GAS INSTALLATION TECHNOLOGY

R. D. Treloar





Contents

Introduction	xi
Acknowledgements	xii
Abbreviations and Acronyms	XV
D 1 TL C. T. L.	
Part 1 The Gas Industry	1
The Gas Industry	2
Nationally Accredited Certification Scheme for Individual Gas Fitting	
Operatives (ACS)	4
Required ACS Assessments and Flowcharts	6
Legislation Affecting the Gas Installer 1	10
Legislation Affecting the Gas Installer 2	12
Industry Documents and British Standards	14
Gas Safety (Installation and Use) Regulations	16
Part 2 Gas Utilisation	19
Gas: Its Origin	20
Characteristics and Properties of Gases	22
Liquefied Petroleum Gas (LPG)	26
The Combustion Process	28
Air Requirements for Combustion	30
Products of Combustion	32
The Gas Flame	34
Flame Pattern and Characteristics	36
Atmospheric Burners	38
Pre-Mix Burners	40
Gas Pressure and Flow	42
Gas Pressure Readings	44
Quick Reference Guide to Taking Pressures	46
Estimating a Suitable Pipe Size	48
Domestic Natural Gas Pipe Sizing	50
Commercial Pipe Sizing	52
Determining Existing Losses due to Pipe Size	54
Gas Rates and Heat Input	56
Quick Reference Tables: Gas Rate/Heat Input	58
The Physical Laws Relating to Gas	60
Measurement of Gas 1	62
Measurement of Gas 2	64

Part 3 Gas Controls	69
Quarter Turn Gas Control Valves	70
Screw Down Gas Control Valves	72
Spring Loaded Gas Control Valves	74
Electrically Operated Gas Control Valves	76
Heat Operated Gas Control Valves	78
Pressure Operated Controls Valves	80
Low and High Pressure Cut-Off Devices	82
Pressure Regulators	84
LPG Regulators 1	88
LPG Regulators 2	90
Flame Supervision Devices	92
Testing Flame Supervision Devices	98
Thermostatic Control	100
Multifunctional Gas Valve 1	102
Multifunctional Gas Valve 2	104
Ignition Devices	106
Vitiation Sensing Devices	108
Pressure and Flow Proving Devices	110
Part 4 Installation Practices	113
Polyethylene (PE) Pipe Jointing	114
Copper Pipe Jointing	116
Mild Steel Pipe Jointing	118
Semi-Rigid and Flexible Pipe Connections	120
Gas Service Pipework	122
Connections to High Rise Buildings	126
Gas Meter Installations	128
Commercial Gas Installations	132
Internal Installation Pipework	134
Pipework Laid in Floors	136
Pipework in Walls	138
Pipework Support and Allowance for Movement	140
Timber Framed Dwellings	142
LPG Storage and Supply	144
LPG Cylinder Installation	146
Storage and Transportation of LPG Cylinders	148
LPG Bulk Tank Installation	150
Gas Supplies from a Bulk Tank Installation	152
Pipe Sizing LPG Installations	154
Part 5 Tightness Testing	157
Tightness Testing and Purging	158
Testing Equipment	150

Tightness Testing with Air (Domestic)	162
Tightness Testing and Purging with Natural Gas (Domestic)	164
Tightness Testing and Purging with LPG (Domestic)	168
Strength Testing for Commercial Pipework	172
Commercial Tightness Testing	176
Direct Purging Commercial Pipework	182
Commercial Purging Procedure	188
Indirect Purging using Nitrogen (N ₂)	190
marreet runging using runtogen (142)	
Part 6 Flues	193
Flue Classification	194
Flue Material and Specification	196
Natural Draught Open Flue Systems	198
Installation of an Open Flue	200
Minimum Open Flue Heights 1	202
Minimum Open Flue Heights 2	204
Open Flue Terminal Design and Location	206
Condensation within Open Flue Systems	208
Brick Chimneys	210
Flexible Stainless Steel Flue Liners	212
Pre-Cast Flue Blocks	214
	216
Flue Pipes	218
Fan Draught Open Flue Systems	220
Shared Open Flue Systems	222
Checking and Testing Open Flue Systems	224
Room Sealed Flue System	226
Fan Assisted Room Sealed Flue Appliance	
Room Sealed and Fan Flue Terminal Locations	228
Shared Room Sealed Flue Systems	230
Fan Dilution System	232
Flue Gas Analysis	234
Test Equipment for Flue Gas Analysis	236
D . 7 W. dilai-	239
Part 7 Ventilation	240
Need for Ventilation	242
Ventilation Location	244
Effective Ventilation	246
Ventilation Sizing and Tables	
Ventilation Calculations 1	250
Ventilation Calculations 2	254
Domestic Ventilation Ready Reckoner	258
PRE COURSE	
Part 8 Gas Installer Responsibility	261
Commissioning Gas Installations/Appliances	262

