to be recouped through toll revenue or other periodic payments during the O&M phase of the agreement. The payments are dictated in part by the ability of the contractor to meet certain performance targets and operational (usage) goals of the facility.

A number of conditions must exist to allow for long-term private-sector asset management of a transportation asset (roadway, bridge, or transportation corridor). These include the following:

- The agency has the legislative authority to collect tolls or transfer the responsibility and risks for asset management to the private sector.
- The intended performance of the facility over time can be described in terms of functional performance parameters that can be measured and tested during the O&M period and at handback.

- Industry is capable of entering into a long-term O&M agreement and meeting the performance goals for the facility with a reasonable return on investment.

If the project does not meet these conditions or industry is not suited for long-term asset management, the agency should instead consider using DB with a short-term performance warranty.

6

PROJECT DELIVERY AND PROCUREMENT CONSIDERATIONS

Chapter Objectives

This chapter addresses

- How the selection of performance requirements can vary with project delivery method;
- Various alternatives to the traditional fixed-price, sealed-bid procurement process and the potential advantages they offer; and
- The use of quality and other performance-related pay adjustment strategies to motivate contractor behavior.

If an agency's objective in using performance specifications is to enhance quality, promote innovation, and/or shift performance risk to the industry, traditional design-bid-build (DBB) delivery with a fixed-price, sealed-bid procurement process may not always offer the best approach to selecting a contractor and delivering a project. This chapter discusses various alternatives to the traditional process in the context of how they can be used to help advance an agency's performance objectives and the goals of rapid renewal.

PERFORMANCE SPECIFICATIONS AND PROJECT DELIVERY

The delivery approach selected for a project largely drives the extent to which an agency can allocate responsibility for performance to the contractor. As illustrated in Figure 6.1, the contractor's responsibility for a project's performance under DBB does not extend beyond the end of construction or, possibly, a limited (1-year) materials and workmanship warranty. In contrast, a design-build-operate-maintain (DBOM)

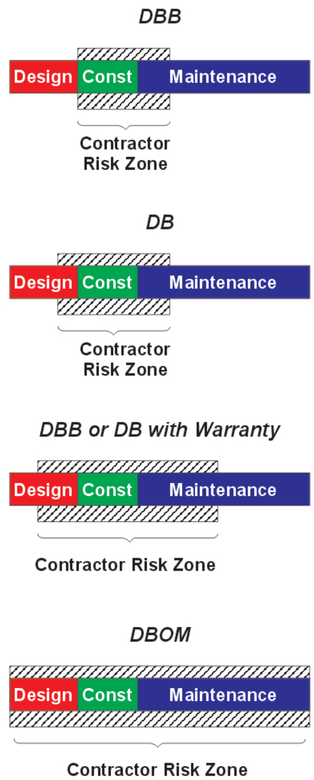

Figure 6.1. *Risk allocation and contract delivery.*

contract inherently exposes the contractor to more performance risk as the contractor assumes responsibility for design, construction, and the repair and rehabilitation measures required over the contract's maintenance period (usually one life cycle or longer). The degree of performance risk allocated to the contractor under design-build (DB) and warranty projects falls between the two extremes.

When deciding to use a performance specification, the agency must consider how a particular delivery approach and its inherent conventions regarding design and postconstruction maintenance affect the selection of performance parameters and the setting of limits or thresholds commensurate with the degree of performance risk to be assumed by the contractor. For example, specifying high-level performance requirements on a DBB project is inappropriate as it would require the contractor to assume risk for items over which it has minimal control or influence. At the other end of the project delivery spectrum, a DBOM project primarily favors the selection of high-level performance parameters that focus on user needs (e.g., safety, comfort, accessibility), as materials and construction requirements represent unnecessary constraints on a contractor required to assume whole-life performance risk.

Other variants of the four delivery approaches discussed in this chapter (e.g., design-build-finance-operate and maintenance contracts) are not specifically addressed in these guidelines or in the companion guide specifications. However, the parameters used to monitor and evaluate the contractor's performance in maintaining the asset over time would be comparable to those in the DBOM case. Another project delivery approach receiving considerable attention as of late is construction manager at risk (CMR). In the case of CMR, although the contractor may be able to provide some early input on design and constructability issues, the performance specifications are not fundamentally different from those implemented under DBB.

