

SUGGESTIONS FOR IMPROVEMENT

Time is of the essence. Typically, the Eisenhower contract provides that the contractor pay liquidated damages in the event of late completion. This provision is reasonable to maintain an emphasis for timely completion by the contractor. A similar emphasis for timely settlement and payment by owner should be included in future contracts. This provision could be written in various ways. One alternative would be a provision for the owner to pay interest on the amount due from the time the cost was incurred until it is paid to the contractor. Such provision would encourage prompt payments and reduce the contractor's financing costs. The long-term results from such a provision should be lower bid prices.

Mobilization items generally reduce the contractor's financing cost and increase the owner's financing costs. Mobilization items encourage bids from firms that are inadequately financed and have insufficient in-house depth of supervision to undertake a project of this nature (the strict prequalification requirement eliminated this concern at Eisenhower). The Eisenhower mobilization item was good in that the amount was not preset by the division. The savings in cost were diminished, however, by the inclusion of demobilization and the payment schedule. The schedule provided that 10 percent of the mobilization item amount would be paid with the final payment. I suggest that demobilization be eliminated from the item in future contracts.

Force-account items were planned by the division in the Eisenhower contract. The items provided an estimated dollar amount to be spent for erosion control, avalanche control, and trial testing for rock enforcement. Provision for these highly variable items on a force-account basis reduced the risk for the contractor and created a lower price by eliminating contingency cost in the bid. The force-account approach gave full flexibility and control for this work to the division, which is good. Payments to the contractor for force-account work in this contract and, in general, in the industry are not good. The schedule interference of force account and bid item work and the general supervision efforts are significant costs that

force-account markups did not cover adequately. Also, equipment rental and operating costs in this contract and in the industry, in general, are not adequately paid. A joint effort by the owner and contractors to establish force-account rates and markup prior to bid could produce a more satisfactory basis.

SUMMARY AND CONCLUSIONS

This major underground construction project was completed on time at a price less than the owner's original estimate. The contractor's cost was reasonably close to the estimate. Total claims processed on this contract were less than one percent of bid amount. The claims were settled within 14 months after completion of the field work.

The following are my conclusions:

1. The changed-condition clause included in the contract is a cornerstone in minimizing contingency costs in bid prices. The alteration, cancellation, and delay provisions also reduce these costs.
2. The nonbinding arbitration or review board provision for claims and disputes was very successful. Similar provisions should be considered for large, high-risk jobs. The provision should not be provided for routine, average-risk work.
3. The escrow-documents provision in the contract gave owner confirmation of contractor's bid pricing. This confirmation aided in the settlement and adjustments for quantity variations. The escrow documents cost bidders extra and the possibility of disclosure is a major concern to contractors. The escrow documents provision would not normally minimize contractual adversary relationships.
4. Further improvements in similar contracts could be made with provisions for faster payment and improved mobilization and force-account specifications.

The Colorado Division of Highways contract for the Eisenhower Memorial Tunnel, second bore, was more desirable to bid than most. The contract provisions were more equitable than most. The contract minimized adversary contractual relationships.

Minimizing Potential for Adversary Contractual Relationships During Construction of Eisenhower Memorial Tunnel

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Some hold the viewpoint that the engineer, especially in public construction, must be ever alert to attempts by the contractor to seize on some advantage in the execution of contracts to the detriment of the public. Certainly, the engineer's first loyalty in the preparation of plans and specifications and the administration of the contract is to the public. However, the referenced viewpoint leads to a basic distrust between the contract parties and creates an adversary relationship during execution of the contract, which serves neither party and may lead to unnecessary and bitter litigation to settle disputes. The contract needs to be fair to both parties: the engineer should recognize that the contractor properly seeks to make a reasonable profit, and the contractor

should acknowledge that the work should meet owner expectations of value and be a good-specification product. Underground construction holds special potential for generating adversary relations because the risks are generally greater than those that arise from other highway construction. Attention is needed in the preparation of such contracts to ensure an equitable sharing of risks without vitiating the basic premise of the competitive bidding process. Several innovations were built into the construction contract for the eastbound bore of the Eisenhower Memorial Tunnel, including among other features the inclusion of an impartial review board into the administrative process for settling differences, special prebid qualifications for the contractors, the require-

ment for escrow documents in support of the contractor's bid proposal, the judicious use of escalation provisions, and special design efforts.

The bidding of a project on any highway contract involves a great amount of risk for the contractor, but in the case of an underground tunnel the risks can be extraordinary. Regardless of the amount of subsurface investigation performed by the highway agency, simple economics will prevent so thorough an investigation as to preclude any unknowns. As a result, there will need to be considerable extrapolation from the known data both by the engineers and the contractors. Necessarily, then, the contractor, in preparing a bid for handling this construction risk, must gamble on the amount of bid contingency to be included in a bid so as to ensure the ability to complete the contract successfully with a reasonable profit for the effort. In the competitive bidding system, too high a contingency for risk makes it likely that the contractor will not be the low bidder and, conversely, too low a contingency for risk may result in not only the low bid but also a high potential for little or no profit if, in fact, he or she is able to complete the project at all. The quality-assurance system used by a state highway agency in putting together its plans, specifications, and estimate (PS&E) for any project, especially tunnel projects, and approved by the Federal Highway Administration (FHWA) will greatly influence a contractor's proposal for performance of the work.

Quality assurance is normally defined as the systematic use of performance requirements, design criteria, specifications, production-control procedures, and acceptance plans for materials, processes, or products to ensure prescribed properties or characteristics of an end product. It is fair to say that, as the highway engineer ponders and applies this general definition to projects, he or she tends not to include the contractor as a part of the system. A little reflection, however, will make it clear that those elements of any quality-assurance system concerned with creating quality, that is, the completion of a quality product in conformance with the plans and specifications, is primarily the responsibility of the contractor. Further, the contractor is responsible for production-control procedures, and therefore, an important and integral participant in the total system. If an adversary contractual relationship is to be minimized, if indeed it need exist at all, there needs to be a recognition of the fact that no specification, no matter how well written, can be expected to be 100 percent perfect. Quality assurance, as it relates to specification compliance and the production of a quality end product, is the goal of a system action.

