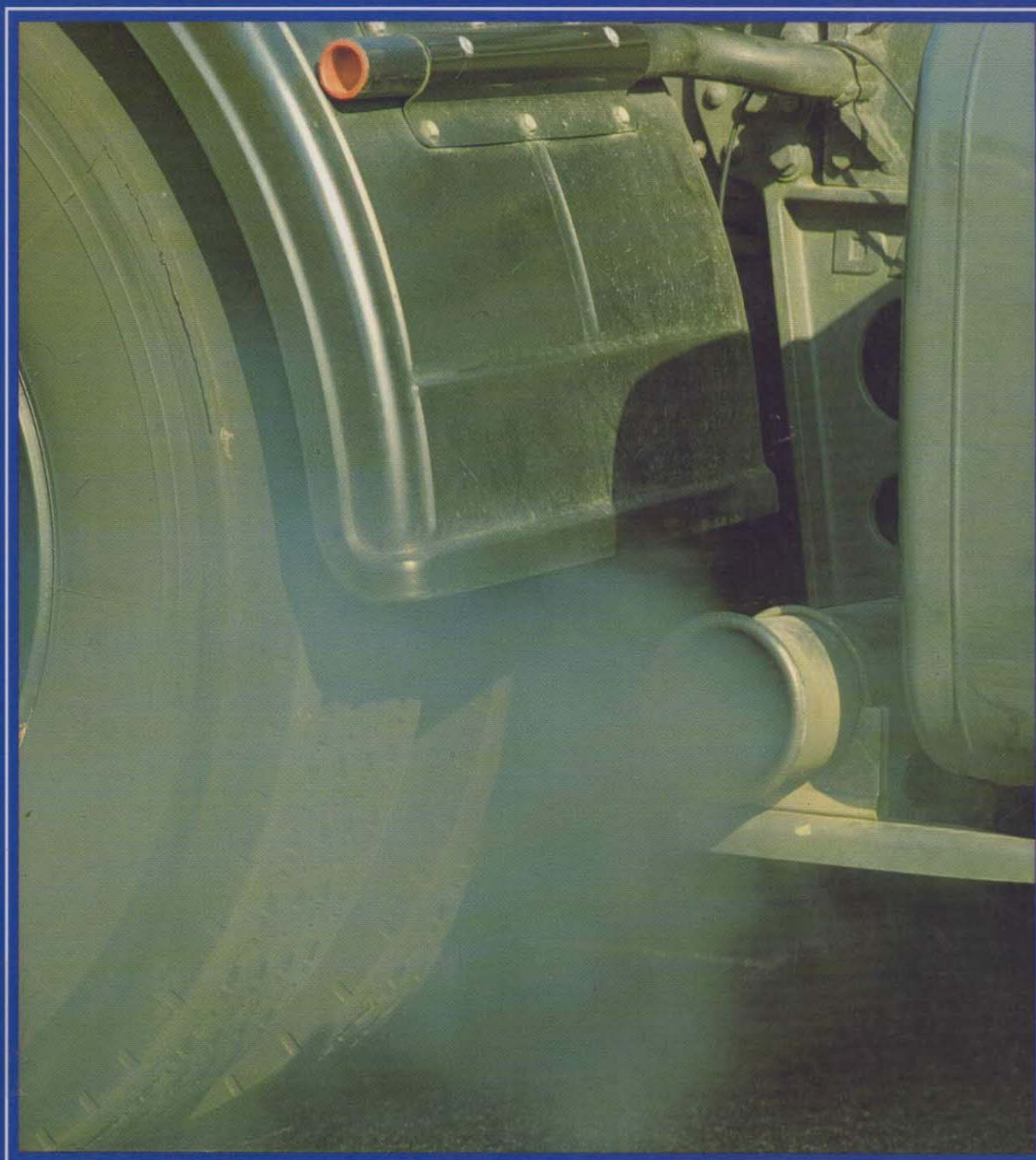




# Air pollution from road vehicles



L H WATKINS

# Contents

---

---

Chapter 1	INTRODUCTION	1
Chapter 2	EXHAUST EMISSIONS AND THEIR MEASUREMENT	5
2.1	The Pollutants	5
2.2	Methods of measurement - in the field	6
2.2.1	The TRRL mobile laboratory	6
2.2.2	Carbon Monoxide	8
2.2.3	Oxides of Nitrogen	10
2.2.4	Sulphur Dioxide	11
2.2.5	Ozone	11
2.2.6	Hydrocarbons	11
2.2.7	Total Suspended Particulates	12
2.2.8	Particulate Lead	12
2.2.9	Polycyclic Aromatic Hydrocarbons	13
2.2.10	Meteorological data	13
2.2.11	Traffic flow data	13
2.2.12	Calibration Facility	14
2.2.13	Data Acquisition	14
2.3	Methods of measurement - laboratory facility	14
2.3.1	Chassis dynamometer	16
2.3.2	Exhaust gas sampling	17
2.3.3	Diesel particulate sampling for light vehicles	21
2.3.4	Heavy duty engine emissions	22
2.3.5	The measurement system	23
2.3.6	Analysis of the sample	24
2.3.7	Emission levels	25
2.3.8	Future developments	26
2.4	Methods of measurement - field/laboratory	27
2.5	Exhaust emission rates	29
2.5.1	Petrol engines	29
2.5.2	Diesel engines	31
2.5.3	Carbon Monoxide	31
2.5.4	Oxides of Nitrogen	32
2.5.5	Hydrocarbons	32
2.5.6	Sulphur Dioxide	33
2.5.7	Particulate matter	33
2.5.8	Particulate lead and manganese	34
2.5.9	Polycyclic-aromatic hydrocarbons (PAH)	38



Chapter 3	EMISSION LEGISLATION	42
3.1	General	42
3.2	United States of America	43
3.2.1	Passenger vehicles	43
3.2.2	Light duty commercial vehicles	44
3.2.3	Heavy duty commercial vehicles	44
3.2.4	Motorcycles	45
3.3	Japan	45
3.3.1	Petrol engines	46
3.3.2	Diesel engines	46
3.4	Europe	47
3.4.1	Gaseous Pollutants	49
3.4.2	Smoke and particulate emissions	53
3.5	Air Quality	55
3.5.1	Air pollution goals	55
3.5.2	USA Standards	56
