PERFORMANCE AUDIT

MISSOURI DEPARTMENT OF TRANSPORTATION
CONTRACT CHANGE ORDERS

From The Office Of State Auditor
Claire McCaskill

While the majority of change orders could not be avoided, some could have been with better oversight of the design and contract preparation phase of construction.

Report No. 2002-96
September 26, 2002
www.auditor.state.mo.us

Office of
Missouri State Auditor
Claire McCaskill

September 2002

YELLOW SHEET

Audit analyzes how well transportation department manages contract revisions - known as change orders - to its construction projects

Auditors found room for improvement in some processes used by the Department of Transportation to manage construction change orders. These orders, which authorize payment for construction design, scope or quantity revisions, are very common to the construction environment. Some orders are unavoidable, but all orders can change a project's total cost.

Auditors reviewed 100 change orders spread among 8 construction projects and issued over 18 months in 2000 and 2001. Department officials initially expected these projects to cost $118.4 million and these 100 change orders increased costs by $12 million. Over this same 18-month time period, the department issued 2,058 change orders totaling $45 million and spent over $1 billion on 545 construction projects. Department officials said Missouri's 3 percent change order rate is comparable or better than neighboring states: Kansas (2-5 percent), Iowa (5.4 percent) and Illinois (4-7 percent).

Majority of change orders were necessary, but some avoidable

Auditors called 59 percent of the change order line items reviewed necessary and unforeseen before awarding the construction contract. The 100 change orders analyzed amounted to 796 change order line items. Auditors found the department could have avoided 330 of these change order line items, which totaled $5.8 million. Auditors consider a change order avoidable if officials had handled the projects properly before the project was submitted for competitive bid. (See page 2)

The most common problems leading to avoidable change orders included: surveying and staking errors, quantity sheet omissions, design flaws and miscommunications. For example, a surveying error caused the misplacement of a roadway's center line by 2 feet, which cost $108,000 to correct. (See page 3) Miscommunication on a St. Louis retrofitting-bridge project added $1.2 million in change orders and additional work. (See page 6)

Some change orders wasted $1.8 million

Auditors categorized the $5.8 million in avoidable change orders into two groups. The first group (totaling $4 million) included change orders which caused necessary additional construction. These additions, if included in the original project contract, would have changed the total cost, either up or down. The second group of change orders (totaling $1.8 million) caused additional construction costs, which could have been avoided with

proper project management. This second group involved change orders on two construction projects. Miscommunication cost one project $1.2 million, while accelerating a second project cost nearly an extra $600,000. (See page 8)

Procedural weaknesses contribute to change orders

Auditors identified five main procedural weaknesses which, if corrected, could reduce change orders including: improving district design reviews, clarifying project manager responsibilities, performing sufficient field checks, tracking causes for change orders and performing post-construction reviews. Department officials said they began tracking causes for change orders in April 2002 and plan to start a post-construction review process. (See page 13)

Better oversight needed of frequently used design consultants

Department officials do not adequately oversee work of outside design consultants who design more than 50 percent of state road projects. Oversight concerns included: not holding consultants accountable for design errors as stipulated in contracts, not tracking consultant reimbursements for design errors, and inadequate consultant evaluations. Increasing oversight could reduce construction costs and decrease design errors. (See page 18)

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The State Auditor's Office audited change orders related to construction contracts of the Missouri Department of Transportation. The objectives of the audit were to (1) determine why change orders were occurring, (2) determine the extent change orders could have been avoided, and (3) identify any system/control weaknesses contributing to the incidence of change orders.

We concluded the department needs to improve the management and oversight of the design and preparation of construction projects, establish better controls and procedures over this process, and improve the management of design consultant activities.

The audit was conducted in accordance with applicable standards contained in *Government Auditing Standards,* issued by the Comptroller General of the United States, and included such tests of the procedures and records as were considered appropriate under the circumstances.

Claire McCaskill
State Auditor

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RESULTS AND RECOMMENDATIONS

1. Management Could Improve Oversight of Construction Project Design and Preparation

The majority of change order line items (466 of 796 or 59 percent) included in our review were necessary and could not have been foreseen at the time of contract award. The remaining 330 change order line items could have been avoided if Missouri Department of Transportation (the department) officials had followed established procedures for the project design and pre-award construction process. The value of these avoidable change order line items was $5.8 million (47 percent) of the total $12 million for the 796 line items. Problems caused by errors, omissions and oversight include:

- Surveying and staking errors
- Quantity sheet omissions and mistakes
- Design errors
- Communication problems
- Other item

Change orders are common in a construction environment such as the one in which the department operates and can be expected when unanticipated events are confronted during the construction process. Change orders generally increase the overall total cost of projects. Not all questionable change orders resulted in increased overall contract costs, since correct original project specifications would have included those costs. However, auditors noted the department could have saved over $1.8 million of the $5.8 million in avoidable change orders, if some matters had been handled more appropriately.

Missouri Department of Transportation Workload

From January 1, 2000, to June 30, 2001, the department paid over $1 billion to contractors for construction work. The value of open construction contracts during that period was over $2.6 billion. In construction planning, the division allocates a 3 percent contingency on the construction plan to provide for potential cost overruns that must be corrected through change orders. Applying this rate to the $2.6 billion in open contracts, the contingency would equate to $83.2 million.

Audit methodology

Between January 1, 2000, and June 30, 2001, department officials issued 2,058 change orders totaling $45 million on 545 contracts. The auditors focused on 8 ongoing construction projects, which had 100 change orders accounting for 796 line items. Department officials initially expected these eight projects to cost $118.4 million. The 100 change orders added $12 million in extra construction costs to these projects. This $12 million represented approximately 27 percent of the $45 million in change orders issued during the 18-month audit period. The auditors determined the reason for each change order line item and whether the change order could have been avoided. For purposes of this audit, the auditors considered a change order avoidable if

adequate procedures performed before submitting the project for competitive bid could have prevented the change.