Elements of the quality-assurance system, insofar as highway projects are concerned, include planning, design, production of plans and specifications including consideration of human and environmental factors, advertisement and award of contract, and construction and maintenance of the highway. Three principal parties are concerned with federal-aid contracts--the state highway agency, the contractor, and FHWA. Only two parties, however, are parties to the contract itself. The FHWA is not a party to the contract and, therefore, no contractual relationship exists between the contractor and FHWA, and neither has contractual rights that can be enforced on the other. The role of FHWA is to review and approve or disapprove of a state decision. Thus, FHWA's decisions normally should not have any impact on the contractor. However, indirectly at least, because of the state's desire to minimize the number of FHWA decisions that result in nonreimbursement to the

state of expenditures made, FHWA's decisions often have an impact on the contract and its administration when it is anticipated that claims and disputes will arise out of the contract and that it may become necessary to settle a contract claim presented by federal-aid contractors to state highway agencies. If a state incurs costs as a result of work performed by it or its contractors that is not in conformity with the approved plans and specifications or approved amendments thereto, then it is not entitled to reimbursement from FHWA. Indeed, FHWA is not legally authorized to reimburse such costs. A primary goal, therefore, of the state highway agency and FHWA is to produce a clear, concise, and precise set of contract documents in order to keep disputes at a minimum and, as a result, to minimize the need for contract claims. Such a goal led to the inclusion in the PS&E for the Edwin C. Johnson (second) Bore of the Eisenhower Memorial Tunnel, along Interstate-70 in Colorado, of a number of new contractual concepts from those normally included in Colorado state highway contracts. The focus of this paper will be to review certain of those concepts as they impacted on the construction subsystem of quality; specifically, the bidding process, the advertisement and award, and the construction phases.

Normally we think most about contractor process-control activities and state activities that relate to the acceptance sampling, testing, and inspection of materials and their placement in the project. These activities are essentially the quality-control and the quality-acceptance features in the construction phase of a project. These features in the construction subsystem conjure the image of using the tools of statistical quality control and sampling theory. There are, however, other concerns in the construction subsystem, and the thrust of this paper is concerned with understanding the contract and the relationships it creates between the two principal actors.

By definition, a contract is an agreement between two or more persons that creates an obligation to do or not to do a particular thing. Its essentials are competent parties, subject matter, legal consideration, mutuality of agreement, and mutuality of obligation. The writing that contains the agreement of the parties, which includes the terms and conditions of the agreement, serves as the proof of obligation. The construction subsystem is, in fact, broader than the actual product produced and the statistical tools that have been adapted to that phase of the system. It also includes the phases of development of plans and specifications, advertisement and award, and engineer-contractor relations as the mutual agreement and obligations to perform are carried out.

It is appropriate, therefore, to begin an analysis of this subject with a look at the design subsystem. Design, as a term of art, relates to the conception of a plan or scheme in one's mind that is intended for subsequent execution. The plans, of course, become the representation of that design, and the specifications are a series of detailed statements concerned with the various elements of the plan. A contractor in public sector work is not normally connected with the design subsystem element or with the development of the later system element of PS&E, at least in the U.S. system of contracting. This is not always the case in the private sector. Also, in many instances, contractors are used in the design phase to critique design proposals as to their practicability and economy for construction.

There was no involvement in this subsystem phase by contractors during development of PS&E for the Eisenhower Memorial Tunnel. The contractor under-

took to perform the construction of the tunnel for a fixed price. In point of fact, the contract is more accurately identified as a unit-price contract, not a fixed-price contract, in that payment was made to the contractor on the basis of work actually performed according to items identified and bid on in the bid documents. The contractor, of course, is in pursuit of an independent business and undertakes to do a specific thing. Obviously, this undertaking must produce a profit, which the contractor naturally will attempt to maximize. The state personnel, on behalf of the public, will be charged with administering the project so as to ensure completion in reasonably close conformance with the PS&E, and this effort may tend to conflict with the goal of the contractor.

From these apparently divergent perspectives, one generally assumes that an adversary relationship will and must exist between the parties. Actually, such a relationship need not, and should not, be the case. Both the engineer and the contractor are interested in getting the work done. The latter, not having been a party either to the conceptual design or its development, must rely on good-faith relationships between the engineer and himself. The contractor must also rely on the very critical advertisement and award subsystem element to get a clear and concise translation of the design quality levels required in order to yield the desired end product. In this instance, a proposal of approximately \$102 million was made by the successful contractor, a joint venture of Peter Kiewit Sons Company and Brown and Root. The contract was to extend for a period of 3.5 years. The offer to perform such an undertaking involved risk management on the part of the contractor. In a relatively short but longer-than-normal period for advertisement and award (six weeks), the contractor had to indemnify systematically the company's exposure to risk of loss, and make decisions that were all but clear as to the best methods for handling these exposures. The bottom line was profitability. The only basis the contractor had for assessing the risks was the plans and specifications that had translated the design concept into a basis for a written contract. This paper deals only with the mining and excavation contract; however, that contract was only one of six major contracts involved in the Eisenhower tunnel before its completion. This was the largest and, no doubt, the most-important contract and, therefore, warranted special features. However, some of the concepts initiated in this contract were carried into the contracts for mechanical, electrical, and final lining.

In these days of departments that are organized functionally, with emphasis on division of labor and specialization of work tasks, those persons assigned by the highway agency to administer the construction contract often are not parties to the design development phase of a project. Fortunately, in this instance, Phillip McOllough, who later was to direct the construction of the project, was a lead figure in directing the design process. This fact alone, in my judgment, created the basis from which a sense of fairness in dealing with the on-the-scene representatives of the contractor could be developed. The contract relationship between McOllough and Peter Kiewit Sons Company, specifically Ray Poulsen, was to prove to be extremely successful. This judgment is based on the fact that the project was, in fact, completed on time, essentially as budgeted, and without significant claims by the contractor as the obligations were performed under the contract.

