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Final Report

EVALUATION OF DESIGN BUILD PRACTICE IN COLORADO IR(CX)70-4(143)

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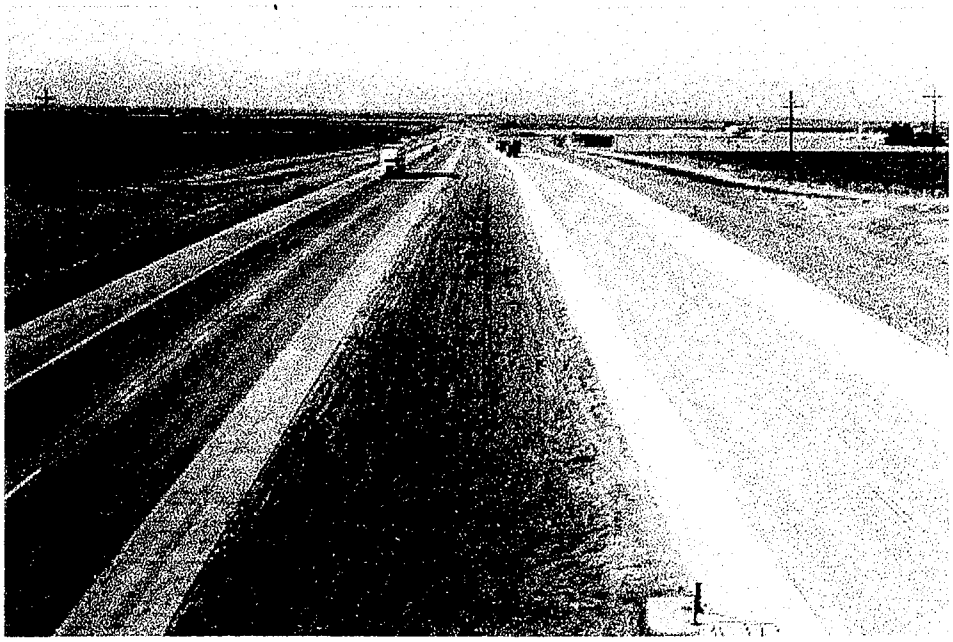

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16. Abstract
This final report summarizes the activities that took place on a design-build project in Region I of Colorado Department of Transportation (CDOT). Under the Special Experimental Project No. 14 (SEP 14), FHWA approved the design-build concept to be used for the 12 miles reconstruction of I-70 east of Denver. Included in this report is an overview of the design-build concept, discussion of significant events and results of a questionnaire on design-build methodology. Also, included in the report is description of all the construction modification orders (CMO) and discussion of quality control / quality assurance processes. The ultimate goal of this study was to identify and document the pros and cons of the design-build practice and to examine its overall applicability to CDOT.

Implementation
The use of design-build methodology for awarding construction projects looks promising. However, there is room for improvement in a fully implemented design-build concept. When early completion of a project is of significant value, the design-build method of project delivery becomes very attractive. CDOT pursuance of the best value concept along with extended warranties for larger and more complex projects is a step in the right direction. The passage of the House Bill 99-1324 will now authorizes CDOT to award contracts to the contractors who provide the best value offer. In addition, this bill also authorizes CDOT to include a warranty provision that requires the design-build firm to perform maintenance services on the completed transportation project.

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Colorado Department of Transportation
Research Branch

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The authors gratefully acknowledge Mr. Steve Horton, Staff Design and Construction Engineer for all his support and valuable contribution. Mr. Horton was instrumental in providing oversight and setting direction for our effort.

EXECUTIVE SUMMARY

This final report summarizes the activities that took place on a design-build project in Region I of Colorado Department of Transportation (CDOT). Included in this report is an overview of the design-build concept, discussion of significant events and results of a questionnaire on design-build methodology. Also, included in the report is description of all the construction modification orders (CMO) and discussion of the revised quality control / quality assurance processes.

During the 1997 construction season, Region 1 of CDOT, entered a new era by awarding its first ever design-build contract under the FHWA's pilot program called, "Special Experimental Project 14 (SEP 14)". As part of the evaluation required by FHWA, CDOT established a task force to investigate the effectiveness of using design-build concept for this project. The ultimate goal of this investigation was to identify and document the pros and cons of the design-build practice and to examine its overall applicability to CDOT.

The design-build concept combines the design and construction phases of a project into a single contract and allows for overlapping some of the design and construction. In essence, construction can begin before design has been completed. Design-build has been credited for accelerating project completion time, promoting innovation, reducing user's cost and assigning more responsibilities to the bidding firms.

Typically, the contract is awarded to a firm who provides the **Best Value Offer**, considering four major criteria: cost, quality, time and management capability of the bidder. The best value offer may not necessarily be the lowest bid. Awarding contracts to the lowest responsive and responsible bidders still prevails in Colorado, as it did for this design-build project. It is CDOT's position that for simple projects with well-defined end results, the low bid process is adequate. Nevertheless, CDOT is in the process of developing design-build guidelines that incorporate the best value concept, primarily for larger and more complex projects. These guidelines will supplement the existing CDOT design-build manual, which calls for awarding contracts to the lowest responsive and responsible bidder. House Bill 99-1324 was signed into law on April 9, 1999 authorizing

CDOT to select contractors for design-build projects based on the best value concept. When a balance of time, quality and price is desired, the best value concept may be more attractive than the lowest bid, since it encourages innovations and allows the contractors to optimize their work force, equipment and schedule.

A questionnaire was developed and disseminated to some of Colorado's contractors, design consultants and selected CDOT personnel. The primary goal of this questionnaire was to acquire feedback on the concept of the design-build methodology and its overall applicability to CDOT (refer to section 4 for details)

As of the end of January 1999, 15 contract modification orders were incorporated into this design-build project. This would seem somewhat high in comparison with the traditional design-bid-build projects. However, it should be noted that unlike most of the traditional bid projects, these CMOs were primarily written as cost savings to the project. Detailed discussions on the CMOs are presented in appendix C. It is CDOT's position that the quality of this design-build project compared favorably with the traditional design-bid-build projects of similar size.

Implementation Statement

The use of design-build methodology for awarding construction projects looks promising. However, there is room for improvement in a fully implemented design-build concept. When early completion of a project is of significant value, the design-build method of project delivery becomes very attractive. CDOT pursuance of the best value concept along with extended warranties for larger and more complex projects is a step in the right direction. Warranty clauses in conjunction with the design-build concept, foster trust between the owners and the contractors, which can lead to improved communication and eventually, improved quality. In addition, a warranty clause provides the owners with added insurance that they are getting quality products that will meet the intended design life.

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1.0 INTRODUCTION

Region I of the Colorado Department of Transportation (CDOT) awarded its first ever design-build contract under the FHWA's pilot program called, "Special Experimental Project 14 (SEP 14)". As part of the evaluation required by FHWA, CDOT established a task force to investigate the effectiveness of using design-build concept for this project. The ultimate goal of this investigation was to identify and document the pros and cons of the design-build practice and examine its overall applicability to CDOT.

According to a 1977 FHWA report called, "Innovative Practices Using Design-Build Contracting" (1), the design-build contracting method offers three major benefits. First of all, the contracting agency (owner) will have to deal with only one party for the quality, cost and overall management of a project. This reduces the owner's responsibility of coordinating activities between the designer and the builder. At the same time this diminishes project administration due to the transfer of roles to the contractor and the designer.

Second, when the designer and the builder are jointly responsible for the overall quality of the final product, the potential for dispute and litigation between them is diminished (2). Finally, overlapping portions of design and construction can result in saving time, which eventually can translate into cost savings for both the traveling public and the contracting agency.

This final report summarizes the activities that took place during the pre-construction and construction phases of the design-build project on I-70 East of Denver. Included in this report is an overview of the design-build concept, description of the procedure used to advertise, evaluate technical proposals and to select the successful bidder. Also included in this report is an overview of the significant events, results of a survey questionnaire on design-build methodology, description of construction modification orders (CMO) and quality control/quality assurance processes.

