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Using Accelerated Contracts with Incentive Provisions for Transitway Construction in Houston

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ABSTRACT

The Metropolitan Transit Authority of Harris County and the State Department of Highways and Public Transportation agreed to jointly construct authorized vehicle lanes or transitways in Houston, Texas. Federal assistance was provided by UMTA and FHWA. Some unique agreements were reached for funding and construction. To build a transitway on Interstate 45 North as quickly as possible and terminate an experimental contraflow lane, some innovative contracting techniques were used to shorten the construction period. Contractors were given the opportunity to bid the number of days for project completion with each day representing a specific dollar value. The number of days bid was used along with unit item quantities to determine the low bidder. In addition, an incentive provision allowed the contractor to earn a bonus for each day the project was completed early. It is believed that competitive bidding shortened the contract performance period from 975 to 360 days and that the incentive further reduced the performance period by 90 days, because the contractor developed innovative construction methods that allowed him to go for the full incentive. This paper provides the results of the construction effort and an initial look at the impacts on the Metropolitan Transit Authority, the State Department of Highways and Public Transportation, the contractor, and the motoring public. A contract management and administration system, which could be used as a model for future joint projects, evolved from this project.

The Metropolitan Transit Authority (Metro) of Harris County and District 12 of the State Department of Highways and Public Transportation (SDHPT) in Houston, Texas, agreed to jointly construct an authorized vehicle land (AVL) on the North Freeway at the same time the main lanes were widened and new breakdown shoulders were added. It was decided that Metro would award the first three contracts for construction of the first 9.6 mi of this project and the SDHPT would contract for the next 4.6 mi. To build the AVL as quickly as possible and terminate an existing contraflow operation on Interstate 45 North (North Freeway), Metro proceeded with an accelerated, incentive-type contract to build a temporary or interim AVL. The historical background of this initiative is reviewed and how the incentive contract was administered is described. An analysis of the estimated period for construction using critical path method (CPM) techniques and the results of competitive bidding played a key role in reducing the construction performance period.

During construction a unique project management system evolved that became the standard for contract execution and coordination among Metro's project manager and contract administrator, the SDHPT resident engineer, and the contractor. The most significant lessons learned from the incentive contract were ascertained by looking at its impact on the contractor and the agencies involved. This analysis will provide an insight into the costs, not necessarily in dollars, to participants in an accelerated

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incentive contract. Metro's experience with the first incentive contract was used as a model for development and award of the next contract, which is in progress. Some conclusions and recommendations can be drawn from a review of this unique contracting initiative.

BACKGROUND

As early as August 1981 Metro and the SDHPT were looking for ways to build the North Freeway transitway as soon as possible in order to terminate contraflow operations--an experimental project on the North Freeway that borrowed a main freeway lane from the off-peak side for the exclusive use of buses and vanpools. It was necessary to build an AVL quickly because the increasing volume of traffic in the off-peak direction would soon prohibit borrowing a main freeway lane.

Because time was critical and design had to be completed in order to start construction, it was decided to approach the project in three stages for the initial AVL segment from the Houston central business district to the North Shepherd interchange, a distance of 9.6 mi. The first and easiest part of the project was the relocation of signs and the installation of high-mast lighting systems that would meet the requirements of the future transitway and widened freeway. This segment of construction was quickly designed, bid, awarded, and completed in October 1984.

The second segment consisted of building an interim AVL in the freeway median with a less-than-desired width in order to terminate contraflow. Major objectives were to remove the median guardrail and fence, enclose both sides of the median and the construction zone with a concrete traffic barrier (CTB), and pave the median with a concrete surface that would be used for the interim AVL. Because the objective was to construct an interim facility as quickly as possible, Metro was willing to accept an AVL that was narrower than standard (12 ft wide versus 19.5 ft).

In the third segment, which will take longer to design and construct, the freeway will be widened, new shoulders will be added, and the AVL will be modified to 19.5 ft wide to provide sufficient room to pass. A fourth segment will extend the AVL from North Shepherd to Beltway 8, an additional 4.6 mi.

When the construction sequence had been confirmed, the agencies began to approach project funding. During September 1981 federal funding assistance was discussed by Metro, Texas SDHPT, UMTA, and FHWA. It was agreed that Metro with UMTA support would fund the construction of the AVL and related facilities and that the SDHPT with FHWA assistance would pay for freeway construction, repairs, and related costs.