How did it happen? McOllough has outlined in a paper in this Record the ideas built into the contract in an effort to maximize good relations. In

addition to the special prequalification to screen out inexperienced contractors, the longer-than-usual period for advertisement and award, and other features described by McOllough, there were three ideas (apart from the personnel assigned to the project) that were most responsible for minimizing adverse contractual relationships during this project. The three included (a) the use of a review board, (b) the provision in the contract for materials escalation clauses, and (c) the escrow document. Special philosophies toward the design element also contributed.

REVIEW BOARD

Perhaps the most significant change in the state's standard contract provisions was the inclusion in the administrative process for this project of a procedure for the processing of claims for adjustments and disputes by a review board. The board was to serve as an impartial arbiter of those situations in which the contractor may have been directed by decisions of the engineer to perform work tasks but in which the contractor had some objection. The use of the term arbiter is not totally correct in that the board had no power to decide the matter, only a power to evaluate and to recommend to the engineer a proposed settlement of the objections or dispute. Such a constraint on the power of the board was necessary to comply with the state law that prohibited the delegation of such a power by the chief engineer to say nothing of FHWA's viewpoint in this matter.

The essential provisions in the specifications that provide for the board and its makeup are as follows:

105.17 Claims for Adjustments and Disputes

(b) Determination of dispute: The engineer will consider any written protest and make his decision. The decision, in writing, shall be furnished to the contractor. This decision shall be final and conclusive subject to written appeal by the contractor requesting a review board. The appeal must be instituted within 30 days of the date of receipt of the engineer's decision. Pending final decision of a dispute, the contractor shall diligently proceed with the work as directed.

Should the contractor appeal the engineer's decision, the matter will be referred to a review board, consisting of one member selected by the division (state highway agency) and one by the contractor, the two to select a third member. The contractor and the engineer shall each be afforded an opportunity to be heard by the review board and to offer evidence. All matters brought before the review board will be reported to the chief engineer.

The decision of the review board shall govern unless the chief engineer shall determine that such decision is not in the best interest of the state, in such instance he may override the board's decision. The division (state highway agency) and the contractor shall each be responsible for one-half the review board's fees and reasonable expenses.

Note that the wording of the specifications created some doubt in the mind of the ultimately successful contractor. During the period of advertisement and award he felt compelled to raise a question at the prebid conference as to the basis on which the chief engineer might overrule the decision of the board. Admittedly, the words, "not in the best interest of the state," are vague and have the

potential for arbitrariness on the part of the chief engineer. The contractor's interpretation, as I understand it, was that overriding of the board's decision would be almost impossible according to the plain language of the specifications, save for a decision that might be outside the limits of the law. The state, the contractor felt, should not have an advantage any more than should the contractor. In my judgment, such a contract could be entered into by the state if delegation of the chief engineer's responsibility were possible to that extent. This would amount to binding arbitration on the part of the state. FHWA would, however, be forced to reserve judgment on automatic federal participation in the board's decision, because legally, FHWA requires that a responsible employee of the state highway agency be in control of the project management. This is viewed as a non-delegatable function. For practical purposes, such a reservation by FHWA most likely would have the effect of a state proceeding with great caution in this area regardless of the merits of such an agreement.

This, then, raises the question as to whether the provision in the specification accomplished the purpose that was envisioned. If the contractor perceived that the chief engineer would review every board decision in detail, then the effect would be perceived as business as usual and no real progress concerning the inclusion of this feature can be claimed. Fortunately, few disputes developed in the mining portion of the total project, and there were no occasions on which the chief engineer was given cause to override the board nor were there occasions that resulted in FHWA's nonparticipation. But the issue is a real one and must be given careful thought should a similar provision be used in another contract. Such a provision is valuable and has a place in the highway contracting process.

The makeup of the board to ensure at least a perceptible measure of impartiality is, perhaps, another area open to the potential for disagreement between the state highway agency and FHWA. In addition to the legal constraints on the power of a board to decide, such a board could not flourish nor even perform in a minimally satisfactory way if its recommendations for settlement were not well reasoned and founded on a contractual base. No matter how well founded is the claim factually, if a proposed settlement is not based on a contractual provision, it is difficult to support. A thorough knowledge of the project and its progress by the board is necessary, as is an understanding of the contract and a commitment of impartiality.

The board for this project included Charles McGraw, retired president of Utah Construction Company, who died during the progress of the tunnel and was replaced by Nixon F. Crossley (state selection); A.A. Matthews, retired principal of a consulting engineer firm that bears his name (contractor selection); and B. Palmer King, retired attorney for the bureau of reclamation.

The specifications for the project provided that, if the contractor objected to any decision or order by the engineer, he or she must proceed without delay after requesting instructions in writing to perform the work or to conform to the decision or order, and maintain cost records of the work in accordance with subsection 109.04, reproduced here in the interest of completeness:

109.04 Extra and Force Account Work

Any extra and force-account work performed without notification to the engineer will not be paid for.

Extra work performed in accordance with the requirements and provisions of subsection 104.03 will be paid for at the unit prices or lump sum stipulated in the order authorizing the work, or the division (state highway agency) may require the contractor to do such work on a force-account basis to be compensated in the following manner:

(a) Labor: For all labor and foremen in direct charge of the specific operations, the contractor shall receive the rate of wage (or scale) agreed upon in writing before beginning work for each and every hour that said labor and foremen are actually engaged in such work.

The contractor shall receive the actual costs paid to, or in behalf of, workmen by reason of subsistence and travel allowances which are the result of a collective bargaining agreement or other employment contract generally applicable to the classes of labor employed on the work.

An amount equal to 45 percent of the sum of the above items will also be paid the contractor to cover overhead, additional bond, property damage and liability insurance, workmen's compensation insurance premiums, unemployment insurance contributions, social security taxes, and profit.

