

Application of
**GENERAL MOTORS
DIESEL MOTIVE POWER**
ON THE
UNION PACIFIC RAILROAD



**ELECTRO - MOTIVE DIVISION
GENERAL MOTORS CORPORATION**

LA GRANGE, ILLINOIS, U. S. A.

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INTRODUCTION

AT REQUEST OF THE UNION PACIFIC RAILROAD, study was undertaken to evaluate the economic advantages that could be anticipated if the railroad were to convert its present combined steam and Diesel operation on the lines Salt Lake City - Los Angeles to complete Diesel locomotive operation.

A survey of the main and branch line freight and passenger movements and yard operations was made on the property in cooperation with railroad personnel. Particular attention was given to commodities being handled, the points where tonnage originated and the suitability of the railroad for improvement of fast freight schedules.

During the course of the study, it was determined that the post war passenger schedules had not been finalized and that passenger traffic had not reached the point where requirements could be proven indicative of forthcoming demands. The railroad, therefore, concurred that this report should be confined to main line and branch freight and switching services with provision of facilities which would be adequate to maintain Diesel freight power as well as Diesel passenger power, on the presumption that passenger service eventually would be completely Dieselized.

A preliminary report was submitted on December 3, 1946. At this time the railroad expressed its desire for further study to indicate the effect on the economic advantages which would be derived from exclusion of the Provo Subdivision, the Salt Lake City yard and certain outlying branches; completion of reassignment of steam locomotives throughout the system; adjustment of Diesel operating costs to reflect lower cumulative repair costs through the fifth year of operation; and the adjustment of initial Diesel prices to reflect approved extras and related railroad expenditures.

The report is rendered, therefore, in two parts. Part One embodies complete Dieselization of all freight, branch and switching operations on the lines Salt Lake City - Los Angeles.

Part Two covers that much of the complete Dieselization which has been adopted by the Railroad for immediate consideration. This includes main line through, helper and local freight service together with switching service at terminals other than Salt Lake City and Provo and certain branch operations to be pooled with yard service. Effect has also been given to the foregoing special considerations, desired by the railroad.

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PART ONE

Complete Dieselization

Freight, Mixed and Yard Service

Salt Lake City — Los Angeles

GENERAL SUMMARY

Complete Dieselization of lines between Salt Lake City and Los Angeles will accomplish faster train schedules and reduce costs of operation and maintenance as follows:

1. Westbound fast freight train schedules are reduced from 45 hours to 39 hours 21 minutes, or 13 per cent. Westbound stock train schedules are reduced from 57 hours to 34 hours 21 minutes, or 40 per cent. This schedule on stock trains provides for 10 hours 07 minutes dead time which it is believed can be substantially reduced with Diesel power.
2. Eastbound fast freight train schedules are reduced from 47 hours 30 minutes to 37 hours 07 minutes, or 22 per cent. Eastbound fruit train schedules are reduced from 42 hours 10 minutes to 39 hours 32 minutes, or 6 per cent. Wait, block and meet time of over 5 hours has been provided in above schedules, which it is believed can be substantially reduced with the combination of CTC and Diesel operation, Caliente to Salt Lake City.
3. During 7 days of the 10-day base period in October 1942, 49 freight trains were operated westbound between Salt Lake City and Caliente. On the basis of 1946 steam power, 40 trains were operated. With Diesel power, this could be reduced to 32 trains, effecting a reduction of 35 per cent under 1942 steam power and 20 per cent under 1946 steam power.

During the same period, 53 freight trains were operated westbound between Caliente and Los Angeles. On the basis of 1946 steam power, 49 trains were operated. With Diesel power, this could be reduced to 41 trains, effecting a reduction of 22.6 per cent under 1942 steam power and 16.3 per cent under 1946 steam power.

Tonnage of westbound stock trains with Diesel power can be increased 6.1 per cent over tonnage handled with 1946 steam power with reduction of 18.9 per cent in elapsed time.

Tonnage of other westbound trains with Diesel power can be increased 32.7 per cent over tonnage handled with 1946 steam power, with reduction of 10.3 per cent in elapsed time.

4. During 7 days of the 10-day base period in October 1942, 52 freight trains were operated eastbound between Los Angeles and Caliente. On the basis of 1946 steam power, 48 trains were operated. With Diesel power, this could be reduced to 41 trains, effecting a reduction of 21.2 per cent under 1942 steam power and 14.6 per cent under 1946 steam power.

During the same period, 47 freight trains were operated eastbound between Caliente and Salt Lake City. On the basis of 1946 steam power, 46 trains were operated. With Diesel power, this could be reduced to 31 trains, effecting a reduction of 34 per cent under 1942 steam power and 31.9 per cent under 1946 steam power.

Tonnage of fruit blocks eastbound can be increased 20.1 per cent between Los Angeles and Salt Lake City with reduction of 7.7 per cent in elapsed time.

Tonnage of other eastbound trains can be increased 31 per cent with reduction of 12.3 per cent in elapsed time.

5. The required number of Diesel locomotives is:

<i>Number of Locomotives</i>	<i>Type</i>	<i>Number of Power Units</i>
23	6000 HP F-3 freight locomotives	92
5	4500 HP F-3 freight locomotives	15
15	3000 HP F-3 freight locomotives	30
3	2000 HP transfer locomotives	6
2	1500 HP branch line locomotives	2
27	1000 HP switching locomotives	27
<hr/> 75	<hr/> TOTAL	<hr/> 172

6. The additional investment required for complete Dieselization of all lines between Salt Lake City and Los Angeles including:
- (a) Main line Through Freight Power
 - (b) Complete Dieselization Helper Service
 - (c) Local freight — all branch and mixed train movement
 - (d) Provo Subdivision
 - (e) All yard switching
- amounts to \$23,024,047 for motive power, \$567,150 for service facilities, or a total of \$23,591,197 additional investment.
7. After deduction of the return from scrapping surplus steam locomotives, the net cash outlay is estimated to be \$22,965,517.
8. Annual primary savings of \$4,479,009 will be realized through this additional investment.
9. After giving effect to added depreciation charges and decreased facility maintenance costs resulting from this new expenditure, net savings of \$3,768,331 per year, or a return of 16.4 per cent will be realized on this added investment.
10. Primary savings of \$2,521,631 are realized on an investment of \$13,137,968 in 23 — 6000 H.P. main line freight locomotives, or 19.2 per cent return on investment before depreciation.

11. In helper service, primary savings of \$813,606 are realized on an investment of \$2,403,664 in eight 3000 H.P. helper engines, or 33.8 per cent return on investment before depreciation.
12. In yard service, an investment of \$2,058,500 in twenty-three 1000 H.P. switchers, will produce primary savings of \$651,226, or 31.6 per cent return on investment before depreciation.
13. The balance of the total investment for complete Dieselization required for local freight, branch line and mixed train operation amounts to \$5,423,915 for:

5 — 4500 HP F-3 freight locomotives
 7 — 3000 HP F-3 freight locomotives
 4 — 2000 HP transfer locomotives
 2 — 1500 HP branch line locomotives
 4 — 1000 HP switching locomotives

and will produce primary savings of \$420,718, or 7.8 per cent return on investment before depreciation.

14. To Dieselize all freight operations between Caliente and Los Angeles will require:

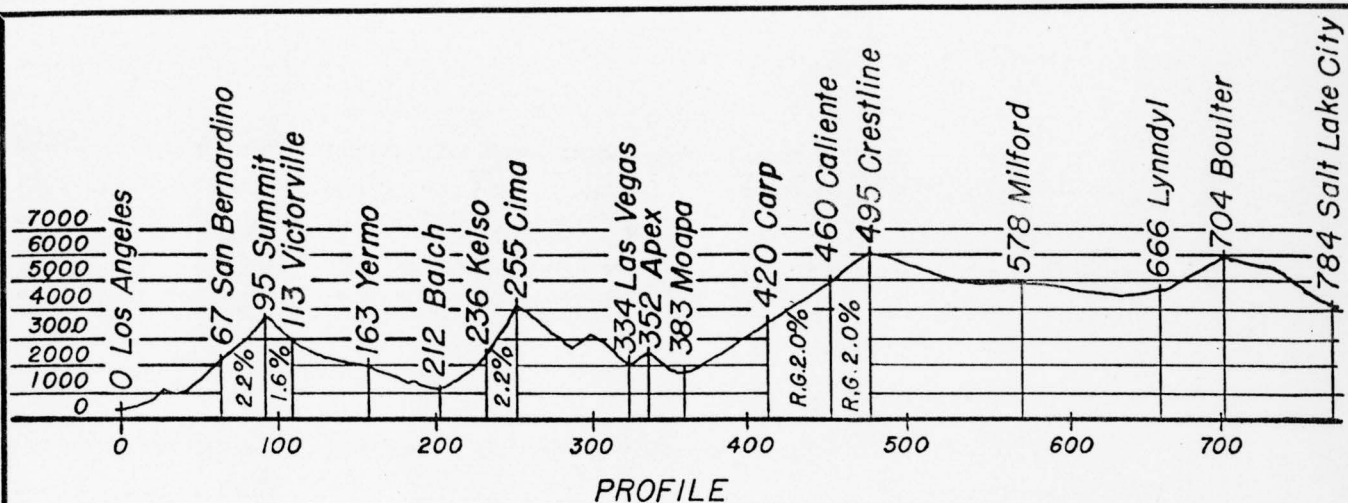
<i>Number of Locomotives</i>	<i>Type</i>	<i>Number of Power Units</i>
18	6000 HP F-3 freight locomotives	72
2	4500 HP F-3 freight locomotives (local freight)	6
6	3000 HP F-3 freight locomotives (helpers)	12
4	3000 HP F-3 freight locomotives (local freight)	8
2	2000 HP transfer locomotives (local and branch)	4
1	1500 HP branch line locomotive	1
14	1000 HP yard switchers	14
3	1000 HP local switchers	3
<hr/>		<hr/>
50	TOTALS	120

Additional investment required:

18	6000 HP F-3 freight locomotives	\$10,281,888
6	3000 HP F-3 freight helpers	1,802,748
14	1000 HP yard switchers	1,253,000
2	4500 HP F-3 freight locomotives (local freight)	} 2,823,768
4	3000 HP F-3 freight locomotives (local freight)	
2	2000 HP transfer (local and branch)	
1	1500 HP branch line	
3	1000 HP switcher (local freight)	

A total investment of \$16,161,404

15. The return on investment for Dieselization from Los Angeles to Caliente will show the same general pattern for different classes of service as indicated for complete Dieselization between Los Angeles and Salt Lake City except that train consists are limited both by State Law, siding and yard capacity, adversely affecting savings. In addition, assignment of power Los Angeles to Salt Lake City as compared with Los Angeles to Caliente is more favorable and actually results in about 15 per cent reduction in standing time at the turning terminal.
16. To repeat, complete Dieselization Salt Lake City to Los Angeles will conservatively produce net savings of \$3,768,331 per year, a return of 16.4 per cent on the additional investment, or recovery of full investment through savings, in approximately 6 years.
17. The investment proposed for facilities to maintain and service Diesel freight and switching power will be sufficient to provide adequate facilities for maintaining and servicing presently operated Diesel passenger and switching power as well as the additional Diesel passenger power required to complete the Dieselization program.
18. The section of the railroad under consideration in this study will be placed in a very favorable competitive position on both freight and passenger schedules and through these improved schedules, additional traffic will inevitably result to still further add to the economies and earnings derived from complete Dieselization with General Motors locomotives.



SECTION I

Operating Characteristics

The lines of the Union Pacific Railroad included in this study comprise about 1,166 miles of railroad extending from Salt Lake City on the east to Los Angeles on the west. This total includes 913 miles of main line and 253 miles of branch lines.

The main line includes two routes between Salt Lake City and Lynndyl — one by way of Tintic and Stockton and the other, known as the Provo Subdivision, by way of Provo. Joint operation, effecting double track operation, is maintained with the Atchison, Topeka and Santa Fe Railroad between Daggett and Riverside, a distance of 101 miles.

A condensed profile covering the through route from Salt Lake City to Los Angeles is shown on the opposite page.

• *Through Freight Train Operation*

The most important traffic items are live stock, fruit, mine products and oil. Principal interchange points are with the Atchison, Topeka and Santa Fe Railroad at Barstow and with the Southern Pacific Railway at Colton. No westbound through freight trains are operated over the Provo Subdivision. Eastbound through freight trains are operated over the Provo Subdivision only where necessary to relieve congestion on the other route between Lynndyl and Salt Lake City.

• *Local Freight and Mixed Train Operation*

Local freight trains are operated to provide intermediate service to points between the major terminals, picking up and setting out carload and less than carload lot shipments along the main line, handling trains between some major terminals and branch line junction points, and handling trains between some major terminals and interchange points.

Mixed trains are operated over the Provo Subdivision between Salt Lake City and Lynndyl, handling passengers and freight.

• *Branch Line Operation*

Branch line trains are operated over sixteen branches between Salt Lake City and Los Angeles. Operations over the Fairfield, Fillmore, Pasadena and Glendale Branches are handled by switching assignments.

• *Switching Assignments*

Switching service is performed at nine terminals on the railroad. This service consists mainly of classifying freight and passenger trains, transfer movements and industrial service.

• *Summary*

The lines Salt Lake City to Los Angeles serve as an important link in the transcontinental movement of traffic over the Union Pacific Railroad.

SECTION II

Period Selected for Study

Before the requirements of complete Dieselization of a railroad or section thereof can be established, a determination of the amount of Diesel motive power which must be provided to handle the railroad's peak traffic must be made, based on a selected period of normal operation not affected by unusual traffic conditions.

The Union Pacific Railroad selected the year 1942 as the period representing the anticipated normal volume of freight business expected in the post-war period. The traffic pattern during this period serves as a basis for the study, since a full year of post war operation had not been completed prior to commencement of the study.

• *Freight Train Operation*

During the year 1942, peak traffic, based on gross tons handled, occurred during the month of October, as shown in the tabulation below.

The period October 1st through October 10th was selected as a representative ten day peak traffic period free of detours or other abnormal conditions.

Freight Train Performance
Year 1942

<i>Month</i>	<i>Train Miles</i>	<i>Locomotive Miles</i>	<i>Gross Ton Miles</i>
January	355,341	482,914	627,253,506
February	315,125	415,993	563,828,424
March	348,638	455,191	623,092,112
April	351,727	464,540	626,501,962
May	334,651	448,996	617,960,400
June	311,211	413,166	574,567,496
July	334,621	457,536	653,594,021
August	351,469	470,219	690,781,691
September	360,800	478,016	694,976,323
<u>October</u>	<u>404,829</u>	<u>536,778</u>	<u>804,223,068</u>
November	388,211	509,205	767,854,348
December	383,875	522,873	796,352,016
TOTAL	4,240,498	5,655,427	8,040,985,367

Both freight steam motive power assignments and operating conditions on the lines Salt Lake City-Los Angeles have changed appreciably since the year 1942. It was therefore determined that this study should incorporate a performance and cost com-

parison of Diesel motive power accomplishing the above work with the performance and costs of presently assigned steam motive power, rather than that assigned during the year 1942.

- *Switching Operation*

The switching assignments and switching hours worked in each yard during the year 1942 were tabulated to obtain assignments during the ten day base period.

- *Summary*

The railroad selected the year 1942 as the year which would most nearly represent the volume of anticipated business and requested that proposed Diesel freight power be compared with the steam power presently assigned to the lines under study.

SECTION III

Steam Motive Power

The Union Pacific Railroad compiled the steam motive power complement which would be required, in addition to the Diesel locomotives presently owned, to perform the 1942 peak freight operation. This steam motive power is listed below together with the characteristics furnished by the railroad.

This complement, totalling 159 steam locomotives is composed of 53 locomotives in through freight operation, 40 locomotives in local freight, branch line and mixed operation, 22 locomotives in freight helper operation and 44 locomotives in yard switching operation.

<i>Number Group</i>	<i>Whyte Symbol</i>	<i>Road Class</i>	<i>Number Assigned</i>	<i>Average Age (Years)</i>	<i>Tractive Effort (Pounds)</i>	<i>Weight on Drivers (Pounds)</i>
THROUGH FREIGHT OPERATION						
3800	4-6-6-4	CSA	40	9	97,400	403,850
5000-5500	2-10-2	TTT	3	26	70,450	292,790
5090	4-10-2	FTT	10	20	72,400	306,900
TOTAL AND AVERAGE			53	12		
LOCAL, BRANCH LINE AND MIXED FREIGHT OPERATION						
59-62	—	Shay	2	41	31,000	173,450
6000	2-8-0	C	10	41	42,450	193,380
1900-2100	2-8-2	MacA	1	35	47,945	206,200
2200-2700	2-8-2	MacA	14	31	53,628	215,345
3500	2-8-8-0	SA	11	25	99,840	470,980
5000-5500	2-10-2	TTT	2	26	70,450	292,790
TOTAL AND AVERAGE			40	32		
FREIGHT HELPER OPERATION						
3500	2-8-8-0	SA	4	25	99,840	470,980
5000-5500	2-10-2	TTT	18	26	70,450	292,790
TOTAL AND AVERAGE			22	26		
SWITCHING OPERATION						
6000	2-8-0	C	21	41	42,770	193,330
4400-4700	0-6-0	Switcher	13	30	34,380	192,710
1900-2100	2-8-2	MacA	3	34	50,468	208,450
2200-2700	2-8-2	MacA	7	32	53,628	214,825
TOTAL AND AVERAGE			44	35		

• *Summary*

The physical characteristics of the existing steam locomotives make it advantageous to the railroad from both economical and operating standpoints to consider replacing them with proven types of Diesel motive power.

SECTION IV

Required Diesel Motive Power

The General Motors Diesel locomotives proposed for Dieselization of the Union Pacific Railroad between Salt Lake City and Los Angeles are 6000 H.P. locomotives in through freight service; 3000 H.P. locomotives in freight helper service; 1000 H.P., 1500 H.P., 2000 H.P., 3000 H.P. and 4500 H.P. locomotives in local freight, branch, and mixed train operation and 1000 H.P. and 2000 H.P. locomotives in switching service.

This motive power complement will provide excellent flexibility so locomotives can always be used to full advantage during periods when fluctuations in traffic volume and traffic conditions make it desirable to increase or decrease a locomotive size from that normally assigned.

• *Through Freight Train Operation*

To clearly analyze the movement of cars and the volume of tonnage handled during the ten day base period, October 1 through October 10, 1942, a graphic sheet was prepared using data taken from dispatchers' train sheets which were made available by the railroad. The graphic train sheet showed the actual steam train operation during the base period, including such pertinent data as tonnage and cars for each train, principal and helper locomotives used and the elapsed time for each train between terminals.

A copy of this graphic train sheet was furnished to the railroad who reconstructed it to show possible train operation using steam locomotives currently in service between Salt Lake City and Los Angeles. This reconstructed train sheet represented the present steam operation as used in this report.

The graphic train sheet of actual operation was also reconstructed to indicate the minimum number and sizes of Diesel freight locomotives and the number of Diesel powered trains which would be required to handle the tonnage and cars actually moved during the base period, providing the improvement in service desired by the railroad. This reconstructed train sheet represented the proposed Diesel operation as used in this report.

The development of the possible plan of Diesel operation included conservative consideration of the availability of tonnage at initial terminals, of the capacity of the railroad for traffic movements, of the required arrival times at Salt Lake City and Los Angeles and of the capacity of the recommended Diesel locomotives to haul more tonnage at higher speeds with less terminal servicing time than is possible with steam motive power.

Consists of through Diesel freight trains were determined by combining tonnages and cars of actual steam trains leaving initial terminals. The tonnages of each train were adjusted at intermediate terminals to coincide with the daily traffic fluctuation

TABLE 1
UNION PACIFIC RAILROAD
Freight Tonnage Ratings
6000 H.P. General Motors Diesel Freight Locomotive
62:15 Gear Ratio

<i>From</i>	<i>To</i>	<i>Maximum Actual Trailing Tons Without Helper</i>	<i>Maximum Car Limits</i>
WESTBOUND			
Salt Lake City	Lynndyl (Main Line)	5900	110
Salt Lake City	Provo	5140	...
Provo	Lynndyl	4550	...
Lynndyl	Milford	8750	110
Milford	Caliente	5420	110
Caliente	Las Vegas	5720	71
Las Vegas	Yermo	4880	86
Yermo	Los Angeles	3580	75
EASTBOUND			
Los Angeles	Yermo	2250	75
Yermo	Las Vegas	2250	86
Las Vegas	Caliente	4020	71
Caliente	Milford	3040	110
Milford	Lynndyl	8860	110
Lynndyl	Salt Lake City (Main Line)	5900	110
Lynndyl	Provo	6070	...
Provo	Salt Lake City	5230	...

as reported on the train sheets during the base period. Tonnage was assumed to be available at the departure time of actual steam trains. When two steam trains, or parts thereof, were combined, the resultant Diesel train departed from the terminal on the time of the second steam train. In accordance with the railroad recommendation, no tonnage was held over ten (10) hours and, in all cases, tonnage due out of Salt Lake City or Los Angeles on the first day was scheduled to arrive in Los Angeles or Salt Lake City prior to the third day cut-off time.