However, the actual contracting was complicated by differences in the minority business enterprise and women-owned business enterprise (MBE/WBE) requirements of UMTA and FHWA. These differences would not allow mixing of funds and resulted in an agreement that Metro would let the contracts that received UMTA support. To formalize this understanding Metro and the SDHPT executed an agreement in which Metro (with UMTA funding assistance) would let three contracts for the construction of the AVL segment from the Houston central business district to North Shepherd, a distance of 9.6 mi. The remaining contracts would be let by SDHPT (with FHWA support) for the segment from North Shepherd to Beltway 8, an additional 4.6 mi.

A consultant was placed under contract to identify the separate costs for public transit and high-occupany vehicle (HOV) use and for general highway use. The report was received on November 13, 1981, and reflected $51.9 million for public transit and $33.6 million for general highway costs. These costs were included in the agreement between Metro and the SDHPT. The first three contracts let by Metro would be for the $51.9 million in public transit, which would be shared by Metro and UMTA on a 20 to 80 percent ratio. General highway use costs would be shared by the SDHPT and FHWA in accordance with the standard 4R funding ratio of 10 to 90 percent.

This paper is a report on the results of the second contract, which was awarded by Metro on November 30, 1983, and completed April 13, 1985.

CONTRACT DEVELOPMENT

When Metro began to develop the second construction contract the primary consideration was to build an interim AVL as quickly as possible in order to eliminate the contraflow operation that was facing closure because of increased main freeway lane traffic in the off-peak direction. Specific traffic counts were available from the Texas Transportation Institute (TTI) to document the increased off-peak direction traffic volume, which was as high as 92,000 during a 24-hr period or an average of 3,800 vehicles per hour or more than 1,200 vehicles per hour per lane at some locations. With a lane taken away for contraflow this resulted in congestion with 3,800 vehicles carried in only two lanes in the off-peak direction. This condition was confirmed through visual observation during contraflow operations. Furthermore, the setup and take-down procedures were expensive and exposed contraflow personnel to main freeway lane hazards during implementation. Setup and take-down costs were averaging $50,000 per month.

Initially Metro weighed the possibility of using only an incentive or bonus payment to induce the contractor to complete the project early; however, the final contract bid package contained an incentive-disincentive provision and redefined a working day. In combination it was believed that these two concepts would get the job done early.

Performance Period Determination

The primary objective of constructing the interim AVL early could be achieved by compressing the schedule as much as possible. When design had been completed the SDHPT submitted the engineer's estimate of construction cost and recommended a performance period of 750 working days. This figure was based on the performance of an average contractor working 5 days a week, 8 hr a day, not including 30 weather days per year and all major holidays. When weather days, weekends, and holidays are added to the working days the total contract performance period equaled 975 calendar days.

According to the SDHPT a good contractor working 6 days a week, 10 hr a day, could complete the project in 540 working days or 702 calendar days. The 540 days for a good contractor's performance became a key figure when a calendar day was redefined. This will be discussed later.

Metro was not satisfied with a performance period of almost 2 years for a good contractor and decided to approach the contract performance period in two parts. The first was to complete the interim AVL quickly and the second was to complete the remainder of the project using a good contractor's performance criteria. At the same time a critical path method (CPM) schedule was developed using the criteria of outstanding performance, which redefined a working day as a calendar day. This redefinition translated

into a working day of 24 hr, 365 working days a year, and no allowance for weather or holidays.

Using the outstanding performance criteria, the new definition of a working day, and results of the CPM analysis, it was determined that the interim AVL could be completed in 360 days (calendar day = working day). If successful this approach would save 615 calendar days in construction time (975 - 360 = 615). This then became Metro's goal--to construct the interim AVL in not more than 360 days.

Contractors Bid Completion Time

With this tight performance period, it was decided to let potential bidders select the number of days for completion with 360 the minimum they would be allowed to bid and 540 (the redefined working day for good contractor performance) the maximum for overall contract completion. The results were quite encouraging because three of the four contractors bid the minimum of 360 days for interim AVL completion; the fourth bid 420, which still would have been a significant time savings had that contractor submitted the lowest bid.

An obvious question arises as to why Metro set 360 as the minimum number of days that could be bid. Because the CPM analysis showed that only an outstanding effort by a contractor would enable completion in 360 days it was selected as the minimum. In addition, failure to set a minimum would encourage unrealistically low bids for performance with no intentions of completing the project in accordance with the days bid. The contractor then could challenge the performance period in court when he failed to complete the project on schedule. Each day of the contractors' selected completion time was valued at $5,000 and the resulting figures were used to determine the low bidder. How the value of $5,000 per day was established will be discussed later.

