COMPARING STATE DOTS' CONSTRUCTION PROJECT COST & SCHEDULE PERFORMANCE – 28 BEST PRACTICES FROM 9 STATES

FINAL REPORT

Requested by:

American Association of State Highway
and Transportation Officials (AASHTO)

Standing Committee on Quality

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April 2007

The information contained in this report was prepared as part of NCHRP Project 20-24, Task 37A, National Cooperative Highway Research Program, Transportation Research Board.

Acknowledgements

This study was requested by the American Association of State Highway and Transportation Officials (AASHTO), and conducted as part of National Cooperative Highway Research Program (NCHRP) Project 20-24. The NCHRP is supported by annual voluntary contributions from the state Departments of Transportation.

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1.0. Overview

This study provides a succinct overview of twenty eight good practices applied among nine state DOTs that outperform their peers in constructing projects within expected cost amounts and schedules.[1] It is based on a detailed analysis of the performance by 20 states in completing more than 26,500 projects over a five year period between 2001 and 2005. The study was initiated in September 2006 at the request of AASHTO's Standing Committee on Quality, as part of a broader effort to encourage DOTs to compare performance among peers.

The study focuses on the construction phase of project delivery, during which adherence to cost and schedule is particularly important. In schedule terms, construction is when the public, as one participating DOT attests, expects their state transportation agency to "get in, get out, and stay out," while in budget terms, a project construction cost overrun directly affects the agency's ability to deliver a promised slate of projects on time.

The foundations for the study are simple cost and schedule measures – variations of "was the project built for the expected cost," and "was the project built on the expected schedule?" They are already used by most DOTs, but performance results are rarely shared. In the study, these measures are applied to carefully reviewed data supplied by state DOTs themselves that is as close to "apples to apples" as possible.[2] To maintain states' anonymity on this sensitive topic, the results comparing states identify only the top performer(s) for each measure by name.

For the five-year time period reviewed, state DOTs in the study averaged 46 percent of all projects built at or below original award amounts and 81 percent built within a cushion of 110 percent of the original award; these figures drop to 18 percent and 70 percent for projects over $5 million. In terms of schedule, state DOTs averaged 53 percent of all projects built within their original schedules but this figure slid to 35 percent for projects over $5 million.

For the approximately two thirds of projects constructed by the average state at a higher cost than expected and the roughly half of projects finished behind their original schedules, surprises in construction such as unexpected sub-surface conditions, utility problems, or environmental issues are most frequently to blame. In a world of uncertainty when the first shovel of dirt is moved, some surprises are inevitable. The clear ability of some DOTs to out perform others suggests that success factors for limiting surprises - or at least limiting their impact on cost and schedule - may include fostering accountability for cost and schedule, monitoring causes of problems to identify common culprits, creating incentives for staff and contractors to do better, and strengthening connections between pre-construction and construction work phases.

Keeping construction on-schedule and on-budget enables DOTs to deliver more projects faster. Each one percent cost overrun on a mid-size state's $1 billion annual program

[1] This study uses the terms "on budget" and "on schedule" as shorthand for projects delivered at or below the original bid award amount set for a contract and/or within the original timeframe set for a contract's completion. States in the study do not necessarily consider projects over budget or late if they exceed these data points, but they are baseline markers by which states' performance can be compared.

[2] Appendices A and B describe in detail the methodologies used for measuring cost and schedule performance and identify limitations regarding "apples to apples" comparability.

translates to $10 million per year that could have been spent on new projects. Furthermore, when contractors are tied up on one delayed project, it prevents them from working on the next one. Gathering transferable lessons learned from among strong performers is appealing because it helps all DOTs do better in an area of great importance to DOTs and their stakeholders.

The outline for the remainder of this report includes the following sections:

- **Section 2.0. Background** – Why compare performance, what measures are used, who participated?
- **Section 3.0. States' Good Practices for On-Time and On-Budget Construction –** A succinct flavor of the success factors identified by strong performers for keeping projects within expected costs and schedules.
- **Section 4.0. States' On-Budget Project Construction Performance Results** – Cost data results tables and methodology FAQ.
- **Section 5.0. States' On Schedule Project Construction Performance Results –** Schedule data results tables and methodology FAQ.
- **Section 6.0. Conclusions.** A brief set of observations about the study premise, methodology, and results.

2.0 Study Background

2.1. Why Compare DOTs' Project Cost & Schedule Performance?

Building projects on-budget and on-schedule is a basic prerequisite of good performance for all state DOTs. On any given day, a DOT has hundreds of projects – large and small - underway with the common purpose of assuring that millions of individual travelers experience a transportation network that works smoothly. Each project may take months or years from start to finish; without skillful planning and execution, delays or cost overruns can easily occur.

A large share of projects finished within expected costs and schedules is an indication that a DOT does a good job during construction of avoiding or managing surprises. Fewer surprises means a DOT can guarantee it will get more projects done faster and for less money. Each year every DOT publishes its list, or "program" of exactly what projects will be undertaken with available funds. Delivering the program is a little like keeping a household budget balanced – if a project goes over its allotted cost, other projects must be cut or delayed. Meanwhile, when projects take longer than expected, the public may be tied up in traffic delays longer. The bottom line is that cost overruns and delays have real consequences – more traffic tie ups, a rougher stretch of pavement somewhere, a weight restricted bridge, more peak hour congestion on a commuter route, or a hazardous intersection unaddressed.

Not surprisingly, many DOTs' CEOs and chief engineers watch project cost and schedule performance closely. Cost overruns or delays are often a sign of failure to take into account site specific factors on a contract – the problems may be due to construction practices or they may have their roots earlier in the project's design phase. Much as a pilot relies on vital gauges -- airspeed, altitude or compass -- in the aircraft to get to his destination, agency leaders use project cost and schedule tracking measures to help set the course of day-to-day processes and long term strategies for achieving better adherence to project schedules and budgets, efficient program delivery, and a more satisfied public.

What if a DOT could compare not only its own project cost and schedule performance quarter to quarter, but its performance over an extended period relative to the performance of its peers? Do variations in performance among states suggest opportunities for practitioners to find new and improved ways to do business? This report uses states' performance data to examine 20 states' project delivery performance over a five year period.

2.2. Who Took Part in the Study?

Twenty state DOTs voluntarily agreed to participate in the study in response to an invitation from AASHTO's Standing Committee on Quality leaders. The following states submitted data on every project they were scheduled to finish between 2001 and 2005:

Arizona	Kentucky	Missouri	South Dakota
California	Louisiana	New Mexico	Tennessee
Delaware	Maine	North Carolina	Vermont
Florida	Michigan	Ohio	Virginia
Illinois	Minnesota	Pennsylvania	Washington

2.3. How is Project Cost and Schedule Performance Measured?

Any attempt to measure project cost and schedule must first settle on the meaning of these terms, which reflects the context they are used in. For example, in a DOT's budget submission, a project's cost is usually its construction cost. To the public, a project's cost might be the number discussed by planners during corridor studies. To an economist conducting a cost benefit analysis, it might also reasonably include planning, environmental compliance, design, and right-of-way costs.

Based on prior work with selected DOT experts, this study uses "original bid award amount" and "originally scheduled completion date" (or original workdays assigned) as its baselines for measuring project cost and schedule performance.[3] DOTs rely mostly on private contractors to build projects and they also frequently use contractors for some or all maintenance activities. A contract's original bid award amount is set as part of the project letting process, based on the winning contractor's bid for the project. A contract's schedule is also set around this time and is usually based on engineers' best estimates of required production time for given project elements. Among states, these are universally recognized measures with similar meanings and calculation methods, which makes their use for comparative analysis attractive.