(See Appendix I, page 23, for a further discussion of the audit methodology.)

Surveying and staking errors

Surveying errors resulted in approximately $1.6 million in avoidable change order line items. The department's Design Division and Construction Division personnel relied on inaccurate information to pinpoint key locations and measurements, took inaccurate field measurements, and did not double-check benchmarks to ensure the accuracy of measurements. The department's Project Development Manual and General Construction Manual guidelines provide that all benchmarks should be double-checked to ensure the accuracy of measurements.

For example, in District 6, inaccurate surveying procedures/measurements caused the intended centerline of a roadway to be off by approximately two feet. As a result, $108,000 in change order line items was needed to correct the problem.

The auditors determined staking errors resulted in over $50,000 in change order line items. The department's Construction Division did not implement double-checking procedures as part of the staking process and relied on inaccurate information to stake locations. General Construction Manual guidelines require a thorough check of all measurements, angles and elevations to prevent errors.

For example, in District 6, Construction Division personnel used inaccurate information to stake a project, which led to road signs in the wrong location. The department paid over $30,000 in change order line items to remove the signs and place them in the correct location.

Table 1.1 shows the costs of avoidable change orders related to surveying and staking errors for the contracts included in the audit.

Table 1.1: Avoidable Change Orders Due to Surveying and Staking Errors

Contract Number	Surveying Errors	Staking Errors	Totals
980522-05-OUH	$ 759,235	$ 0	$ 759,235
990319-609	568,251	10,288	578,539
990423-605	219,766	0	219,766
980619-08-PDH	32,353	40,292	72,645
990423-801	19,391	0	19,391
Totals	$ 1,598,996	$ 50,580	$ 1,649,576

Source: Auditors' analysis of data provided by department officials

(See Appendix II, page 24, for more information regarding surveying and staking procedures.)

Quantity sheet omissions and mistakes

Quantity sheet (identifies the materials necessary to construct the project) omissions and mistakes resulted in approximately $700,000 in avoidable change order line items. The department's districts did not adequately review the design plans' itemized quantity sheets, and General Headquarters personnel did not view their role as a reviewer of district work. As a result, quantity sheet omissions and various other mistakes were made, including miscalculations and errors in transferring amounts from one quantity sheet to another.

For example, materials necessary to construct road signs for a District 6 project were omitted from the itemized quantity sheets. This error resulted in $107,000 in change order line items to add the necessary materials to the project. In District 4, quantity sheet mistakes related to one project resulted in $199,105 in underruns (reductions in the total project cost) when the project inspector discovered several miscalculations in the quantity sheets after the project had been let. While underruns result in an overall reduction in the construction costs, it would be preferable that quantity sheets mistakes are corrected prior to contract award. Doing so would help ensure the correct amount of construction costs are subjected to competitive bidding procedures and would reduce the administrative costs in processing change orders.

Department personnel are responsible for ensuring quantity sheet omissions and mistakes are detected and corrected prior to contracting a project. Table 1.2 documents the costs of avoidable change orders related to quantity sheet omissions and mistakes for the contracts included in the audit.

Table 1.2: Avoidable Change Orders Due to Quantity Sheet Omissions and Mistakes

Contract Number	Quantity Sheet Omissions	Quantity Sheet Mistakes	Totals
991210-401	$ 324,684	$ (259,623)	$ 65,061
990319-609	323,272	(13,567)	309,705
990423-605	113,672	5,175	118,847
990618-903	103,252	7,000	110,252
980619-08-PDH	38,574	30,779	69,353
000121-614	0	27,228	27,228
Totals	$ 903,454	$ (203,008)	$ 700,446

Source: Auditors' analysis of data provided by department officials

(See Appendix II, page 24, for more information regarding itemized quantity sheets.)

In response to these issues, department officials stated "General Headquarters staff checks the accuracy of the largest items in the plans, not every aspect of the plans, so that construction can proceed." They stated they realize "this approach slightly increases the opportunities for change orders, but any cost is more than offset by the savings to Missourians via safer roads." Additionally, they stated it would not be cost effective to regenerate exact quantities and verify mathematics at the General Headquarters level because it would duplicate district work.

Design errors

Design errors, including omissions from and mistakes within original designs, resulted in over $1.4 million in avoidable change order line items. The department's districts did not adequately review the original design plans, and General Headquarters personnel did not view their role as a reviewer of district or design consultant work.

For example, in a District 4 project, the erosion control system set up in the original design was not adequate for the area. Department personnel stated this should have been identified during the system's design. As a result, over $98,000 in change order line items was necessary to change the erosion control system and obtain the correct materials.

In another District 4 project, the original design did not include needed excavation. Excavation is included in a project's design when a specific type of digging is required to break through the ground in certain locations, such as around large rock and obstructions. However, because some excavation was left out of the original design, $166,000 in change order line items resulted to cover the additional excavation.

Although the preparation of many design plans is outsourced to design consultants, department staff are responsible for ensuring design errors are detected and corrected prior to contracting a project.

Table 1.3 documents the costs of avoidable change orders related to design errors for the contracts included in the audit.

Table 1.3: Avoidable Change Orders Due to Design Errors

Contract Number	Omissions from Original Design	Mistakes in Original Design	Totals
990319-609	$ 235,775	$ 137,053	$ 372,828
991210-401	207,843	98,015	305,858
990423-605	111,236	8,545	119,781
980619-08-PDH	24,171	595,364	619,535
990618-903	20,684	12,625	33,309
990423-801	8,210	0	8,210
Totals	$ 607,919	$ 851,602	$ 1,459,521

Source: Auditors' analysis of data provided by department officials

(See Appendix II, page 24, for more information regarding project design plans.)