To recapitulate, Metro's goal was outstanding performance through accelerated construction to obtain the interim AVL portion sooner. This was accomplished through defining a working day as equal to a calendar day, which allowed the contractor to work multiple shifts, 7 days a week, with no allowance for weather or holidays. By combining this definition with competitive bidding (the contractor selected the completion time for the interim AVL) it was possible to reduce the performance period from 975 to 360 calendar days--a reduction of 615 calendar days.

Incentive-Disincentive Provisions

Metro's innovative concepts for reducing the performance period squeezed potential contractors to the maximum. Therefore it was thought that some provision should be made to ensure contract compliance.

Because it was highly desirable that the interim AVL be completed on time, an incentive-disincentive provision was included in the contract to encourage the contractor to put forth his best effort. As an incentive for better performance Metro offered a bonus of $5,000 per day for each day the AVL portion was completed early for a maximum of $450,000, which could be earned if completion occurred 90 days early (on the 270th day based on 360-day bid). In arriving at the daily dollar value for the incentive it was necessary to determine a realistic figure that could be justified.

Contact was made with highway departments in other states that had used incentive contracts to accelerate highway construction. Some of the agencies responding included the Illinois Department of Transportation, the Mississippi State Highway Department, the FHWA (in reference to projects in Kentucky and Georgia), the Colorado Highway Department, and the Texas Transportation Institute of the Texas A&M University System. Information received helped Metro develop an incentive-disincentive provision based on hard, justifiable dollar values. They included administrative costs to Metro and the SDHPT, the salaries of each agency's employees who supported the project (which included SDHPT engineering and inspection staff personnel assigned to the project), and the cost of operating the contraflow lane. These hard costs, all of which were direct costs and easily justified, were estimated to be in excess of $5,000 per day. There were additional freeway user delay costs estimated to be in excess of $38,000 per day, but these were not included because they were more difficult to quantify and substantiate. A maximum period of 90 days was selected for the incentive and disincentive because the CPM developed by Metro showed that even with unlimited people and resources it would be almost impossible for a contractor to complete the interim AVL 90 days early. However, the contractor should be given the opportunity to earn the bonus, and completion more than 90 days early was unrealistic.

As a counterbalance to the incentive a disincentive would be assessed for every day the project was delayed past the 360-day selected completion date. The rational used for establishing the disincentive payment of $5,000 per day was the same as that for the incentive in reverse: Metro and SDHPT costs would continue.

Liquidated Damages

Contract completion time, which included the interim AVL, main freeway lane repairs, and improvements to the AVL near downtown Houston, had been set at 540 days for good performance. Because any delay past that date was unacceptable from a performance view and it could adversely affect the next construction contract, liquidated damages of $5,000 per day were set to start on the 541st day. The value of liquidated damages was established using the same criteria that were used for the incentive-disincentive provision.

CONSTRUCTION COSTS

Engineer's Estimate and Contractor Bid Prices

The effectiveness of the bidding process that was developed for this contract can be gauged by comparing the engineer's estimate (which reflected existing prices for similar construction at market value in the local area) with actual bids. An unusually high bid price by the contractors could indicate that they believed the cost for accelerating construction would be significant and were including this factor in their bid proposal. Indeed, this may have been the case for all except the low bidder. The engineer's estimate was $8,683,867.90 and the low bid came in at $8,186,855.99, which was below the estimate. The other three contractors bid $10,250,808.38, $10,627,868.42, and $10,979,814.66, respectively. This could be interpreted as an attempt by the three higher bidders to offset the cost of acceleration.

Impacts of the Accelerated Contract

Accelerating this contract resulted in an operational interim AVL on September 14, 1984--269 days after

the notice to proceed was issued. After completion of this accelerated contract on April 13, 1985, a quick look at each agency's involvement revealed some adverse impacts and benefits that resulted from the compressed schedule and incentive provisions. A majority were a direct result of the contractor's effort to earn all of the bonus money. Impacts to Metro, the SDHPT, and the contractor will be discussed separately.

Metro

As a result of the accelerated contract, Metro increased its staff and involved more people in supporting increased contract management and administration requirements such as project management, contracts, risk management, insurance, and operations. Contract management salary costs for FY 84, the period when maximum effort was devoted to the incentive part of the contract, were $97,000. Administrative costs were in addition to that figure; however, the savings to Metro from terminating contraflow operations by finishing the interim AVL early would approach $50,000 per month. By reducing the AVL completion time from 975 to 270 days, contraflow operations were terminated about 23 1/2 months early, which saved an estimated $1,150,000; the bonus cost was $450,000, which resulted in an overall savings of $700,000 to Metro.

