BEFORE THE
MARYLAND STATE BOARD OF CONTRACT APPEALS

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| Appeal of FRUIN-COLNON CORPORATION AND HORN CONSTRUCTION CO., INC. (A Joint Venture) | ) ) ) ) | Docket No. MDOT 1025 |
| Under MTA Contract No. NW-03-02 | ) | |

November 24, 1987

Differing Site Condition - The contractor encountered a differing site condition at certain areas of the tunnel and not at others depending on whether it should have anticipated RZ-2 material (e.g. highly weathered rock) or RX material (unweathered rock) in the invert (the tunnel floor) of the tunnel envelope based on an examination of the contract documents.

Differing Site Condition - Equitable Adjustment - The contractor is entitled to an equitable adjustment pursuant to contract General Provision GP-4.04 "Differing Site Conditions" where the parties are not in dispute as to the existence of a differing site condition at the Lafayette Street Vent Shaft.

Differing Site Condition - The method of excavation is not an exclusive indicator of the material being encountered or its hardness. Observation of the material is essential to an accurate classification.

Differing Site Condition - Burden of Proof - A contractor through its expert witness need only show that it reasonably construed the contractual definitions of subsurface soil and rock material that it could expect to encounter where a precise, scientific basis for distinguishing RZ-1 material from RZ-2 material was not provided in the contract. The contract defined the classifications of soil and decomposed rock material that a contractor could expect to encounter during the tunneling work based on MTA developed definitions of RZ-1 material and RZ-2 material.

Differing Site Condition - A reasonable contractor would not conclude that RZ-1 material had strength beyond that normally found in soil based on information contained in the contract documents, including the "Bolton Hill Section, Geotechnical Data Review" (GDR), where the extent of a differing site condition is based on whether the excavated material falls into the contract's classification as soil or as rock or into another classification and the contract data did not indicate a meaningful relationship between blow count measurements and soil strength from soil tests conducted at the site.

Differing Site Condition - A differing site condition existed within the meaning of contract General Provision GP-4.04 due to the contract's understatement of material hardness in certain areas of the Lafayette Avenue tunnel. The contractor reasonably construed the subsurface data included in the contract documents to mean that RZ-1 material would be encountered and that it would behave as a soil, albeit a hard, cohesive soil, but it encountered material having the strength of weak rock.

Differing Site Condition - In the Pennsylvania Avenue tunnels, the contractor unreasonably relied on the contract documents, including the contract core boring information contained in the contract drawings, to conclude that it would not encounter either RZ-2 material or RX material in the last 400 feet of the tunnels. The contractor unreasonably inferred that it would not encounter rock in this area even though there was no boring data available for the area where rock was encountered. Borings taken at other points indicated that the subsurface rock level was rising towards the invert level over the last 400 feet of the tunneling operation. No other geotechnical data indicated that rock would not be encountered in the area beyond one of the available borings which did indicate rock near the invert level.

Differing Site Conditions - Assumption of Risk - The contractor assumed the risk of bidding tunneling excavation in the last approximately 200 feet of tunneling in both Pennsylvania Avenue vicinity tunnels at the same price that it bid for the earlier soft ground tunneling. The subsurface indicators in the contract documents, including the supporting geotechnical data, reasonably indicated that rock would be encountered in the last 150 feet of each tunnel. The contract documents also warned that rock would be encountered in the last 150 feet of each tunnel where the GDR informed bidders that rock excavation techniques may be necessary for RZ-2 material and discussed the need to control overbreak operations when tunneling in such material.

Differing Site Condition - Unforeseen Nature or Extent - In the Pennsylvania Avenue tunneling area, the contractor reasonably should have foreseen the quality and quantity of rock, rock-like material and other types of soil material encountered based on the contract's subsurface data. The extent of this material was forecast by the GDR subsurface data except for two locations where both MTA and the contractor agreed rock clearly was present though unanticipated.

Differing Site Condition - There was a differing site condition at the Lafayette Avenue Vent Shaft due to unanticipated rock encountered during shaft excavation in this vicinity where the material was similar to the RZ-2 material encountered during the earlier tunneling excavation operation in this vicinity which the MTA had recognized as a differing site condition. The contractor's ability to excavate the material with a Gradall is not necessarily an indication that the material excavated was soil rather than rock. Rock can be excavated using a Gradall under certain circumstances.

Differing Site Condition - Equitable Adjustment - Delay - Labor Hour Reduction - A labor hour reduction in the contractor's delay claim is reasonable where the contractor could have avoided damage to the Calweld drill used to auger the unanticipated rock by prudent use of a core bucket and drop beam that was available instead of attempting to use the rock auger which resulted in the breakdown of the bull gear on the Calweld drill.

Equitable Adjustment - Equipment Failure - Proof of Costs - The Board accepts MTA's reduction in the contractor's claim for delay costs for equipment breakdown where the contractor did not establish the age or condition of the equipment (swing pump) or indicate its remaining useful life or maintenance history, and the breakdown could have been caused by an intervening event; namely, a malfunctioning swing brake.

Equitable Adjustment - Delay Analysis - The contractor's "as would have been" schedule used for purposes of measuring the extent of its delay should have been premised on drilling two feet into rock where the final approved design called for a two foot key drilled into solid rock for placing soldier piles, where the contractor anticipated the possibility of having to drill six feet into rock for long (soldier) piles, and where the contractor did not demonstrate that a one foot drilled key into solid rock for placing soldier piles is all that was required and did not submit shop drawings and supporting calculations for a one foot key. A correction of nine (9) work hours to the contractor's "as would have been" schedule is required where it was obligated to drill at least two feet into rock for soldier piles not one foot as it contended.

Equitable Adjustment - Delay Costs - Evidence - MTA may not deduct work hours from the contractor's claimed delay for conducting certain required tests where there is no credible evidence to substantiate its position.

Equitable Adjustment - Delay - Equipment - The contractor's method of pricing the cost for use of a loader and an operator on a half time basis during the extended contract performance period to relocate spoil away from the drill rig and then to load the spoil into dump trucks for disposal was reasonable although the use of this equipment was sporadic. The contractor demonstrated that the loader was actually used 42% of the time during the pile driving operation. This factor was reasonably increased to 50% taking into account the time necessary to move the loader around the site.

Equitable Adjustment - Delay - Equipment - Compensation for the welding machine used during the delay period on the basis of appropriate and normal equipment ownership rates rather than at a standby rate is reasonable where the welding machine was used for more than just the repair of the Calweld drill and there is no evidence that it was idle for long periods of time when the soldier piles were being driven.

Equitable Adjustment - Allowable Equipment Cost - The contractor is entitled to reimbursement for the entire purchase price of certain equipment (the drop beam) to break up rock where it would not have purchased the equipment but for the differing site condition. The purchased equipment was not essential to contract performance since available equipment was adequate to remove the relatively small amount of rock expected within the scope of the specified contract work.

Equitable Adjustment - Equipment Ownership Rates - The contractor is entitled to reimbursement under the terms of the contract for its additional equipment costs for MTA caused delay based on its actual costs as derived from its books and records rather than based on commonly used construction industry rate formulas such as the CalTrans rate method (which is based on estimates of equipment ownership expense developed by the California Department of Transportation for use on its contract projects) or the Association of General Contractors (AGC) rate method. These methods provide a means of calculating equipment costs using formulas based on nationwide average equipment ownership costs.

Equitable Adjustment - Equipment Ownership Rates - Burden of Proof - The basic objective of an equitable adjustment is to make the contractor whole, i.e., to put it in the same financial position it would have been in had the extra work for which the agency is responsible not been required. Actual costs incurred by the contractor in performing the extra work is presumed reasonable. The contractor thus has the burden of showing that its actual costs as shown by its accounting records are inadequate or incomplete or do not fairly represent the full costs it incurred as a result of the delay, if in lieu of such booked costs it desires to use a standard rate manual procedure such as CalTrans rates or AGC rates to calculate its equitable adjustment for increased equipment costs attributable to performing extra work during an extended contract performance period.

Equitable Adjustment - Equipment Ownership Rates - Force Account Work - The contractor is not entitled to calculate its equitable adjustment for the delay period as force account work based on the CalTrans rate method as specified by Special General Provision (SGP) 9.02 for calculation of equipment costs regardless of whether the equipment is contractor-owned, rented, or otherwise acquired. The additional work during the extended contract performance period caused by the differing site condition was not force account work within the meaning of SGP 9.02, since the MTA procurement officer did not direct the contractor to do the work under the force account provisions of the contract as expressly required by SGP 9.02.

Equitable Adjustment - Equipment Ownership Costs - Burden of Proof - Acquisition costs, including equipment assembly and disassembly costs, erection costs, freight-in and freight-out costs, storage and miscellaneous handling costs, are included in the cost basis of equipment when computing equipment costs based on CalTrans rates or AGC rates. However, equipment assembly and disassembly costs, erection costs, freight-in and freight-out costs, storage and miscellaneous handling costs are not reasonably recoverable as part of the contractor's equitable adjustment in the instant appeal where the contractor failed to demonstrate that these costs increased as a result of the differing site condition or that under its accounting methodology it treated these costs as capital costs rather than as expensed items. In order to compute additional equipment ownership costs or to calculate an equipment use allowance rate in determining the additional costs of equipment used during a delay period, calculation of the added cost of the equipment using an acquisition cost basis may include the enumerated types of acquisition costs in addition to the purchase price under certain circumstances if based on appropriate, supporting evidence utilizing reasonable and acceptable general accounting methods.

Equitable Adjustment - Equipment Ownership Costs - Storage Costs - Storage costs are not recoverable as part of an equitable adjustment for delay where the contractor did not demonstrate that such costs increased as a result of the extended contract performance and thus were attributable to MTA caused delay.

Equitable Adjustment - Equipment Ownership Costs - Interest On Investment - Interest on the contractor's equity investment in its equipment, (variously referred to as "interest on investment," "capital cost of money," "imputed cost of equity capital," or "return on investment") is recoverable as an element of the ownership cost of equipment used during the delay period, if adequately established as an allowable cost based on a reasonable accounting and allocation basis.

Equitable Adjustment - Equipment Ownership Costs - Salvage Value - Depreciation - The MTA's method of calculating the contractor's equitable adjustment is reasonable where it used equipment salvage value (residual value) estimates at the time of transfer to another entity at the end of the contract work, or the actual sale price if the equipment was sold to a third party. MTA's methodology was accepted as reasonable over the contractor's depreciation method for computing equipment costs where the contractor's method was based on the equipment's acquisition cost less the estimated salvage value of the equipment at the time of acquisition.

Equitable Adjustment - Tunnel Plant Equipment - Burden of Proof - Tunnel plant materials such as piping, wiring, etc., were types of costs more closely associated with tunnel length and would have been incurred regardless of the differing site condition. The contractor failed to meet its burden of showing that tunnel plant material costs increased directly due to the differing site condition where only so much tunnel plant material was required regardless of when installed and was not shown to have been affected by the delay caused by the differing site condition.

Equitable Adjustment - Delay Analysis - Loss of Efficiency - The contractor appropriately computed its loss of efficiency due to the differing site condition in terms of its average rate of tunneling progress. The contractor determined this rate based on its normal, unimpacted rate of tunneling progress in all four tunnels compared with its tunneling progress through the areas of the tunnel affected by the differing site condition. The average rate of production or tunneling rate for all types of soils in the unimpacted tunneling areas is considered to be the reasonable "as would have been rate" for purposes of determining the effects of the differing site condition.

Equitable Adjustment - Delay - Jury Verdict - Total days of delay were apportioned between the MTA and the contractor on a jury verdict basis where the contractor's method of tunneling through the differing site condition area using the tunnel shield could have been employed earlier.

Equitable Adjustment - Credit - The MTA is entitled to a credit for work done by the contractor's crews during the delay of other work due to equipment downtime for repair for which the MTA was responsible.

Equitable Adjustment - Impaired Equipment - The contractor is entitled to an equitable adjustment for loss of productivity for the remainder of the work on the project outside the differing site condition areas attributable to extraordinary wear on the tunneling equipment (impaired tunneling equipment) attributable to tunneling through rock during the differing site condition phase of the tunneling work.

Equitable Adjustment - Differing Site Condition Delay - Credit - The MTA is not entitled to a credit against the contractor's equitable adjustment for delay due to the differing site condition based on MTA's waiver of the contractually required heading separation (the distance one tunnel must stay ahead of the other parallel tunnel during tunneling). MTA's waiver of the tunnel heading separation at the contractor's request mitigated the contractor's damages for which the MTA would have otherwise been responsible because of the contractor's reduced tunnel productivity due to the differing site condition.

Equitable Adjustment - Excavation - Measurement of Costs - The extent of delay in the contractor's performance and resulting increase in its costs due to excavation through the differing site condition area is measured by the difference between the contractor's anticipated rate of excavation ("would have been rate"), which took into account certain production inefficiencies, and the excavation rate actually achieved.

Equitable Adjustment - Claim Preparation Fees - Claim preparation fees may not be recovered as direct costs under the differing site conditions clause, although they may be allowable as overhead costs. Claim preparation fees are not costs incurred in the performance of contract work, although they are indirect costs necessary to the successful conduct of the contractor's business.

Equitable Adjustment - Credit - The MTA is entitled to a credit for labor and equipment costs incurred by the contractor when excavating the tunnel cross passages while tunneling was stopped awaiting shield repairs attributable to the differing site condition in tunnel 3. MTA is also entitled to a standby credit for other equipment idled during the cross passage excavation awaiting shield repairs in tunnel 3.

Equitable Adjustment - Labor Escalation - The contractor is entitled to increased costs due to higher labor rates that went into effect during the extended contract performance period resulting from the differing site condition.

Equitable Adjustment - Non-Time Related Overhead - The contractor is entitled to non-time related overhead costs for the period the differing site condition affected tunneling work. These costs are prorated on the basis of non-time related overhead costs to total direct costs for the period of the differing site condition.

Equitable Adjustment - Home Office General and Administrative Expense - The contractor is entitled to its increased home office general and administrative costs attributable to the differing site condition computed on a percentage of direct cost basis.

Equitable Adjustment - Extended Field Overhead - Jury Verdict - The contractor is entitled to extended field overhead costs, e.g., the increased costs of maintenance as distinguished from installation costs, during the differing site condition delay assessed on a jury verdict basis where the contractor is reasonably entitled to an equitable adjustment but is unable to separate its increased maintenance costs from installation costs in its accounts.

Equitable Adjustment - Finance Charges - Finance charges incurred for loans to fund the delayed work are recoverable under Maryland law and are treated as time related charges in computing extended field overhead.

Equitable Adjustment - Interest - The Appeals Board awarded predecision interest pursuant to Md. Ann. Code, State Finance and Procurement Article, § 11-137 to begin on a date prior to the decision determined to be fair and reasonable considering the complexity of the issues and its finding that there was no specific date prior to the decision when the obligation to pay and the amount due became certain, definite and liquidated such that the effect of failure to pay the claim was to deprive the contractor of the use of its funds in a fixed amount as of a known date.

Counterclaim - The MTA is not entitled to liquidated damages for the contractor's delay in completing the north access shaft since the contractor was entitled to a time extension for the period of delay in completing the shaft work. However, the MTA is entitled to liquidated damages for 31 days for contractor work after the contract completion date, as extended by MTA caused delays, until the contractor substantially completed the work.

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OPINION

1. Findings of Fact - Entitlement

Introductory

1. On May 20, 1976, the Maryland Mass Transit Administration (MTA) issued an amended Notice to Contractors soliciting bids on the captioned contract. Contractors generally were apprised in this notice that the contract work was to include approximately 11,300 linear feet of single track earth tunnels mined under compressed air conditions and the construction of two mid-line vent structures. Contractors further were informed as to how bid documents and geotechnical data could be obtained.

2. For purposes of bidding and later performing this contract, Fruin-Colnon Corporation formed a joint venture with Horn Construction Co., Inc. On July 27, 1976, the joint venture (Appellant) submitted a bid to the MTA in the amount of $41,658,000. Thereafter, Appellant was determined to be the lowest responsive and responsible bidder and an award ultimately was issued to it on November 16, 1976 for the performance of the captioned contract.

3. Sometime after award and before the onset of the difficulties precipitating this appeal, Appellant entered into an agreement with L & W Concrete Company, a locally owned and minority controlled business, whereby the latter would acquire a five percent interest in the project. (Tr. XXII, p. 8). L & W thus became a third joint venture partner.

4. On October 31, 1978, Fruin-Colnon Corporation purchased the equity interest of Horn Construction Company on this project and on other projects in Atlanta, Georgia and Washington, D.C. where similar joint ventures had been formed between the two parties. (Tr. XXII, p. 3). From the effective date of this buyout agreement, therefore, the joint venture partners on the captioned project became Fruin-Colnon with a 95% interest and L & W Concrete Company with the remaining five percent interest.

**Description of Project - General**

5. The captioned contract has been denominated by the MTA as the Bolton Hills Tunnels Project. The project was an integral part of the first phase of the Baltimore Region Rapid Transit System.

6. Appellant was required contractually to drive a total of four tunnels connecting the Bolton Hill Station with the Laurens Street Station to the North and the Lexington Market Station to the South. The South tunnels

were to be driven first and are referred to by the parties as tunnels 1 (outbound) and 2 (inbound). Each of these tunnels was approximately 2750 feet in length. (Cont. Dwg., Sh. 2). A single shaft from ground level to tunnels 1 and 2 was to be excavated at Monument Street for purposes of providing ventilation to the South tunnels. The North tunnels are referred to as tunnels 3 (inbound) and 4 (outbound) and each was approximately 3000 feet in length. Tunnels 3 and 4 were to be ventilated by a single shaft excavated from ground surface at Lafayette Avenue.

7. The contract called for all four tunnels to be shield driven under compressed air conditions. Compressed air was required so as to minimize the flow of groundwater into the tunnel and concomitantly to increase the standup time of the tunnel face material. (Cont. Tech. Provisions, §2.33, ¶1.1E; Tr. I, p. 30-31).

8. Cross passages were to be mined between each pair of tunnels at locations set forth in the contract drawings. A cross passage is a pedestrian tunnel permitting emergency exit from a tunnel blocked by an accident, fire or some other hazard. (Cont. Tech. Provisions, §2.44, ¶1.1D).

9. Work under the contract was to be completed pursuant to the following schedule requirements measured from the date of notice to proceed:

| Item of Work | Calendar Days | Date |
|---|---|---|
| 1. Complete all Work in the south access shaft and all Work in the [South] inbound and outbound tunnels . . . which is required to be done from the south access shaft and release the south access shaft to others. | 540 | May 6, 1978 |
| 2. Complete all Work in the north access shaft and all Work in the [North] inbound and outbound tunnels . . . which is required to be done from the north access | 790 | Feb. 10, 1979 |

shaft and release the north access shaft to others.

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|---|---|---|
| 5. Complete all Work under this Contract. | 915 | June 15, 1979 |

See Cont. Spec. Prov. 310A; MTA Counterclaim and App. Answer to Counterclaim. Liquidated damages were specified for failure to meet any of the foregoing completion dates.

**Pertinent Contract Provisions**

10. Contract General Provision GP-4.04 "Differing Site Conditions" provided, in pertinent part, that:

> A. The Contractor shall promptly, and before such conditions are disturbed, notify the Engineer in writing of: (1) subsurface or latent physical conditions at the site differing materially from those indicated in this Contract, or (2) unknown physical conditions at the site, of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in this Contract. The Engineer shall promptly investigate the conditions, and if he finds that such conditions do materially so differ and cause an increase or decrease in the Contractor's cost of, or the time required for, performance of any part of the work under this Contract, whether or not changed as a result of such conditions, an equitable adjustment shall be made and the Contract modified in writing accordingly.

11. Pursuant to GP-2.04 "Site Investigation", Appellant acknowledged at the time of bid that:

> . . . he has satisfied himself as to the character, quality and quantity of surface and subsurface materials or obstacles to be encountered in so far as this information is reasonably ascertainable from an inspection of the site, including all exploratory work done by the Administration, as well as from information presented by the drawings and specifications made a part of this Contract. Any failure by the Contractor to acquaint himself with the available information will not relieve him from responsibility for estimating properly the difficulty or cost of successfully performing the work. The Administration assumes no responsibility for any conclusions or interpretations made by the Contractor on the basis of the information made available by the Administration.

12. Contract Special Provision 9.0 set forth the geotechnical "Data Available To Bidders and the Contractor." In pertinent part, this contractual provision stated as follows:

> B. Soils And Exploratory Data And Design Summary Report: The information and data identified herein is made available in order that Bidders and the Contractor may have the same information as is available to the Administration. In the listed documents, factual data has not been differentiated from interpretive data.
>
> 1. The following documents are available to Bidders for inspection at the Offices of the Administration and are available for purchase by Bidders at $100.00 (in the form of money order or certified check made payable to the Mass Transit Administration) for the complete set of the following:
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> i. Baltimore Region Rapid Transit System
> Phase I - Section A
> Bolton Hill Section
> <u>Geotechnical Data Review dated July, 1975</u>
> <u>including:</u>
> <u>(1) Supplement dated May 7, 1976</u>
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> * * *
>
> 2. <u>Cores and soil samples will be available for inspection</u> upon appointment only, during normal office hours of the Administration. Cores and samples are located in warehouses remote from the Administration offices.
>
> C. The data listed below is available for Bidders inspection at the Offices of the Administration. It is expressly understood that the Administration will not be responsible for the completeness or accuracy of the following additional information nor any deductions, interpretations, or conclusions drawn from such following items inasmuch as the information has been provided by others and not subject to verification by the Administration or was prepared early in the program and may be superceded by data listed in B.1 above.
>
> 1. Baltimore Region Rapid Transit System Phase I Plan, Preliminary Foundation Report, dated August, 1971.
>
> 2. Baltimore Region Rapid Transit System General Soils and Geology Report, February, 1968.
>
> 3. Building foundation sketches of selected buildings along the tunnel alignment.

4. Baltimore Gas & Electric Construction drawings in the vicinity of the Monument Street Vent Shaft.

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(Underscoring added).

13. The contract drawings contained a wealth of subsurface data derived from borings and core samples performed by the MTA's General Soils Consultant, Robert B. Balter, Inc. (Balter) and others. Subsurface data was reported in the form of boring logs and core information as appropriate. Each boring log was identified on the contract drawings by a boring number and location designation. The boring logs described the material encountered when augering at various depths below ground surface. Standard penetration test results[1] also are listed for each new material encountered and/or at five foot intervals. Where rock was encountered, core samples were taken and information was reported as to the composition of the rock, its hardness and structure.[2] Further, general remarks at each boring location concerning the presence of water also were recorded.

14. Most of the borings pertinent to this dispute were made in January-February 1975. Subsequent to this period, however, a decision was made to lower the grade of the subway structure by 10 feet. This necessitated the taking of additional borings at the extreme Northern end of the project so as to provide subsurface information to a depth adequate to

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[1]The standard penetration test is taken with a split spoon sampler attached to the end of a drill rod. A 140 pound hammer is then dropped on the drill rod end repeatedly from a height of 30 inches. The number of blows per six inches of drill rod penetration is recorded for an 18 inch depth. The first six inches of penetration are considered seating blows and are not included in the test results. The number of hammer blows for the remaining 12 inches is taken as the blow count or N value. (Tr. V, pp. 43-44). The significance of this value will be discussed later in this opinion.

[2]A core barrel with a diamond cutting edge or a hardened carbide tip is rotated into the rock or rock-like material. As drilling proceeds, a core sample moves up into the barrel and can be retrieved and examined. (Tr. XII, p. 42).

assure safe design. (Tr. XIII, p. 22). These borings are reported on the contract drawings as NWB-101, 102, 103 and 104 and were taken in November 1975.

15. The location of each boring for which a log is set forth on the contract drawings is depicted both in plan and profile view. In this manner, contractors were able to gauge more easily the location of each boring relative to the planned structure.

16. Pertinent stick logs of borings taken in 1971 and 1974 also were shown on the contract drawings. Stick logs graphically depict material encountered at varying strata depths but are not as detailed as the standard boring log. (Tr. III, pp. 82-83).

17. A description of the subsurface materials encountered by Balter was included on sheet 58 of the contract drawings. Soils were described in the borings by the criteria of the Unified Classification System. Rock (RX) was described in the core data by its type, joint description and discontinuities. Material which neither was rock nor soil was called residual material and classified as follows:

RESIDUAL SOIL

Material derived from either the in-situ decomposition of the parent rock with the major or total component being soil-like, or reworked residual soil. This material does not usually exhibit remnant rock structure such as schistosity[3] or relict joints.[4] It may contain rock fragments, most of which are friable. Standard Penetration Tests in this material may have a wide range of results greater or less than 100 blows per foot. The Residual Soil materials are described with appropriate soil descriptions and include an RS notation. Example descriptions are as follows:

Tan moist micaceous[5] SILT and mf sand (ML,RS)
Green moist silty CLAY, little mf sand, trace rock fragments (CH,RS).

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[3]Schistosity implies a layering of metamorphic materials. (Tr. XII, p. 56).
[4]Relict joints are those which existed originally in a parent rock and still are traceable in the decomposed material. (Tr. XII, pp. 55-56).
[5]Micaceous refers to the existence of mica flakes in a sample. Mica decomposes very slowly. (Tr. XII, p. 55).

RESIDUAL ZONE #1

This is a transition zone between Residual Soil and Residual Zone #2. It consists of material derived from the in-situ decomposition of the parent rock with soil-like components and partially weathered and/or fresh rock components. This material, in-situ, usually retains some of the cohesion of the parent rock and exhibits visible remnant rock structure such as schistosity and relict joints. Materials in this zone are usually sampled with soil sampling techniques. In most, but not all, cases the Standard Penetration Test results are greater than 100 blows per foot. The material is identified as RZ-1 and its constituents, when the material is disaggregated, are described according to the Unified Classification System for soils. Example descriptions are as follows:

Brown moist micaceous SILT, some of sand (RZ-1,ML)
Dark green to gray moist CLAY, trace of sand, little rock fragments (RZ-1, CH)

In addition, the term Resid. Zone #1 is added along side the boring log.

RESIDUAL ZONE #2

Material which is clearly rock-like derived from partial decomposition of the parent rock with partially weathered and/or fresh rock components, commonly including a soil-like matrix on filler. This material usually requires sampling with rock coring equipment. This zone is described with appropriate rock descriptions, notation of the soil-like matrix or filler when appropriate and a parenthetic notation of the RZ-2 designation. An example description is as follows:

Brown and black GABBRO FRAGMENTS, some silt (RZ-2).

**Geotechnical Data Review**

18. Although a substantial amount of geotechnical data was made available to bidders, the most pertinent to the instant dispute was the "Bolton Hill Section, Geotechnical Data Review" (GDR) dated July 1975 and its May 7, 1976 supplement (Exh. S-61). As we previously have found, this information was referenced in contract Special Provision 9.0. (See finding of fact 12).

