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Use of Performance Requirements for Design and Construction in Public-Private Partnership Concessions

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16. Abstract

P3s concessions are an integrated service delivery approach where a public transportation agency enters a contractual agreement with a private sector entity to deliver a service and/or facility for a specific period. Under the P3 approach, the private sector entity is singly responsible for the design, construction, finance, operations, maintenance, operation and renewal (if needed) of facilities for a specified concession period. P3s provide a plethora of opportunities to innovate and generate value through integrated delivery, effective transfer of construction and operations risks that the private sector can best manage and a whole life perspective in the initial construction investment. Public agencies can maximize the opportunities for innovation when they allow the private sector reasonable flexibility to create efficient solutions while at the same time managing the associated risks. The public agency can provide this flexibility to stimulate innovations by specifying outcomes that align with the objectives of the stakeholders rather than mandating means and methods in their request for bid proposals. This paper discusses how the agency can stimulate innovations to generate value with the use of performance requirements for design and construction of P3 projects.

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Preface

On July 17, 2014, the Build America Investment Initiative was implemented as a government-wide effort to increase infrastructure investment and economic growth. As part of that effort, the U.S. Department of Transportation (USDOT) established the Build America Transportation Investment Center (BATIC). The BATIC helped public and private project sponsors better understand and utilize public-private partnerships (P3s) and provided assistance to sponsors seeking to navigate the regulatory and credit processes and programs within the Department. In December 2015, the Fixing America's Surface Transportation Act (FAST Act) was enacted, which directed USDOT to establish a National Surface Transportation Infrastructure Finance Bureau, which was renamed the Build America Bureau (the Bureau).

Building upon the work of the BATIC, the Bureau was established in July 2016 as USDOT's go-to organization to help project sponsors who are seeking to use Federal financing tools to develop, finance and deliver transportation infrastructure projects. The Bureau serves as the single point of contact to help navigate the often complex process of project development, identify and secure financing, and obtain technical assistance for project sponsors, including assistance in P3s. The Bureau replaces the BATIC and is now home to DOT's credit programs, including Transportation Infrastructure Finance and Innovation Act (TIFIA), the Railroad Rehabilitation and Improvement Financing (RRIF) and Private Activity Bonds (PAB). The Bureau also houses the newly-established FASTLANE grant program and offers technical expertise in areas such as P3s, transit oriented development and environmental review and permitting. The Bureau is also tasked with streamlining the credit and grant funding processes and providing enhanced technical assistance and encouraging innovative best practices in project planning, financing, P3s, project delivery, and monitoring.

Working through the Bureau, USDOT has made significant progress in its work to assist project sponsors in evaluating the feasibility of P3s, and helping simplify their implementation. In response to requirements under the Moving Ahead for Progress in the 21st Century Act (MAP-21) and the FAST Act to develop best practices and tools for P3s, the Bureau, jointly with FHWA, is publishing this report on U.S. highway P3 concessions.

Executive Summary

Public-Private Partnership (P3) concessions involving equity financing provide an integrated service delivery approach where a public transportation agency enters into a contractual agreement with a private sector entity to deliver a service and/or facility for a specific period. Under the P3 approach, the private sector entity is singly responsible for the design, construction, operations, maintenance and renewal (if needed) of the facility, with or without the responsibility to provide financing, over a stipulated concession period (typically 75 years or less).

P3s provide a plethora of opportunities to innovate and generate value through integrated delivery, effective transfer of construction and operations risks that the private sector can best manage and a whole life perspective in the initial construction investment. Public agencies can maximize the opportunities for innovation when they allow the private sector reasonable flexibility to create efficient solutions while at the same time managing the associated risks. The public agency can provide this flexibility to stimulate innovations by specifying outcomes that align with the objectives of the stakeholders rather than mandating means and methods in their request for bid proposals. This discussion paper discusses how the agency can stimulate innovations to generate value with the use of performance requirements for design and construction of P3 projects. This discussion paper also presents examples on the legal interpretations of performance requirements.

As illustrated in the example below, performance requirements provide an alternative way to communicate technical requirements of a P3 project.

Example Comparison of Performance and Directive Requirements

Directive/Prescriptive	Performance
Example 1: Bridge Project	
• New steel spliced girder bridge • 12 inch reinforced concrete deck • Three span configuration of 102.3 feet., 130 feet, and 105.7 feet • 50'-0" curb-to-curb width • Minimum clearances and dimensions as shown on the plans	• New bridge to be provided shall be concrete or steel with an acceptable minimum design life of 50 years • Configuration to be three span with no more than two piers
Example 2: Interchange Project	
Provide new four level fully directional interchange • All ramp connections shall be provided as shown in the plans • Ramp widths, transitions and geometry shall be as shown in the criteria plans • Traffic movements, transitions and pavement widths shall conform to the criteria plan • All minimum vertical clearances shall be as shown on the criteria plans	• Provide a new fully-directional interchange with all ramps and traffic movements as shown on the criteria plans • Alternative interchange configurations that meet or exceed the LOS and traffic capacities in the criteria plans will be considered as long as ROW, utility, and environmental impacts are similar or reduced • P3 Developer is responsible for providing documentation that the above conditions are satisfied

Source: Adapted from Texas Department of Transportation

In contrast to the traditional approach which prescribes "means and methods," performance requirements place an emphasis on the measurable outcomes defined in the contractual requirements that align with user, operational, structural, functional, budgetary, and delivery objectives of the project, while leaving the details on how to achieve them to the private sector. Well-written performance requirements clearly lay out the project scope, constraints and agency expectations early in the procurement process. This creates a win-win situation for both public agencies and P3 proposers; the proposers have a higher degree of flexibility to devise a broad range of viable alternatives to meet those end goals and the agency avoids inadvertently owning risks or liability that originate from any prescriptive design requirements.

Performance requirements are developed in the project-scoping phase once the purpose and need of the project are established. Performance requirements and related criteria are derived based on the agency's expectations on how efficiently the facility should be delivered (i.e., project management objectives) and how well the facility should perform (i.e., product success objectives). For P3 projects in particular, the project scoping process should extend to include the post-construction operational performance of the roadway facility and the asset lifecycle needs. Performance requirements should be written such that they can be evaluated from risk allocation, whole life costing and enforcement perspectives.

Alternative technical concepts (ATC) can serve as an excellent tool in the procurement process, particularly when there are challenges in specifying performance requirements. The ATC process allows proposers to come up with alternative solutions equal to or better than the agency's technical and operational requirements or constraints. Through this process, the agency not only re-evaluates its mandatory requirements and constraints, but also establishes the opportunity to attract new ideas and maximize value at the proposer's risk.

Post-construction, the agency has the responsibility to review the monitoring and reporting of performance carried out by the private partner and enforce the agency's contractual remedies if performance does not meet the requirements. As observed in many P3 projects, a third-party certifier may be involved to provide an independent assessment of the facility's performance. When performance requirements are used, the agency will have to adopt an audit approach to oversight and avoid taking back any risks unintentionally through additional directives that would override contractually agreed requirements. For construction quality, there is a need for a common approach to measure quality characteristics and implement a quality acceptance plan that relates construction/ operational outcomes with proposed performance criteria. The agency and the P3 private partner should identify clearly in the P3 agreement, or in the quality management plan (QMP), the construction specifications, quality characteristics, acceptance criteria for contractor quality control (QC) and agency acceptance, sampling frequencies and testing protocols, and statistical criteria for verification.

Incorporating the use of performance requirements into P3 projects is not without implementation challenges. The agency will need to adopt organizational change management strategies including institutional capacity building to facilitate drafting effective performance requirements, promoting an audit-based performance-oriented approach among agency staff that is vastly different from the traditional prescriptive mindset, and engaging stakeholders for buy-in. Agencies may need to adopt deployment strategies such as seeking technical assistance, hiring of procurement experts and/or specialist advisors, and seeking input from "champion" agencies.

Table of Contents

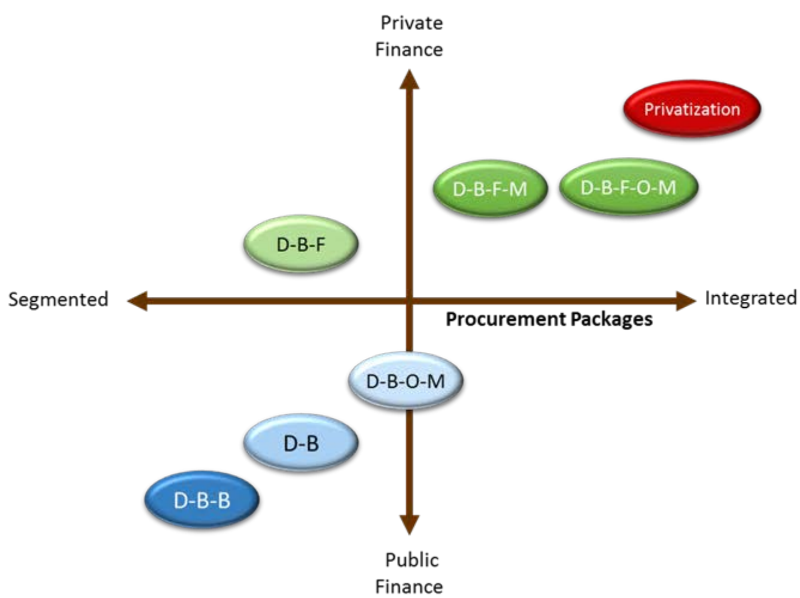
Tables

Figures

1 Overview of the Public Private Partnership (P3) Service Delivery Process

There are many approaches to the delivery of roadway projects. Though discussed extensively elsewhere (FHWA, 2010), the fundamental difference among these approaches is the type of services provided by the private sector through a single contract. Under the traditional design-bid-build (D-B-B) model, an agency procures only construction services (or design and construction services separately) from the private sector, whereas in a public private partnership (P3), the agency procures additional services, including combinations of design, financing, maintenance and operations, under a single contract from the P3 private partner. Figure 1 illustrates these differences among various delivery approaches. In essence, the P3 concept extends beyond the procurement of assets to delivering services mutually agreed upon by the parties involved. In other words, the P3 is a delivery of services and assets rather than a simple procurement like D-B-B.

Figure 1. Range of Potential Project/Service Delivery Methods and Private-Sector Responsibilities



	Design	Construction	Finance	Maintenance	Operations
D-B-B		✓			
D-B	✓	✓			
D-B-O-M	✓	✓		✓	✓
D-B-F	✓	✓	✓		
D-B-F-M	✓	✓	✓	✓	
D-B-F-O-M	✓	✓	✓	✓	✓

Source: WSP | Parsons Brinckerhoff

Having a single point of responsibility for an integrated delivery of design, construction, maintenance and financing of a highway facility generates opportunities for effective risk management and efficiency gains in terms of cost, schedule and lifecycle performance. A potential outcome from this arrangement is a reduction of total cost of ownership. However, these benefits are not guaranteed, especially when the private sector does not have adequate opportunities to innovate and integrate operational and maintenance responsibilities with design and construction, or are constrained by the public agency's mandatory requirements on means and methods. Therefore, critical to the success of the P3 project delivery is the use of performance requirements.

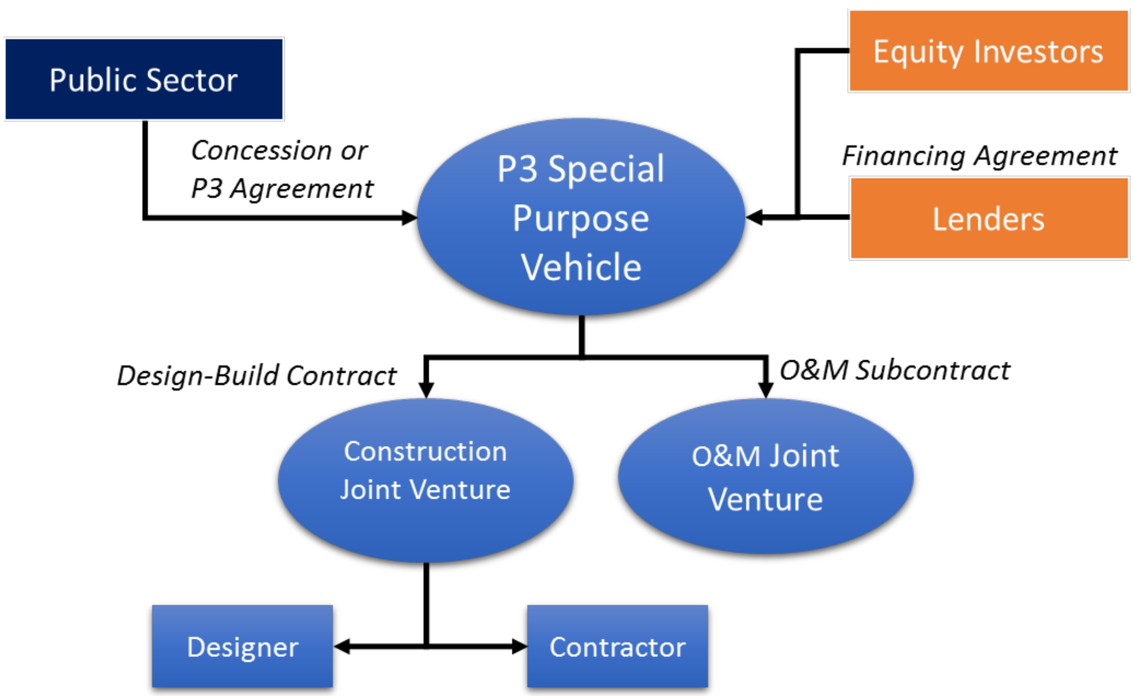
1.1 Structure of Public Private Partnerships (P3)

Specific to performance requirements, the P3 approaches that are of most interest are Design-Build-Finance-Maintain (D-B-F-M) and Design-Build-Finance-Operate-Maintain (D-B-F-O-M). Under these two approaches, the private sector has the responsibility to maintain constructed assets at a desired performance level during the operational period, which typically is for a period of 30 to 50 years or even longer. (The same is true of outright privatization; however, since there is no ongoing relationship or contract between the private and public sectors that is not considered a P3.)

In the case of Design-Build (D-B) and Design-Build-Finance (D-B-F), performance criteria are still of interest. However, since the private sector does not have responsibilities for future maintenance and operations of the constructed facility, the performance requirements can only be part of acceptance or completion testing in D-B and D-B-F, which limits their usefulness. Design-Build-Operate-Maintain (D-B-O-M) has similar challenges as, even with large retentions, the construction contractor has limited incentives to maintain operational performance, as there is no private finance to provide material "skin in the game." As a result, this discussion on performance requirements will focus on the use of D-B-F-M and D-B-F-O-M models of P3.

Figure 2 illustrates the arrangement of D-B-F-M and D-B-F-O-M through a typical P3 contractual structure. The contractual agreement is between the agency and the P3 private partner's P3 Special Purpose Vehicle (SPV), while the D-B and O&M contractors are most typically subcontractors to the SPV. The P3 private partner is responsible for integrating all those parts, i.e. design, construction, financing, operations, maintenance and renewal, to deliver the service to the users during the concession period.

Figure 2. Typical P3/D-B-F-O-M Contract Structure



Source: WSP | Parsons Brinckerhoff

The P3 is more than the sum of its parts, as the P3 private partner optimizes all of the elements, from design through maintenance and operations, to deliver the service for the lowest cost over the life of the project in order to have a winning proposal. Furthermore, the P3 private partner has a strong focus on repaying the financing used to pay for the initial construction and earning a return on its equity contribution through its payment mechanisms, i.e., direct or shadow toll revenues, or availability payments (AP) from the agency. Regardless of the payment mechanism type, the P3 private partner's net income is linked intrinsically to performance of service delivery. In essence, the P3 private partner assumes the risks to ensure that the constructed asset will operate at a level of performance in the future and will last at least a given minimum period before needing maintenance or renewal. In contrast, under a D-B-B delivery, the contractor has no incentive to ensure that the construction does anything other than match the agency-provided design and the quality meets applicable standards upon completion.

1.2 Typical Reasons for Selecting P3 Project Delivery

The ability to bring in upfront private financing is a key reason for selecting P3 as the preferred alternative method. In addition, from the project delivery perspective, the typical reasons for selecting P3s include the factors discussed in this subsection.

1.2.1 Cost Minimization

P3 delivery can be a lower cost option than a D-B-B delivery from both short-term and long-term perspectives. In the short-term, P3s can result in limited or no payments until the facility is operational; because of its integrated service delivery arrangement, there is much lower potential for change in requirements and expensive change orders than in D-B-B, while most design and construction cost overrun risks are transferred to the private sector. In the longer horizon, the private sector has the incentive to undertake timely maintenance of the facility to mitigate cost risks, which can result in lower costs of facility ownership. In contrast, there is a greater potential for deferred maintenance on facilities that rely on a constrained source of public funding which may often lead to interventions that are more expensive.

1.2.2 Single Point of Responsibility

For many resource-constrained agencies, having a single point of responsibility is attractive to alleviate the concerns caused by any gaps between contracts and the need to coordinate various subcontractors. The P3 private partner can harness the strengths and streamline the responsibilities of each subcontractor. The single-point interface or integration of responsibilities is particularly attractive for managing complex systems, such as ITS and tolling.

1.2.3 Optimization of Design for Operation & Maintenance

Including operational requirements in the design process brings in lifecycle perspectives and has the potential to reduce the total cost of ownership during and beyond the P3 concession period. Taking cognizance of future maintenance and rehabilitation needs, the choices made during design and construction have the potential to optimize between initial expenditure and future investments. Finally, the handback requirements in a P3 give a secured residual value or life of the project assets.

1.2.4 Predictability of Costs

Under both AP and toll risk P3 arrangements, the agency has an early and much higher level of certainty of future investment needs. In an AP P3 structure, the payments are fixed in the P3 agreement based on the commitments made in the proposal process and are not modified during the concession period (though a portion may be indexed at CPI). Contrastingly, the agency lacks this level of cost certainty in D-B-B arrangements due to uncertainties related to future asset performance.

1.3 Critical Success Factors

The advantages of selecting P3 as the preferred project delivery method discussed in the section above can be ensured only when the transfer of risk from the agency to the P3 private partner is effective and the efficiency gains are realized.