SDHPT

Having an accelerated contract resulted in significant adverse impacts on the engineering and inspection staff of the SDHPT. The state was not manned to support a construction schedule based on 24 hr a day, 7 days a week, and a cap had been placed on hiring additional personnel. A solution was to transfer people within residencies to get more support for the Phase 1B contract and to work engineers and inspectors overtime. Nineteen people accumulated 2,695 overtime hours, and the highest individual total was 461 hr (which amounted to more than $9,000 in overtime pay).

What was the impact on the state of this large overtime accrual? State policy until September 1984 was to offset overtime with compensatory time off. Cash payment was not permitted for accrued overtime, so it became necessary to modify that policy. When the large overtime accrual became a problem, the local district engineer began to work with the state office in Austin to get the policy changed. A favorable decision was reached and cash payment for overtime was authorized effective September 1984. However, the overtime accumulated before September 1984 was a major problem because the offsetting compensatory time had to be taken (state policy) within 1 year of accrual. Allowing state engineers and inspectors to take compensatory time off after this contract was completed would severely affect support for Metro's Phase 2 incentive contract.

Metro approached the state with a proposal to reimburse the state for a portion of the overtime costs, which would allow sufficient support for the forthcoming Phase 2 contract. An existing agreement between Metro and the SDHPT was modified to authorize payment by Metro and resolved the overtime issue. In spite of the difficulties encountered, the SDHPT resident engineer stated that the incentive and accelerated contract provisions were the biggest factor in early completion of the interim AVL.

Contractor

The contractor experienced some significant impacts as a result of the accelerated provisions. His work schedule was based on a calendar day instead of a workday, and in order to earn the bonus he was forced to work 24 hr a day, 7 days a week, with no weather days or holidays. These long hours resulted in a high turnover rate in construction workers, which was 600 percent during the life of the contract (according to Champagne-Webber's office manager). They hired 100 people to start the job, completed it with 98, and hired 600 between start and job completion. To complete the contract in the minimum time the contractor was forced to work around the clock, which resulted in a lot of overtime and increased labor costs. An in-house assessment by Metro estimated labor costs to be about 150 percent of the normal amount. The contractor stated that his average labor cost for the project was $15.42 per hour, which verifies the in-house determination because normal costs should be between $9 and $10 per hour.

Metro required the contractor to maintain a dedicated AVL lane for use during peak traffic periods during construction. Sometimes this was a temporary AVL within the work zone and sometimes it was a contraflow operation, and it was successfully maintained until the interim AVL became operational in November 1984. Maintaining the AVL between 6:00 a.m. and 8:30 a.m. and between 4:00 p.m. and 6:30 p.m. limited the contractor's flexibility and the times when he had free access to the protected work zone. Barrier protection for the work zone both helped AVL operation and provided safety for the construction workers. No serious injuries occurred, but many small incidents drove the constructor's insurance rates up 33 percent.

How much of the $450,000 bonus was profit? According to the contractor only about $100,000 was realized as profit to the company; the remainder was absorbed in increased costs for accelerating the construction schedule.

RESULTS OF CONSTRUCTION

Accelerated and Incentive Contract Portion

In spite of the tight schedule and support problems the contractor finished this portion of the contract in 269 days and earned the full bonus of $450,000. The contract performance period for this part was reduced from 975 to 269 working days, which was a reduction of 706 days or more than 23 months.

Contract Completion Time

The momentum developed while constructing the interim AVL continued through final project completion. The contract was completed in 470 days instead of 540, which saved another 70 days on the overall contract. Modifications late in the contract performance period prevented an even earlier completion date.

CONTRACT MANAGEMENT AND ADMINISTRATION

After this contract was let, the key element that made possible the end results was the way in which the contract was managed and administered. The general guidelines for execution of the north transitway and freeway widening contract were spelled out in an agreement between Metro and the SDHPT. In this agreement under "Scope of Performance by the State," Paragraph 5, the following language is found:

> The State will serve as the duly authorized agent of Metro for the limited purpose of managing construction, including the inspec-

> tion of all work to be performed under such contracts for compliance with engineering and design specifications; provided, however, that this shall not change the legal responsibilities set out in such contracts and in . . . this Agreement. Field changes will be initiated and handled with the Contractor solely by State personnel acting for Metro, but subject to approval by Metro prior to being accomplished. To assure Contractor accountability to the State's on-site inspectors and engineering personnel, Metro agrees that Metro personnel will not directly interact with Contractor personnel, but will communicate with the contractor through State personnel in all matters concerning engineering, design, or construction performance. All other matters pertaining to said contracts will be handled by Metro directly with said Contractors/subcontractors.