2.4. What are the Cost and Schedule Performance Measures?

Two basic measures were used to analyze states' data. The measures were developed in 2005 for a pilot analysis and identical definitions were retained for this broader study. In each instance, a lenient and strict version of the measure was calculated.[4] All data for the measures was self reported by states from their project management systems. Individual states' data was reviewed only for completeness and no assessment was made about the accuracy of individual states' data. Basic measures were as follows:

- **Cost - Share of State's Contracts Completed within Original Award Amount.** The share of eligible contracts (all of a state's contracts with an originally scheduled completion date between 2001 and 2005 and a final voucher date reported) for which the actual reported final cost is equal to or less than the original award amount (strict version), or within 10 percent of the original award amount (lenient version).
- **Schedule - Share of State's Contracts Completed within Original Schedule.** The share of eligible contracts (all of a state's contracts with an originally scheduled completion date between 2001 and 2005) for which the actual reported completion date or number of working days charged is equal to or less than the originally scheduled completion date or amount of originally authorized working days (strict version), or the updated completion date or amount of working days (lenient version included in Appendix C).

[3] *Measuring Performance Among State DOTs*, NCHRP Project 20-24 (37) 2005

[4] The lenient version of the schedule measure is discussed in the report, but results are presented in Appendix C because data was not consistently available for all DOTs.

3.0 Good Practices for Project Construction

Results for the measures described in Chapter Two suggest that states vary in their ability to construct projects on-time and on-budget. (See Chapters Four and Five for data on individual states' performance results.) These results beg the question - "what are strong performers doing to keep their projects within original cost and schedule limits?"

The study reports on 28 activities and processes that DOTs in the top half of the study group say they are doing to control project cost and schedule. The intent is to provide a brief flavor of these states' activities as a starting point for DOTs interested in ideas for improving project delivery.

3.1. What Defines a Strong Performer?

Strong Cost Performers. Among the states studied, the share of projects completed within their original bid award amount ranged from 31 percent to 64 percent. (Projects completed within 110 percent of the original bid ranged from 52 percent to 89 percent.) With 64 percent of its projects on-budget versus an average of 46 percent among the DOTs studied, Kentucky Transportation Cabinet ranks number one in performance.

Using a more lenient standard of performance (a cushion of 10 percent), Missouri DOT and Illinois DOT do best; they jointly kept 89 percent of their projects on-budget under this metric and they exceeded the average by 8 percent. Illinois, Kentucky, and Missouri are obvious starting places to seek out good practices used by states to keep projects on-budget.

To ensure a full range of best practices was captured, Florida, Michigan, and Pennsylvania were added to this list as the states that performed best in terms of 1) projects under $5 million and 2) projects over $5 million, and 3) a composite ranking based on overall performance across strict and lenient results for large and small projects.

Strong Schedule Performers. Among the states studied, the share of projects completed within their original scheduled timeframe ranged from 24 percent to 73 percent. Three states with very similar performance – Louisiana Department of Transportation and Development, Kentucky Transportation Cabinet, and Tennessee DOT – are all separated from the next best state by six to eight percentage points; therefore these states were clear front runners for further scrutiny. Louisiana DOT has a record of keeping 73 percent of projects on schedule between 2001 and 2005, while Kentucky Transportation Cabinet and Tennessee DOT both have a record of keeping 71 percent of projects on-budget. . The average across all 17 states is 53 percent.

3.2. What Cost Performance Good Practices Were Found?

Phone interviews (See Appendix D for interview guide used) with senior staff at each of the six top performing states yielded a mix of legislation, policies, and processes that together provide a list of practical ideas for any state considering ways to strengthen on-budget delivery of projects. No single state employs every idea on the list, but the ideas provide a menu of transferable strategies to which any state may wish to give further consideration.

- **Poor Past Performance is a Strong Motivator.** Harsh outside criticism is an unpleasant, but powerful motivator for anyone to change their habits. Staff at Missouri, Florida, and Illinois DOTs all reference periods in their recent histories when large, program-wide, project cost overruns led their stakeholders to put the DOTs "under the microscope." During the mid-1990s, Florida DOT's projects routinely overran by 15 to 20 percent; likewise, Missouri DOT ran into difficulties delivering a program of projects funded by a 1992 6 cent gas tax increase. At each DOT, these periods of intense scrutiny led to overhaul of cost tracking systems and processes and dramatic improvements in performance. Many of the ideas in this section stem from such periods of scrutiny.

- **CEO and Career Managers Must Provide Leadership.** At most of the DOTs interviewed, controlling project costs is a top priority for leaders. This leadership takes many forms. At Florida DOT, for example, the Secretary and Deputy Secretary attend monthly production meetings and at Missouri DOT the CEO has established a financial bonus program for outstanding performance in controlling costs, while PennDOT's leaders refer to their initiative as "check book balancing." At all the DOTs interviewed, continual leadership at the highest levels in the agency helps ensure staff understands their mission and can expect praise when they do a good job. Leadership is viewed as the catalyst without which success is elusive.

- **Pay Special Attention to Setting Accurate Project Cost Estimates.** Avoiding cost overruns in construction means doing good work in preconstruction. Each of the strong performers emphasizes the value of good coordination between the construction and pre-construction phases of project delivery. This can mean using multi-disciplinary project teams and being careful to collect and share accurate information about project performance. PennDOT makes a particular point of setting project cost estimates that are not based only on historic data, but on a clear picture of individual project characteristics. In a similar vein, Michigan and Illinois DOTs describe the importance of sharing information about previously unanticipated costs during construction with designers so that future projects can avoid such problems.

- **Measure On-Budget Performance Monthly or Quarterly.** All the top performing states have in place performance measures that are similar, if not identical to the cost measure used in this study. Florida DOT, for example, sets a quarterly target of having 90 percent of its projects within 10 percent of bid amount and has been tracking cost performance for almost a decade. Michigan DOT's Transportation Commission requires the DOT to report "final cost versus bid amount" on a monthly basis. Missouri DOT includes an "award amount to final cost" measure in its quarterly "Tracker" performance report with a goal of keeping cost overruns below two percent on all projects. At Illinois DOT, "net change order percent" is tracked district by district on a monthly basis. At Pennsylvania DOT, final amount to original award is tracked on a quarterly basis and Districts are required to keep cost overruns within three percent. "What gets measured gets done" was a common refrain among the states; they ascribe great power to the simple act of measuring which they claim gives staff a strong incentive to improve performance.

- **Track Causes of Cost Overruns.** Florida, Illinois, and Michigan use coding systems as part of their cost measurement programs to categorize causes of cost overruns; PennDOT is gearing up to implement a similar system. Each time a cost overrun occurs, the cause(s) are matched to a standard list that identifies whether the problem lies with a contractor or in-house, utilities, sub-surface problems and so on. This

information allows the DOTs to identify recurring problems and address them in what they describe as a "feedback loop." Causes of cost overruns often have their roots in pre-construction. A feedback loop allows the DOT to address issues in pre-construction that affect construction.