19. Appellant purchased a copy of the GDR and reviewed it prior to submitting the low bid under the captioned contract. (Tr. II, pp. 120-121).

20. The GDR presents Balter's review and analysis of the geotechnical data amassed during the final design of the Bolton Hill Tunnels. Originally prepared in July 1975, the report was supplemented in May 1976 to address the additional data obtained to facilitate design changes to the tunnel structures necessitated by the lowered profile. (Exh. S-61; Tr. XIII, p. 23).

21. Principal designation of materials encountered by Balter essentially fell into three broad categories. These were: (1) soils; (2) residual materials; and (3) rock.

22. Soil classifications were as follows:

| STRATA | DESCRIPTIONS |
|---|---|
| C-1 | Well graded sand and well graded and poorly graded gravel with less than 12% fines. |
| C-1-a | Poorly graded sand with less than 12% fines. |
| C-2 | Well graded and poorly graded gravel with more than 12% fines. |
| C-2-a | Well graded and poorly graded gravel with more than 12% fines. |
| C-3 | Deposited soils consisting predominantly of silt. |
| C-4 | Deposited soils consisting predominantly of clay. |

Strata ". . . with 'C' designations are sediments of the Cretaceous age which have been highly preconsolidated and are generally, therefore, very dense and hard." Exh. S-61, p. 5. These soils also were referred to in testimony as alluvial soils. Alluvial soils are those which have been deposited by river flow and appear as layers of sand, gravel, clay and silt. (Tr. XXI, p. 92).

23. Residual materials are classified in the GDR as residual soils (RS), residual zone #1 (RZ-1) material, and residual zone #2 (RZ-2) material.



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24. The residual materials and their properties were described in the GDR as follows:

> RS: These materials have been formed from either the in-situ decomposition of the parent rock or the reworking of residual soil. This material is basically soil-like and does not exhibit visible remnant rock structure. It may contain rock fragments but they are usually friable and small. Based on our examination of the samples, test results and our experiences, the strength characteristics of these materials are similar to cohesive sediments of similar characteristics, with little additional strength remaining from the parent material. The residual soils are designated on the SUBSURFACE PROFILES by an upper boundary line separating them from the Cretaceous deposits and a lower boundary established by the RZ-1 materials. Within the residual soil zone, intermediate boundaries are included separating the predominantly silty materials from the predominantly clayey materials. These materials are often difficult to distinguish from similar sediments, especially when apparent reworking has occurred during geologic history. . . .
>
> RZ-1: These materials are considered as transitional between the residual soil and the underlying RZ-2, or rock, although they do occur in certain instances immediately below the deposited soils. They have been derived in-situ from the decomposition of the parent formation and consist of soil-like components and partially weathered and/or fresh rock-like components. Visible remnant rock structure is usually apparent in these materials and they have cohesive-like strength of their origin. These materials were sampled with soil sampling techniques, in most all cases, and their soil descriptions were based on grain size and plasticity characteristics after the remnant rock structure had been destroyed by manipulation. Because of their remnant rock structure, these materials are expected to act as cohesive materials even though this characteristic is not apparent from the grain size and plasticity. Borehole samples recovered rock fragments ranging between the # 10 sieve and approximately 1.5 inches. However, it is likely that the partially weathered and/or fresh rock components will have highly irregular dimensions, depending on the discontinuities in the original rock mass through which weathering progressed. Undisturbed samples of the material exhibit wide variations in density, moisture content and strength within the same sample. This zone exhibits heterogeneity with respect to strength and hardness because of the differential weathering response and decomposition of the materials. Our evaluation of the conditions of this material, based on examination of the samples, indicates that it will tend to act as a very hard, very dense, slightly cohesive to cohesive soil throughout most of the zone and be removable by power hand tools. However, there will be areas of unpredictable but lesser extent of partially weathered and/or fresh rock materials which may require other means of excavation. . . .
>
> RZ-2: This zone is basically comprised of rock-like material having been derived in-situ by partial decomposition of the parent formation with partially weathered and/or fresh rock components. These materials usually retain considerable strength of the parent rock

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and rock structure. The RZ-2 materials are commonly heterogeneous with respect to weathering, ranging from decomposition throughout the entire body to partial decomposition throughout the material. RZ-2 materials cannot usually be disaggregated by manual means and they are described with rock terminology and notation of soil-like matrix or filler when appropriate. Materials in this zone usually require rock sampling techniques for obtaining specimens from boreholes. This material will probably have to be excavated with rock excavating techniques. Material classified as RZ-2 was encountered in borings NWB-102 and 104. It was believed to have been penetrated in boring NWB-5 based on the field inspector's observations of the difficulty in advancing the borehole through this zone as compared to advancement in the RZ-1 zone. Because the suspect RZ-2 zone was fairly thin, 3.2 feet, it was missed in sampling. Thus, this layer is noted as Probable RZ-2 on the log from 80.8 to 83.5 feet in depth.

ROCK: Throughout most of the Bolton Hill Section rock was encountered sufficiently below the present vertical alignment to make it of little concern. However, rock was encountered above the tunnel invert level in borings NWC-1 and very close to the invert level in boring NWB-104. The rock along the alignment is composed primarily of gneiss with some local pegmatite intrusions. The gneiss exhibits numerous highly broken and jointed zones with clay as filling materials which may indicate the presence of shear zones. Thin quartz and pegmatite lenses seldom exceeding 3" in width occur in some samples. Unconfined compression tests performed by the GSC for various other projects in this formation indicate values ranging from 400 to 2100 KSF.

25. The residual materials thus were broken into three categories in an attempt to convey more accurately the properties of the material to be encountered. MTA consultants on prior projects had used the sole designation "decomposed rock zone" to identify that material which neither was fresh rock, soil nor fill. This had presented a number of problems to designers and contractors in that residual materials were found to be markedly different in strength depending upon the degree of decomposition. (Tr. XII, pp. 34-35).

26. It is uncontroverted that decomposing rock will have differing properties depending upon how advanced the weathering process is. Granite rock, as found in Baltimore, begins to weather along joint lines where water and contaminants can enter. Over time, the weathering process continues

inward along these joint lines and the rock material chemically begins to alter.[6] (Tr. IV, p. 59). The rock eventually breaks into large and small blocks surrounded by a clay soil.

Generally, rock weathers from the top down so that as you get deeper into the ground you encounter larger masses of unweathered rock enveloped in soil and, eventually, solid or fresh rock (RZ-2 and RX material). Closer to the surface, smaller portions of rock enveloped in soil usually are encountered (i. e., RZ-1 material). However, fractures in rock may be vertical or horizontal. Hence, it is possible to have masses of unweathered or slightly weathered rock near ground surface with more advanced weathering on either side or below. (Tr. V, pp. 33-35).

27. In summary, therefore, the GDR described a two component system for residual zone materials. These components were soil and rock. (Tr. IV, p. 57; XII, pp. 33-34). RZ-1 primarily was to be "soil-like" in property while RZ-2, with its greater concentration of rock and lesser component of soil-like material, would retain the properties of its parent rock. (Tr. IV, pp. 58, 64; finding of fact 24). As is apparent from our earlier findings, this method of describing soils was adopted by the MTA Engineers who drafted the contract drawings and specifications.

28. The GDR further apprised bidders that:

> Tunneling will be carried out in predominantly granular soils calssified [sic] as very dense and exhibiting little to no cohesion together with zones of cohesive sediments and residual materials. Pockets or strata of gravel are in evidence throughout the alignment. RZ-2 and rock will probably be encountered above the invert level in the far northern end of the project. Throughout most of the alignment, the invert and lower face of the tunnels pass through C-1, C-2, RS, or RZ-1 categories of materials. There are portions of the alignment where RS and/or RZ-1 materials will be encountered in the upper face and portions where they may extend to levels above the

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[6] Granite rock is composed of three minerals - quartz, fledspar and hornblende. When water seeps down and enters joints in the granite rock, the oxygen therein reacts with the feldspar and hornblende to form ultimately a clay. (Tr. V, pp. 33-34).

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crown. In the RZ-1 materials partly weathered or fresh rock may need to be excavated. Finally, groundwater has been encountered within the tunnel area or above the crown throughout the alignment. These conditions indicate that considerable care and vigilance will be required in executing the tunnel work. Workmanship of high caliber, together with close supervision, will be necessary.

* * *

Where RZ-2 materials and/or rock must be excavated, overbreak beyond the periphery of the shield may occur. In such instances, the voids created must be properly backfilled as soon as is practicable. It may be necessary, where overbreak is experienced in the invert zone, to provide a cradle for proper line and grade maintenance of the shield. Excavation of rock, RZ-2, or rock components within the RZ-1 material should be performed so as not to disturb the remainder of the face, particularly if it consists of C-1 or C-2 materials. The cohesive sediments and residual materials (C-3, C-4, RS and RZ-1) are expected to pose few face stability problems. However, silty materials could exhibit a tendency to slowly ravel or bleed wherever seepage forces exist. Also, movement along relict joints in the residual materials or rock could occur.

(Exh. S-61, May 7, 1976 supplement #1, pp. 2-3).

29. Boring NWC-1 was made at the Northern end of tunnels 3 and 4, but was not logged formally or included in the contract drawings. A stick log of this boring was included in the GDR. (Tr. XIII, p. 97). This stick log shows that RZ-1 was to be encountered exclusively down to elevation 89 where rock material was cored. (Tr. XII, pp. 81-82). Although the MTA's expert, Mr. Edward Zeigler,[7] initially testified that the rock level shown in NWC-1 would, if encountered at the elevation shown, interfere with the driving of the tunnel, he later agreed that the clearance between the shield and the top of rock would be at least 0.27 feet. (Tr. XIII, p. 117-118; Exh. A-74; Tr. XIV, p. 44). Clearly, therefore, the admonition in the GDR that rock was encountered above the tunnel invert level in boring NWC-1 was not

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[7] Mr. Zeigler has a bachelor's degree in Civil Engineering from the University of Maryland obtained in 1946. He has some graduate training in soil mechanics and is a registered professional engineer in Maryland and in a number of other states. Mr. Zeigler is the manager of the geotechnical engineering services for the MTA's Construction Management Organization and is employed by Rummel, Klepper & Kahl where he heads the geotechnical engineering department. (Exh. S-1).

borne out by a comparison of this boring to the design structure elevation at the same location and we so find. In fact, the subsurface data derived by Balter failed to demonstrate a single instance where the rock levels actually encountered were, at an elevation sufficient to interfere with the tunnel driving operation.

**Unit Price Schedule**

30. A unit price schedule contained in the bidding documents was to be utilized by bidders in submitting their bids. It consisted of 140 pay items for which lump sum or unit prices were to be quoted as called for. Two pay items were set forth for the actual driving of the tunnels. These were bid item 97, the linear foot price for shield driven tunnels under compressed air over an estimated 10,929 linear feet, and bid item 98, the unit price for the same type tunneling over the last 130 feet of the outbound North tunnel and 170 feet of the inbound North tunnel.

31. In the early design phases, only a single bid item was included on the unit price schedule for the driving of the four tunnels. However, by April 8, 1976, Bechtel Incorporated, the designer of the Bolton Hill tunnels, had elected to revise the unit price schedule to provide for the two bid items described above. The reason given by the Bechtel project estimator was that rock had been encountered in the borings taken within the last 160 feet of the North tunnels and mixed face tunneling thus would be required in this area. (Exhs. A-10, A-11).

32. A mixed face tunnel is one wherein the face, i.e., the material being excavated, consists both of soil and rock. (Tr. I, p. 37).

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Preparation of Appellant's Bid

33. Fruin-Colnon Corporation (F/C) and Horn Construction Company independently estimated the cost of performing the subject contract. (Tr. III, pp. 2-3).

34. F/C's bid estimate was prepared by a team headed by Mr. Hayden Anderson. Mr. Anderson was assisted by Mr. Stuart Bartholomew, F/C's executive vice president, and Mr. Earl Anderson, who eventually became the tunneling superintendent on the captioned contract and had some 30 years experience with tunneling projects. (Tr. III, pp. 2-3; III, p. 71). Jacobs Associates was hired to prepare a portion of the estimate concerning the compressed air facilities and concrete operation. (Tr. III, p. 3).

35. Mr. Hayden Anderson visited the jobsite prior to bid and, as previously found, obtained and reviewed the geotechnical data referenced in the bid documents. (Tr. III, pp. 4-5).

36. The estimate, as prepared by Hayden Anderson, was reviewed in final form by Mr. Bartholomew. (Tr. III, p. 6). Mr. Bartholomew was responsible for coordinating F/C's estimate with that being prepared by Horn Construction Company, and for making all final adjustments.

37. F/C did not hire a geologist to assist it in the preparation of the bid, nor was any member of its estimating team qualified in this regard. (Tr. III, p. 80; IV, p. 46).

38. Mr. Bartholomew testified that Appellant did not anticipate the encountering of rock above the invert of the tunnels. (Tr. I, p. 31). Further, based on Appellant's pre-bid review of the contract bid documents and geotechnical data, it was expected that all tunneling would be in soil or soil-like material. (Tr. I, pp. 31, 49-50). Put another way, Appellant expected to tunnel through sand, silt, clay and RZ-1 material. (Tr. I,

pp. 31-34).

39. Appellant's conclusions as to the type of ground to be encountered were premised upon a review of the borings and the absence of any technical specifications relating to mixed face tunneling. (Tr. I, pp. 85-86). For example, where it is anticipated that rock is to be excavated, Mr. Bartholomew testified without contradiction that a contractor would expect to find specifications relating to the permissible use of explosives. These specifications typically set forth the requirements for submittal and approval of blasting patterns and the delays to be used in detonating explosives, restrictions on the quantity of explosives which safely may be detonated in a compressed air tunnel, and directives for the support and guidance of a shield where blasting operations are being conducted in front of the shield's leading edge. (Tr. I, p. 86). We find as a fact that such provisions were not included in the instant contract.

Appellant's conclusions further were bolstered by the contract specifications for the tunneling shield. Contract Technical Provision 2.33, paragraph 3.4 A. (3) set forth the pertinent requirement for the design of the shield as follows:

> Control the face efficiently using such support procedures as breasting, face jacks or other acceptable methods, either singly or in combination. In addition to these measures, fully breast the tunnel face from the springline to the crown during tunneling operations within 50 feet horizontally each side of all forty building structures listed in the Unit Price Schedule and 50 feet horizontally each side of the centerline of the 80 inch diameter sanitary sewer at the intersection of W. Mulberry and Eutaw Streets. Remove no more than 20 percent of the total breasting area at any one time.

Mr. Bartholomew testified that this provision is consistent with F/C's pre-bid expectation that the material to be encountered would have a tendency to flow into the shield under compressed air, particularly if an underground water table were present to put a hydraulic gradient behind the materials.

(Tr. I, p. 46). The breasting jacks were intended in this regard to control the free flow of materials into the face and avoid the potential disaster of a tunnel collapse. (Tr. XIII, pp. 68-69).

41. With regard to the 40 building structures referenced in the foregoing Technical Provision, the contract also mandated that any settlement of these buildings be monitored and that compaction grouting be instituted when directed by the Resident Engineer. (See bid items 3-42; Technical Provisions, §2.3D). Mr. Bartholomew's uncontroverted testimony was that this requirement again was consistent with materials that were cohesionless and demonstrated rapid settlement tendencies under a hydraulic head. (Tr. I, p. 51).

42. The only subsurface data indicating a potential for the encountering of RX or RZ-2 material, and hence a mixed face tunnel, was the May 7, 1976 supplement to the July 1975 GDR. (Exh. S-61). As previously found, Appellant and Mr. Bartholomew ignored the warning that ". . . RZ-2 and rock will probably be encountered above the invert level in the far northern end of the project because it was not supported by borings NWC-1 and NWB-104 both of which showed these materials below the bottom elevation of the shield." (Tr. I, pp. 79-84). For this reason, F/C and Horn did not bid a different price for tunneling the last 150 feet of each North tunnel under bid item 98. (Tr. III, p. 9).

**Relevant Post Bid Actions of Appellant**

43. In September 1976, Appellant obtained proposals from six companies which manufacture tunnel shields. The shields offered by these companies then were compared and a decision subsequently was made to purchase two such shields from the Zokor Corporation. Appellant's purchase

order was issued on October 29, 1976. (Exhs. A-3, S-69; Tr. I, pp. 24-27). The anticipated lead time was 17 weeks for the first shield and 21 weeks for the second. (Exh. A-3, p. 13).

44. The term "tunnel shield" is truly descriptive only of the cylindrical hull which encompasses a complex hydraulic system. Enclosed in the shield hull, in this instance, were an excavator arm, a ring erector, a loading conveyer, a liner plate unloading and handling system, and an electric/hydraulic power system. (Exh. S-69). This package of equipment more properly is referred to as a "tunnel driving machine."

45. The Zokor shield purchased by Appellant had an outside diameter of 19'-4 1/2" and a total length of 19'-1". The front of the shield was hooded and equipped with cutting teeth. (Exhs. A-20, A-3, S-62). The top half of the shield front featured two shelves referred to as the upper and lower breasting shelves. (See Exh. S-62; A-61(15), A-61(1)). These shelves were designed to catch and restrain free flowing materials. (Tr. I, pp. 19-20). In the center of the bottom front of the shield was the hydraulic excavator with sloped plow plates beneath it to enable the excavator bucket to scoop and slide material onto a conveyer belt running from the bottom front of the shield and out through the rear of the shield. (Exhs. A-61(1), A-61(5), A-61(16)). This material, upon reaching the rear of the shield, was to be loaded onto muck cars which were to move within the tunnel on a skid deck. These muck cars, when filled, were to carry the excavated material to underground muck hoppers where surface cranes then could be utilized to lift the material for disposal. (Tr. I, pp. 14-15).

In the rear of the shield hull was a segment erector. This device was designed to lift four foot wide steel liner plates off of segment cars, rotate the liner plates, and hold them in place until workmen could bolt them to the previously installed, adjacent liner plates. (Exhs. A-20, A-61(14); Tr. VII, p. 55; Tr. VI, p. 10). These liner plates (rings) were to serve as temporary support for the tunnel area behind the shield, until a permanent concrete liner was poured.

Finally, each tunnel driving machine was equipped with 20 shove jacks and six breast jacks. (Exh. A-20, Tr. VII, p. 61). The shove jacks were located in the rear of the shield and were spaced equally along the circumference of the hull. (Exh. A-20). These jacks[8] were designed to apply pressure against the last installed liner plates thereby forcing the shield forward a total of 4'-6" at a time. (Tr. VI,, p. 9). In this manner, the front cutting edge of the shield would advance into the unexcavated face of the tunnel and the tunnel driving machine would operate in the manner of a huge cookie cutter. The breast jacks were located in the upper front part of the shield behind the breasting shelves. These jacks, like the breasting shelves, were available to slow the flow of earth into the shield where ground conditions were less stable.

46. Mr. Bartholomew testified that had Appellant anticipated a mixed face tunnel, the design of the tunnel driving machine would have been different. The shield hull would have been heavier and reinforced cutting edges would have been specified. Further, the excavator would have been designed either with the capability to retract completely out of the tunnel heading or at least to back up so as to facilitate the use of drilling equipment and the loading of explosives. (Tr. I, p. 35). Where rock is anticipated

[8]All 20 shove jacks never were used to propel the shield at once. Usually 15 to 16 were required. (Tr. VII, p. 164).

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in the invert of the tunnel, it also may also be necessary to use an open face shield (i.e., one without breasting shelves, an excavator and plow plates). (Tr. XXII, pp. 31-34; Exh. A-90). Based upon this uncontroverted testimony and our review of the equipment purchased for the instant job, we find that Appellant clearly anticipated driving its tunnels predominantly through soil or soil-like material at the time it purchased its tunnel driving machines.

**Contract Performance At South Tunnels and Monument Street Shaft**

47. Appellant began tunneling in the South outbound tunnel (tunnel #1) on August 8, 1977 and in the inbound tunnel (tunnel #2) on September 20, 1977. (Exh. S-59B, Charts II-1, II-2). The tunnel driving machines were lowered into the ground through an access shaft located at the South end of the Bolton Hill Station structure and tunneling proceeded in the direction of the Lexington Market Station. Tunneling in these two areas was concurrent with tunnel #2 trailing tunnel #1 by a contractually specified 200 feet in heading separation. The tunnel driving operations were completed on March 7 and April 6, 1978 respectively.

48. In the South tunnels, Appellant did not encounter any material considered by it to be rock or rock-like (i.e., RX or RZ-2 material) and thus did not file any claims alleging differing site conditions. This also was true with regard to Appellant's excavation of the Monument Street Vent Shaft.

49. Neither Appellant nor the MTA, retained or employed a geologist or geotechnical engineer to map the tunnel faces encountered in the South tunnels. The only contemporaneous record of the materials encountered in the South tunnels is found in the following documents:

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a) Daily Construction Reports - The daily construction report was the diary of the tunnel superintendent, Mr. Earl Anderson. (Exhs. 74-A, 74-B). In preparing his diary, Mr. Anderson reviewed the shift superintendent's reports for the previous swing and graveyard shifts[9] and further discussed the graveyard report with his shift superintendent when he arrived each morning. Mr. Anderson was on the job for the day shift and had first hand knowledge of the tunneling operation as it occurred during this period. (Tr. V, pp. 108-109). His reports were dictated daily and included the number of shoves[10] made per shift, the number of rings[11] installed per shift, delays encountered on each shift and the cause thereof, and ground conditions where especially hard materials were found. (Tr. V, p. 109-110). The shift superintendents were salaried employees who apparently were hired for their tunnel experience. There is no evidence to suggest that either these superintendents or Mr. Anderson were trained geologists.

b) Shield Reports - The shield reports were prepared by Appellant's heading engineers. The reports were entered on standard forms showing the ring number inside the tail of the shield, steering measurements, current attitude of the shield hull, a check on the operation of the hydraulic system and a sketch of the tunnel face geology. (Exhs. S-76A and S-76B). The heading engineers who prepared the reports either were young civil engineers or experienced surveyors and were considered sufficiently skilled and trained to keep the tunnel driving machine on proper line and grade by use of lasers

[9]The tunneling operation was conducted 24 hours a day over three shifts. Day shift was from 7:30 a.m. to 3:30 p.m., swing shift was from 3:30 p.m. to 11:30 p.m., and the graveyard shift was from 11:30 p.m. to 7:30 a.m. (Tr. V, p. 109).

[10]When the shove jacks are activated to propel the shield hull forward, this is referred to as a shove.

[11]A ring is the complete installation of four foot liner plates around the circumference of the unsupported tunnel.

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and targets. (Tr. VIII, p. 122). The record does not demonstrate that these engineers had advanced training in geology or geotechnical engineering. (See Tr. X, pp. 9-10).

**Layfayette Street Vent Shaft - Soldier Piles**

50. The Lafayette Vent Shaft is centered on Bolton Hill outbound tunnel station 80+90 near the intersection of Lafayette Avenue and Tiffany Street. The shaft is approximately 62.5 feet long, 44 feet wide and 78 feet deep. Construction of the shaft was performed by a cut and cover procedure, whereby the street surface was removed and earth excavation commenced from the surface. Thereafter, the former street surface was replaced with timber decking while the excavation continued below. In this manner, traffic could be maintained during the construction process. (Exh. A-23; Cont. Dwgs. S62-4, S63-4, S63-5). The shaft straddles the North tunnels.

51. The cut and cover construction procedure necessitated that both the decking and adjacent soils be supported during the excavation of the shaft. Appellant was responsible for the design of these support systems and retained Werner and Associates (Werner), a California firm, to perform this work. (Tr. VIII, pp. 115-116).

52. Contract Technical Provison §2.21, paragraph 1.2B(1)(d) mandated in part that the bottom of the support system be carried ". . . to a depth below the main excavation, adequate to prevent lateral movement."

53. Werner's initial design called for the pile holes to be augered and the piles placed to a depth 16 feet below the shaft bottom (subgrade). (Tr. VII, p. 116). This design assumed that only soils would be encountered in augering the piles. (Exh. S-32). In reviewing this design, the MTA's General Engineering Consultant placed a note next to the 16 foot design calculation

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stating that borings NWB 30 & 31 show "rock" rather than soil at the subgrade level. Thereafter, Mr. Werner revised his calculations to show a six foot minimum toe for soldier piles drilled in "rock" and a ten foot driven toe presumably for soldier piles augered into soil. (Exh. S-33; Tr. VIII, p. 116). These designs both were approved by the MTA.

54. Boring NWB 30, taken 66 feet to the right of outbound station 80+18, shows RZ-1 material at depths ranging from 70 to 79.5 feet below the surface. Slightly weathered gneiss was encountered below the 79.5 foot strata depth. Boring NWB 31, taken 31 feet to the right of outbound tunnel station 82+70, shows RZ-1 material beginning at a strata depth of 73 feet and continuing to the bottom of the hole at elevation 86.5 feet. Rock was not encountered. These two borings were located to either side of the shaft.

55. Mr. Werner did not testify concerning his design. However, since the Lafayette Street Vent Shaft was to be constructed to an approximate strata depth of 79 feet (Exh. S-32, p. 2) and boring NWB-30 shows rock at strata depth 79.5 feet, we find that Mr. Werner's ultimate design was premised upon toeing the soldier piles six feet into rock where such material was encountered.

56. Mr. Werner's design work was completed and approved by November 1977. (Exh. S-34). It called for the augering and placement of 36 soldier piles. Seventeen of these piles were to be only 40 to 50 feet in length so as to not interfere with the tunnel driving operation. Those piles running adjacent to the North tunnels were to be augered and placed to a full depth of 90 to 91 feet. (Tr. XI, p. 124; Exh. S-35).

57. The North tunnels were to be driven through the shaft area prior to completion of the shaft excavation. Appellant's design contemplated excavating only ten feet of earth within the shaft prior to completion of the

tunnels. (Exh. S-34). This sequence was essential since the tunnels were being driven under compressed air and could not be pierced until the air system was removed. (Tr. II, pp. 77-78). In order to facilitate the later excavation of the shaft through the completed tunnels, Appellant used steel ribs and timber to support the tunnels in this area in lieu of the four foot liner plates. (Tr. X, p. 69).

58. Pile augering began at the vent shaft on March 30, 1978. (Exh. A-1(2)). Appellant soon encountered rock when drilling piles L-23 and L-25 at approximately 80 feet and 76 feet below street elevation respectively. Relying upon boring I-7, Appellant believed that rock would not be encountered until a strata depth of 84 feet was attained. Appellant thus filed its claim for a differing site condition by letter dated April 17, 1978. (Appeal file, Tab IV(1)).