1.3.1 Transfer of Risk

The risk profiles and responsibilities in P3 contracts are significantly different from those of traditional D-B-B projects. Under a D-B-B, the public agency retains significant risks in design, construction and future asset and operational performance of the facility with an exception in regard to contractor's materials and workmanship. Examples of the agency's risks under D-B-B include differing site conditions, errors and omissions in design, performance of the finished product, interfacing with different job packages, latent defects and acceptance of non-performing construction. Under P3, on the other hand, the agency is ultimately only responsible for any variance from base line information provided to a P3 private partner at the time of proposal; any such variance provides the contractor with the basis to claim additional time and/or compensation.

In addition to these risks, large-scale infrastructure projects are subject to additional complex interface risks and scope changes that occur throughout the development and implementation phase of a project. The retention of these risks by the public sponsor under D-B-B often leads to cost overruns with project cost at completion of construction (including all the risk payments and change orders) on average ending up higher than the engineer's estimate developed at the time of project initiation and often exceeding the amounts set aside for contingencies.

When done correctly, some of these risks can be transferred to the P3 private partner to create potential efficiency gains related to cost, schedule, asset lifecycle and operational performance. Critical to such gains is the optimal allocation of risks and responsibilities in the P3 contract to the parties best able to manage them. With optimal risk structuring, the financial implications of risks are managed better through effective risk mitigation. For instance, many risks relating to facility construction, asset management and operational performance can be transferred to the P3 private partner, while many third-party interface risks (with the exception sometimes of utility relocation and site clearing), differing site conditions and force majeure may be retained by the public agency.

Typically, D-B contracts within a P3 are structured with a guaranteed maximum price (GMP) and offer very limited opportunities for claiming additional time or compensation. Such claims are generally restricted to unusual events that are outside of the P3 private partner's control (e.g., limited access to site, archeological discoveries, unknown hazardous material, or political unrest). In addition, within a P3, the D-B subcontractor accepts direct financial liabilities in case of cost overrun or schedule delay, including liquidated damages and recourse to D-B subcontractor's assets for failure to perform. Such contractual clauses are strictly enforced by the debt and equity providers within a P3 concession framework (in addition to performance bonds) providing several layers of protection for the public sponsor's budget and schedule.

1.3.2 Efficiency Gains

While the P3 private partner is expected to carry additional risks, a D-B-F-O-M contract also provides the opportunity to create cost and schedule efficiencies (i.e., cost savings) by integrating design and construction activities with asset lifecycle and operational performance considerations under a single contract. The primary sources for such efficiencies include:

- **Construction means and methods**: The design is developed in collaboration with the contractor and tailored to its specific equipment and areas of expertise such as excavation and tunneling techniques, approach to construction staging, types of piles and methods for pile driving, etc.
- **Design optimization**: A D-B contract (particularly when part of a P3) is based on performance requirements rather than design specifications, leaving great latitude to the P3 private partner's designer, in collaboration with their contractor (and their operator), to choose among bridge and tunnel types, pavement types, other material choices, road profile optimizing cut and fill, etc. Such design choices aim at lowering not only the upfront capital costs but also the maintenance costs over the lifecycle of the project and are tailored to fit the operating procedures of the operator under a P3.
- **Schedule acceleration**: Under P3 (as with D-B), design and construction activities take place in parallel eliminating the need to wait for a complete design before starting construction. By working collaboratively, the designer and contractor can also respond faster to ambiguity in design or errors and omissions as well as unexpected events occurring on site without having to go back to the agency for approval.
- **Larger contract size**: For planning and delivery purposes or due to limitations of DOT delivery capacity, larger projects are sometime delivered under smaller separate D-B-B or D-B contracts. In such a case, additional efficiencies can be created by reducing the interface among different contractors, providing continuity and increased coordination among construction activities, and reducing mobilization and demobilization costs.

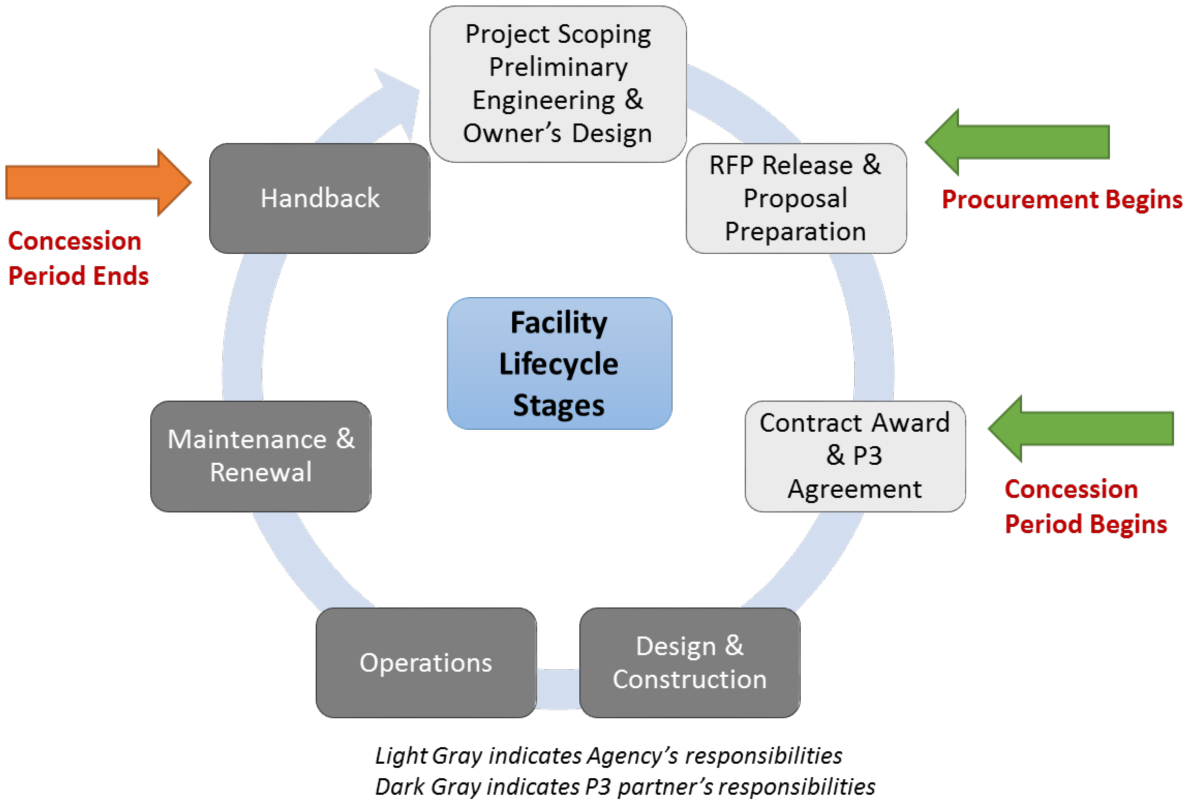
Because the P3 private partner is bidding a single price for the project –to either receive the lowest subsidy through an AP or pay the highest upfront concession fee (or receive the lowest subsidy) for a toll concession – it focuses design on minimizing the cost of the project over its whole life to be as competitive as possible. Choices of pavement and structural design all have impacts on routine maintenance costs and renewal frequencies.

Thus, reductions in lifecycle cost are a direct result of the optimization of design for specific construction means and methods (lowering upfront capital cost), long-term maintenance requirements, and operating requirements. Additional operating efficiencies can be gained, for large-enough operations, by eliminating interfaces among multiple parties (i.e. the P3 private partner is the single point of contact managing these parties), and efficient staff utilization.

1.4 Need for Innovation Opportunities and Flexibility

To realize the full benefits of optimal risk transfer and efficiency gains, the P3 contractual arrangement must ensure that the P3 private partner has adequate opportunities and flexibility to innovate. When technical requirements of the public agency mandate the use of specific means and methods or highly specified designs, there is huge potential for conflict or incompatibility between the resulting constructed asset and operational requirements. Note that, as illustrated in Figure 3, the P3 private partner assumes the risks and responsibilities for facility design and construction, asset management and its operational performance.

Figure 3. Typical Lifecycle Stages of a Facility Under P3 Contracts



Source: WSP | Parsons Brinckerhoff

Therefore, so that the P3 private partner may execute its responsibilities effectively, it is prudent to provide the P3 private partner the flexibility to make and control design decisions that may affect performance. Without this flexibility, there is significant potential for dispute as the P3 private partner can claim to have adhered to the means and methods or detailed design, and is therefore not liable for poor performance or failure. While it is typical to set out a hierarchy of requirements in a P3 agreement, the use of prescriptive requirements is likely to build sufficient ambiguity to weaken the transfer of risk.

On the other hand, performance requirements remove the specific need to adhere to standard means and methods and are agnostic as to how the performance is achieved. Performance requirements allow the P3 agreement to specify outcomes only, while eliminating potential contradictions. With performance requirements, the P3 private partner assumes liability for its own design and construction methods to produce a product that achieves the operational requirements. This can result in the following innovations:

- Initial construction where alternative approaches selected by the P3 private partner can reduce cost or accelerate the schedule;
- Operations where desired results can be achieved with fewer staff but using different initial design (to ease access for inspection) or equipment (e.g., snow ploughs);

Life cycle perspective in design, to minimize whole life costs including those of future replacement and renewal, because the operator and D-B subcontractor frequently work together from the proposal stage of the project.

2 Use of Performance Requirements in Highway Design and Construction

2.1 Introduction to Performance Requirements

2.1.1 Requirements in Traditional Highway Procurement

As discussed earlier, in D-B-B contracting, the agency (or the agency's agent) is responsible for preparing the 100 percent design documents, including plans and specifications. Following the completion of design, the agency then hires a contractor to perform the construction work through a fixed, low-bid competitive procurement process. The contractor is obligated to build the facility exactly in accordance to the plans and specifications provided by the agency. With the exception of a limited warranty for defects in workmanship and materials quality, the contractor is not liable for defective specifications, errors and omissions in design documents, or the long-term performance on the constructed facility. Neither does the contractor have any say on how design decisions will influence the future performance of the facility nor does it have the privilege to deviate from those decisions. The agency takes responsibility for internal hand-over of as-built information between its construction and maintenance disciplines, and the long-term maintenance and maintenance of the facility. The agency retains the risk of the long-term performance of the constructed facility.

2.1.2 Why Are Performance Requirements needed in a P3 Procurement?

Under D-B and P3, agencies have traditionally articulated the requirements for design and construction, in lieu of plans and specifications. This is accomplished in the Request for Proposals (RFP) and in a draft form of the Technical Provisions[1] appendix to the D-B or P3 agreement. The Technical Provisions of the P3 agreement describe the project scope as well as the technical requirements for the products and services that the designers must accommodate in preparing plans and specifications for construction.

The agency's technical criteria in the P3 Technical Provisions should capture the functional purpose and needs of a project that are required to be fulfilled for successful commissioning and operation of the project. The technical criteria include the "necessary must-haves" of the project and, where strictly necessary, prescriptive language (regarding the design, construction, maintenance and operations technical standards and any manuals) that must be adhered to. The agency sets out the functional requirements (i.e., what service the facility is intended to provide) in the P3 agreement using technical criteria in performance terms. The details on how these are to be provided are left to the P3 private partner. Owing to its policies, public needs and environmental responsibilities, where necessary, the agency can use specific prescriptive terms in the P3 agreement technical provisions to lay out project constraints and limitations, e.g., for safety, right-of-way and environmental constraints. With this, the P3 proposers would still have flexibility to propose alternative solutions within the agency's constraints and suggest changes to prescriptive requirements that they feel would prevent achieving the project goals effectively. That kind of change happens as part of the negotiation process between the agency and the shortlisted P3 proposers and is available to all the Proposers. During the proposal process, P3 proposers can also provide alternative solutions that are better than or equal to the requirements outlined in the P3 agreement technical provisions through an alternative technical concept (ATC) process.

Once the P3 contract is signed and construction commences, the agency can approve on a case-by-case basis any requests made by the P3 private partner to deviate from any identified technical requirements, in the form of design exceptions, waivers or variances. Although it is the agency's prerogative, the language of a P3

[1] DOTs/ Highway agencies may use a different terminology, such as the Scope of Work or Technical Requirements.

agreement's technical provisions can exceed the bounds of the "necessary must-haves" principle. In other words, the agency may over-specify technical criteria through prescriptive requirements and thereby over-determine how the facility should be designed and constructed. Being prescriptive can be appealing as agencies are assured that their desired solutions will be implemented in a way (i.e., means and method) with which they are familiar. However, they can be antithetical to the primary purpose of selecting P3 as the preferred procurement approach.

Since the P3 proposers' technical proposals must conform to those requirements to be responsive, over-specificity in the design requirements (with the exception of safety and security, right-of-way, environmental, and policy related requirements) has potential to leave little room for innovation or value addition and to undermine the transfer of performance risk (Gransberg et al, 2008). Recognizing that the agency's initial design decisions may not always yield the most cost-effective solution, the lack of opportunities for P3 proposers to propose alternative ideas may deprive the project of optimal technical solutions and potential efficiency gains. Furthermore, agencies can end up inadvertently owning the design risks from the downstream consequences of their design decisions on constructability and performance of the facility (Xia et al, 2012). From the legal perspective, the agency assumes full or partial liability for all issues that originate from any prescriptive design requirements. An agency's retention of performance risks can lead to an increase in the agency's total cost of facility ownership over time as well as undermine the incentives to operate and maintain the resulting facility in an efficient manner.

Furthermore, P3 agreements have post-construction performance requirements, in terms of minimum acceptable condition criteria for asset and operational performance. In addition, the P3 agreement will have to specify the associated inspection frequencies and measurement methodologies, and associated timeliness requirements, to monitor those performance requirements during the O&M period. At the end of the P3 agreement term there will also be handback requirements outlining the required condition of the facility and the timeline for bringing it up to that standard. However, what is often lacking is a thorough understanding of how the performance expected during the use phase and handback of the facility is influenced by decisions made during design and construction; in this context, the performance requirements in the design–build phase provides a pivotal continuity between the D-B and operations phases.

2.1.3 What are Performance Requirements?

Performance requirements provide an alternative way to communicate technical requirements of a project in the P3 agreement. Unlike traditional prescriptive specifications, performance requirements do not prescribe the "methods" for the P3 private partner to design and construct the facility using the agency's base design; rather much emphasis is placed on the requirements of the proposed facility that the P3 private partner must contractually fulfil from user, operational, structural, functional, budgetary, and delivery perspectives.

> **Essential Functions** define how well the highway facility needs to perform and the objectives for a successful delivery of the facility.

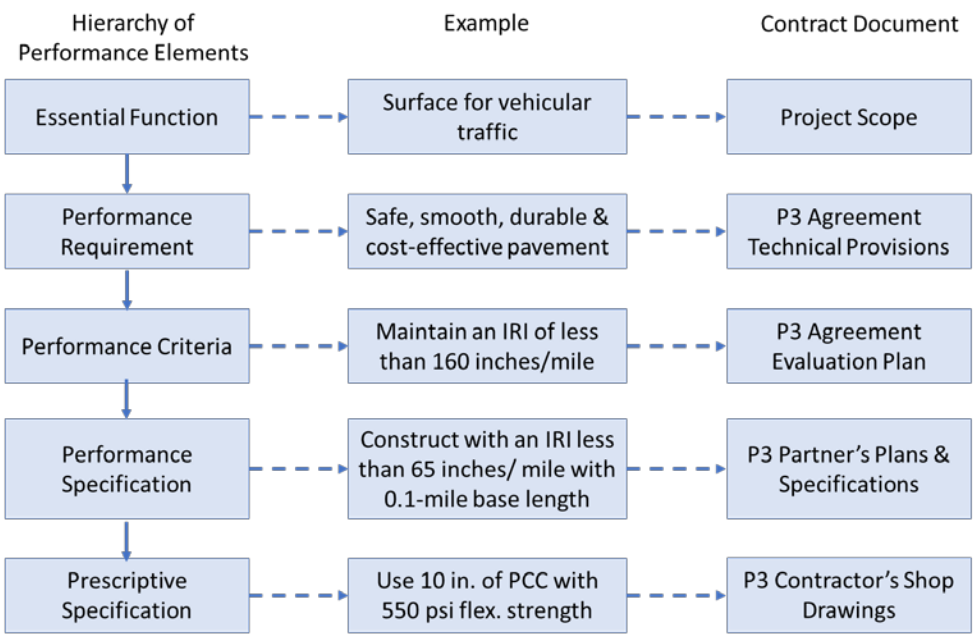
Through federally mandated planning processes and agency scoping procedures, each highway project has its own list of "essential functions" without which the highway facility will not perform and the facility will not be successfully delivered as planned. The essential functions are generally traced back to the project purpose and needs, stakeholder expectations, environmental commitments, project constraints and the reasons for selecting a P3 delivery method. The performance requirements identify what is needed to achieve the essential functions of the project, and each performance requirement is defined by one or more performance criteria. The essential functions, performance requirements and performance criteria are typically established during the scoping phase of the project development process.

A well-written set of performance requirements clearly lays out the project scope, agency's expectations and constraints early in the procurement process, while maintaining the quality, cost and schedule needs of the project. This creates a "win-win" situation for both public agencies and P3 proposers in that the proposers are provided with a higher degree of flexibility to devise a broad range of viable alternatives meeting those requirements and the agencies can tap into the technical strengths of the proposers to obtain the best value out of the competition during the procurement process.

Performance specifications are construction specifications designed to focus on the desired quality level or performance of the finished work. Different from performance requirements, performance specifications indicate that a decision has already been made. Performance specifications move away from "method" specifications to provide flexibility to contractors in selecting materials, equipment, techniques, procedures and methods and responsibility to improve the quality or cost, or both, of the end product. Figure 4, which has been adapted from Gransberg et al. (2006), illustrates the hierarchy of performance elements, from essential functions to prescriptive specifications, with an example. Table 1 presents comparative examples of performance and directive requirements for sample project types.

> **Performance requirements** define what is need to be done to accomplish the objectives of the project, while **Performance criteria** are measures that demonstrate a specific owner requirement has been met

Figure 4. Hierarchy of Performance Elements with an Example



Source: Adapted from Gransberg, et al, 2006.