- **Use Production Meetings to Keep Staff Accountable.** Performance measures should not only be tracked, but should be used to keep managers accountable. Florida DOT issues reports on project costs on a monthly basis and managers for projects that are not meeting cost targets must explain why in front of the agency's secretary during monthly production meetings. PennDOT has a Program Management Committee that includes the Secretary, the Chief Engineer and Deputy Secretaries. District Engineers must justify any project cost overruns to the Committee.
- **Don't Wait Until a Project is Finished to Measure Performance.** Florida DOT reports that it keeps track of on-budget project performance at major milestones throughout construction. The Secretary and Deputy Secretary attend a monthly production meeting at which projects that do not meet cost milestones are discussed with the intention of ensuring they can be put back on track. Illinois reports that it employs a similar system.
- **Link Performance to Pay.** With the goal of delivering "fast projects that are great value," Missouri DOT's CEO expects all projects to stay within a two percent limit for cost overruns. In a pilot initiative called "Performance Plus" and now about to be launched state-wide, Missouri DOT gives monetary rewards to employees whose projects have cost overruns at one percent or less. Depending on cost overrun performance results at the project office, district, and organization-wide levels, employees may be eligible for up to $2,000 in cash incentives per year. In its first quarter as a pilot, the Performance Plus program generated $4.3 million in savings at a cost of $53,000 in bonuses.
- **Legislatively Mandated Cost Overrun Targets.** One top performing state, Michigan, describes legislatively mandated targets for cost overruns. Any project with a cost overrun above 10 percent must be reviewed by the State Administrative Board, and any project with a cost overrun above 15 percent must be reviewed by both the State Administrative Board and the Michigan Transportation Commission, whose six members are appointed by the Governor. This reporting requirement acts as a big incentive for project managers to keep a careful watch on costs.
- **Employ Value Engineering.** Michigan and Missouri DOTs identify their value engineering programs as a useful way to help manage costs. Value engineering allows contractors that identify valid cost savings opportunities during construction to share in those savings, thus giving them greater incentive to cut project costs while helping the DOT save money. Florida DOT notes that its value engineering program is essentially incorporated into the letting process, with contractors free to propose alternatives at the bidding stage.
- **Maintain Dialogue with Contractor Community.** Several strong performers including Florida, Illinois, and Missouri DOTs cite the importance of open and regular dialogue with the contracting community as a key to their success in controlling costs. Quarterly meetings with different segments of the contracting community are common among strong performers. These meetings help DOTs to assure contractors about the motivation of cost control efforts and to work together on collaborative solutions.

- **Hold Contractors Accountable.** Just as the strong performers hold their own staff accountable for performance, several also hold contractors accountable. Florida DOT has the power to prevent contractors from bidding if they have a frequent record of cost overruns; contractors are issued "deficiency letters" when problems occur and if they receive enough letters they may be barred from bidding.
- **Encourage Team-based Project Development Processes.** Unforeseen issues in construction, often related to geo-technical, right-of-way, environmental, or utility factors, are the most common cause of project cost overruns. One top performing state, Missouri, noted the importance of developing projects using teams that include experts in different disciplines. As a result, problems that might otherwise go unnoticed stand a better chance of being addressed before construction.

3.3. What Schedule Performance Good Practices Were Found?

For schedule performance, phone interviews (See Appendix D for interview guide used) with senior staff at each of the three top performing states yielded a mix of legislation, policies, and processes that together provide a list of practical ideas for any state considering ways to strengthen on schedule delivery of projects. No single state employs every idea on the list, but the ideas provide a menu of transferable strategies to which any state may wish to give further consideration.

- **Input from Construction Project Managers on Schedule Estimates.** Carefully developed project schedule estimates ensure that unrealistic deadlines are not put in place. Both Tennessee DOT and Louisiana DOTD ascribe much of their success in maintaining project schedules to effective project schedule estimating procedures. Both agencies use generic unit production times to develop rough schedule estimates, but they always conduct a project-specific review of estimated schedule that involves the Headquarters, District, or project engineers. The project engineer will refine the schedule if needed, to account for limited lane closure restrictions for example. At Tennessee DOT, they have carefully scrutinized unit production times used in schedule estimating, using an outside University of Tennessee contractor.
- **Recruit and Retain Skilled Staff.** Kentucky Transportation Cabinet reports that one of the most significant factors in keeping projects on schedule is the ability to recruit and retain experienced people.
- **Advanced Geo-Technical Survey Techniques**. Kentucky Transportation Cabinet reports that accurate geo-technical survey information is particularly critical in Kentucky because the state's Karst (limestone) geology frequently makes subsurface conditions highly unpredictable. The DOT has found that use of GPS technology, particularly for bridge work, is helping to ensure geo-technical drilling locations match planned project sites and that site-related geo-tech issues therefore are less likely to become problems during construction.
- **Use Accurate Unit Production Times.** At Tennessee DOT, they have carefully scrutinized unit production times used in schedule estimating via a research project conducted by the University of Tennessee. This has helped to improve the accuracy of unit production times used to set project schedules.
- **Conduct Overall Constructability Reviews.** Louisiana DOTD and Kentucky Transportation Cabinet report that they are making greater use of constructability reviews to verify that plans and specifications are biddable and can be built. A

constructability review brings in a range of experts (including traffic, design, maintenance, and district staff) with unique construction-related knowledge and experience towards the final stages of design to help identify and address problems that might otherwise cause delays and other problems during construction. If the experience and expertise of the construction community is accessed during the design stage, more constructible projects are produced that are less likely to experience delays.

- **Measure On-Schedule Performance.** For several years, Tennessee DOT and Kentucky Transportation Cabinet have measured schedule as an internal measure. At Tennessee DOT, schedule data is compiled monthly by HQ and shared with Region Directors. Louisiana DOTD is about to measure schedule as part of a newly created and publicly available "performance dashboard." As with cost performance, states describe the benefits of "what gets measured gets done." In Tennessee, schedule performance is regularly reviewed by senior management; they ascribe great power to the simple act of measuring which they claim gives staff a strong incentive to improve performance. Tennessee not only measures whether projects are completed on schedule, but whether significant construction milestones are also on schedule.

- **Track Causes of Delays.** Tennessee uses a coding system as part of its schedule measurement program to categorize causes of delays. Each time a delay occurs, the cause(s) are matched to a standard list that identifies whether the problem lies with a contractor or in-house, utilities, sub-surface problems and so on. This information allows the DOTs to identify recurring problems and address them in what they describe as a "feedback loop." Causes of delays often have their roots in pre-construction. A feedback loop allows the DOT to address issues in pre-construction that affect construction.

- **Use Monthly Progress Reports to Keep Staff Accountable.** As with cost performance, performance measures should not only be tracked, but should be used to keep managers accountable. At Tennessee DOT, "the rubber hits the road" with monthly Construction Progress Reports that are reviewed by Directors and staff from each of Tennessee DOT's four regions and Headquarters. These reports are used to focus attention on any projects that are more than 15 percent behind on their current milestone. Louisiana DOTD does not use a production meeting approach, but does have regular meetings for individual projects that serve a similar function.

- **Pay for Utility Relocation.** Tennessee DOT has found that utility relocation is often a major contributory factor to construction delays. In 2002, the State Legislature passed legislation that allows the State to pay for utility relocation costs on priority projects as long as utilities are either moved prior to bid date or the contractor is granted complete control over moving utilities during the project. Delays caused by utilities have dropped from 35 to 45 projects per year before the legislation to 12 to 15 projects afterwards. The annual cost of paying for utility relocation was originally estimated at $25 million per year but the first couple of years exceeded Tennessee's estimate. The costs associated with the utility relocations have leveled off but the funding for these relocations will be under the microscope due to budget shortfalls.