In addition to the 45 percent stated above, the actual amount of fringe benefits will be paid to the contractor for those work classifications which carry fringe benefits resulting from collective bargaining agreements or as required by U.S. Department of Labor wage schedules. (Fringe benefits are those payments made by the contractor to a third party, trustee, or directly to the employee to cover such things as, but not limited to, health and welfare, pensions, vacations, and apprenticeship program.) The 45 percent loading factor shall not apply to fringe benefits paid to a third party, trustee, or to the workman.

(b) Materials: For materials accepted by the engineer and used, the contractor shall receive the actual cost of such materials delivered on the work, including transportation charges paid by him (exclusive of machinery rentals as hereinafter set forth), to which cost 25 percent will be added for handling and profit.

(c) When extra work on a force-account basis is performed by a subcontractor on the project in accordance with the provisions of an extra work order, a percentage based on the following table will be allowed as additional to the percentages in (a) and (b) above, to reimburse the prime contractor for the administrative expenses incurred in connection with the work. Bid items in the original contract are not to be considered.

To \$1000--10 percent,

Over \$1000 to \$10 000--\$100 plus 5 percent of excess over \$1000,

Over \$10 000--\$550 plus 3 percent of excess over \$10 000.

Approval of this additional percentage will be made after receipted invoices are furnished by the contractor.

The subcontractor will not be permitted to load billings except as outlined in (a) and (b) above.

(d) Equipment: For any machinery or special equipment (other than small tools) including fuel and lubricants, plus transportation costs, the use of which has been authorized by the engineer, the contractor shall receive rental rates as established and published by the division (state highway agency) for this project. Rates for equipment used but not listed in the project

rental rate manual will be established by using the formula set up in the rental manual.

For a review board to be effective, it is necessary, as has been previously stated, that, as a group and individually, they be informed and knowledgeable concerning the progress of the work. Accordingly, individual contracts were prepared with each of the three review board members. The contracts included a requirement for regular meetings at the project site within a time frame not to exceed 90-day intervals. Either party (i.e., the state or the contractor) by contract was to have the discretionary power to call the board into service by written communication to meet for special problems that arose during the contract and that required resolution. The intent of the contract was that the board should submit a singular report of its findings concerning any matters brought before it; however, provision for dissenting views was included so as to provide the chief engineer with as much data as possible from which to accept or reject the board's report. Each board member was required to place in the record a report of the routine project inspections and meetings to include only factual information in accordance with his or her perspective but not to contain conclusions or recommendations, presumably to minimize bias in the event of dispute proceedings.

The review board concept is intended to offer an objective look at problems. The concern of FHWA is that, in agreeing to such a concept for the adjudication of claims by such a board, the findings of the board may be conclusive under state law or by provisions of the contract as to a dispute between the contractor and the state, but it is not conclusive between the state and FHWA insofar as federal-aid reimbursement is concerned. In the interest of a relatively harmonious relationship between the state and FHWA, we attempt to make our decisions compatible with the policies and laws of the state; specifically, in this instance, to accept the findings of the review board and ultimately those of the chief engineer as our own. This approach proceeds from the position that legal problems that arise in highway construction contracts generally involve mixed issues of law and engineering, and settlement of those questions within the equitable adjustment provisions of the contract, which is a key to settlement of issues, is appropriate where possible to avoid unnecessary and lengthy recourse to the court system. Following a general principle of contract law, the specifications written by the state would be interpreted against the state where ambiguity was found to exist. In all probability, the contractor interpretation (that override authority should exist only in cases where decisions of the board are based on illegalities) would prevail were the argument to be tested. Thus, it is appropriate, perhaps, that it may have been more desirable for reference in the specification to "not in the best interest of the state" to have been further defined and replaced by a reference to decisions based on illegal premises. Alternatively, the state must assume risk of potential for nonreimbursement of what the board perceives to be a legitimate settlement if this type of board is to cause the contractor to perceive a lowering of risk and thus a likely area for submitting a lesser contingency in the bid as a result of this feature. In a project such as the Eisenhower Memorial Tunnel, there is potential for large settlements even in small disputes because of the repetitive nature of the work in the tunnel, and then an objective review board has much merit.

The review board met routinely on at least 14 occasions throughout the life of the project and was

called on to review and recommend settlement of four disputes. From my perspective, this relatively small need for the board signifies a successful project, but the degree to which that success should be attributed to the presence of the board is difficult to assess. A board composed, as it was, of representatives selected by the parties has the potential for becoming an adversary proceeding in itself. Ideally, the selected representatives, who presumably bring to the board perspectives that are consistent and compatible with viewpoints of the parties by whom they were selected, can rise above such a narrow approach and exhibit a degree of freedom from any bias on those occasions when it is called on to act. My perspective is that members of such a board should be agreed on by both parties; however, all members should come from a subset of a larger number of nominations by the parties rather than as was the basis in this contract. I hasten to add that in the Eisenhower Memorial Tunnel project no basis surfaced for either supporting my perspective or for supporting the board makeup as it was constituted. To be sure, the presence of a board made up of knowledgeable and respected persons associated with the contracting and legal professions appeared to have a deterrent effect on the filing of claims. This statement is made without any intent to detract from the superb qualifications of both the contractor and the state, in this instance, to administer the contract. Nevertheless, an accumulation of data is available to the board during its routine visits to the project. The data become factual data to each member, somewhat personal in nature, from which the board can draw when a dispute does arise.

I have come to believe in the concept of a board; however, with the caveat that such boards need not and should not become commonplace in highway construction contracts. The concept is most useful in large and complicated contracts, especially in the mining, excavation, mechanical, and electrical aspects of tunnel work because of the specialized nature of that work and the probability that the state will not have the expertise readily available to evaluate the propriety of a contractor's claim. The fears of FHWA, in this instance at least, that the owner is at the mercy of the members of the board and that, emotionally, such boards tend to favor the views of the contractor, did not materialize. The findings of the board were clearly set out in the reports it prepared. In only one instance was it necessary to return to the board for a clearer articulation of how its decision followed from the contract and from the factual data as reported and from which its recommendations for settlement flowed.

