INDUSTRIAL WASTE TREATMENT COURSE OUTLINE

VOLUME I, THIRD EDITION

Chapter	Торіс	Page
1	THE INDUSTRIAL PLANT OPERATOR Ken Kerri, Office of Water Programs, California State University, Sacramento, CA Dan Campbell, New York DEC, Albany, NY	1
2	INDUSTRIAL WASTEWATERS	
3	REGULATORY REQUIREMENTSRobert Montgomery, City of Oxnard, CA	69
4	PREVENTING AND MINIMIZING WASTES AT THE SOURCE Philip Lo, Sanitation Districts of LA County, Whittier, CA Theresa Dodge, Sanitation Districts of LA County, Whittier, CA Alison Gemmell, Del Monte Foods, Walnut Creek, CA Rob Lamppa, Land O'Lakes, Inc., Arden Hills, MN Mischelle Mische, Sanitation Districts of LA County, Whittier, CA John Polanski, University of Minnesota, Minneapolis, MN	109
5	INDUSTRIAL WASTE MONITORING Larry Bristow, Sacramento County, CA	151
6	FLOW MEASUREMENT	207
7	PRELIMINARY TREATMENT (EQUALIZATION, SCREENING, AND pH ADJUSTMENT)	249
8	PHYSICAL—CHEMICAL TREATMENT PROCESSES (COAGULATION, FLOCCULATION, AND SEDIMENTATION)	309
9	FILTRATIONJames L. Johnson, City of Santa Rosa, CA Ross Gudgel, Operational Performance Solutions, Pearl City, HI Robert G. Blanck, Koch Membrane Systems, Wilmington, MA Francis J. Brady, Koch Membrane Systems, Wilmington, MA	383

10	CARBON ADSORPTION)	481
11	TREATMENT OF METAL WASTESTREAMSBill Strangio, Strangio and Associates, San Jose, CA	517
12	INSTRUMENTATION Leonard Ainsworth, June Lake PUD, June Lake, CA	607
13	SAFETYRobert Reed, NEC Electronics, Inc., Roseville, CA Revised by Russ Armstrong, Sacramento County, CA	665
14	MAINTENANCE	739
Appendix	COMPREHENSIVE REVIEW QUESTIONS AND SUGGESTED ANSWERS	877
	INDUSTRIAL WASTE WORDS	903
	SUBJECT INDEX	949

SUBJECT INDEX

Α	Air chamber, pump, 835, 838
AIDS (Acquired Immune Deficiency Syndrome), 29, 676	Air drying, metal sludges, 574 Air gap device, 716, 717, 862, 863
Abbreviations	Air pockets, adsorption, 507
instrumentation, 616	Air pressure, air stripping, 490
regulatory requirements, 79–80	Air strainer, ejectors, 839
Abnormal conditions, carbon adsorption, 506	Air stripping
Abnormal operations	air pressure, 490
gravity filters, 408	chemical characteristics, 490
pressure filters, 426, 427	controlling discharge, 491
upflow filters, 440	discharge, 491
Abrasion number, 515	equipment, 491
Absorption, 495	incineration, 492
Absorption, alkaline buffers, 293	maintenance, 493
Accident	operation, 492
form, 720	organics, volatile, 489
frequency, 675	packed tower, 489
investigation, 718	principles, 490
operators, 675, 720	product recovery, 492
record, 686	purpose, 489
reports, 720	safety, 494
Accidental discharge, 201	start-up, 492
Accuracies, flow measurement, 240–244	temperature, 490
Acidity error, pH adjustment, 294	troubleshooting, 493
Acids, 182, 681	types of systems, 489
Acoustic flow measurement, 238	vapor phase, 491
Activated carbon adsorption	volatile organics, 489
See Carbon adsorption	Air supply instrumentation, 650
Activated sludge	Air-vacuum relief valve, 502
flow measurement, 244–246	Algae, 30, 32
pumps, 753	Alarm instrumentation, 649
Acts, pollution control, 81	Alarms, carbon adsorption, 511
Acute health effect, 35, 532, 682	Alarms, gravity filters, 406
Administration of a monitoring program	Algae, 410
database, 160	Alignment
dealing with industry, 161 enforcement, 160	motors, 814, 815, 816
organization, 160	pumps, 756, 782, 831, 847, 848 Alkali conversion table, 288
Administrative fine penalties, 100	
Adsorber loading, 505	Alkali neutralization graph, 289 Alkalinity error, pH adjustment, 294
Adsorption	Alternating current, 790
See Carbon adsorption	Alum, 327, 346, 418
Aeration tanks, activated sludge, 707	Aluminum sulfate, 327, 346, 418
Aerobic bacteria, 28	Amines, 711
Agglomeration, 322	Ammeter, 793
Agricultural use of water, 36	Amphoteric, 597
Air binding, 409, 425	Amps, 790
,,	F o, / / o

Anaerobic bacteria, 29	Biosolids, 116, 260
Anaerobic sludge digestion	Bloodborne Pathogens (BBP) program, 679
drip traps, 706	Blow down receiver, ejectors, 839
flame arresters, 706	Blowdown, 40
Analog readout, 791	Blowers
Analysis, carbon adsorption, 508	safety, 681, 862
•	· · · · · · · · · · · · · · · · · · ·
Anhydrous, 328	ventilation, 677, 862
Anion, 294	Bonnet valve, 855, 857
Annular space, 436	Bourdon tube, 630
Anodizing, 56	See Chapter 9, ADVANCED WASTE TREATMENT
Apparent density tests, 515	Breathing apparatus, self-contained, 719
Applying protective coating, 709	Bright dipping, 58
Aquatic vegetation, 36	Brine, reverse osmosis, 474
Aspirator, 367	Brinelling, 774
Audits, pollution prevention, 118	Bubble pipe, level measurement
Authority, pollution control, 81	See Volume II, Chapter 15
Automatic samplers, 163	Bubbler, level measurement, 633, 635
Axial flow pumps, 759, 766	Bubblers, flow measurement, 232
	Bubbler-type controls, 775
В	Budget administrator, 8
	Buffer capacity, 286, 537
BMR, 87, 95	Building codes, 101
BOD, 268	Buildings, maintenance, 750
Backflow prevention, 716	Bulking, sludge, 322, 408
Backwashing	
gravity filter, 396, 400, 402, 404, 406	С
pressure filters, 423–425	_
Bag filters, metal sludges, 569	COD removal efficiencies, adsorption, 506
Ball valves, 835, 838	Calculations, reverse osmosis, 466–474
Bar screens, 268–272	Calibration
Bar screens, safety, 701	equipment, 652
Baseline monitoring reports	flowmeters, 240, 241, 243
initial, 87	gas detectors, 862
requirements, 95	probes, 564
Bases, 681	Cannell, James W., 810
Basins, flow equalization, 244, 260, 261–267	Capacitance strips, 233
Batch processes, metals, 527, 533–536	Capacity, pump, 759, 833
Battery charging, 179, 206	Carbon adsorption
Bearings, electric motor, 841	abnormal adsorption conditions, 506
Bearings, pump, 753, 756, 761, 762, 764, 765, 767, 768, 769,	abrasion number, 515
774, 775, 785, 831, 834, 839	adsorber loading, 505
Belt drives, pump maintenance, 843, 845, 846	air pockets, 507
Benching, excavations, 696, 699	alarms, 511
Benefits	analysis, 508
flow equalization, 259	apparent density tests, 515
pollution prevention, 117	COD removal efficiencies, 506
Bernoulli effect, 641	carbon regeneration, 508
Best Available Technology (BAT), 91	carbon transfer, 509
Best Practicable Technology (BPT), 91	chemical loading, 505
Biochemical Oxygen Demand (BOD), 268	chemical warfare service (CWS) test, 515
Biocides, 711	coatings, deterioration, 507
Biological contamination, 33, 35	collapsed screens, 507
Biological process, effects of industrial wastes	decolorizing index, 515
See Toxic wastes	disposal of carbon, 510
Biological treatment, pH adjustment, 301	dust control, 510
Biomass, 493	effective size, 515
Diomass, T/J	CITCULATE SIZE, JIJ