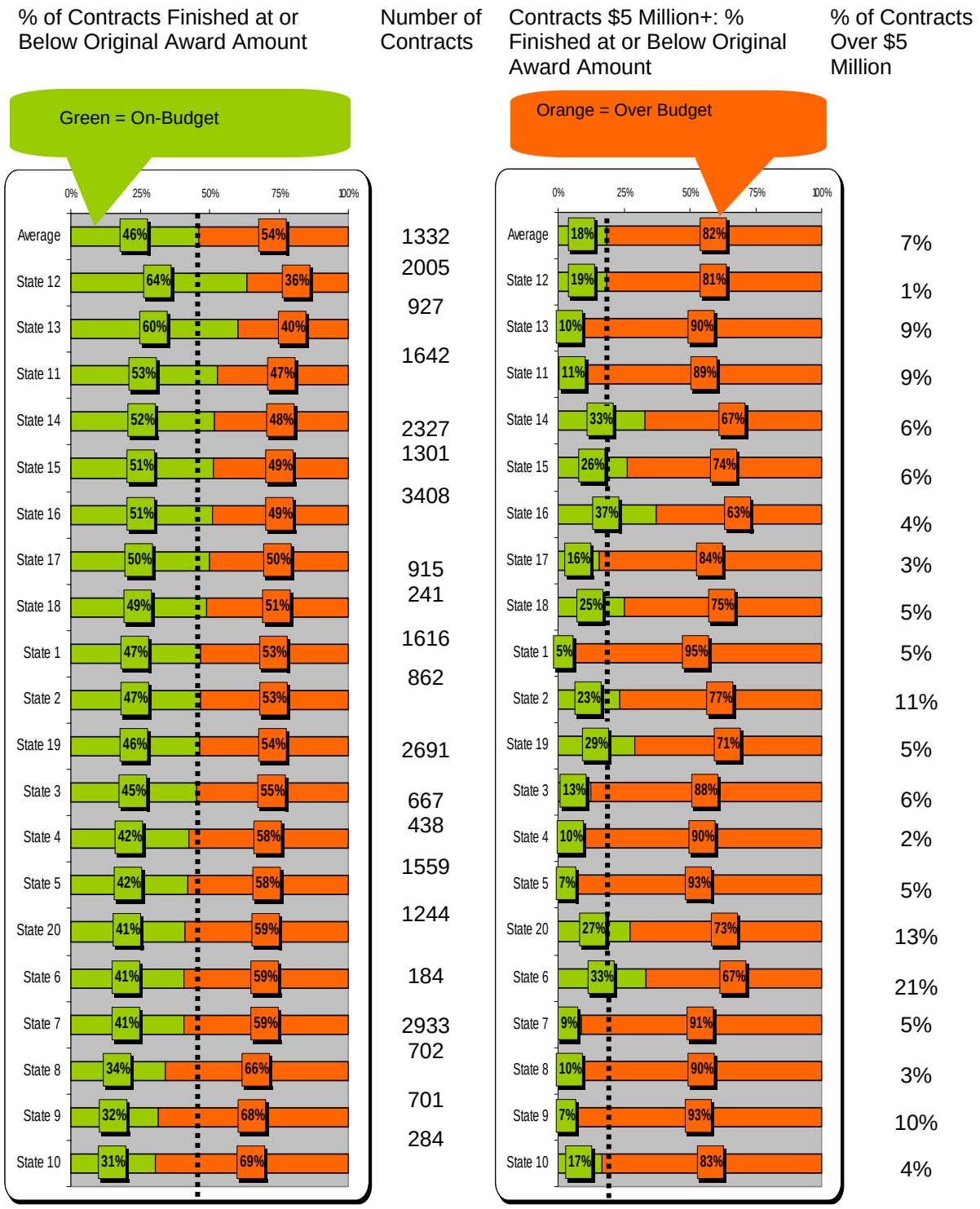
- **Give Contractor Sliding Window for Completing Projects.** For about eight years, Tennessee DOT has been applying "sliding windows" to its resurfacing program. For each resurfacing project, a specific number of working days is set, e.g. 45 days, but contractors are allowed to complete projects within a set time window, e.g. three

months. Once the contractor chooses to start the project within the window, however, it must be finished in the number of working days originally set.

- **Mandatory Pre-bid Meetings for Large Projects.** Kentucky Transportation Cabinet reports that mandatory pre-bid meetings for large projects are a useful technique for ensuring that all contractors bidding on these jobs understand schedule issues and are able to assemble better bids.
- **Contractor Input on Specifications/Pilot Projects to Test Specifications.** Poor construction specifications can cause schedule problems, so Kentucky Transportation Cabinet meets with the contractor community to gather input on the practicality of new specifications before they are introduced and will sometimes pilot test specifications on one or two projects before introducing them statewide.
- **Give Contractor Incentives for Early Completion.** On its larger projects, Louisiana DOTD uses monetary incentives of as much as $15,000 per day for projects that are completed ahead of schedule.
- **Hold Contractors Accountable.** Just as the strong performers hold their own staff accountable for performance in program and project production meetings, Louisiana and Tennessee DOTs hold contractors accountable. Louisiana and Tennessee will both disqualify contractors from bidding on projects if they fail to meet expectations.
- **Take Care of ROW, Permits, and Utilities.** Tennessee DOT notes the importance of ensuring that all utility and environmental permits are taken care of before construction starts so that delays are minimized. Similarly, KTC notes that efficient utility and right-of-way processes are vital to keeping projects on schedule.

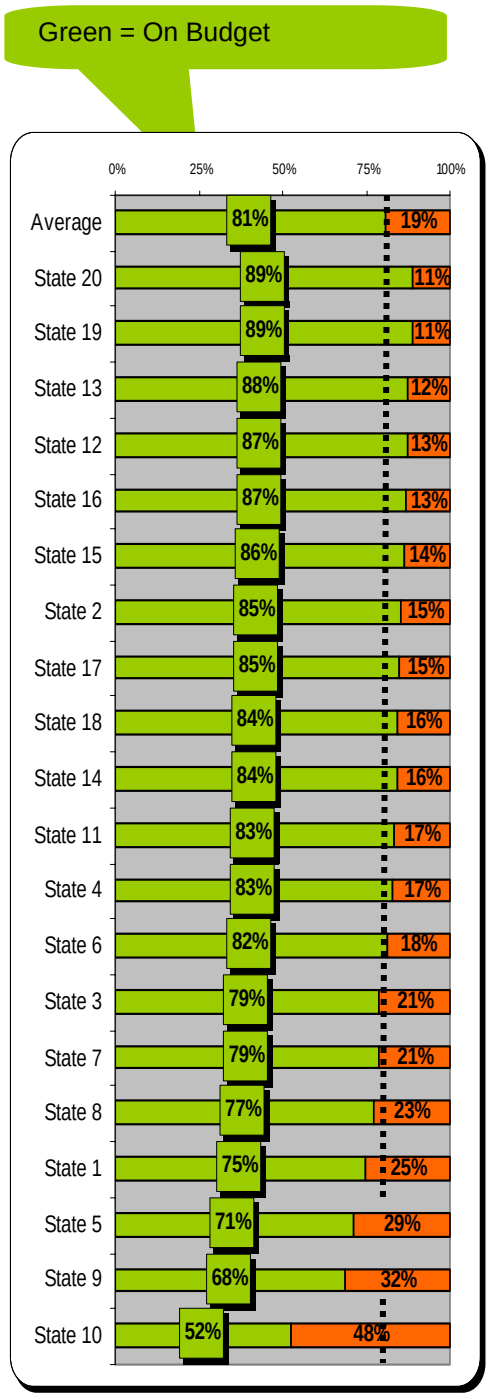
4.0. States' On-Budget Project Construction Performance

