TECHNICAL PROPOSAL

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FIXED STATION LOCOMOTIVE

CONTROL SYSTEM

RADIATION INCORPORATED

SUBSIDIARY OF HARRIS-INTERTYPE CORPORATION

CONTROL DIVISION

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FIXED STATION LOCOMOTIVE CONTROL SYSTEM

1.0 INTRODUCTION

1.1 Purpose

This technical proposal describes a system for the remote control of a locomotive from a control station or tower.

This proposal discusses the specific method for implementing this program and summarizes the relevant company background, experience, capability, facilities and organizational structure available to undertake this task. Radiation Incorporated offers:

- Operating locomotive control system experience
- A competent project team which designs superior system on schedule
- Manufacturing experience, ability and capacity

1.2 Program Objective

The customary means of controlling a locomotive is by electrical cable and air hoses. This proposed control system will provide the electrical switching necessary for control of a locomotive from a central control point or tower and convert the control information to a code suitable for reliable radio transmission to the locomotive, thus providing independent remote control and monitoring of the locomotive from the tower.

1.3 System Configuration Layout

An artist's conception of the proposed Control Console appears in Figure 1-1 of this proposal. The configuration and layout proposed is the result of the coordinated effort between mechanical, electrical and the human engineering.

1.4 System Description (Block Diagram)

A block diagram of the proposed system is shown in Figure 1-3 and includes the control station and one remote station.

The Control Console switches provide electrical contacts for the logic circuitry. This circuitry generates, at the proper time, a message containing all the information set on the control console switches. The message is transmitted by the control station radio and is received at the remote station. The received information is accepted by the system logic and is analyzed. If the message is a valid one and the address code is correct, the logic circuitry energizes the appropriate interface relays. These relays provide direct electrical control of the locomotive functions.

The locomotive status sensors detect locomotive functions activated. These sensors provide the information necessary to generate a report-back message in the remote station logic. This message is transmitted back to the control station via radios where it is accepted and analyzed by the control logic. The logic then displays the received information on the control console.

1.5 Equipment to be Supplied by Radiation

Control Station

1. Control Console - Switching and Indicators.
2. Control Station Logic Cabinet.
3. Logic Power Supply - Operation from 115 VAC.
4. VHF Radio, power supply (for 115 VAC input), base and antenna. Antenna coax cable and antenna mounting to be provided by the customer.

2.0 TECHNICAL DESCRIPTION

The following description encompasses for all practical purposes the physical, electrical and functional characteristics of the proposed system.

2.1 Physical Characteristics

The control tower equipment cabinet will contain, in addition to the console switches and indicators, the control logic and power supply. A sketch of the control console is shown in Figure 1-2.

Printed circuit board connectors will have double bifurcated gold plated contacts.

Printed circuit boards will be glass epoxy material, and will be coated for environmental protection and reliability.

2.2 Electrical Characteristics

The system logic furnished will consist entirely of silicon solid-state devices.

Both input and output circuits will have suitable transient protection devices to prevent spurious operation or damage of the equipment.

2.3 Environmental

Equipment will operate over an ambient temperature range from -40°F to +140°F and up to a relative humidity of 95%.

2.4 Communications Channel

The communication link will be via radio operation in the 160 MHz or 450 MHz band. These radios will be modulated by a frequency-shift signal.

Frequency Shift (FSK) equipment will employ 2.5/1.5 KHz mark/space frequencies and will be furnished by Radiation. The FSK equipment will have input and output impedances of 600 ohms.

2.5 Operation

The control (tower) station will provide electrical switching necessary for independent control of the locomotive. These switch positions will be converted to a suitable digital code for transmission by the radio. The remote station will receive the digital code from the radio receiver and convert this code to an electrical signal for relay closures to match the original signal. These relays will control the locomotive and must remain actuated until the function is negated. If a function is changed on the control, a corresponding change will be made on the remote.

2.5.1 Communication

Each transmission will contain an address code to insure reception by the proper remote unit. The fixed control station being proposed will be able to select any one of the address codes.

2.5.2 Comparison and Display

The supplier will incorporate a comparison feature in the control station logic to permit comparison of the input conditions with the status of

the controls on the remotes, as indicated by the "report-back" codes. This comparison circuitry will be capable of initiating a command transmission. Certain report-back codes will light display lamps on the control console.

2.5.3 Command Transmissions

Command functions from the control unit to the remote unit will be initiated:

1. When any control console function is changed.
2. When the comparison feature is not satisfied.
3. A minimum of once every 21 seconds.

Each control function will be transmitted on each transmission.

2.5.4 Report-Back Transmission

Report-back transmission will be initiated:

1. Within 100 milliseconds after a command transmission has been received.

2. When there is a change in status of any reportable condition on the locomotive.

3. Whenever an alarm is sensed in the locomotive.

Each report-back code shall be transmitted on each transmission.

2.5.5 Continuity and No Continuity

There will be a transmission between the control station and the remote station at least once every 21 seconds.

If continuity is lost during tower control operation, logic added to the remote equipment will detect the loss of continuity and do the following:

1. Return the remote equipment to an Idle condition.

2. Apply air brakes at a service rate.

Penalty reset will be accomplished by depressing the console automatic brake release pushbutton.

2.6 Functions Performed

Diesel locomotives are controlled by signals on a 27 wire train control cable. These cables plug in locomotive to locomotive, and practically any number of adjacent locomotives can be controlled in tandem. These signals on the control wires consist of the presence or absence of the 72 volt locomotive battery.

To operate a locomotive from a stationary position, it is necessary to replace the control cable with coding equipment, logic circuits and a radio link. There are some functions, such as air brake control, that are not associated with the control cable, however, these functions must also be encoded and transmitted to the locomotive.