ESCALATION CLAUSES

Another important innovation in this contract, which had an effect of minimizing a potential adversary relationship, was the inclusion of escalation clauses for materials and labor. Highway law, as codified in Section 112 of Title 23, U.S. Code, requires that the construction of each project, "shall be performed by contract awarded by competitive bidding, unless the secretary shall affirmatively find that, under the circumstances relating to such project, some other method is in the public interest." Certainly this project was bid competitively. Two contractors submitted bids, Healy-Ball-Granite-Greenfield and Peter Kiewit Sons Company and Brown and Root, Inc., in a joint venture, in respective amounts of \$102 988 770 and \$102 800 000. Yet, when a contract is expected to extend over a period of more than three years,

Table 1. Computation of labor escalation.

Item	Amount (\$)		
	Tunnel Laborer	Carpenter	Clerk-Typist
Federal wage-scale basic rates ^a	6.75	7.85	
Actual cost basic rates ^a	7.00	8.10	3.50
Federal wage-scale on review date ^a	7.10	8.05	
Contractor pay-scale on review date ^a	7.25	8.60	3.75
Federal wage-scale change ^b	+0.35	+0.20	
Contractor pay-scale change ^c	+0.25	+0.50	+0.25

^aAmount includes fringe benefits.

^bThe percentage change is +0.052 percent for tunnel laborer and +0.025 percent for carpenter.

^cThe percentage change is +0.036 percent for tunnel laborer, +0.062 percent for carpenter, and +0.71 percent for clerk-typist.

especially in inflationary times, it is appropriate and in the public interest to provide some degree of protection to the contractor against a rapid cost spiral of the most inflationary and unstable items. Presumably such an approach returns to the public the cost of excessive caution on the part of the contractor.

Since all contractors begin with the same awareness, the compromise to competitive bidding is small, if indeed it exists at all. Provisions for adjustments beyond those included in the state's normal practice were included in the contract through the following contract subsections:

109.09 Adjustment of Labor Costs

Adjustments for increase or decrease of labor costs will not be made during the first 545 calendar days of the contract.

On the first year anniversary date of the contract, the labor rates, including fringe benefits, being paid at that time by the contractor for each labor classification employed shall be recorded. These rates shall become the "actual cost--basic rates."

On the first-year-anniversary date of the contract, the labor rates, including fringe benefits, specified by the federal requirements wage schedule for the region applicable to Clear Creek and Summit Counties for each labor classification employed shall be recorded. These rates shall become the "federal wage scale--basic rates."

On the 180th calendar day from the first-year-anniversary date of the contract and on each succeeding 180th calendar day thereafter, the labor rates being paid by the contractor for each classification employed will be reviewed. In the event there is any change from the "actual cost--basic rates," payments to the contractor will be adjusted as hereinafter provided.

The percentage of change in actual rates paid by the contractor for each labor classification will be determined.

The applicable federal wage schedule rates in effect on the review date will be compared with the "federal wage scale--basic rates" and the percentage of change determined for each labor classification.

Effective with the first payroll paid following the review date, monies due the contractor will be adjusted for change in labor costs as follows:

(a) Monthly payments of monies due the contractor will be adjusted by the lesser of the monetary amounts arrived at by:

1. Computation in accordance with subparagraphs (b), (d), and (f) below as applied to applicable hours of work.

2. Computation in accordance with subparagraphs (c), (e), and (f) below as applied to applicable hours of work.

(b) Ninety percent of the percentage change in the federal wage scale rates from the "federal wage scale--basic rates" for each labor classification that has incurred changes will be determined.

(c) Ninety percent of the percentage change in rates, being paid by the contractor, from the "actual cost--basic rates" for each labor classification that has incurred changes will be determined.

(d) The percentages derived in subparagraph (b) above will be applied to the applicable "federal wage scale--basic rates" for each labor classification that has incurred changes.

(e) The percentages derived in subparagraph (c) above will be applied to the applicable "actual cost--basic rates" for each labor classification that has incurred changes.

(f) For personnel of the contractor's labor force that are not included in the applicable federal wage scale (e.g., supervisor, engineers, administrative personnel, clerical personnel) the allowable percentage of adjustment for any classification shall not exceed the lesser percentage computed in accordance with subparagraphs (b) and (c) above for laborer (tunnel).

(g) Monetary adjustments made in accordance with the provisions of this subsection will not be considered when computing retainage to be withheld by the division (state highway agency).

(h) Adjustment example: [Table 1 shows the adjustment example.]

Allowable escalation adjustment payable to the contractor on payrolls paid subsequent to the review date (until next review date) will be

Laborer (tunnel): $0.90\% \times 0.036\% = 0.0324\%$;
 $0.0324\% \times \$7.00 = \0.23 (adjusted to nearest full cent).

Carpenter: $0.90\% \times 0.025\% = 0.0225\%$; $0.0225\% \times \$8.10 = +\0.18 (adjusted to nearest full cent).

Clerk typist: $0.90\% \times 0.036\% = 0.0324\%$;
 $0.0324\% \times \$3.50 = +\0.11 (adjusted to nearest full cent).

(Note: The adjustment will apply to overtime rates as well as straight-time rates and will apply to all hours worked and paid.)

109.10 Adjustment of Material Costs

In calculating unit bid prices for pay items contained in the proposal, exclusive of the item for fixed fee, the bidder shall use material procurement costs (f.o.b. project site) as follows:

(a) Structural steel @ \$660.00/ton: This item shall be limited to structural steel used for excavation support and shall not include structural steel used for other purposes such as jumbo fabrication, etc.

(b) Reinforcing steel @ \$320.00/ton: This item shall cover all reinforcing steel used on the

project, including that reinforcing steel used for rock support.

(c) Gasoline @ \$0.382/gal:

(d) Diesel fuel @ \$0.330/gal:

Items (c) and (d) shall cover all gasoline and diesel fuel used by equipment assigned to the project.

(e) Liquid petroleum gas (LPG) @ \$0.30/gal: This item shall cover all LPG used on the project including that gas used for heating tunnel ventilation air.