4.1. Share of States' 2001 to 2005 Projects Finished at or Below <u>Exact</u> Original Award Amount (Strict Measure)

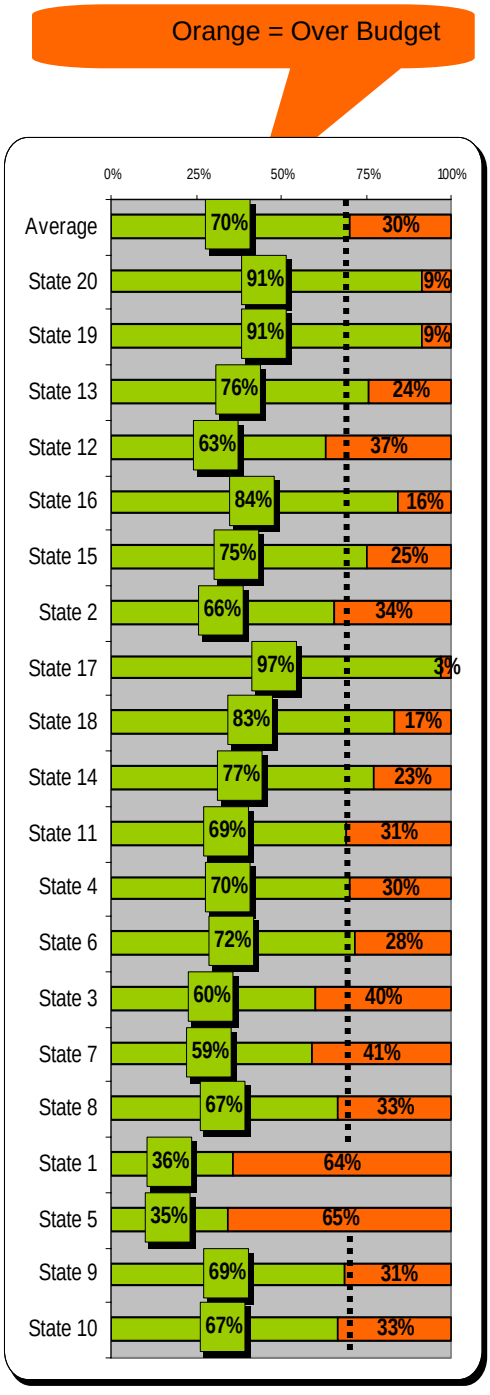


4.2. Share of States' 2001 to 2005 Projects Constructed at or Below 110% of Original Award Amount (Lenient Measure)

% of Contracts Finished at or Below 110% of Original Award Amount



% of Contracts $5M+: % Finished at or Below 110% of Original Award Amount



Cost Measure Technical Specifications FAQ

Measure: Percent of states' 2001 to 2005 completed contracts for which final cost is equal to or less than the original award amount/within 110% of original award amount.[5]

What is the source of the contract data? Each state provided data for the study directly from its own electronic records. Cost data on every contract issued by a DOT are collected by states in electronic contract and project management software programs, which may easily be queried to extract specific information, such as final cost, original bid amount, or working days charged for contracts that meet a specified set of criteria, such as falling within a specific year or dollar range.[6]

Did states exclude any contracts from their submissions? Instructions for data submission asked all states to "exclude any 'blanket' contracts for providing on-call work such as pothole patching or mowing or contracts for non-construction and maintenance services." Follow-up conversations with individual DOTs suggest that this instruction received differing interpretations, with some DOTs excluding more projects than others. A few DOTs excluded small amounts of bad data prior to making their submissions. Neither reason for excluding projects is likely to bias the analysis results.

Why are states left anonymous in presentation of results? Many states agreed to participate in the study on condition that their relative rank in terms of performance was not shared with other states unless they were found to be a top performer.

How is a contract determined to belong between 2001 and 2005? The year assigned by a DOT to a contract in its data submission may be set several ways, such as its start date, its originally scheduled completion date, or its actual completion date. As a result, the same contract may fall within a different year depending on the method used to assign a date to it. For this study, originally scheduled completion date, or its equivalent, was used to categorize all projects by year.[7]

Why does the lenient measure allow a cushion of 10%? In the pilot version of this study, the seven participating states recognized that not all states may set absolute concurrence with original award amount as their cost measure. The states agreed that 10 percent is a reasonable margin of error for project costs.

How were 2001 to 2005 contracts identified as "finished?" Only contracts where all costs had been accounted for were included in the analysis. This determination was made based on presence of a final voucher date or its equivalent. A contract without such a date was assumed to potentially have outstanding costs.

Were any contracts excluded from the analysis? Projects were excluded only if they did not have a final voucher date, an originally scheduled completion date outside 2001 to 2005, or in instances where data essential to performance calculations were missing. For each state, the number of cases where data were missing and contracts had to be excluded was found to be small relative to the total number of contracts reviewed and therefore is presumed not to bias the results of the analysis.

Why isn't a year-by-year breakout of data provided? The analysis is presented as a single result for all contracts between 2001 to 2005, however, a year-by-year breakout of results is feasible. A cursory review of the data suggests that such a breakout could be misleading because states in the study generally have fewer 2004 and 2005 projects with final voucher dates compared to earlier years. While simple projects completed in 2004 and 2005 are quickly closed out and are likely to be on-budget, the projects not closed out in 2004 and 2005 are conceivably subject to problems. A year-by-year analysis is therefore likely to provide an unrealistically favorable picture for later years versus earlier years.

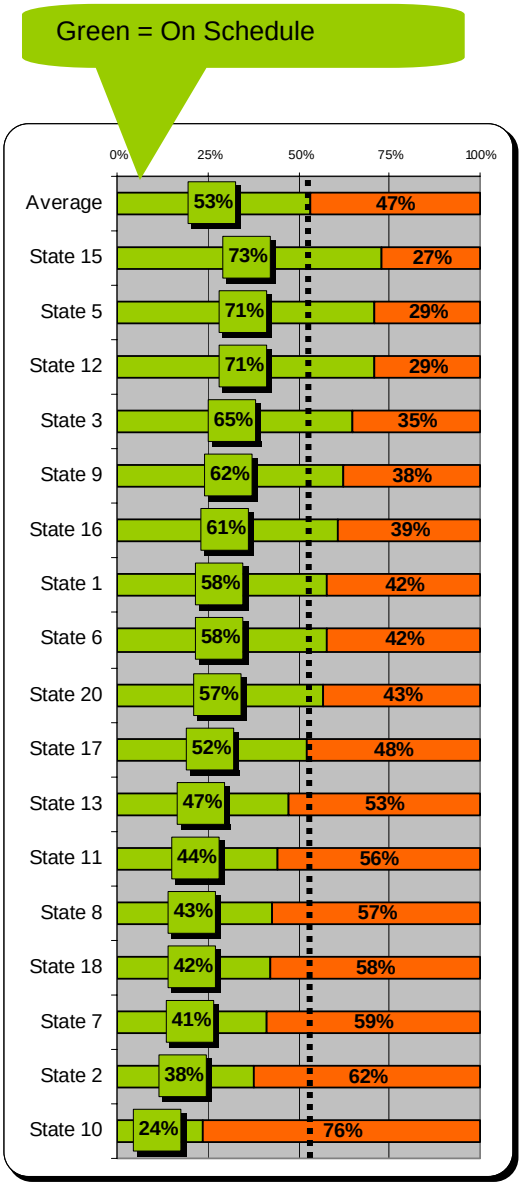
[5] Refer to Appendix A for a detailed discussion of the method for calculating cost performance among states.
[6] Commonly used systems include AASHTO's TRNS*PORT and SiteManager
[7] Many states do not set an original scheduled completion date for contracts. An anticipated number of working days is used instead to derive an estimated originally scheduled completion date for the purpose ONLY of classifying a project in a year.