In response to these issues, department officials stated "the labor costs alone to produce perfect plans would more than offset any savings from lowered change order administration costs. The level of accuracy desired by the State Auditor's Office may be unachievable on a construction project, without significantly increasing costs. Trying to achieve such a level of flawlessness would waste taxpayer money."

Communication problems

Better communication could have prevented change order line items amounting to over $1.2 million. Nearly all of this money could have been saved with more appropriate handling.

District 6: Inadequate design consultant preliminary surveying

Better communication with design consultants needed

The department could have saved $486,817 and avoided numerous surveying errors and completion date extensions had District 6 personnel properly communicated with the design consultant on a bridge-retrofitting project. The design consultant used an inaccurate method to conduct preliminary surveying procedures. The department's project managers are responsible for ongoing communication with the design consultants to ensure the design plans are progressing and the consultants are performing accurate project design procedures.

The department planned the bridge retrofitting project to strengthen and stabilize a two-tier bridge in St. Louis to withstand an earthquake. Four of the bridge's footings were located in a parking lot owned by the U.S. General Services Administration (GSA). The design consultant's inaccurate preliminary survey measurements caused all of the footings to be inaccurately designed. Two of the footings were constructed approximately one foot above the level of the parking lot before the problem was recognized.

The contract with the GSA required the parking lot to be restored to its original condition. As a result of the two inaccurate footings, the parking lot lost some parking spaces and was no longer in the same condition. Due to the nature of the bridgework, department personnel could not reconstruct the two footings and had to redesign the remaining two footings. To restore the parking lot to its original condition, the department had to (1) increase traffic control activities; (2) raise the height of the parking lot to the level of the footings; (3) remove, relocate, and revise the parking lot islands; and (4) add lighting work and pavement markings.

District 6: Lease agreement with the General Services Administration

The department could have saved $727,766 and avoided numerous project delays and change order line items if department officials obtained a signed lease agreement from the GSA before awarding the contract. These unnecessary construction costs are related to the same project discussed in the previous section.

The department did not obtain necessary agreement

The GSA denied the contractor access to its property causing delays that resulted in change order line items. Department personnel said property ownership was initially the subject of some dispute, and the department did not properly communicate with GSA officials to reach an agreement prior to contract award. The department did not

have a written lease agreement with the GSA until 3 months after the construction contract was awarded. Section 4-03.17 (3) of the Project Development Manual requires all such agreements to be completed prior to submission of the plans for the bid opening.

In response to this issue, department officials stated, the department "obtained the necessary agreement with GSA, albeit 3 months after the award of the contract. It was an administrative decision to let the project before the lease agreement was finalized to avoid delaying the construction of this important project. The department is acquiring the property in question to ensure that any future conflicts with the GSA will be avoided when work on this bridge will be needed."

District 4: Division communication problems

District 4 Design Division and Traffic Division personnel could have avoided $72,983 in change order line items by properly communicating sign purchasing for a project in the downtown Kansas City area. Traffic Division staff established quantities and ordered signs without knowing a contractor already working on a project in the area was required to furnish the signs. This change order amount could have been avoided had staff from the two divisions discussed this issue before ordering additional signs.

Table 1.4 documents the costs of avoidable change orders related to communication problems for the contracts included in the audit.

Table 1.4: Avoidable Change Orders Due to Communication Problems

Contract Number	Communication Problems
000121-614	$ 486,817
000121-614	727,766
980522-05-OUH	72,983
Total	$ 1,287,566

Source: Auditors' analysis of data provided by department officials

Other item

Department officials decided to accelerate completion of a project 10 months after project start which resulted in change orders that could have been avoided.

District 4: Project acceleration

The department issued $597,590 in change orders authorizing additional construction costs to accelerate the completion of a road project (contract number 991210-401) in District 4. District 4 Design Division personnel informed the auditors that General Headquarters officials made this decision to open four lanes of the roadway before winter.

The decision to accelerate the project's completion required changes in traffic phasing, contractor overtime costs, and additional materials. While completing the project before winter may have been an appropriate decision, this matter should have been considered prior to awarding the construction contract. General Headquarters personnel informed the auditors the decision to accelerate the project was made 10 months after awarding the contract.

Categories of avoidable change orders

To analyze the cost savings we reported in the previous sections, we categorized the avoidable change order line items into two groups. These categories described below totaled approximately $5.8 million:

- Change order line items related to contract items/costs that would have been properly included in the original contract design and specifications if adequate procedures had been performed before the contract was competitively bid. A cost savings, if any, could not be determined on these change orders because of the uncertainty in the contract bids. Had these items been included in the bid process, the items would have likely added some costs to the original contracts. The total amount of these change order line items was $4.0 million.

- Change order line items related to contract items/costs that could have been prevented if adequate procedures had been performed before the contract was competitively bid. The change orders identified in this category totaled $1.8 million and involved two construction projects. This category included the extra construction costs of $486,817 and $727,766 noted in the **Communication problems** section, and the $597,590 discussed in the **Other item** section.

Conclusion

Better oversight and management of the project design and pre-award construction process could have avoided many change orders and at least $1.8 million in costs. While many of the avoidable change orders would not have necessarily resulted in reduced construction costs, keeping change orders to a minimum would help (1) ensure the maximum amount of construction costs are subjected to competitive bidding procedures, (2) reduce the effect of change orders on the department's planning process, and (3) reduce the amount of administrative time and effort in processing change orders.

Recommendation

We recommend the Director, Department of Transportation:

1.1 Improve management and oversight of the project design and pre-award construction process to reduce the incidence of change orders and keep such contract changes to a minimum.