(f) Electrical power:

1. Energy used:

First 20 000 kW·h @ \$0.015 48/kW·h

Next 60 000 kW·h @ \$0.013 68/kW·h

Next 200 000 kW·h @ \$0.012 78/kW·h

Next 220 000 kW·h @ \$0.011 10/kW·h

Over 500 000 kW·h @ \$0.009 86/kW·h

2. Demand charge:

First 100 kW @ [lump sum] \$237.00

Next 200 kW @ \$1.98/kW

Next 200 kW @ \$1.86/kW

Over 500 kW @ \$1.63/kW

3. Fossil fuel cost adjustment:

\$0.001 433/kW·h used.

This item shall cover all electrical power used on the project.

Upon procurement of materials listed above, appropriate adjustments will be made to monies due the contractor. These adjustments will be in the amount of the difference between cost actually paid by the contractor and the cost as computed by using the unit prices designated above. These adjustments may be an increase or a decrease.

The purchase price to be paid by the contractor for any and all of the above listed materials and the quantities to be purchased must have prior approval by the engineer.

The provisions of this subsection shall not apply to any materials not listed herein.

The contractor will be required to file a statement executed by, or on behalf of, the person, firm, association, or corporation to whom such contract is to be awarded, certifying that such person, firm, association, or corporation has not, either directly or indirectly, participated in any collusion, or otherwise taken any action to influence the price paid for materials procured under this subsection, so as to create an inequitable cost to the division (state highway agency). This statement shall contain the form prescribed in subsection 106.03(b)5. The original of such statement shall be filed with the division (state highway agency) for each adjustment of prices.

Once again, the magnitude and duration of the project led the state to a determination that a departure from the normal contract was appropriate; FHWA concurred in that determination. I had some misgivings as to the appropriateness of whether an adjustment of labor costs as determined by a percentage equivalent to the percentage of change for each labor classification in the wage schedule should be included in the contract. Also, FHWA had a long-standing policy not to approve cost-escalation clauses for labor because wage rates are at least partially under the control of contractors. However, during the period of advertisement and award, we were aware of the following:

1. Labor negotiations for all major unions were to be conducted subsequent to the award, and predictability of union demands and ultimate agreements was virtually impossible;

2. Labor agreements were being shortened in time period because of inflationary pressures on the economy; and

3. Crafts disputes could occur more readily in tunnel undertakings than under most highway contracts.

Contract agreement was reached to include such a labor escalation clause, and the compromise was to not provide for adjustments during the first 545 calendar days of the project but to provide for a review and adjustment of rates thereafter. As indicated in the reproduced portion of the pertinent specification, labor escalation was based on the applicable federal wage schedule determination for the project and keyed to an areawide wage scale. The escalation was pegged at 90 percent of the actual escalation after the initial nonescalation period to ensure some degree of commitment by management to reasonably bargain during negotiations.

The outcome of the labor escalation through July 1979 was in an approximate amount of \$1 669 800. If we assume that approximately one-third of the bid cost of \$102.8 million was for labor (approximately \$34.2 million), this represented only an increase of about five percent over the four-year period of the contract: this during a time when labor escalation generally rose at a considerably higher rate. It is, of course, difficult to assess the actual impact of the specification itself in this low-percentage wage escalation. Suffice it to say, however, that it was an effort to at least lessen the bidder's risk that, in my judgment, was supportive of the concept of minimizing the adversary relationship inherent in normal highway contract administration. When one considers the prevailing attitude of competitive bid for all work, with the contractor accepting all the risks associated with procuring and incorporating labor and materials in the finished product, such a willingness to share in major risk items manifests an intent toward mutual cooperation among the parties and a desire to complete the project on time and profitably as well.

In addition, the materials escalation (through July 1979) for each of the selected items is shown in Table 2. The total cost of materials was \$1 330 161.94. Thus, including a common-carrier provision for escalation, which is normal for Colorado highway contracts, the total escalation costs as of July 1979, including labor and materials, amounted to approximately \$3 049 990--this at a time when the rate of inflation was much higher in other highway contracts and in the economy in general. One can conclude that items of work carefully selected can have a slowing effect on costs associated with a particular project. In Figure 1 a comparison is given on escalation-controlled items versus general cost index.

ESCROW DOCUMENTS

The specification innovation most calculated to minimize the adversary relationship was the requirement for the contractor to deposit escrow documents as part of the bid. The pertinent provisions related to the escrow documents and the fixed-fee provision of the specification follow.

102.07 Escrow Documents Rev. 6-17-74

Each bidder shall submit with his proposal complete documentation clearly itemizing and

separating costs for each contract item, except the contract item "fixed fee", contained in the proposal. Costs used to determine each unit price shall be separated and identified as costs of: labor, equipment, materials, fixed costs--on-project site, fixed costs--off-project site, and other costs included must be specifically identified.

(a) The documentation shall include copies of all quotes, memoranda, narratives or any other information used to arrive at the bid prices contained in the bid schedule and shall be clearly marked with the appropriate bid schedule

item reference number. For purposes of identification, all such supporting documentation will be known as the escrow documents.

(b) The escrow documents shall be submitted in a sealed container along with the sealed envelope containing the proposal and will be clearly marked with the bidder's name, date of submittal, project number, and titled "escrow documents." The escrow documents shall be accompanied with an affidavit signed by the bidder, stating that he has personally examined the contents of the escrow document container and has found that the documents are in the container and are correct and complete. Escrow documents of the apparent successful bidder shall be examined in his presence for adequacy and accuracy prior to award. After award of the contract, the escrow documents of all other bidders will be returned unopened.

(c) The escrow documents of the successful bidder will be returned at such time that the contract is completed and final settlement has been achieved.

(d) Escrow documents shall be stored at a location and in a manner agreeable to the division (state highway agency) and the contractor.