59. In early May 1978, Appellant's Project Manager retained Mr. Robert James Irish,[12] a consulting engineering geologist, to analyze the ground conditions being encountered in the pile driving operation and compare them to the conditions forecast in the GDR and contract borings. (Tr. IV, p. 49). Mr. Irish visited Appellant's offices on May 8, 1978 and immediately reviewed the prebid geotechnical data and the daily construction reports maintained by Earl Anderson. After completing this task, Mr. Irish next visited the pile driving operation and had himself lowered by crane into a 48" hole being augered for pile L-27. (Tr. IV, pp. 49-50). Using a portable light source and a geologist's pick, Mr. Irish examined the materials at various depths.

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[12] Mr. Irish has an M.S. in Geology conferred by Oregon State University in 1954. He is a registered geologist and certified engineering geologist in the State of California. At the time of hearing, Mr. Irish was the Chief of the Geology Division for Woodward-Clyde Consultants. (Exh. A-22).

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60. By letter dated May 16, 1978, Mr. Irish forwarded his report to Appellant on the pile driving conditions. (Exh. A-23). The report may be summarized as follows:

a. Prebid geotechnical data - Three borings are relevant to the shaft excavation. These are borings NWB-30, NWB-31, and I-7. The latter boring was drilled at the location of the vent shaft itself. None of the borings showed rock above the level of the shaft subgrade elevation. Further, there was no other geotechnical data made available to bidders indicating that rock would be encountered at a level above subgrade.

b. Pile holes L-23, L-25 and L-27, located on the south side of the shaft, penetrated gneiss respectively at subgrade, six feet and seven feet above subgrade. The former two pile holes were evaluated based upon the driller's log for those holes. The latter pile hole was the one personally inspected by Mr. Irish. The rock observed by Mr. Irish in pile hole L-27 was a ". . . fresh, hard, dense, fine to medium grained gneiss that is only poorly lineated and poorly banded and is unjointed." (Exh. A-23, pp. 2-3). Mr. Irish also noted that the driller's log for pile hole L-9, located at the northwestern corner of the shaft site, penetrated gneiss at an elevation two feet below subgrade.

c. Based upon the foregoing, Mr. Irish opined as follows:

> The evidence is not conclusive but would indicate that the bedrock surface slopes north to northeastward from about 71 feet below ground surface on the site to about 80 feet below ground surface at the northwestern corner of the site. That conclusion has two main construction ramifications. First, the bottom one-quarter to one-half of the inbound tunnel and possibly the bottom one-eighth to one-quarter of the outbound tunnel through the vent shaft station interval and possibly adjacent intervals may have to be excavated by conventional blast excavation methods through rock. Second, the excavation support system, designed for soil conditions only, may need to be modified to accomodate for rock as well as soil. The additional work and costs are likely to be substantial, particularly if the soldier pile holes are drilled through 5-10 feet or more of strong, hard gneiss.

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d. Mr. Irish further concluded that ground conditions at the site were substantially different from those indicated by prebid geotechnical data. He suggested, however, that three test borings be drilled at the northeastern corner and the east-central and west-central sections of the shaft perimeter to more fully assess the nature of the ground conditions and to decide whether changes in the shaft support system would be appropriate.

61. Appellant had planned to auger holes for the placement of vent shaft piles primarily with an earth auger. The auger was to be attached to a Calweld drill mounted on an American 999 crane. (Tr. XI, p. 124). When rock was encountered, however, a rock auger had to be attached to the drill. The rock auger had to be alternated with a core bucket in order to remove the broken rock. (Tr. XI, p. 128). Where the rock especially was hard, a drop beam had to be used to assist in breaking the material. A drop beam, as explained by Appellant's Mr. Kohl, is a heavy wide flange steel beam. A point is then cut on the bottom of the beam to facilitate the fracturing of rock when the beam is dropped into the hole. (Tr. XI, p. 158).

62. When Appellant began encountering rock above the invert level, it engaged Ed Heine & Associates, a Washington D.C. construction and design consulting firm, to review its design for the support system at the Lafayette Vent Shaft. (Tr. VIII, p. 118). Mr. Heine submitted certain design changes which were approved by the MTA. These design changes included two schemes. Scheme I represented a design for the placement of piles where unweathered rock was encountered above the shaft subgrade. Although testimony was not adduced in this regard, it appears that piles were to be keyed one foot into the drilled rock. Piles placed in this manner further

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were to be secured by two rockbolts. Scheme II represented a new design for the placement of piles where unweathered rock was encountered below subgrade. In this situation, piles were to be keyed two feet into drilled rock. (See Exh. S-38).

63. The MTA has recognized that Appellant encountered a differing site condition with regard to its pile placement operation. The parties are not in agreement either as to the amount of the equitable adjustment due Appellant or the delay attributable to the encountering of rock.

## Tunneling Through Lafayette Vent Shaft Area

64. Appellant commenced tunneling at the North inbound tunnel (tunnel #3) on May 4, 1978 and at the North outbound tunnel (tunnel #4) on June 7, 1978. (Exh. S-59B, Charts II-3 and II-4).

65. Beginning on Monday, July 31, 1978, Appellant's Mr. Anderson reported progressively harder material being excavated in tunnel #3 as follows:

> July 31, 1978 - ". . . On the swing shift . . . [t]he hard clay in the bottom is starting to come up into the face a little farther. . . ."

> August 1, 1978 - " On the day shift . . .[t]he hard ground is now even with the bottom shelf and it is very firm. It's getting hard enough in the bottom to the point to where the excavator would not cut the ground and we had to stop and put new teeth in the excavator . . . On the swing shift . . . the face is getting real hard above the bottom [breasting] shelf. The bottom half of the shield now has to be spaded out ahead of the front lift to ensure that we don't push the shield up on some hard rock . . . On the graveyard shift . . . [t]he ground is getting real hard in the bottom and the hard ground is now up above the bottom shelf. The shield has to be completely relieved,[13] including the bottom lip, in order to move it. It's pretty tough spading. . . ."

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[13] Where the ground to be excavated becomes hard enough to resist movement of the shield, it is necessary to hand excavate the tunnel face around the circumference of the shield to permit it to advance. This is called relieving the shield. (Tr. VI, pp. 41-42).

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> August 2, 1978 - "On the day shift . . . [t]he bottom 2/3 of the face is real hard sand and clay and a whole lot like being sand stone. The ground has to be completely relieved out ahead of the shield in order to move it . . . On the graveyard shift . . . [t]he ground may be softening up slightly. At least, the excavator can dig part of it. . . ."

(Exh. S-74B). On the preceding days, Appellant installed rings 208 through 226 and was working between approximate inbound stations 78+45 and 79+17. (Exh. S-59B, Chart II-3).

66. By letter dated August 3, 1978, Appellant's Project Manager, Mr. Williamson, wrote the MTA Resident Engineer as follows:

> We have encountered extremely hard ground in tunnel No. [sic] 3 which was not anticipated, beginning at approximately Station 78+80, which is extremely difficult to excavate, and which has caused our tunneling progress to nearly stop.

Notice of a differing site condition, as required by GP-4.04, further was given. (Appeal file, Tab IV(2)).

67. On August 4, 1978, Appellant again enlisted Mr. Irish to observe the conditions being encountered in tunnel 3. (Tr. IV, p. 54). Mr. Irish mapped the tunnel face at inbound station 79+38 and observed that the excavator arm and Appellant's miners were ripping out large blocks of material on the lower and upper halves of the face respectively. (Tr. IV, pp. 55-56). Mr. Irish, while watching the excavation operation, initially classified the material as sandstone. Upon closer examination, however, he concluded that it was moderately to highly weathered rock. (Tr. IV, p. 56). Although the material encountered did not appear to have two components, Mr. Irish nevertheless called it RZ-2 in order to maintain some parallel relationship to those classifications employed by Balter in the GDR. (Tr. IV, pp. 56-57).

68. Before leaving the job site on August 4, 1978, Mr. Irish met with MTA technical representatives, the Resident Engineer, and Appellant's project engineer, Mr. Kohl, to review his preliminary conclusions. Mr. Irish stated at that time that rock was being encountered. Both sides agreed to carefully document ground conditions so as to be able to determine with precision the nature and extent of any differing site condition. (Appeal file, Tab IV (3)).

69. Following the August 4, 1978 meeting and continuing through September 28, 1978, Mr. Irish returned to the site on a weekly basis to map the tunnel face and take samples. (Tr. IV, p. 67; IX, p. 22). The MTA had its inspectors and geotechnical people likewise map the face at regular intervals and take samples. On several occasions, the MTA also had its consultants visit the tunnels to observe ground conditions. (Appeal file, Tabs IV (6), (8), (10), (11), (13), (52) - with minutes).

70. By letter dated August 17, 1978, Appellant apprised the MTA Resident Engineer that it had encountered what it considered to be a differing site condition in tunnel 4 beginning at approximately outbound station 77+80. (Appeal file, Tab IV(7)). Thereafter, the parties documented ground conditions in both tunnels. (Appeal file, Tab IV (8)).

71. In October 1978, Mr. Irish prepared a report on the tunneling conditions reasonably to be anticipated and those actually encountered. (Exh. A-29). His findings and conclusions may be summarized as follows:

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a) Interpretation of Pre-Bid Geologic Data

"Interpretive geologic profiles included with the July 1975 report [Exh. S-61] indicated that the twin bore tunnels in the Lafayette Avenue area would extend mainly through water-deposited sands, gravels and silts of the Patuxent Formation, but in the vicinity of Stations 81+00 and 83+00[14] would impinge on residual soils referred to by Balter as RZ-1 material." (Exh. A-29, p. 4). RZ-1 was to be expected nearly full face at station 81+00 and was plotted to taper out of the face at approximate stations 79+30 and 82+40 (Exhs. A-52(1), S-59B, Chart II-3). RZ-1 again was expected to penetrate the invert at approximate station 82+70 and fill seven feet of the lower face at station 83+00. (Exhs. A52(1), S-59B, Chart II-3). Both weathered (RZ-2) and unweathered (RX) rock were shown on the profiles to lie well below the invert elevations of the Bolton Hill twin bore tunnels. (Exh. A-29, p. 4). Neither the unconfined compressive strength tests nor the standard penetration tests run on samples recovered from the borings taken in this area indicated that materials other than soil would be encountered. For these reasons, it was concluded that a prudent bidder should not have expected weathered or unweathered rock to extend upward into the tunnel envelope in this area. (Exh. A-29, p. 11).

b) Geologic Materials Encountered

1. Rock (RX) - A buried rock ridge ran northeastward across the tunnel corridor in the vicinity of Lafayette Avenue. "Unweathered Baltimore gneiss (Balter's RX material), which required drilling and blasting for excavation, extended 1 to 6 feet above the inbound invert for an aggregate distance of about 16 feet, and for an aggregate distance of about 40 feet

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[14] Balter drew only one profile for the tunnel area. The assumption is that Balter expected the same material to be encountered in both tunnels. (Tr. V, p. 24).

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along the outbound tunnel." (Exh. A-29, pp. 11-12). The foregoing rock was encountered between stations 80+15 and 80+28 and again between stations 80+33 and 80+36 in the inbound tunnel and between stations 80+10 and 80+50 in the outbound tunnel. (Exhs. A-29, Figs. 1 and 2; A-52(1) and (2)).

2. RZ-2 Material - "Weathered rock approximately matching in appearance and characteristics Balter's description of RZ-2 zone material and some unweathered rock was penetrated full-face by the inbound tunnel from about Station 79+50 to about Station 80+35 (85 feet) and by the outbound tunnel from Station 79+00 [according to MTA's records][15] to about 80+20 (120 feet)." (Exh. A-29, p. 12). RZ-2 also penetrated to a lesser extent between inbound stations 78+71 and 79+50, inbound station 80+35 and 83+16, outbound stations 80+20 and 81+89, and outbound stations 78+08 and 78+39. (Exh. A-29, Figs. 1 and 2).

c) Removal of RX and RZ-2 Materials - "Weathered and unweathered rock requiring blast excavation was intercepted in the inbound tunnel from Station 80+17 to 80+66 (59 feet) and in the outbound tunnel from Station 79+96 to 80+43 (47 feet). The rest of the weathered rock was broken from the tunnel faces with air spades above the spring line[16] and by air spades and the ripper excavator of the tunnel shield below the spring line." (Exh. A-29, pp. 12-13).

d) Classification of Materials - Mr. Irish observed that the residual soils and weathered rock were divided naturally into an upper zone of yellow material with gray layers and a lower zone of gray material. (Tr. IV, p. 78; Exh. A-29, p. 13). He thus attempted recognize these zones in classifying

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[15]Mr. Irish could not interpolate the ground conditions in this area given the incompatibility of the mappings to either side of this station and the distance which had been tunneled between mappings. (Tr. IV, pp. 80-81).
[16]The spring line is the imaginary horizontal diameter line of the circular shield hull face.

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material while maintaining the Balter terminology. Most of the yellow weathered gneiss was classified as RZ-2 material except in the northwestern end of the claim area in both tunnels where the RZ-2 was capped by RZ-1 yellow. (Exh. A-29, p. 13). The gray RZ-2 commonly was capped by or included a zone of gray RZ-1.

Mr. Irish testified that he was surprised to find that the two component system described by Balter in the GDR was not present in the material observed. (Tr. IV, pp. 79-80). In this regard, he stated that:

> What I saw was a complete face or a complete unit of weathered rock without any soil elements in it. I called that RZ-2. In other words, when I came to a zone that was very stiff soil, it did not have a rock element in it. It was totally soil there. He tried to write as I saw it that RZ-1 is primarily soil and will act like one. So I called my one unit or my one component unit of soil RZ-1. But that's where the relationship ends.

(Tr. IV, p. 79).

The yellow weathered gneiss mapped by Mr. Irish as RZ-2 material was a moderately to highly weathered, well layered, massively jointed rock that resembled in its physical characteristics interbedded sandstones and claystones. "The sandstone-like rock was mainly quartz and partly decomposed feldspar cemented in a clay matrix, with bands of claystone in it. It was friable,[17] thin to thick banded, and it broke with strong hand pressure or a light hammer blow . . ." (Exh. A-29, p. 14). Mr. Irish further reported that test sized samples commonly could not be broken off with a geologist pick and an air spade was required for this purpose. The ripper excavator on the tunnel driving machine could only scrape away at this material.

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[17] Friable material refers to highly weathered samples which perhaps can be broken by finger pressure. (Tr. XII, p. 92).

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The yellow weathered gneiss mapped as RZ-1 material was basically a soil but had ". . . relic gneissic rock structure." (Exh. A-29, p. 15). The material ranged from a dense clayey sand to a stiff clay or sandy clay. This material was not ripped out in large blocks.

Gray RZ-2 material was seen by Mr. Irish as moderately to highly weathered rock, including locally thin bands of dark brown clay and claystone-like rock of RZ-1 or RS quality. "Typically it was tough and moderately strong, requiring a light hammer blow to break." (Exh. A-29, p. 15). The ripper excavator of the tunnel shield in part ripped and spaded the gray RZ-2 material. Drill and blast excavation (i.e., explosives) also was required.

e) <u>Conclusion</u>

The pre-bid geotechnical information that could be directly related to the Lafayette Avenue area of the Bolton Hill twin bore tunnels indicated that those tunnels would penetrate only soils that could be excavated with a tunnel shield fitted with a spade excavator. In fact, the inbound tunnel penetrated rock, both weathered and unweathered gneiss, for a distance of about 400 feet, of which about 85 feet was full-face in rock; and the outbound tunnel penetrated about 400 linear feet of rock, of which about 120 feet was full-face. The remaining tunnel footage of the problem interval was mixed-face, which is a more difficult situation for a tunneler than either full-face rock or full-face soil, particularly if not expected. (Exh. A-29, pp. 19-20). For this reason, Mr. Irish further concluded that a differing site condition had been encountered. This report apparently later was transmitted to the MTA on December 15, 1978. (Appeal file, Tab IV(70)).

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72. By letter dated October 13, 1978, the MTA Resident Engineer forwarded to the joint venture a copy of a September 12, 1978 report filed by its consultants, Drs. Deere and Merritt. (Appeal file, Tab IV (17)). These consultants concurred in Mr. Irish's assessment[18] of the pre-bid geologic data. The report further recognized that RZ-2 and RX materials had been encountered and that a differing site condition was present. Disagreement with Mr. Irish was noted concerning his categorization of certain material as RZ-2 which the consultants believed was RZ-1. The extent of RZ-2 and RX was not determined, however, pending development and review of the tunnel face maps and profiles.

73. By letter dated March 27, 1979, the MTA geotechnical consultants, Drs. Tor L. Brekke, Don U. Deere, Andrew H. Merritt and Ralph B. Peck, submitted a report to the MTA on Appellant's differing site condition. The report did not contain any supporting data but did set forth the following conclusions:

> In the vicinity of Lafayette Avenue, materials corresponding to these descriptions [i.e., the GDR description of RZ-1] were indeed encountered. However, for an appreciable distance the RZ-1 materials were underlain by less weathered and more resistant residual materials, classified as RZ-2, which in turn were underlain by relatively unweathered rock, classified as RX. The latter two materials required drilling and blasting. It is our opinion that the presence of the RZ-2 and RX materials constitutes a differing site condition in terms of the contract provisions. The differing conditions required a change in tunnelling procedures and resulted in a decrease in the rate of progress.
>
> In our opinion, the differing site conditions existed between the approximate limits of Stations 79+60 to 80+50 in the outbound tunnel and between the approximate limits of Stations 79+80 and 81+00 in the inbound tunnel.
>
> Appreciably wider limits within which RZ-2 material or RX were encountered are claimed by the contractor and his consulting geologist. In our opinion, the residual materials beyond the approximate limits

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[18] Mr. Irish's assessment of the pre-bid geologic reports and the actual ground conditions encountered was made known to the MTA consultants during field meetings conducted prior to the formal transmittal of the Irish report. (Appeal file, Tabs IV (10, 11, 13)).

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> stated above are clearly in the RZ-1 category and do not constitute differing site conditions. The presence of the RZ-1 materials could have reasonably been expected on the basis of the contract documents, and the behavior of the RZ-1 materials during tunnelling was essentially as described in the Geotechnical Data Review.

(Appeal file, Tab IV (46)). These conclusions were communicated to Appellant by letter dated April 24, 1979. (Appeal file, Tab IV (42)).

74. The dispute over the appropriate limits of the differing site condition in the tunnels culminated in a meeting held on August 17, 1979 wherein the principals, lawyers and consultants for both parties attended. The meeting primarily was arranged so that Appellant could obtain some insight as to the reasons for the MTA consultants' recommendations. (Appeal file, Tab IV (57)). However, Appellant did take the opportunity to respond to the MTA's arguments through its own experts. In essence, the meeting ended in disagreement as to whether the RZ-2 yellow, as mapped by Mr. Irish, more properly should have been classified as RZ-1 as the MTA's experts concluded.

75. The MTA's position as presented during the August 17, 1979 meeting was forged by a number of people working under the direction of Mr. Edward Zeigler, the Manager of Geotechnical Services for the MTA's Construction Manager. (Tr. XII, p. 82). Mr. Zeigler's analysis of the anticipated versus encountered tunnel conditions more fully was set forth in his August 1979 report to the MTA. (Exh. S-6). The report's conclusions were based upon: (1) field observations, i.e., method of excavation, hardness of material as judged by use of geologist pick or pen knife, face mappings; (2) study of samples under a binocular microscope to determine mineralogy; (3) Resident Engineer's inspectors' logs; (4) inspection reports of the four MTA geotechnical consultants and their input concerning material classifications;

(5) plotting of the geologic profile of the tunnel based upon field mappings; and (6) photographic documentation. Face maps and geologic profiles for the two tunnels were appended to the report.

76. A tabular comparison of the geologic tunnel profiles prepared by Appellant's Mr. Irish and the MTA's Mr. Ziegler for the Lafayette Shaft claim area appears as follows:

| | Tunnel 3 | | Tunnel 4 | |
|---|---|---|---|---|
| Material Identified | Irish (Stations) | Zeigler (Stations) | Irish (Stations) | Zeigler (Stations) |
| RZ-1 yellow | 81+85 to 83+18 | | 81+59 to 82+20 | |
| RZ-1 gray | 80+10 to 80+88 | 78+80 to 81+64[19] | 79+88 to 80+25 | 78+30 to 80+80 81+15 to 81+46 |
| RZ-2 yellow | 78+70 to 83+70 | | 79+65 to 81+89 | |
| RZ-2 gray | 79+75 to 80+76 | 79+90 to 80+76 | 78+08 to 79+97[20] 80+05 to 80+63 | 79+70 to 80+43 |
| RX | 80+15 to 80+28 80+33 to 80+36 | 80+14 to 80+65 | 80+09 to 80+47 | 79+89 to 80+27 |

We find as a fact that the respective plottings substantially are in agreement as to the location and extent of RX material. Further, Mr. Irish's plotting of RZ-2 gray material comports nicely with Mr. Zeigler's classification of RZ-2 material. A good portion of what Mr. Irish has called RZ-2 yellow, however, was identified as RZ-1 material by Mr. Zeigler and the other MTA consultants. (Appeal file, Tab IV (57)).

77. In late August 1978, as he was attempting to classify materials mapped in the tunnel, Mr. Irish inspected the core samples taken by Balter and compared them to the contract boring logs. What he observed was that Balter had logged unweathered, slightly weathered and moderately weathered

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[19] Mr. Zeigler used the Balter classifications only and did not attempt to categorize materials by color.

[20] Mr. Irish relied on Appellant's records to interpolate in this area.

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material as RX. Most of the highly weathered rock was classified as RZ-2. (Tr. IV, p. 66). In the 50 boring logs where RZ-1 was reported, it was rare that core samples were taken. Recovered RZ-1 material frequently was obtained by soil sampling techniques. (Tr. IV, pp. 66-67). Mr. Irish thus concluded that where he saw a zone of very stiff soil without a rock element, the material was RZ-1. If he saw a complete face or unit of weathered rock without any soil elements in it, Mr. Irish classified it as RZ-2. (Tr. IV, p. 79). Where Mr. Irish observed soft clay, he mapped this as RS. (Tr. V, p. 4). All classifications were based on Mr. Irish's field observations. Material hardness was determined by means of a geologist pick and the difficulty which the miners had in removing material. (Tr. V, pp. 57-58).

78. The MTA's mappings were based on observations made by its geotechnical personnel or inspectors and a consideration of the method of excavation utilized. (Tr. XII, pp. 106-107). Generally, where Appellant utilized an air spade to remove residual material from the tunnel face, Mr. Zeigler and his people classified it as RZ-1. Rock excavation techniques, such as the use of air hammers or "bull points", resulted in an RZ-2 classification being given to the material. (Tr. XXI, p. 30; XII, pp. 25-26).

79. Distinguishing RZ-1 from RZ-2 material in the field was accomplished by MTA geotechnical personnel by means of two tests. First, if a knife blade or geologist pick could be inserted into the soil-like portions of RZ-1 for at least a half inch, the material was indicated as RZ-1. Second, if samples of the residual material could be disaggregated by hand pressure, this offered confirming evidence of RZ-1 material. (Tr. XII, p. 25). Neither of these field tests was precise, however, and the results somewhat were dependent upon the strength of the inspector. (Tr. XIII, p. 67).

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80. After the parties respectively mapped the tunnel faces in the claim area and prepared geologic profiles, their attention turned to the corroboration of their findings and conclusions. Two principal tests were relied upon for this purpose. These were the standard penetration test conducted during the pre-bid boring operations and the unconfined compressive strength results on samples taken from the tunnels.

81. Mr. Irish testified that the most significant difference between soil and rock is its strength. (Tr. IV, p. 84). In this regard, a number of studies have been performed seeking to classify materials by their strength measured in pounds per square inch (psi). (Exh. A-34). The upper limit of soil strength in these studies ranges from 100 psi to 200 psi. Mr. Irish, however, testified that the studies performed by Penn State University's Dr. Bieniawski in 1973 are the ones with which he is most comfortable. (Tr. IV, p. 85). Dr. Bieniawski determined that the upper limit of soil strength is 145 psi. (Exh. A-34). Material with an unconfined compressive test result measuring above this figure was considered under the study to be either very low strength rock, low strength rock, medium strength rock, high strength rock, or very high strength rock depending on the strength recorded. (Tr. IV, pp. 87-88). Such quantitative characterization is important to engineers for design purposes. (Tr. IV, p. 89).

Clay also has been characterized by means of an unconfined compressive strength test. Mr. Irish testified that Drs. Terzaghi and Peck in their well known 1967 textbook classified clay samples as follows:

| Classification | Upper Limit (psi) |
|---|---|
| very soft | 3.5 |
| soft | 7.0 |
| medium | 14.0 |
| stiff | 28.0 |
| very stiff | 57.0 |
| hard | no upper limit given |

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(Tr. IV, p. 90; Exh. A-34).

Mr. Irish further testified that Balter performed only three laboratory unconfined compressive strength tests on RZ-1 material encountered during the pre-bid boring operation. These samples tested at 22 (NWB-27), 25 (NWB-31) and 36 psi (NWB-37) respectively. (Exh. S-61; Tr. IV, pp. 94-95). Utilizing the foregoing studies, Mr. Irish concluded that Balter clearly intended to convey the notion that RZ-1 material was a soil. (Tr. IV, pp. 91-92).

82. While mapping the tunnel faces in the claim area in August and September 1978, Mr. Irish took a total of 29 samples of the material viewed. These samples were numbered, wrapped in double plastic, and boxed. Cards were completed recording the location where each sample was taken and the date. (Tr. IX, pp. 26-28). Several hundred other samples were taken by Appellant's heading engineers. All samples were kept in Appellant's field offices for over a year before being shipped to the University of Illinois for testing. (Tr. XIII, p. 50).

83. It is undisputed that samples of material lose moisture over time and, as they dry, gain strength. (Tr. IX, p. 72; XIII, pp. 50-51). Appellant's samples were not placed in a moisture controlled room which would have prevented drying. (Tr. IX, p. 88). Accordingly, the unconfined compressive strength test results obtained by Appellant did not reflect the strength of the materials recovered as they originally existed in the ground. (Tr. IX, pp. 72-73).

84. The unconfined compressive strength test results for the Irish samples earlier classified as RZ-2 were as follows:

| Material | Sample No. | PSI |
|---|---|---|
| RZ-2 yellow | 1 | 56 |
| | 2 | 434 |
| | 3 | 1065 |
| | 5 | 156 |
| | 7 | 191 |
| | 11 | 246 |

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| | | |
|---|---|---|
| | 14 | 621 |
| | 15 | 306 |
| | 17 | 208 |
| | 19 | 938 |
| | 20 | 690 |
| | 21 | 578 |
| | 22 | 214 |
| | 25 | 282 |
| | 26 | 214 |
| | 28 | 594 |
| RZ-2 gray | 6 | 119 |
| | 8 | 3934 |
| | 9 | 338 |
| | 13 | 270 |
| | 18 | 404 |

(Exhs. A-52(1)(2); A-64).