Carbon adsorption (continued)	Cavitation, 369, 595, 760
emergency conditions, 506	Cellulose acetate membranes, 465
equipment, 496	Centrifugal force, 755
fixed beds, 497	Centrifugal pumps
fouling, 507	description, 753, 759, 761–767
hardness number, 515	maintenance, 783, 830
head losses, 507	Centrifugation
hydraulic loading, 505	See Chapter 3, ADVANCED WASTE TREATMENT
iodine number, 496, 515	Centrifuges, metal sludges, 568
laboratory procedures, 515	Chain drives, 844
manufacture of carbon, 495	Chain of custody, 172
methylene blue number, 516	Change oil, pump, 835
moisture, 516	Changed discharge, 96
molasses number, 496, 516	Channels (flow), maintenance, 751
moving bed, 497	Characteristics of industrial wastes, 159
operation, 505	Charging batteries, 179, 206
physical–chemical treatment, 481–516	Check valves, 783, 833, 839, 853, 854
plans, 510	Checklists, pollution prevention, 120, 123–150
plugged screens, 507	Chelating agent, 56, 301, 493, 531, 532
principles, 496	Chelation, 48, 56
process, 496	Chemical characteristics, wastewater, 28
purpose, 495	Chemical conditioning
reactivation of carbon, 508	See Chapter 3, ADVANCED WASTE TREATMENT
regeneration, carbon, 508	Chemical conditioning of sludge, dissolved air flotation (DAF)
safety, 509	thickeners, 373
sampling and analysis, 508	Chemical contamination, 35
shutdown, 506	Chemical feed
sieve analysis, 516	filters, 418
specifications, 510	flow measurement, 246
spent activated carbon, 508, 510	instrumentation, 641
start-up, 498–505	physical–chemical treatment, 309–382
total ash of regenerated carbon, 516	Chemical loading, adsorption, 505
transfer of carbon, 509	Chemical treatment
uniformity coefficient, 515	agglomeration, 322
unloading station, 510	alum, 327, 346
upflow column, 503, 504	aluminum sulfate, 327
upstream processes, 507, 511	bulking, 322
ventilation, 511	caustic soda, 345
Carbon regeneration, 508	chemical feed, 342–358
Carbon transfer, 509	chemical mixing, 342
Carbon usage, management, 481–516	chemical storage, 342
Carcinogens, 709, 711	chemicals, 327–331
Casing, pump, 753, 757, 761, 762	clarifiers, 358–366, 375, 376
Categorical pretreatment standards, 88–97	coagulation, 321, 358
Categories, pretreatment	colloids, 322
application, 93–97	co-precipitation, 326
determination request, 92	day tank, 342, 343
exempt, 92	destabilization, 324, 325
industrial, 89, 93	diaphragm pump, 349, 350
local limits, 92	
	equipment, 342–358
modification, 96	feed equipment, 342–358
regulated, 88–93	ferric chloride, 328
Cation, 294	flocculation, 321, 358, 359
Caustic soda, 345	gravimetric belt chemical feeder, 353
Caustic wastes, 182	iron salts, 324, 325, 328
Cave-ins, 696	iar test, 331–341

Chemical treatment (continued)	equipment, 865, 866
lime, 328, 344	high-velocity pressure units, 866
log, 356, 357	methods of clearing, 865, 866
MSDS, 340	pipes, 865
maintenance, 374	pressure clearing methods, 865, 866
material safety, 328, 340, 377	pumps, 866
material safety data sheet, 340	scum lines, 865
metal salts, 324, 325, 328	sludge lines, 865
operation, 355, 358, 374–377	valves, 865, 866
phosphate monitoring, 340	Closed channel, flow measurement, 218, 233–238
polishing process, 322, 323	Closed impeller, 763
polymer, 324, 325, 347	Coagulation, 299, 321, 358, 436
polymer map, 329, 330	Coarse screens, 268–272, 283
polymeric flocculants, 328	Coatings, deterioration, adsorption, 507
pumps, chemical feed, 348, 349, 350	Code of Federal Regulations (CFR), 81, 83, 84
rotary feeder, 352	Codes
safety, 340, 377	See Ordinances, local
sedimentation, 321, 358–377	
	Collection system
shutdown, 355	Collection system
solids contact clarifier, 362, 363	effects of discharges, 47–50
start-up, 355, 374, 375	flow equalization, 260
troubleshooting, 377, 378	pH adjustment, 285–304
tube settlers, 364, 365	Collection system, 689, 710
volumetric screw feeder, 350	Colloids, 322
Chemicals	Color, true, 338
feed, 342–358	Combustible gas monitor, 678, 682, 710
labeling, 722, 723, 727, 728	Comminution, safety, 702
mixing, 342	Common metals removal, 538–541
safety, 681, 708, 713	Comparative depth measurements, 240–242
settling, 327–331	Compatible pollutants, 38, 42
storage, 342, 713	Competent person, 676
toxic, 681	Complexed metals removal, 546
Chemicals, pH adjustment, 287	Compliance
Chemical warfare service (CWS) test, 515	reports, 95
CHEMTREC [(800) 424-9300], 600	schedule, 95
Chlorine monitor, 678	Composite samples, 163, 217, 246, 367, 580
Chlorine safety, 678, 703, 708, 729	Computerization, 655
Cholera, 29	Concentrated solutions, 43
"Christmas Tree" arrangement, reverse osmosis, 474, 475	Concentration-based standards, 93
Chromium, 532	Concentration factor, sludge, 372
Chronic health effect, 35, 532, 682	Concentration polarization, 456, 474
Cipolletti weir, 223, 583	Conditioning of sludges, chemical conditioning, 373
Circuit breakers, 795, 796, 797, 798–801	Conductivity, 51, 233
Clarifiers	Conductors, 791
chemical treatment, 358-366, 375, 376	Cones, traffic, 178
safety, 377, 704	Configurations
Clean Air Act regulations, 103	filters, 397, 398
Clean Water Act regulations, 103	membranes, 449
Cleaning pipelines, 865, 866	Confined space
Cleaning probes, 560	entry, 630
Cleaning procedures, membranes, 460	upflow filters, 441, 445
Cleaning pumps, 831	Confined space entry permit, 680
Clearing plugged pipes, pumps, and valves	Confined spaces, 179, 675, 676–681, 689, 703, 704, 707, 86
costs, 865	Connecting rods, 835, 838, 839
cutting tools, 866	Construction, equalization tanks, 265
digested sludge lines, 865	Contacts, starters, 810–813

