

Electrification of Railways

REPORT OF A COMMITTEE
APPOINTED BY
THE RAILWAY EXECUTIVE AND
THE LONDON TRANSPORT EXECUTIVE

LONDON
BRITISH TRANSPORT COMMISSION

1951

CONTENTS

CHAPTER 1 INTRODUCTION

Paragraphs	Pages
1 to 18	1-3

CHAPTER II SUMMARY OF THE RECOMMENDATIONS OF THE PRINGLE COMMITTEE

Type of Current	19	5
Permissible Voltage	19	5
Standard Voltage of Motors	19	5
Generation and Frequency	19	5
Method of Collection	19	5
Method of Contact	19	5
Interrunning	19	6
Standardisation of Third Rail and Overhead Equipment	19	6
Prevention of Electrolysis and of Inductive Interference	19	6

CHAPTER III PARTICULARS OF BRITISH RAILWAYS SYSTEM

Mileage Statistics (Table 1)	21	7
Rolling Stock Statistics (Table 2)	21	7
Train Mile, Wagon Mile and Ton-mile Statistics (Table 3)	22	8
Traffic Density (Table 4 and Map A)	23	8-9
Existing Systems of Electrification with Statistics (Table 5 and Maps B, C, D, E and F)	24	9-11

CHAPTER IV GENERAL JUSTIFICATION FOR RAILWAY ELECTRIFICATION

Basic Factors	26 and 27	13
Stimulation of Traffic	28	13-14
Economic Justification in relation to Fixed Charges ...	29	14
The Criterion of Traffic Density... ..	30 to 32	14-15

CHAPTER IX

FINANCIAL COMPARISONS BETWEEN DIFFERENT SYSTEMS

	Paragraphs	Pages
Economic Effects of raising the System Voltage and Relationship of Traffic Density to System Voltage	99 to 102	41
Brief Characteristics of Four Schemes selected for Preparation of Comparative Estimates on Four Systems of Electrification and the Basis of the Estimates...	103 to 107	42-43
The Comparative Estimates (Table 8)	108	43-46

CHAPTER X

A SINGLE SYSTEM OF ELECTRIFICATION

The Advantages of a Single System of Electrification...	109	47
The Southern Region Third Rail System	110 and 111	47
Other Conductor Rail Installations	112	48
Disadvantages of Third Rail System as a General Standard	113 to 115	48
Recommendation for Overhead Line System at a Single Voltage	116	49

CHAPTER XI

EXISTING THIRD RAIL INSTALLATIONS

Route and Single-track Mileage Third Rail	117	51
Scope for Third Rail System in the Southern Region...	118	51
Consideration of Lines—		
East of Portsmouth	119	51-52
West of Portsmouth (Table 9)	120 to 127	52-54
Recommendation for Southern Region (Map G) ...	128	54
Recommendation for Other Regions' Third Rail Installations	129	54

CHAPTER XII

EXISTING FOURTH RAIL INSTALLATIONS

Route and Single-track Mileage Fourth Rail	130	55
Differences between Third and Fourth Rail Systems ...	131	55
Special Conditions on London Transport	132	55
Consideration of Signalling	133 to 135	56
Rail Bonds, Third and Fourth Rail Systems	136	56
Faults in the Power Circuits	137	56-57
Limitation of Fault Currents	138	57
Voltage Surges	139	57
Resistance Losses	140	57
Leakage of Current from Running Rails	141	57-58
Track Maintenance	142	58
Possibilities of converting Fourth Rail to Third Rail System	143	58
Recommendation on Fourth Rail System	144 and 145	58

CHAPTER XIII
INTERRUNNING

	Paragraphs	Pages
General Question of Interrunning and Implication of the London Plan Working Party's Recommendations and of the Pringle Committee's Recommendations	146 to 148	59
Present Arrangements whereby London Transport trains run over Third Rail System of Southern Region...	149 and 150	59-60
Dual Electrical Equipments for Locomotive and Multiple-unit Motor-coach Operation—		
750- and 1,500-volt Direct Current Systems	151 and 152	60-61
750- and 3,000-volt Direct Current Systems... ..	153 to 158	61-62
1,500- and 3,000-volt Direct Current Systems... ..	159 to 160	62-63
Direct Current and Single-phase Low-frequency Alternating Current Systems	161 to 164	63-64
Direct Current and Single-phase 50-cycle Alternating Current Systems	165 and 166	64
Through-working between Southern and Other Regions	167 and 168	64
Cross-London Freight and Van Traffic (Table 10) ...	169	64-65
Further Consideration of London Plan Working Party's Proposals particularly in relation to Dual-equipment of Track and Rolling Stock	170 to 173	65-66
Recommendation on Number of Dual-equipped Locomotives	174	66

