

# Subject Index

## A

- Acceptability, indoor air
  - quality, 198-200
- A. C. Fine and A. C. Coarse,
  - Dustron results, 123
- Aerodynamic particle sizer,
  - 134-135
- Aerosol filtration (See also
  - Gas filtration)
  - efficiency measurements,
    - 175-176
  - granular bed
    - flow fields, 47-49
    - mechanisms, 50-52
    - minimum efficiency, 54-57
    - most penetrating particle
      - size, 52-54
  - mechanisms, 404-407
  - models for membrane filters
    - capillary tube, 76-83, 88-90
    - fibrous, for porous media,
      - 83-86, 90
  - most penetrating particle size,
    - 405-407
- Aerosols
  - ASTM F21.20 Round Robin tests
    - (See ASTM F21.20 Round
      - Robin test procedure)
  - deposition in model filters,
    - 71-72
  - latex, 142, 144-146
  - monodisperse, generation,
    - 129-131
  - small-diameter, filter media
    - and filters (DIN 24184
      - Standard), 219
  - test and atmospheric, table,
    - 218
  - "worst case," 173-174
- AFNOR NFX 44011 (uranin aerosol
  - test), 218
- Air cleaners, electrostatic,
  - problems with, 226
- Air cleaner testing (See also
  - Filter testing)
  - SAE J726 Standard, 266-268
  - accuracy and initial effi-
    - ciency, 270-272
  - recommendations for revi-
    - sions, 273
  - reproducibility, 269-270
  - special adaptations, 272
- Air cleanliness in cleanrooms
  - air filtration and, 386
  - air flow and pressurization,
    - 399
  - definition and classification,
    - 394-395
  - factors affecting, 397-398
  - Federal Standard 209B: 384
  - HEPA and ULPA filters, 386
  - HEPA filters and room integ-
    - riety, 398-399
  - history, 391
  - instrumentation and metho-
    - dology, 395-396
  - internal sources, 386
  - in microelectronics industry,
    - 387-388
  - particle measurement methods,
    - 384-386
  - in pharmaceutical, medical, and
    - food industries, 388
  - room types and testing modes,
    - 396-397
  - standards and specifications,
    - 384
  - validation (certification),
    - 392-393
- Air permeability measurements,
  - 105-108
- Air pollutants, effect on gas
  - turbines, 258-259
- Air quality
  - acceptability criteria, 198-200
  - ambient, effect on gas tur-
    - bines, 259-260
  - control
    - interaction of mini- and
      - microenvironments, 209
    - methods, 196-198
    - strategies, 200-212
  - indoor, technical definition,
    - 199
- AIT 744 Lampblack, 231, 232,
  - 235-237
- Alumina dust test (British
  - Standard 2831), 217
- ARI Standard 850-84 (commercial
  - and industrial air filter
    - equipment), 217

- ASHRAE Standards  
 52-76: 194, 215-216, 219-226,  
 229-237  
 55-1981: 199  
 62-73: 195  
 62-1981: 194-196, 199  
 ASHRAE test dust, 116  
 ASTM F21.20 Round Robin test  
 procedure, 149-151, 154  
 filter media, 153  
 participants, 154  
 particle concentration and  
 accumulation, 161  
 percent penetration data  
 analysis, 154-160  
 pressure drop data analysis,  
 161-162  
 latex sphere challenge  
 particles, 153-154  
 ASTM Standards  
 D737-75: 105  
 D757-75: 278  
 D1682-64: 279  
 D2176: 279  
 D2176-69: 296  
 D2905-81: 146  
 D2906-85: 152  
 D2986: 280  
 D3467: 226  
 D3786: 279  
 D4029-83: 295  
 F778: 163  
 F778-82: 105-107, 109, 123,  
 162, 216  
 Australian Standard 1132-1973  
 (general ventilation  
 filters), 219

## B

- Baghouses (See also Fabric  
 filters; Fabric filtration)  
 technology for utility opera-  
 tions  
 cleaning, 336-338  
 filtration, 335-336  
 sonic power augmentation, 338  
 troubleshooting  
 clay emissions, 285-286  
 pressure drop, 287  
 system upgrade, 286  
 woven fiberglass  
 need for new test methods,  
 296-297  
 test method research, 298-299  
 test methods, 295-296