Contamination	Department of Transportation (DOT) regulations, 104
biological, 33, 35	Desiccation, 652, 659
chemical, 35	Destabilization, chemical, 324, 325
radioactive, 35	Dial indicators, alignment, 847, 848
Continuous discharges, 45	Diaphragm bulb, level measurement, 775
Continuous monitoring, 161	Diaphragm pump, 349, 350, 593
Continuous processes, metals, 533–536	Diatomaceous earth, 569
Control systems	Differential pressure devices, 233, 234, 583, 584
flow equalization, 266	Digested sludge handling, unplugging pipelines, 865
instrumentation, 621–630	Digested sludge, pumps, 753
metal wastestreams, 560–568	Digester heating, heat exchanger, 704
pH adjustment, 298–299	Digestion, equipment safety, 704
Controllers	Digital readout, 791
pH adjustment, 298	Dilute solutions, 42
programmable, 567	Direct current, 790
Controllers, 649, 650	Discharge
Controls, level, 775, 840	changed, 96
Conventional pollutants, 116	pH adjustment, 300
Cooking water, 35	standards, prohibited, 87
Co-precipitation, 326	Discharge, pump, 753, 759, 782, 783, 784, 786, 839
Cost savings, pollution prevention, 117	Discharge table, weir, 221
Costs	Dischargers
preventive maintenance, 749	direct, 82
repair, 749	indirect, 82
safety, 718	regulated, 82
unplugging pipelines, 865	Discharges, industrial, 44, 45
Couplings, 756, 769, 782, 846, 847, 848	Disconnect switch, 796
Criminal actions, 100	Displaced volume meter, 235, 237, 583, 584
Cross connections, 716, 830	Disposal of carbon, 510
Current, electrical, 790, 791, 793, 794, 795, 796, 800, 801	Dissolved air flotation (DAF) thickeners
Current measurements, 567	age of sludge, 369
	air to solids (A/S) ratio, 370, 371, 373, 374
Cutting tools, plugged pipes, 866 Cycle	biological flotation, 367
natural purification, 32	biological sludges, 369
nutrient, 32	blanket thickness, 371, 373, 374
Cylinder, calibration, chemical pumps, 243	chemical conditioning, 373
D	concentration factor, 372
D	dispersed air flotation, 367
DDD 1 1 552	efficiency, 373
DPD method, 552	effluent, 373, 374
Dairy processing, 130–131	factors affecting performance, 369, 372
Dall flow tube, 235	float characteristics, 373
Dalton, 447	guidelines, operation, 369, 372
Database, 160	hydraulic loading, 369, 373
Dateometer, 843	observations, 373
Day tank, 420	operating guidelines, 369, 372
Day tank, chemicals, 342, 343	operation, 369, 372
Decant, 416	performance, 369, 372
Decant tank, filters, 425	pressure flotation, 367
Decant water, 264	primary sludge thickening, 369
Decibel, 688	recycle rate, 371
Decolorizing index, 515	rising sludge, 369
Dehumidifiers, 862	shutdown, 372
Delamination, 461	sludge blanket, 371, 374
Delegation of federal authority, 82	solids loading, 369, 373
Demineralization, reverse osmosis, 463	solids recovery, 372

Dissolved air flotation (DAF) thickeners (continued)	Electric shock, 684
start-up, 371	Electrical
thickened sludge characteristics, 371, 373	capacitance strips, 233
troubleshooting, 373, 374	instrumentation hazards, 628
vacuum flotation, 367	symbols, 616–620
variables, 369	Electrical controls, 775
visual inspection, 373	Electrical equipment maintenance, 788–803
withdrawal of sludge, 369	Electrical safety, 684
Dissolved solids, in wastewater, 30	Electrical system
Doctor blade, 275, 569	control, 795
Domestic sewage exemption, 102	starters, 810–813
Domestic wastes, 28	switch gear, 795
Domestic wastewater, characteristics, 28	Electricity
Doppler method, flow measurement, 238	circuit breakers, 795, 796, 797, 798–801
Dosimeter, 682	circuits, 788, 790, 792, 793, 794, 796, 800, 801
Drag out, 39, 119, 528	fuses, 796, 798
Drag shield, 696	hazards, 788
Drain, backwash, 400	meters, 791–795
Draining pumps, 775, 785, 834	starters, 810–813
Drinking water, 33, 862	terms, 790
Drip traps, 706	testers, 791–795
Drowning, 707	tools, 791–795
Drums, traffic control, 178	Electrode switches, 775, 840
Dry cleaning, 132	Electrode troubleshooting, 302
Drying sludge, 574	Electrodes, pH adjustment, 291
Dust control, carbon, 511	Electroless plating solutions, 531
Dusts, 675, 688	Electrolyte, 287, 328
Dye dilution method, 242	Electromagnetic flowmeter, 235
Dysentery, 29, 676	Elements
	control systems, 298
E	measuring, 645
	primary and secondary, 221–235
EPA	Emergency conditions, adsorption, 506
authority, 81	Emergency procedures
organizational structure, 82	electric shock, 685
pollution control, 81	planning, 719, 867
regulated categories, 92	Employers, operators, 5, 9
regulation development, 91	Emulsion, 260
reporting requirements, 94	Energy grade line, 219
Ear protecting devices, 688	Energy requirements, pumps, 759, 782, 786
Eccentric	Enforcement, 160
pipe, 756	Entrain, 703
pump, 835, 838	Equalization of flows
Economics, pollution prevention, 117	basins, 244, 260, 261–267
Eductor, 498	benefits, 259
Effective size, 515	collection system, 260
Effects, industrial wastewaters, 46–53	construction, tanks, 265
Efficiency, dissolved air flotation (DAF) thickeners, 373	controls, flow, 266
Efficiency, pump, 833	flows, 44
Effluent	location, 260
flow measurement, 243	manufacturing process, 261
pumps, 753	mixing, 265
Effluent effects, industrial wastewater, 53	need, 257
Effluent rate control valve, 405	operation strategy, 266
Ejectors, 768, 772, 839	pumps, 266
Electric motors, 775, 803–826, 841–843	sizing tank, 261–265

Equalization of flows (continued)	head loss, 396, 405
strategy, operation, 266	inlet, 400
tanks, 244, 260, 261–267	instrumentation, 405–406
volume, 261–265	log, operation, 413
when, 257	media, 400
Equalization, pH adjustment, 294	methods, 396
Equipment	mudballs, 400
	operation, 406–413
air stripping, 491 calibration, 652	-
	parts, 400–405
carbon adsorption, 496	plans, 414
chemical treatment, 342–358	rapid sand filter, 396, 402
records, 749, 750, 826, 827, 828	rate control valve, 405
service card, 749, 750	safety, 414
test, 652	scouring, media, 400
Equipment storage, 179	shutdown, 412
Equivalence point, 288	specifications, 414
Errors, pH adjustment, 294	strategy, 410
Etching and chemical milling, 58	systems, 395
Excavations, 696	totalizer, 405
Exemptions	troubleshooting, 412
domestic sewage, 102	troughs, 400
on-site treatment, 102	turbidity, 405
Exfiltration, 49	types, 396
Exothermic, 531	7.1
	underdrains, 400, 403
Explosive gases, 678, 682, 710, 711	wash water troughs, 400
Eye protection, 713, 714	Filters, membrane
_	See Membrane filtration
F	Filters, pressure
	abnormal operation, 426, 427
Face shield, 708, 713	backwash, 423-425
Face velocity, 293	chemical feed, 418
Failure, motors, 806, 807, 820-826	decant tank, 425
Fall arrest system, 676, 706	facilities, 416–425
Falling hazards, 630	filter feed pumps, 418
Federal pollution control regulations, 81	filters, 422
Federal Register, 81	holding tank, 416
Federal statutes, 101–104	maintenance, 426, 428
Also see Regulations	operation, 426
Feedback control, 295, 296	plans, 429
Feed equipment, chemical, 342–358	pumps, 418
Feed forward control, 295	recovery, backwash, 425
	•
Feeler gauge, alignment, 814	safety, 427
Felony criminal actions, 100	specifications, 429
Ferric chloride, 328	strategy, 426
Film badges, 682	use, 416, 417
Filter aid, 408	wet well, 416
Filter backwash, flows, 246	Filters, upflow
Filter feed pumps, 418	abnormal operation, 440
Filter press, 569	coagulation, 436
Filters, gravity	equipment, 433–436
abnormal operation, 408	flocculation, 436
alarms, 406	maintenance, 440, 443, 444
backwashing, 396, 400, 402, 404, 406	metering, flow, 436
description, 395	metering, turbidity, 433–436
drain, backwash, 400	operation, 436–440
effluent rate control valve, 405	plans, 445
• •	1 , -