2.6.1 Throttle - (Must keep throttle depressed to maintain train movement) Safety Feature

A diesel locomotive has eight throttle positions which control the power by means of five train line wires associated with five relays. The throttle positions are encoded to binary form for transmission to remote unit and are decoded there to directly control the throttle relays. On report-back, the transmitted binary code is decoded to decimal for display.

Throttle Position	Operated Relays	Console Display
No. 1		Throttle 1
No. 2	A Valve	Throttle 2
No. 3	C Valve	Throttle 3
No. 4	A & C Valves	Throttle 4
No. 5	B, C & D Valves	Throttle 5
No. 6	A, B, C & D Valves	Throttle 6
No. 7	B & C Valves	Throttle 7
No. 8	A, B & C Valves	Throttle 8

2.6.2 Air Brakes

The air brake function on a locomotive will be actuated within 0.25 seconds after the function is initiated by operation of the pushbutton on the control console, and will remain actuated the entire time that the pushbutton is actuated on the control console.

The Air Brake functions is lapped within 0.25 seconds after the AIR BRAKE pushbutton is released.

The method of operation of the "automatic" and the independent" air brakes are similar and separate controls are provided for these two operations. Emergency brake application is a momentary signal. Circuitry will be incorporated so that application and removal of system power in any sequence on remote or control units will not cause emergency brake application.

2.6.3 Air Brake Feed Valve

In order to prevent accidental operation of the air brake feed valve solenoid on the locomotive, circuit interlocks will be incorporated. To cut in the feed valve, the operator must perform these operations:

1. Move FEED VALVE switch to the IN position.
2. Move MODE switch from the ISOLATE position.
3. Operate the AIR BRAKE release pushbutton.

The sequence is not important for Items 1 and 2, but 3 must be performed as the final step.

To cut out the FEED VALVE, the operator must set FEED VALVE switch to OUT and the MODE switch to ISOLATE.

2.7 Alarms

Receipt of an alarm status from the remote unit will actuate an audible alarm as well as light the corresponding console indicator. The alarm will sound until the alarm reset pushbutton is operated. Alarm functions are:

1. ALARM
2. WHEEL SLIP
3. PC

2.8 Isolate Condition

The ISOLATE position of the MODE switch will effectively isolate the remote locomotive and place the following restrictions on the unit:

1. With the locomotive in ISOLATE, the control unit will initiate no subsequent transmission after receiving a report-back containing the ISOLATE signal, except the automatic transmission every 21 seconds to maintain system continuity.

2. The locomotive will not perform any functions other than emergency brake application.

3. The remote unit will continue to initiate a transmission in reply to a command transmission or for any alarm function sensed in the locomotive.

2.9 Power Requirements

Logic circuits will operate from a ±12 VDC power supply (furnished by Radiation). The radio will operate from a power supply (furnished by Radiation). Both power supplies will operate from 115 volt, 60 Hz line supply.

2.10 Transmitted Functions

2.10.1 Control Unit to Remote Unit

Throttle - 1 - 8
Engine Run
Forward
Reverse
Generator Field
Engine Shut Down
Independent Brake Application
Independent Brake Release
Automatic Brake Application
Automatic Brake Release
Emergency Brake Application (2 Codes for Security)
Air Brake Feed Valve (2 Codes for Security)
Isolate (2 Codes for Security)

2.10.2 Remote Unit to Control Unit

Throttle 1 - 8
Engine Run
Forward
Reverse
Generator Field
Engine Brake
Independent Brake Release
Automatic Brake Release
Emergency Brake Application
Air Brake Feed Valve
Isolate
Wheel Slip
PC
Alarm

2.11 Console Display

2.11.1 Indicator Lamps

PC
ALARM
WS (Wheel Slip)
XMIT
CONT. (Continuity)
NO CONT. (No Continuity)
ENG. BRK.
FORWARD
NEUTRAL
REVERSE
IDLE
ISOLATE
Throttle 1 - 8
EMERG. APP.
FEED VALVE IN/OUT