- British Standards  
 2831: 217  
 3928: 217-218

## C

- Capillary tube model  
 conventional membranes and,  
 88-90  
 geometry, 77-78  
 particle deposition theories  
 diffusion, 82-83  
 direct interception, 80-81  
 impaction and interception,  
 81-82  
 inertial impaction, 80  
 by mechanism, table, 79  
 Carbon black, dust spot testing,  
 231, 233, 235  
 Certification of cleanrooms (See  
 Validation of cleanrooms)  
 Chemical analysis, fabric filter  
 media, 280-281  
 Clay emissions, troubleshooting  
 baghouses, 285-286  
 Cleanliness, air (See Air  
 cleanliness)  
 Cleanrooms  
 air cleanliness  
 air flow and pressurization,  
 399  
 definition and classifica-  
 tion, 394-395  
 factors affecting, 397-398  
 HEPA filters and room  
 integrity, 398-399  
 instrumentation and metho-  
 dology, 395-396  
 requirements, 384  
 room types and testing modes,  
 396-397  
 validation (certification),  
 392-393  
 Federal Standard 209B: 384  
 HEPA and ULPA filters, 386  
 internal particle sources, 386  
 in microelectronics industry,  
 387-388  
 particle measurement, 384-386  
 in pharmaceutical, medical, and  
 food industries, 388  
 Commercial and industrial air  
 filter equipment (ARI  
 Standard 850-84), 217  
 Condensation nucleus counter,  
 133-134

Contaminants

- A. C. Fine and A. C. Coarse,  
Dustron results, 123
- gaseous, filter testing, 226
- gas turbine filters, 263-264
- personal exposure control,  
208-212
- preparation, Dustron, 116-117
- Control strategies
- personal exposure, 208-212
- room ventilation, 201-208

D

Dendrite growth

- in granular bed filters, 64-65
- numerical modeling, 21-24

Deposition effect, particles on  
granular filters, 60-63

Diffusion, capillary tube parti-  
cle deposition, 82-83

DIN 24184 (filter media and  
filters for small-diameter  
aerosols), 219

DIN 24185 (general ventilation  
filters), 219

Diocetyl phthalate/photometer  
technique, 127-128

Dustcake

- description and filtration  
mechanics, 339-340
- model development, 340-342
- removal methods
- reverse gas, 336-337
- shaking, 337-338
- sonic power augmentation, 338

Dust collectors, pulse-cleaned  
cartridge (See Pulse-  
cleaned cartridge dust  
collectors)

Dustron

- condition filters, 119
- contaminant preparation,  
116-117
- contaminant types, 123
- electronics, 116
- felt vs. wire surfaces and,  
121-122
- filter media, 123-125
- filter preparation, 117
- gravimetric analysis and data  
reduction, 119
- instrumentation and control,  
114-115
- pneumatics, 111-114
- procedure, fig., 117
- software, 116

- standard media for, 120-121
- system capabilities, 119-120
- test condition selection, 118
- test initiation, 118-119

Dusts, test, 123, 267-269

Dust-spot efficiency revisions  
(ASHRAE 52-76), 223-226

Dust spot testing

- carbon black feeding system,  
fig., 233
- development, 231-232
- test data summary, fig., 234
- test variables, 232, 235

E

Efficiency

- during dust collector season-  
ing, fig., 250
- fabric filtration, testing, 280
- filter fiber, 3-5
- fractional
- for ACF loading of heavy duty  
engine air cleaner, fig.,  
271
- pulse-cleaned cartridge dust  
collectors, 244
- standard test dusts and, 269
- HFATS, description, 349-351
- initial, 142
- NIOSH approach to updating,  
173-177
- particulate filter testing,  
169-170
- proposed specifications
- aerosol size, 346-347
- penetration rejection  
criterion, 347-348
- test material density, 348
- shortcomings of certification  
testing methods
- discriminating ability and  
reproducibility, 173
- environmental conditions, 173
- integrated vs. instantaneous  
monitoring, 171-172
- particle size, aerosol type,  
and flow rate, 172
- steady state, pulse-cleaned  
cartridge dust collectors,  
248-249
- test procedures and require-  
ments, 170-171
- test system, 175
- Effluent concentration, and  
pressure drop in granular  
filters, fig., 61-62