Table 1. Example Comparison of Performance and Directive Requirements

Directive/Prescriptive	Performance
Example 1: Bridge Project	
• New steel spliced girder bridge • 12 inch reinforced concrete deck • Three span configuration of 102.3 feet., 130 feet, and 105.7 feet • 50'-0" curb-to-curb width • Minimum clearances and dimensions as shown on the plans	• New bridge to be provided shall be concrete or steel with an acceptable minimum design life of 50 years • Configuration to be three span with no more than two piers • Provide three 12-foot travel lanes with 10-foot outside shoulder and 4-foot insider shoulder
Example 2: Interchange Project	
Provide new four level fully directional interchange • All ramp connections shall be provided as shown in the plans • Ramp widths, transitions and geometry shall be as shown in the criteria plans • Traffic movements, transitions and pavement widths shall conform to the criteria plan • All minimum vertical clearances shall be as shown on the criteria plans	• Provide a new fully-directional interchange with all ramps and traffic movements as shown on the criteria plans • Alternative interchange configurations that meet or exceed the LOS and traffic capacities in the criteria plans will be considered as long as ROW, utility, and environmental impacts are similar or reduced • P3 Developer is responsible for providing documentation that the above conditions are satisfied

Source: Texas Department of Transportation

2.1.4 Benefits of using Performance Requirements in Design and Construction

The benefits of using performance requirements in the design and construction phases of a P3 project include the following:

- Performance requirements provide a basis for a contractual agreement between the agency and the P3 private partner on what the constructed facility must do. Well-drafted performance requirements are unambiguous and easy to measure, limits the potential for dispute and reduces the cost of monitoring the P3 agreement.
- Use of performance requirements reduces the development effort of the agency. Less rework is required to address poorly written, missing and misunderstood requirements or specifications. Further, the agency does not spend its resources twice to determine design details.
- Through performance requirements, the agency effectively transfers those risks that the P3 private partner can best manage.
- With performance requirements, the agency reduces over-specificity in the language of the P3 agreement technical provisions and minimizes the public partner's unintentional exposure to performance risks.
- Use of performance requirements do not constrain the private sector's opportunity for innovation and creativity; instead, they allow agencies to get the best value out of the competitive bidding process.
- Performance requirements provide a basis for validating and verifying all decisions and assumptions made during the delivery process, including cost estimates and schedules.

2.2 Common Principles behind Use of Performance Requirements in P3

2.2.1 Performance Requirements versus Risk Allocation and Management

Performance requirements are written to be in place for a long period, such as 30, 50, or 75 years, without major changes. While P3 proposers expect certainty and unambiguity in contract requirements for pricing, the agency is likely to have a thorough understanding of potential risks and their consequences to structure a successful P3 project. Transferring too much risk to the private sector could result in poor-value bids with large contingencies for risks the P3 private partner cannot manage. On the other hand, allocating too little risk will stifle innovation and creativity, making the project more expensive. There should be an effective and balanced allocation of risks between the two parties:

- Some risks are more economically retained by the agency.
- Some risks can be better managed by and should be transferred to the P3 private partner.
- Other risks have some limited ability to be mitigated, and are best shared between the parties to retain incentives without incurring unnecessarily large risk contingencies in proposal pricing.

In a P3 project delivery process, the agency undertakes an extensive risk analysis exercise to evaluate the financial and operational implications of high level and major risks, such as toll revenue, inflation and *force majeure*. Risk assessments at the design and construction level typically focus on the delivery details such as differing site conditions and quality assurance (QA). More often, there is a need to bridge the two major phases, i.e., integrated design-build delivery and the longer-term O&M, through better understanding of how decisions made exclusively for design and construction would impact the overall longer-term performance of the facility.

The use of performance requirements provides agencies with some protection against potential liability from directive, overly specific and defective requirements in a P3 agreement's technical provisions. However, to realize the full benefits of performance requirements, additional risk evaluation may be necessary to understand the consequences of performance requirements themselves on facility performance.

> As a sovereign entity, most public agencies retain the risks and responsibilities for the safety and security of the highway system against force majeure events, including natural and manmade disasters. To manage the risks effectively, the agency may prescribe a specific level of redundancy in the design of critical structures, such as bridges and tunnels. For instance, the agency may prescribe a specific "redundancy factor" (e.g., load modifiers) for use in the design of superstructure and substructure elements rather than directing the design outcomes, such as material strength or girder size. While the P3 private partner will have the flexibility to control the design outcomes, the risk of maintaining the design redundancy over the entire concession period rests with the P3 private partner.

The contract duration is a key determinant in structuring risk allocation between the two parties, which then forms the basis for specifying performance requirements. The shorter the contract term, the more inclined is the agency to have greater control over design details. The agency's concerns are typically related to design details of assets that need life-cycle management, and particularly pertinent to capital intensive assets, including pavements, bridges and tunnels. Not only do these assets have longer service lives that may extend beyond the contract term, but these may also cause significant political, safety and security risks to the agency in the event of failure. There is typically less concern with aspects relating to highway design, construction and work zone management, and operations and routine highway maintenance.

In comparison with long-term P3 concessions, the agency is more likely to rely on design directives to achieve its asset preservation objectives on projects with shorter contract terms. Commensurate with the contract duration, the agency might allow the private sector to assume responsibilities relating to material and structural designs of assets, but would prefer to use design directives to control asset life-cycle management plans for preservation, maintenance and rehabilitation of assets. In short term warranty projects (say 5 to 10 years), the contractor is typically responsible only for materials design, construction quality and workmanship, while the agency retains the responsibility to provide structural design details of assets. For intermediate term contracts, including 15-year Capital Maintenance Agreements and 25-year DBFOM, the contractor may be allowed to perform structural design of assets, but only in accordance with the agency-approved design procedures and life-cycle management plan.

2.2.2 Performance Requirements versus Whole Life Costing

Reducing the whole life cost of the facility is one of the business case justifications of P3 project delivery. Unlike the D-B-B and D-B delivery methods, the private sector has the direct incentive in a P3 concession to think beyond the short-term "first-cost" approach, and adopt the long-term "life cycle cost" view to manage costs, risks and performance over time.

Performance requirements provide the flexibility to allow P3 proposers to optimize in design, material strategy and construction to achieve lower life cycle costs over time. A classic example is the selection of pavement type in P3 projects. Some agencies allow the P3 proposers to select a pavement type of their choice or from among agency-provided choices while others prescribe what pavement type to use. Among the commonly available pavement types, one pavement type (e.g., asphalt concrete pavement) may be preferable over another pavement type (e.g., Portland cement concrete pavement) or vice versa on the "first-cost" basis, but may require more frequent interventions over the project life for maintenance and rehabilitation to restore pavement condition to acceptable levels.

Pavement type selection is a critical factor for optimizing lifecycle costs of pavements. Three broad scenarios exist with regard to pavement type selection in P3 projects:

- **Prescriptive:** The agency specifies the pavement type in the technical requirements for pavement design. Some owners may specify the thickness and material types of each pavement layer. While there may be some scope for design optimization, the P3 private partner must follow the agency-specified pavement type and thickness design.
- **Restrictive:** The agency specifies the pavement types that the P3 private partner may choose from. Some owners may specify the thickness and material types for the allowed pavement types, while other owners may allow the P3 private partner to optimize thickness and material choices for the selected pavement type in accordance with the standard procedures.
- **Permissive:** Through performance requirements, the agency provides flexibility to the P3 private partner in pavement type selection and thickness design. The P3 private partner is often required to provide detailed documentation of the design inputs, the narrative on the determination of design inputs, design methodologies and outputs.

In a P3 arrangement, the P3 private partner bears significantly greater financial risks as the party responsible for pavement performance over the life of the P3 agreement. However, as the public owner of the facility, the agency has the ultimate political responsibility toward users/taxpayers to ensure the performance of the pavement. In such situations, the P3 private partner should be able to select a pavement type that produces the lowest lifecycle cost among allowable alternatives while meeting the operational performance requirements and bear the financial consequences if it fails to meet those requirements. Furthermore, the P3 private partner should be allowed to optimize the asset lifecycle strategies and associated investment decisions to produce the lowest net present cost. In other words, the P3 private partner should have the flexibility on how and when to allocate its investments (e.g., up-front capital costs vs future renewal costs) as long as the performance requirements are met.

While typical public agencies and proposers undertake a whole life cost analysis at the project level, similar lifecycle cost analyses are required at asset-level during design, at least for high value assets such as pavements and bridges. Through performance requirements, the agency can allow for multiple alternatives while the proposers are incentivized to optimize lifecycle cost to win the bid.

2.2.3 Performance Requirements and Environmental Review

The environmental review process remains a challenge for design-build contractual arrangements, including the P3 concessions. The outcome of the environmental review process is a Record of Decision that indicates the formal approval by the Federal Agency such as the FHWA or the Army Corps of Engineers. A ROD identifies the selected alternative, lists other alternatives considered, states the basis for the decision, and outlines mitigation strategies to be adopted with the selected alternative. A procuring agency cannot proceed with contract award until a ROD is signed. Recognizing the deviation from the standard course of project development stages for accelerated delivery, some agencies choose a sequential approach to obtain permit approvals before the initiation of the procurement process to minimize approval risks, while other agencies overlap both processes to save time.

With the use of performance requirements or alternative technical concepts, the construction design details may be different from the preliminary design details prepared for the environmental impact statement and identified in the ROD. The general rule is that if the environmental footprint of the proposed alternative is less than the commitments made in the environmental review process, and upon verification, an environmental re-evaluation will not be required. If the footprint of the proposed alternative exceeds those commitments, the agency has to either reject the concept considering the cost and schedule risks with the re-evaluation process, or may provide conditional approval but transfer their approval-related risks to the P3 proposer along with any additional cost/time to be borne by the proposer.

Acknowledging these challenges, some agencies have recognized the need to obtain an environmental decision that is reasonably broad enough to allow a spectrum of design alternatives. Quoting from the Missouri DOT ATC Frequently Asked Questions, the following statement provides valuable assistance for handling permitting concerns with performance requirements as well (MoDOT, undated):

> "When using the ATC process on a project, the NEPA document has to first of all recognize that the project allows the opportunity for the ATC process, and secondly leave the evaluation broad enough to identify all the environmental impacts for a maximum footprint of various design alternatives, rather than narrowing the design to only one solution. Historically in past projects, the NEPA documents were overly prescriptive identifying that the preferred alternative is the only solution. The NEPA document should identify the impacts globally and not be too specific about the type of solution to be implemented. Ultimately, if an ATC does require NEPA re-evaluation, then we offer a conditional approval within the ATC process and follow-up with a re-evaluation after award. MoDOT's environmental staff is involved on the ATC Review Team throughout the project development to continually evaluate the environmental needs. If a contractor proposes a design that is different from the preferred alternative selected in the NEPA document, we can award the contract and complete NEPA afterward if the proposed design impacts were analyzed in the original NEPA document (i.e., it was an alternative carried through for analysis but was not the preferred alternative). We work very closely with our FHWA partners in Missouri. There are certain things we have to do to meet our federal requirements, and we communicate that to the bidders throughout the ATC review process."

2.2.4 Performance Requirements and Enforcement

Performance requirements are generally developed for those items where the performance can be verified using measurable criteria. The agency should ensure that the proposed performance criteria, triggers for further actions, and monitoring frequency and measurement methods, at a minimum align with its levels of service goals and asset management objectives. Performance requirements are often used:

- to ensure on-time completion of the construction project, and minimize work zone disruptions during construction
- to address corridor management, highway maintenance, and asset preservation requirements, and ensure desired levels of service in the use phase
- to ensure that the assets have desired remaining useful life on handback.

Non-Compliance Points and Disincentives

Highway agencies enforce a system of non-compliance points (i.e., hold points) and disincentives to ensure that the contractual requirements are satisfied. Typically, depending on the type of non-compliance, the agencies may incorporate a timeliness requirement to allow for remedial actions, and upon unsatisfactory outcome, noncompliance points will be accrued, and disincentives come into effect. Some agencies adopt a risk-based approach where the frequency and extent of monitoring, and accordingly the liquidated damages or disincentives, might increase with the level of non-compliance detected by the agency.

Disincentive payments should be devised so as to recover potential losses incurred by the agency and users caused by contractual “non-compliance”, but not as a penalty. Note that any arbitrary selection of disincentive amounts may risk being legally disputable and unenforceable. With performance requirements, it is particularly advisable to follow scientifically sound approaches, supported by robust analysis of operational and asset life-cycle performance, to determine “damages.” The agency should also take cognizance of any pre-existing latent defects that may have been carried through after the contract was awarded.

The agency should incorporate all clauses relating to system-wide changes, including those related to specifications and performance thresholds, within the non-compliance criteria of a contract. These clauses allow the agency to improve the performance thresholds over the contractual period, when such improvements to specifications and practices happen at the programmatic level due to various reasons relating to legislative or technological changes.

In the aftermath of the Supreme Court of Alabama's verdict in *State Highway Department vs Milton Construction Company* (1991), the disincentive clause can be deemed as an unreasonable and unenforceable penalty, if the disincentive clause is not scientifically designed to recover the actual damages caused by the contractor's failure to meet a requirement. For example, a performance deduction of a disproportionately high sum, such as $1 million, for failure to maintain grass at the required height would trigger a legal challenge based on the damages from tall grass. However, the disincentive clause may be enforceable if the agency scientifically demonstrates the relationship between the disincentive amount and vegetation growth, say with the use of an appropriate crash modification factor showing increased crash risks with vegetation growth affecting sight lines/ distances of drivers.

Handback Requirements

Most agencies incorporate specific clauses in the P3 contract to ensure that the assets are “handed back” in good condition at the end of the contract period. In addition to the minimum service quality standards and asset condition criteria required during the use phase, the agency will have to include technical criteria, as a part of performance requirements, specifying the required condition of the assets that the P3 private partner should handback at the end of the concession term.

The handback criteria should be asset-specific and must be demonstrated at the elemental level. The handback criteria can be specified in terms of condition indicators, remaining useful life, percent assets in good condition, or the ability to meet certain performance tests. Consistent with the agency's asset management plans, the handback criteria must take into account both functional and structural adequacy of assets. To ensure a minimum remaining useful life on handback, the major asset types, say pavements and bridges, must demonstrate certain residual structural adequacy, irrespective of their functional condition. Further, to address any performance deficiencies at contract expiration, the agency should specify contractually whether the P3 private partner is contractually obligated to restore or replace to the required standards or whether it will be assessed with potential financial retentions based on the fair market value of the asset type.

As in the case of most asset types, the agency will have to rely on asset performance modeling to forecast future conditions and estimate remaining useful life. To facilitate such efforts, the contract should clearly specify the rules of asset performance evaluation, including those for tracking of asset conditions over time, compilation of maintenance, preservation and rehabilitation histories, traffic and cost modeling, and the evaluation schedule. The P3 private partner is expected to retain records related to all the above asset decisions during the concession period to provide critical information for analysis, as needed by the agency.

The concept of performance requirements is not new to highway agencies and the highway construction industry at large. Performance requirements that adopt an outcome-based approach have been in use in the U.S. via various procurement models, including design-build, schedule-focused alternate contracting clauses, short-term and long-term warranties, and performance-based maintenance contracting. In general, agencies tend to be more flexible or performance-oriented when specifying design requirements for some technical areas, while they realize the need to be more directive for other technical areas.

Highway Design

From an historic perspective, highway agencies have evolved over time to be flexible with established standards, practices, or solutions for highway design, as every project is unique in terms of user needs, community values, setting and character of the project area, cultural and ecological resources, and the natural environment. The highway design process is required to be context sensitive and balance the design needs with those of the surrounding natural and human environments. Recognizing the need for flexibility, the FHWA issued a publication that demonstrated flexibility in design approaches to integrate highway functions with those of the community, following which the AASHTO published a Guide for Achieving Flexibility in Highway Design in 2004 (FHWA, 1997; AASHTO, 2004). In describing the philosophy of highway geometric design, the AASHTO calls it "both a science and an art" and further encourages "designers to be creative and sensitive in addressing the many facets of design to fit a particular situation".

More than 30 State DOTs have implemented performance-based practical design (PBPD) to provide design solutions that meet the purpose but not exceed the needs of a project. PBPD is an approach to decision-making that encourages engineered solutions rather than reliance on maximum values or limits found in design specifications (FHWA, 2015).

Consistent with the philosophy of incorporating flexibility in highway design, PBPD adopts data-driven decision-making with the support of performance analysis tools. Several tools, including the IHSDM, RSA, HCM, HCM, and a plethora of traffic simulation tools enable a wide variety of operational and safety performance analyses for PBPD.

PBPD relies on reducing the design redundancy between the agency-approved standards and project needs. This new design approach ensures substantive operational and safety performance without compromising on long-term safety or user needs to save money. The design exceptions are recognized and managed in the same way as the conventional highway design process. PBPD will provide a scientifically sound basis to evaluate various highway design alternatives proposed as ATCs or using performance requirements.

In this context, most agencies have been more receptive to performance requirements in highway design. Performance requirements facilitate innovative design solutions to meet the functional and operational needs of the project in a given context within the current agency standards, criteria, policies. The experience with alternative technical concepts indicates that agencies, by and large, are more likely to use discretion with design variances (i.e., design elements not meeting the AASHTO Green Book's non-controlling criteria) under select scenarios, while they are less likely to use discretion with design exceptions (i.e. design elements not meeting the AASHTO Green Book's 13 controlling criteria). Note that agencies are required to undergo a design exception approval process with the FHWA. However, when substantive long-term safety performance is demonstrated in the design, design exceptions are likely to be approved with or without mitigation strategies.

Performance modeling, which is foundational for allowing performance requirements, provide further opportunities to extend the use of performance requirements in highway designs. Analytical tools, including Interactive Highway Safety Design Model (IHSDM), Road Safety Audits (RSA), Highway Capacity Manual (HCM), and Highway Safety Manual (HSM), facilitate quantitative evaluation of safety and operational effects of geometric design decisions in the highway design process. The use of such tools will provide a more scientific basis to evaluate the P3 private partner's design products.

Work Zone Management During Construction

Highway agencies are more likely to allow performance requirements in work zone management during construction. Most agencies have experience with schedule-focused contracting provisions, such as cost plus time bidding, lane rental, locked incentives and interim schedule milestones, on complex highway projects in urban areas. The schedule-focused contracting clauses are typically devised with an incentive-disincentive (I-D) based payment mechanisms to share a monetary savings with the contractor for improving work zone performance (e.g., for early opening to traffic or minimizing delay time or queue length of work zone traffic) beyond the minimum acceptable threshold, or to compensate losses for performance deficiencies. Work zone road user costs form the economic basis for devising I-D mechanisms.