2.11.2 Console Switches

Pushbuttons

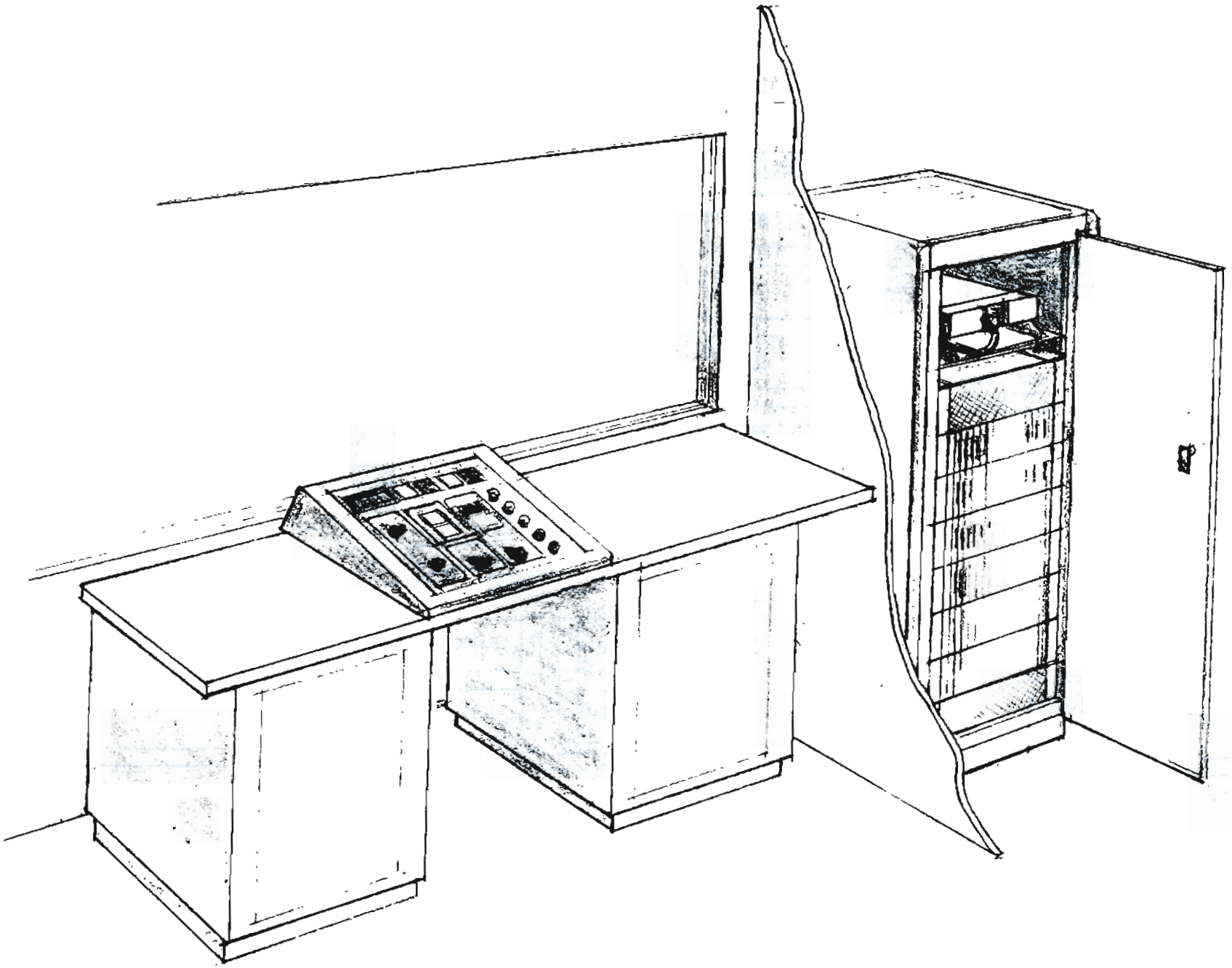
Engine Shut Down
Emergency Brake Application
Automatic Brake Application
Automatic Brake Release
Independent Brake Application
Independent Brake Release
Alarm Reset
FEED VALVE IN/OUT
Tower Control
Lead Control
FORWARD
NEUTRAL
REVERSE
IDLE
ISOLATE
Throttle 1 - 8

Toggle Switches (Circuit Breakers)

Main Power
Radio Power

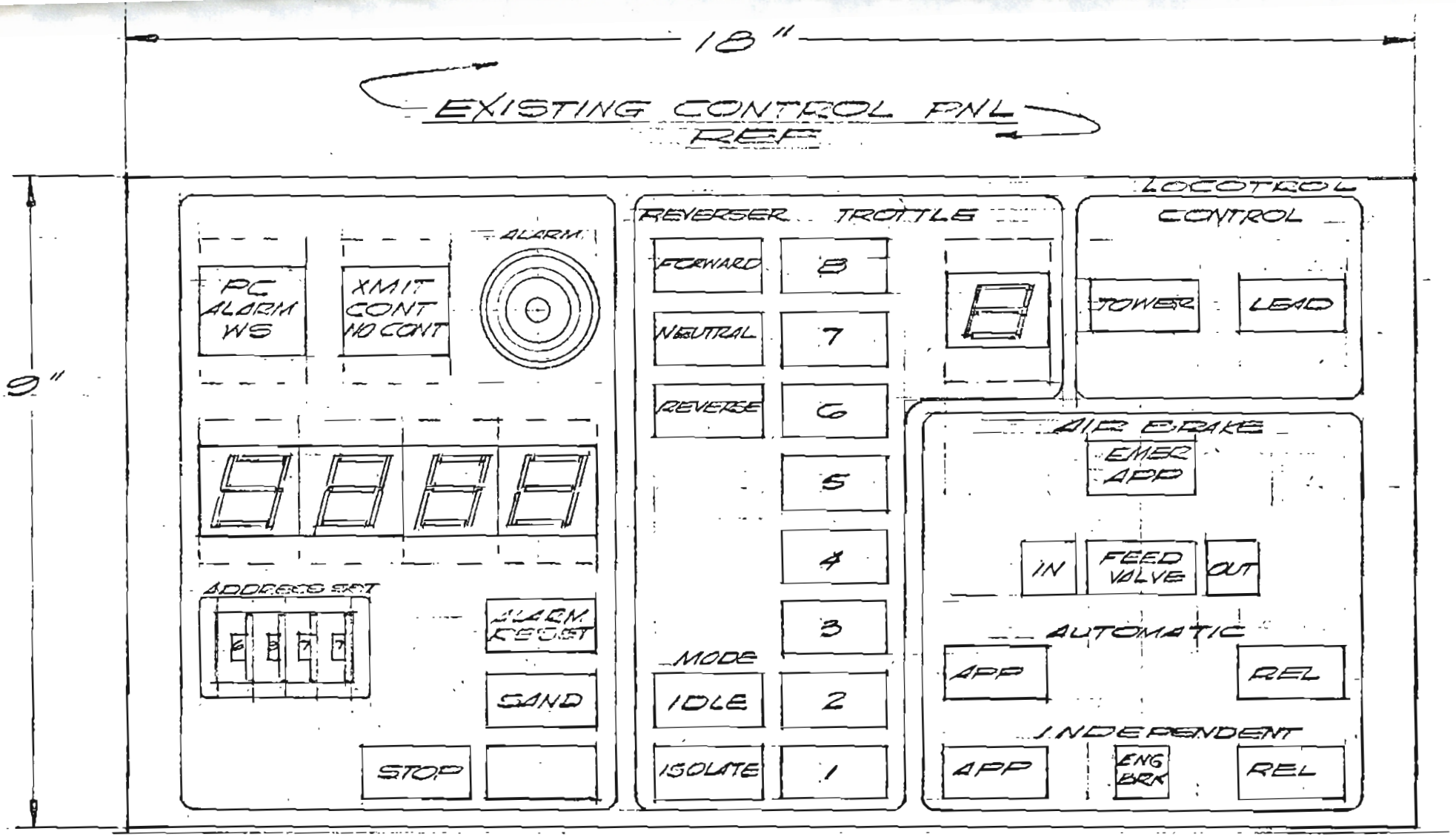
Thumbwheel Switches

Address Select



(Desk Not Included)