Department of Transportation Response

The Missouri Department of Transportation is confident Missouri taxpayers get the best value for their dollars by receiving quality and efficient services in return for their investment in the state transportation system. The department's project plans demonstrate a high degree of accuracy, thoroughness and sound engineering judgment. MoDOT is committed to making its design and construction processes as efficient as possible to assure the citizens of Missouri that the resources provided are being appropriately used for their benefit.

For example, MoDOT's change order rate of 3 percent is comparable to or better than that of neighboring states: Kansas DOT (2-5 percent), Iowa DOT (5.4 percent) and Illinois DOT (4-7 percent). On major construction jobs, change orders[1] are as common as steel and concrete. Change orders – paperwork that authorizes a change in scope of an aspect of construction – are as much a part of the contract as are the drawings and specifications. They are amendments to the contract for construction that authorize changes in the original plans and specifications for the project. Change orders do not necessarily equate to higher costs. In many instances, the work necessary to avoid all change orders would cost the state more than the change order.

A variety of factors can prompt the need for change orders: unknown and hidden conditions in the project area, unexpected scheduling delays, weather conditions and so on. Change orders can increase or decrease the cost and times allowed for completion of a project and are paid from a 3 percent contingency budget. An approval process must be followed before the work is done.

The report from the State Auditor's Office concedes that change orders are common in the construction industry. And although the SAO has cited instances where it asserts additional costs for change orders resulted from inadequate oversight, these few examples were presented after reviewing documents from the record-sized $2.6 billion program during the period within question. In this case, a few projects were shown to cause a substantial portion of all the difficulties.

One cannot accurately infer the entire program, or even a significant portion of the program, experiences similar problems. A systemic problem cannot be assumed based on this atypical and miniscule slice of the construction-work pie. The report disregards the statistical fact that a program having hundreds of projects such as the one MoDOT administers will typically include a large majority of projects that are completed relatively problem-free while a few projects will contain most of the challenges.

MoDOT long ago recognized that greater efficiency, not flawlessness, is required to best serve Missourians. Over the past decade, MoDOT has administered a program that has grown to record levels with a smaller staff, effectively maintaining quality while providing greater productivity.

Roadwork is, in actuality, custom work. The American Association of State Highway and Transportation Officials recognizes that pre-construction engineering ultimately results in a product that has never been produced before and potentially never will be produced again in exactly the same manner. Many different standards, processes, phases and groups are involved in the production of a road.[1]

The SAO's report utilizes boxed statements interspersed throughout the text. MoDOT contends that most of these boxed statements are misrepresentations of the design and construction process as a whole and should be removed, clarified or qualified. Because the oversimplified boxed statements are out of context, a person focusing on these blurbs to guide them through the report could form an opinion that is not necessarily supported by the data and details in the narrative text.

1.1 MoDOT remains committed to continuously improving its processes. Given the favorable comparison of our percentage of change orders (3 percent) to those of neighboring states (two-seven percent), and the small value of questioned change orders ($1.8 million) relative to the size of the construction program ($2.685 billion), MoDOT is confident its project design and pre-award construction process is effectively managed. Change orders do not necessarily equate to higher costs. In many instances, the work necessary to avoid all change orders would cost the state more than the change order(s).

As stated in the SAO report, change orders are common in the construction industry. Every roadway project is virtually assured of having at least one change order, because by necessity, plans use estimated quantities. It is important to understand that most change orders are subject to competitive bidding prices. The vast majority of change order items correct overrun or under run quantities of bid items. MoDOT incorporates field-measured quantities into its final change orders so taxpayers get what they pay for while the contractor is paid only for what is actually used or constructed.

Although the SAO found examples where change orders resulted in additional costs, they focused on only eight of 545 active construction projects. The amount of change orders on these eight projects was atypical. This is evidenced by the fact that by reviewing only eight of 545 projects that were active during the period, the SAO was able to review 27 percent of the change orders issued in that 18-month period. Statistically, a program with hundreds of projects will typically include a large majority of projects that are completed relatively problem-free while a few projects will contain most of the headaches. One cannot infer that the entire program, or even a significant portion of the program, experiences similar problems.

[1] *For a summary of MoDOT's change order process, refer to Appendix A at the end of this response.*

MoDOT's change order rate of three percent is comparable to or below that of neighboring states:

Kansas DOT (2-5 percent)
Iowa DOT (5.4 percent)
Illinois DOT (4-7 percent)
MoDOT (3 percent)

In addition, MoDOT's percentage of change orders has remained stable for 10 years during a period when the construction program has expanded more than three-fold while staffing levels have remained constant or fallen slightly. The SAO reviewed projects active from Jan. 1, 2000, to June 30, 2001. Those projects were worth about $2.6 billion, yet the SAO reported only $1.8 million in change orders the SAO characterized as avoidable, an amount representing less than one-fourteenth of one percent of MoDOT's program during that period.

MoDOT recognizes that trying to develop perfect plans, that will have no change orders, is impossible. Any time humans are involved in processes as complicated as road and bridge design and construction, mistakes will be made. However, a distinction must be made between critical, life-threatening "mistakes," which MoDOT does not accept, and non-critical errors such as quantities, which are difficult and costly to estimate exactly.

MoDOT districts check project plans and quantities while General Headquarters checks the accuracy of the largest items in the plans. General Headquarters does not regenerate all of the mathematics because this would be a duplication of district work and is not cost effective.

Because perfect plans are impossible, MoDOT designates an extra 3 percent, categorized as "contingencies," into each highway project to account for changes on the site during the design of the project or for irregularities encountered in the field. This expedites the delivery of safer roads and provides a savings in life and human suffering that more than justifies the small cost for change orders. Thus, when the report states that $1.8 million could have been saved, the reader may be left with a tacit, but incorrect, impression that MoDOT may not have set aside resources to accommodate these expenditures.

