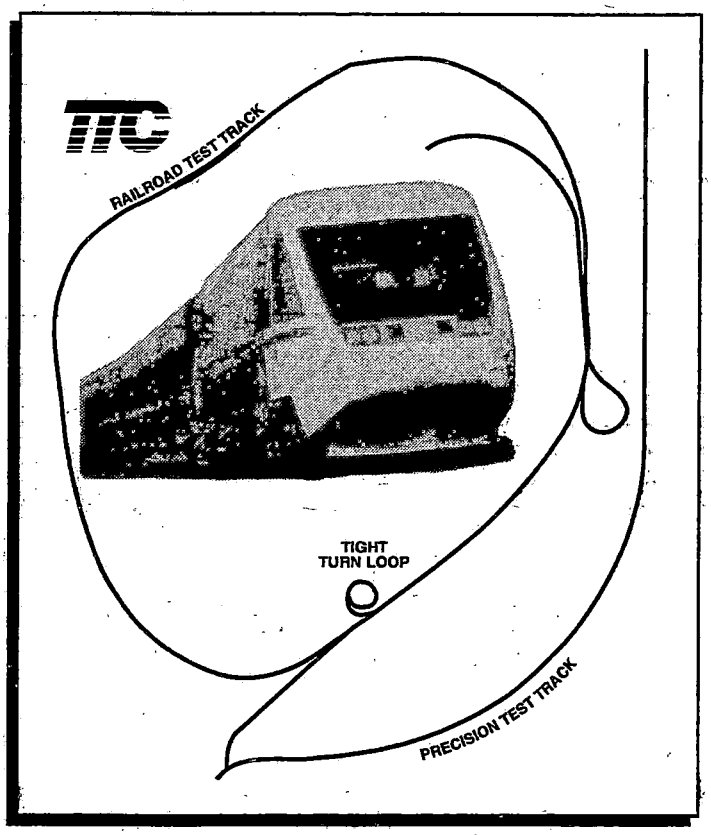
TECHNICAL MEMORANDUM 4

RTT UPGRADE PROGRAM
TRANSPORTATION TEST CENTER, PUEBLO, COLORADO



Broken Rail/ Open Switch Point Detection System

October 1995

By:
Parsons Brinckerhoff Quade & Douglas, Inc.

For:
U.S. Department of Transportation
Federal Railroad Administration

Volpe National Transportation Systems Center

12-Safety

U.S. Department of Transportation

Research and Special Programs Administration

Memorandum

Subject: INFORMATION: RTT Rehabilitation Program: Technical Memorandum No. 4 and Working Group Meeting Agenda, December 5, 1995

Date: November 15, 1995

From: James Lamond, DTS-77
Robert Dorer, DTS-701

Reply to Attn. of:

To: Distribution

Attached is Technical Memorandum No. 4, "Broken Rail Open Switch Point Detection System," prepared by Parsons Brinckerhoff Quade and Douglas, Inc. This memorandum discusses the conceptual design as required for Task 2 of the work plan. Please review this document, as well as the draft minutes of the August 18 working group meeting, for discussion at the December 5, 1995 working group meeting. This meeting is scheduled for 8:00 am in the Penn Way room, TTC, Pueblo, CO.

Also, attached is the proposed agenda for the December meeting. Please notify either of us by December 1 of any additions or deletions you wish to be made to this agenda.

Attachments

Distribution:

R. McCown	RDV-33	J. Bedingfield	AAR/TTC
G. Deily	RDV-31	E. Lombardi	Amtrak
G. Spons	RTC-1	G. Binns	Amtrak
W. O'Sullivan	RRS-15	W. Peterson	Consultant-AAR/TTC
K. Hawthorne	AAR/TTC	V. Terrill	Consultant-AAR/TTC
K. Laine	AAR/TTC	K. Chamberlain	PBQD
D. Read	AAR/TTC	K. Briggs	PBQD
M. White	AAR/TTC	K. Addison	PBQD
J. Peters	AAR/TTC		