2.0 BACKGROUND

Presently, the "design-bid-build" is the primary method used by CDOT to select contractors. Under the design-bid-build, CDOT designs the project in-house or hires a consultant. The project is then advertised and awarded to the lowest bidder. Under this method, design must be complete before the project is advertised.

The "design-build" method, on the other hand, combines both the design and construction phases of a project into a single contract and allows for overlapping of some design and construction. In essence, construction can begin before design for a project has been completed.

Under the design-build method of contracting, the owner (state transportation agencies) identifies the project's desired end result product. The prospective bidders are then provided with anywhere from 20 to 30 percent of the design, including mandatory requirements. In return, the bidders are asked to prepare a technical proposal and a price proposal showing how they intend to complete the remaining design and the entire construction. The submitted proposals are then reviewed and rated by a Technical Review Committee (TRC). Typically, four major criteria are used in the selection process:

- Cost of the project
- Quality of the proposed design/innovations
- Management capability of the bidder
- Time required to complete the entire project

In general, the contract is awarded to a firm who provides the Best Value Offer. The best value offer may not necessarily be the lowest bid. For example, for the Utah's $1.4 billion design-build project (reconstruction of the I-15 corridor) the Utah Department of Transportation (UDOT) awarded the contract to the bidder who provided the best value offer to UDOT, considering not only the price, but other factors such as design quality,

timeliness, and management capability. Utah legislators amended their procurement laws allowing UDOT the use of design-build with the best value offer (3).

It is important to note that the "best value concept" which is used in typical design-build projects was not used for this design-build project. The bidding rules of Colorado did not allow such contracting practices at the time of contract award. Awarding contracts to the lowest responsive and responsible bidders still prevailed in Colorado, as it did for this design-build project. However, with the passage of the House Bill 99-1324, CDOT will now have the option of using the best value concept in awarding projects. CDOT is in the process of developing design-build guidelines that incorporate the best-value concept, primarily for larger and more complex projects. These guidelines should be in place before year 2000.

These guidelines, once in place, will not replace the existing CDOT design-build manual, which calls for awarding contracts to the lowest responsive/responsible bidder. The best-value concept will be an addition to the already in place CDOT design-build manual (4). When a balance of time, quality and price is desired, the best value concept may be more attractive than the lowest bid, since it encourages innovations and allows the contractors to optimize their work force, equipment and schedules.

3.0 OBJECTIVE

The primary objectives of this research study is to identify and document the pros and cons of the design-build practice and examine its overall applicability to CDOT. To satisfy these objectives and to address the requirement of the FHWA's SEP 14, the research team for this study established the following milestones:

1- 90 days after the design/build contract is awarded, a report should be issued to discuss the procedure used to select the successful bidder and to reveal the reactions of contractors and consultants on the Design-Build concept.

2- Interim reports should be prepared on an annual basis or as needed to discuss progress to date, significant events and encountered problems.

3- A final report should be issued 90 days after the completion of the entire project. This report will identify the merits and limitations of the design build concept using the criteria established in the work plan (see appendix A) and recommendations for future design-build projects.

4.0 CDOT'S DESIGN-BUILD MANUAL

CDOT, in cooperation with Federal Highway Administration (FHWA), the American Consulting Engineers Council of Colorado and the Colorado Contractors Association developed a set of comprehensive guidelines, "Design-Build Manual" (4) to be used for CDOT's design-build projects. These guidelines are compatible with the Current CDOT's policy of awarding contracts to the lowest responsive and responsible bidder. For a complete review of these guidelines refer to CDOT's Design-Build Manual.

5.0 PROJECT DESCRIPTION & SCOPE OF WORK

The subject project is located on Interstate 70, between mileposts 290-302, approximately 20 miles east of Denver. The project called for completion of the remaining design and the entire reconstruction of 12 miles of I-70 from Airpark Road, east to Bennett. Overall, the project required addressing the following 19 salient features:

1. Traffic control design plans and phasing details
2. Bridge design plans
3. Roadway and hydraulic design plans
4. Hot bituminous pavement bond-breaker
5. Permanent pavement marking
6. Detours
7. Construction traffic control
8. Permanent signing

9. Structures (Bridges, Box Culverts, drainage pipes,)
10. Concrete overlay
11. Lighting
12. Guardrail, bridge rail, median barrier, end anchorages
13. Seeding and mulching
14. Erosion control (storm water management plan)
15. Permits
16. Earthwork
17. Surveying
18. Fencing
19. Mobilization

5.1 Advertisement (Request for Proposals)

Traditionally, CDOT advertise all its construction projects in a statewide business journal called, the "**Daily Journal**". Concurrently, these projects are advertised electronically in CompuServe which is an on line service to notify pre-qualified Colorado contractors. In addition to the above two methods and in an effort to generate more interest and solicit more bids, the Region I design-build project was also pre-advertised in a national engineering magazine called, "Engineering News Record" (ENR). The ENR notice (refer to Appendix B) was published approximately one month prior to the formal advertisement in the Daily Journal and on CompuServe.

Prior to advertising the project, several meetings were held with the contracting and consulting firms in order to acquaint them with the scope of work, address their comments and to acquire their inputs and feedback. The following is the list of activities that took place in the advertisement and overall procurement process:

- Meeting with the ACPA officials — Jan 30
- Preliminary review meeting with design-build teams — Mar 21
- Project was formally advertised — Apr 03

- Pre-Bid conference — Apr 17
- Bid opening — May 22
- Presentation by the winning team to address the TRC's comments — May 29
- Award of contract — June 03
- Notice to proceed — June 23

Note: Typically, CDOT provides a 3-week ad period for the traditional design-bid-build projects. However, for this design-build project, the ad period was extended to six weeks to allow the proposers to establish teams. For future design-build projects, the ad period may be extended beyond the six-week period for Field Inspection and Review (FIR) plans that are less than 20 percent complete.

5.2 Technical & Price Proposal

Altogether, a total of 37 bidding packages at a cost of $50 per package were distributed to the interested proposers across the country. The bidding packages provided the proposers with approximately 30 percent of the design, including a complete survey for the western six miles of the project and a minimal survey for the remaining portion of the project.

The proposers were then asked to prepare a technical proposal and a price proposal showing how they intend to complete the remaining design and the entire construction. Included in the bidding package were numerous **mandatory requirements**, such as the preference for concrete pavement over flexible pavement, and special bridge and lighting requirements.

In general, the design-build project required the proposers to show a lump sum cost for all the 19 salient features listed above in section 5.0 of this report. In addition to the normal requirement of pre-qualification for the contractor, the technical proposals were also required to clearly demonstrate the qualification of the design team. Overall, the design team was required to demonstrate the following minimum qualifications:

a) Pre-qualification of the design team by CDOT.

b) Evidence of an errors & omissions insurance not less than $1,000,000.00.

C) Proof of successful completion of the design of one interstate project or multi-lanes divided freeway having construction or reconstruction costs in excess of $5,000,000.00 over the last 5 years.

Only two local Colorado firms submitted technical proposals for this project, Interstate Highway Construction (IHC) and Castle Rock Construction Company (CRCC). A Technical Review Committee (TRC) consisting of the Region's Construction, Materials and Design personnel was assembled to review the technical proposal of the apparent low bidder, IHC. This committee was charged with the task of assessing the overall responsiveness of the lowest bidder's technical proposal and ensuring that all the requirements of the bidding package were addressed.

Contract award was contingent upon IHC adequately addressing any issues and concerns raised by the TRC. Overall, nine questions were raised by the TRC and they were all adequately responded to by IHC. The TRC would have considered reviewing the CRCC's technical proposal if the IHC's technical proposal had been determined to be non-responsive. It is important to note that "best value" concept, which is used in typical design-build projects was not used on this project, because the bidding rules of Colorado did not allow such contracting practices at that time.