85. Mr. Irish testified that loss of moisture content will not give a soil sample the strength of a rock. Hence, since virtually all of his samples broke under a test pressure demonstrating rock strength, Mr. Irish was satisfied that his RZ-2 classifications were accurate. (Tr. IX, p. 82). Further, Mr. Irish testified that his samples of RZ-2 yellow and gray were taken at the same time and stored in the same manner. For this reason, we are told that any loss of moisture content would have affected the strength of the respective samples in a proportional way. The relative range of test results for his RZ-2 yellow and gray samples led Mr. Irish to conclude that the RZ-2 yellow properly was considered to be rock and originally had comparable strength to RZ-2 gray. (Tr. IX, pp. 72-73; Tr. XX, pp. 44-45).

86. The MTA's Mr. Zeigler testified that unconfined compressive strength is not an appropriate means of classifying residual materials given their two component composition. Depending upon which component was being tested, the range in strength could vary greatly. (Tr. XII, p. 30). Further, Mr. Zeigler stated that the contract documents did not seek to classify materials in this manner. Mr. Zeigler also testified that all of the

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samples taken by Mr. Irish necessarily would not have lost moisture content in a uniform manner. (Tr. XIV, p. 19). For this reason, he concluded that the unconfined compressive tests run on the Irish samples, more than a year after the samples were taken from the tunnel face, were meaningless. (Tr. XIII, pp. 50-51).

87. Whether the degree of drying in samples would be uniform depends upon the material comprising the sample. Sand, for example, dries out to a lesser extent than clay. (Tr. XIV, p. 14). Mr. Irish's uncontroverted testimony was that the residual materials on this project were comprised of from 50 to 75 percent sand and 25 to 50 percent clay and silt. (Tr. XX, pp. 37-39). Given these proportions, the degree of drying experienced by each of his samples would have been the same.

88. The MTA's Mr. Zeigler testified that the standard penetration test results included in the boring logs verified the material classifications made by his people. Contract drawing sheet number 58 advised bidders that for RZ-1 material, the Standard Penetration Test results in most, "but not all", cases would be greater than 100 blows per foot. Pursuant to the studies submitted by Mr. Irish classifying materials by strength, and given Professors Terzaghi and Peck's blow count description of clays, Mr. Zeigler contends that a blow count of 100 would convert to an unconfined compressive strength of 145 to 200 psi. (Tr. XIII, p. 55). Laboratory tests performed on fresh RZ-1 samples taken by the MTA inspectors and geotechnical personnel showed an average unconfined compressive strength of 150 psi. Hence, the MTA's classification of RZ-1 was consistent. (Tr. XII, p. 104).

89. Mr. Zeigler also testified that for cohesive soils, geotechnical engineers commonly convert blow counts to unconfined compressive strength by using an 8:1 ratio. Thus for a blow count of 100, the unconfined

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compressive strength would be 12.5 tons per square foot (100/8) or 174 psi. (Tr. XXI, p. 50). Again such a measure of strength for RZ-1 material would comport nicely with the MTA classifications.

Mr. Irish, however, disagreed with Mr. Zeigler and contended that the ratio of blow counts to unconfined compressive strength only is valid if measured at the job site through testing. (Tr. XX, p. 55). In support of this testimony, Mr. Irish presented a 1969 paper written by Dr. Victor de Mello, a professor at the University of Sao Paulo, Brazil and a person recognized as an authority in soil mechanics by the MTA's Mr. Zeigler. (Exh. A-77; Tr. XXI, p. 65). Dr. Mello prepared a chart comparing the ratios obtained in numerous studies done on clay by various researchers. This chart showed that the ratios ranged from 3.3:1 to 120:1. (Tr. XX, p. 54). Dr. Mello's conclusion was that it was meaningless to apply any ratio without testing the clay layer at the site to gauge its sensitivity. (Tr. XX, p. 55; Exh. A-27, pp. 94-95). Mr. Irish further testified that Balter had not studied the ratio present in the Bolton Hill Tunnels area and, accordingly, the GDR did not contain a reference to it. In summary, Mr. Irish testified that neither a prudent bidder nor a geologist could have projected the unconfined compressive strength of RZ-1 based upon the blow counts reported in the GDR. (Tr. XX, pp. 56-59).

90. Finally, both Mr. Irish and Mr. Bartholomew questioned the reliability of the standard penetration test in rocky soils. Since RZ-1 was supposed to be a two component material, a bidder could not know whether a high blow count value was due to the split spoon sample encountering rock residue within the soil matrix. Under such circumstances, the resulting high blow count necessarily would not be indicative of cohesive strength of the

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soil component. (Tr. V, p. 41; XX, p. 56; XXII, p. 41). Mr. Zeigler disagreed with the foregoing contending that the standard penetration test is effective and used extensively for measuring the properties of RZ-1 material. (Tr. XIII, p. 89). By looking at the material recovered in the split spoon sampler, Mr. Zeigler testified that it is possible to tell whether rock is being encountered. However, both parties agree that when a rock remnant is encountered by the sampler, the blow count is increased. (Tr. XIII, p. 95). Mr. Zeigler thus admitted that it would be impossible from this test alone to determine if a boulder or a pebble was impeding the sampler. (Tr. XIII, pp. 89-91).

**Excavating The Lafayette Vent Shaft**

91. Tunneling work was completed on or about January 18, 1979. Excavation of the Lafayette Shaft thereafter was able to resume on January 30, 1979. (Exh. S-74B).

92. Appellant contends that it first encountered RZ-2 material during its excavation operation on March 15, 1979. (Exh. A-1(1), §III). The Daily Construction Report for this day shows only that a problem occurred with the American 999 crane and that the excavation process was delayed. (Exh. S-74B). Drilling and shooting operations in the shaft first were reported by Appellant's Superintendent on April 4, 1979. Since ground conditions generally were not described in the Daily Construction Reports, the use of explosives is the only evidence available from the reports to signal the encountering of rock. Material which could not be removed by Appellant's "Gradall"[21] apparently was encountered on April 2, 1979 thus necessitating the use of explosives. (Exh. III-1 to Exh. S-59B).

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[21]The Gradall used here was a tractor mounted hydraulic excavator. The bucket on the excavator arm was equipped with ripper teeth. (Exh. A-19).

93. Rock removal techniques, i.e., explosives, were required for the remainder of the shaft excavation continuing through April 13, 1979. (Exh. S-74B).

94. During the excavation of the Lafayette Vent Shaft, both Mr. Irish and the MTA's Mr. Wirth[22] mapped the walls. (Tr. XXI, pp. 29-30; Tr. IV, p. 100). In addition, Mr. Wirth sampled the residual materials encountered in the shaft excavation from the tunnel crown to the shaft invert. (Exh. A-31; Tr. XII, p. 102). These samples then were tested by the State Highway Administration Laboratory. Additional in-situ (i.e., in place) tests were performed on the residual materials by means of a Schmidt Rebound Hammer. (Exh. A-31). The parties utilized their respective information to prepare isometric drawings of the shaft detailing the materials encountered at various elevations. (Exh. A-35(1) and (2); Exh. A-33; Exh. S-6, fig. 15; Exh. A-31).

95. The parties' methods for classifying materials at the shaft were the same as those used in the tunnel. Thus, it is not surprising that a disagreement exists as to what constitutes RZ-1 and RZ-2 material. Generally, the MTA recognized RZ-2 material only where it was necessary to remove residual material with rock excavation techniques. (Tr. XXI, pp. 29-30).

96. The unconfined compressive strength test results for the samples taken by the MTA at the Lafayette Vent Shaft and the categorizations earlier performed by both parties were as follows:

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[22] Mr. Wirth was employed by the MTA's Construction Management Organization as a geotechnical engineer. He has a Bachelor's Degree in geology and a Master's Degree in Civil Engineering both from the University of Notre Dame.

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| Sample | Sta. (O.B.) | qu(psi) | MTA Categorization | Irish[23] Categorization |
|---|---|---|---|---|
| S #1 | 80+68 | 514 | Hard lens/RZ-1 | RZ-2 yellow |
| #2 | 80+67 | 199 | RZ-1 | RZ-2 yellow |
| #3 | 80+67 | 163 | RZ-1 | RZ-2 yellow |
| #4 | 81+05 | 334 | Hard lens/RZ-1 | |
| #5 | 80+86 | 341 | Hard lens/RZ-1 | RZ-2 yellow |
| #6 | 80+87 | 501 | Hard lens/RZ-1 | RZ-2 yellow |
| #7 | 80+67 | 117 | RZ-1 | RZ-2 gray |
| #8 | 81+04 | 381 | RZ-2 | |
| #10 | 81+13 | 243 | RZ-1 | RZ-2 gray |
| #11 | 81+02 | 133 | RZ-1 | |
| #12 | 80+67 | 74.4 | RZ-1 | RZ-2 grap |
| #13 | 81+07 | 62.2 | RZ-1 | |
| #14 | 81+02 | 36.8 | RS: Very soft, difficult obtaining intact sample | RZ-2 yellow |
| #15 | 81+09 | 229 | RZ-1 | RZ-2 yellow |
| #16 | 81+09 | 69.6 | RZ-1 amphibolite | |
| #17 | 81+09 | 85.2 | RZ-1 amphibolite | |
| #18 | 80+68 | 408 | RZ-2 | RZ-2 gray |
| #19 | 80+70 | 272 | RZ-1 | RZ-2 gray |

(Exh. A-31). Mr. Zeigler testified that the average unconfined compressive strength for the RZ-1 material, excluding the hard lens, was 150 psi. The average for all RZ-1 material was 220 psi. (Tr. XXI, p. 72). Mr. Zeigler noted that this correlated quite well with the projected RZ-1 strength of 174 psi obtained by converting the Balter blow count prediction for RZ-1 to unconfined compressive strength by use of the 8:1 ratio discussed earlier. (Tr. XXI, pp. 72-73).

97. Mr. Irish analyzed the test results obtained by the MTA for its Lafayette Vent Shaft samples and noted that 11 of the 19 samples tested ranged from 199 psi to 514 psi. In his view, these clearly were rock values and properly were mapped by him. (Tr. V, p. 3). Mr. Irish again noted that the only unconfined compressive strength tests run by Balter showed a range for RZ-1 of from 22 to 36.4 psi. In mapping the materials found at

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[23]Mr. Irish was unable to correlate six of the samples to his categorization because the samples were taken from the center of the shaft and he had mapped only the walls. (Tr. IV, p. 111).

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the shaft, the MTA included as RZ-1, materials ranging in strength from 62 psi to 272 psi. The upper value thus was approximately eight times the prebid Balter test result for RZ-1 material and nearly twice the nationally recognized upper strength limit for soils. (Tr. IV, p. 100).

With regard to sample number 12 which tested at 74.4 psi, Mr. Irish was asked whether his mapping of the material as RZ-2 perhaps was erroneous. He responded that in this area of sampling, water was pouring out of the walls over the residual soils and rock thereby reducing their strength significantly. (Tr. IV, p. 125).

98. Mr. Irish further testified that the mapping of the vent shaft permitted the parties to see a large wall of the material encountered in the excavation and tunneling for the first time. (Tr. V, p. 4). This view confirmed his original observation that the residual materials were not comprised of two components.

<u>Tunneling Near Pennsylvania Avenue</u>

99. Appellant's Mr. Anderson reported in his Daily Construction Report on December 14, 1978 that the face in tunnel 4 was getting harder all the time and that it had to be spaded to relieve the shield. (Exh. S-74B). Mr. Williamson became concerned at this time that conditions similar to the Lafayette Shaft were being encountered.

100. Mr. Irish again was called to the Bolton Hills site by Appellant's Mr. Williamson on December 15, 1978 to observe ground conditions in the tunnels and map the faces. (Tr. IV, p. 14).

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101. Mr. Zeigler and Drs. Deere and Merritt met with a representative of Appellant on December 19, 1978 and learned that Mr. Irish had mapped the tunnel material being encountered as RZ-2. Dr. Merritt visited tunnels 3 and 4 and reportedly concluded that the material being encountered was RZ-1. (Appeal file, Tab IV (21)).

102. On December 20, 1978, Mr. Irish again visited the tunnels and observed RZ-2 material in both faces. Notice of a differing site condition accordingly was transmitted by Appellant's Mr. Williamson to the MTA Resident Engineer. (Appeal file, Tab IV (22)).

103. Mr. Williamson again wrote the MTA Resident Engineer on December 27, 1978 advising him that Mr. Irish's weekly visit resulted in a mapping of RZ-2 material in tunnel 3 and RX material in tunnel 4. (Appeal file, Tab IV (23)).

104. With regard to Mr. Irish's mappings on December 15 and 20, 1978, the MTA Resident Engineer, by letter dated December 29, 1978, advised Appellant that his experts viewed the material present in the face as RZ-1 and not RZ-2. (Appeal file, Tab IV (24)). The MTA Resident Engineer did concur, however, that the material mapped in tunnel 4 on December 27, 1978 was RX. (Appeal file, Tab IV (25)).

105. On January 3, 1979, Mr. Irish again concluded that RZ-2 material was being encountered in tunnel 3 and that RX material was present in tunnel 4. (Appeal file, Tab IV (22)).

106. By letter dated January 12, 1979, Appellant's Mr. Williamson apprised the MTA Resident Engineer that RX material was encountered in tunnel 3 on January 9, 1979. The rock face was mapped by Mr. Irish on

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January 10, 1979. (Appeal file, Tab IV (28)). The MTA Resident Engineer concurred in Appellant's classification of material encountered by letter dated January 15, 1979. (Appeal file, Tab IV (29)).

107. Mr. Williamson again wrote the MTA Resident Engineer on January 18, 1979 to claim a differing site condition due to RX material being encountered in tunnel 3 on January 15, 1979. Mr. Irish's map of the face again was enclosed. (Appeal file, Tab IV (30)).

108. Based on his weekly mappings of the tunnels in the Pennsylvania Avenue end of the North tunnels, Mr. Irish prepared a report in March 1979. A copy of this report was forwarded to the MTA on April 4, 1979. (Appeal file, Tab IV (41)). Mr. Irish's report is summarized below:

a. Prebid Geologic Data - Although Balter stated in the GDR that "both RX and RZ-2 material probably would be encountered above the invert level in the far northern end of the project," the borings taken did not support this conclusion. The Balter logs showed only alluvial soils, RS and RZ-1 materials in the tunnels. (Exh. A-37, p. 7).

b. Materials Encountered - Both tunnels penetrated sectors of highly to severely weathered rock that had to be spaded, and unweathered to slightly weathered rock that had to be "drill and blast" excavated before the tunnel shields could be advanced. RX material ". . . was intercepted by the outbound tunnel from Station 99+13 to the end of that tunnel at Station 99+47." The same material was encountered ". . . in the inbound tunnel at two locations, one at about Stations 98+62 to 98+66, the other from about Station 99+55 to the end of that tunnel at Station 99+85." (Exh. A-37, p. 12). RX material protruded above the inverts of the tunnels generally no more than 4 to 5 feet, but extended about 9 feet above the invert by Station 99+85. "RZ-2 material was intercepted both partial and full-face through at least 80

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feet in aggregate of the outbound tunnel (No. 4) northwest of Station 97+63, and at least 105 feet in aggregate of the inbound tunnel (No. 3) northwest of Station 96+25." (Exh. A-37, p. 13). The shield typically could not be advanced in this material unless relieved.

c. Conclusion - When Appellant encountered RZ-2 and RX material in this area, it incurred a differing site condition.

109. Although not analyzed in his report, Mr. Irish also took samples of the materials he encountered while mapping the faces in the Pennsylvania Avenue claim area. These samples were tested for unconfined compressive strength in October 1979 with the following results:

| Sample # | Strength | Earlier Irish Classification |
|---|---|---|
| A | 255 | RZ-1y |
| B | 132 | RZ-2y |
| C | 143 | RZ-2y |
| D | 9186 | Quartz |
| E | 179 | RZ-2y |
| F | 242 | RZ-2y |
| G | 309 | RZ-1/RZ-2 |
| H | 218 | RZ-1/RZ-2 |
| I | 670 | RZ-1y |
| J | 37,184 | Quartz |
| K | 214 | RZ-1g |
| L | 136 | RZ-1g |
| M | 488 | RZ-1g/RZ-2g |
| N | 1148 | RZ-2g |
| O | 3849 | RX |
| P | 382 | RZ-2y |
| Q | 532 | RZ-2y |
| R | 771 | RZ-2g |
| S | 874 | RZ-2g |
| T | 131 | RZ-1g |
| U | 75 | RZ-1g |
| V | 114 | RZ-2g |
| W | 2793 | RZ-2y |
| X | 361 | RZ-1g |
| Y | 810 | RZ-2y |
| Z | 941 | RZ-2g |
| ZZ | 11,669 | RX |

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(Exhs. A-48, A-48A, A-52(3), A-52(4)).

110. In December 1979, the MTA's Messrs. Zeigler and Wirth issued a report on Appellant's claim for consideration by the MTA Administrator. (Exh. S-7). This report is summarized as follows:

a. Prebid Geologic Data - The GDR and the borings taken by Balter together indicated that the last 400 feet of the North tunnels were to be excavated almost entirely in residual materials. Sand and gravel only should have been expected above springline. RX and RZ-2 materials were shown near the invert in the last 150 feet of the tunnel and a reasonable bidder should have realized that these materials could be encountered given the imprecision involved in the interpolation of boring data.

b. Bid Item 98 - This item was included solely to recognize the markedly different tunneling conditions expected in the last 150 feet of the North tunnels.

c. Materials Encountered - The Construction Manager's Geotechnical Services began mapping the faces on December 15, 1978 when the inbound tunnel was at Station 95+66 and the outbound tunnel was at Station 97+63. Material classifications were made in the same manner as in the Lafayette Shaft. Messrs. Zeigler and Wirth also reviewed the logs maintained by the MTA Resident Engineer's inspectors and sought input from the MTA's geotechnical consultants. Samples were taken and tested with the following results:

Table 2
Bolton Hill Tunnels
Summary of Unconfined Compression Tests

| Boring | Station | Sample | Depth | Classification | qu(p.s.i..) |
|---|---|---|---|---|---|
| | 99+02 | 1 | 55' - 73' | RZ-1, CH | 99.5 |
| | 99+02 | 2A | " | " | 93.5 |
| | 99+02 | 2B | " | " | 89.3 |
| | 99+02 | 3 | " | " | 76.8 |
| | 99+02 | 4 | " | " | 39.6 |
| | 99+02 | 5 | " | " | 89.7 |
| | 99+32 | 8 | 68' | RZ-1, SM | 16.3 |

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| | | | | | |
|---|---|---|---|---|---|
| | 99+32 | 8 | 68' | RZ-1, SM | Y7.5 |
| | 99+32 | 9 | 58' | RZ-1, SM | 46.1 |
| | 99+32 | 10 | 58' | RZ-1, SM | 72.0 |
| | 99+58 | 11 | 66' | RZ-1, ML | 61.1 |
| | 99+58 | 12A | 69' | RZ-2 | 3436 |
| | 99+58 | 12B | 69' | RZ-2 | 2610 |
| | 99+70 | 13 | 69' | RZ-2 | 3612 |
| NWB-104 | | 14 | 67.5 | RZ-1 | 700 |
| NWC-1 | | 15 | 79.5 | RZ-2 | 2473 |
| NWB-103 | | Y6 | 92.5 | Rx(Slight Dec) | 11010 |
| NWB-104 | | 17 | 79.0 | Rx (Very Slight (Dec) | 15445 |
| NWB-32 | | 18 | 92.5 | Rx(Fresh) | 17220 |

d. Conclusions - RZ-2 Material was encountered a maximum of seven feet above invert in the inbound tunnel and a maximum of five feet above invert in the outbound tunnel. RX material was encountered a maximum of 1.5 feet above invert in the inbound tunnel and a maximum of 2.5 feet above invert in the outbound tunnel. No RZ-2 material or RX material was encountered in back of Station 98+00.[24]

Appellant should have anticipated that RZ-2 or RX material could be expected in the invert portion of each tunnel face. Accordingly, no differing site condition is recognized.

111. Based on this report, the MTA Resident Engineer denied Appellant's claim on December 27, 1979. (Appeal file, TAB IV (49)). An appeal thereafter was taken to the MTA Administrator on January 4, 1980. (Appeal file, Tab IV (50)). This appeal was denied in a final decision dated November 12, 1980. (Appeal file, Tab II).

[24] The parties disagree as to whether the materials encountered between stations 95+66 inbound and 98+00 inbound were RZ-1 or RZ-2.

## II. Decision - Entitlement

### A. Pile Drilling Operations

As noted in finding of fact number 63, supra at p. 26, the parties are not in dispute as to the existence of a differing site condition at the Lafayette Street Vent Shaft. The equitable adjustment due Appellant pursuant to contract General Provision GP-4.04 will be discussed hereafter in section III of this decision.

### B. Tunneling In The Vicinity of Lafayette Avenue

The MTA concedes, as well, that a differing site condition was encountered by Appellant in tunnel 3 between stations 79+80 and 81+00. Likewise, it is agreed that a differing site condition was encountered by Appellant in tunnel 4 between stations 79+60 and 80+50. In these areas, the MTA acknowledges that RZ-2 and RX materials were found, whereas the contract represented the existence of both cretaceous and RZ-1 materials.

Appellant maintains, however, that the differing site condition which it encountered extended beyond the areas recognized by the MTA. The areas in dispute are as follows:

| Inbound (Tunnel 3) | Outbound (Tunnel 4) |
|---|---|
| Stations 78+70 to 79+80 (110 feet) | 77+80 to 79+60 (180 feet) |
| Stations 81+00 to 83+10 (210 feet) | 80+50 to 81+90 (140 feet) |

Within these limits, Appellant states that it encountered RZ-2 material. The MTA, on the other hand, maintains that the material was RZ-1, exactly as forecast by the geotechnical data included in or referenced by the contract. For this reason, the MTA has not recognized a differing site condition in the disputed areas.

It is uncontroverted that the subsurface conditions expected to be encountered in the alleged differing site condition area were sands, silt, gravel, residual soil and RZ-1 material. This is true both for tunnels 3 and 4. A reading of the GDR which Appellant obtained and relied upon prior to bid unambiguously states that RZ-1 material will act as a very hard, very dense, slightly cohesive to cohesive soil. (Exh. S-61, p. 8). The foregoing also makes clear that RZ-1 would be removable by the use of power hand tools. While a contractor thus should have understood that power hand tools might be necessary to loosen RZ-1 material encountered in the tunnel face, it likewise was evident from the GDR that rock excavation techniques would not be necessary to remove this material. We find that Appellant reasonably inferred from the contract indicators that RZ-1 material would act as a soil mass when encountered in the tunneling process.

RZ-2 material, on the other hand, was described in the GDR as rock-like. The May 7, 1976 Supplement to the GDR further stated that RZ-2 would "probably have to be excavated with rock excavating techniques." The preceding qualification as to the use of rock excavation techniques apparently stems from the fact that RZ-2 is heterogeneous with respect to weathering, ranging from decomposition throughout the entire body to partial decomposition throughout the material. Thus, it is conceivable that RZ-2 material, if substantially decomposed, might also be removable by the use of hand operated, hydraulic spaders and by the excavator, particularly when used to rip material in the tunnel face.

In classifying the materials actually encountered in the disputed differing site condition area, the method of excavation thus could not be used as an exclusive indicator of the material being encountered or its hardness.

This finding is confirmed by the testimony both of Appellant's expert, Mr. Mathews, and the MTA's expert, Mr. Zeigler. The latter candidly stated that observation of the material is essential to an accurate classification. (Tr. VII, pp. 10-17; Tr. XIV, pp. 38-39).

Appellant's classification of soils in the disputed areas was performed by Mr. Irish. Based on the GDR and contract indicators, Mr. Irish, like Appellant's Mr. Bartholomew, understood RZ-1 material to be rock which had decomposed to the point where the mass of it was a soil, with remnant blocks of weathered rock. (Tr. IV, p. 60). RZ-2 was understood to be decomposed rock which, in the main, had not yet been altered to a soil. Although he never observed a two component soil of the type described in either the contract or the GDR, Mr. Irish tried to remain faithful to the definitions given to RZ-1 and RZ-2 materials. Where Mr. Irish saw a zone of very stiff soil, without a rock element, he recorded it as RZ-1 material. A complete face or unit of weathered rock, without soil elements, was classified as RZ-2. (Tr. IV, p. 79).

The MTA's consultants testified that they did observe a two component soil system as described in the contract documents. In order to distinguish RZ-1 from RZ-2 material, these consultants took into account the following:

1. The method of excavation; e.g., if an air spade was used it was indicative of RZ-1 material.
2. The hardness of the material; pocket knife or geologist's hammer used as a gauge.
3. Relationship to nearby material; generally RZ-1 was believed to overlay RZ-2 material.
4. General contract criteria; e.g., could the material be disaggregated by hand.

(Tr. XXI, pp. 27-28; Exh. S-6; Tr. XII, p. 25).

In weighing the testimony adduced from the respective experts, we are mindful that the classification scheme for decomposed rock employed by the MTA was developed by its own soil consultant for use initially on this project. Further, a precise, scientific basis for distinguishing RZ-1 from RZ-2 material was not provided in the contract. Accordingly, the classification process is dependent entirely upon expert observation and the factors set forth in both the contract documents and the GDR. Since the definitions for RZ-1 and RZ-2 materials were developed by the MTA, Appellant and its expert need only show that they reasonably construed the contractual definitions of soil types in the classification process. Martin G. Imbach, Inc., MDOT 1020, 1 MSBCA ¶52 (May 31, 1983).

The GDR set forth unconfined compressive strength test results on three samples of RZ-1 material as follows:

Boring NWB-27 at 90 feet — 36 pounds per square inch (psi)
Boring NWB-41 at 64 feet — 25 psi
Boring NWB-37 at 77 feet — 22 psi

Unconfined compressive strength readings in this range would be indicative of a stiff to very stiff clay. (Exh. A-34; Finding 81).

The MTA recovered samples from the disputed area which it identified as RZ-1 material. These samples were tested for unconfined compressive strength at the Maryland State Highway Administration Laboratories. The samples ranged in strength from 62.2 psi to 514 psi, with the average being 220 psi. (See Finding 96). The majority of these samples were obtained from areas where Mr. Irish had classified the material encountered as RZ-2. Despite the fact that the contract documents did not attempt to classify RZ-1 and RZ-2 materials by virtue of their unconfined compressive strength, we find that the materials encountered in the disputed area were much harder than a reasonable contractor would have anticipated from a review of the contract documents. Further, as Mr. Irish noted, the strength of these samples approximated that of a weak rock and justified their classification by him as RZ-2 material under the contract definitions.

The MTA contends, however, that Appellant should have expected RZ-1 to be much stronger than that indicated by the unconfined compressive strength results set forth in the GDR because: (1) the GDR stated that this material would exhibit heterogeniety with respect to strength and hardness; and (2) the contract drawings represented that this material had Standard Penetration Test results greater than 100 blows per foot in most cases. The record, however, establishes that a meaningful relationship between blow count measurements and soil strength cannot be formulated without testing of the soils at the site. Test results of this type were not performed by the MTA and, in the absence of such data, there was nothing in either the contract or the GDR which reasonably would have led a contractor to conclude that RZ-1 material would have strength beyond that normally found in a soil.