There is a plethora of tools, ranging from simple spreadsheet based sketch planning tools to sophisticated microscopic simulation tools, to understand and assess the mobility impacts of work zone strategies prior to deployment and monitor performance during construction. Furthermore, construction analysis tools, such as Construction Analysis for Pavement Rehabilitation Strategies (CA4PRS), which facilitates scenario analysis and optimization of construction production rates, lane closure strategies, work zone traffic analysis, and schedule analysis, are useful for work zone planning. In a nutshell, the experience with these contracting clauses, supported by the availability of work zone performance analytical tools, should make it easier for the implementation of performance requirements in work zone management.

To evaluate user-based performance goals on construction projects, the FHWA's Highways for LIFE (HfL) program developed contractually non-binding performance criteria that are related to safety, congestion, user satisfaction and quality aspects of a construction project (see Table 2). The HfL program successfully demonstrated the application of use-based performance criteria on many construction demonstration projects across the country that received grant funding for innovation implementation. The goals can serve as a template for performance requirements to manage the project delivery process from the users' perspective.

Table 2. Highways for LIFE Performance Criteria for Construction from Users' Perspective

Safety	• Work zone safety during construction — Work zone crash rate equal to or less than the preconstruction rate at the project location. • Worker safety during construction — Incident rate for worker injuries of less than 4.0, based on incidents reported via Occupational Safety and Health Administration (OSHA) Form 300. • Facility safety after construction — Twenty percent reduction in fatalities and injuries in 3-year average crash rates, using preconstruction rates as the baseline.
Construction Congestion	• Faster construction — Fifty percent reduction in the time highway users are impacted, compared to traditional methods. • Trip time during construction — Less than 10 percent increase in trip time compared to the average preconstruction speed, using 100 percent sampling. • Queue length during construction — A moving queue length of less than 0.5 mile (mi) (0.8 kilometer (km)) in a rural area or less than 1.5 mi (2.4 km) in an urban area (in both cases at a travel speed 20 percent less than the posted speed).
Quality	• Smoothness— International Roughness Index (IRI) measurement of less than 48 inches per mile. • Noise —Tire -pavement noise measurement of less than 96.0 A-weighted decibels (dB(A)), using the onboard sound intensity (OBSI) test method.
User Satisfaction	• An assessment of how satisfied users are with the new facility compared to its previous condition and with the approach used to minimize disruption during construction. The goal is a measurement of 4-plus on a 7-point Likert scale.

Operations and Maintenance

Performance requirements are more mature in highway operations and maintenance of P3 projects. Many agencies routinely use performance requirements to specify the corridor management and maintenance needs in the RFP, while the P3 private partner's O&M contractor selects the means and methods to meet those requirements. Some agencies, including those in Texas, District of Columbia and Virginia, have implemented performance requirements on non-P3 projects using performance-based maintenance contracting.

Asset Preservation

Experience has shown that the highway agencies are inclined to be more directive with design requirements for major asset types: pavements, tunnels and bridges. To facilitate the implementation of performance requirements, it is necessary to understand the rationale behind the agency's use of directive requirements:

- Pavements, tunnels and bridges are complex asset systems, whose performance is influenced by a wide range of factors including material properties, construction techniques, climate, traffic, and soil profiles.
- These assets have long service lives, which may extend well beyond a typical contract term. Pavements have a typical lifespan of 35 to 60 years to reconstruction, while bridges have a typical service life of 75 to 100 years. Tunnels are designed to last for more than 100 years.
- Each asset type has a unique life-cycle management plan, i.e., a structured sequence of maintenance, rehabilitation, restoration and replacement actions, to maintain the assets in a state of good repair.
- Irrespective of the party that inherits the performance risks, the public agency carries significant financial, safety and security, and political risks associated with any potential failure of these assets.

Furthermore, the agency gains a significant amount of heuristic knowledge or "local" experience over many years on how these assets perform based on asset performance data indicating the influence of climate, characteristics and variability of local materials and soil profiles, and traffic patterns and loadings. This knowledge could have a decisive influence on why agencies tend to go with directive requirements. When performance requirements are allowed, the agency is likely to have less control over the design details of the P3 private partner, and if there are any deviations from the standard agency practices, the agency may lack enough evidence or performance data to characterize the risks more accurately. The agency can utilize a combination of performance prediction analytical models, performance testing and performance related specifications to understand interactions and dependencies among the influencing factors. Such tools would help agencies manage potential risks associated with the use of performance requirements for major assets.

3 Agency's Preparations for Performance Requirements (Pre-award)

3.1 Project Scoping under Traditional Project Delivery

> "The project scoping process is a series of project-focused activities that develop key design parameters and other project requirements to a sufficient level of definition such that scope discovery is complete and a budget and project completion date can be accurately established to minimize the risk of significant change and project overruns"
> *—NCHRP Report 821 (Anderson et al, 2015)*

The project development process for highways typically begins with the scoping process. Project scoping primarily focuses on identifying all necessary elements and potential risks that need to be considered in the delivery of a roadway project. The purpose of project scoping is to avoid any unintended consequences in the later phases of project development and ensure on-schedule and on-budget delivery of the project (ODOT, 1999). Highway agencies have extensive experience in conducting project scoping, and there is ample guidance available in the literature on conducting an effective scoping exercise.

The outcome of the project scoping process is a scoping document that typically includes, but is not limited to the following: (i) the context of the project, including location, project limits, background of the existing facility, and the role in the larger transportation network, (ii) the purpose and needs statement identifying the operational, asset condition and safety deficiencies in the existing system and the drivers of the proposed project, (iii) baseline scope for physical assets and operations, (iv) preliminary cost estimates (with contingencies) and schedules, including project development costs, (v) third-party requirements, such as right-of-way, utilities, railroads, permits, and requirements of other governmental entities, (vi) current and future operational factors, including current travel conditions, freight and transit, travel demand, crash history, etc., (vii) operational scenarios, potential alternatives, and preferred design solutions, (viii) design standards, design criteria and variances, (ix) potential stakeholders and their inputs, (x) proposed project/service delivery methods, and (xi) environmental impact summaries, including air quality, wetlands, wildlife, historic and archealogical resources etc.

While the project scoping process of highway owners has evolved into a comprehensive and effective exercise, the state-of-the practice is largely tailored to address the design and construction phases of a roadway project, including those delivered under D-B-B, D-B and D-B-F. For a P3 project, the project scoping process does not extend to include the post-construction asset lifecycle and operational performance of the roadway facility. However, note that much of the project scoping exercise is still valid as the general scope or the concept of the project described forms the basis for the environmental review process.

From the performance requirements perspective, the current project scoping process clearly identifies the purpose and needs statement as well as the base concept that form the basis for identifying user requirements and essential functions; however, the scoping process falls short of deriving performance requirements and performance criteria.

3.2 Identifying Performance Requirements During Project Scoping

The agency's preparations for writing performance requirements begin with project scoping. Beginning in the scoping phase, the agency undertakes a thorough analysis of the requirements of the project and the facility from the perspective of the users and other stakeholders as well as the P3 private partner. The agency analyzes the user needs, the project-related (or facility-related) as well as exogenous constraints, and the primary factors for considering the P3 delivery method. The agency conducts an investigation of operational deficiencies with the existing highway facility or network, explore opportunities for improvement, and identify user needs. The findings of the investigations are summarized in the agency's scoping document. The scoping document describes how the facility will be operated and used, and further identifies the major features (e.g., physical and operational features) of the project.

Based on the scoping document's findings, the agency generates a list of requirements for each major feature of the project, of which some requirements are absolute "needs" and others can be considered as "wants." The "needs" are those requirements that are truly necessary to ensure the "as-planned" project/service delivery and post-construction performance of the facility, otherwise referred to as "essential functions." When identifying the "essential functions" for a project, the agency should ask what the facility/project must do and what the needs are to achieve the objectives. Similarly, the project constraints, including cost, schedule, quality, performance and other technical factors, are identified for each feature of the project.

Factors that may help identify the needs of a highway project:

- *Capacity and transportation demand*
- Safety
- Legislative directive
- Economic development and planned growth
- Modal interrelationships
- System linkage ('connecting link')
- Transportation facility deficiencies

Source: MnDOT Highway Project Development Process.

The agency then establishes performance requirements that define the essential functions as well as the associated performance criteria to measure them. They are typically written using concise and objective statements. Performance requirements describe what outputs need to be delivered to accomplish the objectives of the project, as summarized in the scoping document. Through the "what" part of the performance requirements, the agency allows the agency to open up for one or more solutions to meet a functional requirement, while the responsibility to determine the preferred solution, i.e., the "how" part, lies with the P3 private partner.

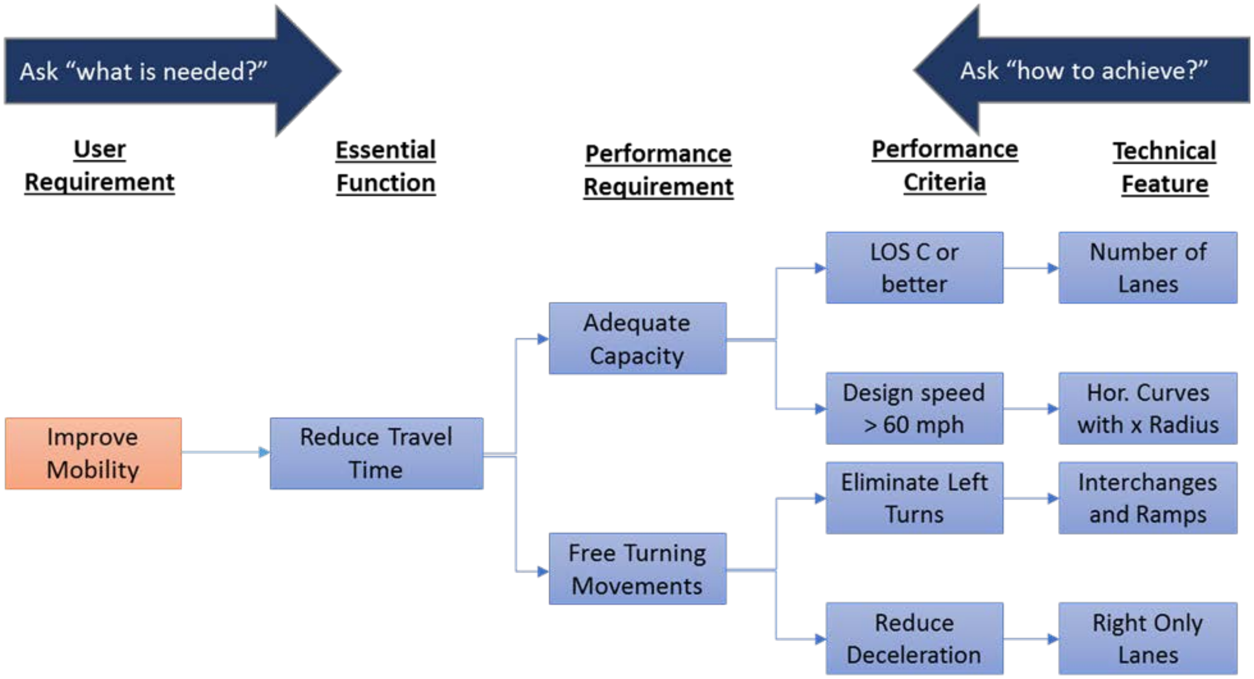
Performance criteria establish the rules by which the agency will evaluate the effectiveness of the design and construction as well as the facility performance downstream. Performance criteria set the baseline for desired performance as well as threshold or ceiling metrics for the agency's acceptance, and therefore, should be objective and measurable. Performance criteria are typically quantifiable; and wherever quantification is not feasible, performance criteria should at least be verifiable to avoid any likelihood of differences of opinion between the agency and the P3 private partner. When identifying the "performance criteria" for a project, the agency should ask how the performance criterion will help determine if the performance requirement was met.

The products of the project scoping exercise, i.e., the list of essential functions, performance requirements and performance criteria, culminate in an agency's project requirements document that forms the basis for writing the Technical Provisions. An agency's project requirements typically includes project needs and goals, technical constraints (e.g. site, design, environmental), budget and schedule considerations, performance benchmarks and metrics, acceptable outcome-based codes and standards, warranty requirements, success criteria, and special directives and limitations. A good project requirements document describes the final output, and not how to do it.

Function Analysis System Technique can be used to analyze performance requirements of a project.

"Function Analysis System Technique (FAST)," a design tool, can be used to analyze the performance requirements of a project using "what" and "how" questions (Borza, 2011). Using the FAST tool, the agency can develop a graphical representation of the logical relationships between various functions of a project, and how to achieve them (Johnson, 2013). Figure 5 presents an illustration of the FAST tool with an example.

Figure 5. Sample Analysis of Performance Elements using Function Analysis System Technique



Source: Adapted from Johnson, 2013.

The above-discussed process to be undertaken during the project-scoping phase is summarized in the following steps:

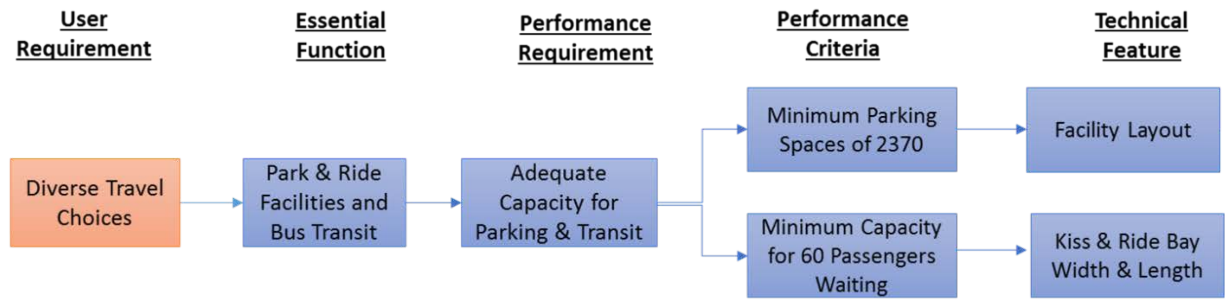
- Perform a thorough analysis of project requirements, constraints, and project/service delivery goals.
- Develop a scoping document that describe how the facility will be operated and used.
- Identify the major features of work.
- Identify the essential functions and preferable requirements for each feature of work.
- Identify the project constraints for each feature of work.
- Identify performance requirements for each essential function, and performance criteria for each requirement.
- Compile them in an agency's project requirements document for use in the RFP preparation phase.

Note that the identification of performance requirements will begin in the project scoping phase but may not be finalized until the RFP is ready for release.

Figure 6. An Example with Virginia I-66 Outside the Beltway P3 Project

Purpose & Need:

Need: Improvements are needed to address limited variety of travel mode choices (i.e. transit, bicycling and pedestrian facilities). As alternatives to single-occupant vehicle (SOV) travel are limited, new infrastructure to support multimodal opportunities are needed (VDOT, 2015).
Goal: Improving multimodal mobility along the I-66 corridor by providing diverse travel choices through an efficient network of Park-and-Ride, HOV, transit, and express lane opportunities in a cost-effective and timely manner.
Project Requirement: Design, construct, and transfer at Project Completion of Transferred Project Assets, including Park-and-Ride facilities, at strategic points along the corridor.



Source: VDOT and WSP | Parsons Brinckerhoff

3.3 Developing Performance Requirements/Criteria during RFQ/RFP Preparations

3.3.1 Types of Performance Requirements

Figuratively referred as the three-legged stool, the key elements of highway project/service delivery are (i) cost, (ii) schedule, and (iii) design details. In a P3 arrangement, another leg or element, "lifecycle performance," is added to this stool. While the cost, schedule, and performance elements typically remain as constraints, the only variable element is design details. In other words, the P3 private partner attempts to develop design details to the constraints of cost, schedule, and performance. Similarly, the agency has the responsibility to ensure that the performance requirements define what is needed from a successful project.

In a typical set of Technical Provisions, there are four essential types of performance requirements, which include, but are not limited to, the following examples:

- **Management:** The performance requirements will emphasize the qualifications of key members of the SPV management and operations team (including certification requirements), past performance, safety requirements, and maintenance of a project management plan.
- **Schedule:** The performance requirements may include any firm completion date or intermediate milestones for critical phases of the project, impacts of road closures, requirements of traffic maintenance and work noise impact restrictions.
- **Construction:** This includes discipline-specific requirements for design and construction (either initial or renewals during the life of the concession/ P3 Agreement):
  - Performance requirements for design typically include: (i) design/quality requirements in performance terms by technical discipline, (ii) design requirements in prescriptive terms by technical discipline, (iii) project constraints (e.g., environmental and permitting requirements, programmatic mandates, utilities and railroads, vertical clearances, right-of-way clearances), and (iv) qualifications for design quality management.

  - Performance requirements for construction typically include: (i) quality requirements for acceptance by technical discipline, (ii) qualifications for construction quality management, and (iii) construction specifications.
- **Operational:** This includes how the completed asset performs as well as requirements for the operations:
  - Performance requirements for the operational asset including quality requirements by asset type.
  - Performance requirements for operations by function.
  - Performance requirements for handback including quality requirements by asset type.

3.3.2 Writing Performance Criteria

Performance requirements place an emphasis on the outcomes rather than inputs. Further, as laid down in a P3 agreement, the measured performance outcomes are contractually binding and form the basis for payment and incentive mechanisms. Hence, it is critical to write performance requirements/criteria in a clear, definite and consistent manner to avoid any ambiguities and misinterpretations.

It is a generally agreed principle that performance requirements/criteria should be written using an abductive reasoning approach. Under this approach, the agency specifies "rule" and "result" in the Technical Provisions, while leaving the task of identifying the "case" that produces the "result" within the constraints of the "rule" to the P3 private partner. In addition, the agency can ensure the effectiveness of the proposed performance requirement/criteria by evaluating them using the "SMART" model.

The "SMART" model presents a systematic way to evaluate the effectiveness of the proposed performance requirement/criteria using five measures, as presented in Figure 7: **S**pecific, **M**easurable, **A**chievable, **R**elevant and **T**ime-bound (CDC, 2011). Using the "SMART" criteria, the agency can ensure that the proposed performance requirement/criteria will be directly tied to the intended result and can be measured or verified.

Figure 7. Description of SMART Criteria for Evaluating Performance Requirements

Specific	Are the criteria clear on what should be done ?
Measurable	Are the criteria quantifiable and how can the results be measured ?
Achievable	Are the criteria realistic, practical and achievable ?
Relevant	Are the criteria relevant to the goals and strategies of the project ?
Time-Bound	Are the criteria achievable within a reasonable time frame ?