Servicing Gas Installations/Appliances	268
Installation of Second-Hand Appliances	270
Gas Safety and Landlord Inspections	272
Gas Industry Unsafe Situations	274
Dealing with Unsafe Situations	276
Gas Escape Procedures	278
Reporting of Injuries, Diseases and Dangerous Occurrences	
Regulations (RIDDOR)	280
a line of historical control of the latest and the	
Part 9 Domestic Appliances	283
Gas Fires and Space Heaters	284
Component Parts of a Gas Fire	286
Open Flued Radiant Convector Gas Fires	288
Open Flued Solid Fuel Effect Fires and Heaters	290
Installation of Open Flued Gas Fires 1	292
Installation of Open Flued Gas Fires 2	294
Installation of Open Flued Gas Fires 3	296
Decorative Fuel Effect Gas Fires DFE	298
Fan Flued and Room Sealed Heaters	300
Flueless Space Heaters	302
Commissioning and Servicing Space Heaters	304
Domestic Gas Cookers	308
Installation of Cooking Appliances	312
Domestic Flued Cooking Range	314
Commissioning and Servicing Cookers	316
Instantaneous Gas Water Heaters	320
Instantaneous Water Heater Operation	322
Gas Storage Water Heaters	326
Installation of Water Heaters	328
Commissioning and Servicing of Water Heaters	330
Domestic Gas Boilers	334
Conventional or Regular Gas Boilers	336
The Combination Boiler	338
The Condensing Boiler	340
Installation of Domestic Gas Boilers	342
Commissioning and Servicing Gas Boilers	344
Domestic Ducted Warm Air Heaters	. 348
Installations of Warm Air Heaters	350
Commissioning and Servicing Warm Air Heaters	352
Domestic Tumble Dryers	356
Installation of Domestic Tumble Dryers	358
Domestic Gas Refrigerators	360
Leisure Appliances	362
Greenhouse Heaters and Gas Pokers	364

Part 10 Commercial Appliances	367
Commercial Boilers	368
Commercial Boiler Gas Control Systems	370
Commercial Warm Air Heaters	372
Commercial Direct Fired Air Heaters	374
Commercial Indirect Fired Air Heaters	376
Overhead Radiant Heaters	378
Commercial Laundry Equipment	382
Boosters and Compressors	386
Commercial Catering	390
Catering Establishments	392
Ventilation/Extraction in Commercial Kitchens	394
Commercial Cookers and Ovens	396
Specialist Ovens and Steamers	398
Boiling Pans, Hot Cupboards and Bain-Maries	400
Grills, Griddles and Fryers	402
Drinking Water Boilers	404
Mobile Catering Units	406
Part 11 Non-Permanent Dwellings	409
Residential Park Homes	410
Leisure Accommodation Vehicles	412
Caravan Holiday Homes	414
Touring and Motorised Caravans	416
Gas Supply on Boats	418
Pipework Installation on Boats	420
Appliances and Ventilation for Boats	422
Part 12 Electrical Work	425
Electricity	426
Electrical Safety	428
Bonding	430
Safe Isolation	432
Inspection and Testing	434
Fault Diagnosis of Basic Electrical Controls	436
Index	439