3.5.3	EEC Standards	57
3.5.4	Some standards from individual countries	62
3.6	Fuel Quality	63
3.6.1	Petrol	63
3.6.2	Diesel	63
Chapter 4	ENVIRONMENTAL EFFECTS	66
4.1	Health effects	66
4.1.1	Carbon Monoxide	66
4.1.2	Oxides of Nitrogen	68
4.1.3	Photochemical Oxidants	68
4.1.4	Lead	72
4.1.5	Polycyclic Hydrocarbons (PAH)	73
4.1.6	Smoke	74
4.2	Subjective Effects	74
4.3	Ecological Effects	77
4.3.1	Roadside Pollution	77
4.3.2	Ozone and PAN (Peroxyacetyl nitrate)	79
4.3.3	Acidity, 'acid rain'	81
4.3.4	The 'Greenhouse' effect	83
Chapter 5	EMISSION CONTROL TECHNOLOGY	87
5.1	Current vehicles (petrol engines)	87
5.1.1	Basic engine modifications (Hickman, 1989)	87
5.1.2	Catalytic converters	91
5.1.3	Relative effectiveness of emission control technologies	92
5.1.4	Evaporative emissions	93
5.1.5	Lead	97

	5.1.6 Fuel consumption	98
	5.1.7 Costs	99
5.2	Current vehicles (diesel engines)	103
	5.2.1 Engine design	103
	5.2.2 Basic engine modifications	104
	5.2.3 Effects of fuel consumption	108
	5.2.4 Particulate traps	110
	5.2.5 Costs	113
5.3	Alternative engines and fuels	117
	5.3.1 'Lean-burn' engines	117
	5.3.2 Rotary (Wankel) engines	119
	5.3.3 Gas turbines	119
	5.3.4 Steam engines	120
	5.3.5 Stirling engines	120
	5.3.6 Alternative fuels	120
Chapter 6	SURVEYS AND FORECASTING	128
6.1	Field surveys of pollution	128
	6.1.1 Lead in the Atmosphere	128
	6.1.2 Other Pollutants	132
6.2	Subjective Response	138
6.3	Estimating air pollution from road traffic data	139
	6.3.1 Computer method (Hickman, 1982)	139
	6.3.2 Presentation and interpretation of computer model results	144
	6.3.3 Graphical method (Waterfield, 1982)	146
6.4	Effects on air pollution of traffic control	148
Chapter 7	SUMMARY AND CONCLUSIONS	151