Design-Bid-Build

Design-bid-build (DBB) is the traditional project delivery system through which an agency contracts with separate entities for design and construction services. Given this separation of services, a DBB project presents few opportunities for a contractor to provide input on design and constructability issues. Specifying high-level performance parameters under this approach is therefore inappropriate, as that would require the contractor to assume risk for items over which it has minimal to no control. Implementing a performance specification under the DBB approach primarily involves end-result parameters to address specific project goals (e.g., use of a smoothness requirement on a pavement project). The goal of such a performance specification is not to monitor and evaluate a product's performance over time (as may be the case for a performance warranty or a specified operations and maintenance period) but to

- Focus on material properties and construction practices deemed to have the most effect on long-term performance; and
- Incorporate financial incentives/disincentives to promote enhanced quality or durability.

Design-Build

Design-build (DB) is a delivery system in which the agency retains a single entity to design and construct a project. In contrast to DBB delivery, a DB project offers more opportunities for a contractor to provide input on design and constructability issues, especially if innovation is an agency goal. Several of the more prescriptive materials and construction requirements typically included in a DBB specification can therefore be eliminated or relaxed under DB to extend more flexibility to the contractor. However, by relieving the contractor of further responsibility for facility performance at the end of construction (beyond the standard materials and workmanship warranty), the agency is still limited to an acceptance plan based primarily on end-result properties similar to those included under the DBB approach.

In exchange for providing more design freedom and for reducing its typical inspection and testing activities to accommodate an accelerated construction schedule, the agency may tighten up the acceptable tolerances under DB to help ensure that schedule or cost considerations do not compromise quality.

Performance Warranties

Performance warranties are used to guarantee the integrity of a product and the contractor's responsibility to repair or replace defects for a defined postconstruction period (e.g., 5 to 10 years). Warranties may be applied to both DBB and DB projects to similar effect, assuming that the agency provides sufficient latitude to the contractor with respect to the design and construction of the warranted project element(s).

A warranty allows the agency to expand the performance measurement strategy used under DBB or DB to include functional parameters that monitor and evaluate the actual performance or condition of the project over time. The protection against defective work and premature failure offered by the warranty allows the agency to eliminate or relax some of its standard materials and construction requirements if doing so can help save time and/or minimize disruption in the interest of rapid renewal.

Given their limited duration, short-term performance warranties primarily protect the agency against only premature failures. Although a warranty provision of sufficient duration to address long-term performance can be developed, bonding issues may limit the practicality of implementing such a specification.

Design-Build-Operate-Maintain

Under DBOM a single entity designs, constructs, operates, and maintains a project for a specified period (usually the life cycle of the project element or longer). Note that the DBOM approach can be extended to include private-sector financing as well.

The assignment of postconstruction maintenance responsibility and, with that, allocation of whole-life performance risk to the contractor allows the agency to shift its emphasis from the end-result acceptance properties relied on under the DBB and DB methods to postconstruction measurement strategies that evaluate the actual performance or condition of the facility over time. Given the degree of performance risk assumed by the contractor, performance specifications implemented under a DBOM approach should provide contractors maximum flexibility with regard to design, construction means and methods, and the repair and rehabilitation measures that will be required over the contract period. Few, if any, materials and construction requirements should be included in the measurement strategy to avoid undermining the effectiveness of the risk transfer to the contractor.

To motivate the contractor to provide high-quality construction and to perform preventive maintenance in a timely and efficient manner, the contract term should be of sufficient duration to expose the contractor to the consequences of its actions (i.e., allow the contractor to enjoy the profits that may stem from high-quality work and to suffer losses resulting from poor workmanship and planning). Ideally, this concept will lead not only to significant efficiency gains, but also to technological innovation.

PROCUREMENT CONSIDERATIONS

The traditional fixed-price, sealed-bid procurement process may not always offer the best approach to selecting a contractor. Various alternatives to the traditional process are therefore discussed in this section in the context of how they can be used to help advance project goals. As summarized in Figure 6.2, some methods may be more appropriate than others given the level of performance requirements and delivery method selected for a project.