5.0 States' On-Schedule Project Construction Performance

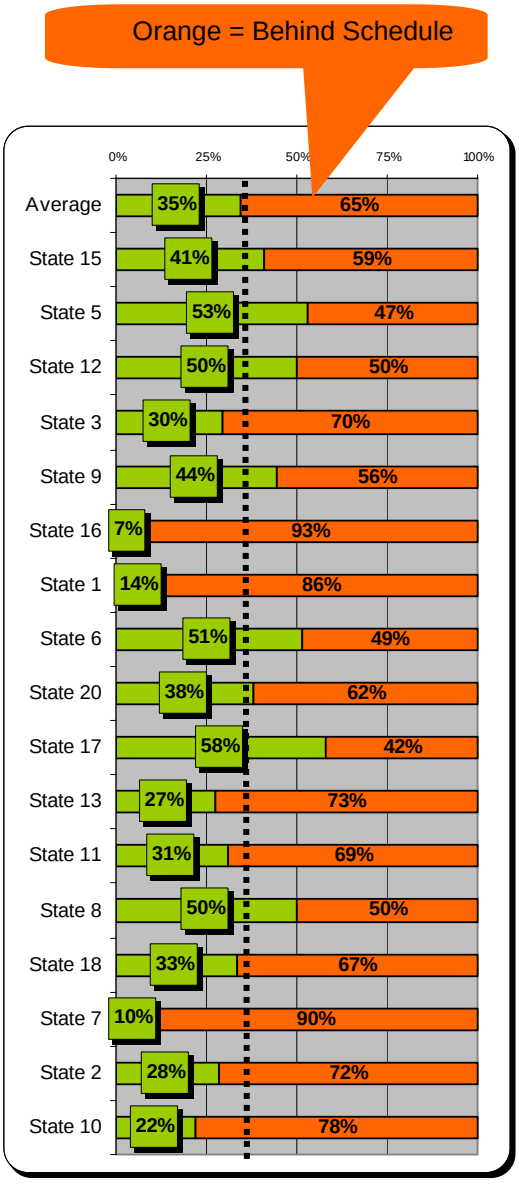
5.1 Share of States' 2001 to 2005 Projects Constructed on or Before Original Scheduled Completion Date (or Within Original Working Days)

Special Note – Data on the results of the lenient on schedule measure are included in Appendix C

% of Contracts Finished on or Before Original Scheduled Completion Date or Within Original Working Days



Contracts $5 Million+: % Finished on or Before Original Scheduled Completion Date or Within Original Working Days



Schedule Measure Technical Specifications FAQ

Measure: Percent of states' 2001 to 2005 contracts for which the contract's final completion date or working days used are equal to or less than its originally scheduled completion date or originally authorized working days.

Why are only 17 states reported on for the schedule measure? Three of the 20 states that participated in the study were unable to provide adequate schedule data to allow an "apples to apples" comparison with other states.

Why is schedule measured using calendar dates in some cases and working days in others? Some states require contracts to be finished by a specific calendar date. Other states allow contractors a number of working days to finish a project. Many states use working days for some projects and calendar days for others. In terms of measuring performance, however, a calendar date or a number of working days are equally valid metrics for gauging a project's schedule performance.

How is a project's finish date determined? For working day projects, dates are not used to calculate performance; the reported number of days charged to a project is assumed to demonstrate whether it is on schedule. For calendar day projects, the physical completion date or substantial completion date is used as the date a project is finished in place of a project close out date. Many states report that the close out date may occur months after a project is open to traffic, while the substantial completion date more accurately reflects the point at which the public is able to benefit from the project.

Why don't projects included in the schedule measure require a final voucher date? Unlike the cost measure, a final voucher date was not required to include a project in the schedule analysis because some projects may be late even before a final voucher date is issued.

Which projects submitted by states were included in the schedule analysis? To be included in the schedule analysis, a contract was required to have an originally scheduled completion date, or its equivalent, that fell between 2001 and 2005.[8] Projects were not required to have a final voucher date, therefore slightly more projects were examined in total as part of this measure.

What is the source of the contract data? (See FAQ for cost measure)

Did states exclude any contracts from their submissions? (See FAQ for cost measure)

How is a contract determined to belong between 2001 and 2005? (See FAQ for cost measure)

Were any contracts excluded from the analysis? For each state, the number of cases where data were missing and contracts had to be excluded was found to be small relative to the total number of contracts reviewed and therefore is presumed not to bias the results of the analysis.

[8] Many states do not set an originally scheduled completion date for contracts. An anticipated number of working days is used instead to derive an estimated originally scheduled completion date for the purpose ONLY of classifying a project in a year.

6.0 Conclusions

- **States' Overall Cost and Schedule Performance Shows Room for Improvement.** On average, state DOTs in the study delivered 46 percent of all projects at or below original cost. (A pilot study, involving only seven states and using data from 2001 to 2004, found a comparable 43 percent of projects at or below original award amounts.) In terms of schedule, state DOTs averaged 53 percent of all projects within their original schedules. (The pilot study found 43 percent of projects were completed by their originally scheduled completion date.)
- **In All States, Large Projects are More Often Delivered Over Budget and Behind Schedule.** For the five year time period reviewed, state DOTs in the study averaged 18 percent of projects over $5 million at or below original cost. Meanwhile only 35 percent of projects over $5 million are delivered on their original schedule.
- **Magnitude of Cost Overruns is Within 10 Percent for Most Projects.** On average, 81 percent of all projects are delivered within 110 percent of original cost and 70 percent of projects over $5 million are delivered within 110% of original cost. The average percent overrun for all projects among all states (including projects exactly on-budget, those under budget, and those over budget) is four percent. If a state's annual program is assumed to be about one billion dollars, this translates to about $40 million in cost overruns per year, much of which may be avoidable.
- **Best Performers do Much Better than Poorest Performers.** On the schedule side, a 49 percentage point difference separates the best and worst performers and on the cost side, a 33 percentage point difference separates the best and worst performers for the strict measure. The magnitude of this gap suggests that best performers practices may well provide useful lessons learned for other DOTs.

Appendix A
Detailed Cost Performance Methodology

Cost Performance Methodology

What Data Was Submitted by States? Each state self-reported requested data fields for almost all contracts entered into their project management systems between 2001 and 2005. (States were asked to exclude only "blanket" contracts for providing on-call work such as pothole patching or mowing or contracts for non-construction and maintenance services.) As part of the cost performance methodology, states reported all or some of the following cost-related data fields for each contract they submitted:

- **Original Specified Completion Date.** The date by which contract is expected to be complete. (Provided for contracts with a calendar day completion date, and contracts with a working day limit, if available.)
- **Original Number of Work Days Allowed.** The number of working days assigned to the contract. (Contracts with working days only.)
- **Notice to Proceed.** Date when contractor is authorized to proceed with work on the contract. (Required for all contracts.)
- **Unique Contract Identifier Number.** State-assigned unique numeric contract identification tag, used to identify each contract. (Required for all contracts.)
- **Contract Final Voucher Date.** A date that indicates contract receives a final voucher when all contractor work has been accepted and invoices paid. (Provide if final voucher date has occurred.)
- **Original Contract Award Amount.** The winning contractor's bid, with any additional "contingency" amount backed out if necessary.
- **Final Cost.** Specifies total payments to contractors and is used to calculate on-budget performance against original award amount.