Table 1 lists the Diesel locomotive tonnage ratings and train car limits which governed the plan of Diesel operation. The tonnage ratings were derived from conservative calculations. The train car limits were furnished by the railroad. The train car limits for the Los Angeles Division were based upon present operating rules. Those on the Utah Division were based upon the application of Centralized Traffic Control and 120 car sidings planned for this division.

Elapsed times between terminals for Diesel powered trains were obtained by adding an average delay to a conservatively calculated running time. The average delay was determined from an analysis of dispatchers' train sheets covering the Los Angeles and Utah divisions during the period August 26 through August 28, 1946, and from a review of the delays incurred during the demonstration of General Motors F-3 Diesel freight locomotive No. 291 over these two divisions. The average delays used are tabulated in Table 2 on the following page.

Sufficient time has been allowed at intermediate terminals for reducing or filling trains, inspection, changing crews and fueling. Where intermediate terminal delays for the proposed Diesel trains are less than those indicated in Union Pacific Railroad Manifest Train Schedule No. 6, April 1946, the reduction is attributable to the fact that Diesel locomotives require no servicing at intermediate terminals while steam locomotives are serviced at each engine terminal.

Terminal delays for icing eastbound Fruit Blocks at Las Vegas and Milford were established on the basis of 2 minutes per load with a minimum of 1 hour and a maximum 1 1/2 hours.

It is believed that the delays listed in Table 2 can be decreased appreciably when full advantage can be taken of the potentialities of Diesel motive power and the anticipated extension of centralized traffic control.

TABLE 2
UNION PACIFIC RAILROAD
Intermediate and Terminal Delays
Proposed Diesel Main Line Freight Operation

<i>Type and Location</i>	WESTBOUND		EASTBOUND	
	<i>Stock Trains Hrs:Min</i>	<i>Other Trains Hrs:Min</i>	<i>Fruit Trains Hrs:Min</i>	<i>Other Trains Hrs:Min</i>
Wait, Blocked and Meets				
Salt Lake City-Lynndyl	:24	:24	:50	:50
Lynndyl-Milford	:36	:45	:59	:59
Milford-Caliente	:57	:57	:54	:54
Caliente-Las Vegas	:25	:25	:26	:26
Las Vegas-Yermo	:59	:59	:58	:58
Yermo-Los Angeles	1:13	1:13	1:17	1:17
TOTAL	4:34	4:43	5:24	5:24
Picking Up and Setting Out Cars				
Salt Lake City-Lynndyl	:14	:14	:14	:14
Lynndyl-Milford	:11	:11	:02	:02
Milford-Caliente	:08	:08	:13	:13
Caliente-Las Vegas	:08	:08	:10	:10
Las Vegas-Yermo	:06	:06	:09	:09
Yermo-Los Angeles	:25	:25	:35	:35
TOTAL	1:12	1:12	1:23	1:23
Air, Inspection, and Retainers				
Salt Lake City-Lynndyl	:08	:08	:05	:05
Lynndyl-Milford	:04	:14	:20	:20
Milford-Caliente	:15	:15	:21	:21
Caliente-Las Vegas	:05	:05	:13	:13
Las Vegas-Yermo	:09	:09	:07	:07
Yermo-Los Angeles	:20	:20	:15	:15
TOTAL	1:01	1:11	1:21	1:21
Cutting In and Out Helpers				
Milford-Caliente . . . . .	....	....	:14	:14
Las Vegas-Yermo . . . . .	....	....	:32	:32
Yermo-Los Angeles . . . . .	....	:18	:20	:20
TOTAL . . . . .	....	:18	1:06	1:06
Terminal Delays				
Lynndyl	:25	:30	:30	:30
Milford	:25	:30	1:15	1:00
Caliente	1:00	1:00	1:00	1:00
Las Vegas	:45	1:00	1:15	1:00
Yermo	:45	1:00	1:00	1:00
TOTAL	3:20	4:00	5:00	4:30
GRAND TOTAL	10:07	11:24	14:14	13:44

Westbound Operation

Table 3 which follows, lists through freight schedules from Salt Lake City to Los Angeles as contained in the railroad's Manifest Train Schedule Number 6, dated April 1946, as anticipated with present steam power and as possible with the proposed Diesel power. The average tonnage per train is listed at the bottom of the table for steam and Diesel over each Subdivision of the main line.

It will be noted that the schedules of all through freight trains may be reduced with Diesel power. Stock trains can be operated from Salt Lake City to Los Angeles in less than 36 hours, thus eliminating the 10 hour stock resting layover necessary at Las Vegas, if given preferential handling to minimize road and terminal delays. Until such time as overall delays can be reduced from the 10 hours allowed, the tonnage of these trains should be held to approximately 2700 tons.

Merchandise and forwarder trains require no special handling to better present schedules when Diesel powered.

Forty-nine actual steam trains were required to handle the tonnage and cars westbound from Salt Lake City during seven consecutive days, October 3rd through October 9th, 1942, in the ten day base period. To handle this same tonnage with 1946 steam power would require 40 trains, while 32 Diesel powered trains would be necessary. The use of Diesel freight locomotives in through freight service would produce a 35 per cent reduction in trains over 1942, and a 20 per cent reduction on the basis of 1942 business handled with 1946 steam power.

West of Caliente, additional trains are required because of the lower train car limits on the Los Angeles Division. During these same seven consecutive days, October 3rd through October 9th, 1942, 53 actual steam trains were required westbound between Caliente and Los Angeles. This would be reduced to 49 trains with the use of 1946 steam power and further reduced to 41 trains with Diesel freight locomotives; a 29.2 per cent reduction on the basis of 1942 business and 19.5 per cent reduction on the basis of 1942 business handled with 1946 power.

Table 4 shown on page 25, lists average tons per train, and average elapsed time per train over each subdivision between Salt Lake City and Los Angeles for the proposed Diesel operation, as compared with steam operation. The table shows that from Salt Lake City to Los Angeles, Diesel power on stock trains could haul an average of 6.1 per cent more tonnage than with the proposed steam power, with a reduction in elapsed time, excluding intermediate terminal delays, of 18.9 per cent.

Diesel locomotives on other trains would be able to haul on an average of 32.7 per cent more tonnage per train than with the 1946 steam power, with a decrease in average elapsed time, excluding intermediate terminal delays, of 10.3 per cent.

TABLE 3
UNION PACIFIC RAILROAD
Comparison of Through Freight Schedules
Salt Lake City - Los Angeles
3800 Class Steam — 6000 H. P. F-3 Diesel

WESTBOUND																			
Stock (NLS) Trains								Forwarder Trains						Fast Freight (MLA) Trains					
Union Pacific Schedule No. 6								Union Pacific Schedule No. 6						Union Pacific Schedule No. 6					
Steam Diesel								Steam Diesel						Steam Diesel					
Time Day								Time Day						Time Day					
Salt Lake City	Lv.	8:00P	1	8:00P	1	8:00P	1	9:00P	1	9:00P	1	9:00P	1	10:00P	1	10:00P	1	10:00P	1
Lynndyl	Ar.	2:00A	2	1:15A	2	12:18A	2	3:00A	2	2:15A	2	2:14A	2	4:00A	2	3:27A	2	3:14A	2
	Lv.	3:00A	2	1:48A	2	12:43A	2	3:45A	2	2:48A	2	2:44A	2	5:00A	2	4:06A	2	3:44A	2
Milford	Ar.	6:00A	2	5:23A	2	3:25A	2	7:00A	2	6:23A	2	6:24A	2	8:15A	2	7:50A	2	7:24A	2
	Lv.	7:00A	2	6:16A	2	3:50A	2	8:00A	2	7:16A	2	6:55A	2	9:15A	2	8:47A	2	7:54A	2
(Mt. T.) Caliente (Pac. T.)	Ar.	1:00P	2	11:46A	2	8:33A	2	2:00P	2	12:48P	2	12:11P	2	3:15P	2	2:24P	2	1:11P	2
	Lv.	1:30P	2	12:43P	2	8:33A	2	2:15P	2	1:43P	2	12:13P	2	3:30P	2	3:19P	2	1:13P	2
Las Vegas	Ar.	6:30P	2	5:36P	2	12:37P	2	7:15P	2	6:36P	2	4:23P	2	8:45P	2	7:59P	2	5:23P	2
	Lv.	4:30A	3	*3:36A	3	1:22P	2	9:15P	2	9:01P	2	5:28P	2	10:45P	2	10:32P	2	6:28P	2
Yermo	Ar.	2:00P	3	12:22P	3	8:43P	2	5:15A	3	5:47A	3	1:36A	3	7:15A	3	7:42A	3	2:36A	3
	Lv.	4:00P	3	2:28P	3	9:28P	2	6:15A	3	7:53A	3	2:41A	3	8:15A	3	9:52A	3	3:41A	3
Los Angeles	Ar.	4:00A	4	12:43A	4	5:21A	3	4:00P	3	6:08P	3	11:21P	3	6:00P	3	8:25P	3	12:21P	3
Through Time		Hrs:Min.		Hrs:Min.		Hrs:Min.		Hrs:Min.		Hrs:Min.		Hrs:Min.		Hrs:Min.		Hrs:Min.		Hrs:Min.	
		57:00		53:43		34:21		44:00		46:08		39:21		45:00		47:25		39:21	
AVERAGE TONNAGE HANDLED																			
Salt Lake City-Lynndyl						2780		2686				2780		4470		2890		4470	
Lynndyl-Milford						2873		2722				2873		4819		2993		4819	
Milford-Caliente						2804		2743				2804		4571		2879		4571	
Caliente-Las Vegas						2663		2724				2663		3074		2789		3074	
Las Vegas-Yermo						2447		2723				2447		3428		2688		3428	
Yermo-Los Angeles						2331		2579				2331		3261		2636		3261	

*Schedule time (10 Hrs) allotted to feed, water and rest stock.

TABLE 4
UNION PACIFIC RAILROAD
Comparison of Average Tonnages and Elapsed Times
Proposed Diesel Operation VS. Steam Operation

District	Steam Operation			Proposed Diesel Operation			Diesel VS. Steam	
	Average Tons Per Train	Average Elapsed Time per Train	Average Load Factor Over Ruling Grade	Average Tons Per Train	Average Elapsed Time Per Train	Average Load Factor Over Ruling Grade	Increased Average Tons Per Train	Decreased Average Elapsed Time Per Train
WESTBOUND — Stock Trains								
		Hrs:Min.			Hrs:Min.			
Salt Lake City-Lynndyl	2780	5:15	80.0%	2686	4:18	45.5%	-3.4%	18.1%
Lynndyl-Milford	2873	3:35	58.5%	2722	2:42	31.1%	-5.25%	24.6%
Milford-Caliente	2804	5:32	72.5%*	2743	4:43	50.6%	-2.2%	14.8%
Caliente-Las Vegas	2663	4:53	78.7%	2724	4:04	47.6%	2.3%	16.7%
Las Vegas-Yermo	2447	8:46	80.0%	2723	7:21	55.8%	11.3%	16.2%
Yermo-Los Angeles	2331	10:15	71.4%*	2579	7:53	72.0%	10.6%	23.1%
Salt Lake City-Los Angeles	2573	38:16**		2729	31:01**		6.1%	18.9%
WESTBOUND — Other Trains								
Salt Lake City-Lynndyl	2890	5:27	82.9%	4470	5:14	75.8%	54.7%	4.0%
Lynndyl-Milford	2993	3:44	61.7%	4819	3:40	55.1%	61.0%	1.8%
Milford-Caliente	2879	5:37	71.8%*	4571	5:16	84.3%	58.9%	6.2%
Caliente-Las Vegas	2789	4:40	85.0%	3074	4:10	53.7%	10.2%	10.7%
Las Vegas-Yermo	2688	9:10	80.2%	3428	8:08	70.2%	27.5%	11.3%
Yermo-Los Angeles	2636	10:33	71.6%*	3261	8:40	84.8%	23.7%	17.9%
Salt Lake City-Los Angeles	2782	39:11**		3692	35:08**		32.7%	10.3%

*Includes Helper Locomotive Tonnage Rating on Trains Using Helpers.

**Excludes Intermediate Terminal Delays.

TABLE 5
UNION PACIFIC RAILROAD
Comparison of Through Freight Schedules
Salt Lake City - Los Angeles
3800 Class Steam — 6000 H.P. F-3 Diesel

		Fruit (CN-CUX) Trains						EASTBOUND						Mdse. (MS) Trains						Fast Freight (UX) Trains					
		Union Pacific Schedule No. 6		Steam		Proposed Diesel		Union Pacific Schedule No. 6		Steam		Proposed Diesel		Union Pacific Schedule No. 6		Steam		Proposed Diesel							
		Time	Day	Time	Day	Time	Day	Time	Day	Time	Day	Time	Day	Time	Day	Time	Day	Time	Day						
Los Angeles	Lv.	7:00P	1	8:34P	1	9:24P	1	2:00A	1	2:00A	1	2:00A	1	11:00A	1	11:00A	1	11:00A	1						
Colton	Lv.	11:59P	1	11:59P	1	11:59P	1	5:30A	1	5:15A	1	4:41A	1	2:30P	1	2:15P	1	1:22P	1						
San Bernardino	Lv.	1:00A	2	1:47A	2	12:52A	2	7:00A	1	7:22A	1	5:32A	1	4:00P	1	4:22P	1	2:14P	1						
Yermo	{ Ar.	5:45A	2	7:18A	2	5:49A	2	12:30P	1	12:46P	1	10:37A	1	9:30P	1	9:46P	1	6:49P	1						
	{ Lv.	6:45A	2	9:41A	2	6:49A	2	2:00P	1	3:10P	1	11:37A	1	11:00P	1	12:10A	2	7:49P	1						
Las Vegas	{ Ar.	1:30P	2	5:48P	2	2:10P	2	11:00P	1	11:14P	1	7:06P	1	7:00A	2	8:14A	2	2:14A	2						
	{ Lv.	3:00P	2	8:13P	2	3:25P	2	1:00A	2	1:32A	2	8:06P	1	9:00A	2	10:32A	2	3:14A	2						
Caliente (Pac. T.)	{ Ar.	8:00P	2	1:40A	3	8:56P	2	6:30A	2	7:12A	2	1:26A	2	2:30P	2	4:12P	2	8:18A	2						
(Mt. T.)	{ Lv.	10:00P	2	5:00A	3	10:56P	2	9:00A	2	10:03A	2	3:26A	2	5:00P	2	7:03P	2	10:18A	2						
Milford	{ Ar.	3:30A	3	9:32A	3	4:05A	3	3:00P	2	3:56P	2	8:50A	2	11:00P	2	12:56A	3	3:32P	2						
	{ Lv.	4:30A	3	11:14A	3	5:20A	3	4:00P	2	5:34P	2	9:50A	2	12:15A	3	2:34A	3	4:32P	2						
Lynndyl	{ Ar.	7:15A	3	2:31P	3	8:48A	3	7:30P	2	8:56P	2	1:39P	2	3:45A	3	5:56A	3	8:01P	2						
	{ Lv.	8:00A	3	3:38P	3	9:18A	3	8:30P	2	10:03P	2	2:09P	2	4:45A	3	7:03A	3	8:38P	2						
Salt Lake City	Ar.	2:10P	3	8:57P	3	1:56P	3	3:00A	3	3:15A	3	6:53P	2	11:30A	3	12:15P	3	1:07P	3						
		Hrs:Min.		Hrs:Min.		Hrs:Min.		Hrs:Min.		Hrs:Min.		Hrs:Min.		Hrs:Min.		Hrs:Min.		Hrs:Min.							
Through Time		42:10		47:23		39:32		48:00		48:15		39:53		47:30		48:15		37:07							
AVERAGE TONNAGE HANDLED																									
Los Angeles-Yermo				2787		2950				2341		3016				2341		2012							
Yermo-Las Vegas				2701		2902				2265		3263				2265		2509							
Las Vegas-Caliente				2658		2877				2128		2724				2128		1882							
Caliente-Milford				2463		3377				2096		3628				2096		3733							
Milford-Lynndyl				2675		3686				2410		4176				2410		3785							
Lynndyl-Salt Lake City				2439		3586				2318		3830				2318		3191							

Eastbound Operation

During the seven consecutive days, October 3rd through October 9th, 1942, 52 actual steam trains departed eastbound from Los Angeles. The graphic train sheet, reconstructed on the basis of 1946 steam motive power, shows that the same tonnage and cars could be handled with 48 trains. With the proposed Diesel locomotives, 41 trains would be required. The use of Diesel freight locomotives in freight service would produce a 21.2 per cent reduction in trains over 1942, and a 14.6 per cent reduction if the 1942 business were handled with 1946 power.

The initial loaded tonnage on fruit (CN) trains was assumed to be all fruit, since supporting data was not available to indicate otherwise. Care was then taken to see that this loaded tonnage was handled through to Salt Lake City in each train.

A reduction in train car limit from 86 cars between Yermo and Las Vegas to 71 cars between Las Vegas and Caliente, made it necessary to add one additional eastbound empty drag train between Las Vegas and Caliente on October 6th, 7th, and 9th, in order to move the empties which were being dropped from the 86 car trains arriving in Las Vegas from Yermo.

It was assumed that these trains could be scheduled to leave Las Vegas at the most convenient time and therefore could be handled with all or part of one of the 6000 H.P. Diesel freight locomotives which turn at Caliente. There will be sufficient time during the layover of these locomotives to enable them to run light to Las Vegas and return to Caliente with the extra train. Another possibility would be to use the locomotive assigned to the Moapa local during its layover time at Las Vegas.

From Caliente to Salt Lake City, train car limits and locomotive tonnage ratings are high enough to permit a reduction in the average number of through freight trains over the number leaving Los Angeles.

During the seven day consecutive period, October 3rd through October 9th, 1942, 47 actual steam trains were dispatched eastbound out of Caliente. With 1946 steam power, this would be reduced to 46 trains, and with the proposed Diesel locomotive freight power this could be further reduced to 31 trains; a reduction of 32.5 per cent over 1942 business handled with 1946 power.

In Table Number 5, the elapsed time of the proposed Diesel powered trains and the elapsed time of the present steam operated trains Los Angeles to Salt Lake City have been compared with the railroad's manifest train schedule No. 6, dated April, 1946.

According to schedule No. 6, fruit blocks (CN-CUX) should leave Los Angeles at 7:00 P.M. to meet the 11:50 P.M. cut off time at Colton and are due in Salt Lake City at 2:10 P.M. the third day, a through time of 42 hours 10 minutes. The proposed Diesel train could leave Los Angeles as late as 9:24 P.M. in order to meet the 11:59 P.M. cut

TABLE 6
UNION PACIFIC RAILROAD
Comparison of Average Tonnages and Elapsed Times
Proposed Diesel Operation VS. Steam Operation

<i>District</i>	Steam Operation			Proposed Diesel Operation			Diesel VS. Steam	
	<i>Average Tons Per Train</i>	<i>Average Elapsed Time per Train</i>	<i>Average Load Factor Over Ruling Grade</i>	<i>Average Tons Per Train</i>	<i>Average Elapsed Time Per Train</i>	<i>Average Load Factor Over Ruling Grade</i>	<i>Increased Average Tons Per Train</i>	<i>Decreased Average Elapsed Time Per Train</i>
EASTBOUND — CN Trains								
		<i>Hrs:Min.</i>			<i>Hrs:Min.</i>			
• Los Angeles-Yermo	2787	10:44	92.3%*	2950	8:25	88.4%*	5.9%	21.6%
• Yermo-Las Vegas	2701	8:07	85.8%*	2902	7:21	94.9%*	7.4%	9.4%
• Las Vegas-Caliente	2658	5:27	68.0%*	2877	5:31	71.5%	8.2%	-1.2%
• Caliente-Milford	2463	4:32	85.4%*	3377	5:09	65.6%*	37.2%	-13.6%
• Milford-Lynndyl	2675	3:17	76.7%	3686	3:28	41.6%	37.8%	-5.6%
• Lynndyl-Salt Lake City	2439	5:19	71.0%	3586	4:38	60.8%	47.1%	12.9%
Los Angeles-Salt Lake City	2638	37:26**		3168	34:32**		20.1%	7.7%
EASTBOUND — Other Trains								
Los Angeles-Yermo	2341	10:46	91.3%*	2705	8:19	89.8%*	15.6%	22.8%
Yermo-Las Vegas	2265	8:04	83.8%*	2675	7:10	94.5%*	18.1%	11.0%
Las Vegas-Caliente	2128	5:40	68.9%*	2416	5:10	60.1%	13.5%	8.8%
Caliente-Milford	2096	5:53	74.7%*	3784	5:16	86.7%*	80.5%	10.5%
Milford-Lynndyl	2410	3:22	69.8%	4005	3:33	45.2%	66.2%	-5.5%
Lynndyl-Salt Lake City	2318	5:12	66.8%	3671	4:41	62.2%	58.2%	9.9%
Los Angeles-Salt Lake City	2258	38:57 **		2958	34:09**		31.0%	12.3%

*Includes Helper Locomotive Tonnage Rating on Trains Using Helpers.