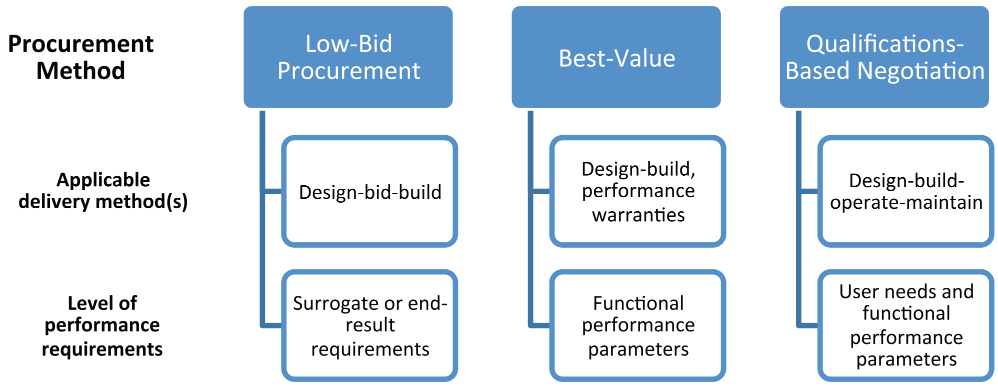

Figure 6.2. *Procurement strategies versus delivery approach and performance requirements.*

To the extent possible, the procurement process should be tailored to align with the performance specifications and delivery method selected for a project. In this sense, the performance specifications, delivery method, and procurement strategy can act as complementary components of an overall performance contracting system designed to achieve a project's goals (see Figure 1.2).

Cost-Based Procurement Options

Traditional Low-Bid Approach

Most highway construction contracts are awarded to the contractor that submits the lowest responsive bid. This low-bid procurement approach has long-standing legal precedence, promotes open competition, and provides the lowest initial price that responsible, competitive bidders can offer. Furthermore, awarding only on the basis of price and responsiveness introduces relatively little subjectivity into the evaluation and selection process.

In general, this lowest-price-responsive-proposal approach is most appropriate for small to medium-size projects with a relatively standardized design and for which no innovation or time savings are sought. To help achieve performance goals, the agency can link its prequalification process to the contractor's ability to meet certain minimum prescribed requirements related to the contractor's quality management systems, personnel, and past performance on similar projects.

However, in the interest of rapid renewal, the agency may also wish to consider factors such as the construction schedule, traffic disruption, and quality enhancements in a competitive framework. By incorporating these factors into the procurement process, the agency can provide bidders with an incentive to optimize their bid prices against rapid renewal goals. For example, if construction duration is critical, cost-plus-time bidding can provide the optimum trade-off between cost and time.

Cost-Plus-Time Bidding

Cost-plus-time (A + B) bidding uses a cost parameter (A) and a time parameter (B) to determine a bid value. The cost component (A) is the traditional bid for the contract items and is the dollar amount for the work to be performed under the contract. The time component (B) is the total number of calendar days required to complete the project, as estimated by the bidder, multiplied by an agency-determined daily road user cost (RUC) to translate time into dollars: $A + B(\text{RUC})$ = total bid.

The total bid value is used only to evaluate bids. The contract amount is based on the bid price (A), not the total bid value. The number of days bid (B) becomes the contract time. Note that the lowest combined bid may not necessarily result in the shortest B time. A + B bidding relies on the contractor to provide the optimal combination of cost and time.

Multiparameter Bidding

To incorporate the value of quality in the bidding and contractor selection process, the agency may extend the A + B bidding concept to include an additional cost parameter (C) related to quality. The total bid value is used only to evaluate the low bidder. The contract amount is based on the bid price (A), not the total bid value ($A + B + C$).