Electric power generation  
 baghouse configuration, 334-335  
 baghouse operations, 335-338  
 dustcake characteristics,  
 338-342  
 fiberglass fabric filters,  
 292-300  
   need for new test methods and  
   research, 296-299  
   test methods, 295-296  
   process description, 333-334  
 Electrostatic air cleaners,  
 problems with, 226  
 Electrostatic enhancement of  
 fabric filtration  
   methods  
     external electric field,  
     324-328  
     particle charging, 321-324  
     pressure reduction mechanisms,  
     319-3221  
 Environment, thermal, acceptable,  
 199  
 EUROVENT 4/5 (general ventilation  
 filters), 218

## F

Fabric filters (See also  
 Baghouses)  
 cleaning  
   reverse gas, 336-337  
   shaking, 337-338  
   sonic power augmentation, 338  
 electrical forces  
   particle collection effi-  
   ciency and, 318-319  
   pressure drop and, 319  
 fiberglass  
   accelerated fabric testing,  
   298  
   bag failure analysis, 298  
   bag standardization, 299  
   bag testing, pilot scale, 299  
   Manufacturers Advisory Group,  
   299  
   new, testing, 298-299  
   test methods, 295-297  
 lab testing objectives, 282-283  
 quality assurance programs,  
 283-285  
 resistance, 303-306  
 specific resistance coefficient  
   experimental measurements,  
   306-310  
   in situ measurement, 312-314  
   measurement, 311-312

  in modeling, 310-311  
   troubleshooting  
     baghouse system upgrade, 286  
     clay emission collection,  
     285-286  
     pressure drop, 287  
 Fabric filtration  
   electrostatic enhancement  
     economic viability, 328-329  
     by external electric field,  
     324-328  
     by particle charging,  
     321-324, 328  
     pressure reduction mecha-  
     nisms, 319-321  
   in utility power plants  
     baghouse configuration,  
     334-335  
     baghouse operations, 335-338  
     dustcake characteristics,  
     338-340  
     process, 333-334  
 Fabric testing  
   laboratory  
     objectives, 282-283  
     usefulness, 288-290  
   limitations, 289  
   methods  
     chemical analysis, 281  
     efficiency testing, 280  
     Flex Test, 279-280  
     microscopic examination,  
     280-281  
     Mullen Burst, 279  
     permeability, 278  
     tensile strength, 278-279  
     visual bag inspection, 281  
   quality assurance programs,  
   283-285  
   recommendations, 289-290  
   troubleshooting  
     baghouse system upgrade, 286  
     collecting clay emissions,  
     285-286, 290  
     pressure drop, 287, 290  
 Federal Specification F-F-310:  
 216  
 Federal Standards  
   209B: 384, 394, 396, 400  
   209C: 396  
 Fiberglass filters  
   Manufacturers Advisory Group,  
   299  
   research needs  
     bag failure analysis, 298  
     bag standardization, 299