For CDOT's design-build project, cost was the primary consideration, subject to a responsive/responsibility determination of the bidder. Because the IHC was able to meet all the established criteria for award, there was no need for the TRC to consider the CRCC's technical proposal. As a result, the CRCC's technical proposal was never opened. Under the best value method of awarding contracts, all submitted technical proposals are reviewed and the contract is awarded to the proposer who provides the best value offer, considering not only the price, but other factors such as design quality, timeliness, and management capability.

It is the general consensus that best value concept encourages innovation and promotes value engineering features by allowing the contractors to optimize their work force, equipment, and schedules. In reality, the best value concept can be referred to as reaching a balance between quality, time and price.

As mentioned earlier, at that time the procurement laws of Colorado did not allow such contracting practices. Awarding contracts to the lowest responsive and responsible bidder still prevailed in Colorado as it did for this design-build project.

5.3 Disadvantage Business Enterprise (DBE) Goals

The contract goal for the DBE participation was established at 10 percent of the total contract amount. The Equal Employment Opportunity Representative (EEO Reps) in Region I worked closely with the Design Engineer to review items that were likely to be on this project and determined the DBE goals based on the total amount of the contract. The contractor was requested to submit documentation demonstrating how they intend to satisfy the DBE participation goals.

In the event that contractor is unable to meet the requirements of DBE goals, the contractor is then required to submit a **good-faith-effort** documentation, demonstrating their effort. The good faith effort documentation is analyzed by a review committee and is sent to the Chief Engineer for approval. In general, the contractor is required to meet the requirements of CDOT's form 718 for the good-faith-effort.

5.4 Subcontracting Requirements

Subcontracting was allowed in accordance with the current CDOT requirements. Presently, CDOT typically requires the prime contractor to perform at least 50 percent of the total contract, although this can be reduced in the special provisions.

5.5 Right-of-Way

The existing right-of-way was clearly identified in the plans prior to advertising the project. The original design did not anticipate acquisition of new right-of-way. The contractor was not permitted to perform any project related work outside the existing right-of-way, without prior approval by CDOT. Where the contractor was obligated to obtain temporary easements to facilitate their work, written CDOT's concurrence was required. In such instances, the contractor was solely responsible for all costs, environmental clearances and other permits required for the easements.

5.6 Environmental Impact Studies

The environmental clearances for the existing right-of-way were obtained by CDOT. The contractor is required to identify any new right-of-way, staging areas, borrow areas, and stockpile locations early in the design stage. CDOT will then obtain clearances for these areas.

Two wetlands were identified for this project. If due to the design more wetland areas are located, the contractor is required to avoid impacting them. Nevertheless, if the impacts are unavoidable, they are required to be mitigated on a 1:1 ratio. CDOT will assist the contractor on wetland mitigation and obtaining the required permits. However, the contractor is not allowed to perform any earthwork until the permits have been obtained by CDOT.

5.7 Utilities

No major utility conflicts were identified on this project. Known existing utilities within the project limits were identified by CDOT and are listed on the plan and profile sheets.

5.8 Quality Control (QC)

The contractor was required to develop a quality control plan, clearly demonstrating the frequency of testing and sampling, qualification of the testing personnel, and reporting

procedures. Incentive/disincentive clauses were incorporated into the contract in accordance with CDOT's procedures. Quality assurance (QA) remained responsibility of the CDOT's project personnel.

5.9 Award and Execution of Contract

The apparent low bidder was the Interstate Highway Construction of Englewood, Colorado, with a bid of $25,919,163. Castle Rock Company of Castle Rock, Colorado, submitted the second lowest bid in the amount of $26,870,000. The engineer's estimate was at $26,600,000. A seven-calendar day extension was granted to IHC to resubmit their proposal incorporating the TRC's Comments. The contract was awarded to IHC as the lowest responsive and responsible bidder on June 3, 1997. Notice to proceed was issued on June 23, 1997.

6.0 WARRANTIES

Warranty clauses, coupled with the design-build concept can provide contracting agencies with added insurance that they are getting quality products that last their design-life. Presently, CDOT, under the **Senate Bill 97-128**, is evaluating the effectiveness of warranties in three pilot projects. In conforming to the law, contracts for the projects with warranty specifications required the contractors to guarantee their work for three years. This is a departure from current practice where CDOT is responsible for pavement maintenance and repair once the contractor has completed the initial project (5).

Long-term maintenance was an essential part of the Utah's 1.4 billion dollars design-build project. Originally, the contractors were requested to provide a 25-year maintenance plan as part of their bidding package. However, to raise the comfort level of the proposers, the maintenance period was reduced to 10 years- an initial 5-year maintenance option and five-one year renewable options covering years 6 through 10 (6).

No warranties were required for this Project. The Federal Highway Administration (FHWA) regulations, "23 CFR 635.413" no longer prohibits the use of warranties on

National Highway System (NHS). However, to use warranties on NHS, transportation agencies are required to acquire an advance approval by the FHWA's Division Administrator (5). In addition, it is the FHWA's position that warranty clauses shall be used only for specific items and shall not place undue burden on the contractor.

7.0 VALUE ENGINEERING

At the preliminary stages of the project development, it was believed that value engineering (VE) clause, had no place in the design-build projects with mandatory requirements. However, further into the project development it was realized that even design-build projects with mandatory requirements could be subjected to contractors' value engineering analysis. Since the existing standard VE specification could not be used, the UDOT's VE specification developed for the I-15 design-build project was used as a guide on this project.

One value-engineering feature submitted by the contractor was incorporated into this project by a contract modification order (CMO). The savings from this VE feature amounted to approximately $270,000, which was equally divided between CDOT and the contractor. Refer to CMO No.2, "VE for Median Design Change" in appendix C.

8.0 STIPENDS

Full or partial payment of stipend to the unsuccessful proposers was not provided for on this design-build project. In essence, bidders who performed design work prior to the award, but were not awarded the project, have performed that work solely at their own cost. This could be a deterrent for the potential proposers.

Potential bidders indicated to the Project Engineer that the cost of preparing the bid was increased by about 300 to 400 percent compare to regular design-bid-build projects. The cost was estimated to be in the range of $100,000 to $150,000. Some of the subcontractors expressed concern that high cost associated with their bid preparation prevented them from participating in the bids.

There are still ongoing discussions as to the cost-effectiveness of providing stipends to the unsuccessful bidders. It is UDOT's position that payment of stipend to the unsuccessful proposers allowed them access to their innovations, which could in turn be applied to the project. The stipend also provided UDOT with competitive price proposals and overall improved project quality and delivery. UDOT reimbursed the two unsuccessful proposers a stipend in the amount of $950,000 each to cover a portion of their proposal preparation cost (approximately 50 percent).

9.0 RESULTS OF THE DESIGN-BUILD QUESTIONNAIRE

A questionnaire was developed and disseminated by the study panel to some of Colorado's contractors, design consultants and selected CDOT personnel. The primary goal of this questionnaire was to acquire feedback on the concept of the design-build methodology and its overall applicability to CDOT. The research team believed that feedback from the design and construction agencies, as well as CDOT staff would be an important part of the future development of the design-build practice in CDOT.

Fifteen questionnaires were disseminated to Colorado contractors, design consultants and selected CDOT personnel. The following is a summary of the 11 returned responses:

Question 1: The proponents of the design-build concept claim the following advantages. Which ones do you agree with?

a) Lowering overall agency cost ----yes ----no
b) Reducing total design-construction time ----yes ----no
c) Improve finished product ----yes ----no
d) Promote innovation ----yes ----no
e) Reduce claims ----yes ----no
f) Reduce CMOs ----yes ----no

g) Reduce motorist delays ----yes ----no

Answers to Question 1: In general, the answers to question 1 were positive. The following summarizes the responses to question 1:

- Most of the respondents agreed that design-build promotes innovation, reduces the overall project time and as a result reduces user's costs (delays and vehicle operation costs). However, majority of the respondents expressed that design-build does not necessarily reduce the overall agency cost. They argued that cost saving was never the intent of the design-build projects. The overall project cost-effectiveness however, could be maximized by further eliminating duplicated efforts, particularly during the quality control/assurance processes.