To incorporate a quality parameter into the bidding process, NCHRP Report 451 (Anderson and Russell 2001) suggests using the multiparameter equation in the form of $(A + B)C$, where C is a quality factor used to adjust the contractor's bid based on anticipated or bid quality levels. For example, if the agency collects contractors' historical quality data, this past performance on agency projects could be used with the pay factor equation to determine the quality factor for bid evaluation. Calculating the quality factor as the inverse of the pay factor equation (1/PF) reduces bids from contractors with high quality levels on past projects (i.e., pay factors exceeding 100%) while increasing bids from contractors with poor quality on past projects (i.e., pay factors less than 100%). This approach thus rewards contractors for higher levels of quality delivered on previous projects for the agency. Note that under this approach, the C quality parameter is used only to determine the low bidder. Once the project is under way, the agency assesses the quality level actually achieved on the project for payment purposes. Alternatively, the agency can allow contractors to estimate and bid their own C quality value. The contractor will then be held to achieving the quality level bid or risk receiving reduced payment. This approach can be implemented by applying a factor of C_{actual}/C_{bid} to the results of the pay factor equation. If the contractor exceeds the quality level bid ($C_{actual}/C_{bid} > 1$), payment would be increased. If the contractor could not meet the quality level bid ($C_{actual}/C_{bid} < 1$), payment would be decreased.

Design and Bid Alternatives

The multiparameter bidding concept can also be used to evaluate alternative designs and alternative bids proposed by contractors (e.g., asphalt versus concrete pavements, steel versus concrete bridges). In this case, C represents a life-cycle cost adjustment factor that the agency can use to help ensure that the alternate proposal will not impair the service life and maintainability of the project (similar to how value engineering proposals may be used after contract award). Alternates can be used to allow competition to drive the most cost-effective material choice or design and to shift some design responsibility to the industry, particularly if the agency is not otherwise authorized to use design-build. Potential advantages and disadvantages associated with using alternates, as well as the other cost-based procurement methods discussed in this section, are summarized in Figure 6.3.

Best-Value Procurement

Cost-based methods have the advantage of being the most similar to the highway industry's traditional low-bid approach to procuring construction contractors. However, if the agency wishes to transfer more performance responsibility to the industry (e.g., through design-build delivery or warranty provisions), those approaches may not offer sufficient flexibility with regard to evaluating technical factors, such as innovation and quality enhancements, which do not readily lend themselves to a strict first-cost or life-cycle cost comparison.

Best-value procurement allows agencies to consider key technical factors, in addition to price, in the bid evaluation process to help select a capable, qualified contractor that understands the agency's performance expectations for the project. By aligning the nonprice technical factors included in the solicitation documents to the project goals and performance specifications, the agency can create a more transparent (albeit still somewhat subjective) way to consider performance goals in the contractor selection process.

Evaluation System Planning

Early in the project development process, the agency personnel assigned to the project should begin to outline a plan for evaluating the proposals submitted. The evaluation and selection plan should describe the evaluation factors and their relative importance (weighting), proposal rating guidelines, and other information critical to maintaining the integrity and fairness of the selection process. Adherence to this plan will help the agency defend its selection decision in the event of a bid protest.

A key element of evaluation system planning is identifying the evaluation criteria that will be used to assess the ability of proposers to meet the needs and goals expressed in the project's performance specifications. For example, although not a complete guarantee of quality and/or innovation, the experience of consultants and subcontractors in relevant specialty areas can often serve as an indicator of the proposers' ability to successfully complete the project or a particular portion of the work. Such information can be obtained either through a request for qualifications (RFQ) or a prequalification process. The technical proposals submitted in response to a request for proposal (RFP) can then provide further indication of the proposers' understanding of the work and ability to meet the performance specifications. For example, if the performance specifications will transfer construction quality management responsibility to the contractor, the RFP can require proposers to address their general approach to quality management in their technical proposals. By evaluating and scoring these approaches, the agency can continue to exert some control over the approach used to ensure quality.

Low-Bid

Objective

- Obtain lowest initial price that responsible, competitive bidders can offer

Advantages

- Has well-established legal precedence
- Promotes open competition
- Is an objective evaluation and selection process

Disadvantages

- The agency cannot consider factors other than cost.
- Contractors may be encouraged to submit unrealistically low bids, with the assumption that cost variances can be addressed through change orders issued during construction.