- fabric testing, 298-299
  - pilot-scale bag testing, 299
  - test methods, 296-297
- test methods, 295-296
- Fibrous filters, 407-408
  - clean, pressure drop, 19-21
  - efficiency, 3-5
  - filtration theory, 2-7
  - model for porous media, 83-86, 90-91
  - performance, 5-7
  - pressure drop, 2-3
  - theory, 2-7
- Fibrous filtration
  - electrically enhanced,
    - numerical modeling
    - dendrite growth, 21-24
  - model formulation, 14-16
  - particle trajectories, 17-19
  - pressure drop in clean filters, 19-21
  - pressure loss, mitered cylinder model
    - matrix geometry, 30-37
    - slip effects, 40
    - theory, 29-30
    - thickness effects, 37-40
- Filter media and filters for small-diameter aerosols (DIN 24184 Standard), 219
- Filters
  - downstream particle shedding, 415-418
  - Dustron, 117-118
  - efficiency (See Efficiency)
  - fabric (See Fabric filters)
  - felt vs. wire surfaces, 121-122
  - fiberglass (See Fiberglass filters)
  - fibrous (See Fibrous filters)
  - gas turbines, inlet
    - aging, 263
    - configuration, 262-263
    - contaminants, 263-264
    - self-cleaning, 264-265
    - testing, 261-262
  - granular (See Granular filters)
  - HEPA (See High efficiency particulate air filters)
  - membrane (See Membrane filters)
  - model, aerosol deposition, 71-72
  - particulate, testing, 169-171
  - process gas, 412-414
  - ULPA (See Ultra-low penetration air filters)
- Filter testing (See also Air cleaner testing)
- AFNOR NFX 44011 (uranin aerosol test), 218
- ARI Standard 850-84 (commercial and industrial air filter equipment), 217
- ASHRAE Standard 52-76 (See ASHRAE Standards)
- ASTM F-778-82 (See ASTM Standards)
- Australian Standard 1132-1973 (general ventilation filters), 219
- automated flat sample (See Dustron)
- automated for efficiency measurements
  - aerodynamic particle sizer, 134-135
  - aerosol flow system, 132-133
  - aerosol generation of particles  $< 0.5\mu\text{m}$  and  $\geq 0.5\mu\text{m}$ , 129-130, 131
  - condensation nucleus counter, 133-134
  - filter holder assembly, 131-132
  - microcomputer system, 135-136
  - operation, 137
  - schematic, 130
  - test data, 137-138
  - variations, 139
- British Standards (See British Standards)
- DIN 24184 (filter media and filters for small-diameter aerosols), 219
- DIN 24185 (general ventilation filters), 219
- dioctyl phthalate/photometer, 127
- dust spot technique for ASHRAE 52-76:
  - air flows, 235
  - concentration and supply pressure, 235
  - development, 231-232
  - effects of carbon blacks, 235
  - number of holes, 235
  - test container, 232
  - test data, table, 234
- EUROVENT 4/5 (general ventilation filters), 218
- Federal Specification F-F-310: 216
- gaseous contaminant, 226
- for gas turbines, 261-262

gravimetric techniques, 128  
 HFATS (See High flow alternative filter test system)  
 MIL-STD-282 (thermal DOP test for HEPA filters), 216  
 sodium chloride/flame photometer, 128  
 UL 900 (flame resistance), 217  
 Filtration (See also Removal control)  
   for cleanrooms, 386  
   internal particle sources in cleanrooms, 386  
   systems for gas turbines, 261  
   theory for fibrous filters, 2-7  
 Fit testing, quantitative  
   history, 182-186  
   problems and research needs, 186-188  
 Flame resistance (UL 900), 217  
 Flat sheet  
   filter media, standard test for initial efficiency, 141-151  
   procedure, 146-151  
   test system and materials, 144-146  
   filtration performance test (See Dustron)  
 Flex test, 279-280  
 Flow (See also Inertial flow; Laminar flow; Slip flow; Turbulent flow)  
   fields in granular beds, 47-49  
 HEPA filters  
   characteristics, 370-372  
   standards for testing, 373-374  
   mixed, in cleanrooms, 396  
   and pressurization in cleanrooms, 399  
 Food industry, air cleanliness requirements, 388  
 Fractional efficiency (See Efficiency)

## G

Gas filtration (See also Aerosol filtration)  
   by fibrous media, 1-12  
   process  
     downstream cleanliness, 415-418  
     filters, 412-414  
 Gas turbines  
   air filtration systems, 261  
   air pollutant effects, 258-259

  ambient air quality and, 259-260  
   filters  
     aging, 263  
     configuration, 262-263  
     contaminants, 263-264  
     self-cleaning, 264-265  
     testing, 261-262  
 Granular bed filtration  
   flow fields, 47-49  
   minimum efficiency, 54-57  
   most penetrating particle size, 52-54  
   particle collection mechanisms, 50-52  
 Granular filters  
   dendrite growth, 64-65  
   deposition effect, 60-63  
   deposit morphology on model filters, fig., 65  
   effluent concentration and pressure drop data, fig., 61-62  
   performance  
     experimental determination, 69-71  
     theory, 63-69  
 Gravimetric techniques for filter testing, 128