MoDOT is committed to deliver the maximum number of projects as quickly as possible and has, therefore, been responsive to the public to expedite completion of some roadway projects. It is understood that some difficulties will arise under these circumstances. For instance, Route 13, the accelerated project referred to in the SAO report, is one of the highest crash locations in the state. MoDOT was asked by area representatives and communities to complete the project one year earlier to more quickly gain the safety benefits of a four-lane highway. MoDOT views the cost of this acceleration as a small investment compared to the safety benefits achieved.

Appendix A

Change Orders

A construction change order is a supplement to the contract. It provides the authority to pay for quantity revisions and authorizes changes in scope of work, design concept, or specifications. A change order must be approved before the work is done. Approval exceptions may be granted for minor or routine changes or emergencies for which telephone approval has been granted.

MoDOT utilizes four levels of change orders:

- *Level 1 requires a Resident Engineer's approval and involves a change in a contract item of less than $50,000 or a new contingent item under $20,000.*

- *Level 2 requires the approval of a District Engineer and may require approval from the Federal Highway Administration. It pertains to a change in a contract item between $50,000 and $100,000, a new contingent item between $20,000 and $50,000, or a final change order not meeting the criteria of Levels 3 or 4.*

- *Level 3, a major change order, requires the approval of the State Project Operations Engineer and often approval from FHWA. It entails a change in a contract or contingent item over $100,000, a new contingent item over $50,000, a specification change, a revision in contract price, a change in a contract item amount or change in a major item over 25 percent, a change in design concept, a differing site condition, or any value engineering change orders.*

- *Level 4, a major change order, requires the approval of both the Chief Engineer and the Chief Operating Officer as well as from all the previously mentioned approval levels. It entails additions greater than 50 percent if the original contract amount was $500,000 or less, additions greater than 25 percent if the original contract amount was greater than $500,000, or contract additions greater than $1,000,000.*

In MoDOT's construction management software, SiteManager, the reason for each item in a change order must be specified with a standard two-letter code that is inserted immediately after the item number. Thus, the costs of the various types of changes can be tracked.

Auditor's Comment

The focus of our audit was on the causes for change orders. We selected contracts with several change orders, which represented 27 percent of the total change order dollar value during our audit period. In analyzing what caused the change order line items, we found 59 percent were unavoidable and concluded division officials did all they could prior to contract award to ensure a correct design. For the remaining 41 percent, we focused on ways to improve management of the change order process to reduce change order occurrences and relevant processing costs. We concluded the state could have saved at least $1.8 million with proper project management.

2. Better Controls and Procedures Would Help Ensure Design and Construction Funds are Used Effectively

Department officials have not evaluated management systems to identify internal control weaknesses and to prevent errors and omissions in the design and preparation of construction projects. Control/procedural problems noted which contributed to the incidence of construction change orders include:

- Inadequate district design reviews
- Lack of documented project manager responsibilities
- Insufficient field checks
- Lack of a quality control system
- Lack of post-construction reviews

Based on discussions with department personnel and visits to two district offices, the auditors identified several control/procedural weaknesses that could be corrected to reduce the incidence and cost of avoidable change orders.

Inadequate district design reviews

Improvement is needed in the review of design plans at the district level. Personnel in Districts 4 and 6 said they were not performing extensive design plan reviews on every project, partly due to time pressure from General Headquarters to award the contracts. The districts are responsible for providing General Headquarters with accurate and complete design plans. However, without proper reviews, district staff cannot be certain design plans sent to General Headquarters are accurate and complete.

District personnel said time pressure sometimes causes them to send designs to General Headquarters without correcting already detected errors. Change orders will result when design plans are sent to General Headquarters that have not been properly reviewed and knowingly have errors.

Department personnel at District 4 said they do not review consultant-prepared designs as extensively as they review design plans prepared in-house. Section 1-03.4 of the department's Project Development Manual states design consultants should be treated as an extension of the department. Therefore, reviews of consultant-prepared design plans should be as thorough as the reviews of design plans prepared by department personnel.

District 6 officials said they are in the process of incorporating a new "Quality Assurance Quality Control" system into their current review process and District 4 officials have established a Technical Service Group. Both of these controls are intended to help reduce design errors and quantity sheet errors/omissions. However, because these controls were recently implemented, their impact could not be determined yet.

Lack of documented project manager responsibilities

The project managers are responsible for the proper design of individual construction projects. The department has not prepared written guidelines that specifically outline the project managers' responsibilities.

General Headquarters personnel said project managers sometimes tell them they do not fully understand their job duties and expectations. While District 4 personnel indicated the district's project managers have training sessions and annual meetings, at times these managers are still unclear about their responsibilities. District 6 personnel said they assume the district's project managers know their responsibilities when they begin their job because most of them are promoted from within. However, auditors determined that promoting from within does not necessarily mean within the same district.

The lack of documented project manager responsibilities has led to inconsistencies within the department. For example, districts are not consistent in how closely the project managers monitor the design consultants to ensure the contractual obligations have been met. Personnel at four districts contacted (Districts 4, 5, 6 and 8) said they each have different levels of communication between the project manager and the design consultants. Another inconsistency is the project managers' level of involvement in the project after the design is complete. District 6 leaves the extent of project manager involvement during the construction process to the discretion of each individual project manager. Therefore, even duties performed by the various project managers within a district may not necessarily be consistent.

Managing of project designs is inconsistent

A Design Division official said project managers are professionals with engineering licenses and therefore, the department should be able to rely on them to know and understand their responsibilities. However, considering the reports that some project managers are uncertain as to their duties and responsibilities and the need to achieve an adequate level of consistency within the department, the duties and responsibilities of the project managers should be clearly identified and documented.