Cost + Time Bidding

Objective

- Provide the optimum trade-off between time and cost

Advantages

- Has high likelihood of reducing contract time
- Minimizes time/cost impacts to traveling public
- Promotes innovative scheduling
- Encourages contractors to maximize efficiency of crews and equipment

Disadvantages

- Contractors may sacrifice quality and safety to meet an unreasonably low time component bid to win the contract.
- Bid prices and other direct project costs may be higher.
- Administrative costs may be higher because of accelerated schedules that increase demands on agency personnel (though such costs may be offset by shorter construction duration)

Multiparameter Bidding

Objective

- Achieve equal or better quality than specified, at optimal time and cost

Advantages

- Encourages improved end-product quality
- Achieves multiple goals by lowering life-cycle costs while saving time
- Encourages innovative construction techniques that can improve quality and timely delivery

Disadvantages

- Open competition may be reduced.
- Translating a level of quality into a dollar value and determining an appropriate weighting to combine with other factors may be difficult.
- Bid prices and other direct project costs may be higher.

Design-Bid Alternates

Objective

- Provide equal or improved performance at lower initial or life-cycle cost

Advantages

- Allows competition between products with different maintenance and service life expectations
- Has potential for lower initial costs or life-cycle costs
- Promotes innovation

Disadvantages

- Review of alternate design submissions may be time-consuming.
- Evaluating costs of alternatives may be difficult.
- Life-cycle costing to determine low bid may be difficult.
- Bid protests are more likely.

Figure 6.3. *Comparison of cost-based procurement options.*

The agency should begin to think about evaluation factors soon after identifying the project goals and preparing the performance specifications. Project goals typically fall into the categories of time, budget, and quality, and evaluation factors generally follow suit, falling into the categories of schedule, price, and technical criteria. Evaluation factors may be set up on a pass–fail basis, in which the proposers have to meet certain minimum prescribed requirements to be responsive, or on a more qualitative, best-value basis, in which evaluators rate the proposals according to the evaluation criteria included in the RFP. Either way, to be effective, each criterion should be defined in terms of some measurable standard against which responsiveness can be measured.

Evaluation factors should be designed to solicit information that can support meaningful comparison and discrimination among competing proposals. When identifying these factors, the agency should consider the time and effort that proposers will have to invest in preparing responsive proposals and that agency personnel will invest in evaluating the information.

Implementing a Best-Value Selection Process

Several options are available for evaluating and selecting a contractor (e.g., adjusted bid, weighted criteria, trade-off analysis). Although all are viable approaches, the adjusted bid method is the most common approach for first-time users. (Caution: Some states may specifically prohibit the use of a best-value process or restrict the selection process to a specific method.)

Regardless of the exact selection mechanism used, the RFP must clearly establish and communicate a transparent process by which the agency will evaluate proposals and select the successful contractor. A general process for implementing best-value procurement is described in this section. For additional information, refer to NCHRP Report 561, *Best-Value Procurement Methods for Highway Construction Projects* (Scott et al. 2006).

Negotiated Procurements for DBOM

Given the long-term nature of most DBOM contracts, the best-value procurement process is often supplemented with (if not supplanted by) complex financial negotiations, particularly if the private-sector partner is financing all or part of the initial construction. Typically, the agency identifies a fixed O&M term (e.g., 30 years), for which contractors propose an annual payment schedule or cash flow curve. If construction-phase services were also financed by the contractor but will not be compensated through toll revenue, the payment schedule may also include repayment of the initial construction and financing costs.

Note that in preparing its proposed payment schedule, the contractor will want to ensure that the project will provide a reasonable return on its invested capital, net of design and construction, operation and maintenance, various reserve or coverage funds, and other expenditures. A positive net present value (NPV) of the net proceeds from the project represents a viable opportunity for the contractor, as does a project for which the internal rate of return (IRR) on invested capital exceeds that which can be obtained by investing funds elsewhere.

A Closer Look: Implementing Best Value

The following discussion identifies the general steps involved in implementing a best-value procurement process. For further details, refer to NCHRP Report 561, *Best-Value Procurement Methods for Highway Construction Projects* (Scott et al. 2006).