In C.J. Langenfelder & Son, Inc., MDOT 1000, 1003, 1006, 1 MSBCA ¶2 (15 Aug. 80), aff'd, Md. Port Administration v. C.J. Langenfelder & Son, Inc., 50 Md. App. 525 (1982), this Board stated that:

> A 'type 1' differing site condition is contingent upon the existence of some contractual indication concerning the subsurface or physical conditions to be expected. The indication need not be express, may be proven by inference or implication, and need only be sufficient to impress or lull a reasonable bidder. Foster Construction Co., et al. v. United States, 193 Ct.Cl. 587, 435 F.2d 873, 881 (1970).

We previously found that Appellant reasonably construed the contract subsurface indicators in concluding that RZ-1 material would be encountered in the disputed area and that this material would behave as a soil, albeit a hard, cohesive soil. What Appellant encountered, however, was a material having the strength of weak rock. This understatement of material hardness by the contract subsurface data constituted a differing site condition under contract General Provision GP-4.04. American Dredging Company v. United States, 207 Ct.Cl. 1010 (1975); C.J. Langenfelder & Son, supra.

As to the limits of the differing site condition, we find the delineation of material by Appellant's expert to correlate closely with the description of hard ground found in the daily diary of Mr. Earl Anderson, Appellant's tunneling superintendent. Mr. Anderson has worked in tunneling operations since 1950 and has been a superintendent since 1959. While he is not a geologist, Mr. Anderson had the greatest amount of tunneling experience of any witness appearing before the Board and his description of the hardness of material encountered is considered significant.

In the disputed claim area, Mr. Anderson began describing a change in ground conditions on August 1, 1978, near Station 78+80. Mr. Anderson noted that hard ground was experienced at the level of the bottom shelf of the shield. (Exh. S-74B, Aug. 1, 1978). This hard material necessitated that the shield be relieved on a continuous basis through Station 79+80. Mr. Anderson's testimony was that relieving the shield in this manner is required only when one is involved in mixed-faced tunneling. (Tr. V, p. 77).

In tunnel 4, Mr. Anderson likewise began noting especially hard ground as of August 22, 1978, near Station 78+80. This description of hard ground is continuous to Station 79+60 where the MTA recognizes the differing site condition. Mr. Anderson did not denote difficult tunneling conditions prior to Station 78+80, contrary to Appellant's contention that ground conditions worsened at Station 77+80.

With respect to the disputed claim areas in each tunnel beyond the recognized differing site condition, Mr. Anderson's daily reports confirm the existence of uncommonly hard ground and the need to relieve the shield. We find these reports to corroborate Mr. Irish's classification of materials in the foregoing areas.

For all of the preceding reasons, therefore, we find that the differing site condition in tunnel 3 ranges from Station 78+80 to Station 83+10. In tunnel 4, the differing site condition extends from Station 78+80 to Station 81+90.

C. Tunneling In The Vicinity of Pennsylvania Avenue

The parties agree that the borings contained in the contract drawings indicated that the last 400 feet of tunneling would be through RS and RZ-1 materials. Cretaceous materials, consisting mostly of dense sand and gravel, were to have been anticipated only above springline. (Exh. S-7, p. 11; Exh. A-37, p. 12). However, the May 1976 GDR Supplement cautioned bidders that rock had been encountered above the tunnel invert level in boring NWC-1 and very close to the invert level in boring NWB-104. For this reason, the Supplement further concluded that RZ-2 and rock ". . . will probably be encountered above the invert level in the far northern end of the project." (Exh. S-61, p. 2 of Supp.).

Boring NWC-1 was taken approximately at Station 99+25, with boring NWB-104 being taken at Station 98+27.7. The former boring showed rock at an elevation only 0.27 feet (3 inches) from the tunnel invert. (See Finding 29). The latter boring revealed RZ-2 material encroaching to within 3.9 feet of the invert, with solid rock even further below the planned structure bottom. (Tr. XIII, pp. 88-103). Although the Unit Price Schedule invited separate unit pricing for the tunneling from Stations 98+00 to 99+30 outbound, and from Stations 98+00 to 99+70.17 inbound, Appellant concluded from its review of the above borings that mixed face tunneling would not be required in this area and, accordingly, did not change its unit price.

Before considering the question of what materials were encountered in the Pennsylvania Avenue claim area, we first must decide whether Appellant reasonably relied on the above contract indicators in concluding that neither RZ-2 nor RX materials would be encountered in the last 400 feet of the Northern tunnels. We conclude that it did not.

Although the GDR incorrectly stated that boring NWC-1 showed rock above the tunnel invert level, Appellant recognized prior to bid that this boring showed rock material only three inches below the shield bottom. While boring NWC-1 may be presumed to be an accurate representation of the ground conditions at the point where it was taken, there were no borings or other geotechnical information which would have permitted Appellant to determine the inclination of the rock in this area and thus whether the rock was at the same elevation throughout both tunnels at Station 99+25, the approximate station where this boring was drilled.

At stations beyond 99+25, the probability of encountering rock increased. For example, boring NWB-102 was taken at Station 96+33 and revealed RZ-2 material at an elevation 12 feet below the invert. (Tr. XIII, p. 88). NWB-104, taken approximately 200 feet to the North of NWB-102, detected rock only 3.9 feet below tunnel invert. Over the next 100 feet, the distance between borings NWB-104 and NWC-1, the rock rose to within 3 inches of the tunnel invert. Clearly, the rock was rising towards the invert level over the last 400 feet of the tunneling operation and there was nothing in the geotechnical data that would have permitted Appellant to conclude that rock would not have been encountered beyond the location of boring NWC-1.

When all of the foregoing is considered together, it cannot be said that the contract subsurface indicators were such as to have reasonably led Appellant to conclude that absolutely no rock would be encountered in the last 150 feet of each tunnel. Compare Pacific Alaska Contractors, Inc. v. United States, 193 Ct.Cl. 850 (1971). Thus, when Appellant chose to bid the tunneling excavation for the last 150 feet in each tunnel at the same unit price as for the earlier soft ground tunneling, it did so at its own risk.

In reaching the above conclusion, we are mindful also of the policy behind the "Differing Site Condition" clause. This policy is intended to reduce bid contingencies by encouraging bidders to rely upon contract indicators of subsurface conditions in preparing bids. If conditions are otherwise, the government grants an equitable adjustment. Under this premise, the government pays for work commensurate with the level of effort required and the contractor neither absorbs a substantial loss nor makes a windful profit. Here, however, the contract documents and supporting geotechnical data cannot be read as telling bidders either that rock would not be encountered in the last 150 feet of each tunnel, or that the MTA would pay extra if such were not the case. In fact, the message given was just the opposite.

Appellant contends that if mixed faced tunneling was to be encountered in the last 150 feet of each tunnel, some indication as to excavation requirements should have been stated. However, the GDR informed bidders that rock excavation techniques may be necessary where RZ-2 material was encountered and further discussed the need to control overbreak when tunneling in such material. (Exh. S-61, p. 1 of Supp.). This warning would not have served any purpose if the encountering of rock or rock-like material was not to be anticipated.

Although we have found that some rock or rock-like material should have been expected, there still is a question of whether the quantity of rock and other materials encountered by Appellant was substantially different from that which reasonably should have been expected based upon the contract subsurface indicators. We thus turn our attention to the materials actually encountered.

Appellant contends that it encountered a differing site condition in tunnel 3 between Station 95+50 and the end of the job at Station 99+70.17. While it expected to find RS and RZ-1 material in this area, Appellant states that it experienced RZ-2 and RX materials. There is no dispute that Appellant encountered RZ-2 or RX material requiring explosives for excavation from Stations 98+62 to 98+66 and from Station 99+55 to the end of the job. In the remainder of the claim area, the MTA contends that Appellant encountered RZ-1 material, as forecast in the GDR.

In tunnel 4, Appellant contends that it encountered a differing site condition from Stations 97+63 to the end of the job at Station 99+30. The parties agree that RX material was found beginning at Station 99+13 and continuing to the end of the job. Throughout the remainder of the claim area, we again have a dispute as to whether the material tunneled through was RZ-1 or RZ-2.

We conclude that the material encountered in the claim area in tunnel 3, other than the rock which clearly was present in two locations, was RZ-1 material. In support of this finding, we note first that the RZ-1 classifications made by the MTA are supported by compressive strength tests performed on samples taken from the tunnel face. (Exh. S-7, p. 15A). These compressive strengths ranged from 16.3 psi to 99.5 psi, all clearly soil strengths.

The foregoing is not conclusive in and of itself, however, since it is difficult to determine precisely where the samples were taken. Appellant's expert classified much of the material in the claim area as RZ-1 and thus it is possible that the MTA samples came from those locations where Appellant also found RZ-1 material. (Tr. XX pp. 81-90).

The MTA's classification of materials, however, is corroborated by Mr. Anderson's daily tunneling reports. Our review of the Anderson reports for the period from December 15, 1978 through the need of the job reveals no complaints about either the hardness of the ground or the need to relieve the shield. The exceptions to this finding occur on the days when both parties agree that rock was encountered. We conclude, therefore, that soft ground tunneling conditions were encountered in the claim area, except where the parties agree that rock material was encountered which necessitated removal by explosives.

In tunnel 4, explosives were required to remove rock or RZ-2 material from about Station 99+55 to the end of the tunnel at Station 99+85. Prior to encountering this material, Mr. Anderson reported problems with hard materials in the claim area only on December 19 and 20, 1978. (Exh. S-74B). The conditions described by Mr. Anderson on these two days did require the shield to be relieved. At this time, Appellant was working in the area beyond Station 98+00 and the difficult conditions apparently abated by the graveyard shift on December 20, 1978. (Exh. S-74B).

In summary, Appellant encountered rock above the invert of each tunnel beyond Station 99+00. Boring NWC-1 showed rock very close to invert level in this vicinity and thus the conditions encountered were not materially different from those forecast. Appellant's claim in this area thus is denied.

Rock also was encountered approximately from Stations 98+62 to 98+66 in tunnel 3. The closest boring to this area, NWB-104 showed RZ-2 material to be 3.9 feet below the invert, with RX material even further below. By Station 99+25, RX material was shown as rising to within 3" of the projected invert at the location of boring NWC-1. Thus, the RX material was depicted as rising quickly in elevation in this region, and no similar indication as to RZ-2 material was provided. These factors reasonably should have indicated to Appellant that RZ-2 or RX materials might be encountered in the invert beyond Station 98+27.7 where boring NWB-104 was taken.

In tunnel 4, based on Mr. Irish's mapping and Mr. Anderson's reports, we find that RZ-2 material was encountered on December 19 and 20, 1978, approximately at Station 98+25. Boring NWB-104 was taken at almost this precise location in the vicinity of the planned outbound tunnel and it showed RZ-2 material 3.9 feet below invert. The encountering of RZ-2 material in this area did constitute a materially different condition than that forecast by contract indicators and hence, a differing site condition.

D. Excavating The Lafayette Avenue Vent Shaft

After the North tunnels were completed in January 1979, excavation at the Lafayette Avenue Vent Shaft was able to resume. (See Finding 57). Appellant contends that it encountered RZ-2 material in the shaft beginning on March 15, 1979. RX material was discovered on April 2, 1979, necessitating removal by drilling and blasting. This latter condition was continually experienced through April 11, 1979 when blasting was completed. During the next two days, shot rock was removed from the shaft invert, thus ending the shaft excavation operation at the shaft. (Exh. S-74B, Apr. 13, 1979).

The MTA acknowledges that a differing site condition was encountered at the shaft during the excavation operation conducted between April 2 and 11, 1979. Prior to April 2, 1979, the MTA does not recognize a differing site condition, primarily because Appellant was able to excavate with a Gradall 880. This latter piece of equipment is tractor mounted and has an excavation bucket connected to the end of a hydraulically operated arm. (Exh. A-19). According to the MTA, the Gradall is an earth excavation tool and is not used to remove rock material.

As we previously have concluded, the method of excavation used is not a precise indicator of the type of material encountered. (See p. 53). Mr. Robert Schuler, Appellant's equipment superintendent, further testified that he had operated a Gradall 880 on other jobs and had used it to rip rock. (Tr. VII, p. 26). Mr. Schuler also testified that he was at the shaft during the excavation process and remembered the Gradall being used to remove rock. (Tr. VII, p. 26-28).

Appellant's Superintendent's Diary for the period in question shows that Mr. Schuler had daily job site responsibilities at the shaft. (Exh. S-74B). Further supporting his testimony is a photograph of the shaft excavation taken on March 24, 1979, showing a number of rock fragments which had been excavated. (Exh. A-19). The Superintendent's Diary entry of March 23, 1979 likewise denotes that Appellant was encountering ". . . some pretty hard material at springline of tunnels." (Exh. S-74B). Finally, as we already have found, a differing site condition was experienced in the tunnels in this area. For all of these reasons, therefore, the Board finds that RZ-2 material was encountered in the shaft excavation process by March 22, 1979.

As to the period from March 15 to March 21, 1979, we are also persuaded that RZ-2 material was encountered. By March 15, excavation at the shaft had proceeded down to the level of the springline of the tunnels in the area between the tunnels. (Exh. S-74B, Mar. 15, 1979). Mr. Irish's plot of the ground materials at the shaft shows RZ-2 material at springline and above throughout most of the shaft region. (Exh. A-33). This is corroborated by the records of Mr. Don White, Appellant's heading engineer, and the MTA's own inspectors. (Exhs. A-57, A-76). Neither Mr. White nor the MTA inspectors were trained geologists. However, each observed materials that they categorized as rock during this period. We thus accept Appellant's contention that RZ-2 material was encountered commencing on March 15, 1979.

Finally, with respect to April 12 and 13, 1979, Appellant spent these days cleaning out shot rock from the bottom of the shaft excavation. Appellant's Superintendent, in fact, noted that shaft excavation was complete on April 13, 1979. (Exh. S-74B, Apr. 13, 1979). This cleanup work would not have been necessary in an earth excavation and thus these two days should be considered in gauging the impact of the differing site condition at the shaft.

## III. Quantum

### A. Pile Drilling Operations

#### 1. Findings of Fact

a. Appellant contends that it sustained a 42 work day delay as a result of having to drill through rock when preparing to place soldier piles. (Exh. A-1(2)). The MTA would reduce this impact by the time lost as a result of (1) the breakdowns of Appellant's Calweld drill and the swing pump on its crane; (2) drilling into a second foot of rock; (3) a dewatering test; and (4) locating utility lines.

b. Appellant's Calweld drill broke down while being used to auger rock on April 10, 1978. Upon dismantling the unit, Appellant found that the bull gear on the drill had been stripped and that there were cracks in (1) the bearing housing; (2) mountings for the torque cylinders; and (3) in the hinge which held the drill rig to the crane. The Calweld drill was not repaired until the afternoon of April 20, 1978, thus delaying the augering process by 65 work hours.

Appellant's equipment superintendent, Mr. Schuler, testified that the bull gear had been replaced one month earlier on the job when the drill was being used at the Monument Street Vent Shaft. (Tr. VII, pp. 122-23). Mr. Schuler could not say why the gear had to be replaced at that time, nor was there testimony as to the useful life of a bull gear. Mr. Schuler did opine that the bull gear failed at Lafayette Avenue because the rock material placed severe torque on the drill. (Tr. VII, pp. 33-34). Further, concomitant cracking of other parts, as witnessed at Lafayette Avenue, was not similarly experienced at Monument Street when the bull gear repair was made.

After repair of the bull gear, the Calweld drill was used to auger material at the remaining 17 deep pile holes. Despite the fact that rock was encountered, the bull gear held up throughout. Appellant attributes this to the fact that a core bucket and drop beam were used thereafter, thus placing less stress on the drill. However, the core bucket and drop beam were available to Appellant on April 10, 1978 and could have been used exclusively, rather than interchangeably with the rock auguer.

While we are convinced by the testimony that the damage caused to the drill resulted from the encountering of hard rock, it appears that the delay could have been avoided by the prudent use of a core bucket and drop beam. It would have been one thing if Appellant had been using a rock auger to go through RZ-2 material and suddenly hit harder material which damaged its drill. However, here Appellant had been drilling hard rock with its auger for nearly two days at pile L-25 when the bull gear on this drill broke. Despite the fact that the core bucket and drop beam were available to it, Appellant imprudently attempted to use the rock auger. This action, in our view, was the primary cause of the bull gear breakdown. (Tr. XIX, p. 70-71). Accordingly, the 65 work hour reduction to Appellant's delay is reasonable.

c. Appellant's Calweld drill was attached to an American 999 Crane. The swing pump on the crane necessitated repair commencing on June 19, 1978, thus stopping the drilling of soldier piles through June 22, 1978. (Exh. S-74B, S-59B). A delay of 28 work hours was sustained.

Mr. Schuler testified that, in his opinion, the house brake on the crane was unable to hold the kelly bar of the drill in a vertical position because of the excessive lateral force or movement created by the drill going through the hard rock material. As a result, the hydraulics overheated and failed. (Tr. VII, pp. 39-42).

Problems with the swing pump on the crane also were experienced on December 13, 1978, after the drilling operation was completed. The record, however, does not indicate the precise nature of the problem. (Exh. S-74B; Tr. XVI, pp. 81-82; Tr. XVIII, pp. 143-145).

Based on the foregoing, we cannot accept Mr. Schuler's testimony as a basis to conclude that the swing pump on the crane failed as a result of the differing site condition. There was no testimony as to the age or condition of the swing pump, nor was there an indication of its useful life or maintenance history. Further, the problem with the swing pump may have been caused by an improperly functioning swing brake. (Tr. XIX, p. 71). As such, Mr. Schuler's testimony was speculative and is rejected. The Board, accordingly, accepts the MTA's 28 work hour reduction to Appellant's delay calculation.

d. Appellant's delay analysis was premised on an "as would have been" schedule calling for the long piles to be keyed one foot into rock. The MTA contends that Appellant was obligated to drill at least two feet into rock and thus a correction to the foregoing schedule should be made to adjust for the time it would take to drill the second foot into rock. A correction of one-half hour per foot, or 9 hours, has been proposed without challenge by the MTA.

Appellant now contends that it did not anticipate encountering rock when drilling for soldier piles. At the hearing, it adduced testimony from Mr. A.A. Mathews who analyzed the boring log information to conclude that rock should have been encountered on average at an elevation 10 feet below the shaft subgrade. (Exh. A-39). Appellant also contends that a one foot key into rock was more than sufficient.

Despite the foregoing, we cannot accept Appellant's argument. Mr. Williamson's letter to the MTA dated April 17, 1978 stated that Appellant anticipated encountering rock material 84.2 feet below street surface.

(Rule 4, Tab IV(l)). The rock elevation anticipated by Appellant was approximately six feet below the shaft subgrade and not 10 feet. Further, Appellant's August 12, 1977 pile design contemplated a minimum six foot toe for pile drilled into rock. While Appellant now says that the term rock refers to RZ-1 material, its designer was never called to testify as such. The consistency between the August 12, 1977 design and Mr. Williamson's letter makes clear to us that Appellant contemplated the possibility that up to six feet of drilling into rock may have been necessary for the long piles.

Whether a one foot key into solid rock is all that was required likewise was not proven. Appellant was responsible for the pile design and never submitted shop drawings and supporting calculations for a one foot key. The final approved design called for a two foot key into solid rock. Accordingly, Appellant should have premised its "as would have been" schedule on drilling two feet into rock. The 9 work hour correction thus is accepted.

e. With respect to the MTA's deductions of four work hours on June 27, 1978 for a dewatering test, and two work hours on July 11, 1978 for the location of utility lines, there is no credible evidence to substantiate this position. While the MTA's Mr. Earl Turner cites support in the records of the construction manager, these records were not identified. Appellant's records, on the other hand, do not indicate these delays.

f. With respect to the costs resulting from the differing site condition, the parties disagree only as to (1) loader and loader operator costs; (2) the method of charging for the 400 amp welder and a drop beam; and (3) equipment rates.

g. A loader was necessary during the pile drilling operation to relocate the spoil away from the drill rig and then load the spoil into dump trucks for disposal. It use was sporadic, however, and for this reason Appellant seeks compensation for the operator and loader on a half-time basis.

The MTA refuses any compensation for this equipment, despite the extended pile drilling operation, because the loader could be brought to the shaft area on an as-needed basis. Further, since the quantity of spoil material was reduced as a result of so much rock being encountered, the loader was needed less than might have been anticipated at bid time.

Appellant's Mr. Kohl calculated that the amount of spoil material was reduced only by five percent. (Exh. A-41; Tr. XI, pp. 141-42). Additionally, Mr. Turner's chart (Exh. 1-1 to Exh. S-59B) reveals that the loader actually was used 42% of the time during the pile driving operation. Since this does not take into account the time necessary to move the loader around the site, the 50% figure proposed by Appellant seems reasonable. Accordingly, we accept Appellant's method of pricing the extended cost for the loader and operator.

h. A 400 Amp. welder was required to weld pile casings and to repair the Calweld drill. The MTA argues that this piece of equipment should be compensated for at a standby rate, while Appellant asks for the normal equipment rate. The issue is determined by whether the welding machine was idle during a part of the time when the piles were being driven. We find that since the welding machine was used for more than just the repair of the Calweld drill, there is no evidence that it sat idle for long periods of time. Compensation at the appropriate ownership rate thus is reasonable.

i. Appellant incurred an expense of $2,103 for a drop beam to help break up the rock encountered in the pile holes. Mr. Kohl testified that the drop beam would not have been purchased but for the differing site condition. (Tr. VIII, p. 158). Accordingly, Appellant seeks recovery of the entire expense as compensation for the differing site condition.

The MTA argues that the drop beam would have been necessary in any event because Appellant had no other rock drilling equipment. Since Appellant had to key into two feet of rock for the 19 long piles, the MTA says that the drop beam was essential.

We find that the facts support Appellant. Even though some rock removal was to be expected, it was to be a relatively small amount. Appellant was able to remove some 24 feet of hard rock without the use of a drop beam and it is not inconceivable that its equipment would have been adequate to key each of the long piles two feet into rock.

2. Decision

Appellant's pile driving operation was extended by 29 work days as a result of the differing site condition. This constituted an additional 232 work hours. As a result, Appellant incurred the following additional direct costs:

| | | |
|---|---|---|
| a. Labor | | |
| Pile driver | $11.976/hr. x 232 hr. = | $ 2778.43 |
| Miner | 10.873/hr. x 232 hr. = | 2522.54 |
| Crane Operator | 13.884/hr. x 232 hr. = | 3221.09 |
| Crane Oiler | 11.559/hr. x 232 hr. = | 2681.69 |
| Subtotal | | $11203.75 |
| Loader Operator | 13.884/hr. x 116 hr. = | 1610.54 |
| Total | | $12814.29 |
| b. Small Tools & Supplies | | |
| | 8.6%[25] x $12,814.29 = | $1102.03 |

[25] The parties have stipulated to this rate. (MTA Reply Brief, p. 24).

c. Material

| | | |
|---|---|---|
| Drill tools and teeth at $30/hr | = | $ 6960.00 |
| Drop beam | = | 2103.00 |
| Total | | $ 9063.00 |

d. Equipment

Appellant is entitled to compensation for the use of a 110 ton crane and a Calweld drill for the entire 232 hours of extended performance. Also, it is entitled to compensation for a Ford A-64 loader and a 400 Amp. welder for a total of 116 hours of use. The parties are in dispute as to the appropriate ownership rates to be charged for this and other equipment to be compensated as part of the equitable adjustment.

1. Equipment Rates

The central issue here is whether we will base Appellant's equitable adjustment on actual costs recorded in its books and records or on a commonly used industry rate book. For the following reasons, under the circumstances of the instant appeal, we base our determination of Appellant's equitable adjustment for equipment usage on actual costs derived from its books and records.

Appellant maintains that it is entitled to an equitable adjustment consisting, in part, of the costs incurred for equipment it used during the contract period as extended by the differing site condition. It calculates its increased costs based on use of AGC rates[26] and "CalTrans" Rates.[27] The CalTrans equipment rate method and the AGC rate method for calculating equipment costs are based on a compilation of average ownership costs on a nationwide basis. These two rate books are sometimes relied upon by contractors to bid on projects and can be used to estimate equipment ownership costs during periods of construction work.

Appellant maintains that in determining its equitable adjustment the MTA should have looked first to the CalTrans rates to calculate equipment rates. Where the CalTrans rate manual does not have a rate for a piece of equipment, Appellant maintains that MTA should have used AGC rates. The basis of Appellant's position is Contract Special General Provision ("SGP") 9.02 which provides for the application of CalTrans rates for equipment used in all force account work, regardless of whether the equipment was contractor-owned, rented, or otherwise acquired.

"Force account work" generally refers to a contract provision under which the parties have agreed in advance to a forward pricing arrangement for any unanticipated, emergency work arising during the contract performance period. See: George Bennett v. United States, 178 Ct.Cl. 61, 66-67 (1967). See generally: Laas v. Montana State Highway Commission, 157 Mont. 121, 483 P.2d 699 (1971). It is clear that Contract General Provision

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[26] Equipment ownership and operating costs are sometimes computed on the basis of rates or formulas published by various organizations. One such study is published by the Associated General Contractors of America, Inc. (AGC). This study permits a contractor by use of the AGC formulas to compute ownership costs based on a percentage of the contractor's capital investment in each piece of equipment. L.L. Hall Constr. Co. v. United States, 177 Ct.Cl. 870 (1966); George Bennett v. United States, 178 Ct.Cl. 61 (1967).

[27] The CalTrans Equipment Rate method is another method used to estimate equipment ownership expense and was developed by the California Department of Transportation for use on its contract projects. CalTrans rates are sometimes used outside California as a standard method for deriving equipment costs by contracting parties. Blasky and Walters, "Recovery for Equipment Usage," Construction Briefings, No. 83-5, Federal Publications, Inc. (May 1983).

GP-9.02C required a determination by MTA and a subsequent directive that the work be done on a force account basis pursuant to GP-9.02C as modified by SGP 9.01. Here, the MTA did not give such a directive to Appellant. Based on this consideration, we hold that the extra work here involved is to be compensated for under the equitable adjustment provisions of the Differing Site Conditions Clause (GP-4.04) and not the contract force account provisions.