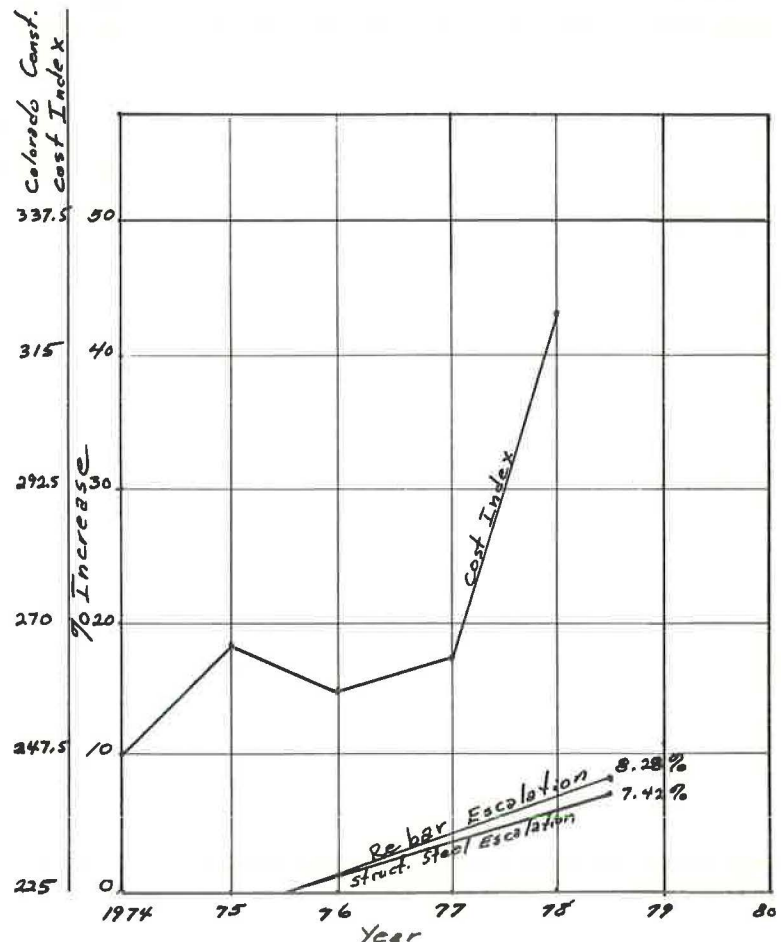
Escrow documents may be examined any time deemed necessary by the chief engineer to determine the contractor's bid concept. This examination may be required for payment purposes for any and all contract items, subject to the following requirements:

Table 2. Increase in cost of materials.

Item	Escalation in Cost (\$)	Unit	Pegged Price per Unit (\$)	Last Price Paid per Unit (\$)	Increase (%)
Structural steel	856 208.47	ton	660	709	7.42
Reinforcing steel	100 726.62	lb	0.16	0.173	8.28
Gasoline	26 970.87	gal	0.382	0.869	127.0
Diesel fuel	33 412.69	gal	0.33	0.48	45.0
Liquid petroleum gas	84 649.33	gal	0.30	0.414	38.0
Electrical power	228 195.96	^a	^a		

^aSee section 109.10(f).

Figure 1. Comparison of escalation-controlled items versus general cost index.



1. Examination of documents shall be made by those specifically delegated by the chief engineer and a contractor representative.

2. These documents are considered proprietary and confidential in nature and shall be treated as such by those designated to review them. These documents, or any of the contents thereof, shall not be made available to any person or persons not herein designated without the specific consent of the contractor.

SECTION 699 Fixed Fee

699.01: Description

This section provides a contract item for profit earned by performance of work stipulated in the contract.

699.02: Basis of Payment

The amount bid for this contract item shall be adjusted only in the event of elimination of contract items under the provisions of subsection 109.05--eliminated items. If a contract item, or items, is eliminated, the amount of the "fixed fee" shall be reduced by a percentage equivalent to the percentage of reduction in contract work. This percentage of reduction in contract work shall be computed by dividing the sum of all contract item bid amounts, except the amount bid for contract item "fixed fee," into the sum of bid amounts for the contract items, or item, that are eliminated.

699.03 Profit, if any, for extra work shall be paid under the provisions of subsection 109.04--extra and force-account work.

699.04 Partial payments for fixed fee will be made once each month as the work progresses. These partial payments, as defined in subsection 109.06, will be made as follows:

(a) One percent of the bid price for "fixed fee" will be paid for each one percent of the original contract amount earned until 90 percent of "fixed fee" is paid.

(b) The remaining 10 percent of "fixed fee" will be included in the final payment.

(c) Payment will not be made for more than 100 percent of the amount bid for this item. Payment will be made under pay item--fixed fee; pay unit--lump sum.

The escrow documents, in effect, were the supporting documentation for the contractor's proposal for doing the work. The concept provided a mechanism for evaluation of the contractor's bid proposal, and later a control of costs associated with extra or otherwise directed work, through the requirement for a cost-accounting system that was related directly to pay items in the contract. The specification essentially provided for the contractor to prepare a proposal for each unit price bid on the basis of a bid item for a fixed fee separate from the anticipated costs for labor, equipment, materials, on-project fixed costs, and off-project fixed costs. The concept also provided a mechanism for price and time adjustment as a result of material procurement delays, adjustment of labor costs, and adjustment in material costs for certain defined materials (specification subsection 109.10).

Some concern was expressed that the requirement

for a breakdown of the overhead cost items could lead to a tendency by the contractor to unbalanced bidding. Also, a faction believed that such unbalanced bidding by the contractor could result in the use of the escrow documents to the contractor's advantage by placing in the record higher bid items in those areas where a challenge might be anticipated to the specification during the work. Such actions by the contractor are possible; however, a contractor who is serious about submitting a proposal to perform work cannot risk major unbalancing of a bid unless, of course, the degree of certainty is high that he or she ultimately will profit from the unbalance. In a project that has a magnitude of \$100 million, this possibility is remote; although, of course, some unbalancing of bids is inherent in the highway bidding process for any contract items related to an extent to the contractor's experience and equipment for prosecuting the particular type of work. The commitment to maintaining the proprietary and confidential aspect of these documents and the provision that the contractor have input into the decision as to when such documents will be used, I believe, is essential to the contractor's willingness to submit such documents in a fair and truthful manner.