1. Develop qualifications, technical, schedule, and cost evaluation criteria. The nonprice factors and their maximum point values or weightings should align closely with the goals and the actual value that the criterion brings to the project.
2. Devise a scoring system to evaluate the proposal's responsiveness to the evaluation criteria established in the RFP. If using an adjusted bid approach, divide price by the total score to determine the adjusted bid. If using a weighted criteria method, score and sum the technical factors and price to determine the total score.
3. If using a two-phase selection process, prepare and issue an RFQ. (Otherwise, proceed to Step 7.) An RFQ constitutes the first phase of a two-phase procurement approach. The purpose of the RFQ is to narrow down the number of interested proposers to a short list of three to five qualified and capable firms that may then respond to the RFP. The short list is based on an evaluation of the statements of qualifications (SOQs) that prospective contractors submit in response to the RFQ.

   The RFQ is not intended to solicit specific ideas on how each firm will meet the performance specifications. Rather, an RFQ process should be used to identify firms capable of effectively delivering the project, reserving the evaluation of specific design and construction approaches for the RFP stage.

   The RFQ solicitation should include the following items as a minimum:

   - Project description;
   - Statement of project goals and objectives;
   - Procurement schedule;
   - SOQ submittal requirements;
   - Explanation of the SOQ evaluation process, including evaluation factors and their relative importance, and the short-listing process;
   - General discussion of the RFP, to the extent this information is known at the time of RFQ issuance;
   - Other pertinent provisions (e.g., protest procedures, state and department rights and disclaimers, and equal opportunity requirements); and
   - Forms required for the SOQ.
4. Receive SOQs.

5. Evaluate SOQs as described in the evaluation plan and determine which are fully responsive in meeting the qualifications criteria. Criteria may be evaluated on a pass–fail basis or using a point score to determine responsiveness. While project-specific needs and goals will drive the exact technical factors included in an RFQ, typical evaluation factors address the following:
   - Proposer's understanding of the project and issues;
   - Key personnel experience and qualifications; and
   - Proposer's resources and ability to handle a project of similar size and complexity.
6. Announce the short list of fully responsive SOQs.
7. Publish the RFP for the short-listed competitors. If required qualifications were previously established through an RFQ stage, the RFP should focus on the approach proposers will take to complete the project. To the extent possible, the RFP should not reevaluate factors that were already evaluated at the RFQ/SOQ stage, unless such information has undergone significant changes in the interim. In the case of a single-phase procurement, the RFP should address both qualifications and the technical approach to the project.

   The RFP solicitation should include the following items as a minimum:
   - Scope of work, plans, and specifications;
   - Procurement schedule and process;
   - Project goals and objectives;
   - Required qualifications (if an RFQ step was not used);
   - Proposal submittal requirements (for both the price and technical proposals);
   - Explanation of the proposal evaluation process, including evaluation factors and their relative importance, the evaluation method, and the selection process;
   - Method to carry forward the SOQ qualifications ranking/scores into the final evaluation;
   - Other pertinent provisions (e.g., protest procedures, state and department rights and disclaimers, and equal opportunity requirements); and
   - Proposal forms.
8. Evaluate the submitted proposals against the RFP requirements and determine which are fully responsive. The agency may require that the proposers submit separate technical and price proposals. Open the technical proposal first and evaluate it for responsiveness, then score the responsive proposals in each technical area. Then open the price proposals to determine their responsiveness to the pricing requirements.
9. Eliminate any nonresponsive proposals.

continued

A Closer Look: Implementing Best Value (*continued*)

10. Roll up evaluation results and determine the total point score for each responsive proposal. At this stage, the department may issue a request for clarification to individual proposers, schedule oral presentations, or hold discussions with proposers to clarify or verify certain aspects of the proposal. The results of this communication will be factored into the evaluation.

11. Compute the final scores and select the proposer offering the best value to the agency.

    For adjusted bid, the following formula may be used:

    $AB = P/T$

    where

    AB = adjusted bid,

    P = project price, and

    T = technical score.

    Award to AB_{min}

    For weighted criteria, the following formula may be used:

    $TS = W_1 S_1 + W_2 S_2 + \ldots + W_i S_i + W_{(i+1)} PS$

    where

    TS = total score,

    W_i = weight of factor i,

    S_i = score of factor i, and

    PS = price score.

    Award contract to the proposer that earned the highest total score. The price scores are typically normalized against the lowest price.

The adjusted score calculation is simple and easier to implement. The weighted criteria can be more complex to implement but allows greater flexibility in determining the relative importance of price versus various other evaluation criteria. For example, if innovation is a project goal, higher weights could be assigned to technical criteria than to price. Alternatively, if the agency is faced with a tight budget, price can be given the higher weight, encouraging technical approaches that will reduce costs.