Insufficient field checks

General Headquarters personnel said district staff are not performing field checks on every project as required, due to lack of time, staff, and experience. In addition, the completed field checks are not always as thorough as needed.

The lack of adequate field checks allows design errors to go undetected prior to the award of a construction contract, resulting in the need for change orders. The department's Project Development Manual requires preliminary design and final field checks to be conducted. *(See Appendix II, page 24, for a further discussion of the field check process.)*

Lack of a quality control system

Quality control concerns were noted in the Design Division and throughout the department. Design Division officials at General Headquarters have not established an effective quality control system to ensure district staff are adequately preparing or reviewing project designs before they are submitted to General Headquarters. While these Design Division officials process the project designs, they do not review the designs or approve them at any stage of the project's development. An effective quality control system is needed to ensure accurate and complete project designs are submitted.

During the period reviewed, department officials did not track and analyze the reasons change orders occurred. As a result, the cause for change orders is not adequately monitored to identify areas that need improvement. Such analyses would provide the opportunity to identify and address problems in the design and construction processes and could help reduce the incidence of change orders in future projects.

Department begins tracking reasons for change orders

Department officials have recognized the need to track reasons for change orders and said they implemented a system in April 2002. This information should be used to analyze the primary causes of change orders and identify areas of improvement.

Lack of post-construction reviews

Department officials do not require post-construction reviews to identify problems and/or causes of project overruns. Such reviews could help the department avoid similar problems on future projects. Personnel from several districts (Districts 4, 5, 6 and 8) have said they are not performing post-construction reviews on a consistent basis due to a lack of time and an incentive for contractor participation.

Some district personnel stated they view post-construction reviews as not beneficial and a waste of time; however, personnel at General Headquarters believe post-construction reviews are beneficial. The department should review this matter, and if it is determined that post-construction reviews are beneficial and would help to reduce the incidence of change orders, such reviews should be required at the conclusion of each construction project.

Conclusion

Various control and procedural weaknesses have contributed to the incidence of change orders. These weaknesses occurred because of time pressures, inconsistent reviews of projects, staff not following established procedures and lack of some quality controls.

Recommendations

We recommend the Director, Department of Transportation:

2.1 Ensure district staff perform adequate reviews of all design plans and make necessary corrections before the plans are sent to General Headquarters.

2.2 Establish written guidelines that outline the specific duties and responsibilities of the project managers. These should include, but not be limited to, how closely the project managers monitor the design consultants to ensure contractual obligations have been met, and the project managers' involvement in projects after the design completion.

2.3 Ensure all field checks are performed according to the guidelines set forth in the Project Development Manual.

2.4 Establish an effective quality control system to ensure district staff are submitting accurate and complete project design plans to General Headquarters.

2.5 Evaluate the usefulness of post-construction reviews and take appropriate action to establish policy regarding these reviews.

Department of Transportation Responses

2.1 MoDOT has processes in place to perform adequate reviews of design plans and will continue to develop these processes through education, communication and oversight. It is incorrect to assume that all change orders result from inadequately reviewed plans. There are many factors involved in producing quality plans in a timely manner. MoDOT regards its review process to be reasonable and appropriate.

2.2 MoDOT disagrees with this recommendation. The department's project managers have a written job description allowing for differences in managerial style among project managers. Just as each project is unique and requires customized handling, MoDOT recognizes that each project manager will have a differing managerial style. Some "inconsistencies" in project design management are not only unavoidable, but are desirable, depending on the complexity of the project to foster an environment that promotes ingenuity and innovation.

2.3 MoDOT currently has guidelines in place for performing appropriate field checks. and will continue to do so. We will continue to encourage participation in field checks through education, communication and oversight.

2.4 MoDOT has processes in place to perform adequate reviews of design plans and will continue to develop these processes through education, communication and oversight as stated in 2.1.

2.5 We will implement post-construction reviews on sample projects during the next year, and then develop a process based on best practices found.

3. Management of Design Consultant Activities Could Be Improved

Management and accountability over design consultant services is not adequate. Control and procedural problems noted include:

- Lack of design consultant accountability
- No tracking of consultant reimbursements for design errors
- Inadequate design consultant evaluations

Design consultants are used on more than 50 percent of the department's projects. Department officials said time and manpower issues have led to an ever-increasing need to use consultants, which makes establishing adequate controls imperative.

Lack of design consultant accountability

While contracts with design consultants include provisions to hold the consultants responsible for negligent acts, errors, or omissions, department officials have not taken steps to ensure design consultants are held accountable for such actions.

Section (5)(C) of the consultant contracts provides:

> "The Consultant shall be responsible for the professional quality, technical accuracy and the coordination of designs, drawings, specifications, and other services furnished under this Agreement. At any time during construction or during any phase of work performed by others based upon data, plans, designs or specifications provided by the Consultant, the Consultant shall prepare any data, plans, designs or specifications needed to correct any negligent acts, errors, or omissions of the Consultant or anyone for whom it is legally responsible in failing to comply with the foregoing standard. The services necessary to correct such negligent acts, errors, or omissions shall be performed without additional compensation, even though final payment may have been received by the Consultant. The Consultant shall provide such services as expeditiously as is consistent with professional performance. Acceptance of the services will not relieve the Consultant of the responsibility to correct such negligent acts, errors, or omissions."

In addition, Section 15(B) of the consultant contracts provides:

> "The Consultant shall be responsible for the direct damages incurred by the Commission as result of the negligent acts, errors, or omissions of the Consultant or anyone for whom the Consultant is legally responsible, and for any losses or costs to repair or remedy construction as a result of such negligent acts, errors or omissions; provided, however, the Consultant shall not be liable to the Commission for such losses, costs, repairs and/or remedies which constitute betterment of or an addition of value to the construction or the project."