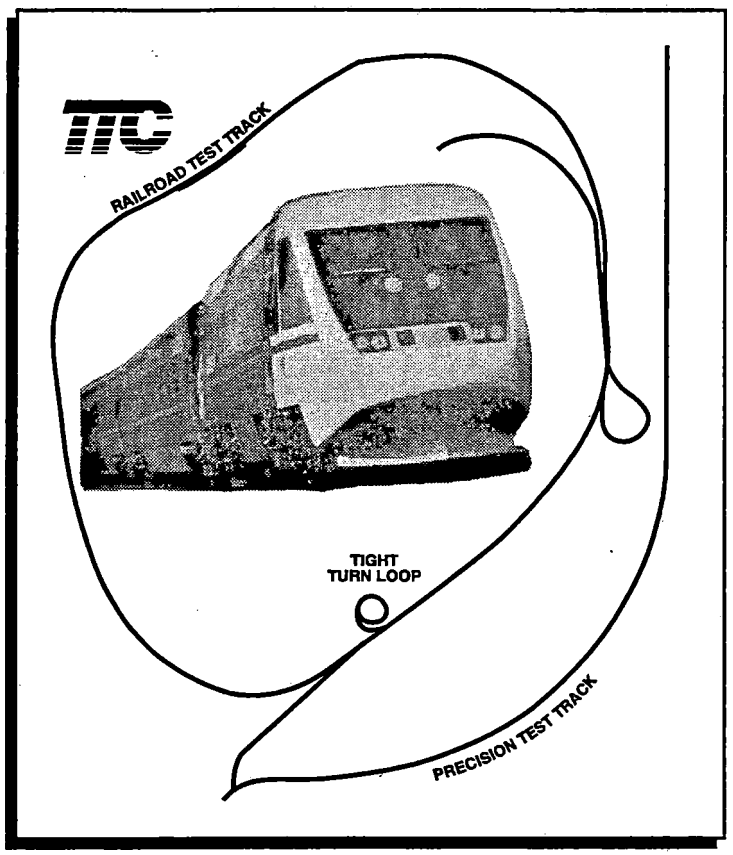
AGENDA

RTT Rehabilitation Project
Transportation Technology Center, Pueblo, CO
December 5, 1995 8:00 am Penn Way Room

Welcome and Introduction	Spons/Laine
Review agenda, change, update	Dorer/Lamond
FRA program update	Deily/McCown
Amtrak update	Lombardi
Review draft minutes of the August 18 working group	all
Review of Project Budget Status	Laine/Dorer
Status of Project Tasks	
Task 1 and Task 5 - jointed rail to CWR and turnout upgrade	Read
Task 3 - Catenary restoration and phase break design - review phase break 70% drawings	Peters/Addison
Task 4 - Reverse curve realignment	Chamberlain/Briggs/Addison
Task 2 - Broken rail open switch point detection system - review Technical Memo #4	Briggs
Industrial Support Update	Peterson/Terrill
Review project schedule and action items	all
Adjourn	

TECHNICAL MEMORANDUM 4

RTT UPGRADE PROGRAM
TRANSPORTATION TEST CENTER, PUEBLO, COLORADO



Broken Rail/ Open Switch Point Detection System

October 1995

By:
Parsons Brinckerhoff Quade & Douglas, Inc.

For:
U.S. Department of Transportation
Federal Railroad Administration

Volpe National Transportation Systems Center

CONTRACT NO. DTRS-57-91-D-00055
RAILROAD TEST TRACK (RTT) UPGRADE PROGRAM
AT THE TRANSPORTATION TECHNOLOGY CENTER, PUEBLO, COLORADO

TECHNICAL MEMORANDUM NO. 4
BROKEN RAIL/OPEN SWITCHPOINT DETECTION SYSTEM

BACKGROUND

In the fall of 1993, an assessment was made of the existing conditions on the Railroad Test Track (RTT) at the Transportation Technology Center in Pueblo, Colorado with the objective of identifying modifications to the track structure, track geometry, catenary system and signal system to support testing of high speed passenger trainsets in the very high (125 - 150 mph) and ultra high (>150 mph) speed regimes.

Since that time, several working meetings have been held to determine the scope of work and phasing of work to accomplish the above objectives. The rehabilitation/modification work has been phased to meet the limited amount of funding currently available for this program. AAR has developed a Phase I Work Plan for the Railroad Test Track Refurbishment, dated July 1995. This work plan has five tasks:

- Task 1. Convert existing jointed rail to continuously welded rail (CWR).
- Task 2. Preliminary (conceptual) design of a broken rail/open switch point detection system.
- Task 3. Restore overhead catenary system to original condition and upgrade the AC substation.
- Task 4. Change the alignment of the 0°-50' reverse curve to 1°-15'.
- Task 5. Upgrade RTT turnouts.

This memorandum addresses the conceptual design aspects for Task 2 and has been prepared to:

- Provide basic information with regard to signal system technologies that can detect broken rails and open switch points.

- Review the various technologies that would be acceptable for use on the RTT.

- Revisit the costs for installing the above technologies or variations of the above technologies recognizing that a selected system is to be installed in a test environment and that certain flexibilities may be possible that would not be possible in a revenue operating scenario.

Technology Assessment

Existing technologies were reviewed and consideration was given:

- To systems that are currently under design.
- To systems that are available and are either relay or microprocessor based.
- To systems that are proven through application because RTT is primarily an equipment test track.
- To the requirement that the chosen system have some measure of vitality.
- That the chosen system have a low initial cost and be easy to maintain.

