

Contents

<i>Foreword by Malcolm Tagg, Director General, VBRA</i>	xiii
<i>Preface</i>	xv
<i>Acknowledgements</i>	xix
<i>Glossary</i>	xxiii
<i>Abbreviations and symbols</i>	xxix
1 The history, development and construction of the car body	1
1.1 Development of the motor car body	1
1.2 Creation of a new design from concept to realization	14
1.3 Methods of construction	32
1.4 Basic body construction	37
1.5 Identification of major body pressings	43
1.6 Vehicle type approval	52
<i>Questions</i>	57
2 Health and safety	59
2.1 Personal safety and health practices	59
2.2 Fire precautions	65
2.3 Safety signs in the workshop	70
2.4 General safety precautions in the workshop	72
2.5 Electrical hazards	75
2.6 COSHH	75
2.7 RIDDOR	75
2.8 Maintain the health, safety and security of the work environment	76
<i>Questions</i>	84
3 Hand and power tools	85
3.1 Hand tools used in body repair work	85
3.2 Hammers	85
3.3 Hand Dollies	88
3.4 Body spoons	89
3.5 Body files	90
3.6 Hand snips	91
3.7 Specialist panel beating tools	92
3.8 Recommended basic toolkits for panel beaters	97
3.9 Hand tools used in the fabrication of sheet metal	98
3.10 Hammers and mallets	98
3.11 Sandbags and hardwood blocks	100

viii Contents

3.12	Sheet metal bench stakes	100
3.13	Hand grooving tools	102
3.14	Rivet sets	102
3.15	Cutting tools	102
3.16	Bending and swaging tools	104
3.17	General-purpose assembly and dismantling tools	105
3.18	Power tools used in body repair work	109
3.19	Air power chisel	110
3.20	Metal cutting shears and nibblers	110
3.21	Power saw	113
3.22	Power drills	113
3.23	Sanding machines	114
3.24	Other power tools	117
3.25	Dust extraction for power tools	119
	<i>Questions</i>	121
4	Metals and non-metals used in vehicle bodies	122
4.1	Manufacture of steel coil and sheet for the automobile industry	122
4.2	Specifications of steels used in the automobile industry	123
4.3	Carbon steel	124
4.4	Alloy steels	130
4.5	Stainless steel	132
4.6	Aluminium	133
4.7	Aluminium alloys	134
4.8	Rubber	141
4.9	Sealers	142
4.10	Sound deadening, thermal insulating and undersealing materials	144
4.11	Interior furnishings	146
4.12	Plastics	148
4.13	Plastics repair	153
4.14	Safety glass	156
	<i>Questions</i>	158
5	Metal forming processes and machines	160
5.1	Properties of metals	160
5.2	Heat treatment of metals and metal alloys	163
5.3	How metal is formed to provide strength	167
5.4	Machines for sheet metal fabrication	169
5.5	Shearing theory	169
5.6	Cutting machines	169
5.7	Bending theory	171
5.8	Bending machines	172
5.9	Rolling machines	173
5.10	Wheeling machines	175
5.11	Swaging machines	176
5.12	Brake presses	178
5.13	Forming and drawing	180
5.14	Sheet metal cutting for press work	182
	<i>Questions</i>	182

6 Measuring and marking-out instruments	184
6.1 Marking out	184
6.2 Basic marking-out and measuring instruments	185
6.3 Precision marking-out and measuring instruments	192
<i>Questions</i>	196
7 Methods of joining	197
7.1 Development of joining methods	197
7.2 Solid rivets	197
7.3 Bifurcated, tubular and semitubular rivets	199
7.4 Blind rivets	200
7.5 Structural fasteners	208
7.6 Screws and bolts	211
7.7 Fastening devices	218
7.8 Adhesives	223
<i>Questions</i>	233
8 Soft and hard soldering methods	235
8.1 Comparison of fusion and non-fusion jointing processes	235
8.2 Soft and hard solders	236
8.3 Soft soldering	236
8.4 Hard soldering	240
<i>Questions</i>	247
9 Gas welding, gas cutting and plasma arc cutting	248
9.1 Development of gas welding	248
9.2 Systems of gas welding	249
9.3 Oxy-acetylene welding equipment	250
9.4 Definitions of welding terms	256
9.5 Welding rods and fluxes	257
9.6 Flame control and types of flame	257
9.7 Methods of welding	259
9.8 Edge preparation and types of joint	260
9.9 Welding technique: butt joint in mild steel	263
9.10 Welding various metals	263
9.11 Gas cutting	264
9.12 Gases: characteristics and colour coding	266
9.13 Safety measures	268
9.14 Plasma arc cutting	271
<i>Questions</i>	275
10 Electric resistance welding	277
10.1 Resistance welding in car body manufacture	277
10.2 Resistance spot welding	279
10.3 Resistance projection welding	280
10.4 Resistance seam welding	280
10.5 Resistance flash welding	281
10.6 Resistance butt welding	281
10.7 Resistance welding in body repair work	282