**Excludes Intermediate Terminal Delays.

off time at Colton, and would arrive in Salt Lake City at 1:56 P.M. the 3rd day, a through time of 39 hours 32 minutes.

The schedules for merchandise (MS) trains and for fast freight (UX) trains have been similarly compared.

Referring to Table Number 6, it can be noted that CN trains with the proposed Diesel power could handle, on the average, 20.1 per cent more tonnage between Los Angeles and Salt Lake City, than with the present steam power. At the same time, a reduction of 7.7 per cent in elapsed time, excluding intermediate terminal delays could be anticipated between these terminals. Other trains could handle an average of 31 per cent more tonnage with the proposed Diesel freight locomotives than with the present steam locomotives, and a reduction of 12.3 per cent in elapsed time, excluding intermediate terminal delays, could be effected.

The average load factors of the Diesel locomotives on the ruling grades over the various subdivisions are sufficiently low to permit the railroad to handle unusual increases in tonnage offered for movement without disrupting the overall pattern of operation.

Protection Power

The proposed assignment of Diesel freight locomotives creates motive power pools at Salt Lake City and Los Angeles. The Los Angeles pool is the larger and varies from a minimum of one locomotive to a maximum of six locomotives. The pool at Salt Lake City varies from a minimum of one locomotive to a maximum of four locomotives. The maximum and minimum periods in both pools are of short duration and do not exceed three hours. In addition to these two pools, there is always one locomotive and at times two locomotives laying over at Caliente. These are the locomotives that turn at Caliente because of the reduction in the number of eastbound trains at this point.

In view of the number of locomotives normally available at Salt Lake City, Los Angeles and Caliente, and considering the ample maintenance time scheduled, no protection or purely standby power is considered necessary during the base peak period. The fewer number of trains operated in other months, outside of the annual peak period, will provide additional Diesel locomotives available for protection power against shopping requirements or for other assignments such as east of Ogden.

Maintenance

Adequate maintenance time is provided for all Diesel locomotives assigned to through freight operation in the proposed plan of operation at Los Angeles and Salt Lake City.

The proposed assignment of Diesel freight locomotives during the peak traffic period provides an average layover time of 12 hours 54 minutes at Los Angeles and 10 hours 6 minutes at Salt Lake City.

Under the General Motors plan of progressive maintenance, locomotives are brought in for maintenance after making 2,000 to 3,000 miles in service. The principal

Diesel freight locomotives average approximately 346 miles per day during the reconstructed seven day period, October 3rd through October 9th; therefore, maintenance will be required for each locomotive at approximately six to seven day intervals. Since each locomotive will have at least two layovers at Los Angeles during this seven day period, all routine maintenance can be completed without the necessity of taking the locomotive out of service. The use of identical units in helper and local service will allow free interchange with principal locomotive units in scheduling these locomotives for maintenance.

The decrease in the number of trains required in other than the peak period will lengthen the already adequate maintenance periods and provide available power for use east of Ogden.

• *Helper Service*

Helper service for the proposed Diesel freight train operation will be required eastbound from San Bernardino to Summit, Kelso to Cima, and Caliente to Crestline. Occasional westbound helper service is required from Victorville to Summit.

All of the Diesel helper locomotives will be 3000 H.P. F-3 locomotives having the same gearing as those recommended for through freight service.

Following is a tabulation of tonnage ratings of a 6000 H.P. freight locomotive with a 3000 H. P. helper on the grades requiring this service:

<i>Eastbound</i>		<i>Maximum Actual Trailing Tons</i>	<i>Occasional Westbound</i>		<i>Maximum Actual Trailing Tons</i>
<i>From</i>	<i>To</i>		<i>From</i>	<i>To</i>	
San Bernardino	Summit . .	3380	Victorville	Summit . .	5370
Kelso	Cima . .	3380			
Caliente	Crestline .	4560			

Diesel helper locomotive assignments applicable to the proposed plan of Diesel operation during the base period for the four districts that require this service are described briefly as follows:

SAN BERNARDINO — SUMMIT

Eastbound helper service is required daily from San Bernardino to Summit. During seven consecutive days of the base period, three helper assignments are required on the first and fifth days, four on the third and seventh days, five on the second and sixth days, and six on the fourth day. Approximately 4 hours 30 minutes have been allowed for the helper locomotive round trip of 52.5 miles.

Three 3000 H.P. Diesel helper locomotives are assigned at San Bernardino to cover this service. These locomotives run a total of 2,150 miles in this service during

the seven days of the base period. This represents a 38.8 per cent reduction from the total helper locomotive miles accumulated by the present steam operation over the same period.

VICTORVILLE — SUMMIT

Westbound helper service is required on only one day during this period. These assignments, of which there are four, can be handled by three helper locomotives which are assigned at San Bernardino in conjunction with their assignments from San Bernardino to Summit. These locomotives run a total of 152 miles on this day. The saving in helper locomotive miles over the present steam operation is 93.8 per cent.

KELSO — CIMA

Eastbound helper service is required daily from Kelso to Cima, a distance of 18.7 miles. On two of the days, four assignments are required, on two other days five assignments are necessary, and six assignments are needed on two other days. On the remaining day seven helper assignments are required. Slightly more than three hours are included for each helper locomotive round trip of 37.4 miles.

Three 3000 H.P. Diesel helper locomotives are assigned to this service. During the seven days, these locomotives run a total of 1,870 miles. This will reduce helper locomotive mileage from that made by steam locomotives by 47.8 per cent.

CALIENTE — CRESTLINE

Eastbound helper service is required daily from Caliente to Crestline, a distance of 34 miles. During the seven day period, the required numbers of trips were one, two, three and five on separate days, with four trips required on three days. Each helper locomotive round trip is allotted approximately four hours.

Two 3000 H.P. Diesel helper locomotives are assigned to this service. In seven days they run a total of 2,052 miles. A reduction in helper locomotive miles of 47.3 per cent is thus effected over the present steam operation for the same period.

CARP — CALIENTE

MODENA — CRESTLINE

The exclusive use of 6000 H.P. Diesel locomotives in principal freight service eliminates the necessity of helper locomotives over these districts.

• *Branch Line Freight, Local Freight and Mixed Train Operation*

Diesel motive power has been assigned to the trains in these services based on the size of locomotive required to handle the maximum train operated during the base period after allowance for the discontinuance of certain local service operated in 1942. Local and branch service has been eliminated or changed as advised by the railroad and assignments made accordingly.

Whenever possible, advantage was taken of power pooling to reduce locomotive requirements without interfering with the operation.

The following tabulation shows the divisions and operations to which locomotives are assigned, the number required, the size and type, and the maintenance point.

	<i>Number Required</i>	<i>Locomotive</i>		<i>Maintenance Point</i>
		<i>Size</i>	<i>Type</i>	
UTAH DIVISION				
Provo Subdivision				
Fairfield Branch	*1	1000 HP	Switcher	Salt Lake City
Mixed Trains Nos. 305 and 306	2	3000 HP	AA	Salt Lake City
Provo Local	2	4500 HP	ABA	Salt Lake City
3rd Subdivision				
Tintic Branches	1	1000 HP	Switcher	Salt Lake City
Stockton Local	1	3000 HP	AA	Salt Lake City
Salt Lake City-Lynndyl Supply Local	***1	3000 HP	AA	Salt Lake City
2nd Subdivision				
Fillmore Branch	**1	3000 HP	AA	Salt Lake City
Lynndyl-Milford Supply Local	***1	3000 HP	AA	Salt Lake City
1st Subdivision				
Pioche and Prince Branches	1	1500 HP	Branch Line	Caliente
Cedar City Branch	1	2000 HP	Transfer	Cedar City
Iron Mountain Branch	1	4500 HP	ABA	Milford
Milford-Caliente Supply Local	***1	4500 HP	ABA	Milford
LOS ANGELES DIVISION				
3rd Subdivision				
St. Thomas Branch	1	1500 HP	Branch Line	Mead Lake
Las Vegas-Moapa Local	1	3000 HP	AA	Las Vegas
Caliente-Las Vegas Supply Local	***1	3000 HP	AA	Las Vegas
2nd Subdivision				
Boulder City Branch	1	3000 HP	Transfer	Las Vegas
Las Vegas-Sloan Local	1	3000 HP	AA	Las Vegas
Las Vegas-Yermo Supply Local	***1	3000 HP	AA	Las Vegas
Yermo-Kelso Local	1	3000 HP	AA	Yermo
1st Subdivision				
San Pedro Branch	2	1000 HP	Switcher	Los Angeles
Pasadena and Glendale Branches	****1	1000 HP	Switcher	Los Angeles
Anaheim Branch	1	1000 HP	Switcher	Los Angeles
San Bernardino-Leon Local	1	4500 HP	ABA	San Bernardino
Yermo-Barstow Local	1	4500 HP	ABA	Yermo
San Bernardino-Riverside Local	1	2000 HP	Transfer	San Bernardino
Los Angeles-San Bernardino Local	1	3000 HP	AA	Los Angeles
<hr/>				
TOTAL	21			

*Locomotive included in Salt Lake City Pool.
 **Locomotive included in Trains Nos. 305 and 306 Assignment.
 ***Locomotives furnished from layover power.
 ****Locomotives included in Los Angeles Pool.

Four 1000 H.P. Diesel switchers, two 1500 H.P. Diesel branch line locomotives, three 2000 H.P. Diesel transfer locomotives, seven 3000 H.P. Diesel freight locomotives and five 4500 H.P. Diesel freight locomotives, or a total of twenty-one Diesel locomotives are required for the operation of local freight, branch line freight and mixed trains. These locomotives are so scheduled that sufficient time is available for maintenance.

• *Yard Switching Operation*

There are assigned to the lines Salt Lake City-Los Angeles twenty-eight 1000 H.P. Diesel switching locomotives which are concentrated at Salt Lake City and Los Angeles. Table 7 on the following page, shows the assignment of these locomotives as well as the additional Diesel locomotives required to complete the Dieselization of the yard switching operations on the lines under study.

The yard switching assignments actually worked during the base period were analyzed for each yard and revised in accordance with advice from the railroad. The switching hours worked, reported by the railroad, at Salt Lake City were revised to exclude those hours covering the operation at Midvale where, under joint operation, locomotives are furnished by the Denver & Rio Grande Western Railroad eliminating the necessity for assignment of Union Pacific power. The Wilmington Harbor Belt Line Terminal has been excluded from consideration since this is a joint operation with the Southern Pacific Railway, The Atchison, Topeka and Santa Fe Railway, and the Pacific Electric, in which the Union Pacific furnishes its quota of switch engines. It is considered that Dieselization of this joint operation should be contained in a separate joint study.

The assignments shown on this table are seven day assignments with the exception of one assignment at Provo, one assignment at Las Vegas, four assignments at Los Angeles, and the one Crestmore assignment.

1000 H.P. yard switching locomotives have been selected in order to provide the maximum flexibility in switching power assignments and uniformity of size to promote greatest maintenance efficiency.

SALT LAKE CITY TERMINAL

The fifty-four 8 hour assignments at Salt Lake City can normally be handled by a total of twenty-one Diesel switching locomotives. Five additional 1000 H.P. Diesel switching locomotives will, therefore, be required to replace the remaining eight steam switching locomotives. These assignments are based on the peak 1942 work load and additional locomotives have been calculated accordingly. However, with complete Dieselization and with reorganization of locomotive assignments to allow for maintenance during light work periods, it is believed that the number of assignments may be reduced thereby creating a one or two switcher locomotive protection pool against any requirement which may arise. Maintenance and inspection can be performed without the necessity of providing an additional relief locomotive due to the distribution of the assignments.

TABLE 7
UNION PACIFIC RAILROAD
Switching Locomotive Requirements
Salt Lake City - Los Angeles

Yard and Branch Line Freight Included in Yard Assignments

Yard or Branch	Switching Hours Worked 1942		Locomotive Assignments Tricks			Days Assigned	Branch Lines Included	Existing Switching Locomotives		Total Diesel Locomotives Required	Additional Diesel Locomotives Required
	Steam	Diesel	1	2	3			Steam	Diesel		
Salt Lake City	98,117	49,841	21	17	16	7	Fairfield Branch	8	16—1000 HP	21	5—1000 HP
Lynndyl	8,712	....	1	1	1	7	Fillmore Branch	2	0	1	1—1000 HP
Provo	5,983	....	2	0	0	1-7	1-6	2	0	2	2—1000 HP
Milford	6,587	....	1	1	1	7	. . . . .	1	0	1	1—1000 HP
Caliente	8,559	....	1	1	1	7	. . . . .	2	0	2	2—1000 HP
Las Vegas	27,945	....	3	3	4	9-7	1-6	6	0	2	2—1000 HP
Yermo	11,391	....	1	1	2	7	. . . . .	2	0	2	2—1000 HP
Crestmore	4,013	....	1	0	0	1-6	Crestmore Branch	1	0	1	1—1000 HP
Los Angeles	98,787	20,265	17	19	15	47-7	4-6 Pasadena Branch Glendale Branch	13	12—1000 HP	19	7—1000 HP
	—	—						—	—	—	—
TOTAL	270,094	70,106						37	28	51	23

LYNN DYL TERMINAL

There are three 8 hour assignments seven days per week at Lynndyl which are now handled by two steam locomotives which also cover operation on the Fillmore Branch. The assignment of one 1000 H.P. Diesel switching locomotive will cover the switching assignment. Protection and coverage of the Fillmore Branch run can be accomplished by locomotives assigned to the Provo Subdivision. Maintenance and inspection of these Diesel locomotives can be handled currently.

PROVO TERMINAL

The one 8 hour assignment seven days per week and the one 8 hour assignment six days per week, now being handled by two steam locomotives, can be handled by two 1000 H.P. Diesel switching locomotives with maintenance and inspection possible without the necessity of providing a relief locomotive.

MILFORD TERMINAL

The three 8 hour assignments daily at this point now being handled by one steam locomotive can be covered by one 1000 H.P. Diesel switching locomotive. Maintenance and inspection can be handled currently.

CALIENTE TERMINAL

The three 8 hour assignments per day are now being handled by two steam locomotives. Although one Diesel locomotive could cover the amount of work accomplished in 1942, two 1000 H.P. Diesel switching locomotives are assigned, since under the proposed plan of operation, an increase in switching requirements will occur at Caliente, where a majority of the Diesel trains will be switched to take advantage of the increase in train car limit east of Caliente, Maintenance and inspection can be handled currently.

LAS VEGAS TERMINAL

The nine 8 hour assignments seven days a week and one 8 hour assignment six days a week are presently covered by six steam locomotives. Under the proposed plan of Diesel operation, live stock trains will operate through from Salt Lake City to Los Angeles eliminating the requirement for rest, feed and water at Las Vegas and the consequent live stock switching assignment at Las Vegas. This reduction leaves six 8 hour assignments seven days a week and one 8 hour assignment six days a week. The one 8 hour assignment six days a week can be handled by the 2000 H.P. Diesel transfer locomotive assigned to the Boulder City Branch and tying up at Las Vegas. This locomotive can also furnish relief for the other Diesel yard switching locomotives when required. Therefore, two additional 1000 H.P. Diesel switching locomotives each assigned to twenty-four hour duty at Las Vegas are sufficient to satisfy requirements at this point if stock feeding is eliminated at this terminal.

YERMO TERMINAL

The four 8 hour assignments seven days per week are normally handled by two steam locomotives. Two 1000 H.P. Diesel switching locomotives will be required to replace the steam locomotives and sufficient time will be available for maintenance and inspection currently.

CRESTMORE

The one 8 hour assignment six days per week now being handled by one steam locomotive can be handled by one 1000 H.P. Diesel switching locomotive with maintenance and inspection performed currently.

LOS ANGELES TERMINAL

The fifty-one 8 hour assignments now handled by thirteen steam locomotives and twelve 1000 H.P. switching locomotives can be handled by a total of nineteen 1000 H.P. Diesel switching locomotives. This is based on the locomotive assignments by tricks during the 1946 peak period and as in the case of the Salt Lake City terminal, it is believed that with complete Dieselization and reorganization of assignments, the number of assignments may be reduced, thus creating a protection pool of from one to two locomotives for use where required. Two of the assignments are based upon a six month LAUPT requirement each year. Maintenance and inspection can be performed currently.

Twenty-three 1000 H.P. Diesel switching locomotives will be required to cover the various yard assignments. These twenty-three locomotives are in addition to the twenty-eight Diesel switching locomotives now assigned to Salt Lake City and Los Angeles terminals. The number of Diesel locomotives recommended is based on the operation as performed in the year 1942 unless indicated to the contrary, and it will be necessary for the railroad to evaluate any operational changes which would make necessary any increase or decrease in the number of locomotives required.

• Summary

To provide sufficient motive power under the proposed plan of Dieselization of the Union Pacific Railroad between Salt Lake City and Los Angeles will require the following:

<i>Number of Locomotives</i>	<i>Type</i>	<i>Number of Power Units</i>
23	6000 HP freight locomotives	92
5	4500 HP freight locomotives	15
15	3000 HP freight locomotives	30
3	2000 HP transfer locomotives	6
2	1500 HP branch line locomotives	2
27	1000 HP switching locomotives	27
TOTALS		172

in addition to the 28 Diesel switching locomotives now assigned to this territory. This represents a total of seventy-five new Diesel locomotives or a grand total of one hundred three Diesel locomotives not including Diesel locomotives required for passenger service.

SECTION V

Diesel Facilities

To insure the maximum gains from Dieselization, no reasonable effort should be spared to maintain them to a high degree of efficiency and serviceability. As with any type of high grade machinery under intensive use, no matter how well designed and built, Diesel motive power requires proper inspection. That is, proper maintenance and periodic repairs in the interest of maximum efficiency, maximum availability and service.

Recognizing these facts, General Motors has developed basic plans for Diesel locomotive shops and maintenance facilities and procedures so that Diesel locomotives can be inspected and maintained in the minimum time, with maximum efficiency in every detail of the work, thus insuring the maximum operating efficiency of each unit in service. General Motors Diesel locomotives can operate 2,000 to 3,000 miles between maintenance periods, when progressively maintained. With this program, maintenance operations are performed in successive steps to keep the locomotives in first class condition. As outlined in Section IV, Diesel locomotives have been cycled to insure adequate maintenance time when the locomotive has accumulated 2,000 miles. Experience has proved that locomotives maintained in this manner accumulate high availability records with low operating costs.

With fewer locomotives in operation on the railroad, requiring less frequent maintenance than the present steam locomotives, it follows that the investment in supporting facilities can be greatly reduced.

Los Angeles is now the principal western maintenance point for all through passenger power. Los Angeles will also be the principal maintenance point for all freight power. It is possible to remodel the Machine and Erecting Shop at Los Angeles for maintenance of Diesel locomotives. All heavy repairs required on Diesel locomotives assigned between Los Angeles and Salt Lake City can be accomplished at Los Angeles Shops.