Non-conventional railroad signaling technologies that are currently under design do not meet the above criteria as they:

- Have not yet been used or proven in an operating railroad or test environment.
- Are not sufficiently developed to be installed on the RTT.
- Do not have proven vital circuits to detect a broken rail or open switch point.

System Definition

As a result of much discussion held during several work committee meetings for the test track rehabilitation program and at a signal technologies meeting held on July 26, 1995 at the AAR office in Washington, DC the basic signal system requirements for the RTT have been determined:

a. Broken rail detection.
b. Open switch point detection.

Technologies currently on the market employ vital life safety circuits through the use of a track circuit. Two types of track circuit technologies have been identified that are readily available and meet basic system requirements.

1. Conventional phase selective 100Hz track circuits are available (requires use of line wire) from the following suppliers:

   - General Railway Signal (GRS) - "ACT503".
   - Union Switch and Signal (US&S) - "TRU-II".
   - Safetran - "SE-3".

2. Proprietary, microprocessor based, systems that are currently available or under development are:

   - General Railway Signal (GRS) - "Genracode".
   - Harmon Electronics - "Electrified Electrocode 4 (E^2C4)".
   - Union Switch and Signal (US&S) - "Microtrax" not available until the fall of 1996.

The first two product lines are currently available. The US&S system is expected out in late 1996.

RTT (Railroad Test Track) Characteristics

The RTT loop is approximately 70,000 feet long. It is an electrified loop powered by a 60 Hz overhead contact system (OCS). There are nine turnouts on the RTT. Seven of these turnouts have stands with mechanical lock rods and point protection. This mechanical system was put in service in the late 1970's. Power and circuit cables were installed along the RTT to turnout locations. The switch locking system is no longer in service and assumed to be in a state of disrepair. AAR is currently appraising the power supply side of the system only to determine its condition.

Signal System Characteristics

The technology to be employed at the RTT will be installed on an electrified railroad. Double rail track circuits with impedance bonds are the basic building block of a signal system in that environment. The typical AC track circuit has a maximum length of about 6,000 feet. Therefore, the RTT will be broken down into approximately twelve (12) track circuit segments. A power supply is necessary for all track circuit segments. Conventional phase selective track circuits with line wire or microprocessor based track circuits which move information via the rails may be used. The use of the microprocessor based track circuit eliminates the need for an express cable along the entire length of the RTT and associated conventional relays to process signal logic.

ESTIMATED COSTS

PBQ&D has developed estimated costs for a signal system to be installed on the RTT. These costs include the necessary labor, equipment and materials to furnish and install a system that will detect a broken rail and an open switch point. The estimates are based on assumptions developed at the signal meeting held at the AAR on July 26, 1995. These assumptions include the following:

- The signal system exists in an electrified railroad environment (60 Hz with phase breaks). The technology employed shall be capable of detecting a broken rail or open switchpoint and employ vital safety circuits.
- There are seven (7) T-20 locking switch stands on the RTT that can be used in the proposed signal system.
- A power supply installed in the late 1970's as part of the open point detection system can be used in the design of the proposed system.
- A traffic direction lever is required for current of traffic indication and will be installed at a convenient location near the RTT.
- The installed signal system will provide for cab signal at either:
  - 4 aspect 100 Hz, or
  - 9 aspect 100/250 Hz
- Wayside signals will be included as part of the system with conventional phase selective track circuits. The cost can be modified to reflect a less expensive indication mechanism such as a strobe light, beacon, traffic signal, etc.
- All required power cabling to be plowed-in. No cabling will be hung off catenary poles.
- All additional power required for field locations will be supplied by:
  - buried cable, or
  - small generators at remote locations
- Additional power will not be supplied by solar panels because of the substantial power requirements at each wayside location. Solar power has been dismissed at this time but could be revisited in a preliminary design.

Three signal estimates have been prepared. These estimates are based on the above assumptions. Individual detail sheets provide costs for:

- Signal, bonds and wayside equipment.
- Cable.
- Mobilization.
- Indirect Field Costs.
- GL & PD insurance and office overhead.
- Contractor's profit.
- Contingency.

The estimated costs for the three (3) signal systems are enclosed. The first sheet of each estimate is a summary sheet. This sheet contains the accumulated costs for the above-ground bonds and wayside equipment and the below-ground costs for cabling. The final two pages of each estimate contain the detailed unit cost breakdown for bonds, and wayside equipment and cable.

The above and below-ground costs are broken out because of the severe budget constraints. If funds become available, and a signal system is warranted, the installation of the system could be performed in two or more phases.

Basic descriptions of the three signal systems are included below. The system descriptions and estimate of costs are presented in the same chronological order.

