

APPENDIX I

Euromap Documents Concerned with Injection Moulding

Euromap is the European committee of machinery manufacturers for the plastics and rubber industries. Its membership is drawn from representatives of associations, which cover machinery manufacturers, in Belgium, West Germany, France, Italy, The Netherlands, Spain, Switzerland and the UK.

Euromap's technical committee has compiled a series of recommendations relating to special features of primary processing equipment. These recommendations are designed to standardise and simplify the wealth of technical data for the benefit of machinery manufacturers and processors.

At present the documents cover injection moulding machines, extruders and blow moulding machines. In the UK such Euromap documents are available from The British Plastics Federation, 5 Belgrave Square, London, SW1X 8PH.

Euromap 1: Description of Injection Moulding Machines

Provides guidelines on technical information to be included in a description of an injection moulding machine and draws attention to the details that should be taken into account when evaluating a machine.

Euromap 2: Mould Fixing Dimension for Injection Moulding Machines

Specific information relating to mould mounting is provided on fixing holes and slots, symbols, dimensions and correlation of threads or slots to the lines.

Euromap 3: Injection Moulding Machine Clamping Units, Essential Dimensions

Descriptions of injection moulding machines should contain a sketch of

the clamping unit showing all important dimensions. This recommendation lists the minimum number of dimensions.

Euromap 4: Determination of the Available Injection Power in Injection Moulding Machines

This recommendation provides conditions for measuring, according to a uniform method, the available injection power in injection moulding machines hydraulically driven by means of a piston or a screw and obtaining comparable results.

Euromap 5: Procedures for the Determination of Important Production Data for an Injection Moulding Machine

Procedures are described for the determination of plasticising flow, rate of injection and specific energy consumption, by means of any injection moulded part. Conditions of manufacture must be clearly set out in the manufacturing report and this ensures that results can be reproduced.

Euromap 6: Determination of the Duration of the No-load Cycle of Injection Moulding Machines

This recommendation lays down requirements for determining, by a uniform method, the duration of the no-load cycle of injection moulding machines and for obtaining comparable results.

Euromap 7: Determination of the Maximum Clamping Force of Injection Moulding Machines

Two methods are set out for determining uniformly the clamping force of injection moulding machines and for obtaining comparable results.

Euromap 8: Determination of the Nominal Opening Force of Injection Moulding Machines

The recommendation establishes the requirement that the opening force of injection moulding machines be determined by clearly defined methods.

Euromap 9: Testing the Parallelism of the Clamping Plates of Injection Moulding Machines

A uniform method for determining deviations from the parallel of the clamping plates of injection moulding machines so that comparable results can be obtained.

Euromap 10: The Testing of Injection Moulding Machines—General Rules for Testing

These rules, which are applicable to injection moulding machines processing both plastics and rubber, establish a uniform basis for preparing and carrying out the tests and include directions relating to the conditions under which the tests are to be performed. The appendices contain a specimen test report and declaration of acceptance.

APPENDIX II

Troubleshooting—An Instant Checklist of Likely Remedies for the Most Common Faults on Injection Machines

Index

- Aachen mixing system, 66–7
- Accelerators, 22
- Accessibility, 106
- Accidents, 102
- Accumulators, 87, 94
- Acetals, 316–19
- Acrylic, 264–7
- Acrylonitrile-butadiene rubber, 372
- Acrylonitrile-butadiene styrene (ABS), 260–4
 - electroplating, 122
 - electroplating tests, 123–5
- Activation, 126
- Activators, 22
- Additives, 21, 222
- Adhesive(s)
 - bonding, 158, 160–6
 - design considerations, 165
 - cyanoacrylate, 164–5
 - design considerations, 165
 - epoxide, 164
 - hot-melt, 163
 - pressure-sensitive, 161
 - reactive, 163
- Adiabatic machines, 67–8
- Adjustable length scotch, 106
- Air shot technique, 229
- Aminoplastics, 354–9
- Amorphous materials, 169
- Anisotropy, 180, 183
- Annealing, 177–9
- ASTM D 647, 224
- ASTM D 1130-63, 223
- ASTM D 1897-72, 223
- Auger granulation, 12
- Automatic systems, 249
- Back pressure, 227, 228
- Barrelling, 115–16
- Base coat applications, 131–2
- Birefringence, 180–2
- Blending, 16, 25, 27
- Blowing agents, 22
- Bolts, 154
- Bonding cements, 159
- BPF Code of Practice, 102–7
- British Standard 5378, 104
- Buffing, 117
- Burns, 102
- Butadiene rubber, 368, 370
- Butyl rubber, 368, 370
- Cavity pressure control (CPC), 236
- Celluloid Corporation, 45
- Cellulosics, 275–80
- Charpy impact testing, 209, 211
- Clamp speeds, 92
- Clamp stroke, 92
- Clamping, 91, 118
 - force, 91
 - pressure, 227
 - unit, 91–4
- Cleaning for electroplating, 125
- Codes of Practice, 102–7, 223–4
- Colourants, 22