CHAPTER XIV

RECOMMENDATIONS FOR SYSTEMS TO BE ADOPTED

Possibilities of Single-phase 50-cycle System in consideration of Questions of Interrunning, Unbalance on Supply System, Interference with Communication Circuits and Experimental Nature of the System...	176 to 181	67-68
Considerations of Systems in General Use	182	68
Influence of the Comparative Estimates of Cost and Other Factors on the Choice of System	183 to 191	69-70
RECOMMENDATIONS	192	70
Definition of System Voltage	193 and 194	70-71

CHAPTER XV

**RECOMMENDATIONS ON OTHER MATTERS IN
THE PRINGLE COMMITTEE REPORT**

Brief Summary of "Other Matters" in Pringle Committee Report	195	73
Load Gauge	196 and 197	73-74
Standardisation of Conductor Rail and Overhead Equipment (Drawing 1)	198 to 202	74
Electrolytic Corrosion	203 to 208	74-75
Inductive and Radio Interference	209 and 210	76

CHAPTER XVI
ELECTRICAL OPERATION OF FREIGHT SERVICES
AND SHUNTING

<i>Freight Services—</i>	Paragraphs	Pages
Locomotives for Operation on Conductor Rails ...	211	77
Mixed Traffic Locomotives	212 and 213	77
Weight available for Adhesion... ..	214	77-78
Electric Braking	215	78
 <i>Shunting—</i>		
Diesel-electric Locomotives	217	78
Confinement of Electric Locomotives to Electrified Lines	218	78
Disadvantages of Conductor Rails in Yards and Overhead Lines in Areas where Cranes are used ...	219	78
New York Central Diesel-electric Shunting Locomotives with Battery Capacity	220	79
British Railways' Tentative Design for Electric Locomotive with Auxiliary Diesel-engine-driven Generator	221	79
Recommendation	222	79

CHAPTER XVII

SUMMARY OF CONCLUSIONS

Summary of the Main Recommendations upon each of the Terms of Reference	223 to 237	81-83
--	------------	-------

CHAPTER XVIII

ACKNOWLEDGMENTS

	238 to 240	85-86
--	------------	-------

APPENDIX

	Pages
Report on Visit of certain Members of the Committee to Italy and Germany, on Question of Electrolytic Corrosion, Electro-magnetic Induction, the Single-phase, 50-cycle Alternating Current System, Frequency-changing Sub-stations and Other Developments	87-94

MAPS

- A. Traffic Density.
- B. Electrified Lines—Southern—Outer Area.
- C. " " —London Area.
- D. " " —Manchester Area.
- E. " " —Liverpool Area.
- F. " " —Newcastle Area, and Lancashire, Morecambe and Heysham.
- G. Recommended Boundary of Third Rail Electrification—Southern Region.

DRAWING

Standardisation of Overhead Contact Wires and Current Collectors.

LIST OF TABLES IN REPORT

	Pages
Table 1 Mileage Statistics : Railway and London Transport Executives : December 31st, 1949	7
Table 2 Rolling Stock (excluding service vehicles) Railway and London Transport Executives : December 31st, 1949...	7
Table 3 Train Miles, Wagon Miles, and Net Ton-miles (Freight) : Railway Executive Lines : 1948	8
Table 4 Traffic Density : British Railways : 1949	9
Table 5 Electrification on British Railways, in Operation and under Construction	11
Table 6 Approximate Mileage of Railway Electrification in All Countries on Differing Systems and Voltages	19
Table 7 Examples of Spacing of Sub-stations for Direct Current Systems	21
Table 8 Particulars of Comparative Estimates of Typical Schemes on Alternative Electrical Systems	44-45
Table 9 Booked Services in Down Direction over the Four-track Section through Farnborough of Southern Region Main Line	52
Table 10 Cross-London Freight and Van Traffic	65