## H

Heating, ventilating, and air conditioning systems  
   conventional, fig., 194  
   and minienvironment, 201  
 HEPA filters (See High efficiency particulate air filters)  
 HFATS (See High flow alternative filter test system)  
 High efficiency particulate air filters, 2  
   definition, 391  
   efficiency test specifications  
     aerosol size, 346-347  
     penetration rejection criterion, 347-348  
     test material density, 348  
   flow  
     characteristics, 370-372  
     constants and physical characteristics, 368  
     parameters and performance, 368-369  
     standards for testing, 373-374

HFATS (See High flow alternative filter test system)  
 homogeneous and layered, 369-370  
 leakage, in cleanrooms, 398-399  
 pressure and temperature standards, 374  
 pressure drop performance assessment using  
   inertial flow, 366-367  
   slip flow, 367  
   turbulent flow, 367-368  
   viscous laminar flow, 367  
 quality assurance measures, 377  
 recommendations, 377-379  
 test method selection  
   filter characterization/performance, 375-376  
   pressure drop only, 374-375  
   viscous laminar flow and, 376-377  
 thermal DOP test (MIL-STD-282), 216  
 High flow alternative test system  
   description, 349-351  
   performance  
     damaged filter tests, 351-353  
     intact filter tests, 353-357  
     measurement uncertainty, 357-358  
 HVAC systems (See Heating, ventilating, and air conditioning systems)  
 HV Dustron (See Dustron)

## I

IES-RP-CC-006-84-T: 393, 394, 396, 398, 400  
 Impaction, capillary tube particle deposition, 80-82  
 Indoor air quality procedure, 196  
 Inertial flow, HEPA filter  
   pressure drop and, 366-367  
 Interception, capillary tube  
   particle deposition by, 80-82

## L

Laminar flow  
   in cleanrooms, 396  
   viscous, 367, 376-377

## Latex

aerosols, 142, 144-146  
 spheres, results of ASTM Round Robin tests  
   challenge particles, 153  
   filter media, 153  
   participants in, 154  
   particle concentration and accumulation, 1612  
   percent penetration analysis, 154-160  
   pressure drop data analysis, 161-162  
   procedure, 154  
 Liquid extrusion technique, 98

## M

Media resistance, ASTM F-778-82: 216  
 Medical industry, air cleanliness requirements, 388  
 Membrane filters, 74-75, 409-412  
   capillary tube model, 76-83  
   conventional membranes and, 88-90  
   diffusion, 82-83  
   direct interception, 80-81  
   geometry, 77  
   impaction and interception, 81-82  
   inertial impaction, 80  
   overall filter efficiency, 83  
   particle deposition theories, 78-80  
   fibrous filter model, 83-86, 90-91  
   micrographs, fig., 76  
   Nucleopore, 86-88  
 Mercury porosimetry, 98  
 Methylene blue test (British Standard 2831), 217  
 Microelectronics industry  
   air cleanliness requirements, 387-388  
   process gas filter devices, 412-418  
 Microenvironment, personal  
   exposure control, 208-212  
 Microscopy, fabric filter media, 280-281  
 Military Standard 282: 216, 348  
 Minienvironment and HVAC system,  
   thermal and air quality control interaction, 201