- Reduction in contract modification orders (CMO) and claims remain to be determined. One contractor expressed that CMO should not be considered by CDOT as a negative process if the intent is to improve finished product and to promote innovations.

- Responses were mixed regarding the design-build improving the finished product.

Question 2: What is your major concerns (adverse impacts or disadvantages) about the use of design-build contracts? What would you recommend to improve this practice?

Answers to question 2: The following is the summary of responses for question 2:

- Majority of the respondents (primarily contractors/designers) expressed concerns about the clarity of the plans provided by CDOT. They indicated that CDOT needs to clearly define the scope of work and the requirements of technical proposals for the desired end product.

- When the design specifications are narrow in scope, it inhibits innovation and cost savings, said one design consultant.

- To improve the bid process, and because of the limited amount of time allowed for bid preparation, CDOT should make an effort in providing as much information as possible on the existing field condition prior to bid, said one contractor.

- Both the contractors and CDOT personnel expressed that duplication of effort in the QA/QC processes needs to be addressed to optimize cost and manpower.

- To encourage more participation and to promote innovation, stipends should be granted to unsuccessful bidders. Firms would be taking the risk of losing not only the contract but, the expense of submitting a detailed technical proposal. The design-build contracting method may drive some of the small and medium contractors out of business, said one consultant.

- One CDOT engineer expressed that if the design-build concept becomes widespread in building roads and bridges, the concept would diminishes CDOT's level of design expertise that was gained over the last few decades. When possible, CDOT should include a department's designer on the project staff.

Question 3: Do you feel some types of projects are more suitable candidates for design-build contracts? If so, which types?

Answers to question 3: The following is the summary of responses for question 3.

- When early completion of the construction and utilization of the facility is of significant value, the design-build method of project delivery becomes very attractive said one designer. In addition, well-defined, well-understood construction objectives, e.g. bridges/viaducts appear to be better suited for design-build method.

- Majority of the contractors/consultants indicated that larger and more complex projects that requires more time and resources to design and deliver are the most suitable projects for design-build. In addition, larger and more complex projects offer the most opportunities for innovations.

- Simple projects with well-defined end products are the most suitable for design-build, said one consultant and a CDOT engineer.

Question 4: Do you believe warranty clauses should be incorporated into design-build contracts to improve project quality and reliability? If yes, what project features should be warranted and for how long?

Answers to question 4: In general, the responses to warranty clauses were mixed. The following summarizes the answers to question 4.

- Warranty clauses are unduly expensive and only of limited value on standard type projects, said one designer. The requirements to meet proven specifications and criteria offer much more return on the investment than warranty clauses.

- Most of the contractors expressed that warranty clauses are costly and quite difficult to enforce. They emphasized that owner should realize there is a cost to warranty. In addition, the owner should be willing and be able to reasonably evaluate competing bids.

- Warranty clauses would have a positive effect on project quality and reliability. Additionally, warranty clauses will help to build trust between the owners and the contractors, said one contractor.

- As owner of a car and a house, warranty clauses provide me with a sense of comfort. Therefore, it would be logical to include warranty clauses in highway and bridge projects, especially, when your ability to influence the design and construction is limited, said one CDOT engineer.

Question 5: Do you feel that the relative risks associated with the design-build process have been equitably shared among owner, designer and the builder? Please explain.

Answers to question 5: Responses to question 5 are summarized below:

- The concept of bidding, including bidding on design-build is not to be equitable in assigning risk, said one CDOT respondent. Design-build by definition, assigns a much greater risk on the contractor both in bidding and building the project. CDOT through its design-build guidelines has tried to limit the risk to the bidder by addressing high-risk items such as right-of-way, and environmental clearances. In general, risks should be allocated to the party who can best manage it.

- Contractors can manage additional risk but opportunities through contractors' proposed Value-Engineering should be made available to balance the additional risk, said one contractor. At this time, CDOT shares no risk with the contractor for all pre-bid expenses.

- One CDOT engineer indicated that the owner assumes a smaller risk but is not immune to design and construction mishaps that may bring traffic to a halt. The design firm subcontracted to the prime contractor assumes greater risk than if they were to design for CDOT.

10.0 CONSTRUCTION MODIFICATION ORDERS (CMO)

As of mid August 1998, 15 contract modification orders were incorporated into this design-build project. This would seem somewhat high in comparison with the traditional design-bid-build projects. However, it should be noted that unlike most of the traditional bid projects, these CMOs were primarily written as cost savings to the project.

On a few instances, CMOs were required due to additional work not anticipated at the time of bid. For example, one CMO was issued (see CMO No. 4), requiring additional pipes and culverts in order to accommodate the necessary drainage demand for the design year. The costs incurred for these features was negotiated with the project engineer and confirmed by the Cost Estimate Unit of Staff Design.

Another CMO was issued (CMO No. 7) at the request of the region's maintenance to install a Road Weather Information System (RWIS) at the Bennett overpass. Somehow, this request was not included in the preliminary information that was submitted to the bidders prior to bid. As a result, neither the scope of work nor the cost for this feature was reflected in the technical proposals of the bidders. For a complete review of all the CMOs refer to Appendix D.

11.0 QUALITY CONTROL / QUALITY ASSURANCE

The project special provisions required the contractor to submit a Quality Control Plan (QCP) as part of their technical proposal. The QCP describes the procedures to be utilized to verify, independently check, and to review all material tests and construction inspections.

Historically, contractors in the state of Colorado have relied on CDOT to provide some level of Quality Control. Quality Assurance, Independent Assurance Testing (IAT) and Material Acceptance have been the responsibility of CDOT. The original specifications for this design-build project required the contractor to be fully responsible for QC and

CDOT to make random inspections, verifying the contractor's QC performance as stated in the QCP.

As construction progressed, the success of this project gave CDOT, FHWA, and the contractor a level of confidence to explore the idea of using the contractor's test results in the acceptance decision as permitted since July of 1995, in CFR 637, Sub-part b. In addition, potential problems with the materials testing were identified.

If the contractor complied with the specification and CDOT followed the materials manual, there would be an unnecessary level of duplication of testing. This is because the testing frequencies were exactly the same, leading to an overwhelming amount of concrete testing. This, in turn, could lead to delays and confusion during the field operations. In order to take advantage of the new federal provision and to reduce this duplication of effort, several requirements had to be met:

- The sampling and testing must be performed by qualified laboratories and qualified personnel. For this design-build project, the contractor was required to utilize an independent testing firm supervised by a registered professional engineer to perform all sampling and testing.

- The quality of the material had to be validated by verification testing performed on samples that are taken independently of the quality control samples. The revised specification requires an independent sampling schedule.

- The quality control sampling and testing must be evaluated and approved by an Independent Assurance Testing Program. The revised specification requires reviewing quality of sampling and testing personnel and the testing equipment.

- A Dispute Resolution Board (DRB) must be established to address discrepancies between the verification sampling and testing and the quality control sampling and

testing. First, the following steps shall be followed to resolve any dispute without the involvement of DBR:

1. Review molding and testing data (air content, slump, water tank temperature)
2. Check broken cylinders for abnormalities.
3. Review batch tickets for inconsistencies.
4. Check testing procedures.
5. Check independent assurance testing (IAT) data.
6. Review any other data (weather, subgrade conditions, plant problems, etc.)
7. If no reason can be found for the difference in results, CDOT verification tests shall govern.

If there is significant controversy over the results, the Dispute Resolution Board (DRB) created as part of the project specifications, will be called upon to settle disputes in an equitable and fair manner.

To reduce variability of concrete samples, a check-testing program was established. This program consisted of obtaining 3-way split samples to be tested at 7 days by the contractor, CDOT field and the CDOT region. In addition, to assure uniformity, all cylinders required to be vibrated with the same vibrator, cured in the same temperature controlled tanks, tested with the same compression machine and at the same loading rate.