<u>100/250 Hz Microprocessor System</u>
This estimate is based on a microprocessor driven 100/250 Hz cab signal system. This is a nine (9) aspect system which is compatible with the Northeast Corridor equipment which is tested at speeds over 125 mph. There is no wayside automatic signals. These multiple cab frequencies supply five (5) additional cab signals or "speed commands" to vehicles that are equipped. The absence of any code is always restricting and the engineer will bring the train to a stop. The MAS (maximum authorized speed) for the nine (9) aspect equipped engines will recognize the single frequency 100 Hz used in the three aspect cab signal system, clear code, as a slower speed and will not be able to proceed at higher speeds without a penalty brake application. Therefore, it is necessary to employ a multiple frequency cab signal system to allow operation of the trainset with cab signal of MAS of 160 mph. For all estimates it assumed that the power supply for the existing switch locking system will become a part of the power

supply system used for the twelve instrument houses on the RTT and no additional work is required for the existing electric lock system. The estimated cost for this system is $1,381,000.

100 Hz Microprocessor System

This estimate is based on a microprocessor driven 100 Hz system. This is the four aspect cab signal system that is used on railways throughout the United States; primarily on the NEC. This system can be applied with or without wayside signal indications or color light signals. The "clear" code to allow MAS of 160 mph will be unrecognized by equipment that utilizes the multiple frequency (100/250 Hz) system. The estimated cost for this system is $1,410,000.

100 Hz Conventional System

The estimate is based on a conventional 100 Hz phase selective track circuit with four aspect wayside signals. As can be seen from the detail sheet the main difference in cost between the conventional and microprocessor systems is the incremental cost associated with the express cable required to relay information between locations or houses and provide for bi-directional traffic. The estimated cost for this system is $2,426,000.

Other Considerations

Because of the estimated costs to install a signal system on the RTT, and the tight budget constraints for the RTT rehabilitation project, the working group has suggested possible modifications to reduce costs. These suggestions could be more thoroughly investigated in a preliminary design phase of a signal design project. However, based on a cursory review of comments received the following information is provided.

As a simplification of the proposed signal system a simple "go" or "no go" system has been proposed with a single code of 180 cpm at 100 Hz. As discussed in the meeting at Pueblo on August 18, 1995, this system would be capable of detecting a broken rail or open switch point with the track unoccupied by a rail vehicle. However, the presence of a rail vehicle would knock down the track circuits in a similar manner as a broken rail or open switch point and render the system inoperable.

The use of a "constant on" circuit as a modification of the 100 Hz conventional system has been suggested as a way to reduce expected signal costs. With traffic only running in one direction around the RTT, a reduction in the amount of messenger cable could be realized. However, if vehicles are to be turned and tested in any direction around the RTT, messenger cable cost savings would be eliminated and the cost of the system is as estimated for the 100 Hz conventional system.

Wayside signals are not estimated except for the 100 Hz conventional system. A reduction in cost can be made by using a strobe light or some other type of indicator with this signal system. However, cost savings due to the elimination of wayside signals will be insignificant compared to potential cost savings from selecting any microprocessor based cab signal system versus the conventional relay based system with messenger cable.

For all of the signal systems, an increase in length of track circuit over 6000 feet can substantially reduce the cost of the "signal, bonds & wayside equipment" portion of the signal estimates. These signal estimates were developed after contacting manufacturers and discussing "typical condition" track circuit lengths to be used as a basis for making a preliminary order of magnitude estimate. An increase in track circuit length, based on local site conditions at Pueblo, should be investigated during the preliminary design phase of a signal project. Any increase in track circuit length realized will reduce the "signal, bonds & wayside equipment" estimate. As an example, 33% increase in track circuit length (6000 feet to 8000 feet) will reduce "above" costs by about 25% (wayside locations will drop from 12 to 9).

PARSONS BRINCKERHOFF
PROJECT:TRANSPORTATION TEST CENTER

DATE:9/6/95
FILE:A:TTCsig1R

ITEM NO.	DESCRIPTION	QT.	UNIT	LABOR TOTAL COST	EQPMT TOTAL COST
A	SIGNAL, BONDS & WAYSIDE EQUIPMENT	1	L.S.	141,671	19,920
B	CABLE	1	L.S.	158,024	99,000
C	MOBILIZATION @ 10% OF ABOVE COST	1	L.S.	29,970	11,892
	TOTAL, BASE			329,665	130,812
	HANDLING OF AAR FURNISHED MATERIAL @ 5%				
	CONTINGENCY @ 25%				
	TOTAL ESTIMATED COST FOR INSTALLATION				
	TOTAL ESTIMATED FURNISHED MATERIAL COST				
	TOTAL ESTIMATED COST				