FIGURE 1-1 CONTROL CONSOLE & EQUIPMENT CABINET



SCALE: 1/2

FIGURE 1-2. CONTROL PANEL

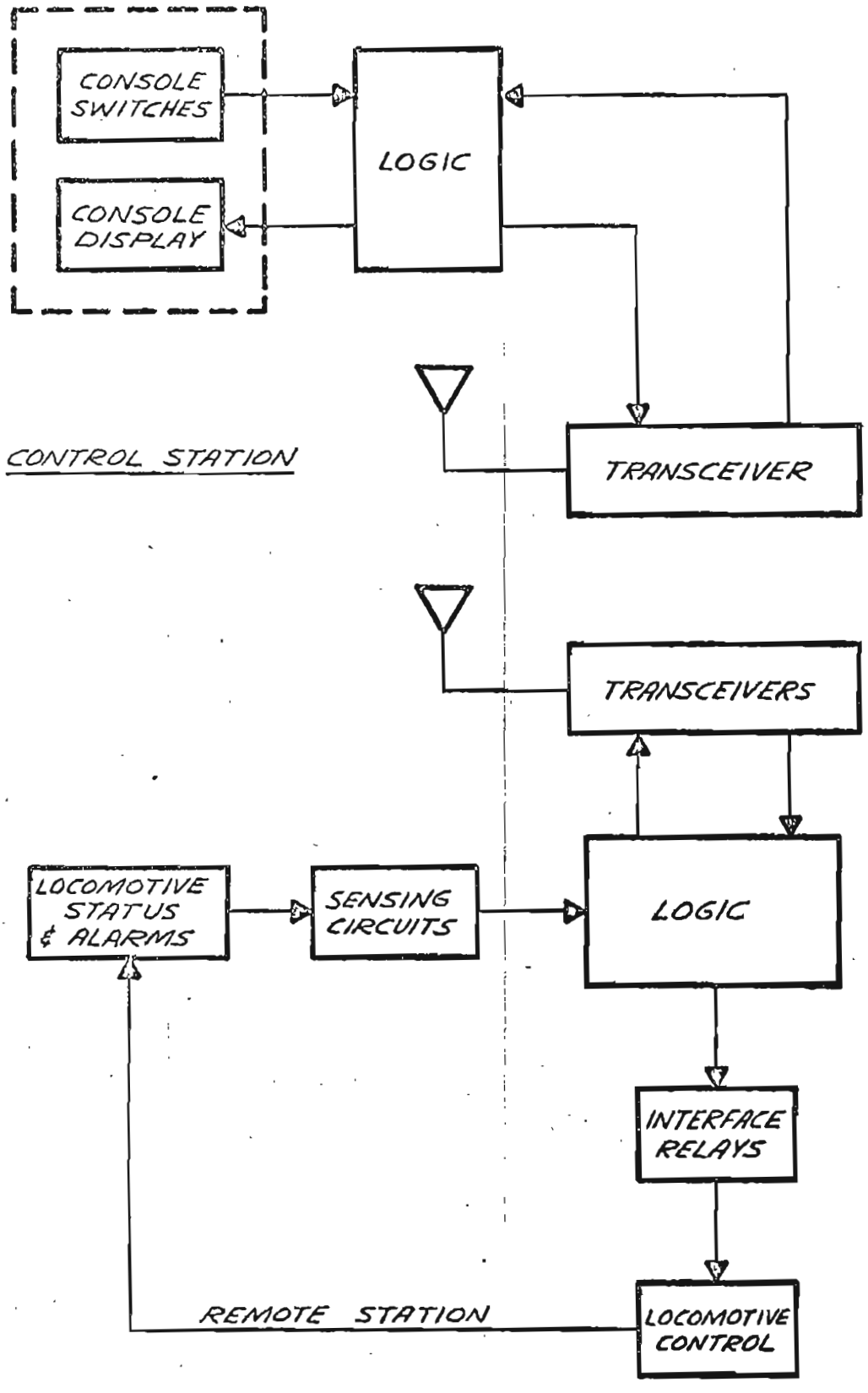


FIG. 1-3 SYSTEM BLOCK DIAGRAM

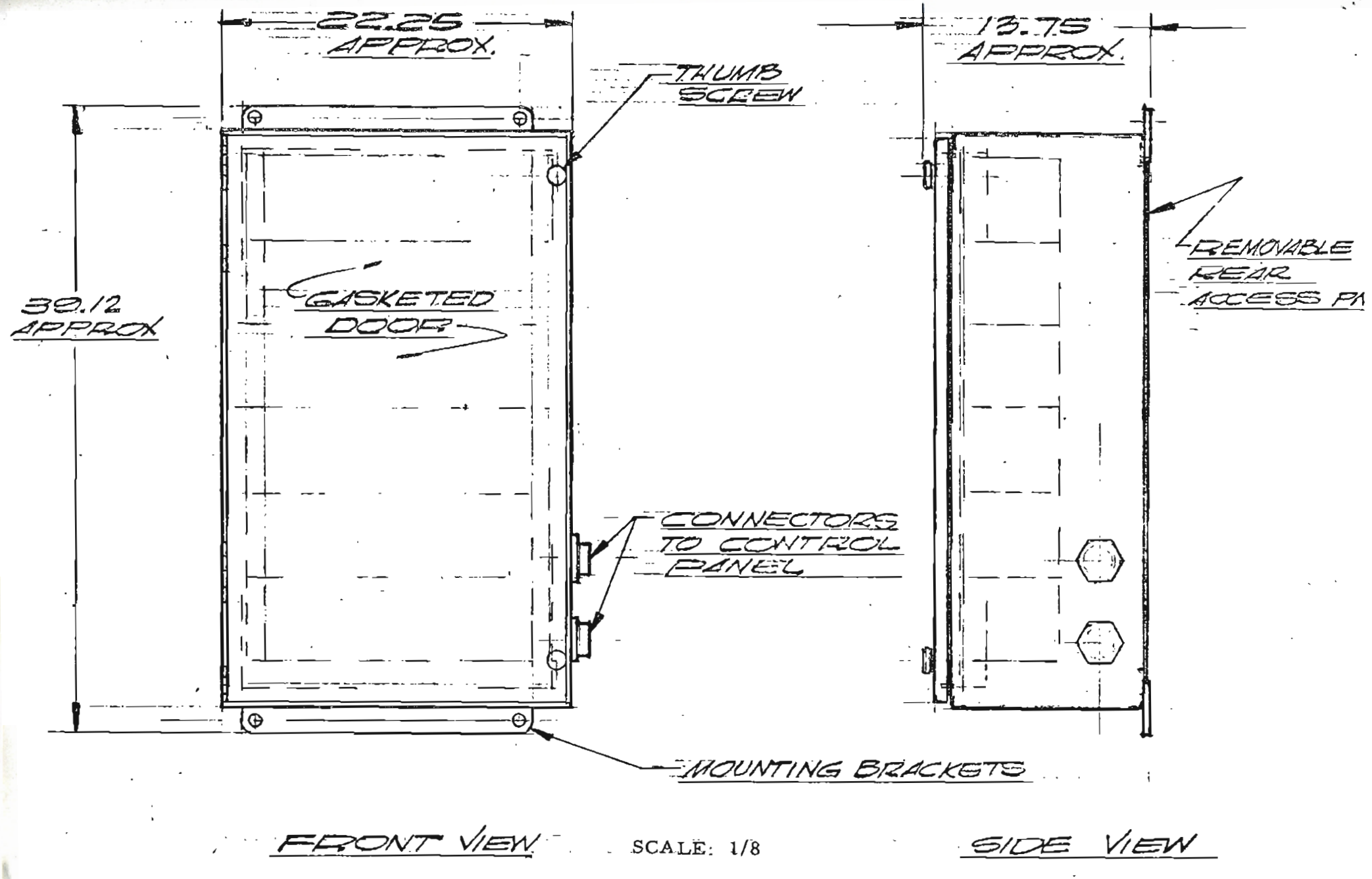


FIGURE 1-4. LOCOTROL LOGIC ENCLOSURE

GRS—

Transducer

cost to install 1 set
remote control equipment

Equipment - $68,000
Installation 38,000
$106,000

BFB

Atuhrotuy is requested for gross investment cash approprtiation of

~~755,200~~

$ ~~780,000~~ [typed over with x's] to equip equip

761,000

seven sets of locomotives (2 units per set) with remote control equipment to permit unmanned helper operation of freight trains between West Colton and Bakersfield. Proposal will

93.5 — 68
59 — 38
34.5 — 106

Max-Harris Controls.
55 + 15%

27
32
59
60
65 m

55m + 6%

Pete Felius

Purchase and install 7 sets of remote control equipment @ ~~81,000~~ 80,200 (93,500) — ~~$ 567,000~~ 561,400

Install wayside radio system to insure control continuity — 202,800 — ~~193,900~~ ~~194,000~~

Total cash investment — ~~$ 761,000~~ ~~755,300~~ 764,200

Equipment — 68,000
Installation — 38,000
106,000

Remote provides backup to human factors.
1 Air test
1 overspeed
1 Control of train line
(Broad train)

Description of remote control equipment.

Equipment for remote conteol of helper locomtoves by the lead unit is basically duplicate radio sets in both units, connected to control consoles and to the various relays energizing specific locomotive functions. Attached are tables outlining the 28 items on the locomotive control console and the 5 items on the air brake console.

Iter-communication is by frequency modulated radio, duplicated in each unit, which transmit data messages back and forth. Each consist of a specific lead and helper unit has a separate coded address which is set before remote operation commences. Capacity of the message is 32 function bits, 11 address bits and 6 sychronizing and error check bits, with a message transmission time of 212 milliseconds for both the command signals from the lead unit and the status signals from the helper unit. If there is no message to be sent, the lead unit makes a continuity check every 21 seconds. Radio propagation in tunnels and deep cuts is very uncertain.

To insure communication between the two units that are about 3,600' apart, repeater radio stations are used which automatically pick up and re-transmit the radio data message. In tunnels and deep cuts these repeater stations are connected to a slotted coaxial cable which acts as continuous antenna for its entire length.

REMOTE LOCOMOTIVE CONTROL

Under normal conditions one to four or more diesel electric units are coupled together to make a locomotive. An engineer controls the locomotive from the first unit. Remote control equipment allows the locomotive on the front of a train to also control helper units by using radio signals to duplicate the established power or braking mode.

Locking the various locomotives in a train together by radio greatly improves train handling as all equipment responds instantanously as a single unit.