What was the Methodology for Analyzing Data? The following methodology was used to calculate "on-budget" performance for applicable contracts reported by states:

Step One. Create 2001 to 2005 Data Set for Each State. Only contracts with an original scheduled completion date between 2001 and 2005 were analyzed in the study; therefore, any contracts with an original scheduled completion date outside this timeframe inadvertently included by the DOT in its data submission were weeded out of the state's data set.

> ***Special Sub Step One.*** Many of the states provided data on "working day" contracts, for which they do not set an original scheduled completion date. In these cases, an estimated original scheduled completion date was calculated using data provided by the DOT. The estimated date determined whether the contract was included or excluded from the study. The methodology for calculating the estimated date was as follows: 1) Divide contract's original number of working days by five to calculate number of work weeks required to complete the contract; 2) Multiply the number of work weeks by seven to arrive at an estimated total number of days over which the contract will be completed excluding weekends when work is assumed not to occur;

3) Add the total number of days needed to complete the contract to its Notice to Proceed date to arrive at an estimated original scheduled completion date.

Step Two. Identify Contracts in Each State's 2001 to 2005 Data Set with a Final Voucher Date. To avoid counting contracts as "on-budget" when not all costs had been reported, only contracts with a final voucher date were analyzed. All contracts without a final voucher date were excluded from the analysis.

Step Three. Subtract Final Cost for Each Eligible Contract from Its Original Contract Award Amount. To calculate the "strict" cost performance measure, contracts where the final cost was less than or equal to the original contract award amount were assumed to be "on-budget," while contracts where the final cost was greater than the original contract award amount were assumed to be "over budget."

> ***Special Sub Step Three.*** To calculate the "lenient" cost performance measure, the step three calculation was repeated verbatim only with an original contract award amount plus ten percent.

Step Four. Sort Results by Contract Dollar Value. Contracts under $2.5 million and over $5 million were segregated from the overall dataset to determine their performance characteristics.

Step Five. Calculate Average Overrun Amount for Over Budget Contracts. For all contracts that are determined to be "over budget" in step three, calculate the difference between the final cost and the original contract award amount and use these values to calculate an average overrun expressed as a percent of the original contract award amount.

What are Limitations of Data/Methodology? This section provides a cursory assessment of observed limitations associated with the data provided by states and methodology used to analyze it.

Issue – States' Criteria for Selecting Reported Contracts Data Unclear. For this study, DOTs were instructed to report all data with an original scheduled completion date between January 1, 2001 and June 30, 2006, regardless of whether contracts are completed or not. Cursory review of the data submitted by states suggests that the criterion used for selecting projects to report was not always original scheduled completion date. Bias, if any, resulting from use of non-specified criterion has not been investigated as part of this study.

Resolution – Further review of the most appropriate criteria for selecting contracts to report, coupled with absolute clarity about the criteria by which all states MUST select data contact would help eliminate misunderstandings and reduce any potential for bias in results.

Issue – Amount of Inaccurate or Missing Contracts Data is Unknown. For this study, DOTs self reported all data. While the consultant reviewed all data for completeness in terms of required data fields, the accuracy of states' data management systems was not scrutinized. The report assumes that since DOTs rely on accurate cost and schedule data for a multitude of internal processes, all or most of their data is likely to be accurate. Some participating states may have reported all contracts while others may have missed or chosen to exclude some contracts. As long as any excluded contracts were selected randomly, the large sample size used for each state participating in the study means that results will not be skewed by missing projects.

Resolution - Greater contact with states during the data reporting would help eliminate misunderstandings.

Issue – Requirement That Contracts Must Have Final Voucher Date & A 2001 to 2005 Original Scheduled Completion Date Makes Year to Year Comparisons Problematic. The original methodology designed for the pilot phase of this analysis required all contracts to have an original scheduled completion date between 2001 and 2005 and a final voucher date. This methodology was adopted for the expanded study. Cursory analysis of the data generated in this study suggests that more contracts with an original scheduled completion date in 2001 are likely to have a final voucher date than those with a more recent original scheduled completion date. (Presentation of year to year results would suggest that the absolute number of contracts managed by each DOT is decreasing, which is incorrect.) This makes sense, because projects with a recent completion date are less likely to have been closed out than those with an earlier completion date. Furthermore, contracts with a recent original scheduled completion date and a final voucher date are likely to be biased towards "on-budget" performance, because only those projects that are simple to resolve can be closed out quickly while those with problems (including cost overruns) are likely to remain open and are thus not caught by the study. Since all states are compared on the same basis for this study, the relative performance of one state to another is not affected.

Resolution – An alternative approach would be to collect data on all contracts with a final voucher date between 2001 and 2005, regardless of their original scheduled completion date. This should ensure a steady stream of projects each year, making a depiction of year-to-year performance easier.

Issue - Requirement That Contracts Must Have Final Voucher Date & A 2001 to 2005 Original Scheduled Completion Date Biases Results in Favor of "On-Budget" Performance. Contracts with a recent original scheduled completion date and a final voucher date are likely to be biased towards "on-budget" performance, because only those projects that are simple to resolve can be closed out quickly while those with problems (including cost overruns) are likely to remain open and are thus not caught by the study. As a result, states' performance automatically looks better in later years of the study period if a year-by-year comparison is presented. Since all states are compared on the same basis for this study, the relative performance of one state to another is not affected.

Resolution – An alternative approach would be to collect data on all contracts with a final voucher date between 2001 and 2005, regardless of their original scheduled completion date.

Appendix B
Detailed Schedule Performance Methodology

What Data Was Submitted by States? Each state self-reported requested data fields for almost all contracts entered in their project management systems between 2001 and 200. (States were asked to exclude only "blanket" contracts for providing on-call work such as pothole patching or mowing or contracts for non-construction and maintenance services.) As part of the schedule performance methodology, states reported all or some of the following schedule-related data fields for each contract:

- **Type of Contract.** For each contract submitted, states specified whether the contract was a working day or calendar day contract. This was used to determine exactly how to calculate "on time" performance.
- **Original Specified Completion Date.** The date by which contract is expected to be complete. (Provided for contracts with a calendar day completion date, and contracts with a working day limit, if available.)
- **Current Specified Completion Date with Time Extensions.** A revised completion date that adds any net time change resulting from work/change orders issued during the contract.
- **Original Number of Work Days Allowed.** The number of working days assigned to the contract. (Contracts with working days only.)
- **Current Number of Work Days Allowed with Time Extensions.** A revised number of working days allowed that adds any net time change resulting from work/change orders issued during the contract.
- **Work Days Charged.** The number of working days charged to the project to date. (Contracts with working days only.)
- **Notice to Proceed.** Date when contractor is authorized to proceed with work on the contract. (Required for all contracts.)
- **Unique Contract Identifier Number.** State-assigned unique numeric contract identification tag, used to identify each contract. (Required for all contracts.)
- **Substantial Completion Date, Physical Completion Date, or Similar.** An indicator of the point at which a project is "open to traffic" (i.e. some additional minor work may be required, but no lane closures or other major work will take place).