Department management has not established an adequate system to ensure design consultants are held accountable for errors as provided in these contract provisions. The department does not maintain central records of efforts to hold design consultants accountable. In response to our inquiry, department officials at General Headquarters called district office officials and identified 11 instances between May 1996 and February 2002 where they had made an effort to hold design consultants financially accountable for errors or omissions.

Developing an accountability system would help recover construction costs for which the consultant is responsible and also may help to decrease design errors. Department officials should also consider holding the consultants accountable for other costs, which result from their design errors, such as legal fees from litigation and the administrative costs of processing change orders.

Improvement is needed in tracking consultant reimbursements for design errors

Department personnel do not track reimbursements received from consultants or those amounts being pursued due to errors made by design consultants. As a result, auditors were unable to determine the extent of reimbursements or possible accounts receivables, or if department staff are making consistent efforts to collect costs resulting from consultant errors.

A tracking system would provide the following benefits:

- Quantify the extent of collections and possible accounts receivables
- Demonstrate that the department is holding design consultants accountable for their errors
- Provide a tool for selecting design consultants for future projects

Design consultant evaluations can be more effective

Rating system is vague

Department officials use an evaluation form to rate the performance of design consultants. However, the rating system used on these forms is vague and does not effectively reflect the actual performance of a consultant on a particular project. The department has not provided descriptions of what the various ratings mean, directions on how to complete the evaluation form, or require the evaluator to include any documentation or explanation supporting the ratings. In addition, a time frame has not been established for when the evaluations need to be completed or guidelines for approving the evaluations.

Some district staff do not complete the required consultant evaluations on every consultant designed project. District 6 officials allow project managers and resident engineers to decide if evaluations are completed. In addition, the staff in that district do not discuss the evaluations with the consultants.

The department's Project Development Manual provides, "…once a consultant has completed the work described in the contract, an evaluation form must be completed, shared with the consultant and submitted to the General Headquarters…It is imperative this information be

shared with the consultant. In this way, each consultant's strengths and areas for improvement can be identified and the quality of services can be improved."

Department officials use the evaluations in a subjective manner, and consider them as only "a starting point" for examining consultant performance. Department personnel stated they also rely on the verbal "opinions" of the evaluators to determine whether a consultant should be used again. According to one district official, the department's past working relationship with a firm plays a big part in the selection of consultants.

While Design Division officials have indicated they are currently reviewing the evaluation forms and their usefulness, the current forms and process are inadequate and do not provide for objectivity in the evaluation of design consultants. Improvements in the current consultant evaluation process should include, but not be limited to (1) establishing guidelines for consistently completing and approving evaluations, (2) requiring adequate documentation to support the ratings, (3) establishing a time frame for having the evaluations completed and submitted to General Headquarters, and (4) ensuring the evaluations are discussed with the consultants as required.

Conclusion

Design consultants are used for over half of the design work in the department. Although they are professional design firms, the department still has a responsibility to monitor the quality of design firm work and take action when design problems are found. The department's practices for using design consultants needs to include a quality control review to ensure that design funds are used effectively and efficiently.

Recommendations

We recommend the Director, Department of Transportation:

3.1 Establish a system to ensure design consultants are held accountable for their errors and omissions in accordance with contract provisions.

3.2 Establish a system or procedures for tracking money reimbursed or being pursued by the department from design consultants as a result of consultant errors or omissions.

3.3 Take action to improve the current design consultant evaluation process to make it more objective and reflect the consultants' actual performance.

Department of Transportation Responses

3.1 We deem our current processes to be reasonable and appropriate. MoDOT holds consultants financially accountable for their errors and we evaluate their performance. It is correct that MoDOT has not maintained centralized records of cases where design consultants are accountable for errors.

While the report states that design consultants are used on more than 50 percent of MoDOT projects, there are so few cases (11 instances between May 1996 and February 2002) where we need to hold the consultant financially accountable for errors that we have not deemed it necessary to create a centralized tracking system. MoDOT records this type of data and can easily retrieve it, as we did at the SAO's request.

3.2 MoDOT agrees and is currently establishing a system to track payments consultants make to address their errors.

3.3 MoDOT has processes in place to evaluate consultants and will continue to develop these processes through education, communication and oversight.

The boxed comment "rating system is vague" is questionable. MoDOT views the rating system as easy to complete. Since this is a professional service issue, the rating must be subjective enough to truly describe the performance of the consultant. MoDOT would like to see greater project manager and resident engineer participation in the evaluation process, and will take the appropriate action to ensure its implementation.

4. Other Matters

Auditors received several complaints from construction contractors regarding the timeliness of payment for work completed on change orders. One major concern in the complaints was that although the work had been agreed upon and completed, payment was delayed while disputes over the cost and time to complete were resolved with the department. We did not include timeliness of payments as an objective in this audit and therefore did not conduct tests to verify the contractors' complaints as a part of this audit. The matter will be analyzed and considered for a future audit.

Department of Transportation Response

MoDOT regards payment for a job properly done as a serious and binding obligation. We are always open to any complaints having to do with timely payment. Over the years, on the few occasions when a complaint was voiced, we consistently asked for specifics. To date, no contractors have come forward to verify such a complaint. MoDOT is not aware of any specific instance where work was completed before the cost and time to complete were resolved with the department.

Resident engineers are to obtain a signed change order before allowing the work to be completed. In an emergency, a verbal approval to proceed may be obtained if the cost and time is agreed upon. A change order is to be completed and signed as soon as possible, even in the case of an emergency.

APPENDIX I

OBJECTIVES, SCOPE AND METHODOLOGY

Objectives

The objectives of this audit were to (1) determine why change orders were occurring, (2) determine the extent change orders could have been avoided, and (3) identify any system/control weaknesses contributing to the incidence of change orders.