Duplicate radio sets in each locomotive connected the control consoles to various relays that control the electrical and air brake functions.

Attached are tables outlining the 28 items on the locomotive control console and the 5 items on the air brake console.

To insure communication between the lead and helper locomotives that are about 3,600' apart, repeater radio stations are used which automatically pick up and re-transmit the radio date message. In tunnels and deep cuts these repeater stations are connected to a slotted coaxial cable which acts as a continuous antenna for its entire length. The system incorporates a number of safety features:

In the event of an emergency brake application, power will be removed from all units.

If radio contact is lost, remote unit will automatically reduce power output and go to idle if a signal is not properly received.

An overspeed of either the control or remote units will result in an automatic brake application.

Established methods of testing the air can determine if angle cocks are closed in the train. (L&N Initial Terminal Road Train Air Brake Tests)

M. R. Gaddis

572-6 (RC)

San Francisco, May 18, 1961

SUBJECT: Remote Control of Helper Units

Mr. S. M. Houston:(2)

Attached are five data sheets covering tests made with helper units operated by remote control between Bakersfield and Mojave.

Test equipment was installed in seven days at Bakersfield roundhouse with the supervision of M&D and Union Switch and Signal Company. The first two days of testing revealed some small defects in the control system and these conditions were corrected. During testing it was found that radio continuity was lost in the area of tunnels 3 and 5 for a period of less than one minute. With the continuity lost for one minute, the locomotive throttle was reduced to the seventh position which did not noticeably affect the train operation. During test run 3-B, the helpers were stopped in tunnel 5 and could not be started by remote control. It was then necessary for the helper engine crew to operate the helper units until the radio signal was again picked up outside the tunnel.

The method of radio signaling used for helper remote control is designed such that other radio transmitters cannot cut in and disrupt the controlling circuits. If it were desired to operate several sets of remote control helpers, each road engine would have its individual tone control tuned to one set of helper units. With separate tone controls there would be no interference between sets of units.

Tests 1 to 5 made on May 15, 16 and 17 between Bakersfield and Mojave indicate that remote control of helper units is possible on the San Joaquin division, however, expense of equipment and maintenance costs are not known at this time.

M. R. Gaddis

cc: Mr. R. R. Robinson
Mr. D. Brown

bc: Mr. M. R. Gaddis (2)

572-6 (RC)

MEMORANDUM

SUBJECT: Remote Control of Helper Units (Bakersfield)

Resume of Test 1 B, May 15, 1961 - Units 5490, 5487, 5466 & 5486

Train 804, 67 loads, 12 empties, 4963 tons. Observation made from helper units.

TIME	LOCATION	SPEED	LOAD	TH. POSITION	REMARKS
7:15AM	Bksfld Yd.	--	Helper units cut in for remote control		
7:18	" "		Brakes applied on helpers from head end		
7:33	" "		Independent brakes released on helpers		
7:36	" "	Start	300A	2	Helpers responded
7:46	East Yard	8	460A	8	Train on main line
7:54	Edison	37	500A	8	
8:04	325	28	140A	5	Light slack action
8:10	333	17	525A	8	
8:28	336	22	450A	8	
8:41	Dealville	Stop	Helpers shut off properly and brakes applied		
8:44	"	Start	800A	2	Brakes released-loaded OK
8:48	340	16	540A	8	
8:50	Tunnel 3-5	17	Helper units lost contact with road engine just out of Tunnel #5 and operated in 7th throttle position for 4 minutes. Road engine reduced to the 6th throttle position to pick up helpers.		
9:10	Bowen	15	510A	8	
9:18	349	Stop	Independent brake applied slow causing 20 ft. of run-out.		
9:20	349	Start	750A	2	2 wheel slips - W.S. signal OK
9:24	Woodford	17	510A	8	
9:34	352	Stop	Independent brake slow to apply to 30#		
9:47	352	Start	650A	2	Independent brake released - 15 sec.
9:53	Walong	14	540A	8	
9:59	Marcel	Stop	Independent brake set to 30# in 33 sec.		
10:02	"	Start	800A	2	15 sec. to release brake
10:06	354	16.5	520A	8	
10:17	Cable	Stop	Independent brake set to 30# in 33 sec.		
10:20	"	Start	820A	2	15 sec. to release brake
10:31	360	27.5	450A	8	
10:38	Monolith	50	75A	2	
10:42	368	49	525A	Dynamic brake responded in accordance with settings on lead unit. Helpers had wheel slip at 725A	
10:50	372	27.6	600A	Dynamic Brake	
11:00	376	23	520A	" "	
11:10	379.7	13	360A	" "	
11:15	Mojave	Stop	Cut out radio controls and crew turned units.		

M. R. SADDIS

Office COPY

572-6 (RC)

MEMORANDUM

SUBJECT: Remote Control of Helper Units (Bakersfield)

Resume of Test 2 W, May 15, 1961 - Units 5490, 5487, 5466 & 5486

Train 3-801, 53 loads, 20 empties, 3579 tons. Observation made from helper units.