Source: WSP | Parsons Brinckerhoff.

3.3.3 Conducting Risk Evaluations

Every technical requirement specified by the agency, irrespective of whether it is performance criteria, design preferences or prescriptive requirements, will have consequences on cost, schedule and performance. The agency should consider conducting a risk evaluation using a "round table" type exercise to assess the consequences of the agency's technical requirements. The agency must ensure that the representatives from all technical disciplines, particularly operations and asset managers, are brought in for the risk evaluation exercise.

The focus of the risk evaluation exercise would be to understand the interrelationships between the agency's proposed technical requirements and their implications on cost, schedule, asset lifecycle and operational performance within the context of project-specific and programmatic constraints, and how the agency's decisions affect the risk landscape of the project. The risk evaluation ensures that the dependence on mandatory technical requirements is only as much as necessary, while the emphasis on performance criteria is only to the extent practicable. Similarly, all mandatory technical requirements are evaluated to avoid unintentional assumption of design liability. Some examples are provided in Table 3.

Table 3. Examples of Risk Evaluations on Technical Requirements

Technical Requirement Examples	Potential Impacts: Cost	Schedule	Asset Performance	Mobility	Safety	Community	Notes
Provide an interchange with pedestrian crossing	⇔	⇔	⇔	⇩	⇩	⇩	Though not prescriptive, the requirement is too open. Limiting the pedestrian-vehicle conflict points to a specific number will control potential operational risks. For instance, by limiting the conflict points to 8, a diverging diamond design with center walkway may be proposed, otherwise, a conventional diamond interchange with 12 conflict points for pedestrian crossing may be proposed.
Place a hot mix asphalt overlay of 5 inches over the existing concrete pavement. Maintain an IRI of 120 or less at all times	⇩	⇔	⇩	⇩	⇩	⇔	Reflective cracking will be an issue for the agency prescribed design solution. To meet the performance requirement, the P3 private partner will have perform frequent rehabilitation treatments, which increases the cost, affects lifecycle performance, and increases the risks of work zone disruption and safety.
Remove and replace the existing soil with the select fill by 3 ft. wherever expansive clays are present	⇩	⇩	⇔	⇔	⇔	⇔	There is no clear definition of severity of expansive clays to be replaced. Most clays may have some expansive minerals but not all clay minerals are detrimental. Providing flexibility to deal with expansive soils, such as the use of stabilization techniques, may provide better solutions than the prescribed method. The agency retains the risks of means and methods, if the removal and replacement does not produce the intended result.

Key: ⇔ indicates no or little impact; ⇩ indicates negative impact; ⇧ indicates positive impact.

The outcomes of the risk evaluation exercise will help allocate the risks between the public agency and the P3 private partner in a balanced and effective manner. The general principle is that risks should be allocated to the party that is in the best position to manage or mitigate them. While the private sector generally has good appetite for risks, the agency will realize good value only for those that the private sector can manage or mitigate effectively; otherwise, the risk will be priced as contingency in the bids. There are some risks for which the agency is best placed to provide more data to reduce the overall risk regardless of allocation, such as the impact of differing site conditions.

3.4 Alternative Technical Concepts

3.4.1 Alternative Technical Concepts in P3 Projects

Alternative Technical Concepts (ATCs) are a valuable contracting mechanism used by highway agencies to allow for innovation and input during the procurement process. ATCs appear to be a natural fit for P3 procurement: the ATC process allows the proposers to propose alternative and innovative solutions to create cost, schedule and work zone management efficiencies during the project delivery phase, and maximize asset life-cycle and operational performance during the facility use phase.

ATCs are defined as the suggested changes proposed by bidders in response to the agency's base technical requirements. As described by the FHWA, an ATC is *"a request by a proposer to modify a contract requirement, specifically for that proposer's use in gaining competitive benefit during the bidding or proposal process…[and] must provide a solution that is equal to or better than the owner's base design requirements in the invitation for bid (IFB for D-B-B) or request for proposal (RFP for D-B) document."*

The use of ATCs is well established in the P3 and D-B procurement processes. More than half of the states in the U.S. have experience with ATCs in D-B contracting, and many projects have demonstrated value increases and/or cost savings with ATCs (FHWA, 2014). State agencies, including Florida, Minnesota and Washington, have institutionalized the ATC process in their D-B programs. ATCs are being used in a growing number in P3 projects, including the I-595 Corridor Improvements Project in Florida, the North Tarrant Express Project in Texas, and the Downtown Tunnel/Midtown Tunnel/ MLK Extension Project in Virginia.

There is a rare need for ATCs with performance requirements, since proposers would have the required flexibility in making decisions to achieve the desired level of performance. When performance requirements are not used, the ATC process can be effective in validating the need for the agency's prescriptive design requirements or the agency's understanding of design constraints. Through this process, not only can the agency re-evaluate its mandatory requirements and constraints, but it also gets an opportunity to maximize value at the proposer's risk.

Furthermore, an agency is likely to undergo an organizational change management process and various implementation stages before successfully transitioning to the use of performance requirements in procurement. Until the use of performance requirements is in place, the agency can use a robust ATC process to attract alternative ideas from the proposers. The ATC process gives the agency both opportunity and control to evaluate each proposal carefully in the procurement stage of P3 delivery. Not only does the ATC process enable the agency to attract alternative concepts, but it also serves as a "sandbox" testing environment during the agency's transition to performance requirements, when effectively utilized with no undue burden to proposers. Implementing an effective ATC program is an essential step for an agency transitioning to performance requirements and will make the transition more practicable.

Handling geotechnical risks contractually has always been challenging, particularly in D-B and P3 projects, since the contract is awarded before a geotechnical investigation is complete. Some agencies have demonstrated the use of ATCs as an effective risk management tool to handle geotechnical risks.

Gransberg and Pereira (2016) presents three case-study projects that demonstrate the successful application of ATCs in mitigating geotechnical risks. First, on the New Mississippi River Bridge Project delivered using Design-Bid-Build, the Missouri DOT saved about $7.5 million in costs for installation of drilled shafts for bridge foundations through ATCs. Second, on the TH61 Hastings River Bridge Design-Build Project in Minnesota, the embankment settlement risks were effectively handled using the ATC process resulting in significant cost savings of about $ 80 to 100 million. Third, on the Tuttle Creek Dam stabilization project, delivered using the Construction Manager/General Contracting method, the Army Corps of Engineers successfully mitigated the liquefaction potential of an earthen dam foundation using the ATC process. This project was completed two years ahead of the planned schedule with costs about 30 percent below the original estimate.

3.4.2 Qualifying an ATC

The foundational principle for qualifying an ATC is that the alternate concept must generate equal or better value to the project, agency and/or stakeholders than the base concept. The term "value" is defined using cost, schedule, performance and risks, and can be related to minimizing costs, expediting schedule, minimizing environmental impacts or right of way needs, improving service quality (i.e., capacity, accessibility, mobility, safety, etc.), and lifecycle performance of assets. Highway agencies do not typically allow any alternate concepts that lead to scope reduction.

The highway agency has the discretion to establish criteria on what specific areas of the P3 delivery it would like to allow or disallow; a good rule of thumb is to select, using an internal assessment during the preliminary design and RFP technical requirements drafting stage, those aspects of the project scope for which the agency wants to encourage ATCs to generate value. There is additional guidance available in federal statutes and literature on what would or would not qualify as an ATC.

The federal statute 23 Code of Federal Regulations (CFR) 636.209(b), which allows ATCs in two-phased design-build solicitations, essentially states (USGPO, 2016a):

> "At your discretion, you may allow proposers to submit alternate technical concepts in their proposals as long as these alternate concepts do not conflict with criteria agreed upon in the environmental decision making process."

While providing flexibility to the procuring agency on the ATCs, the federal statute makes two stipulations:

- the implementation of the alternate concept must trigger a change in the contract or solicitation requirements, while those changes must be within the general scope of the contract, and not fundamentally alter the contractual undertaking under the cardinal change doctrine.
- the alternate concept should be within the approved environmental footprint and not exceed the commitments made by the procuring agency during the environmental review process, and if it does not, new approvals are required.

The NCHRP Synthesis Report 455: *Alternative Technical Concepts for Contract Delivery Methods* conducted a national survey on what respondent agencies perceived as a qualifying ATC (Gransberg et al, 2014). Per the survey, the key benchmark that agencies use to qualify an ATC is that the concept must generate a cost, time, or life cycle benefit to the agency. The survey indicated that highway agencies are open to qualifying a concept that requires a design variation from agency approved standards, policies and standard specifications, or a simple variation from a contract requirement unrelated to design.

Highway agencies are generally not receptive to allowing a concept that violates any of the ten controlling criteria in the AASHTO Green Book, since a formal approval is necessary from the FHWA for design exceptions. The agency has final discretion to opt for undertaking a formal design exception process, if it is convinced that the ATC generates significant value and the potential safety risks relating to the design exception can be mitigated. However, when allowing a concept that conflicts with the existing contract requirements, the agency should make sure that all bidders are aware of this variance through a global addendum without affecting the confidentiality of the proposed ATCs.

Similarly, given the schedule risks with permits and environmental approvals, the agency may decide not to entertain the proposed concept as an ATC, if it does not comply with existing permits or the footprint approved in the NEPA process. In some instances, the agency may provide conditional approval to a concept, while allowing the P3 private partner hold the risk in obtaining any additional approvals within a stipulated time frame and bearing any cost and schedule consequences. To accommodate potential ATCs the agency can, in the NEPA process, choose to obtain approval for a footprint that is reasonably broad enough to cover ATCs.

3.4.3 Interpreting "Equal to or Better than" Clause

As discussed earlier, an ATC, to be valid, must provide an alternate solution that is functionally "equal to or better than" the requirements in the RFP. The outcome of the interpretation of the clause is a decision by the agency to fully approve an alternate concept, approve with conditions or reject in favor of the base concept. Interpreting the clause correctly can be challenging, as there is potential for making inconsistent decisions.

Many highway agencies require bidders to describe in their ATC submittals how their proposed alternate concept is equal to or better than the base concept, including the anticipated cost savings, and schedule and performance benefits. Except for concepts relating to innovations, a significant number of ATCs involving design variances or design exceptions are dependent on trade-off analysis among costs, schedule and performance. Before making a decision, the agency has a responsibility to validate the proposer's projected benefits by either undertaking value analyses on its own or requiring the proposer to substantiate the benefits using widely accepted or approved methods, standards, data and references. In accordance with the Federal regulation, Title 23 CFR Part 627, the FHWA no longer requires value engineering analysis for projects delivered using the design/build method of construction (USGPO, 2016b).

Given the number of ATCs typically handled on P3 projects in a short period, there is little opportunity for back and forth communications between the agency and proposers to clarify any disagreements over the design details, methodology and expected benefits. In cases involving innovative and emerging materials or techniques, there may not be adequate performance history to support the proposer's claims.

To ensure consistency in interpretations, there is a need for the agency to make an "informed" decision on whether the alternate concept provides equal or better value than the base concept based on its comparative "value." This entails establishing the intent of both base and alternate concepts, evaluating them to quantify their comparative value, and ensuring that the original intent is fully achieved with no compromise. In making decisions, the agency must take into consideration the risk profile of a P3 contractual arrangement when interpreting the clause.

Establishing Intent: Understanding the expressed intent of both base and alternate concepts, which is a cardinal rule in contract interpretation, is the critical step in the ATC review. The highway agency must establish the intent of a given concept in the context of the purpose and need of the project and the "essential functions" without which the facility will not perform satisfactorily or will not be delivered as planned.

The intent is typically captured using measurable performance attributes, which can be further defined in terms of service quality, asset maintenance, constructability, safety, and environmental, community and social impacts. The relative importance of these performance attributes must be established, and may change depending on the concept type and the project needs.

Value Assessment: To enable comparative evaluation of the concepts, the agency must identify value metrics that would typically include cost, schedule, risks and performance. Construing the term "value" in a narrow sense or using a single metric, say cost, schedule, a technical parameter or performance objective, must be discouraged; rather, the value should be interpreted holistically given the trade-offs between these metrics.

For example, to interpret the "equal to or better than" clause with regard to two pavement design alternatives, the value cannot be established using initial cost, schedule, structural number or thickness, or future predicted pavement distress. Such comparison may not ensure an "apples to apples" comparison, since each alternative would have different investment needs and service potential. To truly capture value, the two pavement design alternatives should be evaluated based on life-cycle costs that would be incurred to provide a desired level of service over a reasonably long period.

Making Decisions: In the end, the agency's decision to accept or reject the alternate concept will largely depend on the perception of risk that the proposed concept will entail. Taking into account the P3 contractual risk allocation arrangement associated with the concept, the agency may have to apply a stricter interpretation of the clause and follow a more rigorous evaluation when it shares or holds the risk. Note that the agency cannot disregard some aspects of performance, such as safety, user needs, and long-term needs or costs, and has to ensure mitigation of any conflicts with the purpose and need of the project.

A value-based comparison of base and alternate concepts will guide the agency to make more consistent interpretations and informed decisions in the ATC review process. Decision support methodologies, such as the Kepner Tregoe Decision Analysis, Analytical Hierarchy Process, and Risk Management tools, provide a generic but robust framework to facilitate an objective comparison of different alternatives.

Title 23 USC Section 106A requires value engineering analyses on all NHS projects with project costs exceeding $50 million, and all NHS bridge projects with costs exceeding $40 million. Caltrans has taken this requirement a step further to implement value analysis at key milestones of project development, and as early as in the project initiation stage where value analysis would be most effective. Chapter 19 (Value Analysis) of the Caltrans Project Development Procedure Manual presents the policies and procedures for applying value analysis to highway construction projects (Caltrans, 2013). The purpose of a value analysis study is to identify a best proposal from a pool of alternatives with a goal of maximizing performance, minimizing costs, and ensuring that the selected alternative aligns with the project scope, purpose and need.

Caltran's value analysis process adopts a decision analysis methodology that evaluates feasible alternatives against predefined performance criteria to select an alternative with best value (i.e., performance/cost). Performance criteria include a set of performance attributes that are essential to achieve the project objectives, with each attribute assigned with a numerical weighting to indicate its relative importance to the project. Performance attributes may include traffic operations, construction impacts, project schedule, environmental impacts, phasing ability, land-use, and maintainability. Each alternative is evaluated, scored and weighted against the performance attributes and aggregated to produce a performance score. The value potential of each alternative is evaluated using value metrics (i.e., performance score, cost and schedule) to select the best one.

Gransberg et al (2013) recommends that the adoption of a similar approach in the ATC process would reflect the agency objectives and project needs in making ATC related decisions.

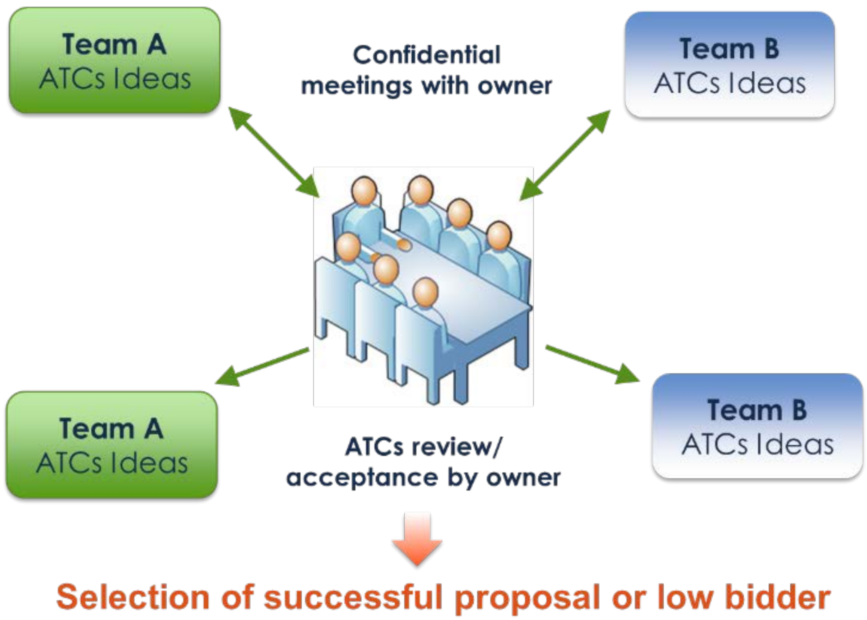
3.4.4 An Overview of ATC Process

The typical two-phased ATC process under a P3 or D-B procurement, as illustrated in Figure 8, is summarized as follows:

- The agency issues an RFQ to interested proposers, and then issues the RFP to shortlisted proposers.
- P3 proposers may submit confidential ATCs in accordance with the ATC provisions in the RFP.
- The agency may elect to hold confidential meetings with each team to review and discuss ATCs for conformance with the RFP requirements.
- If the ATC provides an equal or better solution than the base requirements in the RFP, the agency provides a conceptual approval.
- Each proposer may then use pre-approved ATCs in their technical and price proposals.
- The agency then selects apparent best value based on the evaluation criteria in the RFP.

- Upon award, the P3 private partner becomes responsible for the ATC-based design with submitted price and scope.

Figure 8. Typical Process with Alternative Technical Concepts



Source: FHWA, 2014.

3.4.5 ATC Best Practices

To make the agency's ATC process more effective, some of the best practices are summarized as follows:

- Maintaining confidentiality is critical to the success of the ATC process. The proposers need to be fully assured that their ideas have full intellectual property protection and will not be shared with their competitors. While the one-on-one confidential meetings can greatly help to reassure proposers, the "public records and sunshine clauses" of some state laws can make the ATC process more challenging or even impossible. Also, the agency should consider limiting the number and type of reviewers in the ATC process.
- To ensure fairness among proposers, the agency must follow an open, consistent and transparent process in accepting, reviewing and approving ATCs. The agency must also ensure that its reviewers provide a thorough review, consistent evaluation and adequate feedback on all ATC submittals.
- To ensure a level playing field among all ATCs, the agency should be consistent in applying the "equal to or better than" equivalency criteria. Many state agencies ask the proposers to provide the rationale for why their ATC is equal to or better than the agency's base technical requirements.
- The RFP should clearly specify the areas where ATCs will be accepted as well as the required contents of the ATC submittals. Similarly, the RFP should clearly identify how the variances or errors/ambiguities in the Technical Provisions will be handled during the procurement process.
- The approval decisions on ATCs should be made as early as possible to give proposers adequate time to develop technical solutions and cost estimates in the pursuit phase, which in turn provides better final proposals to the agency.