- Colouring systems, 32–5
 - colour additions, 35
 - costs, 34
 - dry colouring, 32
 - liquid colouring, 33
 - masterbatch colouring, 33
- Component finishing and decoration, 114–67
- Component testing, 240–4
- Constant load testing, 219
- Contamination
 - hydraulic system, of, 96
 - regrind, of, 13
- Control location, 97–8
- Control system, 96–7
- Coolers, 96
- Cooling
 - capacities, 116
 - cycle, 179
 - rate, 178, 185
 - time, 226, 232, 233
- Core-pulling systems, 101
- Correlation coefficients, 186, 187
- Costs
 - acquisition and support, 16
 - colouring systems, 34
 - materials, 17
 - reclaiming, 18
- Counter, operating hours, 100
- Cracks, 166, 195
- Creep curves, 221
- Creep tests, 219
- Crosslinking systems, 23
- Crystallinity, 169–71, 179, 184–5, 222
- Crystallisation rate, 186
- Cutting, 119
 - tools. *See* Machining
- Cyanoacrylate adhesives, 164–5
- Cycle time, 230

- Deflashing, 115–16
- Deformation recovery, 118
- Delivery, 112
- Density effects, 178–9
- Density measurement, 217–18
- Differential shrinkage, 177
- Dimensional stability, 168

- Direct screw transfer, 75
- Dough moulding compound, 363–6
- Dry-offset printing, 140
- Drying and dryers, 18–21
 - hopper dryers, 19–21
 - oven dryers, 18
 - vented injection units, 21
- Durometer hardness, 219
- Dwell pressure, 236
- Dwell time, 225, 231
- Dynamic load application, 222

- Ejection system, 11, 93–4, 100
- Elastomers, 367–83
 - material recommendations, 367–83
- Electrical equipment, 102, 107
- Electrical power outlets, 101
- Electrically conductive mouldings, 143
- Electroless copper plating, 127
- Electroless metal deposition, 126
- Electroless nickel plating, 127, 129
- Electroplating, 122–9
 - ABS, 122–5
 - alternative systems, 127
 - applications, 129
 - metals used, 122
 - process details, 125–9
 - production of mouldings, 123
- Environmental stress-cracking
 - resistance (ESC), 171
- Epoxide adhesives, 164
- EPRom bit processor, 98
- Ethylene propylene rubber, 369, 371
- Euromap, 37, 85, 384–6
- Experiment design, 198–203
- Experimental card layout, 200
- Experimental procedure, 201
- Extrusion moulding, 69

- Fail safe, 107
- Fault finding, 98, 387
- Feed separation, 12
- Feed system, 9, 15, 71
- Fibre reinforced thermoplastics, 344–9
- Fillers, 23, 65
 - fibrous, 174–5, 211

- Filling speed, 191
- First-stage pressure, 227
- Fixed length scotch, 106
- Flash removal, 114
- Flexural strength, 209
- Flow
 - moulding, 73
 - path, wall thickness ratio (FR), 217
 - properties, 213–17
 - tendency, 241
- Fountain effect, 174
- Freeze time, 232–3
- Frozen-in-strain, 169
- Frozen-in-stress, 169

- Gate
 - changing, 195
 - freeze time, 232
 - position, 193, 197
 - size, 193, 197, 233
- Glass fibres, 23, 175, 211
- Glass transition temperature, 176, 186
- Granulated material, 14
- Granulating equipment, 10, 13
- Guards, 103–6