TIME	LOCATION	SPEED	LOAD	TH. POSITION	REMARKS
1:30PM	Mojave	Start	600A	2	Radio cut in-Independent brake released very slowly
1:38	380	17.5	525A	8	
1:51	375.7	Stop	Independent brake 30#		No slack action, very smooth stop.
1:53	"	Start	750A	2	
1:56	375	20.5	440A	8	
2:09	369	33.6	385A	8	
2:15	Monolith	49	250A	8	
2:17	363.5	Stop	Independent brake 30#		Smooth stop
2:27	"	Start	400A	1	
2:32	Summit	33	--	Off	Rear end ran in
2:41	359.2	18	275	Dynamic brake set at 1/4 load on head end.	
3:00	Marcel	19	315	" " " "	
3:07	Walong	Stop	Independent brake 30#		Smooth stop, meet #52
3:12	"	Start	--	Slight run in starting	
3:25	Woodford	Stop	Independent brake 30#		Smooth stop
3:27	"	Start	--	No run in	
3:29	348.6	18	Dynamic brake dropped, radio contact lost		
3:30	346.2	18.5	300A	Dynamic brake picked up	
3:35	Dynamic brake dropped out, all units died, radio contact lost.				
3:39	Units started and radio contact restored.				
3:44 to 4:01	Dynamic brake dropped out and radio control lost several times between the east end of Cliff and MP-339. Train had slight run in each time helper units lost control of dynamic brake.				
4:15	334	25.3	575A	Dynamic brake responded OK	
4:23	330	44.5	Units isolated to prevent run in		
4:30	3 25	54	675A	Dynamic brake OK	
4:36	321	Stop	--	Red signal	
4:48	"	Start		Units isolated	
5:10	Rvafld Jd.	Stop	Remote control cut out.		

Condition causing units to lose control in dynamic braking corrected by EMD and Union Switch and Signal representatives.

M. P. CAUDIS

Office COMD

572-6 (RC)

MEMORANDUM

SUBJECT: Remote Control of Helper Units (Bakersfield)

Resume of Test 3 E, May 16, 1961 - Units 5490, 5487, 5466 & 5486

Train 804, 75 loads, 6 empties, 4946 tons. Observation made from road units.

TIME	LOCATION	SPEED	LOAD	TH. POSITION	REMARKS
7:19AM	Bksfld Yd.	Start	Helper cut in-train started by road power		
7:24	East End Yd.	11MPH	175A	2	Helper cut in to remote control
7:28	Main line	21	750A	8	
7:42	324	29	650A	8	
7:47	327	46	150A	2	No run in on descending grade
7:58	333.5	22	550A	8	Lost remote control for about 5 seconds
8:03	Caliente	30	600A	8	
8:24	341.4	19	600A	8	
8:25	Tunnel #5	19	600A	8	Lost control for 4 sec.
8:28	342.5	Stop	Stopped with helper in Tunnel #5		
8:28:40	"	Lost remote control of helper-necessary for helper crew to cut in units and move out of tunnel.			
8:34	342.7	14	575A	8	Remote control restored to helper units
8:44	345	18.5	510A	8	Helper units OK
8:59	Woodford	Stop	Automatic brake and helper independent used making stop - no run out.		
9:01	"	Start	600A	2	
9:15	Walong	Stop			
9:21	"	Start	590A	2	No run out
9:25	Tunnel #10	Lost remote control-cut in helper and operated with helper engine crew to Summit.			
10:08	Summit	Stop	Cut off helpers and returned light to Bakersfield.		

Inspection of remote control radio equipment revealed that a blown fuse in the Bendix power supply prevented the helper units from leading beyond Tunnel #10. Complete test of control and helper units was made at Bakersfield Shops following failure to determine possible cause of blown fuse. Difficulty may have been due to overload of tone circuits in radio unit.

M. R. DAVIS

Office GS/D

M E M O R A N D U M

572-6 (RC)

SUBJECT: Remote Control of Helper Units (Bakersfield)

Resume of Test 4E, May 17, 1961 - Units 5490, 5487, 5466, & 5486

Train 804 70 loads, 0 empties, 4970 tons, observation made from helper units.

TIME	LOCATION	SPEED	LOAD	TH. POSITION	REMARKS
6:05	Bksfld Yd	-	Helper units cut in for remote control		
6:11	"	-	Ind. brakes applied and released on helper		
6:12	"	Start	Helpers isolated		
6:22	314.7	Stop			
6:25	314.7	Start	600A	8	Helpers respond properly
6:30	317	44.5	425A	8	
6:45	325	32	150A	2	
6:47	326	35	550A	Dynamic Brk.	Light slack action
6:50	327.1	Stop	Ind. Brake applied to 30#		
6:53	327.1	Start	300A	2	Smooth stop and start
7:03	333	17	500A	8	
7:09	334	18	300A	6	Take siding
7:14	Jaliente	20	250A	5	No stop
7:27	339	16.5	520A	8	
7:32	340	Stop	Ind. brake applied to 30#		
7:35	340	Start	625A	2	Brake released
7:41	Tunnel 3	16.5	500A	Lost control 40 sec. throttle reduced to run 6	
7:43	Tunnel 5	16	510A	Remote continuity held thru tunnel on helper	
7:48	343	16.5	515A	6	
8:20	351	Stop	-	Apply and release brake	
8:22	351	Start	500A	No slack action	
8:31	Walong	16	525A	8	
8:47	356	16	530A	8	Coast thru tunnels ok
9:01	359	10	500A	6	Throttle responded properly
9:06	Tehachapi	29	450A	6	
9:13	366.6	54	100	3	
9:15	368	42	9 lb. ind. brk application - 44 lb. B.P.		
9:19	370	31	135A	Dyn. brk. applied by remote control.	
9:21		30.5	425	Dyn. brk. applied 3/4 position	
9:22	371.1	32.5	475	Dynamic brk. applied to maximum	
9:23		27	600	Dynamic brk. applied to maximum	
9:24		26.5	675	Dynamic brk. applied to maximum	
9:35	377	24	550	Dynamic brk. applied to maximum	
9:44	388	14	240	Dynamic brk. applied to maximum	
9:47	Mojave	Stop	Remote control cut out		

M. R. Gaddis

Office of [illegible]
San Francisco, May 18, 1961
(1)

M E M O R A N D U M

572-6 (RC)

SUBJECT: Remote Control of Helper Units (Bakersfield)

Resume of Test 5M, May 17, 1961 - Units 5490, 5467, 5466 & 5436 Trains 881, 55 loads, 15 empties, 3811 tons observation made from helper units.