The issue which we now need address is the extent that Appellant otherwise may be entitled to use standard manual rates to calculate that part of the equitable adjustment attributable to its equipment costs pursuant to the differing site conditions clause of the contract. Appellant thus seeks to receive its costs for its equipment expenses based on the standardized equipment rate formulas, e.g., AGC rate manual costs or CalTrans rate manual costs. In this regard, Appellant contends that equipment cost calculations based on costs appearing on Appellant's books do not equitably compensate it for the additional equipment costs it expended as a result of the DSC for its equipment acquisition costs including: (1) equipment unload, assembly and disassembly costs ("assembly"); (2) erection costs ("erection"); (3) freight-in freight-out costs ("freight"), as part of equipment ownership or use costs and storage and miscellaneous handling costs ("storage"). Appellant contends as well that it has not been equitable reimbursed for its annual ownership costs including: (1) interest on investment (i.e. return on investment or equity capital); (2) taxes; and (3) insurance.

MTA calculates equipment costs measured by the actual costs incurred by Appellant as derived from its books and records. MTA maintains that use of other than actual, booked costs would be unreasonable because it would place Appellant in a different financial position than it would have been in had the differing site condition not occurred.

The basic objective of an equitable adjustment is to make the contractor whole, i.e., to put the contractor in the same financial position it would have been in had the extra work caused by the government not been required. See: MPA v. Langenfelder, 525 Md. App. 537, 438 A.2d 1374 (1982); L.L. Hall Constr. Co. v. United States, 177 Ct.Cl. 870, 885 (1966); George Bennett v. United States, 178 Ct.Cl. 61, 70, 371 F.2d 859 (1967); C.J. Langenfelder & Son, Inc., MDOT BCA Nos. 1000, 1003, 1006, 1 MICPEL ¶2 (August 15, 1980). See also: National Micrographics Systems, Inc. v. OCE-Industries, Inc., 55 Md. App. 526, 465 A.2d 862 (1983); Dialist Co. v. Pulford, 42 Md. App. 173, 399 A.2d 1374 (1979); Pennsylvania Threshermen & Farmers' Mutual Casualty Insurance Co. v. Messenger, 181 Md. 295 (1942). A contractor should be reasonably compensated for extra work that was not considered initially and made a part of his costs in arriving at his original contract bid price. In this regard, actual costs of performing the extra work are presumed reasonable. In other words, the party wishing to substitute the use of a standard rate manual procedure for calculating the equitable adjustment has the burden of demonstrating the inadequacy of the actual costs as shown on the contractor's records. C.J. Langenfelder, supra.

In L.L. Hall v. United States, 177 Ct.Cl. 870 (1966), the U.S. Court of Claims [now the U.S. Claims Court (Cls. Ct.)] noted that the parties had stipulated that for the delay period involved actual equipment costs could not be extracted from plaintiff's books and records with reasonable accuracy.

They agreed that all equipment involved in the claim was owned by the plaintiff and none was rented. Plaintiff maintained that A.E.D. [Associated Equipment Distributors Manual] rates developed based on equipment rental rates were appropriate for computing its additional equipment costs for owner-caused delay. The owner, the United States, maintained that in the absence of actual costs obtained from Plaintiff's books and records the best criterion for determining a contractor's cost of owning its own equipment were the AGC equipment ownership rates. The Court of Claims explained the underpinnings of the AGC manual rate concept as follows:

> The contractors' annual equipment expense as shown by the A.G.C. Contractors' Equipment Ownership Expense Manual 1959, is composed of six items, as follows: (1) Depreciation, (2) Major Repairs and Overhauling, (3) Interest on the Investment, (4) Storage, Incidentals and Equipment Overhead, (5) Insurance, and (6) Taxes. These six items are expressed as percentages of the capital investment.
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> The manual states: '* * * Each contractor must use the value of his own particular piece of equipment, and by applying the recommended percentage per month (adjusted if necessary) against that figure the ownership cost can be determined.' [Plaintiff's exhibit 47, p. 1]
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> 'It has been set forth herein that the purpose of this schedule is to reflect the average expense to a contractor owning and operating his own equipment on his own contracts. The charges which a contractor is justified in making under such circumstances are to be distinguished from those charges which are justifiable where the contractor may lease or rent a machine to others.' [Id., p. 3.]

L.L. Hall v. United States, supra, n. 2, at 881.

L.L. Hall thus involved a contest over whether A.E.D. manual "rental" rates or AGC manual "ownership" rates should be applied. The Court of Claims acknowledged the absence of actual equipment costs that could be reasonably extracted from plaintiff's books and records, and stated:

> There is a special problem in the instant case in that plaintiff from the very beginning of the delay elected not to establish its costs for equipment during idle time but to rely on A.E.D. rental rates and so advised defendant which did not protest at that time. This poses the same problem as had it elected to rely on A.G.C. rates without showing actual costs.

> Can a contractor properly do so? Might not such an election result in higher damages? Is not the best evidence the actual costs? After all, these rate manuals are only guides and estimates based on national averages and subject to many adjustments. Where they are in evidence, and actual costs are not, they are only a tool with which to hammer out a reasonable "jury verdict."
>
> Contractors generally do not keep books to prove damage claims. A large contractor sometimes does so when faced with delays caused by the Government, and where this is done those records are the best evidence.

The Court of Claims in its decision had earlier stated as follows:

> However, examination of the foregoing cases reveals very little that is helpful in understanding why rental rates were applied there to contractor owned equipment or that they were contested, as in the instant case, with A.G.C. rates. They have presumably been applied without contest and as the best formula available in the circumstances to approximate actual equipment costs which were not available. That is also about the most that can be said of court approval of A.G.C. rates. See, for example, Ben C. Gerwick, Inc. v. United States, 152 Ct.Cl. 69, 285 F.2d 432 (1961), a delay-damages case wherein A.G.C. rates, less 50 percent for idle time, applied to acquisition cost, or to appraised acquisition cost, were used to measure damages or additional ownership expense as a result of delay. (Underscoring added).

The L.L. Hall Court further noted that under varying factual circumstances Court of Claims cases have indicated that rental rates are applicable and have been "widely used, and widely disregarded" depending on how well they measure the lost useful value of idle equipment in a particular situation, with a minimum of speculation. The Court importantly emphasized that:

> "Of course, if every contractor could ignore actual equipment operating costs, assuming it had or could reasonably maintain records of such costs, and rely instead on A.E.D. or A.G.C. rates, it would be absurd. Some showing must be made that secondary evidence is appropriate because the primary evidence (actual costs) is nonexistent or unavailable for good reason.[4]

[4] In Perini Corp. v. United States (Ct.Cl. No. 228-58, Commissioner Gamer's report, November 30, 1965) footnote 11, finding 108, rejects plaintiffs' estimated costs based on A.G.C. rates where it claimed its books were deficient in showing actual costs. It was found plaintiffs' books were adequate and were the best evidence and plaintiffs could not disavow them for purposes of their claim." (Underscoring added).

The Court in L.L. Hall went on to state that "there is no justification for use of rental rates as a substitute for unavailable equipment-use costs in the instant case. The A.E.D. manual was not designed for this purpose." (Underscoring added). Finally, the L.L. Hall Court held:

> "The fair and reasonable measure of damages for plaintiff's equipment expenses in this case, for contractor-owned equipment, lacking actual cost records for the delay period, is the acquisition cost of each piece of equipment involved applied to the formula set forth in the A.G.C. ownership expense manual and reduced by 50 percent for idle time, during which time the equipment suffers no wear and tear." (Underscoring added).

L.L. Hall v. United States, supra, at 886.

As illustrated by L.L. Hall, supra, the pecking order established for determining an equitable adjustment, at least in so far as equipment costs are concerned, is as follows:

1. Actual costs based on the contractor's books and records (the best or primary evidence);
2. A.G.C. ownership rates tied to acquisition costs (secondary evidence);
3. A.E.D. rental rates (secondary evidence).

The United States Court of Claims in Meva v. United States, 206 Ct.Cl. 203, 221 (1975) reached the same result. In Meva, a breach of contract case, an issue was whether "plaintiff's 'total costs' of performing the clearing of timber and footings work for utility poles were either $2,539,505 (utilizing AGC equipment costs in the computation) or $2,448,938 (utilizing booked equipment costs in the computation)." Meva v. United States, supra, at 219. The Court rejected plaintiff's total cost approach because Appellant had not established by fully reliable and substantial evidence that its total costs were reasonable, or that it was not responsible for the added expenses. However, the Court of Claims found that the plaintiff there had suffered substantial monetary damage due to defendant's breach of the contract. Accordingly, the

Court of Claims held that the record was sufficient to permit a calculation of plaintiff's damages by way of a "jury verdict" with a reasonable degree of accuracy as to the extent of such damages. Importantly, the Court of Claims stated:

> Actual, booked, equipment costs being available, AGC equipment costs may not be considered in assessing plaintiff's damages. Bennett v. United States, 178 Ct.Cl. 61, 371 F.2d 859 (1967); L.L. Hall Constr. Co. v. United States, 177 Ct.Cl. 870, 379 F.2d 559 (1966).[10a]
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> 10a In the absence of a regulation or directive such as in Nolan Brothers, Inc. v. United States, 194 Ct.Cl. 1, 437 F.2d 1371 (1971), the burden is on the party seeking to substitute AGC costs for the contractor's own actual, booked costs to demonstrate that the contractor's own costs (as shown) are inadequate or incomplete or do not fairly represent the full costs rightly attributable to the particular contract. In this case, plaintiff did not succeed in bearing that burden; its effort to invoke AGC costs consisted mainly of general testimony as to the normal practice of building contractors, not criticism directed specifically to the $2,448,938 of costs calculated from its own actual, booked equipment costs in this particular instance. The plaintiff has simply failed to prove that in this case actual, booked costs are inadequate or incomplete or do not represent the full costs rightly attributable to the contract. (Underscoring added).

Meva v. United States, supra, at 221.

The Meva Court then rendered a "jury verdict" for plaintiff in the amount of $600,000.

In the Federal sector, more recent cases do not vary from the principle that calculating increased equipment costs attributable to delay are in the first instance to be calculated based on actual, booked costs of the equipment as the best evidence of damage unless the parties have expressly agreed otherwise. See: J.F. Shea v. United States, 10 Cls.Ct. 620 (1986). On the other hand, if booked costs are not available, AGC rates are suitable for use in calculating an estimate of the contractor's increased costs for contractor owned equipment due to the delay. A.E.D. rates may be used for calculating increased equipment costs under a contract equitable adjustment provision where it is established that the contractor actually rented the equipment. Compare: Degenaars Co. v. United States, 2 Cls.Ct. 482 (1983) with Meva v. United States, supra.

Other Claims Court decisions which have dealt with computation of contractor equitable adjustments for equipment costs, or breach of contract damages, adhere to the principle set down in L.L. Hall v. United States, supra, and Meva v. United States, supra. Thus, Charles D. Weaver, Order, 209 Ct.Cl. 714, 715-16 (1976) states:

> "Decisions of this court indicate that only where primary evidence, i.e., actual costs, is unavailable, will resort be made to secondary evidence. Bennett v. United States, 178 Ct.Cl. 61, 67, 371 F.2d 859, 862-63 (1967). Also, if secondary evidence is to be used, it must be based on associated general contractor survey data and not rental rates. Meva Corporation v. United States, 206 Ct.Cl. 203, 511 F.2d 548, 559 (1975); and L.L. Hall Constr. Co. v. United States, 177 Ct.Cl. 870, 379 F.2d 559 (1966). As noted above, plaintiff has made no effort to explain the use of rental costs, other than to say it would be unfair to require him to use actual costs. Plaintiff has not met his burden of demonstrating that the actual book costs are unavailable, inadequate, or incomplete, or do not fairly represent the full costs rightly attributable to the particular contract, which he must do in order to substitute AGC costs or rental costs. See: Meva Corporation v. Untied States, supra, n. 10 a. See also, L.L. Hall Constr. Co. v. United States, supra." (Underscoring added).

See: Cen-Vi-Ro of Texas, Inc. Order, 210 Ct.Cl. 684 (1976). See also: Bruce Constr. Corp. v. United States, 163 Ct.Cl. 97, 324 F.2d 516 (1963) and Nager Elec. Co. v. United States, 194 Ct.Cl. 835, 442 F.2d 936 (1971).

Thus, the starting point for determining an equitable adjustment for equipment costs should be based on the rule of best evidence under the circumstances. Accordingly, Appellant has the burden of proving the reasonableness of its method for calculating an equitable adjustment weighted against the benchmark that actual costs are the most reasonable costs if available. It must show that its own booked costs are inadequate or incomplete or do not fairly represent the full costs rightly attributable to the costs it incurred because of the DSC. Meva v. United States, supra, at 221.

We recognize that MTA used "CalTrans" and AGC rates, or both, to determine equitable adjustments in certain instances under the instant contract and has used these cost determination methods for equipment adjustments for extra work under other contracts. However, MTA was not bound to do so when arriving at equitable adjustments for all change orders under the instant contract.

In summary, we find that actual costs for Appellant's equipment usage are available. Since we find that Appellant has not reasonably demonstrated that its booked costs are inadequate, incomplete, or do not fairly represent the full costs attributable to its increased equipment costs due to the DSC, we hold that the appropriate measure of Appellant's equitable adjustment for its increased equipment costs during the delay period is the one espoused by MTA. It is derived from the actual, booked costs Appellant experienced for use of specific equipment during the contract, including the overrun period. Determining Appellant's increase in its costs of ownership for each piece of equipment based on its actual, booked costs and adding in the operating costs (equipment operating expenses (EOE)) for the period of delay encountered reasonably compensates Appellant and places it more nearly in the same financial position it would have attained had the differing site condition not occurred. See: L.L. Hall v. United States, supra, at 886; Hardeman-Manier-Hutcherson, A Joint Venture, ASBCA No. 13188, 68-2 BCA ¶7400.

In this regard, MTA developed an approach to compensating Appellant for its excess equipment ownership costs for the delay caused by the DSC based on its actual costs. Using Appellant's books and records MTA's cost accounting expert listed the capital cost for each piece of equipment. For each piece of equipment he added certain miscellaneous costs such as capital repairs to arrive at a total equipment cost for each piece of equipment. The MTA expert then deducted the salvage value (residual value) of the equipment from the total equipment cost to arrive at a net equipment ownership cost for the piece of equipment. MTA also computed the hours of usage for each piece of equipment for the total contract period including both the agreed contract period and the period of delay. MTA divided Appellant's net ownership costs for each piece of equipment by the total hours of usage to arrive at an ownership rate per hour.[28] The Tunnel Driving Machine is used to illustrate this methodology as follows:

| | | |
|---|---|---|
| Step 1: | Purchase Price | $698,460 |
| | Material | 0 |
| | Overhead, Allocated | 14,815 |
| | Other | 0 |
| | Erection | 0 |
| | Total Acquisition Cost | $713,275 |
| | Salvage Value | (78,614) |
| | Net Equipment Ownership Cost | $634,661 |
| Step 2: | Equipment Ownership Cost of Tunnel Driving Machine / Total Hours' Usage | $634,661 / 10,486 hrs. |
| | Hourly Rate = | $60.52 hour |

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28 MTA's methodology allocated the taxes on equipment as a part of the overhead pool. Appellant has not otherwise shown that it is entitled to an additional amount for increased tax payments on the equipment as a capitalized cost as a direct result of the delay caused by the DSC. Similarly, as discussed below (page 118 of Decision) insurance is not directly recoverable as a capitalized equipment ownership cost but these costs ($11,470) are added back into the overhead pool.

A second element of equipment expense is the cost of operation (Equipment Operating Expense (EOE)). MTA computed Appellant's operating expenses, repairs and maintenance costs on a per hour basis. For the Tunnel Driving Machine, MTA computed the hourly rate as follows:

Step 3: $\frac{\$545{,}516 \text{ (Total Equipment Operating Expense)}}{10{,}486 \text{ hrs. (Total Hours of Usage)}} = \$52.02\text{/hour}$

MTA's total hourly rate for the Tunnel Driving Machine thus is:

| | | |
|---|---|---|
| Step 2: | Ownership Hourly Rate | $ 60.52 |
| Step 3: | EOE Rate | + 52.02 |
| MTA - Total Hourly Ownership and Operating Rate for Compensating Appellant | | $112.54 |

There remain ancillary issues concerning the extent that an equitable adjustment based on increased equipment ownership costs on this project may include equipment assembly and disassembly costs ("assembly"); erection costs ("erection"); freight-in, freight-out costs ("freight"); storage and miscellaneous handling costs ("storage") as well as interest on investment costs in the equipment. These types of costs are considered in deriving costs based on equipment rates when using the CalTrans and AGC manuals. The rates in these manuals, of course, are derived based on the particular theories of those manuals regarding what ownership costs entail.

We find that additional compensation for equipment assembly charges, erection charges, and freight charges under the facts of the instant appeal are not reasonably recoverable as part of the equitable adjustment as these costs are neither time nor use related. Appellant did not reasonably show that these costs increased as a result of the DSC or that it treated these costs as capital costs under its accounting methodology rather than as expensed items. In this regard, charges for unloading, assembling and erecting equipment, brought to the site for performance of the agreed contract work, as well as freight charges and storage charges, to reiterate, were not increased as a direct result of the DSC, although such charges may in some instances be included as part of the acquisition cost on a capitalized cost basis, rather than as an expensed cost distributed as an overhead expense, in computing costs or calculating a usage rate charge for equipment. Under the facts of this case, therefore, we deny Appellant direct compensation for these charges in calculating an equitable adjustment for equipment usage during the extended contract period. Similarly, we deny Appellant storage costs after contract completion as part of the equitable adjustment because they are not shown to be time or use related such that they were increased because of the DSC.

Thus, under circumstances where an overrun occurs due to unanticipated work entitling the contractor to additional costs, it may be appropriate and reasonable only to use the original purchase price of the equipment in calculating an equitable adjustment. On the other hand, under appropriate circumstances, meaning appropriate proof, an equitable adjustment may be based on the purchase price and may include as well as part of the basis the freight charges, erection charges, assembly and disassembly charges, and storage costs, i.e., the use of "acquisition costs" to calculate costs on a depreciation basis or to determine a use allowance, provided the calculations are based on reasonable and acceptable general accounting methods. See: COMAR (Code of Maryland Regulations) 21.09.01.09. See generally: COMAR 21.09.01.22; FAR (Federal Acquisition Regulations), Part 31, §31.205-11(l), Depreciation. In this regard, COMAR 21.09.01.09D provides that factors to consider in establishing a use allowance, in lieu of depreciation, for equipment costs are the original cost, remaining estimated useful life, the reasonable fair market value, and the effect of any increased maintenance or decreased efficiency.

However, under the facts of record before us in the instant case, we are convinced that MTA's method of computing the equitable adjustment for equipment costs reasonably compensates Appellant for its costs on a use allowance basis where the evidence indicates to us that Appellant, a joint venture, failed to prove that freight, erection, assembly and storage charges reasonably should be included in the base cost used to derive equipment rates for purposes of arriving at an equitable adjustment, and, in fact, may have recovered most of such equipment costs as measured by the contract's life under the contract. Accordingly, while use allowances determined based on equipment acquisition costs would not necessarily be unreasonable under the principle of making the contractor whole, we are not convinced here by the greater weight of evidence that Appellant's method of computing equipment costs prevails over MTA's methodology for computing Appellant's equitable adjustment for its equipment overrun charges. Accordingly, we have used MTA's methodology and equipment rates in determining Appellant's equitable adjustment. MTA's cost accounting methods used in this appeal generally do not use assembly, erection, freight, and storage charges to calculate equipment rates as part of the basis for an equitable adjustment.

We next address Appellant's claim for its costs for its interest on investment or equity investment in equipment (i.e., its capital equipment costs or equipment capital cost of money) as an element of equipment ownership costs for the delay period. This cost is sometimes referred to as the "imputed cost of equity capital," also called "Return on Investment (ROI)." <u>See generally</u>: <u>Blue Cross Association and Blue Shield Association (In the</u>

Matter of Pennsylvania Blue Shield), ASBCA No. 21113, 82-2 BCA ¶15,966.

COMAR 21.09.01.22, entitled "Use of Federal Costs Principles," in part states:

> "A. Cost. Negotiations. In dealing with contractors operating according to federal cost principles, such as Defense Acquisition Regulations, Section 15, or Federal Procurement Regulations, Part 1-15, the procurement officer, after notifying the contractor, may use the federal cost principles as guidance in contract negotiation, subject to §B.[29]

COMAR 21.09.01.02 provides that the cost principles set forth under COMAR, Subtitle 9 apply to the cost reimbursement provisions of a contract such as the changes clause.

In this regard, we note that Federal contract cost principles and procedures that COMAR alludes to provide, for contractors operating according to these cost principles, guidelines and required procedures for measuring, recording and allocating such costs for use in the pricing of contracts, subcontracts, and modifications to contracts and subcontracts whenever cost analysis is performed and for the determination, negotiation, or allowance of costs when required by a contract clause. For example, the Federal Acquisition Regulations (FAR) by analogy provide that facilities capital cost of money (cost of capital committed to facilities) is an imputed cost determined by applying a cost-of-money rate to facilities capital employed in contract performance, and that CAS (Cost Accounting Standard) 414, Cost of Money as an Element of the Cost of Facilities Capital, establishes criteria for measuring and allocating, as an element of contract cost, the cost of capital committed to facilities. See generally: Federal Acquisition Regulations (FAR), Part 31 (Contract Cost Principles and Procedures) Subpart 31.205-10

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[29]Section B provides that in Federal assistance programs Federal cost principles prevail over COMAR cost principles.

(Cost of Money) [4 Government Contracts Reporter (CCH) ¶30.601.10]; DOD (Department of Defense) FAR Supplement, Subpart 31.205-10, Cost of Money, [5 Government Contracts Reporter (CCH) ¶34,366].

This Board would not necessarily disallow recovery of the cost of money invested in equipment, i.e., "interest on investment costs," as an imputed cost of ownership for a period of compensable delay in arriving at an equitable adjustment. However, Appellant has not adequately demonstrated here a reasonable accounting or allocation basis necessary for us to arrive at a judgment allowing Appellant's claim for its interest on investment costs as a part of its equitable adjustment for the DSC delay period. We note, in this regard, Appellant will receive profit on the equitable adjustment we award based on its costs. See generally: MPA v. Langenfelder, supra.

In summary, the equitable adjustment for the delay caused by the DSC that we apply is based on two criteria: (a) MTA's usage hour methodology using equipment purchase price plus overhead and other allocated costs and (b) Appellant's equipment operating expenses (EOE). See generally: Hardeman-Monier-Hutcherson, A Joint Venture, ASBCA No. 13188, 68-2 BCA ¶7400.

We next address the use of salvage values in determining equipment costs. Both parties rely on different methods for calculating the salvage value used in determining Appellant's equipment ownership expense for the delay period. Appellant contends that the salvage value is the net book value at the time of transfer after the project's completion to another accounting entity based on its equipment depreciation methods. Appellant thus contends that the depreciation rate it used to calculate the value of equipment at the time of transfer at the end of the job is appropriately determined based on equipment value at the time of acquisition of the particular piece of equipment less the salvage value determined at that time.

MTA, on the other hand, contends that the equipment ownership expense should be calculated based on the salvage value at the time of transfer to another entity at the end of the project, i.e., determined by the actual sale price if the equipment is sold to a third party pursuant to an arms length transaction. Alternatively, if the equipment was transferred from Appellant (Fruin-Colnon acting as a joint venture) to Fruin-Colnon Corporation, a separate corporate entity, MTA contends that the salvage value should be measured by the reasonably estimated market value of the equipment at the time the equipment was transferred from the Appellant, acting as a joint venture, to Fruin-Colnon Corporation.

MTA's position regarding salvage value tends to give a higher dollar amount for salvage value than the net book valuation method espoused by Appellant. In turn, MTA's higher salvage values based on an estimated market value evaluation at the time of transfer at the end of the job, or actual sale price if sold to a third party, results in lower equipment ownership expense than Appellant's depreciation method which is based on lower estimated salvage values applied at the time of equipment acquisition. MTA's valuation method thus tends to result in a lower equitable adjustment for each piece of equipment.

We accept MTA's theory under the evidentiary facts and circumstances of this appeal. We think MTA's salvage value calculation method is reasonable where it determines the loss of value of equipment based on actual costs over the contract period, which includes the delay period resulting from the DSC.

Finally, although not at issue in this section of our opinion, it is an opportune time to address Appellant's claim for an equitable adjustment for increased Tunnel Plant costs occurring due to the DSC. Tunnel plant as described by the evidence is not equipment. The record in this regard does not reflect that the costs of tunnel plant materials, e.g. piping, wiring, etc., increased due to the DSC. Essentially, the costs incurred under the instant contract for this type of material did not directly increase with time but were more closely associated with tunnel length. In other words, only so much of this material was going to be used as required by the length of the tunnel, regardless of when it was installed. The amount of this material required for the work thus would have been required whether or not DSC occurred. Accordingly, we find that Appellant has not clearly met its burden to show that it incurred increased tunnel plant expenses directly attributable to the delay caused by the DSC. It follows that Appellant has not sustained its burden of proof that it is entitled to an equitable adjustment for an increase in tunnel plant costs. See: Massman Construction Co. v. Tennessee Valley Authority, 769 F.2d 1114, 1115 (1985).

2. Summary of Equipment Costs - Pile Driving

| | | |
|---|---|---|
| 110 tn crane x 232 hours x 14.24 | = | $ 3303.68 |
| Calweld Drill x 232 x 25.39 | = | 5890.48 |
| Ford A-64 loader x 116 x 20.00 | = | 2320.00 |
| 400 Amp. welder x 116 x 1.69 | = | 196.04 |
| | | $11,710.20 |

B. **Tunneling Through Lafayette Avenue Differing Site Condition (DSC) and Impacted Tunneling Thereafter**

Appellant's delay analysis is premised upon a comparison of its tunneling progress per day in the differing site condition area and its normal (unimpacted) progress in all four tunnels. In other words, Appellant states that it would have achieved its normal tunneling rate throughout, but for the differing site condition.

The MTA takes issue with this approach primarily because the soils in tunnels 1 and 2 were expected to be largely cretaceous, with traces of residual soils (RS).[30] Tunnels 3 and 4, however, were projected to have substantial quantities of RZ-1 material. The latter material, we are told by MTA, is more difficult and time consuming to tunnel through.

In view of the foregoing, the MTA's expert, Mr. Earl Turner, elected to analyze Appellant's tunneling records to ascertain what the normal tunneling rate was for RZ-1 material. This analysis involved a review of the Appellant's Superintendent's reports to see when spading was reported during the tunneling process. The rate of tunneling achieved during these shifts was considered to be the rate Appellant should have expected when tunneling through RZ-1 material.

We reject Mr. Turner's analysis for several reasons. First, as we have found, the method of excavation utilized by Appellant is not a precise indicator of the material being encountered. Second, the testimony adduced at trial does not establish that spading was a non-standard operation in the tunneling process and further that it was expressly reported by the Appellant's superintendent whenever used. (Tr. VI, pp. 16; 35-38). Third, and most important, the mere fact that spading was reported by Appellant's Superintendent does not mean that tunneling conditions were difficult. In this regard, we note that there were quite a number of shifts wherein spading was reported and progress of three or four rings was achieved. (Exh. S-59B). This type of production is equal to the optimum production attained in reaches wherein spading presumably was not necessary.