NOTES:
THIS ESTIMATE EXCLUDES:
- 0-TTC ENGINEERING PERSONNEL COST
- 0-ENGINEERING & DESIGN COST
- 0-CONSTRUCTION MANAGEMENT COST
- 0-CONTRACTOR INDIRECT FIELD COST, GL & PD INSURANCE, OFFICE OVERHEAD, AND PROFIT ON ALL MATERIAL PURCHASED BY THE ASSOCIATION OF AMERICAN RAILROAD (AAR)

(1) PRE-PURCHASED MATERIAL BY AAR, UNLOADED AT THE SITE FOR THE CONTRACTOR

100/250 HZ. CAB SIGNALS, 9 ASPECT W\O WAYSIDE INDICATOR

"SUMMARY"

TOTAL DIRECT COST	INDIRECT FIELD COST @ 10%	SUB TOTAL	GL & PD INSURANCE & OFFICE OVERHEAD @ 10%	SUB TOTAL	CONTRACTOR PROFIT @ 10%	ESTIMATED TOTAL COST BASE (1995$)	(1) MAT. TOTAL COST
161,591	16,159	177,750	17,775	195,525	19,553	215,078	511,183
257,024	25,702	282,726	28,273	310,999	31,100	342,099	75,016
41,862	4,186	46,048	4,605	50,652	5,065	55,718	
460,477	46,048	506,524	50,652	557,177	55,718	612,894	586,000
						29,300	
						153,224	
						795,000	
						586,000	
						1,381,000	

PARSONS BRINCKERHOFF
PROJECT:TRANSPORTATION TEST CENTER

DATE:9/6/95
FILE:A:TTCsig1R

100/250 HZ. CAB SIGNALS, 9 ASPECT W\O WAYSIDE INDICATOR

UNIT PRICE ANALYSIS

ITEM NO.	DESCRIPTION	QT.	UNIT	MAN-HR. PER UNIT	MAN-HR. TOTAL	LABOR UNIT COST	LABOR TOTAL COST	EQPMT UNIT COST	EQPMT TOTAL COST	MAT. UNIT COST	MAT. TOTAL COST	TOTAL UNIT COST	TOTAL DIRECT COST
A	SIGNAL, BONDS & WAYSIDE EQUIPMENT												
1	"AZ" IMPEDENCE BONDS & CONNECTIONS	24	EA.	4.00	96	104.10	2,498	15	360	2,952	70,848	3,071	73,706
2	HIGH SINGLE CASES	12	EA.	59.70	716	1,553.73	18,645	224	2,687	9,350	112,200	11,128	133,531
3	SWITCH LAYOUTS	2	EA.	48.00	96	1,249.25	2,498	180	360	15,200	30,400	16,629	33,259
4	POWER DISTRIBUTION	12	EA.	32.00	384	832.80	9,994	120	1,440	250	3,000	1,203	14,434
5	S-2 PRE-CAST FOUNDATION	6	EA.	48.19	289	1,254.22	7,525	542	3,253	1,670	10,020	3,466	20,798
6	100 HZ. INVERTERS	12	EA.	80.00	960	2,082.00	24,984	300	3,600	8,755	105,060	11,137	133,644
7	160 AH BATTERIES & CHARGERS	12	EA.	48.00	576	1,249.25	14,991	180	2,160	3,250	39,000	4,679	56,151
8	MASTER SIGNAL LOCATION	1	L.S.	160.00	160	4,164.00	4,164	600	600	8,785	8,785	13,549	13,549
9	INTERMEDIATE SIGNAL LOCATION	5	EA.	80.00	400	2,082.00	10,410	300	1,500	7,840	39,200	10,222	51,110
10	OPERATOR LOCATION	6	EA.	80.00	480	2,082.00	12,492	300	1,800	7,645	45,870	10,027	60,162
11	TRACK INTERFACE UNIT	12	EA.	48.00	576	1,249.25	14,991	180	2,160	3,900	46,800	5,329	63,951
	WORKER'S COMPENSATION INSURANCE	15	%				18,479						18,479
	TOTAL ITEM NO.A	1	L.S.	4733.62	4,734	141671.46	141,671	19,920	19,920	511,183	511,183	672,774	672,774