Index

absolute pressure 60 absorber 361 absorption pressure 42 a.c. 426 ACS 4 accredited test house 210 adventitious air 199 aerated flame 34 air/gas ratio 23, 30 alcohol 29 Aldehydes 29 alternating current 426 amperes 426 anaconda 128 anemometer 67 **ASD 108** at risk installations 274 atmospheric burner 38 atmospheric sensing device 108, 344 automatic change over valve 90

back boiler 338 backflow 328, 338 back-siphonage 328 badged rating 63 bains-marie 400 bake test 318 baking 390 baking oven 398 balanced flue appliance 194, 214 ball valve 70 balanced compartment 224 bar burner 39 barbecue 362 bayonet regulator 91 bayonet valve 74 bi-metallic strip FSD 92 black bulb sensor 380 black dust 268 blanching 390 boats 418 boiler (commercial) 368 boiler (domestic) 336 boiling 390

boiling pan 400 boiling point of gas 22 boiling table 396 bonding 430 booster 386 Bourdon gauge 160 Boyle's law 60 braising 387 branch flue 221 brat pan 402 brick chimney 210 British Standards 14 bubble leak tester 420 Building Act 13 bulk tank installations 150 burner 38 burning velocity 36 butane 23 butterfly valve 70 bypass 100, 316

cabinet heater 302 café set 404 café steam boiler 404 calibration certificate 161 calorific value 23 canopy 299, 394 caravan holiday home 414 carbon monoxide 29 catalytic converter 302 catchment space 292, 304 CE mark 14 ceiling plate 216 ceramic plaque heater 378 Charles's law 61 check meter 132 check valve 81 chemical formulae 22 chimney design 210 class 1 and 2 appliance 196 clay flue pipe 211 closed flue appliance 194 closure plate 289 CO/CO₂ ratio 235

coefficient of expansion 140 combination boiler 338 combination valve (LPG) 152 combustion 28, 32 combustion process 28 commissioning 262 commissioning checklist 265 common flue 220 compensated regulator 84 compression joint 116 compressor 386 condensate pipe 341 condensate trap 344 condensation in flues 208 condensing boiler 340 condenser 361 constituents of gas 21 constant pressure regulator 84 convection 198 convector heater 284 conventional boiler 336 conventional flued appliance 198 conventional grill 308 cooker hose 312 cooker safety shut off valve 74, 311 cooking processes 390 copper sulphide 268 CORGI 2 COSHH 12

damper 211 d.c. 426 debris collection space 210 decorative fuel effect fire 298 decorative heater 284 deep fryer 402 deep frying 391 de-scaling 323, 332 DFE fire 298 diaphragm valve 72 differential pressure control 322 diffusion 60 dilution air 198, 232 direct current 426 direct fired heater 374 direct purging 188 disc and washer check valve 81 disc valve 72 displacement gas meter 62 double diaphragm check valve 81 double wall flue pipe 216 down draught 198

Draegar analyser 236 draught break 200 draught diverter 199 draught stabilisation door 201 drawing symbols 134 drop fan cock 70 drop vent 414 dry fryer 402 dry frying 391

E6 gas meter 66 earth continuity 434 effective flue height 202 efficiency 234 efflux velocity 206 electric shock 448 electrical fire 428 electrical thermostat 100 electricity 426 electricity act 13 electro-fusion welded joint 114 electro-hydraulic valve 76 electro-mechanical valve 76 electronic pulse ignition 106 electronic token meter 66 emergency control valve 124 equipotential bonding 124, 430 ethane 30 evaporator 361 exclusion zone 174 expansion bellows 141 expansion boiler 404 expansion in pipes 140 explosive limits 24 extended plenum 348

fan dilution 232 fan draught flue 218, 226 fan flued appliance 302 filament igniter 106 fire precautions 216 fire stopping 126, 216 firebox (see also flue box) 286 firewall protection 150 first stage regulator 89 flambeaux 362 flame chilling 36 flame failure device 92 flame front 34 flame impingement 36 flame lift 36

flame rectification FSD 96 flame speed 25, 35 flame supervision device 92 flame temperature 23 flammability limits 23, 24 flange joint 119 flare stack 189 flexible hose 120 flexible stainless steel 120 floor plate 216 flow cup 323 flow switch 110, 219 flue block 214 flue box 294 flue classification 194 flue flow test 222 flue gas analysis 234, 236 flue inspection checklist 267 flue liner 211, 213 flue pipe 216 flue route 202 flueless appliance 194 flux 116 force convection oven 396 forced draught burner 40 free standing boiler 337 fuse rating 435 fusion welded joint 114 Fyrite analyser 236