The capital expenditures identified in the cash flow curve should align with expectations regarding the long-term performance of the proposer's technical approach as it relates to both the design and initial construction, as well as the maintenance and rehabilitation scheduled for the operations period. The likely differences in the technical approaches offered by different proposers will preclude a direct comparison of the corresponding payment curves. For example, one proposer may plan for a large initial capital investment with minimal future outlays, while another may propose a lesser design for the initial construction to be followed by a larger investment in the future.

To evaluate and compare the payment schedules offered by different proposers, one approach is to calculate the proposed cash flow on an NPV basis to determine which proposal offers the best value to the agency. Note, however, that NPV calculations depend on assumed future inflation rates on costs and interest rates on debt. Given the time value of money, results beyond 20 years should be viewed with caution when assessing the risk associated with such projects.

INCENTIVE STRATEGIES

To be most effective, a performance specification should motivate industry to strive for excellence in performance (which for a rapid renewal project likely entails optimizing construction efficiency and providing quality workmanship, with minimal traffic disruption). Achieving this objective often requires developing and structuring a payment mechanism that encourages and rewards superior performance for key performance parameters while assessing penalties for noncompliance.

In developing a payment mechanism, the agency must strike a balance between value for money and effective motivation of the contractor to prevent or correct substandard performance. To achieve this balance, the cost of incentives must be weighed against the benefits of enhanced performance and the risks of a possible failure to the agency.

Considerations Regarding Pay Adjustment Strategies

- How much is the agency willing to pay to achieve a level of performance beyond the minimum prescribed?
- Which performance parameters, if any, should be tied to incentives/disincentives?
- Does the incentive strategy align with the payment conventions associated with the chosen project delivery method?
- Have the pay adjustments been designed in a manner that will discourage distortions or behaviors that run contrary to the agency's ultimate objectives?
- Are there alternatives to monetary incentives (e.g., extension of an O&M term)?

Quality-Related Pay Adjustment Factors

If measurements indicate that the facility does not comply with the performance requirements, the specification should describe the reconstructive work or remedial action that the contractor must perform to meet the performance requirements. If, however, the nonconformance falls within an allowable tolerance, the specification may provide the contractor the option of forgoing the repairs in return for accepting reduced payment. The required remedial action—or, alternatively, the pay adjustment—should reflect the severity of the nonconformance.

Application of quality- or performance-related pay adjustment systems is generally more evolved and prevalent for pavements than for other highway discipline areas, such as bridges and earthwork. Nevertheless, even for pavements, no universally accepted method for calculating quality-related pay factors has been established. As discussed further in *Framework for Developing Performance Specifications*, Chapter 2, one approach proposed for use in highway construction entails development of performance-related specifications (PRS) in which mathematical models are used to perform a life-cycle cost (LCC) analysis of the as-constructed facility. More common, however, are statistically based sampling and testing plans that consider the measured variability of the product to determine pay factors.

Time and Other Performance-Related Incentives

Aside from such quality adjustments, incentives can also be used to help achieve other rapid renewal goals, such as accelerated completion and reduced disruption, as well as goals established for environmental compliance, public relations, and public and worker safety. In developing incentive amounts, the agency should keep in mind that the rate should be attractive enough to entice the contractor to achieve the desired result. The determination of this amount is rarely an exact calculation, and judgment is often necessary. This is particularly true for areas with less tangible—or less quantifiable—benefits, such as improved public relations and environmental compliance. Incentive payments for other areas, such as early completion and safety, have more established (albeit still somewhat subjective) calculation techniques. For example, road user costs typically factor heavily in the determination of an incentive program for early completion. Similarly, user costs can also be used to generate incentives related to maintenance and protection of traffic, particularly if road or lane closures are contemplated. Safety incentive fees generally relate to reduced accident costs, with appropriate indices and indicators of impacts available from the insurance industry.