The revised QC/QA process was put in place with one underlying theme, the contractor and CDOT must work together to resolve discrepancies at the earliest possible time, to ensure the success of this program and to minimize risk to CDOT and the Contractor.

12.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the activities that took place in the second phase (construction phase) of the CDOT's Region I design-build project, the literature reviewed, and based on the results of a survey questionnaire, the following conclusions and recommendations are presented:

12.1 Conclusions

- The design-build method of contracting has the potential of promoting innovation, reducing the overall project time and as a result reducing user's costs; however, the design-build concept does not necessarily reduce the overall agency costs.

- For simple design-build projects with well-defined end results, the *low bid* process is ideal, since it minimizes review of voluminous technical proposals. Awarding contracts to the lowest responsible bidders still prevails in Colorado, as it did for this design-build project.

- For larger and more complex design-build project the *best value concept* is more appropriate, since it encourages innovations and allows the contractors to optimize their work force, equipment and schedule.

- Pursuance of the best value concept by CDOT for larger and more complex projects is a step in the right direction. The passage of the HB 99-1324 will now authorizes CDOT to award contracts to the contractors who provide the best-value offer.

- Warranty clauses, coupled with the design-build concept can provide contracting agencies with added insurance that they are getting quality products that last their designed-life. HB 99-1324 also authorizes CDOT to include a warranty provision that requires the design-build firm to perform maintenance services on the completed transportation project if needed.

12.2 Recommendations

- To improve the bid process, and because of the limited time allowed for bid preparation, CDOT should make an effort to provide as much information as possible on the existing field condition prior to bid.

- To optimize cost and manpower, duplication of efforts in quality control/quality assurance processes should be eliminated.

- To encourage more participation and to promote innovation, stipends should be granted to unsuccessful bidders. Firms would be taking the risk of losing not only the contract but, the expense of submitting a detailed technical proposal. In addition, payment of stipend will allow transportation agencies access to the bidding firms' innovations, which could in turn, be applied to the project.

- CMOs should not be considered by CDOT as a negative process, if the intent is to improve finished product and to promote innovations.

- Value Engineering (VE), whenever, appropriate should be applied to the design-build projects, even for projects with mandatory requirements. However, it is believed that the best way to incorporate a VE feature in a construction project is with a warranty clause.

- Risks should be assigned in a balanced manner to the party who can best manage it. CDOT through its design-build guidelines has tried to limit the risk to the bidder by addressing high- risk items such as right-of-way, and environmental clearances.

- Where extra work is warranted, negotiation of the unit prices becomes a cumbersome task, because of the absence of unit prices. This could lead to higher costs for CDOT. To eliminate such occurrences, it is imperative to either improve the accuracy of the

scope of work or where extra work is warranted have predetermined unit prices (bid tabulation) available.

REFERENCES

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2. GAO/RCED-97-138R, "Surface Transportation: State Are Experimenting with Design-Build Contracting", April 29, 1997.
3. Nelson, Roy, "Utah's I-15 Design-Build Project, Pre-construction Phase", June 1997.
4. Colorado Department of Transportation, "Design-Build Manual", August 1997.
5. Harmelink, Donna, "Pavement Warranties", Colorado Department of Transportation, Research Newsletter, 1998-2.
6. NCHRP Synthesis 195, "Use of Warranties in Road Construction", December 1994.
7. "FHWA Initiatives to Encourage Quality Through Innovative Contracting Practices", September 1996.

Appendix A

INNOVATIVE CONTRACTING PRACTICES
SPECIAL EXPERIMENTAL PROJECT NO. 14

COLORADO PROJECT NO. IR(CX) 070-3(143)
AIRPARK ROAD - EAST
WORK PLAN

I. INTRODUCTION

A. The Project

The Colorado Department of Transportation proposes to procure both the design and construction of Interstate 70 east of Denver with a single contract. The Project is one of the components of the reconstruction of the concrete pavement from Denver to Limon. A narrative Project summary and location map is included as Appendix A.

B. Approach and Scope of this Proposal and Work Plan

The nature of this Project, along with critical overall time windows, make it an ideal candidate for design/build contracting. This proposed Work Plan will:

- Describe the innovations CDOT proposes to use
- Outline the currently planned project time line
- Describe the parameters planned for evaluation
- Describe the proposed evaluation methods
- Describe the reports proposed to document the evaluation

II. PURPOSE/DESCRIPTION

A. The innovations to be Evaluated

This will be CDOT's first use of design/build for a full scale highway project. Thus it will be an excellent opportunity to directly evaluate the methods of design/build for Colorado highway projects.

CDOT will be able to evaluate the administrative and institutional impacts of this type of project delivery system (much of this information will be gained by analyzing competitive proposals for the combined design and construction effort). In addition,, CDOT can review the staff and consultant resources required during the initial development of the bid in comparison with design and construction cost savings that are anticipated to be achieved with the use of design/build.

Additionally, many of the technical aspects of the concrete reconstruction have the potential for design and construction innovations by the contractor. Also meriting careful evaluation is how well the single-point responsibility of the design/build contracting process, which is based substantially on performance specifications, can help CDOT meet the goals of reduced cost, accelerated schedule, and quality product.

Finally, CDOT proposes an incentive/disincentive requirement that is intended to enhance the quality of the final product and result in a long term cost control and savings benefit.

B. Specific Items to be Evaluated

1. Confirm or refute generally held beliefs regarding design/build. Available experiential data and generally recognized construction industry sources say that design/build is advantageous and preferable to design/bid/build in terms of the following factors:

- Reducing project delivery time
- Reducing change orders and claims and therefore additional contractor compensation
- Reducing total project costs
- Enhancing quality
- Providing user satisfaction
- Stimulating innovation
- Permitting flexibility in designs, materials, and methods

CDOT proposes to evaluate each of these measures within the framework discussed in Section V below.

2. Effectiveness of Design/Build Methodology. There are specific procurement and contracting methodologies that will be applied in the design/build process.

CDOT proposes to evaluate their effectiveness, These items include:

- The contractor selection process, such as the appropriateness of the criteria, the response of the contracting community, and the competitiveness of the proposals.

- Coordination of technical disciplines and trades in a highway project that features extensive roadway and bridge design and construction.

- Extensive use of performance specification

- A low bid award approach

3. Product improvement through incentive/disincentive payments. Final product performance and construction phasing will be enhanced by providing the design/build contractor incentives to provide quality materials in the completed facility with the least disruption to the traveling public.

III. SCOPE

A. Low Bid Approach

CDOT has selected this project for design/build, contingent on FHWA approval, because it will be advantageous to the State. The CDOT Draft Design/Build guideline is attached to this Proposal as Appendix B. However, this project does not follow all criteria outlined in the draft version. Much of the design/build contractor's effort will be defined by performance specifications. Appendix C contains the current, near final, specifications for this design/build project.

CDOT presently envisions inviting interested design/build contractors and teams to obtain preliminary plans and survey data. All contractors interested in bidding on the contract must be on CDOT's prequalified list. The prequalification criteria will be the same as currently used for contractors including bonding criteria. CDOT believes the bonding companies will scrutinize the ability of the Contractor to perform and complete the work to a much greater extent than CDOT could achieve. The design/build contractors/teams will then be invited to a pre-bid conference, and subsequently will be asked to submit technical and price proposals. The specifications will include such items as the qualifications of the designer member of the team, the financial standing of the contractor, and the design/builders understanding of this design/build project. Failure to meet the minimum criteria will result in disqualification of the bid.

CDOT's will also evaluate whether to include time of contract performance as a proposal evaluation factor. Following project completion the design/build contractor will participate in a detailed debriefing and retrospective evaluation. The contractor will be specifically queried as to how cost, time, and quality could be further enhanced on future design/build projects.

B. Physical Description

The project is described in narrative and graphic form in Appendix A.

Anticipated cost for the improvements is $30 million. This estimate is based on the engineering and economic data known to CDOT at this time.