PARSONS BRINCKERHOFF
PROJECT:TRANSPORTATION TEST CENTER

DATE:9/6/95
FILE:A:TTCsig1R

100/250 HZ. CAB SIGNALS, 9 ASPECT W\O WAYSIDE INDICATOR

UNIT PRICE ANALYSIS

ITEM NO.	DESCRIPTION	QT.	UNIT	MAN-HR. PER UNIT	MAN-HR. TOTAL	LABOR UNIT COST	LABOR TOTAL COST	EQPMT UNIT COST	EQPMT TOTAL COST	MAT. UNIT COST	MAT. TOTAL COST	TOTAL UNIT COST	TOTAL DIRECT COST
B	CABLE												
12	2C/6 TRK.	2,200	FT.	0.13	293	3.47	7,634	2.50	5,500	2.33	5,126	8.30	18,260
13	2C/6 POWER	36,000	FT.	0.13	4,800	3.47	124,920	2.50	90,000	1.85	66,600	7.82	281,520
14	5C/14 SW IND.	1,400	FT.	0.13	187	3.47	4,858	2.50	3,500	2.35	3,290	8.32	11,648
	WORKER'S COMPENSATION INSURANCE	15	%				20,612						20,612
	TOTAL ITEM NO.B	1	L.S.	5280.00	5,280	158023.80	158,024	99,000	99,000	75,016	75,016	332,040	332,040

PARSONS BRINCKERHOFF
PROJECT:TRANSPORTATION TEST CENTER

DATE:9/6/95
FILE:A:TTCsig2R

ITEM NO.	DESCRIPTION	QT.	UNIT	LABOR TOTAL COST
A	SIGNAL, BONDS & WAYSIDE EQUIPMENT	1	L.S.	148,854
B	CABLE	1	L.S.	162,812
C	MOBILIZATION @ 10% OF ABOVE COST	1	L.S.	31,167
	TOTAL, BASE			342,833
	HANDLING OF AAR FURNISHED MATERIAL @ 5%			
	CONTINGENCY @ 25%			
	TOTAL ESTIMATED COST FOR INSTALLATION			
	TOTAL ESTIMATED AAR FURNISHED MATERIAL COST			
	TOTAL ESTIMATED COST			

NOTES:
THIS ESTIMATE EXCLUDES:
- 0-TTC ENGINEERING PERSONNEL COST
- 0-ENGINEERING & DESIGN COST
- 0-CONSTRUCTION MANAGEMENT COST
- 0-CONTRACTOR INDIRECT FIELD COST, GL & PD INSURANCE, OFFICE OVERHEAD, AND PROFIT ON ALL MATERIALS PURCHASED BY THE ASSOCIATION OF AMERICAN RAILROAD (AAR).

(1) PRE-PURCHASED MATERIALS BY AAR, UNLOADED AT THE SITE FOR CONTRACTOR.

100 HZ. CAB W\ THREE ASPECT COLOR INDICATOR

"SUMMARY"

EQPMT TOTAL COST	TOTAL DIRECT COST	INDIRECT FIELD COST @ 10%	SUB TOTAL	GL & PD INSURANCE & OFFICE OVERHEAD @ 10%	SUB TOTAL	CONTRACTOR PROFIT @ 10%	ESTIMATED TOTAL COST BASE (1995$)	(1) MAT. TOTAL COST
20,820	169,674	16,967	186,642	18,664	205,306	20,531	225,836	508,303
102,000	264,812	26,481	291,294	29,129	320,423	32,042	352,465	77,704
12,282	43,449	4,345	47,794	4,779	52,573	5,257	57,830	
135,102	477,935	47,794	525,729	52,573	578,302	57,830	636,132	586,000
							29,300	
							159,033	
							824,000	
							586,000	
							1,410,000	