TIME	LOCATION	SPEED	LOAD	TH. POSITION	REMARKS
10:52	Mojave Yo	Start	400A	2	Remote Control cut-in brakes released
11:07	379	20.5	430A	8	
11:19	375	19.7	400A	8	
11:32	370	39	450A	8	
11:30	Monolith	48	420A	8	
11:43	362	31	430A	Dynamic Brake applied to 3/4	
11:46	Tehachapi	20.5	360A	Position by remote control	
11:53	359	22	100A	Dynamic Brake control lost on helper for about 1 minute causing light run in	
11:57	Cable	20	525A	Dynamic Brake set at 3/4 positive	
12:16	Walong	20	500A	Dynamic Brake set at 3/4 positive	
12:35	346	20	550A	Dynamic Brake set at 3/4 positive	
12:55	340	19	475A	Dynamic Brake set at 3/4 positive	
1:01	339	Stop	Ind. brake applied by remote control no run in		
1:07	339	Start	Light run in.		
1:25	332	34	Helpers shut off-drifting		
1:31	327	46	300	8	
1:36	322	58	650	Dynamic brake on full	
	Bksfld Yd	Stop	Cut out remote control.		

M. R. Gaddis

Office of GCMD
San Francisco, May 18, 1961
(J)

MRG

MEMORANDUM

572-6

San Francisco, August 16, 1965

SUBJECT: U.S. & Signal Radio-Controlled Locomotives.

Mr. M. Gogol:

Eleven test runs were made on the T&L Lines between August 6th and 14th, using remote control equipment manufactured by Westinghouse Air Brake Company.

Radio transmitting equipment was installed on Unit 7431 and receiving equipment was installed on Unit 7432, both at Houston.

Tests were made as follows, operating with maximum available tonnage:

	Loads	Empties	Tonnage
Houston to Avondale - August 6 - No. 244	76	50	6453
Avondale to Houston - August 7, No. 243	50	75	4591
Houston to Shreveport - August 8, No. 144	102	70	8480
Shreveport to Houston - August 8, No. 143	82	49	6605
Houston to Ennis, August 9, No. 257-9	33	49	3510
Ennis to East Yard, August 9, TMS	78	36	5758
East Yard to El Paso, August 10, TXN	61	68	5650
El Paso to East Yard, August 12, STLSSE	95	31	7659
East Yard to Houston, August 12	86	40	8356
Houston to Shreveport, No. 144, Aug. 14	95	76	8354
Shreveport to Houston, No. 143, Aug. 14	129	58	9200

Electrical equipment used on this test was similar to that tested in August 1961 on the San Joaquin Division. The air brake system used had been modified and greatly improved with the application of push button control for the controlling unit. All brake signals are transmitted from the lead unit to the helper unit by radio. These functions include application and release of both train and engine brakes. The use of this remote system allows the brake pipe to be charged more rapidly and offers a much smoother overall brake operation.

The radio transmitting and receiving components applied to units 7431 and 7432 use old style telephone relays which have very slow operating characteristics. This condition caused delays in the operation of the helper unit, particularly when switching from dynamic brake to power. Also some difficulties were experienced when trying to release the brakes on the helper units. Westinghouse representatives stated that with new solid state switching, these problems could be overcome. They stated it would be approximately four months before the new system would be available for test.

The Southern Railway has tested the "WABCO" system, but all of the systems purchased for actual use are manufactured by Radiation, Inc. and have solid state switching.

Following the last test, a meeting was held in Mr. L. R. Smith's office at Houston and all of the data taken was consolidated. A comprehensive report is now being completed at Houston and a copy of this paper will be sent to Mr. F. E. Russell.

M. R. Gaddis

SOUTHERN PACIFIC COMPANY TESTS OF WESTINGHOUSE AIR BRAKE COMPANY'S REMOTE CONTROL SYSTEMS

On July 28 tied up Unit 7431 for installation of control equipment and on July 29 tied up Unit 7432 for installation of remote control equipment manufactured by Westinghouse Air Brake Company. Equipment was installed and fully static and yard tested and available for service August 6.

Operated over following territories with maximum cars and tonnage as shown:

	Loads	Empties	Tonnage
Houston to Avondale - August 6 - No. 244	76	50	6453
Avondale to Houston - August 7, No. 243	50	75	4591
Houston to Shreveport - August 8, No. 144	102	70	8480
Shreveport to Houston - Aug. 8, No. 143	82	49	6605
Houston to Ennis, August 9, No. 257-9	33	49	3510
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Houston to Shreveport, No. 144, Aug. 14	95	76	8354
Shreveport to Houston, No. 143, Aug. 14	129	58	9200

Maximum speed operated 65 MPH, minimum speed 14 MPH. Details of consist and additional data covering trip attached.

System consisted of lead unit 7431 provided with transmitting equipment to send radio controlling impulses to Unit 7432, remotely placed in train. Satellite unit is provided with receiving equipment to interpret and act upon impulses. Units 7432 and other locomotives

composing remote consist entrained at various locations from midway in train to just ahead of caboose.

Description of equipment on Unit 7431 for controlling Unit 7432 is shown in attached copy of WABCO Operating Instruction Manual No. 548-A entitled "Satellite Locomotive Remote Control System" dated September 1963.

The equipment used for the test runs on T&L Lines is essentially the same as described in this manual. It contains a description of the various controls and their functions as well as indications on the remote control console. Manual furthermore describes operating instructions which include preliminary procedures, air brake leakage test, control function test, operating procedures and shut down of remote control equipment.