IV. SCHEDULE

CDOT has set the goal of opening the new facility in October, 1998. To meet this opening deadline, CDOT has established the following milestones for the Project:

Preliminary Notice for interest	February 1997
Advertise Project officially	April 1997
Pre-bid Conference	April 1997
Receive proposals (Bid Opening)	May 1997
Award Contract	June 1997
Project Open to Traffic	October 1998

V. MEASURES

Following is an item-by-item summary of the baseline condition or standard, and the criteria or description for measurement of project performance.

Parameter	Baseline	This Project
Total design and construction time	Objective current estimate for design/bid/build based on past experience for projects of comparable size and complexity	Elapsed time from award of consultant contract to substantial completion of construction
Change orders and claims	Expected percent of change orders and claims based on past CDOT experience	Actual percent of change orders and claims
Total project cost	Objective current estimate of design cost, construction contractor cost, and CDOT internal cost for design/bid/build	Actual total of consultant cost, design/builder cost, and CDOT internal cost
Quality	Agency experience with comparable projects	Assessment by CDOT and consultant as to whether quality is better, equal, or less than would reasonably be attainable via design/bid/build

Parameter	Baseline	This Project
User satisfaction	Agency experience with comparable projects	Under study; may not be susceptible of immediate realistic evaluation
Stimulation of innovation; Flexibility in design, materials, and methods	Agency and consultant knowledge of comparable projects	Post construction identification of design and construction innovations; including contractor debriefing
Design/builder selection process	Not applicable	Subjective post- construction evaluation to address: 1) Did the process select truly qualified design builders? 2) Did the process promote competition? 3) What was the response of the contractors' community? 4) Should there be changes to the criteria or weighting factors for future procurements?
Coordination of disciplines and trades	Agency and consultant experience with comparable projects	Subjective post construction evaluation: Was CDOT (and its consultant) able to avoid involvement in interdisciplinary coordination and disputes?
Performance specifications	Not applicable	Subjective post-construction evaluation including contractor debriefing: 1) Which performance specifications were feasible? 2) Which performance specifications were effective?
Best value procurement	Not applicable	Was the price-quality-time combination applied for this project appropriate?
Overall design/build process	Not applicable	What should be changed and what should be retained if CDOT were to use design/build on future projects? Are there time savings that are of particular value to states with short construction seasons?

VI. REPORTING

Three reports will be prepared for evaluation purposes. These reports are as follows:

Initial Report - The initial report will be prepared within 90 days after the design/build contract is awarded. The report will include a comparison of proposals received to design proposals and construction bids under a conventional design/bid/build; a discussion of differences in the proposals; documented reactions of the industry to the process; a description of the procedure used to select the contractor; and a discussion of any problems or issues that have developed as a result of the design/build process.

Interim Report - Interim reports will be submitted annually and in the event of a significant development related to the design/build process The annual interim reports will include project progress to date, design/build problems or issues, and a comparison of the current project status compared to the project status using a conventional design/bid/build process.

Final Construction Report - An interim final report will be prepared within 90 days after the completion of the initial project performance testing. This report will provide an evaluation of the design/build process as applied to this project. The project will also be evaluated using appropriate sections of the criteria established in the MEASURES section of this proposal. Recommendations for future use of the design/build process will also be included in the report. The report will summarize what should be retained, what should be improved, and what should be discarded for future projects.

FEDERAL AID PROJECT
IR(CX)070-3(143)
AIRPARK ROAD - EAST

NARRATIVE PROJECT BACKGROUND/PURPOSE/DESCRIPTION

Project IR(CX)070-3(143) is a reconstruction project on Interstate 70 located approximately 5 miles east of Denver in Arapahoe County. It begins at MP 290 and extends 12 miles easterly near Bennett interchange.

Construction work consists of concrete overlay. Pavement thickness from 12.5" to 13.5" (min.) as shown shall be placed. HBP bond breaker or complete removal of existing pavement shall be performed as required. Other major work includes interchange modifications, side slope flattening (i.e. clear zone requirements), reshaping of median slopes, traffic detours, traffic control, highway lighting, guardrails, signing, minor structures, drainage, landscaping, surveying, and erosion control.

A minor variance will be requested to eliminate the requirement of reconstructing the vertical curves which do not meet 75 mph criteria for stopping sight distance but exceed 60 mph requirements.

Design work includes preparation of a complete set of plans and specifications. This includes design calculations, documentation, permits application and processing, shop drawings, and all other plans, specifications and documentation necessary to complete the project.

This project will be paid on Lump Sum basis. Lump Sum payment includes all work required to complete the Design and all necessary labor, equipment and materials needed to complete construction of the project. Interim payments will be processed by the Engineer based on percent completion of design and construction.

The Department will provide an initial set of plans and specifications to be used by the Contractor as a guideline in preparing his plans and specifications, construction methods and bid proposal. Further design information will be provided as indicated in the specifications. The Department will also perform Quality Assurance Testing. All material testing shall be in conformance with CDOT's Materials Manual.

At the completion of the project, the Contractor shall submit an As Built set of plans.

Appendix B

CLASSIFIEDS

Colorado Design/Build Project

The Colorado Department of Transportation (CDOT) is proposing to advertise, on or about April 3, 1997, a design/build project [IR (CX) 070-3(143)] to reconstruct 12 miles of Interstate 70 east of Denver in Arapahoe County (approximate MP 290 to MP 302). The design/build project consists of complete reconstruction of the existing four lane freeway to current design standards. In addition, an adjacent 8 mile section of interstate 70 [project IM 0704-(178) approximate MP 302 to MP 310] will be advertised for reconstruction on or about March 20, 1997. The (178) project includes design/build features if the contractor does not elect to utilize the CDOT default design. Preliminary plans and survey information (in electronic form) for both projects will be provided to interested parties on or about March 1, 1997. It is important to note that the plan data is subject to change up to the official ad date; however, the survey data is in its final form. The Contract award(s) for both projects is currently scheduled for June 1997 with anticipated project completion in October 1998. The current budgets are: $30,000,000 and $15,000,000 for the design/build project and the (178) project respectively.

For additional information about the projects, please contact Joe Tasset at (303) 757-9647 or Bill Scheuerman at (303) 757-9130 or Internet E-mail at william.scheuerman@dot.state.co.us.

Department of Environmental Protection
Bureau of Environmental Engineering
Notice to Bidders

WP-269 Bowery Bay Water Pollution Control Plant

Reconstruction and Improvement of Main, North and South Pumping Stations on Roosevelt Island

- Contract 133G - Structures and Equipment
- Contract 133E - Electrical Work
- Contract 133H - HVAC Work
- Contract 133P - Plumbing Work

Separate sealed bids for the above Contracts will be received by:

Department of Environmental Protection
Office of Procurement
Contract Management Division
59-17 Junction Boulevard, 17th Floor
Elmhurst, New York 11373
Telephone (718) 595-3223

until April 2, 1997, 11:30 A.M. at which time and place, bids will be publicly opened and read.

The contractor shall furnish, deliver, install, test and place into satisfactory operation all equipment, materials, devices and structures described in the specifications, as shown on the drawings, as directed by the Engineer and in accordance with the obvious or expressed intent of the contract.

Contract documents may be obtained from the Contract Division by depositing a $100 certified check, money order or cashier's check, payable to the Department of Environmental Protection for each set of documents so obtained. There will be no refund of monies received for bids, plans, specifications, etc., so obtained.

A tour inspection will be held at 10:00 A.M. on March 18, 1997 at the Main Pumping Station located within the AVAC building on Roosevelt Island which is located in the Borough of Manhattan. The Main Pumping Station is located on the contract drawings.

A pre-bid conference will be held at 2:00 P.M. on March 18, 1997 at 59-07 Junction Boulevard, 6th Floor Training Room (High-rise building), Corona, New York 11368.

Prospective bidders are encouraged to submit all questions, in writing, prior to the pre-bid conference, to Paul D. Smith, P.E., Chief, Facilities Design North, Bureau of Environmental Engineering, Department of Environmental Protection, 96-05 Horace Harding Expressway, Elmhurst, New York 11373-5107.