Filters, upflow (continued)	Fine screens, 273–282, 283
safety, 445	Fines, administrative, 100
·	
specifications, 445	Fire, 714, 715
strategy, 439	Fire control, safety, 715
turbidity metering, 433–436	Fire drills, 719
use, 430	Fire extinguishers, 701, 714, 715, 719, 862
Filtration	First aid, 598
abnormal operation, 408, 426, 427, 440	First-aid kit, 862
alarms, 406	Fish, 36
backwashing, 396, 400, 402, 404, 406, 423–425	Fixed beds, carbon adsorption, 497
chemical feed, 418	Flame polished, 713
decant tank, 425	Flame trap, anaerobic digester, 706
description, 395	Flammables, sewers, 49
differential pressure, 399	Float control, 775, 831, 840
drain, backwash, 400	Float mechanism, level measurement, 775, 831, 840
effluent rate control valve, 405	Float switches, 775, 831, 840
equipment, upflow, 433–436	Floats
feed pumps, 418	flow measurement, 230, 231
gravity filters, 395–415	level, 634
head loss, 396, 405	Flocculation, 299, 321, 358, 359, 436
holding tank, 416	Flow equalization
inlet, 400	industrial wastes, 180
instrumentation, 405–406	See Equalization of flows
maintenance, 426, 428, 440, 443, 444	Flow measurement
media, 400	accuracies, 240-244
membrane filtration	acoustic flow measurement, 238
See Membrane filtration	activated sludge, 244-246
methods, 396	basics, 217–221
mudballs, 400, 426, 427	bubblers, 232
operation, 406–413, 426, 436–440, 456–463	calibration, 240, 241, 243
parts, 400–405, 430, 431	capacitance strips, 233
plans, 414, 429, 445	chemical feed, 246
pressure, differential, 399	Cipolletti weir, 223
pumps, pressure filters, 418	closed channel flow, 218, 233–238
rapid sand filter, 396, 402	comparative depth measurements, 240–242
rate control valve, 405	comparisons, 243, 244
recovery, backwash, 425	cylinder, calibration, 243
safety, 414, 427, 445, 463	Dall flow tube, 235
scouring, media, 400	devices, 218
shutdown, 412	differential pressure devices, 233, 234
specifications, 414, 429, 445	discharge, weir, 221
strategy, 410, 426, 439	displaced volume meter, 235, 237
systems, 395	doppler methods, 238
totalizer, 405	dye dilution method, 242
	·
troubleshooting, 412	effluent, 243
troughs, 400	electrical capacitance strips, 233
turbidity, 405, 410, 433–436	electromagnetic flowmeter, 235
types, 395	elements, primary and secondary, 221–235
underdrains, 400, 403	equalization basin, 244
wash water troughs, 400	filter backwash, 246
wet well, 416	floats, 230, 231
Also see Filters, gravity; Filters, pressure; Filters, upflow; and	flow nozzles, 226, 228, 233
Membrane filtration	flumes, 218, 220, 224–226
Final element, pH adjustment, 299	gauges, 230, 231

Flow measurement (continued)	Foot valves, 833
head, 218	Fouling
hydraulic calibration, 240	carbon adsorption, 507
influent, 243	membranes, 456
instrument calibration, 240	pH sensors, 293
Kennison nozzle, 226, 228	Free oil, 458
low flow measurements, 238	Fuels, safety, 710
magnetic flowmeter, 235	Fume hood, 713
mechanical flow devices, 235	Fumes, 678, 681, 682, 709, 711, 713
need, 217	Fundamentally different factors (FDF), 97
nozzles, flow, 226, 228, 233	Fuses, 781, 796, 798
open channel flow, 218, 221–233	, , , , , , , , , , , , , , , , , , ,
operation and maintenance, 226–230	G
orifice plate, 218, 234, 235	
Palmer-Bowlus flume, 226, 227, 241	Gas, detection, 862
Parshall flume, 224, 225, 241	Gas extraction, 139
pipe flow, 218, 233–238	Gases
pressure pipe flow, 218, 233, 234	characteristics, 678
pressure transducers, 233	explosive, 678, 682, 710, 711
primary elements, 221–230	explosive range, 678
primary sludge, 244	safe exposure, 678, 681
propeller meter, 238, 239	testing methods, 678
return activated sludge, 245	toxic, 678, 681, 682, 709, 711, 713
rotameter, 235, 236	Gasket, pump, 835
secondary elements/devices, 230–235	Gasoline, 182
staff gauge, 230, 231	Gasoline vapors, 678, 681, 682
stilling well, 230, 231	Gate valves, 850–853
stormwater, 238	Gauges, flow measurement, 230, 231
submerged pressure transducers, 233	Gear pump, 348
	Gear reducer, 835
transducers, pressure, 233 transit time flow measurement, 238	
ultrasonic devices, 232	Generation of wastewater, 39, 44, 54–62 Generators, 867
velocity meter, 235	Gland
Venturi nozzle, 218, 233, 234	
	pump, 758, 781, 784, 786 valve, 853
very low flow measurements, 238	
waste activated sludge, 245	Gold wastestreams, 532
weirs, 218, 220, 221–224	Good housekeeping
well, stilling, 230	management responsibilities, 675, 718
Flow measurement (rate and total), 636	safety, 701, 702, 704, 710
Flow measurement/totalization, 566, 582–584	Grab samples, 162, 580
Flow nozzles, 226, 228, 233, 583	Graving Glasses 205, 415
Flow regulation, 175, 180	Gravity filters, 395–415
Flowmeters, level measurement, 775	Also see Filters, gravity
Fluid milk processing, 133–134	Greasing, pump, 839
Fluidized, filter, 424	Grit channels, 703
Flumes, 218, 220, 224–226, 583	Grit, pumps, 753
Flux decline, 466	Ground, 801
Flux, membranes	Grounds, maintenance, 751
concentration dependent, 456	***
membrane, 453	H
water measurements, 461	TT 11: 0.1 : 1.505
Flux, reverse osmosis, 465, 466	Handling of chemicals, 597
Foam control, surface-active agents, 711	Hardness number, 515
Foaming, safety hazard, 711	Harness, safety, 676, 679, 862

Hazard communication, 103	I
Hazard communication program, 721–729	
Hazardous chemicals and wastes, safety, 595	IDLH, 584
Hazardous waste	IDLH (Immediately Dangerous to Life or Health), 708
disposal reports, 96	Imbalance, voltage, 808, 810
monitoring, 160	Imhoff cone, 30
regulations, 104	Immediately Dangerous to Life or Health (IDLH), 708
Hazards	Immiscible, solvents, 49
See Safety hazards	Immunization shots, 676
Head, flow measurement, 218	Impacts of waste discharges
Head loss	algae, 32
carbon adsorption, 507	human health, 29
gravity filter, 396, 405	nutrients, 30
Headworks, 701	odors, 28
Health effects	oxygen depletion, 28
acute, 35, 532	pathogenic bacteria, 29
chronic, 35, 532	sludge and scum, 28
organic wastes, 532	toxic substances, 30
Hearing protection devices, 688	Impellers, 753, 759, 761, 762, 763, 764, 766, 782, 784, 833
Heat exchanger, anaerobic digester, 704	Incineration, 492
Heated wastewaters, sewers, 50	Incline screw pumps, 768, 769
Heating (drying sludge), 574	Indicators, instruments, 645
Heavy metal removal, pH adjustment, 301	Industrial pretreatment categories, 89, 93
Hepatitis, 29, 676	Industrial use of water, 36
Hexavalent chromium, 532, 547	Industrial waste monitoring
High-temperature waste, 182	accidental discharge, 201
High-velocity pressure units, 866	administration, 160
History, pollution control regulations, 81	battery charging, 179, 206
Holding tank, filters, 416	care of monitoring equipment, 166
Hollow fiber membranes, 449	chain of custody, 172
Hood, fume, 713	characteristics of industrial wastes, 159
Housekeeping	charging batteries, 179, 206
management responsibilities, 675, 718	composite samples, 163
safety, 701, 702, 704, 710	confined spaces, 179
Hydraulic calibration, flowmeters, 240	continuous monitoring, 161
Hydraulic capacity, 47, 50	database, 160
Hydraulic grade line, 219	dealing with industry, 161
Hydraulic jump, 226, 711	enforcement, 160
Hydraulic loading	equipment storage, 179
carbon adsorption, 505	flow metering, 175
dissolved air flotation (DAF) thickeners, 369, 373	flows, regulation, 180
Hydraulic shock load, 183	grab samples, 162
Hydrocarbons, 182	hazardous wastes, 160
Hydrogen peroxide, odor control	hydrogen sulfide, 159
See Chapter 1, ADVANCED WASTE TREATMENT	identifying waste materials, 171
Hydrogen sulfide	importance, 159
hazards, 29	labeling samples, 172
industrial wastes, 159	locating samples, 172
monitor, 678	maintenance, 170
problems, 29	monitoring, 161, 179
safety hazard, 678, 681, 701, 711	
Hydrolysis, 469, 473	need, 159 objectives, 159
Hydroxide precipitation, metals, 534–536, 538–541, 551	odors, 159
	ordinance, sewer-use, 197
Hygiene, safety considerations, 676	
Hygroscopic, 598	Palmer-Bowlus flume, 163, 175