- Hand trimming, 114
- Hardening, 160
- Hardness, 218–19
- Hazards, 104
- Health and Safety at Work Act 1974, 103
- Heat distortion temperature, 214
- Heating system, 89
- High density polyethylene, 297–301
- High shear rheometer, 215
- Horizontal machines, 59
- Hot foil marking, 134–7
 - application areas, 136
 - application methods, 135
 - carrier film or foil, 134
 - foil composition, 134–5
 - moulded-in foils, 136
- Hydraulic components, 95
- Hydraulic control, 95
- Hydraulic ejectors, 100
- Hydraulic equipment, 102
- Hydraulic interlock, 106
- Hydraulic line pressure, 187
- Hydraulic system, 86, 94–6
 - contamination of, 96
- Hydraulic valves, 103
- Hygrosopic materials, 18

- Impact modifiers, 24
- Impact testing, 170, 211, 239, 242–3
- Injection
 - blow moulding, 77–8
 - capacity, 80–1
 - line pressure, 95, 226
 - moulding process, 1
 - pressure, 87, 189, 226
 - rate, 85–7, 191
 - speed, 189
 - thermoforming, 76–7
 - time, 230
 - transfer moulding, 76
 - unit, 80–91
 - velocity, 85–7
- Injection–compression moulding, 74, 75
- In-line screw machine, 50, 55, 73
 - alternative arrangements, 59–61
 - components, 58
 - horizontal, 59–61
 - lay-out, 58
 - vertical, 59–61
- Inspection, 105, 239–40, 248, 249
- Instrumented falling weight test, 213
- Insulated runner, 71
- Intensifiers, 94
- Interlocking principles, 106
- Intrusion moulding, 73
- Isochronous stress–strain curves, 221
- Isometric stress–log time curves, 221
- Isoprene rubber, 368
- Izod impact strength, 211, 238–9
- Izod impact tests, 170, 239

- Joining, mechanical, 150–60

- Labelling, 141
- Laser cutting, 120
- L:D ratio, 50, 81, 82
- L:D screws, 83
- Legislation, 102
- Letterflex printing, 140
- Level allocation, 200
- Level of use, 14–15
- Limit switch, 104, 106
- Line pressure, 95, 226
- Long-term testing, 219–22
- Low density polyethylene, 292–6
- Lubricants, 24

- Machine
 - construction, 105
 - costs, 112
 - installation, 107
 - operation, 234
 - purchase, 108–13
 - purging, 233–4
 - selection, 108
 - settings, 203, 222, 225, 229
 - specifications, 80–113
 - survey, 112
 - types, 37
- Machining, 117–21
- Maintenance, 111
- Material(s), 1–36, 109
 - blending, 16
 - bulk containers or bins, 3
 - bulk storage, 5
 - compounding, 28–32
 - considerations, 90
 - costs, 17
 - handling, 5–9
 - automated systems, 9
 - bulk containers, 3, 7
 - sacks, 2, 5
 - vacuum hoppers, 9
 - hygroscopic, 18
 - packed in sacks or bags, 2
 - packed in tins or cans, 3
 - properties, 117–18, 151, 369–76
 - reclamation, 9–18
 - automatic systems, 11
- Material(s)—*contd.*
 - reclamation—*contd.*
 - imperfect mouldings, sprues and runners, 14
 - manually operated system, 11
 - recommendations, 251–383
 - elastomers, 376–83
 - temperature requirements, 5
 - testing, 240–4
- Maximum daylight, 93
- Mechanical joining, 150–60
- Mechanical properties, 168–70, 186–7
- Mechanical restraints, 106
- Melt
 - compaction, 225
 - flow index, 214
 - temperature, 185, 186, 187, 189, 191, 200, 228, 229
- Metal inserting, 145, 157–60
- Metallisation, 121
- Microprocessors, 97, 98, 249
- Mixing, 21
 - equipment types, 30
 - high-speed mixers, 26
 - hoppers, 28
 - machine, on, 27
- Moisture content, 241
- Molecular orientation. *See* Orientation effects
- Monitoring, 247
- Moulded-in inserts, 157–60
- Moulding
 - conditions, 185–93, 198–203
 - procedure report, 235
 - techniques, 73–8
 - trials, 109
- Mould(s), 68–73, 110
 - closed time, 226
 - cold-runner, 71
 - family, 72
 - filling, 172–5, 225
 - hot runner, 71
 - insert, 224
 - multicavity, 228
 - open time, 226, 230
 - opening force, 92
 - runnerless, 71
 - sprueless, 71