To implement this agreement Metro was represented by personnel from project management and contracts. The project manager was designated by the director of bus facility project management and communicated directly with the SDHPT resident engineer on all matters concerning engineering, design, or construction performance. A contract administrator was appointed by the director of contracts and procurement and dealt directly with the contractor and subcontractors on all matters pertaining to contract administration. He also acted as spokesperson for Metro in negotiations required for contract modification and was assisted by the project manager and resident engineer as needed.

In simple terms, the Metro project manager worked directly with the state resident engineer on all construction and related issues. The contract administrator, in turn, dealt directly with the contractor on contract modifications and contract administration issues. To illustrate the relationship that exists among the project manager, the contract administrator, the SDHPT resident engineer, the contractor, and Metro support staff, a spheres of influence chart was developed (Figure 1). Each individual's and agency's role is outlined in the paragraphs that follow. The basis of these roles and responsibilities can be visualized by referring to Figure 1.

Project Manager

Duties and responsibilities of the project manager are based directly on his role as Metro's representative and how he fulfills that role with the SDHPT resident engineer. This role is spelled out in the agreement between Metro and the SDHPT. This interface between the project manager and the SDHPT resident engineer provides for two-way processing of design, construction performance, or engineering changes that originate with the contractor, the SDHPT resident engineer, or Metro. To process contract modifications, the project manager develops the supporting documents and provides them to the contract administrator. Contractor proposals and claims for extra work are analyzed and engineering estimates are obtained from the SDHPT resident engineer and Metro. These estimates are combined with previous correspondence to support the contract modification prepared by the contract administrator. The contract modification is submitted to the contractor for approval and signing and then presented to the Metro staff for final approval before execution.

Contract Administrator

Duties and responsibilities of the contract administrator are based on his role as outlined in Metro's agreement with the SDHPT. How he fits into the overall contract management process is shown in Figure 1. The contract administrator is authorized to work directly with the contractor on issues that involve contract administration. The contract administrator maintains close coordination with the project manager on all issues that concern contract modifications required as a result of changes in construction or plan sheet drawings. Contract administration issues dealing with insurance, affirmative action, and so forth are handled with inputs from Metro staff departments. In the case of safety, Metro's safety engineer deals directly with the contractor and his subcontractors. However, even in this case the safety engineer is responsible for coordinating actions with the contract administrator. In addition, the project manager is informed and takes the lead when a safety issue involves engineering, design, or construction performance.

Contract administrator interface with the contractor is maintained on contract-related issues to ensure compliance. The contract administrator is directly responsible for writing contract modifications for change orders (field changes) directed by the state resident engineer, which require Metro approval. When contract modifications have been approved, the contract administrator is responsible for ensuring that they are properly executed and distributed. When negotiations are required to resolve differences, the contract administrator represents Metro as the chief negotiator.

State Resident Engineer

Duties and responsibilities of the SDHPT resident engineer are spelled out in the agreement between Metro and the SDHPT. He provides the link between Metro's project manager and the contractor and is directly responsible for directing engineering, design, and construction performance of the contractor. How the SDHPT resident engineer fits into the management of the contract is shown in Figure 1. The SDHPT provides the resident engineer and inspection support staff for the actual construction. He informs the project manager of any changes in construction that need to be made and directs the contractor to perform the work when a change has been approved by Metro.

In emergency situations in which execution of a field change would delay the contractor and contract performance, the resident engineer informs the project manager of the circumstances in order to initiate a change notice to direct the contractor to do the work. Subsequently, detailed costs and a contract modification are developed to authorize payment.

The resident engineer is Metro's direct representative to the contractor and is responsible for managing the construction schedule, inspecting the work, and ensuring contractor compliance with standard SDHPT specifications and plans for transitway construction. When field changes are necessary, the resident engineer provides the project manager with an engineer's estimate of the cost of the work; this estimate is independent of any estimates submitted by the contractor.