Minimum bubble pressure, 99-105  
 Minimum collection efficiency,  
   granular bed filter, 54-57  
 Mitered cylinder pressure loss  
   model  
     matrix geometry, 30-37  
     single-layer screen models and,  
       42-43  
     slip effects, 40  
     theory, 29-30  
     thickness effects, 37-40  
 MIT Flex test, 279-280  
 Models  
   numerical (See Numerical  
     modeling)  
   membrane filter particle  
     collection  
       capillary tube, 76-83  
       fibrous, 83-86  
 Monodisperse aerosols, gener-  
   ation, 129-131  
 Most penetrating particle size,  
   52-54  
   concept, 405-407  
   membrane filter, fibrous model,  
     90-92  
 Mullen Burst test, 279  
 Multichannel analyzer  
   optical particle counter with,  
     145  
   for time-resolved measurements  
     of pulse-cleaned cartridge  
     dust collectors, 244-246

## N

National Institute for Occupa-  
   tional Health and Safety  
   particulate filter testing,  
     169-171  
   research objectives for up-  
     dating respirator filter  
     testing, 173-177  
   shortcomings of certification  
     testing methods, 171-173  
 NIOSH (See National Institute  
   for Occupational Health and  
   Safety)  
 Nucleopore filter  
   micrograph, fig., 76  
   model, 86-88, 92  
 Numerical modeling of electri-  
   cally enhanced fibrous  
   filtration  
   dendrite growth, 21-24  
   model formulation, 14-16  
   particle trajectories, 17-19

pressure drop in clean filters,  
   19-21

## O

Optical particle counter, 142,  
   145-147, 244-246

## P

Particle deposition (See also  
   Aerosol deposition)  
   effect on granular filters  
     experimental determination,  
       69-71  
     loading phenomenon, 60  
     theory, 63-69  
   stochastic simulation, 66-69  
   theories for capillary tube  
     model, table, 79

Particles  
   aerosols (See Aerosols)  
   measurement methods for  
     cleanrooms, 384-386  
   shedding, downstream, 415-418  
   trajectories with/without  
     electric field, fig., 18  
 Particle size distribution  
   filter resistance and, 303-306  
   specific resistance coeffi-  
     cient, 305-306  
   experimental measurement,  
     310  
   in situ measurement, 312-314  
   measurement, 311-312  
   in modeling, 310-311

Particle-size-penetration test,  
   development (ASHRAE 52-76),  
     223-226

Particle sizer, aerodynamic,  
   134-135

Particulate filters (See also  
   High efficiency particulate  
   air filters)  
   respirator, NIOSH objectives  
     for updating, 173-174  
   testing, 169-171

Permeability  
   air, measurement, 105-108  
   fabric test method, 278

Pharmaceutical industry, air  
   cleanliness requirements,  
     388

Pollutants, air, effect on gas  
   turbines, 258-259

Pore size distribution, 98-99



Pore throat size distribution,  
 99-105

Pore volume distribution (See  
 Pore size distribution)

Pressure drop  
 ASTM F21.20 Round Robin tests,  
 161-162  
 across granular bed, 47-49  
 baghouse, troubleshooting, 287  
 in clean fibrous filters, 19-21  
 during dust collector season-  
 ing, fig., 250  
 and effluent concentration in  
 granular filters, fig,  
 61-62  
 in electrostatically enhanced  
 fabric filters, 319  
 by external electric field,  
 324-328  
 mechanisms, 319-320  
 by particle charging, 321-324  
 filter resistance, 303-306  
 flat-sheet filters, 2-3  
 HEPA filters  
 flow characteristics, 370-372  
 flow standards for testing,  
 373-374  
 inertial flow and, 366-367  
 slip flow and, 367  
 test method selection,  
 374-376  
 turbulent flow and, 367-368  
 viscous laminar flow meters  
 as standards, 376-377  
 specific resistance coefficient  
 experimental measurements,  
 306-310  
in situ measurement, 312-314  
 measurement, 311-312

Pressure loss in fibrous filters  
 matrix geometry of mitered  
 cylinder model, 30-37  
 slip effects, 40  
 theory, 29-30  
 thickness effects, 37-40