- Mould(s)—*contd.***
 stack, 72
 thickness, 92
 three-plate, 71
 two-plate, 69–71
 undercut, 72
 unscrewing, 73
 variable gate, 195
 vertical flash, 72
- Multibarrel machines, 63–4**
Multiple-colour mouldings, 63
Multistation machines, 62–4, 74
Multistep machines, 236–8
Multistep setting, 236, 238
- Natural rubber, 367, 369**
Neoprene, 372
Nitrile rubber, 372
No-load cycle, 99
Normal distribution curve, 244–5
Notch sensitivity, 239
Nozzle contact force, 88
Nuts, 154
Nylon, 174, 309–16
- Oil**
 cooling, 96
 temperature regulation, 96, 100
- Oil-resistant rubbers, 372–4**
Orientation effects, 169, 176–7, 179–86, 195, 198
Orientation stress relaxation, 182
O-rings, 74
Oven heating, 242
- Packing, 175–7**
Painting, 141–3
 curing or setting, 143
 process details, 142
 reasons for, 141–2
- Permeability to gases and liquids, 171**
Phenolics, 359–63
Photoelastic inspection, 242
Physical properties, 168, 182–3
'Piggy-back' machines, 46
- Piston machines, 41**
Plasticisation
 early systems, 44
 terminology, 44
- Plasticised polyvinyl chloride, 272–5**
Plasticisers, 24
Plasticising capacity, 82–5
Platens, 93
Plunger machines, 41
 conflicting requirements, 42
 development, 38
 disadvantages, 41–3
 injection unit requirements, 41
 operating sequence, 38–41
- Pneumatic conveying system, 14**
Polishing, 117
Polybutylene terephthalate, 305–9
Polycarbonate, 280–4
Polychloroprene, 373
Polyethersulphone, 284–9
cis-Polyisoprene, 368
Polyisoprene rubber, 371
Polymer morphology, 169
Polymer selection guide, 378
Polyphenylene oxide (modified), 289–92
Polyphenylene sulphide, 323–7
Polypropylene, 187, 189–91, 301–5
Polystyrene, 186, 232, 251–4
Polyvinylidene fluoride, 319–23
Postmoulded inserts, 160
Power failure, 107
Preplasticisation
 in-line systems, 51–64
 two-stage, 44–51
 attractions of, 49–51
 operating sequence, 46
- Pressure control, 95, 101**
Pressure effects, 175–7, 183, 187, 189, 199, 226–7
Printing, 139–41
 dry-offset, 140
 letterflex, 140
 silk-screen, 139
 wood, 140
- Processing conditions, 168–9**
Production capability, 244–7
Progressive scotch, 106

- Protective agents, 23
- Pump drive, 94
- Pump size, 87

- Quality
 - assurance, 243
 - control, 240, 243, 247
 - limits, 248
 - requirements, 169, 203–4

- Ram machines. *See* Plunger machines
- Random sampling, 248–9
- Range coefficient, 246–7
- Reaction injection moulding, 78
- Records, 238
- Regrind material, 13–15
 - contamination of, 13
- Relaxation, 176–7, 182
- Repeatability, 99
- Replacement machines, 108
- Rigidity, 171, 209
- RIM process, 78
- Risk involvement, 106
- Riveting, 152–4
- Rivets
 - bifurcated, 153
 - blind, 154
 - tubular, 153
- Robots, 107, 249
- Rockwell hardness, 219
- Rotor and ram system, 65
- RSG process, 78
- Rubber(s)
 - injection moulding machine, 46
 - reinforced polypropylene, 327–31
 - rubber compounds, and, 1, 91
 - general purpose, 367–71
 - oil-resistant, 372–4
 - preparation, 29–32
 - special purpose, 374–6
- Runner dimensions, 233