Pay Adjustments and Contract Delivery

The payment conventions and risk allocation inherent in various project delivery approaches also have a large bearing on the structure of incentive strategies used to influence contractor behavior. For example, the unit-price basis of DBB contracts makes them particularly well suited to pay factor adjustments that address end-of-construction quality. Conversely, the postconstruction responsibilities included in a DBOM contract should largely eliminate the need to apply such adjustments at the end of the initial construction phase. However, such contracts may include complex penalty and reward systems to address the postconstruction operation and maintenance of the facility.

DBB and DB

DBB projects are generally bid and measured on a unit-price basis. That makes the application of pay factors, developed using either predictive models or statistically based acceptance procedures, relatively straightforward. In contrast, DB contracts are typically awarded on a lump-sum basis, making them less amenable to pay factor adjustments tied to quantities and unit prices. Therefore, to apply a similar pay adjustment process to a DB contract, the agency may wish to require in the RFP that proposers submit a breakdown of quantities and unit prices for each work item subject to pay adjustment. During the construction phase, the agency can then monitor and measure the associated material quantities, just as they do on a DBB project.

Warranties

Warranty projects generally do not need to include quality-based pay adjustments or incentives for certain construction acceptance criteria, such as initial pavement smoothness, if the agency will be monitoring those criteria during the warranty period. However, the agency may decide to apply pay factors to end-of-construction acceptance properties that will not otherwise be addressed as part of the warranty evaluations.

DBOM

The payment terms in DBOM agreements tend to be more complex than other contract types, particularly if the contractor finances certain front-end costs of the project (e.g., planning, design, construction) that are to be recouped through toll revenue or periodic payments from the agency during the O&M phase of the agreement. However, even without a private financing component, the payment mechanism used under DBOM is critical to the successful transfer of whole-life performance risk to the contractor.

In any case, to ensure the contractor's motivations remain aligned with the project goals, the performance requirements and associated payment mechanisms should be structured in a manner that provides clear economic incentive to the contractor to perform to the required standards and prevent and correct service failures. This can be accomplished through a system of monetary deductions for noncompliance (or bonuses for superior performance) and assessment of lane rental fees (or the like) for taking lanes out of service. For example, during the O&M phase of a DBOM project, the contractor typically receives a periodic payment (sometimes referred to as an availability payment) related to its maintenance obligations. To be entitled to the full payment, the contractor must ensure that the facility complies with the specified performance requirements. The payment remains the same as long as the required performance levels are met. Thus, the contractor may have to carry out a large amount of physical work to meet the required performance levels some months and very little work other months. If the agency's goal is to receive high initial construction quality, the pay adjustment system can be used to make it cost-prohibitive for the contractor to provide poor initial quality at the risk of incurring penalties and lane rental fees to correct service failures during operation.

Perhaps the simplest way to account for performance deficiencies is to apply a straight monetary deduction to the contractor's periodic payment. Alternatively, agencies can use a two-step process in which the contractor incurs a specified number of penalty points for each failure, and the accrued points are translated into a monetary deduction. In that case, deductions may not start until a threshold number of points is exceeded. Under either approach, if performance deteriorates below a certain level, other nonfinancial means can be implemented to compel the contractor to improve performance. They range from increased oversight to termination for breach of contract.

To establish an appropriate magnitude for the payment adjustments (and/or penalty points), agencies should consider the following factors:

- Importance of a particular parameter to the agency;
- Extent to which the safety of the public is compromised; and
- Incidence and persistence of a particular noncompliance item.

In addition, adjustments may be made for the contractor's failure to respond to performance deficiencies in the prescribed time frame. Positive adjustments can also be made to account for greater than expected usage of the facility by heavy vehicles, given their disproportionate effect on service life.

Similar to warranties, the contractor's postconstruction responsibilities should eliminate the need for quality-based pay adjustments at the end of the initial construction phase. However, if timely construction completion is an issue, the agency may choose to apply incentives or disincentives to the completion of the initial construction phase of the contract. Alternatively, the structure of the payment terms for the maintenance phase of the contract may also be used to inherently reward or penalize the contractor for early or late completion. By not beginning the scheduled periodic payments until after issuance of a construction completion certificate, and not adjusting the overall contract period (i.e., construction plus maintenance phase) as a result of the early or late completion of the initial construction phase, the contract in effect imposes a penalty for late completion and a corresponding bonus for early completion.

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