These contracts will be subject to regulations contained in 40 CFR Part 33 of the USEPA rules and regulations as published in the Federal Register on March 28, 1983, Vol. 48, No. 60. The City of New York is a participant of the goal-oriented Minority Business Enterprise (MBE) Program, as well as the Women's Business Enterprise (WBE) Program.

Prospective bidders are advised to examine Bid Specification Article 58A, tax exemption, so that the bid does not include exempted taxes.

PRC Environmental Management, Inc.
Amendment No. 1
Invitation for Bid (IFB) No. CH972766
Peerless Plating Soil Remediation, Muskegon, Michigan

Please be advised that the March 3, 1997 ad for subject IFB is hereby amended. The requirement for disposing of approximately 6,500 cubic yards of contaminated soil is changed to 1,500 cubic yards. The estimated price range is between $0.5 million and $1.5 million. The prebid conference is changed to April 1, 1997. The bid opening is changed to April 15, 1997. Also, a copy of the bid documents will be available for inspection after March 17, 1997.

Massachusetts Water Resources Authority
Seeks Information on Remote Monitoring and Control

Companies which develop, manufacture, and/or provide equipment, software, or consulting services used to plan, design, or implement remote systems for monitoring (operations and/or maintenance) and/or controlling wastewater pumping station and CSO facilities are invited to make a presentation within the months of April through June 1997. Interested firms must request a copy of the presentation guidelines from Brian Kubaska or Derek Barnes at (617) 242-0230 through March 28, 1997. Be advised that presentations are for informational purposes only and do not commit the Authority to purchasing any equipment, software or services.

Appendix C

CMO NO. 1: Value Engineering (VE)

This CMO was written to bring back the VE specification that was eliminated prior to the project advertisement. At the preliminary stages of the project development, it was believed that VE specification could not be applicable to design-build projects with **mandatory requirements.** However, as project developed, it was later determined that even design-build projects with mandatory requirements could be subjected to contractors' VE analysis.

The VE specifications developed and adopted by the Utah Department of Transportation for their 1.4 billion dollar Design-Build project was used as a guide on this project. FHWA determined that this specification was most applicable to CDOT's project due to its special language on design-build concept. CDOT position on VE features for design-build contracts is positive; however, it is believed that the best way to incorporate a VE feature in a construction project is with a warranty clause.

CMO No. 2: VE for Median Design Change

Under the mandatory requirements, the design called for 2 miles of type 4 median barrier to be installed at the west segment of the project. Inadequate clear zone between the opposing traffic lanes was the main reason behind this requirement. As a result, a positive barrier separating the two directions of traffic was required to improve the driving condition and to address safety issues.

The significant cost associated with the construction of a 2-mile concrete barrier directed the contractor's efforts towards a more cost-effective alternative. A value- engineering proposal submitted by the contractor/designer team called for widening of the median to provide the necessary safe separation between the two directions of traffic.

The design impact resulting from the wider median was assessed and found to be cost-effective. Furthermore, the region's maintenance section was pleased with the widened

median concept, because of the provision of easier snow removal during the winter months. This VE feature resulted in the shared cost savings of approximately $270,000.00 and a more efficient snow removal operation.

CMO No. 3: Modified Concrete Pavement Joint

A proposal was submitted by the Contractor to revise the geometry of the concrete joints for this project. A review of the same concrete pavement joint design used on other projects was presented to CDOT for consideration. After consultation with the Region's Materials Engineer and the FHWA, it was agreed to allow this revision.

The depth of the longitudinal and transverse cuts (0.4T and 0.33T respectively) as stated on Section 412.13 remained. However, the width of the joint per newly adopted M412-1 specification was modified. The new joint design called for a single cut, 1/8 of an inch wide joint in place of the traditional double cut 3/8 of an inch wide joint.

The new joint design is cost-effective because it requires less sealant material and is a lot less labor-intensive to install. The sealant material was also modified to allow for silicone self-leveling in place of silicon tooled for both longitudinal and transverse joints. The shared savings from the new joint design amounted to approximately $50,000. It should be noted that CDOT has already adopted the new joint design and is well positioned to realize substantial savings for years to come.

CMO No. 4: Additional Pipes and Box Culverts

This CMO was written due to unexpected additional drainage features. As required by the contract, the Contractor submitted a Hydraulic Report. The report indicated the need for several drainage structures including two box culverts. The CDOT Hydraulics Engineers reviewed the report and confirmed the need for the new drainage structures in order to meet the intended design.

The following drainage structures were added to the project at a cost of approximately half a million dollars:

1) 42" reinforced concrete pipe (RCP) @ Sta. 624+83
2) 48" RCP @ Sta. 833+43
3) 48"x 76" Elliptical pipe @ Sta. 876+89
4) 10 ft. x 6 ft. concrete box culvert (CBC) @ Sta. 825+00
5) Double 6 ft. x 6 ft. CBC @ Sta. 939+00.

As mentioned above, the cost for these drainage structures were negotiated with the project engineer and confirmed by the Cost Estimate Unit of Staff Design.

CMO No. 5: Item 601- Modification of Quality Control/Quality Assurance (QA/QC) Process

This CMO was written to maximize the use of CDOT's limited manpower on the project. During a project meeting with the Contractor, a potential problem was identified regarding the materials testing and construction inspection.

It was determined that the contractor's implementation of the material's testing specification and CDOT's compliance with the Department's field materials manual would result in an unnecessary duplication of testing. The reason is because both testing frequencies being exactly identical. If not modified, it could unnecessarily create an excessive amount of concrete testing that would consequently, result in confusions and delays during the field operations.

With the approval of the FHWA, it was agreed that a reduced testing frequency by CDOT be implemented. A tabulated testing frequency by the contractor and CDOT was established and processed into a CMO. An agreed check testing program and dispute resolution process in accordance with the Code of Federal Regulations were also put in place. For more details on QA/QC refer to Item 6 of this report.

CMO No. 6: Watkins Road Modification

This CMO was written in order to expedite the reconstruction of Watkins Road at the I-70 interchange. The original contract plan called for periodic closure of Watkins road for a period of six weeks. If this plan implemented, it would have had a dramatic impact on the neighboring businesses, schools and residents.

During a public meeting, the original plan was discussed with the business owners and residents in the area. They unanimously expressed their dissatisfaction with the plan due to the apparent potential loss to their businesses resulting from the proposed 6 weeks of periodic traffic disruption. The business owners and residents preferred the option of closing the entire road for 8 days and completing the job earlier rather than keeping it open and disrupting the traffic movement for several weeks.

A final public meeting was held and a revised proposed plan, closing Watkins Road for 8 days was presented. Closing the road for only eight days combined with the provision of convenient detour to and from the neighborhood businesses appeared very attractive to the residents and the business owners. This resolution not only demonstrated work efficiency but also proved the Department's and the construction industries' commitment to public service and concerns. As proposed, it only took 8 days to complete the work.

CMO No. 7: Weather Station

This Contract Modification was written at the request of the region's maintenance to install a Road Weather Information System (RWIS) at the Bennett overpass. A RWIS is a road-monitoring device that incorporates pavement temperature sensors, ice detectors, video cameras and an on board computer designed to improve snow removal efficiency and to provide critical information during the winter months.

CMO No. 8: Road Repairs

This CMO consisted of the repairs for the westbound two-lane, two-way temporary detour and also repairs for the SH 36 which served as the by-pass to the project while repairs were being implemented.

The original contract design of the westbound temporary 2- lane, 2-way detour proved to be inadequate at the east segment of the project. The plan required scarification of the existing deteriorated shoulders and 4 inches of new asphalt. The work was completed in accordance with the above requirements. However, due to the apparent historical soft subgrade in the area, the shoulders failed under the traffic. As a result, the westbound traffic had to be detoured to SH 36 while patch work and repairs were being performed.