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[30]Since the actual ground conditions encountered were not recorded by the parties for tunnels 1 and 2, it has been presumed by the parties that the GDR was accurate. (Tr. VIII, p. 47).

Notwithstanding our rejection of the Turner methodology, a legitimate question has been raised as to whether Appellant reasonably should have expected the same progress in the DSC areas of tunnels 3 and 4 as was achieved in tunnels 1 and 2. The latter tunneling predominantly was through C-1, C-2 and C-3 materials, although some RS and RZ-1 material below springline was encountered. In the DSC region of tunnels 3 and 4, Appellant should have anticipated RZ-1 material at full face in some instances. Elsewhere in this zone, RZ-1 was to be encountered in conjunction with C-3 soils.

As we have found, Appellant reasonably concluded from the geotechnical data provided by MTA that RZ-1 material would behave as a hard, cohesive soil. Further, Appellant reasonably should not have anticipated that the shield would have to be relieved extensively. Accordingly, we find that the average rate of tunneling through soils actually achieved by Appellant in the non-DSC areas of all four tunnels (8.10 rings/day)[31] is appropriate for computing loss of efficiency in the DSC areas. This is not to say that some soils are not more difficult to tunnel through than others. Clearly, a hard clay might require more labor to remove material from the face than gravel. On the other hand, cohesionless soils, such as sand, require extensive breasting to control the flow of material into the shield. (Tr. I. p. 45-50). This condition provides for less productive tunneling than where cohesive soils are encountered. For this reason, therefore, the average rate of production for all soils is considered to be the reasonable "as would have been" rate.

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[31] In areas where Appellant performed unimpacted tunneling in soils other than RZ-1, it placed 988 rings in 123 days. When tunneling in RZ-1 material, Appellant did 130 rings in 15 days. The combined average is 8.10 rings/day. (Exh. A-1(1)).

The impact to Appellant's tunneling progress as a result of the Lafayette Avenue DSC is set forth hereafter:

1. Lafayette Avenue DSC

a. Added Duration For Heading Crews, Shaft Services and Compressors

(1) Actual Duration For Tunneling Through DSC Areas In Tunnel 3 (Sta. 78+80 to 83+10) and Tunnel 4 (78+80 to 81+90).

| Tunnel | Work Days | Rings |
|---|---|---|
| 3 | 34 | 97 |
| 4 | 28 | 101 |
| | 62 | 198 |

(2) Anticipated Duration

$$\frac{198 \text{ rings}}{8.10 \text{ rings/day}} = 24.4 \text{ work days (wd)}$$

In addition to the foregoing impact, Appellant lost eight work days in tunnel 3 and two work days in tunnel 4 when the shield lips (cutting edge) became bent after striking rock. The MTA contends that this time loss was due solely to Appellant's negligence in failing to probe in front of the shield and/or use a cradle to protect the underside of the shield.

As a result of the blasting operation necessitated by the DSC, Appellant experienced some overbreak in the rock (i.e., the tunnel opening was larger than the dimensions of the shield). This resulted in the shield settling at an elevation lower than that specified for the tunnel. A correction in tunnel elevation thereafter was made by using timber lagging to construct a cradle beneath the shield. We see no reason why this approach could not have been taken earlier in view of the fact that rock previously had been encountered in this region when the soldier piles were drilled. In making this finding, however, this does not mean that Appellant should bear responsibility for all ten days lost. Clearly, the use of a timber cradle or other means of probing would have reduced Appellant's tunneling productivity.

Using a jury verdict approach, we conclude that a four work day loss in tunnel 3 and a one work day loss in tunnel 4 should be recognized. See Granite Construction Company, MDOT 1014, 1 MICPEL ¶66 (December 20, 1983).

(3) Added Duration

| | | |
|---|---|---|
| 67 wd (62 + 5) - 24.4 | = | 42.6 wd |
| 42.6 wd x 3 shifts | = | 128 shifts |
| 128 shifts | = | 43 day shifts and 85 swing and graveyard shifts |

b. Credit For Cross Passage Excavation

During the 8-day time frame when the shield was being repaired in tunnel 3, Appellant's crews were used to excavate a cross passage. Since we have found that the MTA is responsible for four days of this delay, a credit should be given for the time spent during the tunnel delay in excavating the cross passage. The credit will be as follows:

$$\frac{\text{800 hours}^{32}}{\text{8 men/crew}} = \frac{\text{100 crew hours}}{\text{8 hr/shift}} = \text{12.5 shifts}$$

12.5 shifts = 4 day and 9 swing and graveyard shift

2. Impact Area Beyond Lafayette Avenue DSC Resulting From Impaired Equipment

Appellant contends that in the tunnel reaches beyond the Lafayette Avenue DSC, its production rate was reduced as a result of the crippling effect which the DSC had on its equipment. The MTA rejects this contention on the basis that the reduced production more probably was the result of

[32] Appellant devoted 1600 manhours to this work over eight days. Since the credit should apply to the four days delay deemed to be the MTA's responsibility, we have divided the 1600 manhours in half.

encountering harder material. Further, the MTA states that Appellant failed to establish a nexus between the DSC and any increase in equipment breakdowns.

In the tunnel reaches beyond the DSC areas in tunnels 3 and 4, Appellant largely encountered the same cretaceous materials experienced in tunnels 1 and 2. (See Exh. A-1(3)). However, pockets of RZ-1 and RS material were more extensive in tunnels 3 and 4, particularly in the northern reaches. Consistent with our earlier findings, however, Appellant should have been able to achieve its average rate of production through this material.

With respect to the impact of the DSC on Appellant's equipment and hence its production, Appellant's Mr. Kohl testified that the DSC nearly demolished the excavator and affected the shove jacks and articulation jacks. (Tr. X, p. 26). Mr. Robert Schuler, Appellant's equipment superintendent, further testified that when tunnels 1 and 2 were completed, the equipment comprising the tunnel driving machine was removed and steam cleaned. All hydraulic parts were pressure tested and all used hoses were replaced with new ones. (Tr. VII, pp. 63-66). Work also was performed on the excavator, erector ring motors, and articulation jacks and pumps. As a result, Mr. Schuler opined that the equipment which Appellant began tunnels 3 and 4 with was as good or better than that which it began tunnels 1 and 2. (Tr. VII, pp. 83-84).

Mr. Schuler testified unequivocably that the conditions experienced in the DSC areas of tunnels 3 and 4 damaged the tunnel driving equipment. For example, the dipper ram on the excavator was exposed to shot rock and the rough material being pulled into the conveyor. As a result, the rods got scratched, resulting in torn seals and disfigured internal mechanisms.

(Tr. VII, pp. 87-89). There was other damage to the bucket cylinders, boom cylinder, swing cylinder, mounting plate, wear plates, and the excavator control system. (Tr. VII, pp. 87-97).

The DSC also was said by Mr. Schuler to have affected the hydraulic system. The oil used in this system had a common reservoir and because the excavator worked beyond capacity, the oil overheated and became more viscous. This caused leakage problems in many pieces of equipment and exacerbated the breakdown problem. (Tr. VII, pp. 100-105). While the repeated problems with equipment were corrected as each was encountered, the time required to perform this work and the difficulty in doing it in the tunnel were said by Mr. Schuler to have affected tunnel productivity and the reliability of each repair.

The MTA countered Mr. Schuler's testimony by establishing that equipment breakdowns also occurred early in the driving of tunnels 3 and 4 before the DSC was encountered. (Tr. XI, pp. 13-54). Further, Appellant's shield reports contained only minimal complaints about hot oil and hydraulic problems following the DSC. (Tr. XVII, pp. 91-96). While we are mindful of this latter testimony and evidence, we accept Mr. Schuler's testimony that wear on the equipment was extraordinary through the DSC area and affected the tunnel driving equipment for the remainder of the project.

a. Impacted Tunneling Up To The Alleged Pennsylvania Avenue DSC Area

(1) Anticipated Duration

$$\frac{690 \text{ rings}}{8.1 \text{ rings/day}} = 85.2 \text{ wd}$$

(2) Added Duration

109 wd (actual) - 85.2 wd = 23.8 wd
23.8 wd x 3 shifts/wd = 71 shifts
71 shifts = 24 day and 47 swing and graveyard shifts

b. Impacted Tunneling Through Pennsylvania Avenue DSC Area

Appellant reasonably should have anticipated tunnel production of 8.1 rings/day throughout tunnels 3 and 4. Immediately following the DSC at Lafayette Avenue, Appellant's production decreased by 22% (8.1 rings/day to 6.31 rings/day). This production loss is attributable to the effect that the DSC had on Appellant's equipment. We conclude, therefore, that Appellant's production through the Pennsylvania Avenue area should have been 22% greater, but for its impaired equipment.

Appellant's lost production through the Pennsylvania Avenue area thus is computed as follows:

1. Actual Production = 140 rings in 30 work days = 4.67 rings/day
2. Anticipated Production = 5.7 rings/day (4.67 x 1.22)
3. Anticipated Duration = 140 rings at 5.7 rings/day = 24.6 days
4. Added Duration = 30 wd - 24.6 wd = 5.4 wd
5. 5.4 wd x 3 shifts/wd = 16.2 shifts
6. 16.2 shifts = 6 day and 10 swing and graveyard shifts

c. MTA's Request For a Credit Due To Heading Separation Variance

The contract mandated that there be a 200 foot heading separation between the tunnel headings. Since tunnel 3 was the lead tunnel, it should have remained at least 200 feet in front of tunnel 4. However, as a result of incurring a differing site condition in tunnel 3 on or about August 1, 1978, the heading separation began to diminish. Accordingly, on August 4, 1978, Appellant requested that this contract requirement be relaxed. By letter dated August 8, 1978, the MTA gave permission to decrease the heading separation temporarily to 50 feet. (Tr. XVII, p. 76).

After both tunnels came through the DSC area at Lafayette Avenue, tunnel 4 was being driven at a much faster rate (7 rings/day versus 5.59 rings/day) and, by October 30, 1978, the two tunnels virtually were side by side. The MTA's Resident Engineer thus directed that corrective action be taken to insure that the appropriate separation be maintained. (Exh. S-51)). Appellant therefore shut the tunnel 3 heading down on October 31, 1978 to permit tunnel 4 driving to proceed ahead.

The MTA now requests a credit for the labor costs which Appellant saved in not having to maintain the 200 foot heading separation between tunnels 3 and 4. But for the gradual waiver of this requirement, the MTA argues that Appellant would have had to suspend operations on the tunnel 3 heading for 12 days in order to permit tunnel 4 driving to go from 200 feet behind to 200 feet ahead of tunnel 3. Since the heading at tunnel 3 was shut down only for a day, Appellant is said to have saved 11 days of labor and standby equipment costs. The MTA seeks a credit equal to 1/2 of these costs.

The MTA's request for a credit is denied. As we have found, Appellant's reduced productivity was due to the effects of the DSC on tunnel 3 progress. By seeking a waiver of the tunnel heading separation, Appellant simply was mitigating the damages which the MTA otherwise would have been responsible for.

d. Time Impact

Appellant reasonably should have anticipated completing tunnel 3 on November 11, 1978.[33] Tunnel 4 would have completed on November 29, 1978, but for the Lafayette Avenue DSC.[34]

The tunnels, as built, were not completed until January 17, 1979. As we earlier found, tunnel 3 should have been completed four work days earlier had it not been for Appellant's failure to protect the shield bottom in the DSC area. The delay to Appellant's contract completion thus is measured by the number of days between November 29, 1978 and January 11, 1979, or 43 calendar days.

e. Pennsylvania Avenue DSC

Although we found that Appellant encountered a differing site condition in tunnel 4 on December 19 and 20, 1978, its progress was not affected significantly. During these two days, Appellant installed 12 rings. Since the progress through this area just prior to the DSC was 7 rings/day,[35] Appellant lost at best one graveyard shift in production. This loss of production effectively will be compensated for by our earlier recognition of the impact which the Lafayette Avenue DSC had on Appellant's equipment.

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[33] The differing site condition was encountered in tunnel 3 on August 1, 1978. From this point forward, it should have completed 401 rings at 8.1 rings per day and 103 rings at 5.71 rings per day. The resulting total of 67.5 wd equals 103 calendar days (1.53 conversion factor). The completion date thus would be November 11, 1978.

[34] Tunnel 4 completion is computed in same manner as tunnel 3. The differing site condition was encountered on August 22, 1978. Thereafter Appellant should have installed 468 rings at 8.1 rings/day and 37 rings at 5.64 rings/day.

[35] We earlier concluded that production would have been 22% greater but for the crippled equipment.

¶165

3. Lafayette Vent Shaft

The volume of RZ-2 and RZ material encountered by Appellant was 1302 cy. (Exh. A-1(1) p. 59). Appellant contends that it could have excavated at a rate of 300 cy/day, but for the encountering of this material. This rate apparently was being achieved prior to March 15, 1979, when the RZ-2 material first was encountered. Accordingly, Appellant states that it should have been able to excavate the entire area where RZ-2 and RX material was found in 4.3 work days (1302/300).

Appellant also recognizes that its excavation rate through the differing site condition would have been diminished in any event by the time required to remove the ribs and boards in the tunnels. Appellant allows 4.2 work days for this activity.

The MTA has not offered any testimony attacking the reasonableness of Appellant's 4.2 work day allowance for removal of the ribs and boards. While the MTA did question the 300 cy/day progress rate assumed above, it did so only on the basis that this rate could not have been maintained while removing the ribs and boards in the tunnel areas. Since Appellant has taken this inefficiency into account in computing the time that would have been required to excavate through the DSC area, we accept the 300 cy/day progress rate as reasonable. But for the DSC, therefore, we find that Appellant would have required 8.5 work days to excavate through the area where RX and RZ-2 material was encountered.

RZ-2 was encountered during 14 work days between March 15, 1979 and April 4, 1979. Appellant contends that its crews worked an extra 1.5 hours per day during this period. In essence, Appellant argues that the 14 work days spent in excavating RZ-2 material was the equivalent of 16.6 standard

(8 hour) work days.

Notwithstanding the testimony of Appellant's Mr. Kohl, the record does not support a finding that Appellant's crews worked overtime on a regular basis in excavating the shaft. A review of the certified payrolls reveals that overtime was sporadic and was not performed by all members of a crew on a given day. (Exh. S-91). We thus find that the time spent by Appellant in excavating the shaft should not be adjusted for overtime.

On the basis of the foregoing, Appellant's performance was extended by 5.5 work days (14 wd-8.5 wd) as a result of excavating RZ-2 material. Appellant's costs thus were increased as follows:

a. Excavate RZ-2 Material

(1) Labor (5.5 shifts)

| Crew | Number of Men | Hours/ 8 Shifts | Rate /hr[36] | Total |
|---|---|---|---|---|
| Shifter | 1 | 44 | $12.829 | 564.48 |
| Miner | 6.75 | 297 | 10.873 | 3,229.28 |
| Pile Driver | 1 | 44 | 11.976 | 526.94 |
| Crane Operator | 1 | 44 | 13.884 | 610.90 |
| Crane Oiler | 1 | 44 | 11.559 | 508.60 |
| Compressor Operator | 1 | 44 | 13.884 | 610.90 |
| TOTAL | | | | $ 6,051.10 |

(2) Small Tools & Supplies
8.6% x $6,051.10 = $ 520.39

(3) Equipment

| Equipment | Hours x | Rate/hr. | | Total |
|---|---|---|---|---|
| 110 Ton Crane | 44 | $14.24 | = | $ 626.56 |
| 1250 Cfm Compressor | 44 | 8.94 | = | 393.36 |
| 400 A Welder | 22 | 1.69 | = | 37.18 |
| Clam Bucket | 44 | 1.02 | = | 44.88 |
| Pump | 44 | 1.83 | = | 80.52 |
| Gradall | 44 | 60.90 | = | 2,679.60 |
| | | | | $3,862.10 |

[36] Labor rates have been stipulated.

(4) Installation of Rock Anchors

(a) Rock Anchor Material $1,563.00

(b) Subcontractor Installation of Rock Anchors $2,580.00

(c) Assistance in Installation of Rock Anchors - 4 shifts April 4 - April 9, 1979

| | |
|---|---|
| Labor (Exh. A-1(1)) | $4,436.00 |
| Small Tools & Supplies at 8.6% | 381.50 |

Equipment

| | | |
|---|---|---|
| 110 Ton Crane at 32 hrs. at $14.24 = | | 455.68 |
| 1250 Cfm Compressor at 32 hrs. at $25.39 | = | 812.48 |
| 400 amp welder at 32 hrs. at $1.69 | = | 54.08 |
| 25 hp Pump at 32 hrs. at $1.83 | = | 58.56 |
| | | $1,380.80 |

b. Excavation of RX Rock - 4 Shifts April 10 - April 13, 1979

| | | |
|---|---|---|
| (1) | Labor (Exh. A-1(1)) | $3,601.00 |
| (2) | Small Tools & Supplies at 8.6% | 309.69 |

(3) Equipment

| | | |
|---|---|---|
| 110 Ton Crane at 32 hrs. at $14.24/hr. | = | 455.68 |
| 1250 Cfm Compressor at 32 hrs. at $8.94/hr. | = | 286.08 |
| Clam Bucket at 32 hrs. at $1.02/hr. | = | 32.64 |
| 25 hp pump at 32 hrs. at $1.83/hr. | = | 58.56 |
| 951 Loader at 32 hrs. at $37.80/hr. | = | 1,209.60 |
| TOTAL | | $2,042.56 |

c. Blasting Mats and Materials $2,500.00 (stip.)

d. Crushed Stone for Subgrade $ 450.00

The MTA disputes this $450 claim since crushed stone was used at the Monument Street Shaft subgrade as well. Appellant's Mr. Kohl testified that the rock was needed to fill the voids caused by the blasting operation. We accept this testimony and find Appellant entitled to $450 for the crushed rock.

4. Tunneling At Lafayette Avenue DSC

a. Heading Crew - Day Shift

(1) Labor (43 day shifts)

| Crew | Number of Men | Hours | Rate | Total |
|---|---|---|---|---|
| Shifter - Comp. Air | 1.00 | 344 | 17.267 | 5,939.85 |
| Miner - Comp. Air | 11.50 | 3956 | 15.093 | 59,707.91 |
| Lock Tender | 1.00 | 344 | 11.895 | 4,091.88 |
| | | | | $69,739.64 |

(2) Equipment

| Equipment | Hours | Rate/hr. | Total |
|---|---|---|---|
| Tunnel Driving Machine | 344 | 112.54 | 38,713.76 |
| Locomotive-14 Ton | 688 | 9.75 | 6,708.00 |
| Muck Car | 4128 | 0.78 | 3,219.84 |
| Segment Car | 688 | 0.45 | 309.60 |
| Flat Car | 344 | 0.45 | 154.80 |
| Grout Car | 688 | 17.40 | 11,971.20 |
| Air Locks | 344 | 19.29 | 6,635.76 |
| | | | $67,712.96 |

(3) Small Tools & Supplies

8.6% x $69,739.64 = $5,997.61

b. Heading Crew - Swing and Graveyard Shifts (85 Shifts)

(1) Labor

| Crew | Number of Men | Hours | Rate | Total |
|---|---|---|---|---|
| Shifter - Comp. Air | 2.00 | 680 | 17.267 | 11,741.56 |
| Miner - Comp. Air | 11.50 | 7820 | 15.093 | 118,027.26 |
| Lock Tender | 1.00 | 680 | 11.895 | 8,088.60 |
| | | | Total | $137,857.42 |

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(2) Equipment

| Equipment | No. | Hours | Rate | Total |
|---|---|---|---|---|
| Tunnel Driving Machine | 1 | 680 | 112.54 | 76,527.20 |
| Locomotice-14 Ton | 2 | 1360 | 9.75 | 13,260.00 |
| Muck Car | 12 | 8160 | 0.78 | 6,364.80 |
| Segment Car | 2 | 1360 | 0.45 | 612.00 |
| Flat Car | 1 | 680 | 0.45 | 306.00 |
| Grout Car | 2 | 1360 | 17.40 | 23,664.00 |
| Air Locks | 1 | 680 | 19.29 | 13,117.20 |
| | | | | $133,851.20 |

(3) Small Tools & Supplies

8.6% x $137,847.42 = $11,854.88

c. Shaft Service & Compressors - Day Shift (43 Shifts)

(1) Labor

| Crew | No. | Hours | Rate | Total |
|---|---|---|---|---|
| Top/Bottom Lander | 2 | 688 | 11.895 | 8,183.76 |
| Crane Operator | 1 | 344 | 13.884 | 4,776.10 |
| Crane Oiler | 1 | 344 | 11.559 | 3,976.30 |
| Locomotive Operator | 1 | 344 | 13.884 | 4,776.10 |
| Batch Plant Operator | .50 | 172 | 13.884 | 2,388.05 |
| Shaft Mechanic | .25 | 86 | 13.884 | 1,194.02 |
| Compressor Operator | .50 | 172 | 13.884 | 2,388.05 |
| | | | Total | $27,682.38 |

(2) Equipment

| Equipment | No. | Hours | Rate | Total |
|---|---|---|---|---|
| 110 Ton Crane | 1 | 344 | 14.24 | 4,898.56 |
| Locomotive-14 Ton | .50 | 172 | 9.75 | 1,677.00 |
| Grout Batch Plant | .50 | 172 | 8.92 | 1,534.24 |
| Low Air Plant | .50 | 172 | 18.85 | 3,242.20 |
| 1250 CFM Compr. | 1 | 344 | 8.94 | 3,075.36 |
| Muck Hopper | 1 | 344 | 8.50 | 2,924.00 |
| Pump-25hp | .50 | 172 | 1.83 | 314.76 |
| | | | | $17,666.12 |

(3) Small Tools & Supplies

8.6% x $27,682.38 = $2,380.68



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d. Shaft Service & Compressors - Swing and Graveyard Shifts (85 Shifts)

(1) Labor

| Crew | No. | Hours | Rate | Total |
|---|---|---|---|---|
| Top/Bottom Lander | 2 | 1360 | 11.895 | 16,177.20 |
| Crane Operator | 1 | 680 | 13.884 | 9,441.12 |
| Crane Oiler | 1 | 680 | 11.559 | 7,860.12 |
| Locomotive Operator | 1 | 680 | 13.884 | 9,441.12 |
| Batch Plant Operator | .50 | 340 | 13.884 | 4,720.56 |
| Compressor Operator | .50 | 340 | 13.884 | 4,720.56 |
| Shaft Mechanic | .25 | 170 | 13.884 | 2,360.28 |
| | | | Total | $54,720.96 |

(2) Equipment

| Equipment | No. | Hours | Rate | Total |
|---|---|---|---|---|
| 110 Tone Crane | 1 | 680 | 14.24 | 9,683.20 |
| Locomotive-14 Ton | .50 | 340 | 9.75 | 3,315.00 |
| Grout Batch Plant | .50 | 340 | 8.92 | 3,032.80 |
| Low Air Plant | .50 | 340 | 18.85 | 6,409.00 |
| 1250 CFM Compr. | 1 | 680 | 8.94 | 6,079.20 |
| Muck Hopper | 1 | 680 | 8.50 | 5,780.00 |
| Pump-25hp | .50 | 340 | 1.83 | 622.20 |
| | | | | $34,921.40 |

(3) Small Tools & Supplies

8.6% x 54,720.96 = $4,706.00

e. Bull Gang - Day Shift (43 Shifts)

(1) Labor

| Crew | No. | Hours | Rate | Total |
|---|---|---|---|---|
| Shifter-Comp. Air | .50 | 172 | 17.267 | 2,969.92 |
| Miner-Comp. Air | .50 | 172 | 14.262 | 2,453.06 |
| Miner-Bull Gang | 3.50 | 1204 | 11.021 | 13,269.28 |
| | | | Total | $18,692.26 |

(2) Small Tools & Supplies

8.6% x $18,692.26 = $1,607.53

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f. Weekend Pumps & Compressors

The DSC encountered in the Lafayette Avenue area delayed completion of the tunnels by 50 calendar days, or seven weeks. This equals 14 weekend days, or 42 shifts.

(1) Labor

| Crew | No. | Hours | Rate | Total |
|---|---|---|---|---|
| Weekend Comp. Oper. | .50 | 168 | 16.008 | 2,689.34 |
| Weekend Pump Oper. | .08 | 27 | 13.884 | 374.87 |
| | | | Total | $3,064.21 |

(2) Equipment

| Equipment | No. | Hours | Rate | Total |
|---|---|---|---|---|
| Low Air Plant | .50 | 168 | 18.85 | 3,166.80 |
| Pump-2nd & 3rd | .50 | 168 | 1.83 | 307.44 |
| | | | Total | $3,474.24 |

(3) Small Tools & Supplies

8.6% x $3,064.21 = $263.52

g. Truck Delay Charges

The parties agree that Appellant is entitled to a truck delay charge of one hour per extra shift worked as a result of tunneling through the differing site condition area. This amount totals:

128 shifts x $26.50/shift = $3,392

h. Consultant Geologists' Fees

Appellant claims entitlement to $40,664 in consulting geologist fees. Most of this cost allegedly was incurred for Mr. Irish's services in providing advice on the installation of soldier piles, in classifying materials throughout the claimed DSC areas, and in advising how these materials should be treated. (Tr. X, p. 62). Approximately $5,000 of this amount was spent for the services of Dr. Heuer who also assisted in analyzing the materials encountered in the DSC areas.

The MTA does not dispute that these claimed amounts were spent. (Tr. XV, pp. 95-96). However, the claimed amount was disallowed as a claim preparation expense. (Tr. XVII, p. 63).

Based on the testimony adduced at trial, the Board finds that Dr. Heuer and Mr. Irish were retained by Appellant principally for documenting its differing site condition claim. The issue therefore is whether such claim preparation fees are recoverable directly as part of an equitable adjustment.

At the time Appellant entered into its contract with the MTA, Maryland had not yet promulgated its procurement regulations. Even if the regulations were applicable however, they do not expressly declare claim preparation fees to be unallowable. COMAR §21.01.

Nevertheless, we find that while claim preparation fees may be allowable as overhead costs, they cannot be recovered as direct costs under the DSC clause. The DSC clause (G.P.-4.04) permits a contractor to recover any increase in cost of performance of any part of its contractual work caused by the encountering of a DSC. Claim preparation fees are not a cost incurred in the performance of contract work. Instead they are indirect costs necessary to the successful conduct of Appellant's business but incidental to the performance of contract work. Power Equipment Corporation, ASBCA No. 5904, 1964 BCA ¶4025. Accordingly, these costs must be placed in Appellant's overhead pool and are recoverable only to the extent that additional overhead costs are awarded.

i. Material Costs

MTA accepts Appellant's claim for blasting signs ($604), vibration readings ($485), blasting materials ($5,582), and additional liner backfill grout ($1,029). An $882 charge for electrical service was denied by MTA. While Appellant's cost account for the DSC included this charge, the MTA's auditor could not trace it to an invoice.