Industrial waste monitoring (continued)	industrial waste treatment system, 40
Parshall flume, 175	interference, 42, 51
permit, sewer-use, 187	intermittent discharges, 45
portable sampling equipment, 163	maintenance activities, 40
preservation of samples, 171, 173	manufacturing processes, 39, 54-62
pretreatment inspection, 161	metal finishing, 54–60
records, 201	metals, 183
refractory materials, 160	nitrogen, 183
regulation of high flows, 180	noncompatible pollutants, 38, 42
representative samples, 162	nutrients, 183
safety, 175, 206	odors, 183
sample preservation and security, 171	oil, 183
sampling points, 162	operator's responsibility, 46
security of samples, 171	organic solids, 182
self-monitoring, 161	POTW, effects on, 53
sewer service charges, 160	pathogens, 183
sewer-use ordinance, 160, 197	pesticides, 183
sewer-use permit, 187	phosphorus, 183
shock loads, 159	pollutants, 42
slug discharge, 171, 192	printed circuit board manufacturing, 60–62, 63
standard industrial classification, 160	radioactive wastes, 183
standard industrial classification, 100 storage of equipment, 179	references, 62
storage time and temperature of samples, 171	responsibility, operator's, 46
	· · · · · · · · · · · · · · · · · · ·
strategy for monitoring, 179	sludge disposal, effects on, 53
thermal wastes, 159	solids, 182
toxic wastes, 159	solvent, 182
traffic safety, 175	tastes, 183
warning systems, 181	thermal waste, 182
water meters, 175	toxic substances, 183
Industrial waste treatment, safety, 681, 682, 710, 711	treatment system, effects on, 50–54
Industrial waste treatment system, 40	turbidity, 182
Industrial wastes	variables, 42–46
need to treat, 32, 33	wastestreams, 42–46
reasons for treatment, 33	wastewater generation, 39, 44, 54–62
types, 28	Infections, 676
Industrial wastewaters	Infectious diseases, 676
acid, 182	Infectious hepatitis, 29
caustic, 182	Infiltration, 49
collection system effects, 47–50	Influent, flow measurement, 243
color, 182	Inlet, gravity filter, 400
compatible pollutants, 38, 42	Inorganic compounds, in wastewater, 31
concentrated solutions, 42	Inorganic wastes, 28
dilute solutions, 42	Inspection of facilities, 751
discharges, 44, 45	Instrument calibration, flowmeters, 240
effects, 46–53	Instrumentation
effluent effects, 53	air supply, 650
frequency, 44	alarms, 649
gasoline, 182	Bourdon tube, 630
generation of wastewater, 39, 44, 54-62	bubbler, 633, 635
grease, 183	calibration, equipment, 652
heavy metals, 183	categories, 645
high temperature, 182	chemical feed rate, 641
hydraulic shock load, 183	computerization, 655
hydrocarbons, 182	control systems, 621–630
importance, 38–41	controllers, 649, 650
-	

Instrumentation (continued)	K
electrical hazards, 628	
electrical symbols, 616–620	Kennison nozzle, 226, 228
elements, measuring, 645	
floats, 634	L
flow measurements (rate and total), 636	
gravity filter, 405–406	Labeling samples, 172
indicators, 645	Labels, chemicals, 722, 723, 727, 728
laboratory, 652	Laboratory equipment
level measurement, 632–635	breathing apparatus, self-contained, 719
maintenance, 656–660	face shield, 708, 713
measurement systems, 621, 622, 630–642	Laboratory hazards
measuring elements, 645	hydrogen sulfide, 678, 681, 701, 711
mechanical hazards, 629	tetanus, 676
microprocessors, 656	Laboratory, instrumentation, 652
motor control panel, 625	Laboratory procedures, carbon adsorption, 515
operation and maintenance, 656–660	Laboratory safety
orifice plate, 640, 641	face shield, 708, 713
panel instruments, 645	tetanus, 676
pneumatic hazards, 629	Lagoons, safety, 707
pressure measurements, 630	Lamella settler, 541–543
probes, 633, 634	Land use ordinances, 101
process analytical instrumentation, 642	Landscaping, 751
recorders, 646	Lantern ring, 831, 833
rotameter, 636	Launders, 436
safety, 628–630	Let's Build a Pump, 754
sensors/transducers, 630–642	Level controls, 567
shutdown, 657–659	Level measurement instruments, 632–635
start-up, 657–659	Library, plant, 752
symbols, 616–620	Lifeline, 676
test equipment, 652	Lift stations, 701, 867
totalizers, 646	Lifting, safe practices, 695
transducers, 630–642	Lime, chemical treatment, 328, 344
Venturi meter, 640, 641	Lipophilic, 53
VOM (Volt-Ohm-Milliammeter), 652, 654	Livestock watering, 36
Instrumentation and controls, 560–568, 592	Loading of material and product, 118
Insulation	Local
materials, 806, 807	limits, 92
motors, 806, 807	ordinances, 98
Insulators, 791	Also see Ordinances, local
Interference, 42, 51	Location, flow equalization, 260
Intermittent discharges, 45	Lockout tag, 685, 702, 788, 789, 831, 832
Iodine number, 496, 515	Lockout/tagout procedures, 685
Ion, 286	Log
Ion exchange, 553–557	chemical feeder, 356, 357
Ion exchange troubleshooting, 555–557	filter operation, 413
Iron salts, 324, 325, 328	Low flow measurements, 238
J	Lower explosive limit, 682, 683, 701, 710 Lubrication, 756, 768, 774, 775, 782, 817, 820, 831, 839, 841, 843, 845, 847, 853
Jar test, 331–341, 408	
Jobs for operators	M
duties, 5	
locations, 5	MSDS (Material Safety Data Sheet), 340, 414, 681, 710, 712,
opportunities, 9	723–725, 777, 865
Jogging, 823	Magnetic flowmeter, 235, 583, 584