CMO No. 9: QC Acceptance (Item 412: PCCP)

This CMO is similar to CMO #5 for Item 601 Structural Concrete. The CMO was initiated to reduce the duplication of materials testing during the course of this project. The revised materials testing program consists of procedures for verification of Contractors test results utilized for pay. This is in conformance with the July 1995 CFR 637 Subpart B. Several methods were incorporated to minimize variability between CDOT verification tests and the Contractors process control. This included a detailed check test program using three- way sampling used to correlate material testing equipment, supplies and personnel. In addition a dispute resolution process was established in case of discrepancies in test results that exceeded the limits of acceptability.

CMO No. 10: SH 36 Repair

This CMO was initiated to provide emergency pothole patching and leveling of SH 36 and the frontage roads due to damage exerted by emergency detours to SH 36 and the contractor haul trucks. Due to an oversight in the pre-construction phase, the repair of the local roads used by the contractor for haul routes was not part of the scope of work for this project. After this CMO had been initiated a wider scope of damage was noted and it was decided to initiate CMO # 12 to accomplish the necessary permanent repairs to SH 36. (See CMO #12 for more information)

CMO No. 11: Airpark Road Temporary Ramp Closure

This CMO was initiated at the request of the contractor to improve project quality and to reduce construction delays to the traveling public. The project mandatory requirement not to close interchanges during construction introduced an opportunity to modify this requirement which produced benefit to CDOT and the contractor. Due to a restricted width of the West Bound I-70 on-ramp at Airpark Road, the construction of large quantities of embankment to facilitate a detour and a concrete paving operation lasting 30 days would have been required to construct this ramp. Instead the contractor proposed to close the ramp for a maximum of 8 days subject to a lane rental fee, thus completing the operation quickly and with higher quality. The affected traffic was easily detoured for three miles to the next interchange with very limited inconvenience.

CMO No. 12: Project Extension SH 36 Road Repair

As previously described in CMO #10, this project due to an oversight in the preconstruction phase left out provision to repair local roads damaged by the contractors haul and detours caused by emergency operations on the I-70 mainline. As time progressed damage to SH 36 became more evident and the patching repairs provided by CMO #10, was so extensive that the pavement integrity was compromised. A decision was made to overlay 5 miles of SH 36 with a 1-3" layer of Bituminous Pavement.

CMO No. 13: Manila Road Safety Improvement

This CMO was written to address safety concerns at the Manila Road underpass located on this project. The scope of the project did not include drainage and guardrail issues for this interchange. As a result during each rain event flooding occurred at this location. To solve this problem a detention pond was installed in the northwest quadrant of the interchange and the flow lines were improved requiring the removal of guardrail and the reinstallation to meet current standards.

CMO No. 14: Contract Time Extension

The purpose of this contract modification order was to extend the contract time for this project. As required by contract, the roadway was to be completed in a four- lane configuration by November 1, 1998, with the exception of the final seeding and mulching by November 15, 1998. After a compilation of the punch list by CDOT personnel, the concern was raised to the contractor by CDOT that it did not look like the project would be completed in time. The contractor agreed that they could not finish the project in the

allotted time. With consideration to the effort made by the contractor to complete the project, CDOT granted additional time so that the cold weather in November did not affect the overall quality of the remaining work. The project was returned to a divided configuration on November 2, 1998, which was essential to avoid two-way-two-lane operation in wintertime. The remaining work did not impact the traveling public and a new schedule was issued to complete the work. The pavement was still completed in record time with 24 miles of 38' width pavement placed in one season.

CMO No. 15: Median Tri-Beam Guardrail

This Contract Modification Order was written to address the installation of Tri-beam guardrail west of the Prairie Dog Draw in the median of I-70 for the purpose of positive separation of East and West Bound Traffic. The location for the proposed guardrail is in one of the few horizontal curves within the project limits and therefore this location has a history of vehicles crossing the median and into opposing traffic. Consideration was given to utilize Tri-beam guardrail during the design phase, but it was the Contractor's Engineer's opinion that increasing the design speed to 75mph, improving the driving surface, and adding signs would be sufficient to reduce the possibility of median cross over accidents. After a review of the guardrail warrants section of the AASHTO roadside design guide and with consideration of the history of cross-median accidents, CDOT has decided that the installation of this guardrail would be the preferred solution to prevent the occurrence of the severe accidents at this location.

Due to the high number of heavy truck traffic diverted to SH 36, this road started to show signs of distress. As the reconstruction of the I-70 progressed, the distresses on SH 36 became more pronounced to a point that required immediate remedial measures. This CMO which was approved by the FHWA was written to provide the necessary funding to repair SH 36.

REPORT PUBLICATION LIST
CDOT Research

98-1 I-76 Truck Study
98-2 HBP Pilot Void Acceptance Projects in Region 2 in 1997
98-3 1997 Hot Bituminous Pavement QC for Day Pilot Project with Void Acceptance
98-4 Hot Bituminous Pavement QC & QA Project Constructed in 1997 Under QPM2 Specification
98-5 Final Report Evaluation of Iowa Vacuum Tester
98-6 Simulation of 12 High Geosynthetic Reinforced Retaining Walls Under Surcharge Loading by Centrifuge Testing
98-7 Colorado Study on Transfer and Development Length of Pre-stressing Strand in High Performance Concrete Box Girders
98-8 Particulate Matter from Roadways
98-9 Evaluation of Design Build Practice in Colorado - Construction Report
98-10 Whitetopping Thickness Design in Colorado

99-1 Colorado Rockfall Simulation Program Update
99-2 Effects of Magnesium Chloride on Asphalt Pavements Quick Study
99-3 Effects of Geometric Characteristics of Interchanges on Truck Safety

99-4 Initial Curring of Portland Cement Concrete Cylinders

99-5 Evaluation of Design/Build Practice in Colorado

97-1 Avalanche Forecasting Methods, Highway 550
97-2 Ground Access Assessment of North American Airport Locations
97-3 Special Polymer Modified Asphalt Cement (Final Report)
97-4 Avalanche Detection Using Atmospheric Infrasound
97-5 Keyway Curb (Final Report)
97-6 IAUAC - (Interim Report)
97-7 Evaluation of Design-Build Practice in Colorado (Pre-Construction Report)
97-8 HBP Pilot Void Acceptance Projects Completed in 1993-1996 (Interim Report)
97-9 QC & QA Projects Constructed in 1996 Under QPM2 Specifications (Fifth Annual Report)
97-10 Loading Test of GRS Bridge Pier and Abutment in Denver, CO

97-11 Faulted Pavements at Bridge Abutments

96-1 Long-Term Performance Tests of Soil-Geosynthetic Composites
96-2 Efficiency of Sediment Basins: Analysis of the Sedient Basins Constructed as Part of the Straight Creek Erosion Control Project.
96-3 The Role of Facing Connection Strength in Mechanically Stabilized Backfill Walls
96-4 Revegetation of MSB Slopes
96-5 Roadside Vegetation Management
96-6 Evaluation of Slope Stabilization Methods (US-40 Berthod Pass) (Construction Report)
96-7 SMA (Stone Matrix Asphalt) Colfax Avenue Viaduct
96-8 Determinating Asphalt Cement Content Using the NCAT Asphalt Content Oven
96-9 HBP QC & QA Projects Constructed in 1995 Under QPM1 and QPM2 Specifications
96-10 Long-Term Performance of Accelerated Rigid Pavements, Project CXMP 13-006-07
96-11 Determining the Degree of Aggregate Degradation After Using the NCAT Asphalt Content Oven
96-12 Evaluation of Rumble Treatments on Asphalt Sh

95-1 SMA (Stone Matrix Asphalts) Flexible Pavement
95-2 PCCP Texturing Methods
95-3 Keyway Curb (Contruction Report)
95-4 EPS, Flow Fill and Structure Fill for Bridge Abutment Backfill
95-5 Environmentally Sensitive Sanding and Deicing Practices
95-6 Reference Energy Mean Emission Levels for Noise Prediction

in Colorado

95-7 Investigation of the Low Temperature Thermal Cracking in Hot Mix Asphalt

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95-13 Research Status Report

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