gas cooker 308 gas detector 160 gas dispersal hole 414 gas escape procedure 278 gas family 23 gas fires 284 gas flame 34 gas flow 42 gas light 362 gas meter 62 gas meter installation 128 gas poker 364 gas pressure 42 gas rate 56 gas receiver 389 gas refrigerator 360 gas relay valve 80 gas reservoir 389 gas riser 125 gas safety record 273 gas safety regulations 16

gas booster 386

gas service 122
gas vaporisation (LPG) 27
gas/air speed 35
Gascoseeker 161
gate valve 72
glowcoil igniter 106
governor 84
Graham's law of diffusion 60
greenhouse heater 364
griddle 402
griddling 391
grill 308
griller 402
grilling 391
gross heat input 56, 58

haemoglobin 29 Health and Safety at Work Act 12 Health and Safety Executive 280 hearth 293 hearth plate 197 heat exchanger 306, 336 heat input 56 heat input ready reckoner 58 heat motor 78 heat shield 228 heating stove 290 high pressure 42 high pressure shut-off 82 high specific gravity gauge 160 high to low pressure regulator 86 higher explosive limits 24 hob 310 hot cupboard 400 hotplate 310 hydrocarbon 20, 28 hydrogen oxide 268 hydrostatic strength testing 173

ignition sequence 41 ignition temperature 23, 25 immediately dangerous 274 impingement 36 incomplete combustion 29 indirect fired heater 376 indirect purging 190 induced draught burner 40 industry unsafe situations 274, 276 inferential gas meter 64 injector 38 inset fire 290

inset live fuel effect fire 290 instantaneous water heater 320 insulation resistance tester 435 insulation joint 124, 127 insulation resistance 434 intumescent vent 244 intermediate pressure 42

J gauge 160 jacketed boiling pan 401

landlords' inspection 272 legislation 10 leisure accommodation vehicle 412 lighting back 36 limit stat 354 line diagram 132 lint arrestor 337 lint filter 356 liquid expansion FSD 92 liquid expansion thermostat 100 lock-up 84 long screw connector 118 low pressure 42 low pressure cut-off 82 lower explosive limits 24 LPG (origin) 20 LPG cylinders 144, 146 LPG regulator 88 LPG storage and supply 144

magnetic valve 76

magnetism 426 mains ignition 106 manometer 160 maximum incidental pressure 44, 173 maximum operating pressure 44, 173 mechanical thermostat 100 mechanical ventilation 240 medium pressure 42 medium pressure regulator 165 meniscus 161 meter box 128 meter by-pass 130 methane 20, 28 micropoint 74, 363 mixing tube 38 mobile catering 406 mobile heater 302, 374 modular boiler 368

modular flue 220 motor caravan 416 multifunctional gas valve 102, 105 multi-meter 435 multi-point water heater 320

natural gas (origin) 20 needle valve 72 net heat input 57, 58 non-return valve 80 not to current standard 275 notching timber joists 137 notice plate 197

ohm 426
Ohm's law 427
open flued appliance 194
operating pressure 46, 84
OPSO 82
orifice meter 66
OSD 108
oven 308
oven bypass 316
over pressure shut-off 82
overheat stat 354
oxygen depletion system 108
oxygen/gas ratio 23, 24

pastry oven 398 patio heater 362 PE pipe 114 permitted leak rate 177 photo-electric FSD 96 piezo-electric ignition 106 pigtail 120 pillar elbow restrictor 73 pilot 95 pipe identification 132 pipe roller and chair 141 pipe sizing (LPG) 154 pipe sizing (natural gas) 48, 54 pipe sleeve 135 pipe support 135, 141 pipes below floors 136 pipes in walls 138 plaque heater 378 plastic flue pipe 340 plug cock 70 plug in quick release valve 74 plug tap 70, 74