x Contents

10.8	Resistance spot welding of high-strength steels	282
10.9	ARO Spotrite Pulsa resistance welding system	287
10.10	Single-sided spot welding	290
	<i>Questions</i>	293
11	Manual metal arc welding	294
11.1	Principles of manual metal arc welding	294
11.2	Electrical terms used in arc welding	295
11.3	Metal arc welding equipment	295
11.4	Electrodes used in welding: BS coding	298
11.5	Arc welding positions	301
11.6	Essential factors of arc welding	302
11.7	Technique of welding	306
11.8	Safety precautions for the welder	307
	<i>Questions</i>	308
12	Gas shielded arc welding	309
12.1	Development of gas shielded arc welding	309
12.2	Gases used for shielded arc processes	310
12.3	TIG welding	312
12.4	TIG spot welding	314
12.5	Equipment used in TIG welding	315
12.6	TIG welding techniques	318
12.7	Application of TIG welding	319
12.8	MIG/MAG welding	319
12.9	MIG/MAG spot/plug welding	320
12.10	Equipment used in MIG/MAG welding	321
12.11	MIG/MAG welding techniques	327
12.12	Applications of MIG/MAG welding in vehicle body construction	331
12.13	Applications of MIG/MAG welding in body repair work	332
12.14	Welding stress and distortion in the MIG/MAG process	335
12.15	Weld testing and inspection	339
12.16	Equipment maintenance and safety	340
	<i>Questions</i>	341
13	Craft techniques and minor accident damage	342
13.1	Panel beating: forming panels by hand	342
13.2	Shaping metal by hand	342
13.3	General guide to the fabrication of hand-made panels	350
13.4	Edge stiffening of sheet metal	353
13.5	Techniques of damage rectification	356
13.6	Hammering techniques	358
13.7	Filing	362
13.8	Sanding or disc grinding	363
13.9	Hot shrinking	364
13.10	Cold shrinking	366
13.11	Body soldering	367
13.12	Chemically hardening fillers (plastic fillers)	368
13.13	Body jack (hydraulic)	372
13.14	Application of the body jack	375

13.15	Care and maintenance of body jack	379
13.16	Repair of component motor body panels	380
13.17	Aluminium panel repair	390
13.18	Body electrical and electronic systems	398
	<i>Questions</i>	403
14	Major accident damage	405
14.1	Damage classification and assessment	405
14.2	Pulling, alignment and repair systems used on major accident damage	406
14.3	Alignment of the modern integral body	438
14.4	Major repair techniques	449
14.5	Estimating and costing	482
	<i>Questions</i>	499
15	Bodyshop planning	501
15.1	Initial planning	501
15.2	Planning the areas of the workshop	503
15.3	Bodyshop heating	509
15.4	Bodyshop lighting	510
15.5	Essential equipment for the bodyshop	512
15.6	Bodyshops and legal requirements	515
15.7	Quality Management for the bodyshop: BS EN ISO 9001–2000	528
	<i>Questions</i>	530
16	Reinforced composite materials	532
16.1	Development of reinforced composite materials	532
16.2	Basic principles of reinforced composite materials	533
16.3	Manufacture of reinforced composite materials	534
16.4	Types of reinforcing material	536
16.5	Resins used in reinforced composite materials	539
16.6	Moulding techniques for reinforced composite laminates	542
16.7	Designing reinforced composite materials for strength	547
16.8	Body production in reinforced composite plastic (Lotus)	560
16.9	Repair of reinforced composite bodies	562
16.10	Common faults in moulded laminates	567
16.11	Safety precautions	572
	<i>Questions</i>	573
17	Automotive finishing and refinishing	574
17.1	History of automotive finishing	574
17.2	Glossary of terms used in spray painting	576
17.3	Basic composition of paint	577
17.4	Types of paint	577
17.5	Materials used in refinishing	579
17.6	Spray painting equipment	582
17.7	Types of spray gun	584
17.8	Basic parts of a standard spray gun	588
17.9	Spray gun maintenance and cleaning	590
17.10	Spray gun motion study	592
17.11	Spraying defects	595

xii Contents

17.12	Sanding and polishing machines	598
17.13	Preparation of a motor vehicle for repainting	600
17.14	Finishing and refinishing processes	602
17.15	Burnishing, polishing and final detail work	614
17.16	Rust-proofing	616
17.17	Comparison of hot and cold spraying	620
17.18	Movement of vehicle in the paint shop	621
17.19	Common spray painting defects	622
17.20	Colour mixing and matching	624
	<i>Questions</i>	625
	<i>Index</i>	627