• *Shop Buildings*

Detailed drawings have been prepared for the Los Angeles Shop with inspection pits between the rails, depressed floors between adjacent tracks and a continuous platform at locomotive floor level, in the main shop area. The floor level platforms will permit servicing both sides of locomotives and the pits between the rails and depressed floor between tracks will permit inspection and maintenance operations on the underneath portions simultaneously. Facilities are so arranged that once the locomotive is spotted within the shop, the normal maintenance can be performed without moving it. For convenience, cleaning and parts reconditioning rooms and storeroom for parts are laid out at the locomotive floor level, minimizing the man hours required to maintain

the locomotives. Space is provided adjacent to the platform area for the repair of engines, generators, traction motors and trucks at Los Angeles. Also drop tables capable of handling complete trucks are provided at this point.

• *Fuel Oil Facilities*

Storage for 100,000 gallons of Diesel Fuel Oil should be provided at Salt Lake City, Caliente, Las Vegas, and Los Angeles; 40,000 gallons at Milford and San Bernardino and 20,000 gallons at Kelso and Yermo; all other points to have 10,000 gallon storage capacity.

The storage capacities listed above will afford approximately a fifteen day supply in all cases, except where a fifteen day supply is less than 10,000 gallons. For economical reasons 10,000 gallons storage capacity has been used as a minimum thereby enabling all points to be served with tank car loads of fuel oil.

• *Lubricating Oil Facilities*

Lubricating oil facilities consisting of three 10,000 gallon storage tanks should be provided at Los Angeles and Salt Lake City; Las Vegas should be provided with 10,000 gallon storage capacity for new oil. Lubricating oil can be handled in drums at all other points.

Oil reclaiming facilities should be installed at Salt Lake City and Los Angeles. All oil drainings east of and including Caliente, should be shipped to Salt Lake City and all drainings west of Caliente should be shipped to Los Angeles.

• *Water Treating Facilities*

It is recommended that distilled water or its equivalent, properly inhibited to prevent metal corrosion, be used in all engine cooling systems of the Diesel locomotives. Plants for the production of this type of water are required at Salt Lake City and Los Angeles and smaller plants at Milford, Las Vegas and Yermo. Treated water can be handled in drums at all other points.

Water treating facilities recommended herein are predicated on the normal expected requirements for locomotives involved and considering the types of water usually available.

• *Cleaning Facilities*

Sufficient cleaning facilities, consisting of washing tanks, drying ovens and rinsing booths for the cleaning of air filters, engine and other parts, should be provided at all points where this work will be done. Cleaning facilities will not be provided at Tintic, Provo, Lynndyl, Cedar City, Caliente, Mead Lake, Kelso and Crestmore. Necessary cleaning of parts for these points can be done at the nearest maintenance terminal as shown under the details of each point.

• *Shop Machinery and Tools*

The shop machinery located in the Machine Shop at Los Angeles can be retained for the maintenance of Diesel locomotives and additional special tools and equipment acquired. No heavy machinery need be retained at the remaining points as they will be supplied with new or reconditioned parts from designated terminals.

• *Sanding Facilities*

Two five ton capacity sand towers should be provided at Salt Lake City and Los Angeles for the sanding of all road and switcher locomotives operating out of these terminals. The recommended equipment will permit the sanding of four boxes simultaneously. Present sanding facilities are to be retained at Tintic, Provo, Milford, Caliente, Las Vegas, Kelso, Yermo and San Bernardino. Due to the small quantities of sand used by Diesel locomotives, sanding at all remaining terminals can readily be performed by hand.

• *Spare Parts*

Recommendations as to parts required will be supplied to the railroad approximately three months before the delivery of any locomotive or group of locomotives purchased.

In connection with facilities for storage of materials for maintenance and protection of these locomotives, it should be noted that space has been provided at each maintenance point for suitable storeroom.

It is recommended that equipment for these storerooms be based on latest designs as to type of bins, location of parts to conserve space, provide better protection for material, and decrease store labor cost.

A Parts and Stores Representative is prepared to go into detail on these facility recommendations upon request at any time, and outline the type of stock control system most successful for Diesel operation.

• *Investment in New Facilities*

The costs of new facilities recommended at each point are shown in Table 8. on page 40. These are estimates only and many of the items recommended therein can be built by the railroad from salvaged material at greatly reduced material costs.

• *Retirement of Existing Facilities*

Upon complete conversion to Diesel locomotive operation, and after the recommended facilities for their service and maintenance have been provided, the present extensive steam locomotive supporting facilities listed in Table 9 on page 41, can be retired completely, or in part.

TABLE 8
UNION PACIFIC RAILROAD
Estimated Cost of New Facilities

<i>Location</i>	<i>Shop Buildings</i>	<i>Fuel Oil Facilities</i>	<i>Lubricating Oil Facilities</i>	<i>Water Treating Facilities</i>	<i>Shop Tools and Machinery</i>	<i>Sanding Facilities</i>	<i>Total</i>
Salt Lake City	\$ 7,235	\$ 11,267	\$ 2,525	\$ 1,102	\$ 5,700	\$ 27,829
Tintic	2,700	43	.....	195	.....	2,938
Provo	2,700	43	.....	195	.....	2,938
Lynndyl	2,700	43	.....	195	.....	2,938
Milford	5,057	43	550	502	.....	6,152
Cedar City	2,700	43	.....	195	.....	2,938
Caliente	7,235	43	.....	195	.....	7,473
Las Vegas	7,235	1,576	550	1,102	.....	10,463
Mead Lake	2,700	43	.....	195	.....	2,938
Kelso	3,557	43	.....	502	.....	4,102
Yermo	3,557	43	550	502	.....	4,652
San Bernardino	5,057	43	.....	502	.....	5,602
Crestmore	2,700	43	.....	195	.....	2,938
Los Angeles	\$450,000	7,235	11,349	2,525	6,440	5,700	483,249
TOTAL	\$450,000	\$ 62,368	\$ 24,665	\$ 6,700	\$ 12,017	\$ 11,400	\$567,150

TABLE 9
UNION PACIFIC RAILROAD
Estimated Ledger Value
Present Steam Facilities to be Retired

<i>Location</i>	<i>Shop Building</i>	<i>Fuel-Coal Stations</i>	<i>Water Facilities</i>	<i>Shop Machinery</i>	<i>Sanding Facilities</i>	<i>Total</i>
Tintic . . . . .	.....	\$ 28,600	\$ 49,130	\$ 450	.....	\$ 78,180
Provo . . . . .	.....	44,300	5,900	69,900	.....	120,100
Lynndyl	\$ 75,000	22,800	69,100	5,240	\$ 3,150	175,290
Milford	45,800	18,900	34,340	2,620	.....	101,660
Caliente	100,000	26,150	95,680	62,700	.....	284,530
Las Vegas	70,100	45,500	61,000	54,540	.....	231,140
Kelso	29,500	17,300	200,000	7,500	.....	254,300
Yermo	50,000	37,200	33,900	11,100	.....	132,200
San Bernardino . . . . .	.....	23,400	10,200	5,400	.....	39,000
Los Angeles	647,000	38,200	49,600	24,900	10,200	769,900
TOTAL	\$1,017,400	\$ 302,350	\$ 608,850	\$ 244,350	\$ 13,350	\$2,186,300

• *Summary*

The maintenance and servicing facilities recommended with an estimated total cost of \$567,150 will enable economical maintenance, insure high locomotive availability and permit the retirement of steam facilities having a ledger value of \$2,186,300.

SECTION VI

Investment

The investment necessary to completely Dieselize a railroad or section thereof, can be divided into two major parts, that necessary to provide motive power and that necessary to provide facilities for proper service and maintenance. This investment is offset partially through salvage of motive power and facilities replaced.

• *New Diesel Locomotives*

The investment in new Diesel locomotives required to complete the Dieselization of the lines between Salt Lake City and Los Angeles is tabulated in Table 10.

The prices applied in Table 10, on page 44, are composed of the General Motors base price plus approved extras at the manufacturing plant. All F-3 locomotive "A" units and, likewise, all F-3 locomotive "B" units, are entered at the same price. Thus, provision has been made for complete interchangeability between F-3 units assigned to through, helper and local operation.

As indicated in Table 10, on page 44, the investment in new Diesel locomotives for through freight operation is \$13,137,968; for freight helper operation is \$2,403,664; for local, branch line and mixed operation is \$5,423,915; and for yard switching operation is \$2,058,500. The total investment in new Diesel locomotives is \$23,024,047.

• *New Facilities*

The estimated investment in new or rearranged facilities for the proper maintenance of Diesel equipment is listed in Table 8 in the foregoing Section V — "Diesel Facilities". Based upon use of present facilities to the greatest extent possible and available construction cost, this investment aggregates \$567,150.

• *Disposal of Surplus Equipment and Roadway Facilities*

The steam locomotives and roadway facilities rendered surplus through Dieselization may be disposed of through transfer to other lines, sale or scrap. Since transfer to other lines or sale may be dependent on operating and market conditions at the time of disposal, only salvage is used in this report as a conservative estimate of the return possible through disposal of surplus equipment and roadway facilities.

STEAM LOCOMOTIVES

The steam motive power assigned to the lines under study may be separated into two groups — the forty 3800 class articulated locomotives averaging nine years of age and the others which average thirty-one years of age.

It is reasonable to assume that the 3800 class locomotives could be sold or reassigned to replace steam locomotives elsewhere on the system which are older and less

TABLE 10
UNION PACIFIC RAILROAD
Investment in New Diesel Motive Power
Main Line Freight, Yard and Branch Operation
Salt Lake City - Los Angeles

<i>Number of Locomotives</i>	<i>Type of Locomotive</i>	<i>No. of Units</i>	<i>Arrangement</i>	<i>Estimated Price of Each Locomotive</i>	<i>Total</i>
THROUGH FREIGHT OPERATION					
23	6000 HP G.M. F-3	92	ABBA	\$571,216	\$13,137,968
23	TOTAL	92			\$13,137,968
FREIGHT HELPER OPERATION					
8	3000 HP G.M. F-3	16	AA	\$300,458	\$ 2,403,664
8	TOTAL	16			\$ 2,403,664
LOCAL FREIGHT, BRANCH LINE AND MIXED TRAIN OPERATION					
4	1000 HP G.M. Switcher	4	AA ABA	\$ 89,500	\$ 358,000
2	1500 HP G.M. Br. Line	2		121,762	243,524
3	2000 HP G.M. Transfer	6		180,000	540,000
7	3000 HP G.M. F-3	14		300,458	2,103,206
5	4500 HP G.M. F-3	15		435,837	2,179,185
21	TOTAL	31			\$ 5,423,915
YARD SWITCHING OPERATION					
23	1000 HP G.M. Switcher	23	....	\$ 89,500	\$ 2,058,500
23	TOTAL	23			\$ 2,058,500
75	GRAND TOTAL	162			\$23,024,047

TABLE 11
UNION PACIFIC RAILROAD
Estimated Net Return from Scrapping Displaced Steam Locomotives
Freight, Yard and Branch Operation
Salt Lake City - Los Angeles

<i>Number of Locomotives To Be Scrapped</i>	<i>Locomotive Class</i>	<i>Average Light Weight (Lbs.)</i>	<i>*Estimated Market Value Each</i>	<i>Net Return From Scrap</i>
2	Shay	120,000	\$1,150	\$ 2,300
13	Switcher	177,000	1,750	22,750
31	Consolidation	242,000	2,380	73,780
3	Lt. MacArthur	300,000	2,950	8,850
22	Heavy MacArthur	321,000	3,150	69,300
23	Two-Ten-Two	394,000	3,900	89,700
10	Four-Ten-Two	450,000	4,400	44,000
15	Mallet	510,000	5,000	75,000
40	Challenger	600,000	6,000	240,000
159	TOTAL			\$625,680

*Market value calculated @ \$22 per ton with dismantling cost absorbed.

TABLE 12
UNION PACIFIC RAILROAD
Net Additional Investment and Net Cash Outlay
Dieselization of Freight, Yard and Branch Operation
Salt Lake City-Los Angeles

TOTAL ESTIMATED EXPENDITURE

Estimated Cost of New Diesel Power

Principal Through Freight Locomotives	\$13,137,968	
Freight Helper Locomotives	2,403,664	
Total Through Freight and Helper		\$15,541,632
Local, Branch Line and Mixed Train Locomotives		5,423,915
Yard Switching Locomotives		2,058,500

TOTAL		\$23,024,047
Estimated Cost of New Roadway Facilities		567,150
TOTAL ESTIMATED EXPENDITURE		\$23,591,197

NET ADDITIONAL INVESTMENT

TOTAL ESTIMATED EXPENDITURE		\$23,591,197
Less Estimated Ledger Value Surplus Steam Power	\$11,761,115	
Less Estimated Ledger Value Surplus Facilities	2,186,300	\$13,947,415
NET ADDITIONAL INVESTMENT		\$ 9,643,782

NET CASH OUTLAY

NET ESTIMATED EXPENDITURE	\$23,591,197	
Less Estimated Net Return from Steam Locomotive Salvage	625,680	
NET CASH OUTLAY		\$22,965,517

economical to operate. The other heavier locomotives might well be reassigned elsewhere to replace smaller steam locomotives where traffic conditions render such replacement economical. For reasons stated above, only the estimated present scrap value of these locomotives will be considered in this report.

The estimated net return from scrapping the displaced steam locomotives, based on values furnished by the railroad is outlined in Table 11 on page 45. The estimated total net return from scrapping 159 steam locomotives is \$625,680.

ROADWAY FACILITIES

The steam Roadway Facilities to be rendered surplus are listed on Table 9 in foregoing Section V with an estimated ledger value of \$2,186,300. Some of these facilities, such as the boiler washout plant and modified steaming system at Los Angeles having an estimated ledger value of \$153,900, could be utilized elsewhere on the system. However, no salvage value will be considered in this report since the net value after dismantling cannot be readily determined.

• *Net Additional Investment and Net Cash Outlay*

Computation of the net additional investment and net cash outlay is summarized in Table 12. The total estimated expenditure for new Diesel power and Roadway Facilities is \$23,591,197. After deducting the estimated ledger values of the steam locomotives and Roadway Facilities rendered surplus, the Net Additional Investment is \$9,643,782. Deduction of the net return from salvage from the estimated expenditure results in an estimated Net Cash Outlay of \$22,965,517.

• *Summary*

The total net cash outlay required to Dieselize the main line and branch line freight operations, to complete the Dieselization of yard switching operations and to provide facilities capable of serving these operations is \$22,965,517.

SECTION VII

Unit Operating Costs

Although the motive power requirements have been predicated on the volume of business handled during the year 1942, the cost data used herein is based on present day labor and material costs.

Steam locomotive and Diesel switching locomotive operating and maintenance costs for the various classes of service are based upon costs reported by the railroad. Operating and maintenance costs of Diesel locomotives in other than yard switching service are based upon those considered equitable. These detailed unit operating costs are shown in Tables 13 through 15 on following pages.

• *Repairs*

Repair costs for each class of steam locomotive and for Diesel locomotives in switching service were furnished by the railroad. Repair costs for road Diesel locomotives are based on general experience and are considered representative of a long-time cumulative cost at wage rates in effect during 1946.

• *Enginemen and Trainmen*

Wages for enginemen and trainmen were furnished by the railroad. In through freight operation, the cost per locomotive mile for trainmen has been adjusted to cover an additional brakeman between Yermo and Las Vegas when operating with trains of over seventy-one cars under the plan of Diesel operation.

• *Fuel*

An average price per gallon of \$0.035806 was used by the railroad in computing steam locomotive fuel oil costs. Prices of \$0.05879 and \$0.05311 per gallon of Diesel fuel oil were used by the railroad in computing Diesel switching locomotive fuel costs at Los Angeles and Salt Lake City, respectively, as these figures represented the approximate cost in July, 1946. A price of \$0.06500 per gallon was used in approximating Diesel fuel oil costs in other services.

• *Water*

The water expense per steam locomotive mile was furnished by the railroad based on system wide averages for each class of locomotive.

• *Lubricants*

The costs of lubricants was obtained from costs furnished by the railroad.

TABLE 13
UNION PACIFIC RAILROAD
Unit Operating Costs per Locomotive Mile
Main Line Freight Operation — Salt Lake City - Los Angeles

Account	STEAM								DIESEL	
	Through Freight				Helper				Through Freight	Helper
	3500 Class	3800 Class	5000- 5500 Class	5090 Class	2700 Class	3500 Class	5000- 5500 Class	5090 Class	6000 H.P.	3000 H.P.
Repairs	\$.6446	\$.5106	\$.5946	\$.5345	\$.4018	\$.6446	\$.5946	\$.5445	\$.3500	\$.2040
Fuel . . . . .	.7700	.7900	.6500	.9800	.4400	.7700	.6500	.9800	.3900	.3000
Water . . . . .	.0387	.0363	.0303	.0315	.0206	.0266	.0242	.0242	.0000	.0000
Lubricants . . . . .	.0256	.0252	.0157	.0207	.0127	.0256	.0157	.0207	.0664	.0350
Other Supplies . . . . .	.0500	.0500	.0400	.0400	.0300	.0500	.0400	.0400	.0040	.0039
Enginehouse Expense . . . . .	.1560	.1560	.1210	.1210	.1970	.1970	.1970	.1970	.0500	.0350
Enginemen—Valley . . . . .	.2313	.2338	.2140	.2182	.....	.....	.....	.....	.2594	.....
—Mountain . . . . .	.2345	.2370	.2203	.2246	.2163	.2345	.2203	.2246	.2604	.2387
Trainmen . . . . .	.2712	.2712	.2712	.2712	.....	.....	.....	.....	.2868	.....
TOTAL—Valley	\$2.1874	\$2.0731	\$1.9368	\$2.2171	.....	.....	.....	.....	\$1.4866	.....
—Mountain	\$2.1906	\$2.0763	\$1.9431	\$2.2235	\$1.3184	\$1.9483	\$1.7418	\$2.0310	\$1.4867	\$.8626
Ave.S.L.C.-L.A.	\$2.1895	\$2.0752	\$1.9409	\$2.2213	.....	.....	.....	.....	\$1.4873	.....