The agency should consider using the ATCs from unsuccessful bidders, if needed, with any restrictions or limitations, especially given the fact that stipends are paid to most bidders for proposal development. The agency can include specific clauses in the stipend agreement to ensure vesting of the full ownership rights to the information presented in the ATC submittal. Some states have legal provisions in-place that essentially transfer the ownership rights of any information contained in proposal submittals, as a matter of public records and governmental property, to the public agency.

4 Design and Construction with Performance Requirements

Once performance requirements are locked into the P3 agreement, the agency has the responsibility to oversee the monitoring and reporting of performance by the private partner and enforce the agency's contractual remedies if performance does not meet the requirements. This section discusses the roles and responsibilities of the agency during the design and construction phase of the project.

The P3 private partner has the final responsibility to ensure that the construction joint venture that enters into a D-B contract with the P3 SPV delivers all design and construction products in conformance with the contract. From the quality management perspective, the P3 private partner is responsible for ensuring that the quality management activities are followed during design and construction in accordance with an agency-approved quality management plan (QMP). The QMP places the responsibility on the P3 private partner to assure a specific level of quality for work items to be completed under the contract. The P3 private partner may either be required to follow a QMP mandated by the agency or allowed to propose a project-specific plan for agency approval. As observed in many P3 projects, the P3 SPV may utilize the services of a third-party independent certifier to provide an independent assessment of the quality of the constructed asset and/or the reliability of the contractor's quality control (QC) test results. The P3 SPV conducts this independent assessment to fulfil fiduciary responsibilities to its lenders. Nevertheless, the P3 private partner must retain and maintain all records until handback for any future use by the agency.

On the other hand, the ultimate quality assurance (QA) functions of the agency remain unchanged in that the agency is responsible for verifying contract compliance and performing final acceptance of work products for progress payments. The agency or the agency's designated agent exercises due diligence to audit the P3 private partner's adherence to the QMP. The agency's audit is typically compliance-focused to monitor, discover and correct the gaps between the QMP requirements and what is presently followed; the agency may elect to re-evaluate the effectiveness of the QMP based on process conformance and quality outcomes, if needed. For acceptance, the agency may elect to undertake verification sampling and testing at lower frequency, relying mostly on the P3 private partner's quality control effort and QMP-required remedial work for nonconformance. As a minimum, for verification sampling and testing,most agencies follow risk-based auditing under which the monitoring and measurement requirements of audits may change with the frequency and severity of quality exceptions and QMP violations.

The primary intent of the agency audits is to reduce the financial, socio-economic and political risks of asset and operational failure that may arise from defective quality of the constructed facility. The auditing process used today has been developed primarily to ensure process conformance with design specifications and "means and methods" of construction. The auditing process relies heavily on design specifications and construction quality assurance specifications to make inferences about future performance outcomes. With performance requirements, there is a need to move toward a performance based audit regime, which may involve performance modeling and performance specifications, to evaluate future risks.

4.1 Roles and Responsibilities during Design

Prior to the procurement, the agency will carry out some initial design for planning and environmental approvals. That design will be used to define the project limits/"envelope" at the start of procurement. This becomes the starting point for the P3 private partner's design; however, to avoid being prescriptive and potentially conflicting with any performance requirements, the design is included on a purely indicative or in legal terms a "Reference Document" basis – often called an indicative preliminary design (or IPD).

The indicative preliminary design is locked in before the commencement of the RFP process and is incorporated into the P3 agreement as a Reference Document only. Using the indicative preliminary design as a reference, the facility is designed by the P3 private partner to achieve the performance requirements within the bounds of P3 agreement technical requirements including operational performance requirements, project limits, environmental constraints, and schedule deadlines. The P3 private partner assumes liability for all design flaws under the P3 agreement, unless the agency assumes the liability through its prescriptive design criteria or unintentional overstep into design decisions. The P3 private partner will internally still try to "pass down" as much of this risk as possible to the designer of record, which has the "stamp and seal" responsibility to ensure that the design packages are in accordance with the P3 private partner's D-B contract requirements with no unapproved design exceptions.

The agency's role is limited to exercising due diligence for compliance during the design process by:

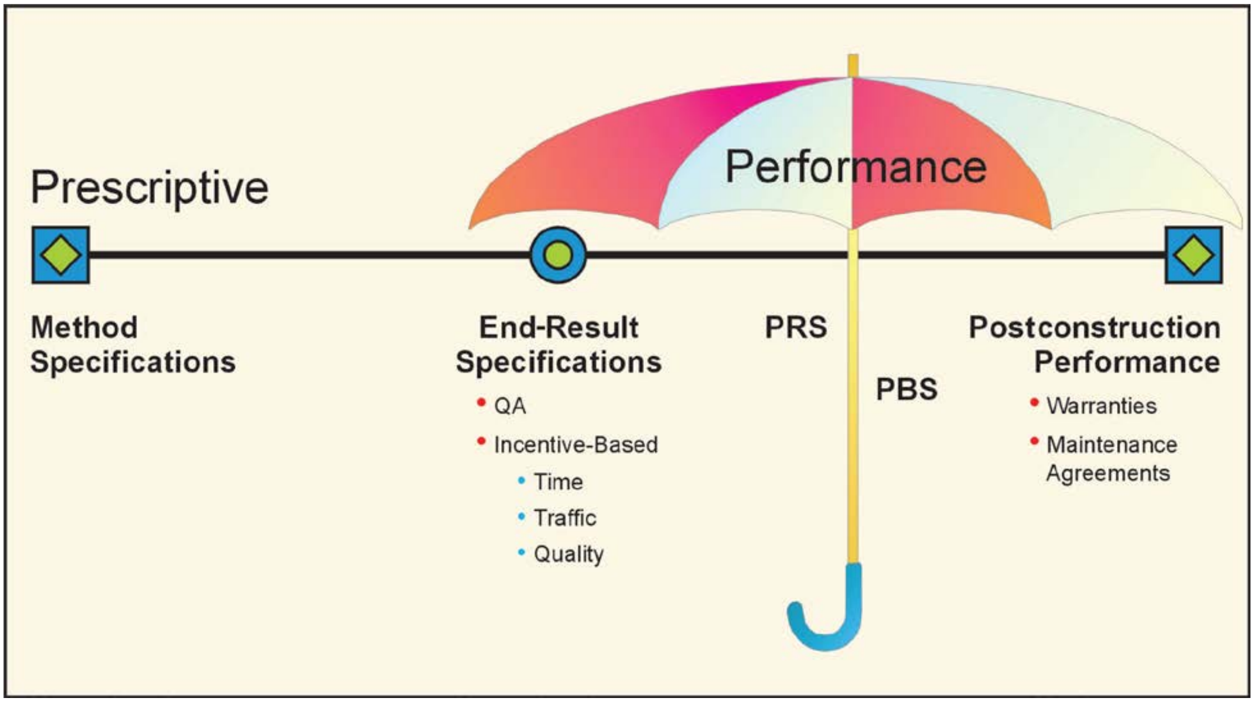
- Checking whether the design products are in compliance with agency-approved design standards and performance requirements;
- Flagging any deviations or variances not approved in the P3 agreement;
- Providing design sign off informally and formally;
- Checking whether the P3 private partner is in compliance with the P3 private partner's approved design QMP;
- Performing design audits at hold points; and
- Providing "acceptance" to 100 percent designs to release for construction.

4.2 Roles and Responsibilities during Construction

4.2.1 Construction Specifications

Figure 9 presents the continuum of highway construction specifications: at the left end of the continuum are method specifications, where the agency specifies means and methods of construction, but takes responsibility for the quality and performance of the constructed asset (Scott et al, 2014). Method specifications consist of an agency's prescriptive instructions to the contractor on how a product should be produced and placed using specified methods, materials, equipment and techniques. Since the agency directs each step of the contractor's operations, the agency takes responsibility for the quality outcomes, while the contractor has to meet the materials and methods requirements of the agency.

Figure 9. Continuum of Highway Specifications



Source: Scott et al, 2014. (PRS is Performance-Related Specifications; PBS is Performance-Based Specifications)

As the continuum shifts to the right end, the private partner assumes more risk and responsibility to ensure the performance of the constructed asset over the concession period. This may include construction period performance specifications that indicate future performance to some extent, or operational performance-based provisions. With performance specifications, the agency relinquishes the control on means and methods to focus on desired outcomes and results. The performance specifications include: (i) performance-related specifications (PRS) that correlate measured quality characteristics with anticipated product performance and evaluate life-cycle cost impacts; and (ii) performance-based specifications (PBS) that utilize measured fundamental engineering properties to predict performance using performance prediction models.

In the middle are the End-Result and Quality Assurance (QA) specifications that place the responsibility for construction process and production on the contractor, and acceptance on the agency. The QA specifications clearly delineate the functions and responsibilities of the contractor (including subcontractors and material producers hired by the contractor) and the agency: the contractor is responsible for quality control and inspection to control process and product variance, as set by the specification limits, through monitoring and capturing of measurable quality characteristics; whereas the agency evaluates the contractor's conformance to specifications using its QA program-approved sampling and testing of select quality characteristics to make acceptance decisions. The agency may use some of the P3 private partner's QC information for their acceptance determination as long as the agency validates the QC data prior to using it (FHWA, 2012).

With its foundations in industrial production-based statistical process control, the QA specifications place the emphasis on the statistical evaluation of the contractor's degree of conformance to the agency's specification criteria. The construction quality is determined based on how well the quality characteristics are controlled within the specification limits. In other words, the agency makes a decision to fully accept the product, reject, or accept with pay adjustments, based on the tendency of the measurements of those quality characteristics to stay within specification limits and their spread. The pay adjustments are made based on the level of quality achieved on the finished product: typically, an incentive is paid to the contractor if the desired level of quality is exceeded, while a disincentive is devised to penalize the contractor for any performance loss due to poor quality.

Agencies typically select quality characteristics and specification limits that are deemed to have direct bearing on good performance; for example, strength and air voids for concrete, retroreflectivity for signs, in-place densities and binder content for hot mix asphalt. However, the methodical relationships between the quality characteristics and performance are not explicitly considered to provide any indication of future performance impacts when making acceptance or pay adjustment decisions.

4.2.2 Construction Quality Assurance

The agency's role during construction is one of auditing the P3 private partner's process by conducting construction inspection on a sampling basis, cross checking the P3 private partner's testing, validating the P3 private partner's QC data, performing its own verification testing, and in general checking whether the P3 private partner is complying with the approved QMP. Note that the agency's acceptance does not imply any kind of fit for purpose or guarantee that the constructed facility will meet the performance requirements in operations.

The P3 private partner's QMP sets the quality standards, in terms of measureable quality characteristics, acceptance limits and quality-based pay adjustments for the constructed asset, as the P3 private partner's SPV has the overall responsibility to ensure desired level of performance over the concession period in accordance with the P3 agreement. Note that the D-B subcontractor works directly for the SPV and may execute a limited warranty agreement for specific asset types.

Adopting "means and methods" specifications from the traditional D-B-B environment is not compatible with performance requirements; rather, the use of "performance specifications" will provide the continuity between the quality characteristics measured during construction and anticipated future performance. The QA specifications, which are in common practice today, have served reasonably well, particularly given that the responsibilities of the O&M phase were traditionally held by the agency. However, when implementing performance requirements, the agency will have to be careful not transfer back from the private partner to itself any performance related risks. It is particularly important to ensure that the quality characteristics adequately, collectively and reliably capture future performance risks, and that the quality-related pay adjustments are commensurate with any performance gains or loss in the future. Performance specifications provide continuity between design and construction, while allowing the agency to readily evaluate the future performance risks of the constructed product.

Ideally, the QMP should identify performance criteria (or quality characteristics derived from agency-specified performance criteria) to measure construction quality and directly relate them to required future performance thresholds. For example, the agency may specify a desired level of lumen outputs of roadway lighting or a smoothness criterion for pavements; in both cases, acceptance limits can be derived directly from agency-specified criteria, such as an initial smoothness threshold of newly constructed pavement and minimum initial lumen output of roadway lighting. This will provide some indication of anticipated future performance. The acceptance limits can be derived by corresponding technical disciplines of an agency using historic construction quality and performance data as well as scientific or empirical forecasting models.

However, there may be many scenarios where performance criteria are not available or cannot be derived directly to measure construction quality. For example, the agency may use a performance criterion that limits pavement rutting to 0.50 inches at all times over the concession period; however, rutting measured on a newly constructed pavement will typically be zero, thus providing, no indication of anticipated future performance. While the designer may have demonstrated designs meeting this criterion, there are many construction-related outcomes, such as the content of the bitumen, or air voids in the bituminous pavement layer, which can "eventually" affect the future rutting performance of pavements [as well as the on-going operational and maintenance performance of the P3 private partner].

Figure 10 illustrates two examples of performance requirements for acceptance of pavement construction quality with pavement smoothness and rutting. In the pavement smoothness example, a maximum allowable limit of IRI was set by the agency at 160 inches/mile, while a rejection limit of 65 inches/mile provides a reasonable indication of the quality of construction as well as the future anticipated performance. However, in the example of pavement rutting, a maximum allowable limit of rutting was set at 0.4 inches, while the quality of construction and its impact on future anticipated rutting performance can only be inferred with other quality characteristics not derived directly, but related to a performance criterion.

Figure 10. Illustration of Quality Characteristics for Two Examples of Performance Requirements

Essential Function	Performance Requirement for Pavement Surface	Performance Criteria for Pavement Smoothness	Design Decisions	Criterion for Construction Acceptance
• Pavement Surface for Vehicular Traffic	• Safe, Smooth and Durable Riding Surface	• Maintain an IRI to less than 160 inches/mile	• Limit initial IRI to less than 65 inches/mile and control the rate of smoothness loss	• IRI less than 65 inches/mile

Essential Function	Performance Requirement for Pavement Surface	Performance Criteria for Pavement Rutting	Design Decisions	Criteria for Construction Acceptance
• Pavement Surface for Vehicular Traffic	• Safe, Smooth and Durable Riding Surface	• Maintain rutting to less than 0.40 inches	• Select a bitumen grade of PG 70-22 • Limit air voids to 7 percent and bitumen content to 5 percent	• Bitumen grade PG 70-22 or better • Air voids within 7 ± 0.50 percent • Bitumen content within 5 ± 0.25 percent

Source: WSP | Parsons Brinckerhoff

Hence, there is a need to incorporate quality characteristics in the QMP that can be readily used to measure construction quality and still provide some indication of anticipated future performance. In such instances, both the agency and the P3 private partner may use performance specifications that include performance-related or performance-based specifications with statistical process control and acceptance elements of QA specifications. Performance specifications are better suited to evaluate whether the intent of the performance requirements has been met at the construction stage. The P3 private partner can utilize performance specifications to relate the basic quality characteristics (e.g., density of concrete) or fundamental engineering properties (e.g., elastic modulus of concrete) to required performance (e.g., structural cracking of concrete) and corresponding life-cycle cost impacts through engineering and/or empirical relationships. On the other hand, the traditional QA specifications rely on the statistical variability of measured quality characteristics and leave the risk of the QA process achieving the final asset performance with the public sector.

Some asset types have more mature performance-related or performance-based specifications than other asset types. The following is the snapshot summary of the readiness of performance-related or performance-based specifications for various asset types and construction impacts:

- Bituminous Materials (includes hot mix asphalt, warm mix asphalt, and other variants): The state-of-the-practice is to follow traditional QA specifications based on statistical analyses of key quality characteristics (e.g., asphalt binder content, in-place air voids, gradation). Both performance-related specifications and some aspects of performance-based testing are ready for piloting and eventual implementation. Various studies, including NCHRP Project 9-22, have developed a framework with supporting tools for implementing performance-related specifications. Similarly, a feasible technical framework is available for performance-based specifications with proven testing capabilities and performance prediction models.

- Cement Concrete for Pavements: Traditional QA specifications use key quality characteristics of fresh and hardened concrete, such as strength at different ages, unit weight, slump, and air content. Though the FHWA-developed "PaveSpec 4.0" tool is implementation ready, the performance-related specifications for concrete pavements have been implemented only on pilot basis. In recent decades, there has been significant progress towards the implementation of performance-based specifications for concrete pavements.
- High Performance Concrete for Bridges: Similar to concrete pavements, QA specifications for bridges use key quality characteristics of fresh and hardened concrete. Historically there has been a greater emphasis on strength properties of concrete; and more recently, considering the longer service lives of bridge structures, there has been an increased emphasis on the measurement of quality attributes relating to bridge durability, such as chloride ion penetration and freeze-thaw durability of in-place concrete. Research advancements have made durability performance modeling possible for bridge structures.
- Earthwork: Due to the inherent geographic and temporal variability in soil properties and differing site conditions, agencies have traditionally used "prescriptive" criteria for geotechnical work. For shallower earthwork, such as pavement subgrade construction, agencies have adopted QA specifications with key quality characteristics, such as moisture content and in-place densities to evaluate the quality of compaction achieved. There is a possibility to progress towards a more performance-related approach with technological advancements in construction equipment (e.g., intelligent compaction machines embedded with sensors that measure compaction quality in real-time) and geophysical methods. However, with deeper foundations and large-scale earthwork, agencies have retained or shared the geotechnical risks with the private partner. Some agencies have adopted a strong risk and asset management approach for geotechnical assets. In the last few years, highway agencies have been using alternative technical concepts to mitigate geotechnical risks (Gransberg and Pereira, 2016).
- Work Zone Operations: Performance specifications are more mature for evaluating the quality of work zone operations during construction. Robust performance measures are available to evaluate the effectiveness of transportation management plans in terms of lane availability, mobility of work zone traffic, safety impacts, and incident detection and clearance. In many highway construction projects, agencies have utilized performance specifications in some form to manage work zone performance. They have served as the basis for schedule-focused alternative contracting strategies, such as lane rental and cost plus time bidding with incentives/disincentives (I/Ds).

In summary, it is not always possible to use performance-related or performance-based specifications, given their varying maturity levels with different asset types. Traditional QA specifications can be substituted for construction acceptance where necessary. Regardless of the type of specifications, it is paramount that the agency and the P3 private partner have clarity on the type of construction specifications, quality characteristics to be measured, acceptance criteria for QC and acceptance, sampling frequencies and testing protocols, and statistical criteria for verification. These must be identified clearly in the P3 agreement or QMP.