PARSONS BRINCKERHOFF
PROJECT:TRANSPORTATION TEST CENTER

DATE:9/6/95
FILE:A:TTCsig2R

100 HZ. CAB W\ THREE ASPECT COLOR INDICATOR

UNIT PRICE ANALYSIS

ITEM NO.	DESCRIPTION	QT.	UNIT	MAN-HR. PER UNIT	MAN-HR. TOTAL	LABOR UNIT COST	LABOR TOTAL COST	EQPMT UNIT COST	EQPMT TOTAL COST	MAT. UNIT COST	MAT. TOTAL COST	TOTAL UNIT COST	TOTAL DIRECT COST
A	SIGNAL, BONDS & WAYSIDE EQUIPMENT												
1	"AZ" IMPEDENCE BONDS & CONNECTIONS	24	EA.	4.00	96	104.10	2,498	15	360	2,952	70,848	3,071	73,706
2	HIGH SINGLE CASES	12	EA.	59.70	716	1,553.73	18,645	224	2,687	9,350	112,200	11,128	133,531
3	SWITCH LAYOUTS	2	EA.	48.00	96	1,249.25	2,498	180	360	15,200	30,400	16,629	33,259
4	POWER DISTRIBUTION	12	EA.	32.00	384	832.80	9,994	120	1,440	250	3,000	1,203	14,434
5	SIGNAL 3 ASPECT HI BACK\BACK	6	EA.	40.00	240	1,041.00	6,246	150	900	1,320	7,920	2,511	15,066
6	S-2 PRE-CAST FOUNDATION	6	EA.	48.19	289	1,254.22	7,525	542	3,253	1,670	10,020	3,466	20,798
7	100 HZ. INVERTERS	12	EA.	80.00	960	2,082.00	24,984	300	3,600	8,755	105,060	11,137	133,644
8	160 AH BATTERIES & CHARGERS	12	EA.	48.00	576	1,249.25	14,991	180	2,160	3,250	39,000	4,679	56,151
9	MASTER SIGNAL LOCATION	1	L.S.	160.00	160	4,164.00	4,164	600	600	7,685	7,685	12,449	12,449
10	INTERMEDIATE SIGNAL LOCATION	5	EA.	80.00	400	2,082.00	10,410	300	1,500	6,980	34,900	9,362	46,810
11	REPEATER LOC.	6	EA.	80.00	480	2,082.00	12,492	300	1,800	6,745	40,470	9,127	54,762
12	TRACK INTERFACE UNIT	12	EA.	48.00	576	1,249.25	14,991	180	2,160	3,900	46,800	5,329	63,951
	WORKER'S COMPENSATION INSURANCE	15	%				19,416						19,416
	TOTAL ITEM NO.A	1	L.S.	4973.62	4,974	148854.36	148,854	20,820	20,820	508,303	508,303	677,977	677,977

PARSONS BRINCKERHOFF
PROJECT:TRANSPORTATION TEST CENTER

DATE:9/6/95
FILE:A:TTCsig2R

100 HZ. CAB W\ THREE ASPECT COLOR INDICATOR

UNIT PRICE ANALYSIS

ITEM NO.	DESCRIPTION	QT.	UNIT	MAN-HR. PER UNIT	MAN-HR. TOTAL	LABOR UNIT COST	LABOR TOTAL COST	EQPMT UNIT COST	EQPMT TOTAL COST	MAT. UNIT COST	MAT. TOTAL COST	TOTAL UNIT COST	TOTAL DIRECT COST
B	CABLE												
13	2C/6 TRK.	2,200	FT.	0.13	293	3.47	7,634	2.50	5,500	2.33	5,126	8.30	18,260
14	2C/6 POWER	36,000	FT.	0.13	4,800	3.47	124,920	2.50	90,000	1.85	66,600	7.82	281,520
15	5C/14 SW IND.	1,400	FT.	0.13	187	3.47	4,858	2.50	3,500	2.35	3,290	8.32	11,648
16	4C/9 LIGHTING	1,200	FT.	0.13	160	3.47	4,164	2.50	3,000	2.24	2,688	8.21	9,852
	WORKER'S COMPENSATION INSURANCE	15	%				21,236						21,236
	TOTAL ITEM NO.B	1	L.S.	5440.00	5,440	162812.40	162,812	102,000	102,000	77,704	77,704	342,516	342,516

PARSONS BRINCKERHOFF
PROJECT:TRANSPORTATION TEST CENTER

DATE:9/6/95
FILE:A:TTCsig3R

ITEM NO.	DESCRIPTION	QT.	UNIT	LABOR TOTAL COST
A	SIGNAL, BONDS & WAYSIDE EQUIPMENT	1	L.S.	91,851
B	CABLE	1	L.S.	450,128
C	MOBILIZATION @ 10% OF ABOVE COST	1	L.S.	54,198
	TOTAL, BASE			596,178
	HANDLING OF AAR FURNISHED MATERIAL @ 5%			
	CONTINGENCY @ 25%			
	TOTAL ESTIMATED COST FOR INSTALLATION			
	TOTAL ESTIMATED AAR FURNISHED MATERIAL COST			
	TOTAL ESTIMATED COST			

NOTES:
THIS ESTIMATE EXCLUDES:
- 0-TTC ENGINEERING PERSONNEL COST
- 0-ENGINEERING & DESIGN COST
- 0-CONSTRUCTION MANAGEMENT COST
- 0-CONTRACTOR INDIRECT FIELD, GL & PD INSURANCE, OFFICE OVERHEAD, AND PROFIT ON ALL MATERIALS PURCHASED BY THE ASSOCIATION OF AMERICAN RAILROAD (AAR).

(1)PRE-PURCHASED MATERIAL BY AAR, UNLOADED AT THE SITE FOR CONTRACTOR.