Appellant's Mr. Kohl testified that the DSC blasting operation required that electricity be turned off. In order to accomplish this, wiring changes had to be made. Since this testimony was uncontroverted, the $882 charge is allowed.

Finally, Appellant claims $3,910 for timber to support the shield. The MTA allows only $552. (Exh. S-50). We accept the MTA's calculation in that it reasonably computes costs only for the area where the lagging apparently was used. Appellant's estimate improperly assumes that the lagging was used throughout the entire DSC area. (Tr. X, p. 60).

j. Turn & Transport Liner Plates

As we have found, Appellant was delayed for 43 day shifts by the Lafayette Avenue DSC. Costs incurred as a result of this impact were as follows:

(1) Labor

| | Hours | Rate | Total |
|---|---|---|---|
| Teamster | 344 | 12.575 | $4,325.80 |

(2) Equipment

| | Hours | Rate | Total |
|---|---|---|---|
| Straddle Carrier (Standby) | 344 | 5.33 | 1,833.52 |
| 15 Ton Forklift (Standby) | 344 | 3.12 | 1,073.28 |
| | | | $2,906.80 |

(3) Small Tools & Supplies

8.6% x $4,728 = $406.61

k. Credit for Cross Passage Excavation

As we previously found, the MTA is entitled to a credit for the labor and equipment costs incurred by Appellant when excavating the cross passages while tunneling was stopped awaiting shield repairs in tunnel 3. The credit is for 4 day shifts and 9 swing shifts:

(1) Labor

(a) 4 day shifts

| Crew | Number of Men | Hours | Rate | Total |
|---|---|---|---|---|
| Shifter-Comp. Air | 1 | 32 | 17.267 | $ 552.54 |
| Miner-Comp. Air | 6 | 192 | 15.093 | 2,897.86 |
| Crane Operator | .50 | 16 | 13.884 | 222.14 |
| Crane Oiler | .50 | 16 | 11.559 | 184.94 |
| | | | | $3,857.48 |

(b) 9 Swing/Graveyard Shifts

| Crew | Number of Men | Hours | Rate | Total |
|---|---|---|---|---|
| Shifter-Comp. Air | 1 | 72 | 17.267 | $1,243.22 |
| Miner-Comp. Air | 6 | 432 | 15.093 | 6,520.18 |
| Crane Operator | .50 | 36 | 13.884 | 499.82 |
| Crane Oiler | .50 | 36 | 11.559 | 416.12 |
| | | | | $8,679.34 |

(2) Equipment

(a) 4 Day Shifts

| Equipment | Hours | Rate | Total |
|---|---|---|---|
| 110 Ton Crane - 1st Shift | 16 | 14.24 | 227.84 |
| Locomotive -14 Ton | 16 | 9.75 | 156.00 |
| Muck hopper | 16 | 8.50 | 136.00 |
| Muck Car | 64 | 0.78 | 49.92 |
| | | | $569.76 |

(b) 9 Swing/Graveyard Shifts

| Equipment | Hours | Rate | Total |
|---|---|---|---|
| 110 Ton Crane - 2nd & 3rd Shifts | 36 | 14.24 | 512.64 |
| Locomotive - 14 Ton | 36 | 9.75 | 351.00 |
| Muck hopper | 36 | 8.50 | 306.00 |
| Muck Car | 144 | 0.78 | 112.32 |
| | | | $1,281.96 |

MTA is also entitled to a standby credit for other equipment idled during the cross passage excavation awaiting shield repairs in tunnel 3. The MTA credit is calculated for the Tunnel Driving Machine (1 unit); Locomotives (1/2 unit); Muck Cars (10 units); Segment Cars (2 units); Grout Cars (2 units); Much Hopper (1/2 unit); Grout Batch Plant (1 unit) as follows:

MTA Standby Credit = (Ownership Rate + EOE Rate) x $\frac{\text{24 hrs.}}{\text{day}}$ x 4 days x No. of Units

MTA's standby credit for Tunnel 3 idle equipment is summarized as follows:

| | |
|---|---|
| TDM ($82.28/hr.) | $ 7,898.88 |
| Locomotives ($5.72/hr.) | 274.56 |
| Muck Cars ($.41/hr.) | 393.60 |
| Segment Cars ($.24/hr.) | 46.08 |
| Grout Cars ($12.48/hr.) | 2,396.16 |
| Muck Hopper ($4.98/hr.) | 239.04 |
| Grout Batch Plant ($5.78/hr.) | 554.88 |
| Total | $11,803.20 |

(3) Small Tools & Supplies

8.6% x $12,536.82 = $1,078.16

5. Impacted Tunneling Through Soils After Lafayette Avenue DSC

We previously found that Appellant was delayed for 30 day shifts and 57 swing/graveyard shifts as a result of its equipment being impaired when moving through the Lafayette Avenue DSC area. Appellant thus is entitled to the following equitable adjustment:

a. Heading Crew (87 shifts)

(1) Labor

| Crew | Number of Men | Hours | Rate | Total |
|---|---|---|---|---|
| Shifter-Comp. Air | 1 | 696 | 17.267 | 12,017.83 |
| Miner-Comp. Air | 11.50 | 8004 | 15.093 | 120,804.37 |
| Lock Tender | 1 | 698 | 11.895 | 8,302.71 |
| | | | Total | $141,124.91 |

(2) Equipment

| Equipment | Hours | Rate | Total |
|---|---|---|---|
| Tunnel Driving Machine | 696 | 112.54 | 78,327.84 |
| Locomotive - 14 Ton | 1392 | 9.75 | 13,572.00 |
| Muck Car - 8 cy | 8352 | 0.78 | 6,514.56 |
| Segment Car | 1392 | 0.45 | 626.40 |
| Flat Car | 696 | 0.45 | 313.20 |
| Grout Car | 1392 | 17.40 | 24,220.80 |
| Air Locks | 696 | 19.29 | 13,425.84 |
| | | | $137,000.64 |

(3) Small Tools & Supplies

8.6% x $141,124.91 = $12,136.74

b. Shaft Service & Compressor Cost

(1) Labor (87 Shifts)

| Crew | Number of Men | Hours | Rate | Total |
|---|---|---|---|---|
| Top/Bottom Lander | 2 | 1392 | 11.895 | 16,557.84 |
| Crane Operator | 1 | 696 | 13.884 | 9,663.26 |
| Crane Oiler | 1 | 696 | 11.559 | 8,045.06 |
| Locomotive Operator | 1 | 696 | 13.884 | 9,663.26 |
| Batch Plant Oper. | 0.50 | 348 | 13.884 | 4,831.63 |
| Shaft Mechanic | 0.25 | 174 | 13.884 | 2,415.82 |
| Compressor Oper. | 0.50 | 348 | 13.884 | 4,831.63 |
| | | | Total | $56,008.50 |

(2) Equipment

(a) Day Shifts (30)

| Equipment | No. | Hours | Rate | Total |
|---|---|---|---|---|
| 110 Ton Crane - 1st Shift | 1 | 240 | 14.24 | 3,417.60 |
| Locomotive - 14 Ton | .50 | 120 | 9.75 | 1,170.00 |
| Grout Batch Plant | .50 | 120 | 8.92 | 1,070.40 |

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| | | | | |
|---|---|---|---|---|
| Low Air Plant | .50 | 120 | 18.85 | 2,262.00 |
| 1250 CFM Comp. - 1st Shift | 1 | 240 | 8.94 | 2,145.60 |
| Muck hopper | 1 | 240 | 8.50 | 2,040.00 |
| Pump - 25 hp - 1st Shift | .50 | 120 | 1.83 | 219.60 |
| | | | | $12,325.20 |

(b) Swing/Graveyard Shifts (57)

| Equipment | No. | Hours | Rate | Total |
|---|---|---|---|---|
| 110 Ton Crane - 1st Shift | 1 | 456 | 14.24 | 6,493.44 |
| Locomotive - 14 Ton | .50 | 228 | 9.75 | 2,223.00 |
| Grout Batch Plant | .50 | 228 | 8.92 | 2,033.76 |
| Low Air Plant | .50 | 228 | 18.85 | 4,297.80 |
| 1250 CFM Comp. - 1st Shift | 1 | 456 | 8.94 | 4,076.64 |
| Muck hopper | 1 | 456 | 8.50 | 3,876.00 |
| Pump - 25 hp - 1st Shift | .50 | 228 | 1.83 | 417.24 |
| | | | | $23,417.88 |

(3) Small Tools & Supplies

8.6% x $56,008.50 = $4,816.73

c. Truck Delay Charges

87 shifts x $26.50/shift = $2,305.50

d. Turn & Transport Liners (30 shifts)

(1) Labor

| | Hours | Rate | Total |
|---|---|---|---|
| Teamster | 240 | 12.575 | $3,018.00 |

(2) Equipment

| Equipment | Hours | Rate | Total |
|---|---|---|---|
| Straddle Carrier - Standby | 120 | 5.33 | 639.60 |
| 15 Ton Forklift - Standby | 120 | 3.12 | 374.40 |
| | | | $1,014.00 |

(3) Small Tools & Supplies

8.6% x $3,018.00 = $259.55

6. Escalation

a. Labor

We previously found that the DSC encountered in tunneling through the Lafayette Avenue area delayed completion of the contract by 43 calendar days. The DSC encountered in completing excavation of the Lafayette Avenue Vent Shaft further delayed contract completion by 13.5 (5.5 + 8.0) work days, or 21 calendar days. Compensable delays thus total 64 calendar days.

The parties agree that craft pay increases went into effect on April 1, 1979, averaging 8.64% per person. Labor costs for the nine weeks covered by the above delay have also been agreed to as follows:

| Week | Week Ending | Direct Labor | Fringes at 11.845% | EOE Labor | Total |
|---|---|---|---|---|---|
| 1 | 4-3-79 | $ 35,248 | 4,175 | 441 | 39,864 |
| 2 | 4-10-79 | 32,910 | 3,898 | 402 | 37,210 |
| 3 | 4-17-79 | 27,165 | 3,218 | 467 | 30,850 |
| 4 | 4-24-79 | 19,732 | 2,337 | 468 | 22,537 |
| 5 | 5-1-79 | 24,096 | 2,854 | 830 | 27,780 |
| 6 | 5-8-79 | 24,051 | 2,849 | 65 | 26,965 |
| 7 | 5-15-79 | 24,219 | 2,869 | 178 | 27,266 |
| 8 | 5-22-79 | 23,625 | 2,798 | 57 | 26,480 |
| 9 | 5-29-79 | 16,349 | 1,937 | 87 | 18,373 |
| | | $227,395 | $26,935 | $2,995 | $257,325 |

Appellant thus is entitled to labor escalation as computed below:

(1) $257,325 x 0.9225[37] x .0864 = $20,509.83
(2) Less 3/7 x 26,480 x .9225 X .0864 = $904.59
(3) Labor escalation allowed = $20,509.83 - 904.52 = $19,605.24

b. Materials & Services

There is no dispute that Appellant is entitled to material and services escalation incurred as a result of MTA's delay to contract

[37] The parties agree that 92.25% of Appellant's personnel were performing work that had been delayed.

completion. The parties also agree on the following methodology:

$12,068[38] x 53/80 = $7,995.05

7. Overhead

Appellant states that it is entitled to an overhead markup on its direct costs to compensate it for those non-time related costs which it has not recovered as extended field overhead. It has suggested a compromise figure of 6%.

Appellant's requested field overhead per day under its extended overhead claim was $4,314/day. We recognized entitlement to $3,573/day. If we assume that the difference is attributable to non-time related overhead costs, the amount over 15 months would be $337,896.

The record does not reflect what Appellant's direct costs were during the 15 month period involved in the overhead computation, the period chosen during which the DSC affected tunneling work, as discussed below (page 115). However, Appellant did incur $31,718,644 in direct expenses on the job. This averages $1,057,288 per month (for 30 months). If one assumes this to be representative of the 15 month period, as discussed, affected by the DSC the total direct job expense would be $15,859,321. The percentage relationship between non-time related overhead and direct costs thus would be 2% ($337,896/$15,859,321). We thus recognize entitlement to a 2% markup on direct costs under this claim.

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38This is the audited amount of escalation incurred by Appellant for the 80 calendar days claimed as delay. See Exh. S-59A.

8. Home Office G&A

Appellant seeks a 3.7% markup on increased direct costs to compensate Fruin-Colnon for its increased home office G&A costs. This rate is reasonable based on the audit performed by the MTA[39] and in view of its application only to direct costs.

The MTA nevertheless rejects this claim on the basis that its contract was solely with a joint venture. Accordingly, the MTA urges that its liability be determined based only on the costs shown on the joint venture books. Since the joint venture books do not indicate any contribution of the joint venture to the Fruin-Colnon home office, it is argued that additional home office overhead not be awarded.

In Maryland, joint venturers essentially are general partners. Warren v. Dorsey Enterprises, Inc., 234 Md. 574, 200 A.2d 76 (1964). Under this project, each partner had overhead costs which presumably were included in the bid price in the form of a markup. While it is impossible to determine precisely how much overhead of Fruin-Colnon's overhead was to be absorbed originally by performance of the contract, it is clear that the costs of performance were increased. Since it is reasonable to compute entitlement to additional home office G&A on a percentage of cost basis, we find Appellant entitled to this cost. However, given that Appellant had a 95% interest in the joint venture and thus did not absorb the full cost increase, its overhead recovery should be limited to this degree (.95 x .037).

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[39]The MTA auditor determined rates of 3.68% for FY 1977, 3.17% for FY 1978 and 3.11% for FY 1979. G&A rates were determined by the rates of G&A expense to total earned revenues. Earned revenues would include markups for overhead and profit.

9. Extended Field Overhead

In order to calculate its extended field overhead, Appellant totalled its overhead accounts for the period from 1978 through May 1979 and then determined a daily rate. The MTA's auditors reviewed Appellant's books and records and made certain accounting corrections which have been accepted by Appellant as accurate. The auditors further made corrections as follows:

1. Inclusion of full costs in an account when only 77% would be appropriate
2. Inclusion of February 1978 costs
3. Not including May 1979 in the 15 month period

These latter adjustments are not accepted by Appellant. In addition, Mr. Turner excluded many costs as being non-time related.

With respect to the 15 month period chosen, Mr. Kohl selected those months during which the differing site condition affected tunneling work. Recognizing that the cost accounting system records costs at the middle of each month, the period chosen thus captures costs from mid-February 1978 to mid-May 1979. (Tr. X, pp. 103-104).

Pile installation at the Lafayette Shaft began in March 1978. Excavation at the shaft was completed in April 1979. Thus we find the 15 month period selected by Appellant to be reasonable and reject the audit adjustments in this regard.

The dispute over inclusion of full costs in an account when only 7% would be appropriate relates to cost account 1856 entitled "Electrical Energy Consumption." The auditors concluded that 93% of the costs properly should have been included in the equipment costs. However, Mr. Turner did not utilize this recommendation and the record before us doesn't support the adjustment.

In summary, we accept the auditors mathematical adjustments to Appellant's overhead accounts as follows:

| Account Code | Adjustment |
|---|---|
| 21005 | $45,973 |
| 22005 | 3,893 |
| net adjustment | ($42,080) |

This reduces the average field overhead per month claimed to $131,157.

We now turn to the further adjustments to field overhead made by Mr. Turner. These adjustments result in the disallowance of all costs set forth in cost account codes 1845, 1846, 1851, 1852, 1853, 1854, 1855, 1858, 1862, 1875, 1877, 1878, 1879, 1881, 1888, 2201, 2202, 2204, 2205, 2208, 2221, 2222, 2229, 2230, 2231, 2232, 2236, 2238, 2241, 2242, 2243, 2245, 2251, 2322, and 2324. In short, the MTA argues that none of these costs are time related and thus were unaffected by the differing site condition.

Appellant seriously challenges only a handful of these adjustments. We thus will focus our attention on those cost codes still in dispute:

1846 - Tunnel Walkway Materials

While Appellant concedes that this account includes the cost of all materials necessary to construct the tunnel walkways in all four tunnels, it states that considerable maintenance materials were required. These material costs allegedly increased as a result of the differing site condition. Appellant, however, is unable to separate its maintenance costs from the installation costs. Recognizing some entitlement in this area, we allow 5% of the total cost incurred under this account, or $488, to remain in the overhead computation. The MTA has conceded the reasonableness of this jury verdict approach.

1862 - Installation of Electrical Service at Vent Shafts

The MTA rejects these costs since they would have been incurred in any event. Mr. Kohl conceded that the installation costs were the major costs included under the account. Some maintenance costs, however, were incurred. For reasons similar to the above, we allow 5% of the total cost incurred under this account, or $1594, to remain in the overhead account.

1879 - Labor, Tunnel Electric Work

Mr. Turner concluded that these costs were not time related because they pertained to the installation of electrical service in the tunnels. Mr. Kohl, however, testified that electricians were in the tunnel 24 hours per day performing constant maintenance. Again, we permit 5% of the total cost incurred under this account, or $8410, to remain in the overhead account.

2221 - Outside Engineering

These costs were incurred for the services of Messrs. Werner, Heine and Irish. Without considering whether any part of these services were related solely to the differing site condition, such costs clearly were not time related and are properly excluded from this computation of extended field overhead.

2230 - AGC Dues

These costs are incurred once per year. Since the project wasn't extended by an additional year, Appellant's costs were not increased.

2236 - Miscellaneous Drayage

These costs are for freight and hauling charges. Appellant states that its costs were increased as a result of increased equipment breakdowns and other problems attributable to the differing site condition. The record before us is insufficient to permit a finding that these types of costs were increased as a result of the differing site condition. Accordingly, we agree with the MTA that such costs should not be included in the overhead computation.

2322 - Finance Charges

The finance charges incurred were for loans taken to fund the work. Since the recovery of these costs is not precluded by Maryland law, they properly should remain as time related charges.

2324 - Incentive Pay

Certain key project personnel received incentive pay at the project conclusion under a plan established by Appellant's Mr. Bartholomew. The bonus was not tendered at all during the 15 months of the differing site condition period. Nothing in the record explains precisely how the bonus was to be paid.

These costs are not recognized as allowable for purposes of computing extended overhead. Based on the evidence before us, we are not confident that the amount of any incentive pay distributed was increased as a result of either the differing site condition or the extended performance period.

2310 - Equipment Insurance

Appellant claimed these costs as part of its equipment ownership expense. However, since Appellant's approach to equipment has not been accepted these costs should be added back into the overhead pool. The amount includable is $11,470. (Exh. S-59B, IX-2, p. 7 of 7).

Appellant's entitlement to extended overhead may be summarized as follows:

| Code | Amount Per Month | Amount per Calendar day |
|---|---|---|
| 1300s | $ 6,553 | $ 215 |
| 1700s | 1,871 | 62 |
| 1800s | 9,161 | 301 |
| 2100s | 51,686 | 1,700 |

| | | |
|---|---|---|
| 2200s | 27,789 | 914 |
| 2300s | 11,550 | 381 |
| | $108,610 | $3,573 |

Appellant's equitable adjustment per extended field overhead thus is 64 days x $3,573/cal. day = $228,672.

10. Profit and Bond

A profit rate of 10% and a bond rate of 0.52% have been agreed to.

## IV. Conclusion

Based on the above, we find Appellant entitled to the following:

| | |
|---|---|
| A. Pile Drilling | |
| 1. Labor | 12,814.29 |
| 2. ST&S | 1,102.03 |
| 3. Material | 9,063.00 |
| 4. Equipment | 11,710.20 |
| | $34,689.52 |
| B. Lafayette Vent Shaft | |
| 1. Excavation - (RZ-2) | |
| a. Labor | 6,051.10 |
| b. ST&S | 520.39 |
| c. Equipment | 3,862.10 |
| d. Installation of Rock Anchors | |
| 1. Material | 1,563.00 |
| 2. Subcontractor | 2,580.00 |
| 3. Assistance in Installation | |
| a. Labor | 4,436.00 |
| b. ST&S | 381.50 |
| c. Equipment | 1,380.80 |
| 2. Excavation - (RX) | |
| a. Labor | 3,601.00 |
| b. ST&S | 309.69 |
| c. Equipment | 2,042.56 |
| d. Blasting Mats | 2,500.00 |
| e. Crushed Stone | 450.00 |
| Total | $29,678.14 |
| C. Tunneling at Lafayette Avenue | |
| 1. Heading Crew | |
| a. Labor | $207,597.06 |
| b. Equipment | 201,564.16 |
| c. ST&S | 17,852.49 |
| 2. Shaft Service & Compressors | |
| a. Labor | 82,403.34 |
| b. Equipment | 52,587.52 |
| c. ST&S | 7,086.68 |
| 3. Bull Gang | |
| a. Labor | 18,692.26 |
| b. ST&S | 1,607.53 |

| | | | |
|---|---|---|---|
| | 4. Weekend Pumps & Compressors | | |
| | a. Labor | | 3,064.21 |
| | b. Equipment | | 3,474.24 |
| | c. ST&S | | 263.52 |
| | 5. Truck Delay Charges | | 3,392.00 |
| | 6. Material Costs | | |
| | a. Blasting Signs | | 604.00 |
| | b. Vibration readings | | 485.00 |
| | c. Blasting Materials | | 5,582.00 |
| | d. Additional Liner Backfill Grout | | 1,029.00 |
| | e. Electrical Service | | 882.00 |
| | f. Timber | | 552.00 |
| | 7. Turn and Transport Liner Plates | | |
| | a. Labor | | 4,325.80 |
| | b. Equipment | | 2,906.80 |
| | c. ST&S | | 406.61 |
| | | Subtotal | $616,358.22 |
| | 8. Credit For Cross Passage | | |
| | a. Labor | | (12,536.82) |
| | b. Equipment | | (13,654.92) |
| | c. ST&S | | ( 1,078.17) |
| | | Subtotal | (27,269.91) |
| | Total - Tunneling at Lafayette Ave. | | $589,088.31 |
| D. | Impacted Tunneling Through Soils AFTER LAFAYETTE AVENUE | | |
| | 1. Heading Crew | | |
| | a. Labor | | 141,124.91 |
| | b. Equipment | | 137,000.64 |
| | c. ST&S | | 12,136.74 |
| | 2. Shaft Service & Comp. Cost | | |
| | a. Labor | | 56,008.50 |
| | b. Equipment | | 35,743.08 |
| | c. ST&S | | 4,816.73 |
| | 3. Truck Delay Charges | | 2,305.50 |
| | 4. Turn & Transport Liners | | |
| | a. Labor | | 3,018.00 |
| | b. Equipment | | 1,014.00 |
| | c. ST&S | | 259.55 |
| | | Total | $ 393,427.65 |
| E. | Total - Direct Costs | | $1,046,883.62 |
| F. | Escalation | | |
| | 1. Labor | | 19,605.24 |
| | 2. Materials & Services | | 7,995.05 |
| | | Subtotal | $1,074,483.91 |
| G. | Overhead at 2% | | 21,489.68 |
| | | Subtotal | $1,095,973.59 |
| H. | Home Office G&A at (.037 x .95) | | 38,578.27 |
| | | Subtotal | $1,134,551.86 |
| I. | Extended Field Overhead | | 228,672.00 |
| | | Subtotal | $1,363,223.86 |
| J. | Profit at 10% | | 136,322.38 |
| | | Subtotal | $1,499,546.24 |

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| | | |
|---|---|---|
| K. | Bond at 0.52% | 7,797.64 |
| | Total Equitable Adjustment = | $1,507,343.88 |
| | Less amounts paid under Change Order 1 | (1,000,000) |
| | TOTAL DUE | $ 507,343.88 |

We have found that Appellant is entitled to an equitable adjustment. With respect to interest on Appellant's equitable adjustment, the currently applicable Maryland procurement law provides as follows:

> (j) Interest on amounts due contractors on claims. - (1) Notwithstanding any contract provision to the contrary, the Board of Contract Appeals, in its discretion, may award interest on amounts found due the contractor on a claim decided under this section.
>
> (2) Interest may accrue beginning on a date prior to the decision of the Board, determined by the Board to be fair and reasonable after hearing all of the facts of the claim, until the date of the decision, but interest may not accrue from a date that is before the receipt of a claim by the procurement officer.
>
> (3) The rate of interest under this subsection shall be at the rate specified in §11-107(a) of the Courts and Judicial Proceedings Article of the Code.

Md. Ann. Code, State Finance and Procurement Article, §11-137.

In this regard, we note that MTA issued a unilateral change order to Appellant for $1,000,000 as its valuation of any equitable adjustment due for the additional work caused by differing site conditions although it intensely disputed the nature and extent of the differing site conditions. In addition, the appeal involves resolution of complex cost accounting issues. Both Appellant and the MTA vigorously contested issues concerning allowability and allocability with regard to the appropriate method of calculating certain costs as part of an equitable adjustment. Given the fact that the technical issues involving entitlement based on the extent of differing site conditions and the quantum issues, involving issues not yet fully addressed by this Board, were complex, there is no specific date prior to our decision when the obligation to pay and the amount due became certain, definite and liquidated such that the effect of failure to pay the claim was to deprive Appellant of the use of a fixed amount as of a known date. Sloane v. House & Associates, No. 87-10

(Md., filed Oct. 30, 1987). Based on the just named factors and considering the claim and subsequent appeal as a whole, we award predecision interest pursuant to our discretion under Section 11-137, supra, at the required rate of 10% to accrue from February 26, 1985. Compare: Sloane v. House & Associates, supra and I.W. Berman Properties v. Porter Bros., 276 Md. 1, 344 A.2d 65 (1975) with MPA v. Langenfelder, 525 Md. App. 537, 438 A.2d 1374 (1982).

## Counterclaim

The MTA seeks liquidated damages under Contract General Provision 8.09 and Special Provision §3.0. As revised by change orders granting time extensions to the Contract, all work associated with the north access shaft was to be completed by March 25, 1979. Since Appellant completed the north shaft work on April 14, 1979, the MTA seeks 11 days of liquidated damages at $5,000/day, after recognizing entitlement to nine days.

Since we have found Appellant entitled to a 64 day time extension and given that the shaft completion was delayed by this same period of delay, the March 25, 1979 interim completion date should be extended to May 28, 1979. The MTA thus is not entitled to the liquidated damages sought for late completion of the north shaft.

The foregoing Contract provisions also required completion of all work by July 27, 1979. Adding 64 days to this requirement yields an adjusted completion date of September 29, 1979. Appellant, however, did not substantially complete its work until October 30, 1979, or 31 days late. The MTA thus is entitled to liquidated damages pursuant to Contract Special Provisions, SP-3, Item 5 (p. SP-2) at the rate of $1,000/day in the amount of $31,000.

The payment to be made to Appellant under this decision is $607,369.64. Interest shall continue to run at 10% per annum from the date of this decision until payment is made.