TABLE 14
UNION PACIFIC RAILROAD
Unit Operating Costs per Locomotive Mile
Local Freight — Branch Line — Mixed Train Operation
Salt Lake City - Los Angeles

Accounts	S T E A M					D I E S E L				
	2100 Class	2700 Class	Shay	5000- 5500 Class	6000 Class	1000 H.P. Switcher	1500 H.P. Br. Line	2000 H.P. Transfer	3000 H.P. F-3	4500 H.P. F-3
Repairs	\$.2580	\$.4018	\$.9875	\$.5946	\$.2797	\$.0833	\$.1500	\$.1500	\$.1800	\$.2700
Fuel . . . . .	.3900	.4400	.4000	.6500	.3600	.1138	.1300	.1950	.2600	.3250
Water . . . . .	.0266	.0266	.0242	.0303	.0242	.0000	.0000	.0000	.0000	.0000
Lubricants . . . . .	.0078	.0127	.0172	.0157	.0069	.0083	.0166	.0249	.0332	.0496
Other Supplies . . . . .	.0300	.0300	.0250	.0400	.0275	.0035	.0036	.0037	.0038	.0039
Enginehouse Expense . . . . .	.2190	.2190	.2800	.2190	.2500	.0120	.0180	.0200	.0300	.0400
Wages										
Valley Rates										
Engineer . . . . .	.1205	.1205	.1136	.1220	.1188	.1205	.1205	.1298	.1298	.1373
Fireman . . . . .	.0994	.0994	.0921	.1012	.0967	.0995	.0995	.1079	.1079	.1143
TOTAL . . . . .	.2199	.2199	.2057	.2232	.2155	.2200	.2200	.2377	.2377	.2516
Mountain Rates										
Engineer . . . . .	.1230	.1230	.....	.1245	.1198	.1215	.1215	.1308	.1308	.1383
Fireman . . . . .	.1025	.1025	.....	.1050	.0977	.0995	.0995	.1079	.1079	.1143
TOTAL . . . . .	.2255	.2255	.....	.2295	.2175	.2210	.2210	.2387	.2387	.2526
Total Valley	\$1.1513	\$1.3500	\$1.9396	\$1.7728	\$1.1638	\$.4836	\$.5382	\$.6613	\$.7847	\$1.0001
Total Mountain	\$1.1569	\$1.3556	\$	\$1.7791	\$1.1658	\$.4846	\$.5392	\$.6623	\$.7857	\$1.0011

TABLE 15
UNION PACIFIC RAILROAD
Unit Operating Costs per Engine Hour
Yard and Branch Lines Included in Yard Assignments
Salt Lake City - Los Angeles

<i>Location</i>	<i>Type Locomotive</i>	<i>Repairs</i>	<i>Fuel</i>	<i>Water</i>	<i>Lubricants</i>	<i>Other Supplies</i>	<i>Engine-house</i>	<i>Engine-men</i>	<i>Total Per Hour</i>
Salt Lake City	Consolidation	\$1.6782	\$1.1600	\$0.2178	\$0.0500	\$0.0300	\$3.2300	\$2.5000	\$8.8660
	Heavy MacArthur	2.4108	1.1600	0.2178	0.0500	0.0300	3.2300	2.5360	9.6346
	Switch	1.5000	1.1600	0.1936	0.0500	0.0300	3.2300	2.5000	8.6636
	1000 HP Diesel	0.7554	0.2700	.....	0.0500	0.0400	0.1800	2.5290	3.8244
Lynndyl	Consolidation	1.6782	1.6500	0.2178	0.0500	0.0300	0.6000	2.5000	6.7260
	Heavy MacArthur	2.4108	1.6500	0.2178	0.0500	0.0300	0.6000	2.5360	7.4946
	1000 HP Diesel	0.7554	0.2700	.....	0.0500	0.0300	0.0345	2.5290	3.6689
Provo	Heavy MacArthur	2.4108	1.7900	0.2178	0.0500	0.0300	2.0800	2.5360	9.1146
	Switch	1.5000	1.7900	0.2178	0.0500	0.0300	2.0800	2.5000	8.1678
	1000 HP Diesel	0.7554	0.3900	.....	0.0500	0.0300	0.1200	2.5290	3.8744
Milford	Consolidation	1.6782	1.5000	0.2178	0.0500	0.0300	0.9900	2.5000	6.9660
	1000 HP Diesel	0.7554	0.2700	.....	0.0500	0.0300	0.0569	2.5290	3.6913
Caliente	Consolidation	1.6782	2.4000	0.2178	0.0500	0.0300	1.3100	2.5000	8.1860
	Heavy MacArthur	2.4108	2.4000	0.2178	0.0500	0.0300	1.3100	2.5360	8.9546
	1000 HP Diesel	0.7554	0.3900	.....	0.0500	0.0300	0.0753	2.5290	3.8297
Las Vegas	Consolidation	1.6782	2.1000	0.2178	0.0500	0.0300	1.5100	2.5000	8.0860
	Heavy MacArthur	2.4108	2.1000	0.2178	0.0500	0.0300	1.5100	2.5360	8.8546
	1000 HP Diesel	0.7554	0.3900	.....	0.0500	0.0300	0.0868	2.5290	3.8412
	2000 HP Diesel	0.9000	0.4500	.....	0.0600	0.0400	0.1000	2.5600	4.1100
Yermo	Consolidation	1.6782	1.8900	0.2178	0.0500	0.0300	0.9700	2.5000	7.3360
	1000 HP Diesel	0.7554	0.3600	.....	0.0500	0.0300	0.0578	2.5290	3.7822
Crestmore	Consolidation	1.6782	1.6100	0.2178	0.0500	0.0300	0.8000	2.5000	6.8860
	1000 HP Diesel	0.7554	0.3000	.....	0.0500	0.0300	0.0460	2.5290	3.7104
Los Angeles	Consolidation	1.6782	1.9700	0.2178	0.0500	0.0300	4.0000	2.5000	10.4460
	Heavy MacArthur	2.4108	1.9700	0.2178	0.0500	0.0300	4.0000	2.5360	11.2146
	Switch	1.5000	1.9700	0.1936	0.0500	0.0300	4.0000	2.5000	10.2436
	1000 HP Diesel	0.7554	0.3900	.....	0.0900	0.0500	0.2300	2.5290	4.0444

- *Enginehouse Expense*

Enginehouse expense covering steam locomotives and Diesel switching locomotives was furnished by the railroad. Enginehouse expense covering Diesel locomotives in other services has been estimated, based on average costs incurred by other railroads.

- *Summary*

Steam locomotive and Diesel switching locomotive unit operating costs used in this report are based on current information furnished by the railroad. Diesel freight, branch line freight and helper locomotive costs are based on average operating costs incurred by locomotives operating on other railroads under similar conditions.

SECTION VIII

Diesel Operating Economies

The economies possible through complete Dieselization of a railroad, or part thereof, can be divided into two major categories, those realized from decreased locomotive operating costs and locomotive miles operated, identified as Primary Savings, and those to be derived from the decreased required maintenance of supporting facilities, identified as Secondary Savings. In addition to these savings, consideration must be given to the increase in depreciation charges due to the increased investment and rates of depreciation for Diesel locomotives as compared with steam locomotives.

• *Primary Savings*

Primary savings are based on the differences in cost of operating Diesel locomotives per mile as compared with steam locomotives, and, in addition, such savings as may be possible through elimination of locomotive miles run.

The tabulation following shows the estimated annual locomotive miles by type of service, and switching hours for the present steam power and for the proposed Diesel operation.

			<i>Steam Locomotive Miles</i>	<i>Proposed Diesel Locomotive Miles</i>	<i>Per Cent Diesel Saving</i>
THROUGH FREIGHT TRAIN OPERATION					
Principal Locomotive Miles	. . .		2,938,178	2,406,391	18.1
THROUGH FREIGHT HELPER LOCOMOTIVE OPERATION					
Victorville	- Summit	WB	88,968	5,475	93.85
Modena	- Crestline	WB	24,287	.....	100.00
San Bernardino	- Summit	EB	117,150	71,661	38.83
Kelso	- Cima	EB	112,571	58,782	47.78
Carp	- Caliente	EB	99,890	.....	100.00
Caliente	- Crestline	EB	121,870	64,225	47.30
	TOTAL		564,736	200,143	64.56
LOCAL FREIGHT, BRANCH LINE AND MIXED TRAIN OPERATION					
Principal Locomotive Miles	. . .		592,517	592,517	0.00
YARD SWITCHING LOCOMOTIVE HOURS					
Principal Locomotive Miles	. . .		132,503	132,503	0.00

Through Freight Train Operation

The recommended Diesel principal freight locomotives have a greater hauling capacity at higher speeds than the steam locomotives now in service; therefore, with Diesel

TABLE 16
UNION PACIFIC RAILROAD
Steam and Diesel Operating Costs and Diesel Savings
Salt Lake City - Los Angeles

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	Locomotive Class	Annual Locomotive Miles	Total Unit Operating Costs Per Locomotive Mile	Annual Operating Costs		Annual Diesel Savings
				Steam	Diesel	
MAIN LINE THROUGH FREIGHT OPERATION EXCLUDING HELPER SERVICE						
Steam	3800	2,544,168	\$2.0752	\$5,279,657	.....	.....
	5000-5500	189,219	1.9409	367,255	.....	.....
	5090	168,358	2.2213	373,974	.....	.....
	3500	36,433	2.1895	79,770	.....	.....
TOTAL		2,938,178		\$6,100,656		
Diesel	6000 HP	2,406,391	\$1.4873	.....	\$3,579,025	\$2,521,631
MAIN LINE FREIGHT HELPER OPERATION						
Steam	2700	31,629	\$1.3184	\$ 41,700	.....	.....
	5000-5500	458,448	1.7418	798,525	.....	.....
	5090	6,842	2.0310	13,896	.....	.....
	3500	67,817	1.9483	132,128	.....	.....
TOTAL		564,736		\$ 986,249		
Diesel	3000 HP	200,143	\$0.8626	.....	\$ 172,643	\$ 813,606

operation, fewer trains will be required to haul the same tonnage with a consequent reduction in principal locomotive miles, as indicated above. This greater hauling capacity and reduction in the number of trains operated will also reduce the necessary helper locomotive service from that required in steam operation.

Steam operation during the base period, October 1-10, 1942, was used as the basis for estimating the annual locomotive miles which would be required operating with present steam power and with Diesel power. The railroad estimated the present steam locomotive mileage required to perform the same work as was accomplished during the base period and during the year 1942. The same ratio was applied to the Diesel locomotive miles required during the base period to arrive at an estimated annual Diesel locomotive mileage. It is to be noted from the foregoing tabulation that, with the proposed Diesel operation, annual freight principal locomotive miles can be reduced 18.1% from the present steam operation.

As indicated in Table 16, this reduction in annual locomotive miles, coupled with the lower Diesel operating cost per locomotive mile predicates an estimated annual saving of \$2,521,631 through Dieselization of main line through freight operation excluding helper service.

The application of 6000 H.P. Diesel locomotives to stock trains will eliminate the necessity for feeding, watering, and resting stock at Las Vegas; therefore, the Las Vegas switching requirements will be reduced by one twenty-four hour assignment, seven days per week. Based upon 8,760 switching hours at a cost of \$13.48 per hour, this contingent primary saving is estimated at \$118,070 annually.

The reduction of locomotive miles included in the Diesel plan of operation is affected by reduction and fill of trains at Caliente to a greater extent than with present operation. It is therefore reasonable to assume that yard switching requirements will increase at this terminal. No credit is taken at other terminals for possible savings in yard switching hours or overtime due to fewer trains being handled. However, in the interest of providing a conservative estimate of the savings to be derived, a contingent annual operating loss of \$46,242 is included herein based upon an estimated annual increase at Caliente of 6,300 switching hours at \$7.34 per hour.

The estimated net primary savings to be derived from Dieselization of main line freight operation, excluding helper service, allowing for additional savings at Las Vegas and loss at Caliente is \$2,593,459.

Through Freight Helper Operation

The method described in the foregoing discussion of through freight operation, for estimating annual locomotive mileage was applied to freight helper operation. The helper service required with Diesel operation is reduced both by the reduction in number of trains and by the greater capacity of the Diesel principal locomotives.

Helper service westbound from Modena to Crestline and eastbound from Carp to Caliente will be eliminated entirely. Approximately 94 per cent of the helper service

TABLE 17
UNION PACIFIC RAILROAD
Steam and Diesel Operating Costs and Diesel Savings
Salt Lake City - Los Angeles
Local Freight, Branch Line, Mixed Train Operation

District	Steam Class	Diesel	Annual Locomotive Miles		Unit Operating Costs Per Locomotive Mile		Annual Operating Costs		Annual Diesel Savings	
			Steam	Diesel	Steam	Diesel	Steam	Diesel		
UTAH DIVISION										
Provo Subdivision										
Fairfield Branch . . .	6000	1000 HP Sw.	7,170	7,170	\$1.1638	\$0.4836	\$ 8,344.46	\$ 3,467.41	\$ 4,877.05	
S.L.C.-Lynndyl Nos. 305 and 306 . .	2200-2700	3000 HP F3	86,441	86,441	1.3500	0.7847	116,695.35	67,830.25	48,865.10	
S.L.C.-Provo Local . .	5000-5500	4500 HP F3	60,979	60,979	1.7728	1.0001	108,103.57	60,985.10	47,118.47	
Third Subdivision										
Tintic Branches . . .	Shay	1000 HP Sw.	3,458	3,458	1.9396	0.4836	6,707.13	1,672.29	5,034.84	
S.L.C.-Stockton Local .	2200-2700	3000 HP F3	31,811	31,811	1.3500	0.7847	42,944.85	24,962.09	17,982.76	
S.L.C.-Lynndyl-Supply Local	2200-2700	3000 HP F3	3,806	3,806	1.3500	0.7847	5,138.10	2,986.57	2,151.53	
Second Subdivision										
Fillmore Branch . . .	6000	3000 HP F3	11,816	11,816	1.1638	0.7847	13,751.46	9,272.02	4,479.44	
Lynndyl-Milford-Supply Local	2200-2700	3000 HP F3	4,103	4,103	1.3500	0.7847	5,539.05	3,219.62	2,319.43	
First Subdivision										
Pioche and Prince Branches	6000	1500 HP BL	22,547	22,547	1.1658	0.5392	26,285.29	12,157.34	14,127.95	
Cedar City Branch . .	2200-2700	2000 HP Tr.	39,428	39,428	1.3556	0.6623	53,448.60	26,113.16	27,335.44	
Iron Mountain Branch .	5000-5500	4500 HP F3	77,597	77,597	1.7791	1.0011	138,052.82	77,682.36	60,370.46	
Milford-Caliente-Supply Local	2200-2700	4500 HP F3	5,302	5,302	1.3556	1.0011	7,187.39	5,307.83	1,879.56	

TABLE 17

(Continued)

UNION PACIFIC RAILROAD
 Steam and Diesel Operating Costs and Diesel Savings
 Salt Lake City - Los Angeles
 Local Freight, Branch Line, Mixed Train Operation

District	Steam Class	Diesel	Annual Locomotive Miles		Unit Operating Costs Per Locomotive Mile		Annual Operating Costs		Annual Diesel Savings	
			Steam	Diesel	Steam	Diesel	Steam	Diesel		
LOS ANGELES DIVISION										
Third Subdivision										
St. Thomas Branch . . .	6000	1500 HP BL	9,117	9,117	\$1.1658	\$0.5392	\$10,628.60	\$ 4,915.89	\$ 5,712.71	
Las Vegas-Moapa Local	5000-5500	3000 HP F3	28,369	28,369	1.7791	0.7857	50,471.28	22,289.52	28,181.76	
Caliente-Las Vegas Supply Local	2200-2700	3000 HP F3	6,056	6,056	1.3556	0.7857	8,209.51	4,758.20	3,451.31	
Second Subdivision										
Boulder City Branch . .	6000	2000 HP Tr	16,044	16,044	1.1658	0.6623	18,704.10	10,625.94	8,078.16	
Las Vegas-Sloan Local	6000	3000 HP F3	11,139	11,139	1.1658	0.7857	12,985.85	8,751.91	4,233.94	
Las Vegas-Yerm Supply Local	2200-2700	3000 HP F3	5,511	5,511	1.3556	0.7857	7,470.71	4,329.99	3,140.72	
Yermo-Kelso Local . .	5090	3000 HP F3	9,321	9,321	2.0513	0.7857	19,120.16	7,323.51	11,796.65	
First Subdivision										
San Pedro Branch . . .	6000	1000 HP Sw	43,675	43,675	1.1638	0.4836	50,828.97	21,121.23	29,707.74	
Pasadena and Glendale Branches	6000	1000 HP Sw	12,011	12,011	1.1638	0.4836	13,978.40	5,808.52	8,169.89	
Anaheim Branch . . .	6000	1000 HP Sw	13,199	13,199	1.1638	0.4836	15,361.00	6,383.04	8,977.96	
San Bernardino-Leon Local	5000-5500	4500 HP F3	27,151	27,151	1.7728	1.0011	48,133.29	27,180.87	20,952.92	
Yermo-Barstow Local .	5000-5500	4500 HP F3	6,910	6,910	1.7728	1.0011	12,250.04	6,917.60	5,332.44	
San Bernardino-Riverside Local	2200-2700	2000 HP Tr	8,437	8,437	1.3500	0.6613	11,389.95	5,579.39	5,810.56	
Los Angeles-San Bernardino (FPU) Local	5000-5500	3000 HP F3	41,119	41,119	1.7728	0.7847	72,895.76	32,266.61	40,629.15	
TOTAL			592,517	592,517			\$884,625.69	\$463,907.76	\$420,717.85	

TABLE 18
UNION PACIFIC RAILROAD
Steam and Diesel Operating Costs and Diesel Savings
Salt Lake City - Los Angeles
Yard and Branch Lines Included in Yard Service

Yard	Consolidation	Heavy MacArthur	Switch	Proposed Diesel		Annual *Operating Costs		Annual Diesel Savings
				1000 HP	2000 HP	Steam Operation	Proposed Diesel	
Salt Lake City								
Annual Engine Hours . . .	5,903	2,504	18,783	27,190	....		
Operating Cost \$	52,336	\$24,125	\$162,728	\$103,985	....	\$ 239,189	\$103,985	\$135,204
Lynndyl								
Annual Engine Hours . . .	8,607	105	....	8,712	....		
Operating Cost \$	57,891	\$ 787	....	\$ 31,963	....	\$ 58,678	\$ 31,963	\$ 26,715
Provo								
Annual Engine Hours . . .	....	2,761	3,222	5,983	....		
Operating Cost . . . .	....	\$25,165	\$ 26,317	\$ 23,181	....	\$ 51,482	\$ 23,181	\$ 28,301
Milford								
Annual Engine Hours . . .	6,587	....	....	6,587	....		
Operating Cost \$	45,885	....	....	\$ 24,315	....	\$ 45,885	\$ 24,315	\$ 21,570
Caliente								
Annual Engine Hours . . .	103	8,456	....	8,559	....		
Operating Cost \$	843	\$75,720	....	\$ 32,778	....	\$ 76,563	\$ 32,778	\$ 43,785
Las Vegas								
Annual Engine Hours . . .	18,970	466	....	16,000	3,436			
Operating Cost \$	\$153,392	\$ 4,126	....	\$ 61,459	\$14,122	\$ 157,518	\$ 75,581	\$ 81,937
Yermo								
Annual Engine Hours . . .	11,391	....	....	11,391	....		
Operating Cost \$	\$ 83,564	....	....	\$ 43,083	....	\$ 83,564	\$ 43,083	\$ 40,481
Crestmore								
Annual Engine Hours . . .	4,013	....	....	4,013	....		
Operating Cost \$	\$ 27,634	....	....	\$ 14,890	....	\$ 27,634	\$ 14,890	\$ 12,744
Los Angeles								
Annual Engine Hours . . .	12,520	6,250	21,862	40,632	....		
Operating Cost \$	\$130,784	\$ 70,091	\$223,946	\$164,332	....	\$ 424,821	\$164,332	\$260,489
TOTAL						\$1,165,334	\$514,108	\$651,226

*1946 Costs Applied.

westbound from Victorville to Summit will be eliminated. An overall reduction of approximately 64 per cent in freight helper locomotive miles is estimated through application of Diesel principal and helper locomotives.

As indicated in Table 16, this reduction in locomotive miles, coupled with the lower Diesel operating cost per locomotive mile indicates an estimated annual saving of \$813,606.

Local Freight, Branch Line, and Mixed Train Operation

No attempt has been made to estimate any reduction in locomotive miles which might be possible under a Dieselization program since the frequency of these operations does not permit reduction of trains through assignment of power with greater hauling capacity.

Table 17, on pages 56 and 57, shows the steam and Diesel costs and estimated annual Diesel savings for each of the local, and branch line operations between Salt Lake City and Los Angeles.

The lesser Diesel unit operating costs applied to the steam locomotive mileage in this service indicates an estimated annual saving of \$420,717.85.

Yard Switching Operation

It is estimated that switching assignments on the lines under study are being performed by steam locomotives at the rate of 132,503 hours annually over and above the stock switching assignment at Las Vegas which was covered under through freight primary savings. Although application of Diesel switching locomotives with their inherent greater flexibility and availability usually will eliminate overtime, no attempt has been made to estimate the savings possible through the elimination of overtime pay nor through a possible lesser number of switching hours with Diesel operation. The proposed Diesel operation is based upon 132,503 switching hours annually.

The annual switching hours to be worked by each type of steam locomotive, and by Diesel locomotives at each terminal, together with applicable costs and savings, are listed in Table 18. This tabulation indicates that the annual primary savings to be realized through completion of the Dieselization of the yards under study is \$651,226.

• Total Primary Savings

The estimated annual primary savings that can be derived from completion of the Dieselization of various services as compared with steam operations follow:

Through Freight Operation	\$2,593,459
Through Freight Helper Operation	813,606
Local Freight, Branch Line and Mixed Train Operation	420,718
Yard Switching Operation	651,226
	<hr/>
	\$4,479,009

• *Secondary Savings*

Diesel locomotives do not require the extensive supporting facilities ordinarily required by steam locomotives, and it will therefore be possible to eliminate the majority of these facilities, thus reducing the annual maintenance and depreciation charges thereon.

Based on the estimated Diesel facilities required, the following estimated secondary savings will be possible through the elimination of certain steam facilities based on the charges estimated by the railroad to apply annually.