Contractor

The contractor is responsible to the state resident engineer for all matters concerning engineering,

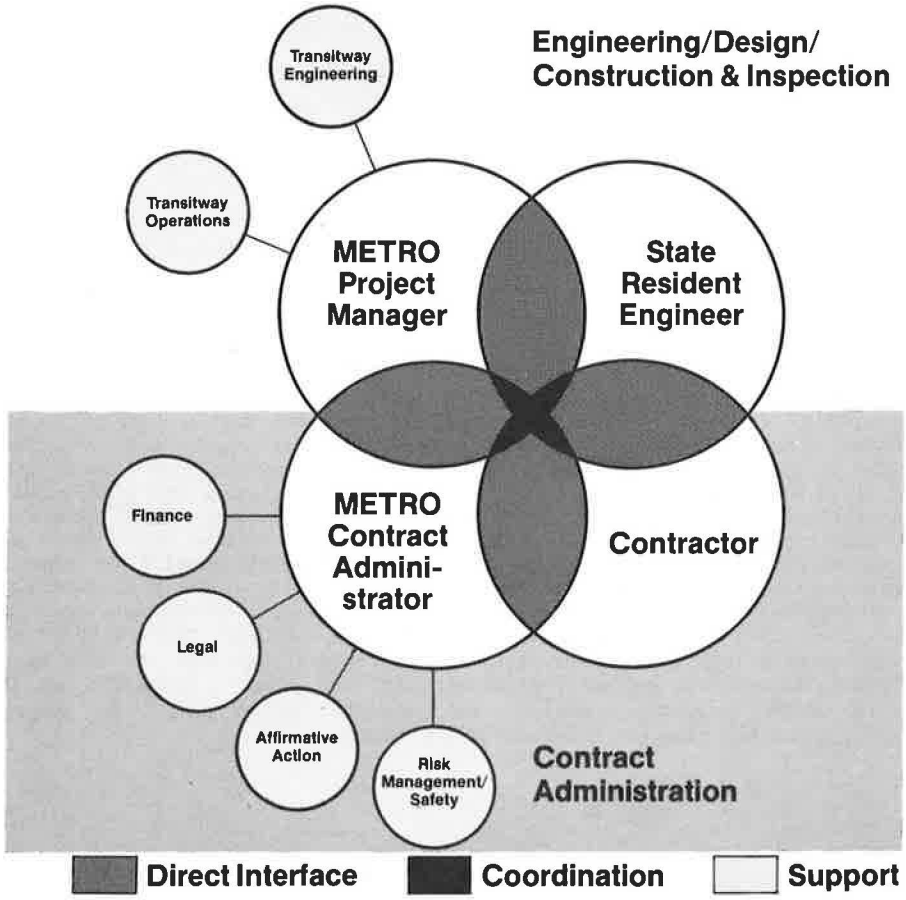

FIGURE 1 North Freeway transitway Phase 1 contract management spheres of influence.

design, and contract performance. The contractor is specifically forbidden to accept directions from Metro personnel on these three items. However, the contractor provides schedules, insurance forms, extra work cost data, and any other items called for in the contract directly to the contract administrator. Issues relating directly to safety, finance, MBE/WBE participation, and AVL operations are handled through contact with the contract administrator or the appropriate Metro staff agency. However, in each case the project manager and the contract administrator are included in discussions and coordination. Figure 1 shows how the contractor interfaces with the SDHPT resident engineer and Metro's contract administrator.

CONCLUSION

Because this was Metro's first attempt to use unique competitive bidding techniques and an incentive to get accelerated construction performance, the jury is still out on any firm conclusions. That performance time was slashed dramatically would indicate success, but it is difficult to pin down who paid the additional costs of acceleration. In this case it is believed that the contractor paid the majority of these costs with the incentive providing some offset. Bidding on future contracts could alter this situation so that the owner would pay through higher bid prices.

CONTINUING INITIATIVE

The interim AVL constructed in Phase 1 is narrow and creates some operational problems as a result. To correct this and other deficiencies Metro has let a second contract for Phase 2, which will add a new freeway lane in each direction, build new shoulders, and widen the transitway to a standard width. Incentive provisions and the requirement for accelerated performance have been included in this $43.4 million contract, which is now 30 percent complete. Some firm conclusions may be forthcoming after this latest effort.

RECOMMENDATION

No firm recommendation can be made about the use of accelerated construction contracts with incentive provisions until further analysis can be done. Metro has requested the Texas Transportation Institute of the Texas A&M University System to review the results of the contract completed and the one in progress to form a basis for future recommendations.

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