- Safety checks, 105
- Safety measures, 101–8
- Sample gauging, 247

- Sample production, 234
- Sandwich moulding, 63–4
- SBS block copolymers, 336–40
- Screw
 - advance, 225
 - decompression, 89
 - delay timer, 57
 - forward time, 225
 - recovery time, 226
 - rotation, 88
 - rotational speed, 199, 224, 228
 - stroke, 82
- Screw/plunger combinations, 46
- Screwed assemblies, 154–60
- Second-stage pressure, 227
- Self-tapping screws, 155–7
- Sensitisation, 126
- Service, 110–12
- Service engineers, 111
- Setting operation, 105
- Shear rate, 215
- Shear stress, 215
- Short-term testing, 207–19, 238
- Shrinkage, 171, 176–7, 182, 187, 198, 218, 231
- Shut-off nozzles, 61
- Silicone mould release, 123
- Silicones, 374
- Silk-screen printing, 139
- Simulated end-use testing, 243
- Single-screw machine, 51–5, 59, 64–5
- Single-stage machine, 65
- Snap fits, 150
- Society of the Plastics Industry Inc. (SPI) comparison test, 83, 229
- Solvent
 - cementing systems, 163
 - systems, 161–3
 - welding, 162
- Spares availability, 110
- Specification matching, 108–9
- Speed controls, 95, 101
- Speed nuts, 155
- Spiral flow testing, 215–17
- Spread clips, 155
- Spreaders, 43–4
- Spring clips, 155
- Spruce break, 88

- Staking, 146–7, 152
- Standard deviation, 244
- Standardisation, 207
- Starting time, 225
- Static electricity, 142
- Statistical analysis, 202, 244
- Stress cracking, 166
- Stress relieving, 175–7
- Stress/strain ratio, 209
- Strip production, 30–2
- Structural foam, 349–54
- Styrene acrylonitrile, 254–7
- Styrene-butadiene rubber, 368, 369
- 'Suck-back', 59
- Surface
 - conditioning, 126
 - gloss, 171
 - imperfections, 123

- Television, 249
- Temperature
 - control, 89, 101, 228
 - effects, 5, 89, 123, 201, 222, 228, 232, *see also* Melt temperature
 - regulation, 96, 100
 - settings, 228
- Tensile creep modulus, 221
- Tensile impact test, 213
- Tensile modulus, 171
- Tensile strength, 209
- Tensile testing, 208
- Test specimens, 223–38
- Testing, 205, 238–49
 - long-term, 219–22
 - short-term, 207–19, 238
 - simulated end-use, 243
 - time, 222
- Thermal conductivity effects, 42
- Thermal expansion coefficient, 151, 154
- Thermal properties, 213–17
- Thermoplastic materials, 1, 2, 10, 120, 149, 166, 233
 - delivery, 2–5
 - machine differences, 57
 - production, 28
- Thermoplastic polyetherester, 340–4
- Thermoplastic polyurethane, 331–6
- Thermosetting materials, 1, 10, 91
 - machine differences, 57
 - moulding techniques, 56–7
- Thiokol rubbers, 374, 375
- Thioplasts, 375
- Thread cutting, 120–1
- Tie-bar clearance, 93
- Tie-bar construction, 93
- Timers, 101
- Tolerance limits, 246
- Torpedoes, 43–4
- Toughened polystyrene, 257–60
- Training courses, 111
- Transparency, 171
- Twin-screw system, 51
- Two-stage machines, 65

- Ultrasonic assembly, 144
- Ultrasonic measurements, 183–4
- Ultrasonic staking or riveting, 146–7
- Ultrasonic welding, 144–7
- Unplasticised polyvinyl chloride, 268–72
- Urethanes, 374

- Vacuum
 - hoppers, 9
 - metallising, 129–34
 - areas of use, 134
 - base coat applications, 131–2
 - moulding preparation, 131
 - moulding production, 124–31
 - process details, 132
 - top lacquer application, 133
 - sputtering, 137–9
 - areas of use, 138
 - coating thickness, 138
 - metals used, 137
 - post-treatment, 138
 - pretreatment, 138
 - process details, 137
- Vented injection unit, 21
- Vicat softening point, 213
- Viscosity, 215

Water concentration, 222
Weight tests, 241
Weissenberg effect, 68
Weld strength, 189-91
Welding, 143-50
 contact, 144
 friction, 149
 hot-plate, 147-9
 induction, 149-50
 remote, 144

Welding—*contd.*
 spin, 149
 ultrasonic, 144-7
Wetting, 160
Wood graining, 140

X-ray microradiographs, 184

Young's modulus, 209