<i>I.C.C. Account Number</i>	<i>Title</i>	<i>Actual</i>	<i>Estimated Diesel</i>	<i>Savings</i>
231	Water Stations	\$ 43,900	.....	\$ 43,900
233	Fuel Stations	20,900	\$ 7,000	13,900
235	Shops and Enginehouses	75,100	37,000	38,100
302	Shop Machinery	175,000	43,750	131,250
	TOTAL	\$314,900	\$87,750	\$227,150

• *Depreciation, Steam and Diesel Locomotives*

The estimated ledger value and annual depreciation charge for the steam motive power now owned, and the estimated ledger value and depreciation charge for the required number of Diesel locomotives to completely Dieselize the railroad, as outlined in Section IV, follows:

<i>Service</i>	<i>STEAM LOCOMOTIVES</i>		<i>DIESEL LOCOMOTIVES</i>		
	<i>Ledger Value</i>	<i>Annual Deprec. Charge</i>	<i>Estimated Cost</i>	<i>Annual Deprec. Charge</i>	<i>Increased Annual Deprec. Charge</i>
Freight	\$10,575,250	\$413,492	\$20,607,547	\$1,318,883	\$905,391
Switching	1,185,865	41,268	2,416,500	119,617	78,349
TOTAL	\$11,761,115	\$454,760	\$23,024,047	\$1,438,500	\$983,740

Depreciation rates of 3.48 per cent and 3.91 per cent were used in the calculation of the annual depreciation charges for steam locomotives whereas rates of 4.95 per cent and 6.40 per cent were used, respectively, for Diesel switching and road locomotives in accordance with information furnished by the railroad. The net increase in estimated annual locomotive depreciation is \$983,740.

Roadway Facilities and Shop Machinery

Due to the extensive retirement of water and coaling stations, shops and enginehouses and shop machinery, a reduction in annual depreciation charges on these facilities will occur. Based upon the retirement of facilities having a ledger value of \$2,186,300 and an annual depreciation rate of 2.10 per cent, the decrease in annual depreciation charges amounts to \$45,912.

• *Summary*

It is recognized that there are other items not included within the scope of this report, such as necessary adjustment of material inventories, insurance, and taxes, which will require determination and appraisal by the Railroad.

Without giving consideration to the possible effect of the items mentioned in the foregoing paragraph, the estimated annual savings due to complete Dieselization are as follows:

Primary Saving	\$4,479,009
Secondary Saving	227,150
	<hr/>
	\$4,706,159
Less-Depreciation Increase	937,828
	<hr/>
Total Estimated Annual Saving	\$3,768,331

This annual saving of \$3,768,331 represents a return on the \$22,965,517 net cash outlay of 16.4 per cent.

PART TWO

Complete Dieselization

Freight and Yard Service

Salt Lake City-Los Angeles

Excluding Salt Lake City Yard, The Provo

Subdivision and Certain Branch Lines

INTRODUCTION

The study contained in this Part Two of the report was made to determine the economic results of special considerations desired by the railroad.

The special considerations included are:

Elimination of the Salt Lake City Yard, the Provo Subdivision and certain branch line operations.

Reassignment of the heavier steam power released from the Salt Lake City-Los Angeles assignment and the economic advantages to be derived therefrom.

Addition of estimated railroad engineering, inspection, messenger service, setting up and breaking in charges, freight charges and contingencies to the General Motors price at La Grange, Illinois.

Lesser Diesel locomotive maintenance costs which should apply through the fifth year of operation.

This supplemental study follows the same general pattern as that contained in Part One. The section covering the period selected for study has been eliminated since the same basic operating data, based upon the period October 1 through 10, 1942, applies.

GENERAL SUMMARY

Dieselization of main line through, helper and local freight, yard and certain branch line services between Salt Lake City and Los Angeles will accomplish faster train schedules and reduce operating and maintenance costs as follows:

1. Westbound fast freight schedules are reduced 13 per cent. Westbound stock train schedules are reduced 20 per cent.
2. Eastbound fast freight schedules are reduced 22 per cent. Eastbound fruit train schedules are reduced 6 per cent.
3. The number of westbound trains required between Salt Lake City and Caliente is reduced 20 per cent. The number of westbound trains required between Caliente and Los Angeles is reduced 16.3 per cent. Tonnage of westbound stock trains can be increased 6.1 per cent with reduction of 18.9 per cent in road time. Tonnage of other westbound trains can be increased 32.7 per cent with a reduction of 10.3 per cent in road time.
4. The number of eastbound trains required between Los Angeles and Caliente will be reduced by 14.6 per cent and between Caliente and Salt Lake City by 31.9 per cent. Tonnage of eastbound fruit trains can be increased 20.1 per cent with a reduction in road time of 7.7 per cent. Tonnage of other eastbound trains can be increased by 31 per cent with a reduction in road time of 12.3 per cent.
5. The required number of Diesel locomotives is:

<i>Number of Locomotives</i>	<i>Type</i>	<i>Number of Power Units</i>
23	6000 HP F-3 freight locomotives	92
2	4500 HP F-3 freight locomotives	6
13	3000 HP F-3 freight locomotives	26
1	2000 HP transfer locomotive	2
20	1000 HP switching locomotives	20
<hr/> 59	TOTAL	<hr/> 146

6. The investment required to Dieselize the lines between Salt Lake City and Los Angeles including:
 - (a) Mainline through freight service
 - (b) Helper service
 - (c) Main line local freight service
 - (d) Yard service west of Salt Lake City
 - (e) Branch Lines included in this Part Two
 amounts to \$20,239,575 for Diesel motive power, plus \$546,690 for facilities, or a total of \$20,786,265 expenditure.
7. After deduction of the return from scrapping surplus steam locomotives, the net cash outlay is estimated to be \$20,238,635.

8. Annual primary savings of \$4,309,628 will be realized during the first five years through this cash outlay.
9. Annual secondary savings of \$972,932 will be realized from reduction of operating costs on other division through reassignment of displaced steam power.
10. After giving effect to added depreciation charges and decreased facility maintenance costs resulting from this investment, net savings of \$4,521,770 per year for the first five years, or a return of 22.34 per cent will be realized on the net cash outlay.
11. During the first five years annual primary savings of \$2,785,970 will be realized on an investment of \$13,371,832 in 23 — 6000 H.P. main line freight locomotives or 20.83 per cent return on investment before depreciation.
12. In helper service, annual primary savings, during the first five years, of \$822,812 are realized on an investment of \$2,446,456 in 8 — 3000 H.P. helper locomotives or 33.63 per cent return on investment before depreciation.
13. In local freight service, annual primary savings, during the first five years, of \$142,082 are realized on an investment of \$2,599,427 in 8 locomotives or 5.47 per cent return on investment before depreciation.
14. In yard service, annual primary savings during the first five years, of \$558,764 are realized on an investment of \$1,821,860 in 20 — 1000 H.P. locomotives or 30.67 per cent return on investment before depreciation.
15. To repeat, Dieselization of main line freight, yard and selected branch lines between Salt Lake City and Los Angeles will produce net savings of \$4,521,770 per year or a return of 22.34 per cent on the net cash outlay, or recovery of full investment through savings, in approximately five years.
16. The investment proposed for facilities to maintain and service Diesel freight and switching power will be sufficient to provide adequate facilities for maintaining and servicing presently operated Diesel passenger and switching power as well as the additional Diesel passenger power required to complete the Dieselization program.
17. The section of the railroad under consideration in this study will be placed in a very favorable competitive position on both freight and passenger schedules and through these improved schedules, additional traffic will inevitably result to still further add to the economies and earnings derived from complete Dieselization with General Motors locomotives.

SECTION I

Operating Characteristics

The lines included in this Part Two of the study are comprised of the main line between Salt Lake City and Los Angeles, excluding the Provo Subdivision and selected branch lines which the railroad considers undesirable to Dieselize now. In addition thereto, consideration is given to steam operation on the Idaho, Nebraska, Kansas and Colorado Divisions employing larger locomotives displaced through Dieselization of freight operations between Salt Lake City and Los Angeles.

• *Through Freight Operation*

All through freight service between Salt Lake City and Los Angeles is included in this Part Two as was done in Part One.

• *Freight Helper Operation*

Since no Diesel helper service is required on the Provo Subdivision or for services herein excluded from consideration, the helper service included in Part One is applicable also to this part of the study.

• *Local Freight, Branch Line and Mixed Train Operation*

Local and mixed train operation over the Provo Subdivision and the weekly supply local trains between Division points are omitted from consideration as well as operations over the Boulder City, St. Thomas, Iron Mountain, Cedar City, Pioche and Prince, Fillmore and Tintic Branches.

• *Yard Switching Operation*

All yard switching operations between Salt Lake City and Los Angeles are included in the operations under consideration in this Part Two, except at Salt Lake City Yard, Tintic and Provo.

TABLE 19
UNION PACIFIC RAILROAD
Steam Locomotives Released and Subsequent Disposition
Through Dieselization
Main Line Freight, Yard and Selected Branch Operation
Salt Lake City-Los Angeles

<i>Assignment from Which Released</i>	<i>No. of Locos.</i>	<i>Class of Locomotives</i>	<i>Replaced by By</i>	<i>Disposition</i>
Salt Lake City to Los Angeles	11	0-6-0 Switcher	Diesel	Scrap
	27	Consolidation	(23 by Diesel 4 by Hvy MacA)	Scrap
	3	Lt MacArthur	Diesel	Scrap
	10	Hvy MacArthur	Diesel	Scrap
	9	Hvy Pacific	Diesel	Scrap
	30	2-10-2	Diesel	Reassigned Kansas and Nebraska Divisions
	10	4-10-2	Diesel	Reassigned S.L.C.- Pocatello
	8	2-8-8-0 Mallet	Diesel	Reassigned Pocatello- Butte
	40	4-6-6-4 Challenger	Diesel	Reassigned Pocatello- Reith-Spokane
	<hr/> TOTAL			
	148			
Salt Lake City- Pocatello-Reith- Spokane	42	2-8-8-0 Mallet	Challenger	{ 8-NWD helpers 6-Rock Springs coal runs 28-Scrap
	11	4-12-2	Challenger	Reassigned Cheyenne, No. Platte-Council Bluffs-Kansas City
	12	2-10-2	Challenger	Reassigned Kansas and Colorado Divisions
	16	Hvy MacArthur	4-10-2	Scrap
	<hr/> TOTAL			
	81			
Cheyenne-North Platte-Council Bluffs-Kansas City	13	2-10-2	4-12-2	Reassigned Kansas and Colorado Divisions
	<hr/> TOTAL			
	13			
Nebraska-Kansas and Colorado Divisions	65	Hvy MacArthur	2-10-2	Scrap
	<hr/> TOTAL			
	65			

SECTION II

Steam Motive Power

The Union Pacific Railroad compiled the steam motive power complement which would be required in addition to the Diesel locomotives presently owned to perform the freight operations covered in this Part Two. This complement is composed of 148 steam locomotives of various types. In addition thereto, the railroad made further study to determine the economic reassignment of the steam motive power replaced by Diesel locomotives.

A listing of the steam locomotives to be released from assignment Salt Lake City-Los Angeles and subsequent disposition of these and lighter steam locomotives on other Divisions is contained in Table 19.

Of the 148 steam locomotives released from assignment Salt Lake City-Los Angeles, sixty of the lighter locomotives are designated for scrap or sale, thirty 2-10-2 locomotives will be reassigned to the Kansas and Nebraska Divisions, ten 4-10-2 locomotives will be reassigned to Salt Lake City-Pocatello service, eight 2-8-8-0 locomotives will be reassigned to Pocatello-Butte service and forty 4-6-6-4 locomotives will be reassigned to Pocatello-Reith-Spokane service.

The forty 4-6-6-4 and eight 2-8-8-0 locomotives reassigned to Pocatello-Reith-Spokane and Pocatello-Butte services, respectively, will release sixty-five steam locomotives, consisting of forty-two 2-8-8-0 locomotives of which eight will be assigned to the Northwestern District helper service, six will be assigned to Rock Springs coal runs and twenty-eight rendered surplus for scrap or sale; eleven 4-12-2 locomotives to be reassigned to Cheyenne-North Platte-Council Bluffs-Kansas City service and twelve 2-10-2 locomotives to be reassigned to the Kansas and Colorado Divisions.

The ten 4-10-2 locomotives reassigned to Salt Lake City-Pocatello service will release 16 MacArthur locomotives for scrapping or sale.

The eleven 4-12-2 locomotives reassigned to the Cheyenne-North Platte-Council Bluffs-Kansas City pool will release thirteen 2-10-2 locomotives for reassignment to the Kansas and Colorado Divisions.

The fifty-five 2-10-2 locomotives reassigned to the Nebraska, Kansas and Colorado Divisions will release sixty-five Heavy MacArthur locomotives for scrapping or sale.

• *Summary*

Dieselization of the lines under consideration in this Part Two will release 148 steam locomotives from the Salt Lake City-Los Angeles assignment. This replacement and subsequent successive reassignments of steam power will render 169 steam locomotives surplus, consisting of 11 switchers, 27 Consolidations, 94 MacArthurs, 9 Pacifics and 28 Mallets for scrapping or sale.

TABLE 20
UNION PACIFIC RAILROAD
Diesel Motive Power Required
Main Line Freight, Yard and Selected Branch Operation
Salt Lake City-Los Angeles

<i>Assignment</i>	<i>No. of Units</i>	<i>H.P. Per Unit</i>	<i>No. of Locos.</i>	<i>H.P. Per Loco.</i>	<i>Type of Loco.</i>
THROUGH FREIGHT OPERATIONS					
Principal through freight locomotives:					
Salt Lake City-Los Angeles	92	1500	23	6000	ABBA, F-3
Freight helper locomotives:					
San Bernardino-Summit-Victorville	6	1500	3	3000	AA, F-3
Kelso-Cima	6	1500	3	3000	AA, F-3
Caliente-Crestline	4	1500	2	3000	AA, F-3
TOTAL	16		8		
TOTAL THROUGH FREIGHT AND HELPER	108		31		
MAINLINE FREIGHT LOCALS					
Salt Lake City-Stockton	2	1500	1	3000	AA, F-3
Las Vegas-Moapa	2	1500	1	3000	AA, F-3
Las Vegas-Sloan	2	1500	1	3000	AA, F-3
Yermo-Kelso	2	1500	1	3000	AA, F-3
Yermo-Barstow	3	1500	1	4500	ABA, F-3
San Bernardino-Leon	3	1500	1	4500	ABA, F-3
Los Angeles-San Bernardino	2	1500	1	3000	AA, F-3
San Bernardino-Riverside	2	1000	1	2000	Transfer (2 switchers with single cab)
TOTAL	18		8		
TERMINAL SWITCHING AND BRANCH OPERATIONS INCLUDED IN YARD ASSIGNMENTS					
Lynndyl	1	1000	1	1000	Switcher
Milford	1	1000	1	1000	Switcher
Caliente	2	1000	2	1000	Switcher
Las Vegas	3	1000	3	1000	Switcher
Yermo	2	1000	2	1000	Switcher
Los Angeles	7	1000	7	1000	Switcher
Crestmore Branch	1	1000	1	1000	Switcher
Anaheim Branch	1	1000	1	1000	Switcher
San Pedro Branch	2	1000	2	1000	Switcher
TOTAL	20		20		
GRAND TOTAL	146		59		

SECTION III

Required Diesel Motive Power

General Motors Diesel locomotives proposed for Dieselization of the Union Pacific Railroad main line freight and yard service between Salt Lake City and Los Angeles are 6000 H.P. locomotives in through freight service; 3000 H.P. locomotives in freight helper service; 2000 H.P., 3000 H.P. and 4500 H.P. locomotives in main line local freight service and 1000 H.P. locomotives in yard switching service and in branch line service included in yard assignments.

This motive power complement will provide excellent flexibility. This is particularly true due to the fact that all the F-3 units assigned to freight helper and local services are to be so equipped that they are completely interchangeable with the F-3 units assigned as principal through freight locomotives. This complement is listed in Table 20.

• *Through Freight Train and Helper Operations*

The through freight train and freight helper operations are unaffected as compared with the complete Dieselization study by the deletion from consideration of the operations eliminated in this Part Two.

The same advantages will be gained in service and train miles that were outlined in the foregoing Part One of this report. The same number of locomotives will be required, namely, twenty-three 6000 H.P. principal through freight locomotives consisting of ninety-two 1500 H.P. F-3 units and eight 3000 H.P. helper locomotives consisting of sixteen 1500 H.P. F-3 units or a total of thirty-one locomotives consisting of 108 F-3 1500 H.P. units in through and helper freight service.

• *Main Line Freight Local Service*

One locomotive is required for each local assignment. These local assignments are Salt Lake City-Stockton, Las Vegas-Moapa, Las Vegas-Sloan, Yermo-Kelso, Yermo-Barstow, San Bernardino-Leon, Los Angeles-San Bernardino and San Bernardino-Riverside. The two locomotives assigned to the Yermo-Barstow and San Bernardino locals are 4500 H.P. locomotives consisting of three 1500 H.P. F-3 units each. The locomotive assigned to the San Bernardino-Riverside local is a 2000 H.P. transfer locomotive consisting of two 1000 H.P. switchers with a single cab. The locomotives assigned to other local service are 3000 H.P. locomotives consisting of two 1500 H.P. F-3 units each.

A total of eight locomotives consisting of sixteen 1500 H.P. F-3 units and two 1000 H.P. switcher units are required for the main line freight local service listed.

• *Terminal Switching and Branch Operations Included in Yard Assignments*

The exclusion of Salt Lake City Yard and the Provo Subdivision from consideration leaves yard switching operations at Lynndyl, Milford, Caliente, Las Vegas, Yermo and

Los Angeles. The Crestmore, Anaheim and San Pedro Branch operations are added to the Los Angeles Yard requirements.

All locomotives provided for this service are 1000 H.P. General Motors switching locomotives. Of the twenty provided, one each is required for the Lynndyl and Milford terminals and Crestmore and Anaheim Branches; two each are required for the Caliente and Yermo terminals and the San Pedro Branch; three are required for the Las Vegas Terminal and seven are required for the Los Angeles Terminal including the one trick assignment, six months per year, at the Los Angeles Union Passenger Terminal.

• *Summary*

The locomotives tabulated below are required to provide sufficient motive power under this plan of Dieselization of the Union Pacific Railroad main line freight and yard service between Salt Lake City and Los Angeles,

	<i>Number of Locomotives</i>	<i>Type</i>	<i>Number of Power Units</i>
	23	6000 HP freight	92
	2	4500 HP freight	6
	13	3000 HP freight	26
	1	2000 HP transfer	2
	20	1000 HP switcher	20
Total	59		146

in addition to the twenty-eight Diesel switching locomotives now assigned to this territory.

SECTION IV

Diesel Facilities

General Motors has developed basic plans for Diesel locomotive shops and maintenance facilities and procedures so that Diesel locomotives can be inspected and maintained in the minimum time with maximum efficiency in every detail of the work, thus insuring the maximum operating efficiency of each unit in service. General Motors Diesel locomotives can operate 2,000 to 3,000 miles between maintenance periods, when progressively maintained. With this program, maintenance operations are performed in successive steps to keep the locomotives in first class condition. As outlined in Section Three, Diesel locomotives have been cycled to insure adequate maintenance time when the locomotive has accumulated 2,000 miles. Experience has proved that locomotives maintained in this manner accumulate high availability records with low operating costs.

With fewer locomotives in operation on the railroad, requiring less frequent maintenance than the present steam locomotives, it follows that the investment in supporting facilities can be greatly reduced.

Los Angeles is now the principal western maintenance point for all through passenger power. Los Angeles will also be the principal maintenance point for all freight power. It is possible to remodel the Machine and Erecting Shop at Los Angeles for maintenance of Diesel locomotives. All heavy repairs required on Diesel locomotives assigned between Los Angeles and Salt Lake City can be accomplished at Los Angeles Shops.

• *Shop Buildings*

Detailed drawings have been prepared for the Los Angeles Shop with inspection pits between the rails, depressed floors between adjacent tracks and a continuous platform at locomotive floor level, in the main shop area. The floor level platforms will permit servicing both sides of locomotives and the pits between the rails and depressed floor between tracks will permit inspection and maintenance operations on the underneath portions simultaneously. Facilities are so arranged that once the locomotive is spotted within the shop the normal maintenance can be performed without moving it. For convenience, cleaning and parts reconditioning rooms and storeroom for parts are laid out at the locomotive floor level, minimizing the man hours required to maintain the locomotives. Space is provided adjacent to the platform area for the repair of engines, generators, traction motors and trucks at Los Angeles. Also drop tables capable of handling complete trucks are provided at this point.

• *Fuel Oil Facilities*

Storage for 100,000 gallons of Diesel Fuel Oil should be provided at Salt Lake City, Caliente, Las Vegas, and Los Angeles, 40,000 gallons at San Bernardino and 20,000 gallons at Kelso and Yermo; all other points should have 10,000 gallon storage capacity.