What was the Methodology for Analyzing Data? The following methodology was used to calculate "on schedule" performance for applicable contracts reported by states:

Step One. Create 2001 to 2005 Data Set for Each State. Only contracts with an original scheduled completion date between 2001 and 2005 were analyzed in the study; therefore, any contracts with an original scheduled completion date outside this timeframe inadvertently included by the DOT in its data submission were weeded out of the state's data set.

> ***Special Sub Step One.*** Many of the states provided data on "working day" contracts, for which they do not set an original scheduled completion date. In these cases, an estimated original scheduled completion date was calculated using data provided by the DOT. The estimated date determined whether the contract was included or

excluded from the study. The methodology for calculating the estimated date was as follows: 1) Divide contract's original number of working days by five to calculate number of work weeks required to complete the contract; 2) Multiply the number of work weeks by seven to arrive at an estimated total number of days over which the contract will be completed excluding weekends when work is assumed not to occur; 3) Add the total number of days needed to complete the contract to its Notice to Proceed date to arrive at an estimated original scheduled completion date.

Step Two. Calendar Day Contracts Only. Identify Subset of Contracts That Have a Substantial Completion Date. For calendar day contracts only, all contracts that have a substantial completion date were included in the analysis.

Step Two. Working Day Contracts Only. Identify Subset of Contracts That Have an Entry for Working Days Charged. For working day contracts only, contracts that have a report of working days charged were included in the analysis.

Step Three. Calendar Day Contracts Only. Verify Whether Substantial Completion Date is Later Than Originally Scheduled Completion Date. To calculate strict performance results, any contract where the substantial completion date occurs after the originally scheduled completion date is assumed to be "behind schedule."

Step Three. Working Day Contracts Only. Verify Whether Number of Actual Working Days is More Than Original Working Days. To calculate strict performance results, any contract where the actual number of working days is more than the original working days is assumed to be "behind schedule."

> ***Special Sub Step Three.*** To calculate the "lenient" schedule measure results, step three for working day and calendar day contracts was repeated using the revised working days and revised scheduled completion date, where available.

Step Four. Sort Results by Contract Dollar Value. Contracts under $2.5 million and over $5 million were segregated from the overall dataset to determine their performance characteristics.

What were Limitations of Data/Methodology? This section provides a cursory assessment of observed limitations associated with the data provided by states and methodology used to analyze it.

Issue – Number of Working Day Contracts in the Analysis is Based on a Simple Methodology that May Have Reduced the Number of Working Day Projects Analyzed. The methodology used to calculate an estimated original scheduled completion date for working day projects is very simple. It is probable that some contracts were incorrectly excluded or included as 2001 to 2005 contracts. One particular limitation is that states did not follow instructions to provide several years of earlier data for working day projects to ensure projects started prior to 2001 but finished within the time period under analysis were included. No investigation was conducted to determine if this biased results.

Resolution – Further review of the most appropriate method for merging analysis of the two types; consider switching from original scheduled completion date as the variable for selecting contracts for data submissions.

Issue – Methodology Does Not Capture Performance for Late Calendar Day Projects that Have No Substantial Completion Date. 2001 to 2005 calendar day contracts in the dataset without a substantial completion date are not included in the analysis, but all 2001 to 2005 working day projects are included. No investigation was conducted to determine if this biased results.

Resolution – Further review of the most appropriate method for merging analysis of the two types of projects is needed to ensure the accuracy of data analysis.

Issue – Amount of Inaccurate or Missing Contracts Data is Unknown. For this study, DOTs self reported all data. While the consultant reviewed all data for completeness in terms of required data fields, the accuracy of states' data management systems was not scrutinized. The report assumes that since DOTs rely on accurate cost and schedule data for a multitude of internal processes, all or most of their data is likely to be accurate, but this is unknown.

Resolution - Greater contact with states during the data reporting would help eliminate misunderstandings

Appendix C
Lenient Schedule Measure Results

Share of States' 2001 to 2005 Projects Finished on or Before Current Scheduled Completion Date (or Within Original Working Days)

State	Number of Projects[1]	Share of Projects Completed on or Before Current Schedule/Within Current Work Days
AZ	799	95%
State 3	794	94%
State 15	1330	91%
State 7	3030	90%
State 16	3591	89%
State	2899	86%
State 2	1560	85%
State	1411	81%
State 13	184	80%
State 7	1670	76%
State 20	1384	73%
State 10	322	59%
State 17	970	54%
State 18	238	46%
State	-	Not Ranked
State	-	Not Ranked
State	-	Not Ranked
State	-	Not Ranked
State	-	Not Ranked
State	-	Not Ranked

Special Note – Only 14 states were able to provide data to allow calculation of this measure and during review of states' data submissions it was apparent that variation in definitions of "current scheduled completion date" might not be consistent among states It is therefore recommended that the results of this measure should not be distributed in a similar fashion to results for the other three measures.

Appendix D
Interview Guides

On-Budget Best Performers Interview Guide

1. Are you comfortable that the analysis we performed provides an accurate depiction of your state's performance in completing contracts within their original bid amounts? (We compared the original bid amount to the final cost for each contract with an original scheduled completion date between 2001 to 2005, and a final voucher date.)

2. Please verify whether your state always/sometimes/never builds in a cushion for unanticipated costs (i.e., a contingency) into a contract's original bid amount?

3. In your experience, what are the most common reasons that might cause final costs to exceed original contract bid amounts? Do the "typical reasons" for large projects and small projects vary? If so, how and why?

4. Do you track a "bid amount to final cost" measure (or something similar, if so please describe) in your state? If so, describe how it is used. (Particularly with regard to issues such as the level at which it is used in the agency, the profile results receive, how results are used to manage, & its overall impact as a performance measure.)

5. What do you think are the greatest benefits (to your DOT and your citizens) of maintaining a good track record in keeping final contract costs within their original bid amounts? (Why do you think this is a good measure of project delivery?)

6. Provide a list of the top tactics that you recommend other states use to keep contracts within their original bid amounts (or within 10%)? (We are interested in how you handle issues such as engineering estimate procedures used to derive bids, letting strategies that generate reliable bids, and any other approaches and strategies that you think are relevant.) Are the tactics different for large projects and small projects? If so how and why?

7. What three points would you emphasize in selling the value of this measure to others?

On Schedule Best Performers Interview Guide

1. Are you comfortable that the analysis we performed provides an accurate depiction of your state's performance in completing contracts on schedule? (We compared the original scheduled completion date or number of working days to the physical/substantial completion date or actual number of working days for each contract with an original scheduled completion date between 2001 to 2005, or its estimated equivalent.)

2. Please explain how and when your state sets its original scheduled completion date or original number of working days for a contract. Do you update this number during the course of a project?

3. In your experience, what are the most common reasons that might cause final schedule to exceed original schedule? Do the "typical reasons" for large projects and small projects vary? If so, how and why?

4. Do you track a "original compared to final schedule" measure (or something similar, if so please describe) in your state? If so, describe how it is used. (Particularly with regard to issues such as the level at which it is used in the agency, the profile results receive, how results are used to manage, & its overall impact as a performance measure.)

5. What do you think are the greatest benefits (to your DOT and your citizens) of maintaining a good track record in keeping final contract schedules within their original planned schedules? (Why do you think this is a good measure of project delivery?)

6. Provide a list of the top tactics that you recommend other states use to keep contracts within their original schedules. Are the tactics different for large projects and small projects? If so how and why?

7. What three points would you emphasize in selling the value of this measure to others?