pluming 206, 340 pneumatic strength testing 175 poaching 390 poker 364 polarity 434 polyethylene pipe 114 polytetrafluoroethylene 118 positive displacement meter 62 positive return air 352 post-aerated flame 34 poured lining 210 pre-aerated flame 34 pre-cast concrete flue blocks 214 pre-mix burner 40 pressure absorption 42 pressure boiler 404 pressure differential 344 pressure drop 44 pressure loss 44 pressure relief valve 346 pressure stat 78 pressure switch 110, 219 pressure zone 199 primary air 36 primary air port 38 primary flue 200 propane 23 propylene 30 proving device 110 proving oven 398 proving unit 433 **PTFE 118** pull test 222 purge points 132 purge stack 186 purge velocity 184 purging (commercial) 182 purging (LPG) 168 purging (domestic natural gas) 167 pyrometer 332

quarter turn valve 70

radial duct 348
radiant heater 284
radiant heating 378
radiant tube heater 366
radon gas 242
range cooker 314, 396
reciprocating compressor 386
refrigerator 360

register plate 210, 291 regular boiler 336 regulator 84, 88 relative density 22 relay valve 80 residential park home 410 resistance 426 restraining cable 356 retention flames 37 return air duct 348, 350 ribbon burner 39 RIDDOR 278 ridge terminal 207, 215 risk assessment 183 roasting 390 rod type thermostat 100 roll check valve 81 room sealed appliance 194 room sealed flue system 224 rotary anemometer 67 rotary displacement meter 64 rotary screw compressor 386 rotating reel oven 399

sacrificial anode 122, 327 safe isolation (electrical) 432 safety cut-off device 75, 311 safety interlock 404 safety shut-off valve 76, 370 salamander grill 403 SAP rating 334 screw down valve 72 sealed heating system 335 second hand appliances 270 second stage regulator 89 secondary air 36 secondary flue 200 secondary meter 132 sectional boiler 368 SEDBUK rating 334 se-duct 230 semi-concealed meter box 129 semi-rigid coupling 141 semi-rigid pipe 120 service 122 servicing checklist 269 servo regulator 102, 105 shallow fryer 402 shallow frying 391 shared flue system 220, 230 shell boiler 368 simmering 390

single point water heater 320 single stage regulator 89, 90 single wall flue pipe 216 sleeving 135 slow ignition device 324, 330 smoke match 223 smoke pellet 223 solenoid valve 76 solver flue 226 soot 36 soundness test of flue 222 space heaters 284 specific gravity 22 spigot restrictor 288 spillage test 223 stability bracket 312 standing pressure 46, 84 steam boiler 404 steaming 390 steaming oven 398 steel pipe jointing 118 stepped duct 348 stewing 391 storage of LPG 148 storage water heater 326 strength testing 172 stub duct 348 substitute natural gas 20 supplementary bonding 430 surface combustion grill 308

tapered body burner 39 temporary bonding wire 430 terminal design 206 terminal guard 228 terminal location 207, 229 test lamp 433 thermal cut-off 78 thermistor thermostat 78 thermocouple 94 thermocouple interrupter 109, 323 thermoelectric FSD 94 thermometer 318, 323 thermostatic control 100 throat restrictor 311 tightness testing 158 timber framed dwellings 142 tilting fryer 402 toasting 391 token meter 66 touring caravan 416 transducer 110 transitional fitting 115

transitional tee 123 transporting LPG 148 tumble dryer (commercial) 382 tumble dryer (domestic) 356 tunnel burner 40 turbine meter 64 twin wall flue pipe 216 type 'A', 'B' and 'C' appliances 194

U type gas meter 62 U-duct 230 U gauge 160 ullage space 150 ultrasonic gas meter 66 under pressure shut-off 82 union joint 119 unsafe situations 276 up-draught 198 UPSO 82 urn 404 UV detector 96

vapour take off (LPG) 144
vent stack 188
ventilation 240, 246
ventilation in pipe ducts 126
ventilation ready reckoner 258
venturi 322
vertex flue 226
visual inspection of flues 214, 259
vitiation 108
vitiation sensing device 108
volt 426
volume meter 62, 160

wall heater 284
warm air heater (commercial) 372
warm air heater (domestic) 348, 350
washing machine 384
water act 13
water governor 322, 330
water heater 320, 325
water throttle 322
watt 426
weep pipe 80
Wobbe number 24
working pressure 43, 46
working pressure drop 42, 46

zero governor 86, 104