TABLE 21
UNION PACIFIC RAILROAD
Estimated Cost of New Facilities

<i>Location</i>	<i>Shop Buildings</i>	<i>Fuel Oil Facilities</i>	<i>Lubricating Oil Facilities</i>	<i>Water Treating Facilities</i>	<i>Shop Tools and Machinery</i>	<i>Sanding Facilities</i>	<i>Total</i>
Salt Lake City	\$ 7,235	\$ 6,267	\$ 550	\$ 4,973	\$ 5,700	\$ 24,725
Lynndyl	2,700	43	.....	195	.....	2,938
Milford	5,057	43	.....	195	.....	5,295
Caliente	7,235	43	.....	195	.....	7,473
Las Vegas	7,235	43	.....	1,102	.....	8,380
Kelso	3,557	43	.....	195	.....	3,795
Yermo	3,557	43	.....	195	.....	3,795
San Bernardino	3,557	43	.....	502	.....	4,102
Crestmore	2,700	43	.....	195	.....	2,938
Los Angeles	\$450,000	7,235	11,349	2,525	6,440	5,700	483,249
TOTAL	\$450,000	\$ 50,068	\$ 17,960	\$ 3,075	\$ 14,187	\$ 11,400	\$546,690

The storage capacities listed above will afford approximately a 15-day supply in all cases, except where a 15-day supply is less than 10,000 gallons. For economical reasons, 10,000 gallon storage capacity has been used as a minimum, thereby enabling all points to be served with tank car loads of fuel oil.

• *Lubricating Oil Facilities*

Lubricating oil facilities, consisting of three 10,000 gallon storage tanks, should be provided at Los Angeles and Salt Lake City; Las Vegas should be provided with 10,000 gallon storage capacity for new oil. Lubricating oil can be handled in drums at all other points.

Oil reclaiming facilities should be installed at Los Angeles; all oil drainings to be shipped to Los Angeles.

• *Water Treating Facilities*

It is recommended that distilled water or its equivalent, properly inhibited to prevent metal corrosion, be used in all engine colling systems of the Diesel locomotives. Plants for the production of the type of water are required at Salt Lake City and Los Angeles. Treated water can be handled in drums at all other points.

Water treating facilities recommended herein are predicated on the normal expected requirements for locomotives involved and considering the types of water usually available.

• *Cleaning Facilities*

Sufficient cleaning facilities, consisting of washing tanks, drying ovens and rinsing booths for the cleaning of air filters, engine and other parts, should be provided at all points where this work will be done. Cleaning facilities will not be provided at Lynndyl, Caliente, Kelso and Las Vegas. Necessary cleaning of parts for these points can be done at the nearest maintenance terminal as shown under the details of each point.

• *Shop Machinery and Tools*

The shop machinery located in the Machine Shop at Los Angeles can be retained for the maintenance of Diesel locomotives and additional special tools and equipment acquired. No heavy machinery need be retained at the remaining points as they will be supplied with new or reconditioned parts from designated terminals.

• *Sanding Facilities*

Two 5-ton capacity sand towers should be provided at Salt Lake City and Los Angeles for the sanding of all road and switcher locomotives operating out of these terminals. The recommended equipment will permit the sanding of four boxes simultaneously.

TABLE 22
UNION PACIFIC RAILROAD
Estimated Ledger Value
Present Steam Facilities to be Retired

<i>Location</i>	<i>Shop Buildings and Enginehouse</i>	<i>Shop Machinery</i>	<i>Fuel Station and Related Equipment</i>	<i>Water Stations</i>	<i>Sanding Facilities</i>	<i>Total</i>
Lynndyl	\$ 75,000	.....	.....	.....	.....	\$ 75,000
Milford	45,500	.....	.....	.....	.....	45,500
Caliente	100,000	\$ 60,000	\$ 26,150	\$ 95,680	.....	281,830
• Las Vegas	70,100	50,000	45,500	61,000	.....	226,600
• Kelso	29,500	7,500	17,300	200,000	.....	254,300
Yermo	50,000	11,100	37,200	33,900	.....	132,200
San Bernardino . . . . .	.....	5,400	23,400	10,200	.....	39,000
Los Angeles	647,000	24,900	38,200	49,600	\$ 10,200	769,900
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
TOTAL	\$1,017,100	\$ 158,900	\$ 187,750	\$ 450,380	\$ 10,200	\$1,824,330

Present sanding facilities are to be retained at Milford, Caliente, Las Vegas, Kelso, Yermo and San Bernardino. Due to the small quantities of sand used by Diesel locomotives, sanding at all remaining terminals can readily be performed by hand.

• *Spare Parts*

Recommendations as to parts required will be supplied to the railroad approximately three months before the delivery of any locomotive or group of locomotives purchased.

In connection with facilities for storage of materials for maintenance and protection of these locomotives, it should be noted that space has been provided at each maintenance point for suitable storeroom.

It is recommended that equipment for these storerooms be based on latest designs as to type of bins, location of parts to conserve space, provide better protection for material, and decrease store labor cost.

A Parts and Stores Representative is prepared to go into detail on these facility recommendations upon request at any time, and outline the type of stock control system most successful for Diesel operation.

• *Investment in New Facilities*

The costs of new facilities recommended at each point are shown in Table 21 on page 74. These are estimates only and many of the items recommended therein can be built by the railroad from salvaged material at greatly reduced costs.

• *Retirement of Existing Facilities*

Upon conversion to Diesel locomotive operation and, after the recommended facilities for their service and maintenance have been provided, the present extensive steam locomotive supporting facilities listed in Table 22, can be retired completely or in part.

• *Summary*

The maintenance and servicing facilities recommended with an estimated total cost of \$546,690 will enable economical maintenance, insure high locomotive availability and permit the retirement of steam facilities having a ledger value of \$1,824,330.

TABLE 23
UNION PACIFIC RAILROAD
Cost of New Diesel Motive Power
Main Line Freight, Yard and Selected Branch Operation
Salt Lake City - Los Angeles

<i>Number of Locomotives</i>	<i>Type of Locomotives</i>	<i>No. of Units</i>	<i>Arrangement</i>	<i>Estimated Cost Per Locomotive</i>	<i>Sub-Total</i>	<i>Grand Total</i>
THROUGH FREIGHT OPERATIONS						
Principal Through Freight Locomotives:						
23	6000 HP G.M. F-3	92	ABBA	\$581,384	\$13,371,832	
Freight Helper Locomotives:						
8	3000 HP G.M. F-3	16	AA	305,807	2,446,456	
31	TOTAL THROUGH FREIGHT AND HELPER	108				\$15,818,288
MAIN LINE FREIGHT LOCALS						
2	4500 HP G.M. F-3	6	ABA	443,594	887,188	
5	3000 HP G.M. F-3	10	AA	305,807	1,529,035	
1	2000 HP G.M. Transfer	2		183,204	183,204	
8	TOTAL	18				\$ 2,599,427
39	Total Other Than Yard Assignment	126				\$18,417,715
TERMINAL SWITCHING AND BRANCH OPERATIONS INCLUDED IN YARD ASSIGNMENTS						
20	1000 HP G.M. Switcher	20		91,093		1,821,860
59	GRAND TOTAL	146				\$20,239,575

SECTION V

Investment

The investment necessary to completely Dieselize a railroad, or section thereof, can be divided into two major parts, that necessary to provide motive power and that necessary to provide facilities for proper service and maintenance. This investment is lessened somewhat through salvage of motive power and facilities replaced.

• *New Diesel Locomotives*

The investment in new Diesel locomotives required to Dieselize the main line freight service and yard switching assignments, including certain branch line operations, is listed in Table 23.

The prices applied in Table 23 are composed of General Motors base price plus approved extras at the manufacturing plant. Additionally, at the railroad's request, additives have been included for railroad engineering, inspection, messenger service, setting up and breaking-in, freight and contingencies consistent with estimates furnished by the railroad.

As indicated in Table 23, the investment in new Diesel locomotives for through freight operation is \$13,371,832; for freight helper operation is \$2,446,456; for local freight operation is \$2,599,427; and for switching service \$1,821,860. The total investment in new Diesel locomotives is \$20,239,575.

• *New Facilities*

The estimated investment in new or rearranged facilities for the proper maintenance of Diesel locomotives is listed in Table 21 in the foregoing Section IV, "Diesel Facilities". Based upon the use of present facilities to the greatest extent possible and available estimates of construction costs, this investment aggregates \$546,690.

• *Disposal of Surplus Equipment and Roadway Facilities*

The steam locomotives and roadway facilities rendered surplus through Dieselization may be disposed of through transfer to other lines, scrapping or sale. Since sale is dependent upon market conditions at the time of disposal, only transfer and salvage are used in this report as a conservative estimate of the return possible through disposal of surplus equipment and roadway facilities.

STEAM LOCOMOTIVES

As indicated in Section II of this Part Two, the release of 148 steam locomotives from the Salt Lake City-Los Angeles assignment will render surplus for scrapping

TABLE 24
UNION PACIFIC RAILROAD
Estimated Net Return from Scrapping Displaced Steam Locomotives
Main Line Freight, Yard and Selected Branch Operation
Salt Lake City - Los Angeles

<i>Number of Locomotives To Be Scrapped</i>	<i>Locomotive Class</i>	<i>Average Light Weight (Lbs.)</i>	<i>*Estimated Market Value Each</i>	<i>Net Return From Scrap</i>
11	Switcher	177,000	\$1,750	\$ 19,250
27	Consolidation	242,000	2,380	64,260
3	Lt. MacArthur	300,000	2,950	8,850
91	Heavy MacArthur	321,000	3,150	286,650
9	Heavy Pacific	324,000	3,180	28,620
28	Mallet	510,000	5,000	140,000
169	TOTAL			\$547,630

*Market value calculated @ \$22 per ton with dismantling cost absorbed.

TABLE 25
UNION PACIFIC RAILROAD
Net Additional Investment and Net Cash Outlay
Main Line Freight, Yard and Selected Branch Operation
Salt Lake City-Los Angeles

TOTAL ESTIMATED EXPENDITURE

Estimated Cost of New Diesel Power

Principal Through Freight Locomotives	\$13,371,832	
Freight Helper Locomotives	2,446,456	
Total Through Freight and Helper		\$15,818,288
Main Line Freight Local Locomotives		2,599,427
Yard Switching and Branch Line Locomotives Included in Yard Assignments		1,821,860

TOTAL		\$20,239,575
Estimated Cost of New Roadway Facilities		546,690
TOTAL ESTIMATED EXPENDITURE		\$20,786,265

NET ADDITIONAL INVESTMENT

TOTAL ESTIMATED EXPENDITURE		\$20,786,265
Less Estimated Ledger Value Surplus Steam Power	\$ 7,782,700	
Less Estimated Ledger Value Surplus Roadway Facilities	1,824,330	9,607,030
NET ADDITIONAL INVESTMENT		\$11,179,235

NET CASH OUTLAY

TOTAL ESTIMATED EXPENDITURE	\$20,786,265	
Less Estimated Net Return from Scrapping Surplus Steam Locomotives	547,630	
NET CASH OUTLAY		\$20,238,635

169 steam locomotives of the lighter classes, after subsequent reassignments of steam locomotives to other Divisions has been accomplished.

Estimated net return from scrapping the 169 surplus steam locomotives is \$547,630, based upon values furnished by the railroad as outlined in Table 24, on page 80.

The railroad has stated that in the event that disposition of these locomotives may be made by sale, the return would approximate three times the above stated value of scrap metals.

ROADWAY FACILITIES

The steam Roadway Facilities to be rendered surplus are listed in Table 22 in foregoing Section IV with an estimated ledger value of \$1,824,330. Some of these facilities, such as the boiler washout plant and modified steaming system at Los Angeles, having an estimated ledger value of \$153,900, could be utilized elsewhere on the system. However, no salvage value will be considered in this report since the net value after dismantling cannot be readily determined.

• *Net Additional Investment and Net Cash Outlay*

Computation of the net additional investment and net cash outlay is summarized in Table 25 on the preceding page. The total estimated expenditure for new Diesel power and roadway facilities is \$20,786,265. After deducting the estimated ledger values of the steam locomotives and roadway facilities rendered surplus, the Net Additional Investment is \$11,179,235. Deduction of the net return from salvage from the total estimated expenditure results in an estimated Net Cash Outlay of \$20,238,635.

The railroad states it is quite probable, upon proper presentation, that the Bureau of Internal Revenue will allow the retirement loss resulting from abandonment of roadway facilities as an income tax deduction due to sudden obsolescence of the property abandoned. In this case, it is estimated that a cash saving of approximately \$500,000 could be accomplished through income tax deduction during the calendar year in which the facilities are abandoned, thereby effectually reducing the initial cash outlay.

• *Summary*

The net cash outlay required to Dieselize the main line freight, yard and selected branch lines, and to provide facilities capable of serving these operations, is \$20,238,635.

SECTION VI

Unit Operating Costs

Although the motive power requirements have been predicated on the volume of business handled during the year 1942, cost data used herein is based on present day labor and material costs.

Steam locomotive and Diesel switching locomotive operating and maintenance costs for the various classes of service are based upon costs reported by the railroad. Operating and maintenance costs of Diesel locomotives in other than yard switching service are based upon those considered equitable. These detailed unit operating costs are shown on Tables 26 through 28 on the following pages.

• *Repairs*

Repair costs for each class of steam locomotive and for Diesel locomotives in switching service were furnished by the railroad. Repair costs for road Diesel locomotives are based upon general experience. At the request of the railroad, they have been reduced to reflect the estimated lower cumulative repair cost through the fifth year of operation at wage rates in effect during 1946.

• *Enginemen and Trainmen*

Wages for enginemen and trainmen were furnished by the railroad. In through freight operation, the cost per locomotive mile for trainmen has been adjusted to cover an additional brakeman between Yermo and Las Vegas when operating with trains of over seventy-one cars under the plan of Diesel operation.

• *Fuel*

An average price per gallon of \$0.035806 was used by the railroad in computing steam locomotive fuel oil costs. Prices of \$0.05879 and \$0.05311 per gallon of Diesel fuel oil were used by the railroad in computing Diesel switching locomotive fuel costs at Los Angeles and Salt Lake City, respectively, as these figures represented the approximate cost in July, 1946. A price of \$0.06500 per gallon was used in approximating Diesel fuel oil costs in other services.

• *Water*

The water expense per steam locomotive mile was furnished by the railroad based on system wide averages for each class of locomotive.

• *Lubricants*

The cost of lubricants was obtained from costs furnished by the railroad.

TABLE 26
UNION PACIFIC RAILROAD
Unit Operating Costs per Locomotive Mile
Main Line Freight Operation — Salt Lake City - Los Angeles
Steam - Diesel

Account	S T E A M						D I E S E L					
	Through Freight						Helper				Through Freight	Helper
	*2700 Class	3500 Class	3800 Class	5000- 5500 Class	5090 Class	**9000 Class	2700 Class	3500 Class	5000- 5500 Class	5090 Class	6000 H.P.	3000 H.P.
Repairs . . .	\$.4018	\$.6446	\$.5106	\$.5946	\$.5345	\$.5154	\$.4018	\$.6446	\$.5946	\$.5445	\$.3500	\$.2040
Fuel . . . . .	.4800	.7700	.7900	.6500	.9800	.7195	.4400	.7700	.6500	.9800	.3900	.3000
Water . . . . .	.0206	.0387	.0363	.0303	.0315	.0339	.0206	.0266	.0242	.0242	.0000	.0000
Lubricants . . .	.0127	.0256	.0252	.0157	.0207	.0210	.0127	.0256	.0157	.0207	.0664	.0350
Other Supplies .	.0300	.0500	.0500	.0400	.0400	.0450	.0300	.0500	.0400	.0400	.0040	.0039
Enginehouse Expense	.1970	.1560	.1560	.1210	.1210	.1385	.1970	.1970	.1970	.1970	.0500	.0350
Enginemen												
Valley . . .	.2108	.2313	.2338	.2140	.2182	.2211	.....	.....	.....	.....	.2594	.....
Mountain . .	.....	.2345	.2370	.2203	.2246	.....	.2163	.2345	.2203	.2246	.2604	.2387
Trainmen . . .	.2712	.2712	.2712	.2712	.2712	.2712	.....	.....	.....	.....	.2868	.....
Total—Valley . .	\$1.6241	\$2.1874	\$2.0731	\$1.9368	\$2.2171	\$1.9656	.....	.....	.....	.....	\$1.4066	.....
—Mountain . .	.....	\$2.1906	\$2.0763	\$1.9431	\$2.2235	.....	\$1.3184	\$1.9483	\$1.7418	\$2.0310	\$1.4076	\$.8166
Ave. S.L.C.-L.A.	.....	\$2.1895	\$2.0752	\$1.9409	\$2.2213	.....	.....	.....	.....	.....	\$1.4073	.....

*On Nebraska, Kansas and Colorado Divisions.

**On Idaho Division.

TABLE 27
UNION PACIFIC RAILROAD
Unit Operating Costs per Locomotive Mile
Local Freight — Branch Line Operation
Salt Lake City - Los Angeles

Accounts	STEAM				DIESEL			
	2100 Class	2700 Class	5000-5500 Class	6000 Class	1000 H.P. Switcher	2000 H.P. Transfer	3000 H.P. F-3	4500 H.P. F-3
Repairs	\$.2580	\$.4018	\$.5946	\$.2797	\$.0833	\$.1500	\$.1800	\$.2700
Fuel . . . . .	.3900	.4400	.6500	.3600	.1138	.1950	.2600	.3250
Water . . . . .	.0266	.0266	.0303	.0242	.0000	.0000	.0000	.0000
Lubricants . . . . .	.0078	.0127	.0157	.0069	.0083	.0249	.0332	.0496
• Other Supplies . . . . .	.0300	.0300	.0400	.0275	.0035	.0037	.0038	.0039
• Enginehouse Expense . . . . .	.2190	.2190	.2190	.2500	.0120	.0200	.0300	.0400
Wages								
Valley Rates								
Engineer . . . . .	.1205	.1205	.1220	.1188	.1205	.1298	.1298	.1373
Fireman . . . . .	.0994	.0994	.1012	.0967	.0995	.1079	.1079	.1143
TOTAL . . . . .	.2199	.2199	.2232	.2155	.2200	.2377	.2377	.2516
Mountain Rates								
Engineer . . . . .	.1230	.1230	.1245	.1198	.1215	.1308	.1308	.1383
Fireman . . . . .	.1025	.1025	.1050	.0977	.0995	.1079	.1079	.1143
TOTAL . . . . .	.2255	.2255	.2295	.2175	.2210	.2387	.2387	.2526
Total Valley	\$1.1513	\$1.3500	\$1.7728	\$1.1638	\$.4409	\$.6313	\$.7447	\$.9401
Total Mountain	\$1.1569	\$1.3556	\$1.7791	\$1.1658	\$.4419	\$.6323	\$.7457	\$.9411

TABLE 28
UNION PACIFIC RAILROAD
Unit Operating Costs per Engine Hour
Yard and Branch Lines Included in Yard Assignments
Salt Lake City - Los Angeles

<i>Location</i>	<i>Type Locomotive</i>	<i>Repairs</i>	<i>Fuel</i>	<i>Water</i>	<i>Lubricants</i>	<i>Other Supplies</i>	<i>Engine-house</i>	<i>Engine-men</i>	<i>Total Per Hour</i>
Lynndyl	Consolidation	\$1.6782	\$1.6500	\$0.2178	\$0.0500	\$0.0300	\$0.6000	\$2.5000	\$6.7260
	Heavy MacArthur	2.4108	1.6500	0.2178	0.0500	0.0300	0.6000	2.5360	7.4946
	1000 HP Diesel	0.5000	0.2700	.....	0.0500	0.0300	0.0345	2.5290	3.4135
Milford	Consolidation	1.6782	1.5000	0.2178	0.0500	0.0300	0.9900	2.5000	6.9660
	1000 HP Diesel	0.5000	0.2700	.....	0.0500	0.0300	0.0569	2.5290	3.4359
Caliente	Consolidation	1.6782	2.4000	0.2178	0.0500	0.0300	1.3100	2.5000	8.1860
	Heavy MacArthur	2.4108	2.4000	0.2178	0.0500	0.0300	1.3100	2.5360	8.9546
	1000 HP Diesel	0.5000	0.3900	.....	0.0500	0.0300	0.0753	2.5290	3.5743
Las Vegas	Consolidation	1.6782	2.1000	0.2178	0.0500	0.0300	1.5100	2.5000	8.0860
	Heavy MacArthur	2.4108	2.1000	0.2178	0.0500	0.0300	1.5100	2.5360	8.8546
	1000 HP Diesel	0.5000	0.3900	.....	0.0500	0.0300	0.0868	2.5290	3.5858
	2000 HP Diesel	0.9000	0.4500	.....	0.0600	0.0400	0.1000	2.5600	4.1100
Yermo	Consolidation	1.6782	1.8900	0.2178	0.0500	0.0300	0.9700	2.5000	7.3360
	1000 HP Diesel	0.5000	0.3600	.....	0.0500	0.0300	0.0578	2.5290	3.5268
Los Angeles	Consolidation	1.6782	1.9700	0.2178	0.0500	0.0300	4.0000	2.5000	10.4460
	Heavy MacArthur	2.4108	1.9700	0.2178	0.0500	0.0300	4.0000	2.5360	11.2146
	Switch	1.5000	1.9700	0.1936	0.0500	0.0300	4.0000	2.5000	10.2436
	1000 HP Diesel	0.5000	0.3900	.....	0.0900	0.0500	0.2300	2.5290	3.7890

- *Enginehouse Expense*

Enginehouse expense covering steam locomotives and Diesel switching locomotives was furnished by the railroad. Enginehouse expense covering Diesel locomotives in other services has been estimated, based on average costs incurred by other railroads.