Maintenance pump-driving equipment, 775 activities, 40 radial flow pumps, 759, 766 air stripping, 493 reciprocating pumps, 759, 786, 835, 838 chemical treatment, 374 repair shop, 753 electric motors, 775, 803–826, 841–843 screw-flow pumps, 768, 770, 771, 786 electrical equipment, 788–803 shutdown, 775, 782, 784, 786 flowmeters, 226–230 single-stage pumps, 759, 767 mechanical seals, 768, 773, 831 sludge pump, 759, 786, 835, 838 metal wastestreams, 590 start-up, 759, 774, 781, 782, 785 motors, 803–826, 841–843 submersible pump, 759, 764 pH adjustment, 302 troubleshooting, 777–782, 845 pressure filters, 426, 428 turbine pumps, 759, 767 pumps, 829 vertical wet well pump, 759, 764, 767, 783, 784 upflow filters, 440, 443, 444 Also see Mechanical maintenance, Meter maintenance,	and
air stripping, 493 chemical treatment, 374 electric motors, 775, 803–826, 841–843 electrical equipment, 788–803 flowmeters, 226–230 mechanical seals, 768, 773, 831 metal wastestreams, 590 motors, 803–826, 841–843 pH adjustment, 302 pressure filters, 426, 428 pumps, 829 screens, 282–284 upflow filters, 440, 443, 444 reciprocating pumps, 759, 786, 835, 838 repair shop, 753 screw-flow pumps, 768, 770, 771, 786 shutdown, 775, 782, 784, 786 shutdown, 775, 782, 787 strage pumps, 759, 766 start-up, 759, 774, 781, 782, 785 submersible pump, 759, 764 troubleshooting, 777–782, 845 turbine pumps, 759, 767 wet well pump, 759, 767 wet well pump, 759, 767, 783, 784 upflow filters, 440, 443, 444 Also see Mechanical maintenance, Meter maintenance,	and
chemical treatment, 374 electric motors, 775, 803–826, 841–843 electrical equipment, 788–803 flowmeters, 226–230 mechanical seals, 768, 773, 831 metal wastestreams, 590 motors, 803–826, 841–843 pH adjustment, 302 pressure filters, 426, 428 pumps, 829 screens, 282–284 upflow filters, 440, 443, 444 repair shop, 753 screw-flow pumps, 768, 770, 771, 786 screw-flow pumps, 768, 770, 771, 786 screw-flow pumps, 759, 767 screw-flo	and
electric motors, 775, 803–826, 841–843 electrical equipment, 788–803 flowmeters, 226–230 mechanical seals, 768, 773, 831 metal wastestreams, 590 motors, 803–826, 841–843 pH adjustment, 302 pressure filters, 426, 428 pumps, 829 screens, 282–284 upflow filters, 440, 443, 444 screw-flow pumps, 768, 770, 771, 786 shutdown, 775, 782, 784, 786 shutdown, 775, 782, 784 shutdown, 775, 785, 786 shutdown, 775, 785, 786 shutdown, 775, 785 shutd	and
electrical equipment, 788–803 flowmeters, 226–230 mechanical seals, 768, 773, 831 metal wastestreams, 590 motors, 803–826, 841–843 pH adjustment, 302 pressure filters, 426, 428 pumps, 829 screens, 282–284 upflow filters, 440, 443, 444 shutdown, 775, 782, 784, 786 single-stage pumps, 759, 767 single-stage pumps, 759, 768 single-stage pumps, 759, 786, 835, 838 start-up, 759, 781, 782, 785 start-up, 759, 774, 781, 782, 785 submersible pump, 759, 764 troubleshooting, 777–782, 845 turbine pumps, 759, 767 vertical wet well pump, 759, 767 wet well pump, 759, 764, 767, 783, 784 Also see Mechanical maintenance, Meter maintenance,	and
flowmeters, 226–230 single-stage pumps, 759, 767 mechanical seals, 768, 773, 831 sludge pump, 759, 786, 835, 838 metal wastestreams, 590 start-up, 759, 774, 781, 782, 785 motors, 803–826, 841–843 submersible pump, 759, 764 pH adjustment, 302 troubleshooting, 777–782, 845 pressure filters, 426, 428 turbine pumps, 759, 767 pumps, 829 vertical wet well pump, 759, 767 screens, 282–284 wet well pump, 759, 764, 767, 783, 784 upflow filters, 440, 443, 444 Also see Mechanical maintenance, Meter maintenance,	and
flowmeters, 226–230 single-stage pumps, 759, 767 mechanical seals, 768, 773, 831 sludge pump, 759, 786, 835, 838 metal wastestreams, 590 start-up, 759, 774, 781, 782, 785 motors, 803–826, 841–843 submersible pump, 759, 764 pH adjustment, 302 troubleshooting, 777–782, 845 pressure filters, 426, 428 turbine pumps, 759, 767 pumps, 829 vertical wet well pump, 759, 767 screens, 282–284 wet well pump, 759, 764, 767, 783, 784 upflow filters, 440, 443, 444 Also see Mechanical maintenance, Meter maintenance,	and
metal wastestreams, 590 start-up, 759, 774, 781, 782, 785 motors, 803–826, 841–843 submersible pump, 759, 764 troubleshooting, 777–782, 845 pressure filters, 426, 428 turbine pumps, 759, 767 pumps, 829 vertical wet well pump, 759, 767 screens, 282–284 wet well pump, 759, 764, 767, 783, 784 upflow filters, 440, 443, 444 Also see Mechanical maintenance, Meter maintenance,	and
motors, 803–826, 841–843 pH adjustment, 302 pressure filters, 426, 428 pumps, 829 screens, 282–284 upflow filters, 440, 443, 444 submersible pump, 759, 764 troubleshooting, 777–782, 845 turbine pumps, 759, 767 vertical wet well pump, 759, 767 wet well pump, 759, 764, 767, 783, 784 Also see Mechanical maintenance, Meter maintenance,	and
pH adjustment, 302 troubleshooting, 777–782, 845 pressure filters, 426, 428 turbine pumps, 759, 767 pumps, 829 vertical wet well pump, 759, 767 screens, 282–284 wet well pump, 759, 764, 767, 783, 784 upflow filters, 440, 443, 444 Also see Mechanical maintenance, Meter maintenance,	and
pressure filters, 426, 428 turbine pumps, 759, 767 pumps, 829 vertical wet well pump, 759, 767 screens, 282–284 wet well pump, 759, 764, 767, 783, 784 upflow filters, 440, 443, 444 Also see Mechanical maintenance, Meter maintenance,	and
pressure filters, 426, 428 turbine pumps, 759, 767 pumps, 829 vertical wet well pump, 759, 767 screens, 282–284 wet well pump, 759, 764, 767, 783, 784 upflow filters, 440, 443, 444 Also see Mechanical maintenance, Meter maintenance,	and
screens, 282–284 wet well pump, 759, 764, 767, 783, 784 upflow filters, 440, 443, 444 Also see Mechanical maintenance, Meter maintenance,	and
upflow filters, 440, 443, 444 Also see Mechanical maintenance, Meter maintenance,	and
•	and
valves, 833, 835, 838, 839, 850, 853, 855–859 chapters 12 (607–664) and 14 (739–875)	
Maintenance activities, 40 Mechanical flow devices, 235	
Maintenance, instruments, 656–660 Mechanical hazards, 629	
Maintenance program, pump, 830 Mechanical maintenance	
Management support, 118 air chamber, 835, 838	
Manholes, 689, 695 air gap separation systems, 862, 863	
Manometer, flow measurements, 235 alignment, 756, 782, 814, 815, 816, 831, 847, 848	
Manufacture of carbon, 495 ball valves, 835, 838	
Manufacturing process bearings, 831, 839, 841, 843	
flow equalization, 261 belt drives, 843–844, 845, 846	
troubleshooting pH changes, 304 capacity, pump, 759, 833	
Manufacturing processes, 39, 54–62 centrifugal pumps, 783, 830	
Map, polymer, 329, 330 chain drives, 844	
Mass-based standards, 93 change oil, 835, 845	
Mass emission rate, 43 check valves, 783, 833, 839, 853, 854	
Material distribution systems, 118 cleaning pump, 831	
Material Safety Data Sheet (MSDS), 340, 414, 681, 710, 712, connecting rods, 835, 838, 839	
723–725, 777, 865 controls, 831	
Material storage and loading, 118 couplings, 756, 769, 782, 846, 847, 848	
Materials, membrane, 449 dehumidifiers, 862	
Mean, 259 draining pump, 775, 785, 834	
Measurement electrode, 291 eccentric, 835, 838	
Measurement of gases, 678, 679, 680, 681, 682, 683, 703 efficiency, pump, 833	
Measurement systems, 621, 622, 630–642 ejectors, 768, 772, 839	
Measuring elements, 645 electric motors, 775, 803–826, 841–843	
Meat packing, beef, 135 electrode switches, 840	
Mechanical bar screen, 269 equipment service card, 749, 750	
Mechanical equipment float switches, 831, 840	
axial flow pumps, 759, 766 frequency of service, 749	
centrifugal pumps, 753, 759, 761–767, 783, 830 gaskets, 835	
electric motors, 775, 803–826, 841–843 gate valves, 850–853	
electrical controls, 775 gear, reducer, 835	
incline screw pumps, 768, 769 greasing, 839	
lubrication, 756, 847 impeller, 833	
multi-stage pumps, 759 lantern ring, 831, 833	
operation, 774, 782 lubrication, 756, 768, 774, 775, 782, 817, 820, 831, 8	339,
piston pumps, 759, 786, 835, 838 841, 843, 845, 847, 853	. ,
pneumatic ejectors, 768, 772, 839 mechanical seals, 831	
positive displacement pump, 759, 786, 835, 838 noises, 782, 835, 841, 845, 847	
progressive cavity pumps, 768, 770, 771, 786, 839 oil change, 835, 845	