Scope and Methodology

The auditors concentrated on construction activity and the related change orders during the period January 1, 2000, to June 30, 2001. The audit included gaining an understanding of the project design process, pre-award construction activities, and the change order process.

The auditors selected and concentrated their examination on 8 construction contracts, which involved 100 change orders, including 796 separate line items. The change orders authorized over $12 million in additional construction costs. This $12 million represents approximately 27 percent of the $45 million in change orders issued for all department construction contracts during the 18-month audit period. These eight contracts were administered through Districts 4, 6, 8, and 9.

The auditors reviewed substantially all of the change orders for the eight contracts examined. In addition, they reviewed any significant change orders issued between June 30, 2001, and the date the project was reviewed. The audit involved work primarily at General Headquarters and visits to the district offices in District 4 (Kansas City) and District 6 (St. Louis).

Based on the review of the records and extensive discussions with department personnel at the General Headquarters and districts, the auditors determined the reason for each change order line item and whether the item could have been avoided.

APPENDIX II

BACKGROUND

Change orders

While it is recognized that change orders will likely occur on any construction contract, it is preferable to keep them to a minimum to:

- Ensure the maximum amount of construction costs are subjected to competitive bidding procedures
- Reduce the effect of change orders on the department's planning process
- Reduce the amount of administrative time and effort in processing change orders

The department's General Construction Manual describes a change order as "a supplement to the contract. It is prepared to provide authority to pay for revisions in quantities and to authorize changes in scope of work, design concept or specifications." Change orders can either increase or decrease the cost of a project, depending on the nature of the change order. Typically, change orders result in an increase in the overall project cost.

Between January 1, 2000, to June 30, 2001, department officials approved change orders, which increased total costs on construction projects by approximately $45 million.

Project design and pre-award construction process

There are various elements involved in the department's project design and pre-award construction process. The following information explains some of the key elements in this process. These elements include:

- Surveying
- Staking
- Itemized quantity sheets
- Project design plans
- Field checks

Surveying

Surveying is one of the first stages in the project design process and occurs before a project's design is prepared. The purpose of surveying is to obtain key measurements, locations, and control points that will be used in preparing design plans. This procedure occurs at the actual field location where the project's construction will take place and is generally performed by a group of district Design Division personnel, referred to as a survey party.

All measurements, locations, and control points obtained by the survey party are required to be double-checked for accuracy. In addition, after a project's design has been awarded

to a contractor, the district's Construction Division survey party will rerun all measurements, locations, and control points again for accuracy before the project's actual construction begins. While department officials have outsourced these surveying procedures in some instances, Construction Division personnel usually perform them.

Surveying is a very important element of the design process. The accuracy in taking the applicable measurements is critical to the overall accuracy of the design plans. Undetected surveying errors and/or the lack of adequate surveying procedures have an adverse effect on a project's design plans, creating a need for change orders to correct any errors.

Staking

Staking procedures establish visible reference points for a project's construction, and occur after the project's design is complete but prior to the start of actual construction. These procedures involve physically placing stakes at predetermined locations in the field where construction will take place. Since this process occurs after the completion of a project's design, the accuracy of the staking relies, in part, on the accuracy of the design plans and survey work.

A district's Construction Division personnel are responsible for performing all staking procedures; however, these procedures are sometimes outsourced to the contractor handling the project. All staked locations are required to be double-checked for accuracy.

The accuracy of the staking procedures is critical in constructing a project. The construction crew uses the staked locations in determining where specific elements of a design are to be constructed. Undetected staking errors will affect the accuracy of a project's construction and create a need for change orders to correct any problems.

Itemized quantity sheets

Quantity sheets detail all materials necessary to complete the construction of a project based on its design. There are two itemized quantity sheets for all designs; the 2B sheet is prepared initially and used in the subsequent preparation of the 2A sheet. The 2B quantity sheet is prepared by the project's designer and consists of a detailed summary of all quantities in relation to their location in the project design. After preparation by the designer and review by the applicable district office, it is submitted to the General Headquarters. The 2A quantity sheet is prepared by Design Division personnel at General Headquarters and consists of a summary listing of all items necessary to construct a project. Both quantity sheets are included in a project's design plans and the 2A sheet is used to prepare the bid documentation, which is provided to prospective contractors.

Quantity sheets directly reflect the actual materials needed for the proper completion of a project. In addition, the materials included in the quantity sheets reflect the materials included in the bids of contractors. Undetected quantity sheet errors, caused by the omission of needed quantities or mistakes in the quantity sheets, affect the accuracy of the overall design plans and contract specifications and create a need for change orders to correct any problems.

Project design plans

A project design plan generally consists of several pages of engineer drawings that identify the measurements, locations, slopes, and structures to be constructed on a project. Either district Design Division personnel or a design consultant prepare the design plans for road projects. The department's Bridge Division at General Headquarters is responsible for all bridge designs. At times, Bridge Division officials will also outsource bridge design plans to consultants.

The accuracy of design plans is critical in avoiding change orders. Design errors occur when something is omitted from the plans, which is necessary for the project's construction or by making a mistake within the design plans. Design errors that are not detected prior to the letting and award of the construction contracts create the need for change orders to correct any errors that are subsequently detected.

Field checks

Field checks are part of a project's design phase. Preliminary, design, and final field checks should take place during a project's design. These field checks are conducted by district personnel, and are performed by physically walking the project construction site and comparing the design to the actual field conditions. The purpose of field checks is to ensure the design plans and the construction site are compatible for construction.

Field checks are an important control in verifying the accuracy of the design plans. The lack and/or inadequacy of field checks allow for inaccuracies in the design plans to go undetected. If plans are not accurate or compatible with actual field conditions, adjustments will be necessary, resulting in the need for change orders.