- *Summary*

Steam locomotive and Diesel switching locomotive unit operating costs used in this report are based on current information furnished by the railroad. Diesel freight, branch line freight and helper locomotive costs are based on average operating costs incurred by locomotives operating on other railroads under similar conditions.

SECTION VII

Diesel Operating Economies

The economies possible through complete Dieselization of a railroad, or part thereof, can be divided into two major categories, those realized from decreased locomotive operating costs and locomotive miles operated identified as Primary savings; and those to be derived from decreased required maintenance of supporting facilities, identified as Secondary savings. In addition to these savings, consideration must be given to the increase in depreciation charges due to the increased investment and rates of depreciation for Diesel locomotives as compared with steam locomotives.

• *Primary Savings*

Primary savings are based on the differences in cost of operating Diesel locomotives per mile as compared with steam locomotives; and, in addition, such savings as may be possible through elimination of locomotive miles run.

The tabulation following shows the estimated annual locomotive miles by type of service, and switching for the present steam power and for the proposed Diesel operation.

			<i>Steam Locomotive Miles</i>	<i>Proposed Diesel Locomotive Miles</i>	<i>Per Cent Diesel Saving</i>
THROUGH FREIGHT TRAIN OPERATION					
Principal Locomotive Miles	.	.	2,938,178	2,406,391	18.1
THROUGH FREIGHT HELPER LOCOMOTIVE OPERATION					
Victorville	- Summit	WB	88,968	5,475	93.85
Modena	- Crestline	WB	24,287	.....	100.00
San Bernardino	- Summit	EB	117,150	71,661	38.83
Kelso	- Cima	EB	112,571	58,782	47.78
Carp	- Caliente	EB	99,890	.....	100.00
Caliente	- Crestline	EB	121,870	64,225	47.30
TOTAL			564,736	200,143	64.56
LOCAL FREIGHT TRAIN OPERATION					
Principal Locomotive Miles	.	.	164,257	164,257	0.00
YARD SWITCHING LOCOMOTIVE HOURS AND BRANCH LINE MILES					
Switching Locomotive Hours	.	.	95,317	95,317	0.00
Branch Line Locomotive Miles	.	.	80,952	80,952	0.00

• *Through Freight Train Operation*

The recommended Diesel principal freight locomotives have a greater hauling capacity at higher speeds than the steam locomotives now in service; therefore, with Diesel opera-

TABLE 29
UNION PACIFIC RAILROAD
Steam and Diesel Operating Costs and Diesel Savings
Salt Lake City - Los Angeles

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	<i>Locomotive Class</i>	<i>Annual Locomotive Miles</i>	<i>* Total Unit Operating Costs Per Locomotive Mile</i>	<i>Annual Operating Costs</i>		<i>Annual Diesel Savings</i>
				<i>Steam</i>	<i>Diesel</i>	
MAINLINE THROUGH FREIGHT OPERATION EXCLUDING HELPER SERVICE						
Steam	3800	2,544,168	\$2.0752	\$5,279,657	.....	.....
	5000-5500	189,219	1.9409	367,255	.....	.....
	5090	168,358	2.2213	373,974	.....	.....
	3500	36,433	2.1895	79,770	.....	.....
TOTAL		2,938,178		\$6,100,656		
Diesel	6000 HP	2,406,391	\$1.4073	.....	\$3,386,514	\$2,714,142
MAINLINE FREIGHT HELPER OPERATION						
Steam	2700	31,629	\$1.3184	\$ 41,700	.....	.....
	5000-5500	458,448	1.7418	798,525	.....	.....
	5090	6,842	2.0310	13,896	.....	.....
	3500	67,817	1.9483	132,128	.....	.....
TOTAL		564,736		\$ 986,249		
Diesel	3000 HP	200,143	\$.8166	.....	\$ 163,437	\$ 822,812

*Diesel costs applicable through first five years of operation.

TABLE 30
UNION PACIFIC RAILROAD
Steam and Diesel Operating Costs and Diesel Savings
Salt Lake City-Los Angeles
MAIN LINE LOCAL FREIGHT SERVICE

<i>District</i>	<i>Type of Loco.</i>	<i>Loco. Class</i>	<i>Annual Loco. Miles</i>	<i>*Unit Operating Costs Per Loco. Mile</i>	<i>Annual Operating Cost</i>	<i>Annual Diesel Savings</i>
UTAH DIVISION						
Salt Lake City-Stockton . . .	Steam	2200-2700	31,811	\$1.3500	\$ 42,945	.....
	Diesel	3000 HP, F-3	31,811	0.7447	23,690	\$ 19,255
LOS ANGELES DIVISION						
Las Vegas-Moapa . . .	Steam	5000-5500	28,369	1.7791	50,471	.....
	Diesel	3000 HP, F-3	28,369	0.7457	21,160	29,311
Las Vegas-Sloan . . .	Steam	6000	11,139	1.1658	12,986	.....
	Diesel	3000 HP, F-3	11,139	0.7457	8,306	4,680
Yermo-Kelso . . .	Steam	5090	9,321	2.0513	19,120	.....
	Diesel	3000 HP, F-3	9,321	0.7457	6,951	12,169
Yermo-Barstow . . .	Steam	5000-5500	6,910	1.7728	12,250	.....
	Diesel	4500 HP, F-3	6,910	0.9401	6,503	5,747
San Bernardino-Leon . . .	Steam	5000-5500	27,151	1.7728	48,133	.....
	Diesel	4500 HP, F-3	27,151	0.9401	25,552	22,581
San Bernardino-Riverside . . .	Steam	2200-2700	8,437	1.3500	11,390	.....
	Diesel	2000 HP Tfr.	8,437	0.6313	5,326	6,064
Los Angeles-San Bernardino	Steam	5000-5500	41,119	1.7728	72,896	.....
	Diesel	3000 HP, F-3	41,119	0.7447	30,621	42,275
TOTAL . . .	Steam		164,257		\$270,191	.....
	Diesel		164,257		\$128,109	\$142,082

*Diesel costs applicable through first five years of operation.

tion, fewer trains will be required to haul the same tonnage with a consequent reduction in principal locomotive miles as indicated above. This greater hauling capacity and reduction in the number of trains operated will also reduce the necessary helper locomotive service from that required in steam operation.

Steam operation during the base period, October 1-10, 1942, was used as the basis for estimating the annual locomotive miles which would be required operating with present steam power and with Diesel power. The railroad estimated the present steam locomotive mileage required to perform the same work as was accomplished during the base period and during the year 1942. This same ratio was applied to the Diesel locomotive miles required during the base period to arrive at an estimated annual Diesel locomotive mileage. It is to be noted from the foregoing tabulation that, with the proposed Diesel operation, annual freight principal locomotive miles can be reduced 18.1 per cent from the present steam operation.

As indicated in Table 29 on page 89, this reduction in annual locomotive miles, coupled with the lower Diesel operating cost per locomotive mile predicates an estimated annual saving of \$2,714,142 through Dieselization of main line through freight operation, excluding helper service.

The application of 6000 H.P. Diesel locomotives to stock trains will eliminate the necessity for feeding, watering, and resting stock at Las Vegas; therefore, the Las Vegas switching requirements will be reduced by one twenty-four hour assignment, seven days per week. Based upon 8,760 switching hours at a cost of \$13.48 per hour, this contingent primary saving is estimated at \$118,070 annually.

The reduction of locomotive miles included in the Diesel plan of operation is affected by reduction and fill of trains at Caliente to a greater extent than with present operation. It is therefore reasonable to assume that yard switching requirements will increase at this terminal. No credit is taken at other terminals for possible savings in yard switching hours or overtime due to fewer trains being handled. However, in the interest of providing a conservative estimate of the savings to be derived, a contingent annual operating loss of \$46,242 is included herein based upon an estimated annual increase at Caliente of 6,300 switching hours at \$7.34 per hour.

The estimated net primary savings to be derived from Dieselization of main line freight operation, excluding helper service, allowing for additional savings at Las Vegas and loss at Caliente is \$2,785,970.

• *Through Freight Helper Operation*

The method described in the foregoing discussion of through freight operation for estimating annual locomotive mileage was applied to freight helper operation. The helper service required with Diesel operation is reduced both by the reduction in number of trains and by the greater capacity of the Diesel principal locomotives.

Helper service westbound from Modena to Crestline and eastbound from Carp to Caliente will be eliminated entirely. Approximately 94 per cent of the helper service

TABLE 31
UNION PACIFIC RAILROAD
Steam and Diesel Operating Costs and Diesel Savings
Salt Lake City-Los Angeles
SELECTED YARD SWITCHING AND BRANCH LINES

<i>Yard</i>	<i>Type of Loco.</i>	<i>Locomotive Class</i>	<i>Annual Switching Hours</i>	<i>*Unit Operating Cost Per Hour</i>	<i>Annual Operating Cost</i>	<i>Annual Diesel Savings</i>
Lynndyl	Steam	Consolidation	8,607	\$ 6.7260	\$ 57,891	.....
	Steam	Hvy MacArthur	105	7.4946	787	.....
	Steam	Total	8,712	.....	58,678	.....
	Diesel	1000 HP Sw.	8,712	3.4135	29,738	\$ 28,940
Milford	Steam	Consolidation	6,587	6.9660	45,885	.....
	Diesel	1000 HP Sw.	6,587	3.4359	22,632	23,253
Caliente	Steam	Consolidation	103	8.1860	843	.....
	Steam	Hvy MacArthur	8,456	8.9546	75,720	.....
	Steam	Total	8,559	.....	76,563	.....
	Diesel	1000 HP Sw.	8,559	3.5743	30,592	45,971
Las Vegas	Steam	Consolidation	18,970	8.0860	153,391	.....
	Steam	Hvy MacArthur	466	8.8546	4,126	.....
	Steam	Total	19,436	.....	157,517	.....
	Diesel	1000 HP Sw.	19,436	3.5858	69,694	87,823
Yermo	Steam	Consolidation	11,391	7.3360	83,564	.....
	Diesel	1000 HP Sw.	11,391	3.5268	40,174	43,390
Los Angeles	Steam	Consolidation	12,520	10.4460	130,784	.....
	Steam	Hvy MacArthur	6,250	11.2146	70,091	.....
	Steam	Switcher	21,862	10.2436	223,946	.....
	Steam	Total	40,632	.....	424,821	.....
	Diesel	1000 HP Sw.	40,632	3.7890	153,955	270,866
TOTAL	Steam	.....	95,317	.....	847,028	.....
	Diesel	.....	95,317	.....	346,785	500,243

BRANCH LINES INCLUDED IN YARD ASSIGNMENTS

			<i>Annual Loco. Miles</i>	<i>Unit Operating Cost Per Loco. Mile</i>		
Crestmore Branch .	Steam	6000	24,078	\$ 1.1638	\$ 28,022	.....
	Diesel	1000 HP Sw.	24,078	0.4409	10,616	\$ 17,406
San Pedro Branch .	Steam	6000	43,675	1.1638	50,829	.....
	Diesel	1000 HP Sw.	43,675	0.4409	19,256	31,573
Anaheim Branch .	Steam	6000	13,199	1.1638	15,361	.....
	Diesel	1000 HP Sw.	13,199	0.4409	5,819	9,542
TOTAL	Steam		80,952		\$ 94,212	.....
	Diesel		80,952		35,691	\$ 58,521
GRAND TOTAL .	Steam				\$941,240	.....
	Diesel				382,476	\$558,764

*Diesel costs applicable through first five years of operation.

westbound from Victorville to Summit will be eliminated. An overall reduction of approximately 64 per cent in freight helper locomotive miles is estimated through application of Diesel principal and helper locomotives.

As outlined in Table 29, this reduction in locomotive miles, coupled with the lower Diesel operating cost per locomotive mile, indicates an estimated annual saving of \$822,812.

• *Main Line Local Freight Operation*

No attempt has been made to estimate any reduction in locomotive miles which might be possible under a Dieselization program since the frequency of these operations does not permit reduction of trains through assignment of power with greater hauling capacity.

Table 30, on page 90, shows the steam and Diesel costs and estimated annual Diesel savings for each of the main line local operations between Salt Lake City and Los Angeles.

The lesser Diesel unit operating costs applied to the steam locomotive mileage in this service indicates an estimated annual saving of \$142,082.

• *Yard Switching and Branch Lines Included in Yard Operations*

It is estimated that switching assignments on the lines under study are being performed by steam locomotives at the rate of 95,317 hours annually, over and above the stock switching assignment at Las Vegas which was covered under through freight primary savings. Operations over the Crestmore, San Pedro and Anaheim Branches are estimated at 80,952 locomotive miles annually. Although application of Diesel switching locomotives with their greater flexibility and availability usually will eliminate overtime, no attempt has been made to estimate the savings possible through the elimination of overtime pay nor through a possible lesser number of switching hours with Diesel operation. The proposed Diesel operation is based upon 95,317 switching hours and 80,952 locomotive miles in branch service annually.

The annual switching hours to be worked by each type of steam locomotive and by Diesel locomotives at each Terminal and annual locomotive miles on each Branch included, together with applicable costs and savings are listed on Table 31. This tabulation indicates that the annual primary savings to be realized through completion of the Dieselization of this service is \$558,764.

• *Total Annual Primary Savings*

The estimated annual primary savings that can be derived from completion of the Dieselization of various services as compared with steam operations follow:

Through Freight Operation	\$2,785,970
Through Freight Helper Operation	822,812
Main Line Local Freight Operation	142,082
Yard and Branch Operation	558,764
	<hr/>
Total Annual Primary Savings	\$4,309,628

TABLE 32
UNION PACIFIC RAILROAD
Annual Operating Savings from Reassignment
of Steam Locomotives

	<i>Locomotive Class</i>	<i>Annual Locomotive Miles</i>	<i>Unit Operating Costs Per Loco. Mile</i>	<i>Annual Operating Costs</i>	<i>Annual Savings</i>
POCATELLO — REITH — SPOKANE					
Present	Mallet	1,776,675	\$2.1874	\$3,886,299	.....
	Two-Ten-Two	733,620	1.9368	1,420,875	.....
	Four-Twelve- Two	752,851	1.9656	1,479,804	.....
	TOTAL	3,263,146		\$6,786,978	
Proposed	Challenger	2,936,832	2.0731	6,088,346	\$698,632
NEBRASKA — KANSAS — COLORADO DIVISIONS					
Present	Hvy MacA	3,674,000	1.6241	\$5,966,943	.....
Proposed	Two-Ten-Two	2,939,200	1.9368	5,692,643	274,300
TOTAL					\$972,932

• *Secondary Savings*

The second savings included in this report consist of those derived from operating savings through replacement of small steam power with larger steam power on other Divisions and from possible reductions in annual maintenance charges for steam roadway facilities.

• *Reassignment of Steam Locomotives*

The operating savings to be derived from reassignment of steam power, as contained in this report, are based upon the replacement of steam locomotives in Pocatello-Reith-Spokane assignment by the newer Challenger (4-6-6-4) locomotives and of Heavy MacArthur locomotives assigned to the Nebraska, Kansas and Colorado Divisions by two-ten-two locomotives.

As indicated in Table 32, the assignment of Challenger steam locomotives to the Pocatello-Reith-Spokane operation will reduce the annual locomotive miles by ten per cent and the unit operating costs per locomotive mile with a resultant annual saving of \$698,632. The replacement of Heavy MacArthurs by two-ten-two's on the Nebraska, Kansas and Colorado Divisions will reduce annual locomotive miles by twenty per cent, although increasing the unit operating cost per mile, with a resultant annual saving of \$274,300. The total annual saving to be derived from reassignment of steam power is estimated at \$972,900.

• *Reduction of Roadway Facility Maintenance Charges*

Based on the Diesel facilities required, the following secondary savings will be possible through the elimination of certain steam facilities in accordance with the charges estimated by the railroad to apply annually:

<i>I.C.C. Account Number</i>	<i>Title</i>	<i>Actual</i>	<i>Estimated Diesel</i>	<i>Savings</i>
231	Water Stations	\$ 43,900	.....	\$ 43,900
233	Fuel Stations	20,900	\$ 7,000	13,900
235	Shops and Enginehouses .	75,100	37,000	38,100
302	Shop Machinery	175,000	43,750	131,250
TOTAL		\$314,900	\$87,750	\$227,150

• *Depreciation, Steam and Diesel Locomotives*

The estimated ledger value and annual depreciation charge for the steam motive power to be scrapped and the estimated ledger value and depreciation charge for the required

number of Diesel locomotives to Dieselize the included services, as outlined in Section III follow:

Service	STEAM LOCOS. SCRAPPED		DIESEL LOCOS.		
	Estimated Ledger Value	Annual Deprec. Charge	Estimated Ledger Value	Annual Deprec. Charge	Annual Deprec. Charge
Freight	\$6,904,830	\$210,430	\$18,417,715	\$1,178,734	\$ 968,304
Switching	877,870	32,235	1,821,860	90,182	57,947
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
TOTAL	\$7,782,700	\$242,665	\$20,239,575	\$1,268,916	\$1,026,251

Depreciation rates of 3.48 per cent and 3.91 per cent were used in the calculation of annual depreciation charges for steam locomotives whereas rates of 4.95 per cent and 6.40 per cent were used, respectively, for Diesel switching and road locomotives, as furnished by the railroad. The net increase in estimated annual locomotive depreciation is \$1,026,251.

• *Depreciation, Roadway Facilities and Shop Machinery*

Due to the extensive retirement of water and coaling stations, shops and enginehouses and shop machinery, a reduction in annual depreciation charges on these facilities will occur. Based upon the retirement of facilities having a ledger value of \$1,824,330 and an annual depreciation rate of 2.10 per cent, the decrease in annual depreciation charges amounts to \$38,311.

• *Summary*

It is recognized that there are other items not included within the scope of this report, such as necessary adjustment of material inventories, insurance, and taxes, which will require determination and appraisal by the railroad.

Without giving consideration to the possible effect of the items mentioned in the foregoing paragraph, the estimated annual savings to be derived from Dieselization of the main line through freight, freight helper, yard and certain branch line operations are as follows:

Primary Saving	\$4,309,628
Secondary Saving	1,200,082
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Estimated Annual Saving	\$5,509,710
Less — Depreciation Increase	987,940
	<hr/>
Estimated Net Annual Savings	\$4,521,770

Primary savings of \$2,785,970 in through freight service represents return on the \$13,371,832 cash outlay for Diesel freight power of 20.83 per cent.

Primary savings of \$822,812 in freight helper service represents return on the \$2,446,456 cash outlay for Diesel helper power of 33.63 per cent.

Primary savings of \$142,082 in local freight service represents return on the \$2,599,427 cash outlay for Diesel local freight power of 5.47 per cent.

Primary savings of \$558,764 in switching service represents return on the \$1,821,860 cash outlay for Diesel switching power of 30.67 per cent.

Estimated net annual savings of \$5,509,710 before depreciation represents a return on the \$20,238,635 net cash outlay for Diesel equipment and facilities of 27.22 per cent.

Estimated net annual savings of \$4,521,770 after depreciation represents a return on the \$20,238,635 net cash outlay for Diesel equipment and facilities of 22.34 per cent.