Mechanical maintenance (continued)	plate and frame membranes, 452
packing, 770, 781, 782, 786, 830, 831, 833, 834, 836–837,	pressure, transmembrane, 455
838, 839, 850, 851	pretreatment, feed, 458
piston pumps, 835, 838	recirculation flow, 455
plug valves, 853, 855–859	recordkeeping, 463
plunger pumps, 835, 838	reverse osmosis, 449
pneumatic ejectors, 768, 772, 839	safety, 463
positive displacement pumps, 835, 838	sampling, 462
preventive maintenance, 830, 865	spiral membranes, 451
progressive cavity pumps, 839	temperature, 456
propeller pumps, 839	transmembrane pressure, 455
pumps, general, 830	tubular membranes, 449
reciprocating pumps, 835, 838	types, 447
reducer, gear, 835	ultrafiltraton, 447
rings, pump, 757, 761, 782, 784, 831, 833	Membrane life, 449
rods, 835, 838, 839	Membranes
safety equipment, 862	performance, 465
seals, 768, 773, 782, 783, 784, 785, 830, 831, 833	properties, 465
service record card, 749, 750	reverse osmosis, 463, 465, 466
shear pins, 835, 849	Mercaptans, 47
sludge pump, 835, 838	Metal fabrication, 136–137
sluice gates, 853, 860, 861	Metal finishing, 54-60, 120, 137-138
stuffing box, 758, 761, 831, 850, 851, 852	Metal finishing standards, 92
switches, 775, 831, 840	Metal removal, 301
TDH, 833	Metal salts, 324, 325, 328
total dynamic head, 833	Metal wastestreams
troubleshooting, 777–782, 845	air drying, 574
valve chamber gasket, 835	bag filters, 569
valves, 833, 835, 838, 839, 850, 853, 855–859	batch processes, 527, 533–536
variable-speed belt drives, 845	calibration of probes, 564
vibrations, 783, 785, 817, 841, 847	centrifuges, 568
water seal, 831, 833	chelating agents, 531, 532
wearing rings, 757, 761, 782, 784, 833	chromium, 532
Mechanical operation, troubleshooting pH adjustment, 302,	cleaning probes, 560
303	common metals removal, 538–541
Mechanical seals, 768, 773, 831	complexed metals removal, 546
Media, gravity filter, 400	continuous processes, 533–536
Megger, 794	controllers, programmable, 567
Megohm, 794	controls, 560–568
Membrane filtration (cross flow)	current measurement, 567
cleaning procedures, 460	cyanide, 532, 549–552
concentrating components, 453	cyanide destruction, 549–552
configurations, membranes, 449	dewatering, sludge, 568–574
elements of membrane process, 453	dilute rinse waters, 532
feed pretreatment, 458	drag out, 528
flux, concentration dependent, 456	drying sludge, 574
flux, membrane, 453	electroless plating solutions, 531
flux, water measurements, 461	filter press, 569
fouling, 456	first aid, 598
hollow fiber membranes, 449	flow measurement/totalization, 566, 582–584
materials, membrane, 449	gold wastestreams, 532
membrane life, 449	handling of chemicals, 597
microfiltration, 447	hazardous chemicals and wastes, safety, 595
nanofiltration, 449	heating (drying sludge), 574
operation, 456–463	hexavalent chromium, 532, 547
permeate, 453	hydroxide precipitation, 534–536, 538–541, 551
permeant, 199	11/01/01/02 precipitation, 154-150, 150-141, 1)1

Metal wastestreams (continued)	Methane gas, 678, 704
instrumentation and controls, 560–568, 592	Methylene blue number, 516
ion exchange, 553–557	Microfiltration, 447
Lamella settler, 541–543	Micron, 273, 322, 496
level controls, 567	Microprocessors, 656
maintenance, 590	Milk processing, 133–134
metallic sludge dewatering, 568-574	Mineral rejection, 466, 467, 468
methods of treatment, 527	Miscible, solvents, 40
neutralization, 537–538	Misdemeanor criminal actions, 100
normal operation, 577–590	Mixing
ORP probes, 560–566, 592	flow equalization, 265
oily waste removal, 557	pH adjustment, 296
operation, 576–590	Moisture, carbon adsorption, 516
organically contaminated wastewaters, 532	Molasses number, 496, 516
organics, toxic, 558	Monitoring, industrial wastes
pH adjustment, 537–538	accidental discharge, 201
pH probes, 560–566, 591	acids, 159
pickle, 533	alkalies, 159
precious metals recovery, 553–557	collection system, 159
preservation of samples, 580	corrosion, 159
probes, 560–566, 591, 592	cyanide, 159
processes, treatment, 533–558	flammable materials, 159
programmable controllers, 567	hazardous wastes, 160
pumps, 585–590, 593	hydrogen sulfide, 159
reduction of hexavalent chromium, 547	labeling samples, 171, 172
representative sampling, 579	Palmer-Bowlus flume, 163, 175
resistance measurements, 567	Parshall flume, 175
reverse osmosis, 555	records, 201
rinse waters, 530, 532	refractory materials, 160
safety, 549, 590, 595-600	sewer service charges, 160
sampling, 579–581	sewer-use ordinance, 160, 197
sampling devices, 580	slug discharge, 171, 192
sand filter, 545	standard industrial classification, 160
silver wastestreams, 532	thermal wastes, 159
sludge dewatering, 568–574	Monitoring, TTO, 94
sludge drying, 574	Mother circuit board, 593
solvent control, 558	Motor control center, 802
source control, 528	Motor control panel, 625
sources, 528	Motor protection devices, 796, 800, 801
spare parts inventory, 591	Motor, pump, 785
spent baths, 531	Motors
storage and handling of chemicals, 597	alignment, 814, 815, 816
sulfide precipitation, 546	contacts, 810–813
toxic organics, 558	electric, 775, 803–826, 841–843
treatment processes, 533–558	failure, 806, 807, 820-826
troubleshooting probes, 565	humming, 841
troubleshooting processes, 591–595	induction, 825
vacuum drying of sludge, 574	insulation, 806, 807
vacuum filters, 569	lubrication, 817, 820
ventilation and exhaust systems, 584	performance, 818–819
voltage measurements, 567	pump, 785
waste minimization, 528	records, 826, 828
wastestream types, 531–533	rotation, 817
Metallic sludge dewatering, 568–574	safety, 813
Metals, 183	starters, 810–813
Meters, electrical, 791–795	temperature limits, 785, 807