5 Implementation Considerations

The concept of performance requirements is relatively new and nascent in the project/service delivery landscape of the U.S. highway industry. Adopting performance requirements for use in regular or routine practice represents a significant step forward for an agency. The agency's procurement team, especially the leaders of various technical disciplines, may have to embrace a new approach that is vastly different from the traditional D-B-B mindset. For example, the agency will need to develop requirements with a focus on lifecycle and operational performance, conduct "oversight" of the delivery of a service and an asset, and understand their legal consequences. Changes may be needed in the procurement workflow, such as allowing more time for drafting performance requirements and the ATC process, and bringing O&M staff into the procurement process to help draft or review the performance requirements for the highway "service". Further, the use of performance requirements represents a paradigm shift for the industry as well. The private sector needs to adapt to the evolving perspectives of a "whole life" or "output" based approach when interpreting technical requirements. Training may be necessary for both agency and private sector staff to help adapt to the shift in roles and responsibilities, the need for performance-oriented perspectives, and change in delivery environment. Recognizing these challenges, this section presents a discussion of implementation strategies, including change management, training needs, and institutional capacity building.

5.1 Organizational Change Management

5.1.1 Challenge of Drafting Performance Requirements

Drafting true performance requirements that bring out the most innovative solutions for design and construction items is an important agency exercise for P3s. The agency needs to understand the important attributes that constitute good performance requirements. The following paragraphs present some of the salient points to consider in drafting performance requirements:

- Performance requirements *need to set clear targets*. This often entails requiring a better understanding of lifecycle operational and maintenance characteristics of assets. Some performance requirements need an understanding of what the end-user values most and how the end-user interacts with these assets.
- *Interdisciplinary teams especially the environmental impact statement (EIS) team, construction and operations (maintenance and asset management) teams should be a part of drafting performance requirements*. Contradictions arise when drafting sections separately. These may be resolved by jointly brainstorming key goals/provisions (e.g., pavement, structures, toll system performance).
- *Independent advisors may also be considered* to audit the performance requirements.
- *Teams responsible for drafting performance requirements* during the request for proposals phase *need to link the requested performance standards to the proposal evaluation process*. The technical evaluation criteria need to be able to clearly evaluate the quality and capability of the proposer to deliver the required performance standards.
- While defining performance requirements, agencies need to *determine the methodology and frequency of monitoring*. Depending on the nature of the performance being measured, the methodology of evaluation includes self-reporting, *ad-hoc* audits, external audits, spot checks, end-user surveys, joint reviews, etc.
- It is important that the agency's and wider government's *interests are protected by the P3 agreement terms and conditions*. Linking project performance requirements to agency and societal goals is another consideration. This linkage is built on the concept that many small and specific performance requirements

help achieve project goals which will eventually lead to larger, more significant societal accomplishments. However, agency goals can change over time in response to societal goals, while P3 agreements are more rigid in defining performance requirements.

- While drafting performance requirements, it is important to *take into account any future changes to service requirements*.
- *Avoid going overboard* in having *irrelevant performance requirements* resulting in needless oversight, audit and contract management effort for the agency and delays in service availability. Superfluous performance requirements could lead to additional private sector costs which could transfer to the agency or the end-user. Having too many performance requirements can result in less focus on crucial performance measures. One of the outcomes of impractical performance requirements is additional effort needed to measure and report performance. This could lead to a complicated and costly execution. It can also be challenging to devise a fair and transparent mechanism to evaluate pros and cons of alternative approaches to meeting performance requirements.
- Performance requirements would also *need to cover end-of-term condition of the assets* and their performance measurement through the handback period.
- Agencies need to *allow sufficient time for drafting performance requirements*. Requirements can be drafted in parallel to the request for qualifications process to meet political need to compress schedule or show action. However, key decisions within public side need to be made on scope, goals, and risk allocation that requires early mobilization of the P3 unit (if there is one). The need for training of new staff plus any project specific lead staff and ramp up of the P3 consultant team are assessed and the needs fulfilled early. The P3 consultant team engages with all relevant public departments to facilitate discussion on goals and support training, if required. Frequently, P3 advisory teams are hired just before request for qualifications which is too late and delays the draft request for proposal. Training needs to include the concept and implications of design, build, finance, operate and maintain (D-B-F-O-M) as a service, integration of O&M and rehabilitation staff in the discussion, and need for "future proofing" (especially handback requirements).

It is challenging, and may even be impossible, to prepare 100 percent pure performance-based requirements. In some cases, drafting these performance requirements may require a few limited prescriptive inputs and methods in order to set proper expectations and avoid misunderstanding. However, prescriptive inputs could be the result of a need to address physical project or stakeholder commitment constraints, and not simply due to preference.

5.1.2 Cultural Change in Design and Construction Oversight

Capacity building to procure and administer P3 contracts includes culture change management, particularly with respect to design and construction oversight. Traditional roles of the agency in these areas will undergo a departure from current practice. In many P3 transactions, the agency's responsibility for design and construction engineering is changed from the "doer" to the "administrator." In other words, agencies become responsible for contract management and oversight of the private partner. This cultural change in roles may lead to a shift in the types of technical skills required within an agency. There may be less need for hands-on design, and more need for understanding and setting of broader performance standards covering the lifecycle operational and maintenance characteristics of the assets, and project management and oversight. Some key aspects to consider include the following:

- *Need for different staff and different skill sets*; not necessarily fewer staff. In fact, for design review, an agency may need to allocate more staff to guarantee turnaround times outlined in contracts and ensure engagement of operations and asset management staff to assess downstream consequences of design and construction innovations (e.g., in asset management). The staff skill sets should cover the following salient aspects of the procurement:

- Focus on the performance outputs;
- Avoid means and methods; and
- Confidently challenge private side as appropriate.

Potential role of an independent engineer in acceptance of work and substantial completion/final acceptance. This affords the following advantages:

- Integrates needs of project funding entities and is more cost effective; and
- Allows sharing the benefit of "duty of care."

The use of an independent engineer is commonly tied to project finance in the power industry and international transportation P3s. However, current state laws often limit ability to transfer approval powers to the independent engineer (e.g., California law does not allow this and Florida law limits the role of the independent engineer).

Several novel aspects of P3 procurement demand training of the agency's P3 staff. Training needs are required to cover the following aspects at a minimum:

- Legal issues—different approach to changes (see Section 5.2 for more details).
- Dispute resolution process—different and potentially slower if not managed throughout the contract. It does not end at Final Acceptance.
- "Audit" approach to Oversight—potential to undermine risk transfer by direction to use methods and insufficient verification and contract enforcement.
- Training of staff in performing *"over the shoulder" reviews to balance the danger of acceptance going too far into "approval."* The agency needs to reserve rights if final integrated product misses performance requirements.
- Agency *staff needs to be sufficiently trained to meet the challenge of substantial completion testing*.
- Rigorous testing - Such testing needs to be rigorous as a big payment is triggered and the results are as binary as possible. In some cases this could mean minor issues are waived to avoid disputes. Deductions for minor issues can be applied to operational period availability payments to reduce disputes; for example, they could be spread over the first year of availability payments.
- Phased Approach - It is a good practice to phase in testing in stages. Also contracts structured such that availability payments are stepped up as successive project phases are opened reduce the risk to the agency.

5.1.3 Engaging Stakeholders

In traditional delivery, environmental, planning, engineering, financial, legal, procurement, operation and maintenance, and rehabilitation experts may be housed in different offices because the traditional project development process steps are often sequential. However, these experts need to coordinate more closely in a P3 service delivery. Many of the project development steps need to be carried out on a collaborative and iterative basis, requiring more frequent interactions and internal coordination. Developing projects iteratively, rather than sequentially, may require forming and managing multidisciplinary teams that understand the interactions of various technical, financial and legal factors. This can facilitate an iterative project development process. It is important to understand the financial, lifecycle operational and maintenance characteristics and legal contractual implications of any performance requirement that the agency develops.

Additionally, it might be required to conduct end-user surveys upfront to find out what operational issues (e.g., safety, comfort, accessibility, travel time, etc.) are most relevant to them. Finally, engaging the proposers in discussions at the procurement phase can help in drafting effective performance measures–this is a major change from traditional delivery.

5.1.4 Best Practice in P3 Operational Audit/ Contract Management

A challenging area of P3 procurement is the cultural shift in operational audit and contract management. Some of the salient aspects to bear in mind are noted below.

- Performance needs to be monitored over the long term. To conduct oversight of long-term concessions, agencies will need to develop their internal capabilities with the understanding that staff may retire or leave and that the demand for specific capabilities may fluctuate over time. Building robust capabilities and documenting institutional knowledge, processes and guidelines is important for maintaining performance monitoring capabilities over time.
- Since P3s apply long-term performance requirements identified at the beginning of the contract, these requirements may be affected by changes in the external environment (e.g., new technology, economic conditions, environmental considerations, etc.). In order to ensure performance throughout the operational period, a P3 will allow for some flexibility to enable sensible approaches to be taken to problems and unforeseen issues as well as opportunities to increase quality or performance during operations. It is important that the contract management process is able to spot such risks and opportunities and act upon them effectively. Good contract management should not be reactive, but should proactively anticipate and respond to the needs of the future. This *might require having an experienced contract management support team* in the agency to help contract managers to handle intermittent but more complex issues, such as changes in performance requirements, scope or refinancing. It *could also require reengaging advisors who assisted with drafting performance requirements* during the procurement phase, to support the contract implementation phase.
- An agency might be accustomed to conducting contract management or operational audits in a specific way. In order *to get an objective assessment* of the private party's performance, a combination of *several evaluation methods must be considered based on the situation*.
- *Micromanagement of the private party can result in additional costs* for the agency and risks that the private party is already being paid to bear.
- *When the contract incorporates and links payments to clear performance requirements, it helps with early detection of any performance deficiencies*. This also results in reduction in payments to the private party, which should provide a built-in incentive to perform to the standards required in the contract.
- *Contract management would need to consider handback performance requirements* to help manage transition of assets and operations at the end of the contract term.
- *Drafting of the contract administration manual* that consolidates information on the terms of the contract and the processes and procedures for managing it, including performance measurement responsibilities and timelines, *would possibly need involvement of the private party.*
- *Performance models* based on asset management and maintenance management data repositories may be used to come up with performance requirements, their frequency and methodology of monitoring. However, these models *may not always be perfectly reliable* and accurate, which could result in issues like

impractical or unenforceable performance requirements. To ensure performance throughout the operational period, a P3 should allow for a bit of leeway to apply prudent measures to overcome such unforeseen issues, e.g., *devising alternate performance requirements or models which account for new data.*

- *Asset lifecycle and operational performance information* is a key enabler for developing effective performance requirements. There is a need to capture information continually and seamlessly beginning with design decisions and construction choices through facility performance and renewal. Breaking down institutional silos or bottlenecks that hinder information capture is paramount. Technological advancements, such as civil integrated management, contribute to the success of information capture and utilization.

5.1.5 Initial Stages of Implementation: What to Expect?

The availability of specific skills needed to develop, deliver, and manage P3s can represent a major implementation challenge. Implementing successful P3s in large part relies on the abilities of the individuals tasked with making them work. Having the right mix of skills is vital to the integrity of the program. A good understanding of the various facets of setting performance requirements strengthens the negotiating position of the government and helps ensure that projects get implemented successfully.

Unless the agency is deeply experienced in delivering P3s, there will be a need to hire procurement experts and/or specialist advisors such as lawyers, financial analysts, and engineering specialists to support the agency during the RFP phase. It might not be practical to cultivate these skills in-house at the start of a P3 program, especially when opportunities to work on a P3 project may be intermittent. Consultant advisors in the P3 space may be more expensive on a per hour basis than agency employees, but they usually bring skills that may not be cost-efficient for the agency to maintain in-house on a permanent basis (e.g., financial analysis, risk analysis, value-for-money analysis, etc.). These advisors can bring expertise from other engagements and do not need to find continuing roles in the agency once their work is complete.

Consultant advisors can be brought in as a team or individually, in which case agencies should ensure coordination among the various team members and the agency staff. These advisors should be brought into the process early and should be paired with agency counterparts. Additionally, agencies will need to train or hire internal staff to be capable of understanding and managing the P3 process and managing the agreement once it is signed. In some cases, advisors hired to assist on a P3 project can also be used to train internal staff. Many of the agency design, engineering, construction, and oversight staff would need to be trained to cross collaborate in drafting performance requirements. Key areas of collaboration include: (i) construction and operations so that construction requirements do not restrict efficient operations; and (ii) construction and maintenance regarding renewals so that maximum flexibility is given to the P3 private partner to optimize the trade-off between initial construction and the need for more frequent interventions.

5.2 Legal Perspectives

5.2.1 Spearin Doctrine

United States v. Spearin remains a landmark construction law case. Under the *Spearin* doctrine, a contractor will not be liable to an agency for loss or damage resulting solely from defects in the plan, design, or specifications provided to the contractor. The agency is deemed implicitly to warrant that its detailed design or method-based specifications are accurate and, if followed, will result in a functioning system. In any claim for liability based on a defective specification, the plaintiff must show that not only is the specification at issue detailed enough for the *Spearin* doctrine to apply, but also that the alleged defects in the specification have directly resulted in the agency's loss or damage. Notwithstanding a finding that a particular specification is a design specification, if the contractor is unable to show that the specification caused additional costs and project delays, it will not be granted relief.

The *Spearin* doctrine was developed in the context of a D-B-B construction project where the agency produced the design documents, supplied these documents to a construction contractor, and the contractor constructed the project in accordance with these design documents. However, the applicability of the *Spearin* doctrine is less certain where the same contractor or developer designs, and constructs (and operates and finances) the project on behalf of the agency as is the case with Design-Build or a P3.

Case law precedent on this issue is not robust. Nevertheless, a decision in 2013 by the U.S. Civilian Board of Contract Appeals is instructive regarding the limits to an agency's ability to transfer risk to a contractor by assigning the contractor design responsibility. In its decision, the Board held that, even where the contractor's method of excavating a hillside had flaws, the agency's defective specifications in the procurement documents (including incorrect dimensions in the prescriptive specifications for the hillside wall and inaccurate geotechnical report) and the contractor's discovery of unanticipated subsurface conditions were responsible for the subsequent instability of the hillside (Drennon Construction & Consulting, Inc. v. United States Department of the Interior, 2013).

5.2.2 Design Specifications v. Performance Requirements

The legal distinction between design (or generally "prescriptive") specifications and performance requirements is straightforward. A design specification "set[s] forth in precise detail the materials to be employed and the manner in which the work is to be performed" (J.L. Simmons Co vs United States, 1969). The contractor is obligated to follow such specification without deviation, "as one would a roadmap." This contrasts with a performance requirement, which is the preferred type on a P3 project where the same contractor both designs and constructs the project as a subcontractor to the P3 private partner's SPV. A typical performance requirement "set[s] forth an objective or standard to be achieved" leaving contractor discretion in how it chooses to meet that objective. The agency's warranty under the *Spearin* doctrine does not apply to performance requirements. Instead, the contractor (i.e., P3 private partner) is deemed to have assumed the risk of designing and constructing to meet the performance criteria.

While straightforward, the distinction between design specifications and performance criteria is not absolute. In distinguishing between design specifications and performance based specifications and resulting liability, courts look at a mixture of legal and factual considerations. Courts look to the obligation created by the criteria. Merely labeling a specification "design" or "performance" is not enough to create, relieve, or limit liability of the contractor/P3 private partner or agency. A simple way to determine whether a specification falls into the category of a "design" specification or "performance" requirement, is to ask whether it specifies "inputs" to the project (i.e., requiring a specific material such as steel or concrete) or "outcomes" for the completed project (i.e., load-bearing capacity, years of useful life, etc.). Rulings in some instructive cases are summarized below:

- *Fru-Con Construction Corp. v. United States*. 32 Fed. Cl. 94 (1998). The issue arose out of problems with the contractor's detailed blasting plan. The contract identified information that the contractor must include in the blasting plan, which was subject to review and approval by agency. However, the court found that guidance provided by the agency did not take away the contractor's opportunity to use its own discretion in developing the blasting plan, since the agency "neither prescribed an exacting blasting procedure nor mandated the use of certain explosives or equipment."
- *J.L. Simmons Co. v. United States*, 412 F.2d 1360 (Ct. Cl. 1969). The court focused on the level of discretion given to the contractor within a specification. Where specification serves as a "road map" or a "recipe" it is treated as a design specification. In this case the specifications at issue set forth, among other things,

specific requirements for the types of piles to be used and the type of pile driving equipment to be used, and the procedures for such use, which were to be approved in advance. These specifications, which effectively directed the contractor's means and methods for driving piles and left the contractor little discretion in performance of this task, were found to be design specifications due to their level of prescription.

- *Caddell Construction Co. v. United States*, 78 Fed. Cl. 406 (2007). The contract expressly provided that means and methods, sequencing, and scheduling were left to the contractor. However, nine pages of the contract were devoted to specifications for structural steel with specific instructions on what types of bolts, washers, nuts, welds, finishes and connections could be used. The court also found instructive the fact that neither the general contractor nor its subcontractor had the expertise necessary to make any changes while still meeting the stated objective of constructing an earthquake resistant building; instead the contract assigned all such decisions to the agency's architect/engineer. In summary, the court found that, while initially stating that means and methods were not prescribed, the detailed and prescriptive nature of the requirements made them design specifications.

5.2.3 "Differing Site Conditions" Clause

Differing site conditions is a major risk that is typically retained by the agency in D-B-B contracts but can lead to expensive claims for time and cost of redesign. The common differing site conditions clause gives the contractor cost and time relief for (a) subsurface or latent physical conditions encountered at the site that differ materially from those indicated in the contract,[1] or (b) unknown physical conditions at the site of an unusual nature, which differ materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the contact. Differing site conditions may include not only geotechnical issues but also major unknown underground utilities. Note that Federal Regulations 23 CFR 636.114 encourages, but not requires, the consideration of differing site conditions when allocating risks in the RFP document.

In P3 Agreements, the agency may seek to absolve itself of any responsibility for errors or omissions in agency-supplied information, including geotechnical and utility information. However, the better practice is some form of explicit risk sharing based on the extent of investigation undertaken by the agency, the proposer's opportunity to conduct its own investigation prior to making its proposal and the cost in doing so, and the perceived risks in the particular site.