The documents were most useful in establishing fair and equitable adjustments to the contract in several instances; specifically, a reduction in cost to the project due to an 87 percent underrun of a contract item, buttress berm grouting. The large percentage reduction qualified for a price change under the provisions of specification 104.02(d)3. The escrow documents were supportive of the contractor's request for change and provided recovery of costs for preparation for the drilling and grouting operations, timbering up for first-stage grouting, and other essentially fixed costs that are normally and reasonably spread against the total bid quantity of grout. Certainly an adjustment would have been provided under the normal specifications for a situation of this magnitude; nevertheless, the escrow documents facilitated the agreement and avoided the usual disparate opinions concerning the contractor's overhead and fixed-fee costs and the method of distribution of such costs to the particular change order.

The documents proved similarly useful in adjusting another contract bid item, item 29, pregrouting, which experienced a 96.6 percent underrun in contract bid quantities; also, a major underrun in contract bid item 43, sheet metal for panning. Each of these are items that are not amenable to precise engineering evaluation as to need during the preparation of the PS&E for a project. It is my judgment that the escrow documents tend to allay the fears of a contractor concerning the potential for wide deviation from plan quantity of these items and, assured with the knowledge that he or she will probably recover fixed costs based on certified and confidential documents, the contractor can and will devote more time and attention to the more substantive provisions of the bid; namely, how to drive through the mountain and at what cost. There is no doubt in my mind that in projects of large scope, protracted negotiations of contract price adjustments for changes and extra work that arises during advancement of the project are avoided. The result is a facilitation of just and reasonable payments to the contractor for justified work without an adversary relationship.

An important element in minimizing the adversary relationship that may have been overlooked somewhat as to its importance is the design, especially in the heavy-ground regions, which provided for the construction of a positive initial tunnel support

system prior to excavation of the primary tunnel cross section. Although the design did not attempt to direct how the contractor should proceed with performance of the work, it clearly established an acceptable and safe sequencing of the work. The initial support system in this tunnel reach provided for a multidrift operation with crown and foundation drifts, in that order or simultaneously, to be completed prior to the excavation of sidewall and arch drifts, for a total of nine drifts in all. Considerable reluctance was expressed during the design phase of the first tunnel to a specification by the owner of such a support system.

The essential responsibility of the state and its engineers is to provide this type of basis on which the contractor can submit a bid proposal. Inherent with this, of course, is acceptance of the risk for the adequacy of the design and specifications. As a professional, this is a responsibility that the engineer must take. In addition, three other support systems, all of a horseshoe configuration, were provided. These were termed light, medium, and heavy tunnel support systems. Although the anticipated approximate stations for each of the four support systems were included in the plans as was a geologic summary of tunnel support types, these locations were not deemed to be fixed or unchanging, and throughout the construction process discussions with the contractor were considered as each support system was finally established. In my view, the proper role of the engineer as a designer and the contractor as a constructor was developed for this project. The design resulted in the contractor's confidence in the designer's understanding and knowledge about what was necessary to hold up the mountain and willingness to accept the risk of that

design. Provision for alternate designs was not made but, in my judgment, the flexibility of set spacing and support system selection resulted in benefits equal to or better than what may have resulted from alternate design opportunities without the major problem of analysis of proposals by the contractor for comparability with the state's design. The design scheme for the construction of the support systems is available to the reader by contacting FHWA or the Colorado Department of Highways.

SUMMARY AND CONCLUSIONS

The innovations introduced into this project have the potential for continuing to improve or eliminate the adversarial relationship that is often thought must exist simply because the engineer and contractor have different perspectives on the purpose for their involvement in the project. This need not be the case. In fact, (a) their purpose for involvement in the project is more alike than dissimilar, (b) continued innovations are warranted to further improve the relationship, and (c) labor and materials escalation, bidder prequalification, affirmative design details, selective and proper use of escrow documents, and clear definition of dispute settlement procedures are a few of many possibilities for improving or eliminating an adversarial relationship that this paper has discussed. An overriding goal for underground construction should be the minimizing of adversarial relationships and, in its place, the development of a team concept between the engineer and contractor. For, after all, the mission of both is to produce works that are beneficial to the public and serve a useful societal need.

Management Strategies for Quality Assurance for Pittsburgh's South Busway

WALTER G. HEINTZLEMAN

The management strategies for quality assurance are examined for Pittsburgh's South Busway Program. Specific consideration is given to (a) management structure, (b) end-result specifications, (c) sharing areas of risk, (d) mutual respect, (e) open communications with bilateral resolution of issues, (f) process for feedback, and (g) monetary and nonmonetary rewards. The avoidance of adversarial relations between owner, engineer, and contractor was key to a successful quality program in an adversarial political environment.

This paper is the first of three to examine and evaluate management strategies for quality assurance used on Pittsburgh's South Busway Program from viewpoints of staff who represent the owner (Port Authority of Allegheny County), engineering manager, and a contractor. This evaluation is an outgrowth of the recognition of the interdependence of quality assurance and productivity and their dependence on management strategies.

These evaluations were initially stimulated as an outgrowth of ideas presented by Judson (1) in his paper at the American Society of Civil Engineers (ASCE) symposium on productivity in the construction industry. These ideas have been expanded in re-

sponse to work being done by the Transportation Research Board.

BUSWAY DESCRIPTION

The port authority is engaged in a capital improvement program in excess of \$0.5 billion. The first element constructed was the South Busway, a 6.4-km (4-mile), two-lane, two-direction, limited-access roadway. It begins at the Smithfield Bridge near downtown Pittsburgh and travels in a southerly direction through a 1.04-km (3400-ft) bus-trolley tunnel, through a trolley yard, across a new 520-m (1700-ft) bridge that crosses two major arteries, and then along a steep hillside that is parallel to the Norfolk and Western (N&W) railroad tracks for 2.5 km (1.5 miles). The busway then drops under a newly constructed N&W railroad bridge to merge again on a common right-of-way with trolleys for the last 1.6 km (1 mile) to its current terminus at the PA-88--PA-51 Glenbury intersection. The busway has 11 stops and three on-off ramps. All bus service is via existing bus routes, which now use the South