Pressurization, air flow in  
 cleanrooms and, 399

Process gas  
 downstream cleanliness, 415-418  
 filters, 412-414

Pulse-cleaned cartridge dust  
 collectors  
 fractional efficiency, 244  
 instrumentation, 244-246  
 recovery from change, 249-251  
 seasoning, 249  
 short-time scale, 251-255

steady state efficiency,  
 248-249  
 time scales, 246-248  
 uncertainty, 246

Pulse-cleaning, effect on collec-  
 tor life and efficiency,  
 251-255

## Q

Quality assurance  
 filter bags, 283-285  
 HEPA filters, 377

Quantitative fit testing  
 history, 182-186  
 problems and research needs,  
 186-188

## R

Removal control, 197, 207, 212  
 acceptability criteria for  
 contaminant exposure,  
 198-200  
 air quality control and,  
 196-198  
 strategies, 200-212  
 personal exposure, 208-212  
 room ventilation, 201-208  
 ventilation control and,  
 194-196

Residential air filter equipment  
 (ARI Standard 680-80), 217

Respirator filtration  
 evaluation methods, 169-171  
 NIOSH objectives for updating,  
 173-177  
 shortcomings of certification  
 testing methods, 171-173

Respirators, quantitative fit  
 testing  
 history, 182-186  
 problems and research needs,  
 186-189

Reverse gas, dustcake removal  
 with, 336-337

Room acceptability ratio, 202,  
 207

Room purifiers, problems with,  
 226

## S

SAE J726 Air Cleaner Test Code  
 accuracy and initial effi-  
 ciency, 270-272  
 dust loading with specific  
 contaminants, 272

performance under wet/humid conditions, 272  
 recommendations, 273  
 standard test dust and reproducibility, 269-270  
 vibration and, 272  
 Seasoning, pulse-cleaned cartridge dust collectors, 249-250  
 Self-cleaning filters, 264-265  
 Shaking, dustcake removal by, 337-338  
 Shedding, particle, 415-418  
 Slip flow, 40  
   HEPA filter pressure drop and, 367  
 Sodium chloride/flame photometer technique, 128  
 Sodium-flame test (British Standard 3928), 217-218  
 Sonic power augmentation, dustcake removal by, 338  
 Specific resistance coefficient, 305-306  
   experimental measurement, 306-310  
   in situ measurement, 312-314  
   measurement, 311-312  
   in modeling, 310-311

## T

Tensile strength, fabric test methods, 278-279  
 Test dusts (See Dusts, test)  
 Thermal DOP test for HEPA filters (MIL-STD-282), 216  
 Thermal environment, acceptable, 199  
 Trajectories, particle, 17-19  
 Troubleshooting fabric filter bags, 285-287  
 Turbulent flow  
   in cleanrooms, 396  
   HEPA filter pressure drop and, 367-368

## U

UL 900 (flame resistance), 217  
 ULPA filters (See Ultra-low penetration air filters)  
 Ultra-low penetration air filters, 386  
 Uranin aerosol test (AFNOR NFX 44011), 218

United States Department of Energy  
   filter efficiency test specifications (proposed)  
   aerosol size, 346-347  
   penetration rejection criterion, 347-348  
   test material density, 348  
 HFATS  
   description, 349-351  
   measurement uncertainty, 357-358  
   performance, 351-357

## V

Validation of cleanrooms, 392-393  
   air cleanliness  
     definition and classification, 394-395  
     factors affecting, 397-398  
   air flow and pressurization, 399  
   Federal Standard 209B: 394-395, 398  
   HEPA filters and room integrity, 398-399  
   IES-RP-CC-006-84-T: 393  
   instrumentation and methodology, 395-396  
   room types and testing modes, 396-397

## Ventilation

control, 194-196, 201-208  
 filters, general  
   Australian Standard 1132-1973: 219  
   DIN 24185: 219  
   EUROVENT 4/5 Standard, 218  
 Ventilation rate procedure, 196  
 Verification of cleanrooms (See Validation of cleanrooms)  
 Very large scale integration circuits  
   design rules, table, 387  
   gaseous impurity concentrations, 403  
 Viscous laminar flow, HEPA filter pressure drop and, 367  
 Visual inspection, fabric filter bags, 281  
 VLSI circuits (See Very large scale integration circuits)

## W

"Worst case" aerosol, 173-174