[1] To establish entitlement to an equitable adjustment based upon a subsurface or latent physical differing site condition, a plaintiff must demonstrate by a preponderance of the evidence that (1) the Contract affirmatively represented the subsurface conditions of the work site that form the basis of the instant claim; (2) plaintiff acted as a reasonably prudent contractor in interpreting the Contract; (3) plaintiff reasonably relied upon the Contract's indications of subsurface conditions; (4) the subsurface conditions actually encountered at the work site differed materially from the subsurface conditions of the work site indicated in the Contract; (5) the subsurface conditions actually encountered were unforeseeable; and (6) plaintiff's claimed excess costs are solely attributable to the materially different subsurface conditions at the work site. *Kiewit Construction Company v. United States*, 56 Fed. Cl. 414 (2003), citing *Weeks Dredging & Contracting, Inc. v. United States*, 13 Cl. Ct. 193, 218 (1987), aff'd, 861 F.2d 728 (Fed. Cir. 1988).

The leading case that supports giving a design-builder (and by extrapolation a P3 private partner) a remedy for differing site conditions in spite of disclaimers is *Metcalf Construction Co. v. United States,* 742 F.3d 984 (Federal Circuit 2014). The federal court of appeals in that case held:

> "Nothing in the contract's general requirements that Metcalf check the site as part of designing and building the housing units, after the contract was entered into, expressly or implicitly warned Metcalf that it could not rely on, and that instead it bore the risk of error in, the government's affirmative representations about the soil conditions."

Some owners provide the winning P3 private partner proposer a limited period of time following contract execution to validate information provided by the agency, or a "scope validation period." By this device, the agency retains the risks of differing site conditions until the design–builder has had the appropriate opportunity to validate the information provided in the request for proposals. Where the P3 private partner cannot obtain immediate access to the site, or certain portions of the site, this period may need to be extended.

Where transferring all the risk to the P3 private partner could result in very large contingencies in the pricing or even in discourage proposals, the agency may agree to retain a portion of the site condition risk by making dedicated a pool of funds or "allowance" available to the project in order to deal with unanticipated conditions. Any costs above that amount would be absorbed by the winning P3 private partner (Loulakis et al, 2015). Note that, due to the constraints of the financing in a P3 and the need for a fixed AP or toll bid, the scope validation approach is not applicable; however, an "allowance" approach to sharing the middle "slice" of the risk is applicable. In this case, the first loss and duty to mitigate apply first to the P3 private partner, then the allowance is used to share the cost in a defined range. For extreme events the full risk is covered by the public partner (as "insurer")

5.2.4 "Brand Name or Equal" Clause

A proprietary specification is created when the description of a product or process cites a specific brand name or is written so narrowly that only one manufacturer could supply the desired item. Where a contract uses a proprietary specification, the contractor has no discretion but is bound to use it, and, therefore, has the benefit of the agency's implied warranty under the *Spearin* doctrine and is not held liable if the product fails to perform or is defective (WRB Corp. v. United States, 1968; Wood-Hopkins Contracting Co. v. Masonry Contractors, Inc., 1970).

While the use of performance criteria is the preferred practice of the federal government, FAR 11.104 acknowledges that the use of "brand name or equal" clauses may be advantageous under certain circumstances (USGPO, 2016c). Pursuant to FAR 11.104(b), such clause "must include, in addition to the brand name, a general description of those salient physical, functional, or performance characteristics of the brand name item that an 'equal' item must meet to be acceptable for award." FHWA has issued the following guidance on use of "brand name or equal" clauses (FHWA Technical Advisory HIAM-20, 2010 and FHWA Construction Program Guide, 2016):

> "The use of trade names in specifications can sometimes be avoided by writing requirements in terms of desired results. A generic, end-result specification is preferable to specifying a proprietary product because it can promote competition. However, simply deleting the name of the product while retaining all of the salient characteristics from the manufacturer's literature or cut sheets would not necessarily create a non-restrictive specification. Without providing some range of quality or performance, it may still be possible that only one manufacturer or vendor could meet the performance criteria. Adding the phrase 'or equal' next to a brand name similarly does not make a proprietary specification competitive if the technical requirements can only be met by the named brand. To ensure a specification is competitive, a reasonable number (as determined by the division office) of manufacturers or vendors should be able to provide or achieve the specified results."

Hence, because a "brand name or equal" specification allows the contractor to propose an alternative to the brand name, it is treated as a type of performance requirement.

In *Florida Board of Regents v. Mycon Corp.*, the specification at issue required the contractor to "provide a skin plate with a smooth, non-corded 'true radius' forming surface, equal to that manufactured by Symons."[2] The court stated that "a contract provision calling for quality of the product to be the equivalent of a specific manufactured product is a performance specification, involving no implied warranty, unlike a design specification."[3] The court found nothing in the contract to contain elaborate, detailed instructions on how to perform the contract and held that the reference to Symons skin plate was not enough to rise to the level of a proprietary specification.[4]

In *Aerodex, Inc. v. United States*, the contract identified a brand name thermal resistor "or approved substantial equal."[5] However, the issue arose due to the fact that the identified brand name product was not commercially available and the government was unable to provide material specifications such that the contractor could find a "substantial equal."[6] The contractor was able to locate a manufacturer that could manufacture a "substantial equal," but sustained costly delays due to the fact that it was required to develop a testing procedure as there was no available testing procedure or equipment to verify compliance with the performance specifications.[7]

The *Aerodex* court stated, "[i]t is not enough for the Government to say … that because it was a performance-type specification, the contractor was obligated to select whatever method it desired to produce the required result. This oversimplifies the burden[.]"[8] Despite treating this as a performance specification, the court looked at the duty of the contractor to inquire about availability during the procurement with the duty of the government to inform the proposer of the availability of the product or the material specifications and testing procedure for approving a "substantial equal," and ultimately ruled in favor of the contractor stating that the

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[2] 651 So.2d 149 (Fla. 1st DCA 1995).
[3] *Id*. at 153
[4] *Id*. at 154
[5] 417 F.2d 1361 (1969).
[6] *Id*. at 1363.
[7] *Id*.
[8] *Id*. at 1370.

government "was in a far better position than plaintiff … to tell whether the resistor would be available from [manufacturer] and, if not, whether the plans would be available."[9]

Eslin Co. is often cited for the principle that the term "or equal" is interpreted to mean "functionally equivalent to the brand name product, but not necessarily the same in every detail."[10] The specification at issue was for windows and called for "Pella Clad TD Double-Hung and Pella LD units" or equal. The specification did not list salient characteristics, but instead listed related performance criteria including manufacturing standards, water tightness, and air leakage.[11] The government withheld approval of the contractor's proposed "or equal" because it did not have a particular sash size that only Pella products met unless the windows were specially manufactured. The Agricultural Board of Contract Appeals treated the performance criteria as the salient characteristics and held that the absence of the particular sash size did not prevent the proposed product from being "functionally equivalent" because there was nothing that notified contractor that the sash size was a salient characteristic.[12]

5.2.5 Order of Precedence

As noted in Section 1, most P3 agreements establish an order of precedence that is to be used in resolving conflicts or differences between contract requirements found in the different contract documents. FAR 52.236-21 (USGPO, 2016c), incorporated into government prime construction contracts contains language that, '[i]n the case of difference between drawings and specifications, the specifications govern." Typically, such order of precedence provisions will provide that if a contract document contains differing provisions related to the same subject matter as in another contract document, the provisions that establish the higher quality manner or method of performance, or use more stringent standards, will prevail. While order of precedence provisions in a contract should never substitute for properly coordinated detailed plans, specifications, and terms and conditions, such provisions provide necessary guidance in the event there is an issue that arises from a conflict within the contract documents.

In an effort to hold a P3 private partner contractually liable for commitments made in its proposal, an agency may incorporate the technical proposal into the P3 agreement. In doing so, there is some level of risk arising from the fact that owners may not have the time nor staff to fully vet a proposal, leaving open the potential of conflict between the proposal and the relevant contractual requirements. Use of an order of precedence clause placing the contract documents at a higher level than the proposal can be a way to manage that risk.

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[9] *Id*. at 1366.

[10] Michael C. Loulakis, Esq. & James B. McDaniel, *Legal Aspects of Performance-Based Specifications for Highway Construction and Maintenance Contracts*, NCHRP Legal Research Digest 61 (2013), citing *Eslin Co*., AGBCA No. 90-222-1, 93-1 B.C.A. (CCH) 25, 321 (1992).

[11] *Id*. at 44.

[12] *Id*.

6 Summary

Under a P3 agreement, the P3 private partner is the single point of responsibility for an integrated delivery of design, construction, maintenance and financing of a highway facility. When done correctly, P3 project delivery facilitates the transfer of more risk to the private sector, potentially resulting in a reduction of total cost of ownership. To realize the full benefits, this contractual arrangement must allow the P3 private partner to integrate fully the O&M considerations with decisions relating to design and construction. The use of performance requirements in the P3 agreement technical provisions is critical to ensure integration between the two phases.

Using performance requirements, a public agency can communicate technical requirements of a project without impairing the P3 private partner's flexibility to innovate and propose alternative solutions. In lieu of prescribing "methods", the performance requirements clearly lay out the project scope and the public agency's expectations and constraints early in the procurement process, while transferring the contractual responsibility and risks to the P3 private partner to achieve them. To have a set of well-written performance requirements, the public agency should conduct the project scoping exercise to effectively identify what technical requirements are needed to achieve the purpose of the proposed facility. Also, project scoping is the phase where the public agency will have more influence to define the risk landscape for both parties. Furthermore, the agency may critically evaluate the proposed performance requirements through a round table style, risk evaluation "vetting" exercise by bringing in stakeholders from the pertinent internal disciplines of the agency, especially the operations and asset managers.

Recognizing that it may be challenging to prepare 100 percent pure performance-based requirements, the public agency may have to use a few limited prescriptive criteria. In such instances, and wherever appropriate, the agency may effectively use the ATC process to solicit "equal to or better than" solutions from the P3 proposers. Note that the ATC process has proven to be high successful for all project delivery methods, including Design-Bid-Build, Design-Build and P3.

With performance requirements, the P3 private partner has the responsibility to prepare design packages and deliver construction plans and specifications; further, the risks of ensuring performance, as mandated by the performance criteria, through design details and construction quality lie with the P3 private partner. On the other hand, the agency's role is limited to providing oversight and monitoring whether or not the design and construction process is in accordance with the P3 private partner's management plan.

Incorporating the use of performance requirements in P3 projects is not without implementation challenges. The agency will need to adopt organizational change management strategies, including institutional capacity building and refinements to the procurement process to facilitate drafting effective performance requirements, measuring compliance, promote an audit-based performance-oriented approach among agency staff that is vastly different from the traditional prescriptive mindset, and engaging stakeholders for buy-in. Agencies may need to adopt deployment strategies, such as technical assistance, hiring of procurement experts and/or specialist advisors, and obtaining input from "champion" agencies. Legal perspectives will need to be considered, such as the applicability of the "Spearin" Doctrine, differing site conditions and the legal interpretations of performance requirements.

7 Future Research Needs

Additional research is necessary to facilitate the implementation of performance requirements in the design and construction of P3 projects. The authors' suggestions are summarized below:

- **Performance Requirements**: A significant level of preparatory work is likely during the initial stages of implementing performance requirements. An agency will be required to develop the linkages between user requirements, design and construction criteria, and performance for at least major scope elements, such as pavements, bridges, geotechnical and geometric design, and articulate them effectively through the technical requirements of the RFP. The SHRP2 R07 project developed similar templates for performance specifications for use in construction by technical area. The development of templates to assist in writing performance requirements for major scope elements would facilitate these early steps. Real-world examples of performance requirement applications as well as costs, benefits and risks associated with their use could help assess the business case for using performance requirements.
- **ATCs**: The post-construction benefits of ATCs are seldom quantified. For ATCs that were accepted, there is a lack of empirical data to evaluate whether risk was truly transferred. It would be beneficial to quantify the value of transferred risk in terms of cost savings, shortened schedule, improved quality or less disruption to the public.
- **Risk Management**: Identification of contractual risks and their allocation between the agency and P3 private partner occur in the initial stages of procurement. However, risk profiles are likely to change over time due to contractual negotiations, such as ATCs, change orders, etc. There is a need to investigate using case studies how the original risk structuring design, as conceived by the agency at the beginning of the procurement process, changes over time at various milestones, and what the actual risk outcomes were.

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9 Glossary

Alternative Technical Concept (ATC)

A suggested change submitted by proposing teams to the contracting agency's supplied basic configurations, project scope, design or construction criteria. Must provide a solution that is equal to or better than the requirements in the RFP document.

Asset management

Systematic and coordinated activities and practices through which an organization optimally and sustainably manages its assets and asset systems, their associated performance, risks and expenditures over their life cycles for the purpose of achieving its organizational strategic plan.

Asset Lifecycle

Time interval that commences with the identification of the need for an asset and terminates with the decommissioning of the asset or any associated liabilities.

Availability Payment (AP)

This is a type of financial arrangement in P3. The agency agrees to make regular payments to the private sector entity based on the facility's availability and level of service achieved for operations and maintenance. Unlike shadow tolls, availability payments do not depend on traffic volume.

Concession Period

Total of construction and operating periods.

Concessionaire

Private entity that assumes ownership and/or operations of a given public asset (e.g., roadway) under the terms of a contract with the agency.

Contingency

An allowance included in the estimated cost of a project to cover unforeseen circumstances.

Design-Bid-Build (D-B-B)

A project delivery method in which the agency procures design and construction services from two separate entities. The agency either performs design work in-house or procures services from a private engineering services entity to perform the design work, and then undertakes a separate procurement with a private construction services entity to perform the construction work.

Design-Build (D-B)

A project delivery method in which the agency combines procurement for both design and construction services into a single contract and from the same private sector entity (the design-builder).

Design-Build-Finance (D-B-F)

A project delivery method in which the agency awards a single contract to the same private sector entity for the design, construction, and full or partial financing of a facility, while the agency retains the responsibility for the long-term maintenance and operation of the facility.

Design-Build-Finance-Operations-Maintenance (D-B-F-O-M)

A service delivery method in which the agency awards a single contract to the same private sector entity for the design and construction of the facility, as well as for project financing and for operations and maintenance of the asset over a given concession period.

Differing Site Condition

May include (i) subsurface or latent physical conditions at the site which differ materially from those indicated in the contract, or (ii) unknown physical conditions at the site, of an unusual nature, which differ materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the contract

End Result Specification

Specifications that require the contractor to take the entire responsibility for supplying a product or an item of construction

Essential Function

Defines how well the highway facility needs to perform and the objectives for a successful delivery of the facility.

Function Analysis System Technique (FAST)

A technique to develop a graphical representation showing the logical relationships between the functions of a project, product, process or service based on the questions "How" and "Why".

Incentive/Disincentive (I/D)

A contract provision which compensates the contractor for each day that identified critical work is completed ahead of schedule and assesses a deduction for each day that completion of the critical work is delayed. The primary function of an I/D provision is to motivate the contractor to complete the work on, or ahead of, schedule, and recover damages to the traveling public for late completion.

International Roughness Index (IRI)

A pavement roughness index computed from a longitudinal profile measurement at a simulation speed of 50 mph (80 km/h).

Life Cycle Cost Analysis (LCCA)

A process for evaluating the total economic worth of a usable project segment by analyzing initial costs and discounted future costs—such as maintenance, user costs, reconstruction, rehabilitation, restoration, and resurfacing costs—over the life of the project segment.

Performance-Based Specifications (PBS)

Improved Quality Assurance Specifications that specify the desired levels of fundamental engineering properties (e.g., resilient modulus, creep properties, and fatigue) that are predictors of performance.

Performance Criterion

A measure that demonstrate a specific owner requirement has been met.

Performance Requirement

Defines what is needed to be done to accomplish the objectives of the project.

Performance-Related Specifications (PRS)

Are improved Quality Assurance Specifications that correlate key material attributes (Quality Characteristics) being measured to the likely performance of the in-place product.

Prescriptive or Method Specification

Specifications that require the contractor to use specified means and methods (e.g., materials in definite proportions, or specific types of equipment and methods to place the material).

Project Scoping
A phase in highway project development that involves a series of project-focused activities that develop key design parameters and other project requirements to a sufficient level of definition such that scope discovery is complete and a budget and project completion date can be accurately established to minimize the risk of significant change and project overruns.

Proprietary Specification
A specification that specifically calls out a brand name, model number, manufacturer of a product, or a product or method of construction that is patented. Typically used when no generic product is available to achieve the technical intent.

Quality Assurance (QA)
All those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality.

Quality Assurance Specifications
Specifications that require contractor QC and agency acceptance activities throughout production and placement of a product. Final acceptance of the product is usually based on a statistical sampling of the measured quality level for key quality characteristics.

Quality Characteristic
That characteristic of a unit or product that is actually measured to determine conformance with a given requirement.

Quality Control (QC)
The process of monitoring specific project results to determine whether they comply with relevant quality standards, and identifying ways to eliminate causes of unsatisfactory performance.

Quality Management Plan (QMP)
A document that describes the P3 private partner's plan comprehensively on 'how' quality will be achieved and managed through various phases of the concession period.

Rejection or Acceptance Limit
The limiting upper or lower value, placed on a quality measure, which will permit rejection or acceptance of a lot.

Risk
An uncertain event or condition that has negative consequence (i.e., threat) or positive consequencs (i.e., opportunities) on project performance if it occurs.

Risk Allocation
The process of assigning engineering, operational and financial responsibility for specific risks to parties involved in the provision of services under P3.

Risk Transfer
The process of shifting the risk and responsibility from one party to another.

Shadow Toll
This is a type of financial arrangement in a P3. The agency agrees to make payments to the private operator, in lieu of tolls paid by facility users, based on usage of a facility. This gives the private sector an incentive to maximize volume.

Spearin Doctrine

A legal principle that holds that the contractor is not liable for any loss or damage resulting from defective plans and specifications, when the contractor follows the plans and specifications provided by the owner, and those plans and specifications turn out to be defective or insufficient.

Special Purpose Vehicle (SPV)

A corporate body (usually a limited company of some type or, sometimes, a limited partnership) created specifically to implement a P3 project, primarily to isolate risks.

Verification

Process of validating the accuracy of test results by examining the data and/or providing objective evidence.

Warranty

A written assurance that a product or service provided by a contractor will meet certain specifications and provide desired performance over a specified period of time, as well as the responsibility of the contractor (or a subcontractor or supplier) for the repair or replacement of the deficient product or service.