100 HZ. TRACK CIRCUITS W\ WAYSIDE SIGNALS (RULE 261)

"SUMMARY"

EQPMT TOTAL COST	TOTAL DIRECT COST	INDIRECT FIELD COST @ 10%	SUB TOTAL	GL & PD INSURANCE & OFFICE OVERHEAD @ 10%	SUB TOTAL	CONTRACTOR PROFIT @ 10%	ESTIMATED TOTAL COST BASE (1995$)	(1) MAT. TOTAL COST
13,677	105,529	10,553	116,082	11,608	127,690	12,769	140,459	420,088
282,000	732,128	73,213	805,341	80,534	885,875	88,588	974,463	429,784
29,568	83,766	8,377	92,142	9,214	101,357	10,136	111,492	
325,245	921,423	92,142	1,013,565	101,357	1,114,922	111,492	1,226,414	850,000
							42,500	
							306,604	
							1,576,000	
							850,000	
							2,426,000	

PARSONS BRINCKERHOFF
PROJECT:TRANSPORTATION TEST CENTER

DATE:9/6/95
FILE:A:TTCsig3R

100 HZ. TRACK CIRCUITS W\ WAYSIDE SIGNALS (RULE 261)

UNIT PRICE ANALYSIS

ITEM NO.	DESCRIPTION	QT.	UNIT	MAN-HR. PER UNIT	MAN-HR. TOTAL	LABOR UNIT COST	LABOR TOTAL COST	EQPMT UNIT COST	EQPMT TOTAL COST	MAT. UNIT COST	MAT. TOTAL COST	TOTAL UNIT COST	TOTAL DIRECT COST
A	SIGNAL, BONDS & WAYSIDE EQUIPMENT												
1	"AZ" IMPEDENCE BONDS & CONNECTIONS	24	EA.	4.00	96	104.10	2,498	15	360	2,952	70,848	3,071	73,706
2	HIGH SINGLE CASES	12	EA.	59.70	716	1,553.73	18,645	224	2,687	9,350	112,200	11,128	133,531
3	SWITCH LAYOUTS	2	EA.	48.00	96	1,249.25	2,498	180	360	15,200	30,400	16,629	33,259
4	POWER DISTRIBUTION	12	EA.	32.00	384	832.80	9,994	120	1,440	250	3,000	1,203	14,434
5	SIGNAL 3 ASPECT HI BACK\BACK	6	EA.	40.00	240	1,041.00	6,246	150	900	1,320	7,920	2,511	15,066
6	S-2 PRE-CAST FOUNDATION	6	EA.	48.19	289	1,254.22	7,525	542	3,253	1,670	10,020	3,466	20,798
7	100 HZ. INVERTERS	12	EA.	80.00	960	2,082.00	24,984	300	3,600	8,755	105,060	11,137	133,644
8	100 HZ. TRACK CIRCUIT	12	EA.	23.95	287	623.35	7,480	90	1,078	6,720	80,640	7,433	89,198
	WORKER'S COMPENSATION INSURANCE	15	%				11,981						11,981
	TOTAL ITEM NO.A	1	L.S.	3069.00	3,069	91851.44	91,851	13,677	13,677	420,088	420,088	525,617	525,617

PARSONS BRINCKERHOFF
PROJECT:TRANSPORTATION TEST CENTER

DATE:9/6/95
FILE:A:TTCsig3R

100 HZ. TRACK CIRCUITS W\ WAYSIDE SIGNALS (RULE 261)

UNIT PRICE ANALYSIS

ITEM NO.	DESCRIPTION	QT.	UNIT	MAN-HR. PER UNIT	MAN-HR. TOTAL	LABOR UNIT COST	LABOR TOTAL COST	EQPMT UNIT COST	EQPMT TOTAL COST	MAT. UNIT COST	MAT. TOTAL COST	TOTAL UNIT COST	TOTAL DIRECT COST
B	CABLE												
9	2C/6 TRK.	2,200	FT.	0.13	293	3.47	7,634	2.50	5,500	2.33	5,126	8.30	18,260
10	2C/6 POWER	36,000	FT.	0.13	4,800	3.47	124,920	2.50	90,000	1.85	66,600	7.82	281,520
11	5C/14 SW IND.	1,400	FT.	0.13	187	3.47	4,858	2.50	3,500	2.35	3,290	8.32	11,648
12	4C/9 LIGHTING	1,200	FT.	0.13	160	3.47	4,164	2.50	3,000	2.24	2,688	8.21	9,852
13	19C/14 EXP	72,000	FT.	0.13	9,600	3.47	249,840	2.50	180,000	4.89	352,080	10.86	781,920
	WORKER'S COMPENSATION INSURANCE	15	%				58,712						58,712
	TOTAL ITEM NO.B	1	L.S.	15040.00	15,040	450128.40	450,128	282,000	282,000	429,784	429,784	1,161,912	1,161,912

Technical Memorandum 4: RTT Upgrade Program, Transportation Test Center, Pueblo, Colorado: Broken Rail/Open Switch Point Detection System, 1995, 12-Safety