Motors (continued) troubleshooting, 820–826 types, 803	Occupational Safety and Health Act (OSHA) regulations, 103 Odors industrial wastes, 159, 183
vibrations, 817, 841, 847	sewers, 47
Moving bed, carbon adsorption, 497	Ohmmeter, 794
Mudballs, 400, 426, 427	Ohm's Law, 790
Multimeter, 791, 792	Oil and gas extracting, 139
Multi-stage pumps, 759	Oil change, pump, 835
With stage pumps, 799	Oily waste removal, 557
N	Olfactory fatigue, 681
14	On-site treatment exemption, 102
NFPA 820 (National Fire Protection Association Standard	Open channel flow, 218, 221–233
820), 684, 704	
	Open impeller, 763
NPDES permit program, 83	Operation
NPDES permits, 85, 416	air stripping, 492
Nameplate, 355, 790, 803 Nanofiltration, 449	carbon adsorption, 505
Nanofiltration, reverse osmosis, 469	chemical treatment, 355, 358, 374–377
	dissolved air flotation (DAF) thickeners, 369, 372
Naphtha, 711	gravity filters, 406–413
Nappe, 221, 222, 224	instrumentation, 656–660
National Fire Protection Association Standard 820 (NFPA	membranes, 456–463
820), 684, 704	metals treatment, 576–590
National Pollutant Discharge Elimination System	pressure filters, 426
permits, 85	pumps, 774, 782
Natural purification, 5, 32	sludge thickeners, 371
Nephelometric, 436	upflow filters, 436–440
Net gross calculations, 97	Operating practices, pollution prevention, 117
Neutralization, 285, 537–538	Operation and maintenance (O & M) manuals, 752
Neutralizing reagents, 286	Operation and maintenance, flowmeters, 226–230
Nitrogen, cycle, 32	Operation guidelines, dissolved air flotation (DAF) thickeners,
Nitrogen, industrial wastes, 183	369, 372
Noise, safety, 685	Operation strategy, flow equalization, 266
Noisy chain drive, 845	Operational strategy
Noisy electric motor, 841	industrial waste monitoring, 180
Noisy pump, 782, 835	monitoring programs, 179
Noncategorical industries, local limits, 92	Operator
Noncompatible pollutants, 38, 42	administrator, 8
Nonsparking tools, 704	duties, 5
Normal operation, metals treatment, 577–590	employers, 5, 9
Notification of changed discharge, 96	employment, 5, 9
Nozzles, flow, 226, 228, 233, 583	job duties, 5
Nuclear power plants, 28	job locations, 5
Nutrient cycle, 32	job opportunities, 9
Nutrients, 30, 183	pay, 5
_	public relations, 8
0	qualifications, 6, 7
	safety, 9
O & M (Operation and Maintenance) manual, 752	training, 6, 10, 721, 728
ORP, 51, 301	Operator's responsibility, 46
ORP probes, 560–566, 592	Operator's role, pollution prevention, 116
OSHA (Occupational Safety and Health Act), 179, 677, 688	Opportunities, pollution prevention, 117–119
OSHA regulations, 103	Ordinance, sewer-use, 197
Objectives	Ordinances, local
maintenance, 745	building codes, 101
safety, 670	land use, 101
Observations, dissolved air flotation (DAF) thickeners, 373	underground tank, 101
Occupational Safety and Health Act (OSHA), 179, 677, 688	wastewater, 98-100

Ordinances, sanitary sewer, 100	biological treatment, 300
Organic compounds in wastewater, 31	chemicals used, 287
Organic loading or overloads	control system, 298–299
See specific process of interest	controller, 298
Organic, wastes, 182	dead time, 296
Organically contaminated wastewaters, 532	definition, 286
Organics	discharge, 300
total toxic, 94	electrode troubleshooting, 302
toxic, 558	electrodes, 291
volatile, 489	elements, 298
Orifice plate, 218, 234, 235, 424, 583, 584, 640, 641	equalization, 294
Osmosis, 463, 464	errors, 294
Overload protection, 796	face velocity, 293
Oxidation, chemical, pH adjustment, 301	feedback control, 295, 296
Oxidation-reduction potential (ORP), 51, 301	feed forward control, 295
Oxygen consuming wastes, 36	final element, 299
Oxygen deficiency/enrichment, 675, 676, 678, 681	fouling, 293
Oxygen depletion, 28	heavy metal removal, 301
Oxygen depiction, 20	maintenance, 302
P	manufacturing process changes, troubleshooting, 30-
1	measurement electrode, 291
PLC (programmable logic controller), 458, 812	mechanical operation, troubleshooting, 302, 303
POTW, 7, 33	metal removal, 301
effects, wastestreams, 53	mixing, 296
facilities, 98	9
	need, 285
Packed tower, air stripping, 489	oxidation, 301
Packing, 770, 781, 782, 786, 830, 831, 833, 834, 836–837,	primary element, 298
838, 839, 850, 851	reduction, 301
Paint, building and equipment, 750	reference electrode, 291
Paints, 129	residence time, 296
Palmer-Bowlus flume, 163, 175, 226, 227, 241, 583	response time, 293
Panel instruments, 645	sensors, 290–294
Parshall flume, 175, 224, 225, 241, 583	strategy, 294
Pathogens, 183	temperature, 293
Pay for operators, 5	titration curves, 287, 288, 290
Penalties, administrative fines, 100	transmitter, 298
Permeability constants, 466	troubleshooting, 302–304
Permeate, 453, 466	velocity, face, 293
Permeate projections, computerized, 470, 471	pH control
Permit, confined space entry, 680	See pH adjustment
Permit, sewer-use, 187	pH, effects on, reverse osmosis, 469, 473
Permits, effluent discharge, 85	pH probes, 290-294, 560-566, 591
Permits NPDES, 83, 416	Phosgene, 711
Personal hygiene, 676	Phosphate monitoring, 340
Personal training, 6	Phosphorus, industrial wastewaters, 183
Pesticides, 129, 183	Photo processing, 146
Petroleum refining, 140–145	Physical injuries, 676
pH	Physical treatment, clarification
adjustment, 285–304, 537–538	equipment, 358–366
definition, 30	operation, 374–377
probes, 290–294, 560–566, 591	safety, 377
problems, sewers, 48	troubleshooting, 377, 378
safety, 712	Physical treatment processes
pH adjustment	See Air stripping, Carbon adsorption, Filtration
absorption, alkaline buffers, 293	Pickle, 533
	- 10
	Pine flow measurements 218 233_238
acidity error, 294 alkalinity error, 294	Pipe flow measurements, 218, 233–238 Piping, maintenance, 865

Piston pumps, 759, 786, 835, 838	oil and gas extraction, 139
Pitot tube, 584	operating practices, 117
Plans	operator's role, 27, 116
carbon adsorption, 510	opportunities, 117–119
gravity filters, 414	paints, 129
pressure filters, 429	pesticides, 129
upflow filters, 445	petroleum refining, 140–145
Plans and specifications	photo processing, 146
electrical systems, 867	printed circuit board manufacturing, 146–147
equipment, 867	printing, 148
lift stations, 867	process modification, 119
pump stations, 867	process operations, 118
safety, 720	product reformulation, 119
Plant, appearance, 751	product storage and loading, 118
Plate and frame membranes, 452	pulp and paper manufacturing, Kraft segment, 149
Plug valves, 853, 855–859	radiator repair, 150
Plugged screens, carbon adsorption, 507	raw material purchasing, 118
Plugging sewers, 47	reformulation of product, 119
Plunger pumps, 348, 835, 838	regulatory requirements, 116
Pneumatic ejectors, 768, 772, 839	segregation of wastes, 118
Pneumatic hazards, 629	storage of material and product, 118
Pocket dosimeter, 682	strategy, 115
Polarization, concentration, 456	walk-through, 120
Pole shader, 823	waste segregation, 118
Policy, safety, 720	Polyelectrolyte, 328, 408, 419
Polio, 29	Polymer, 324, 325, 347, 416, 419, 436, 709
Polishing process, chemical treatment, 322, 323	Polymer map, 329, 330
Pollutants	Polymeric flocculants, 328
conventional, 116	Ponds, safety, 707
priority toxic, 90	Portable generators, 867
Pollutants from wastestreams, 42	Portable samplers, 163
Pollution	Positive displacement pumps
solids, 36	sludge, 759, 786, 835, 838
visible, 36	wastewater, 759, 786, 835, 838
water, 7	Potable water, 716, 862
Pollution control regulations, 81	Potting compounds, 449, 564
Pollution prevention	Power 701
audits, 118 benefits, 117	requirements, 791
	supply, 818–819
checklists, 120, 123–150	Power outage, 867
chemical formulating, 121, 129	Power, pump, 759, 782, 786 Precious metals recovery, 553–557
chemical manufacturing, 124–128	Precipitate, 287, 324
cost savings, 117	Preliminary treatment, 257
dairy processing, 130–131	·
dry cleaning, 132 economics, 117	Preserving samples, 171, 173, 580 Pressure cleaning pipelines, 865, 866
fluid milk processing, 133–134	Pressure measurements, 630
gas extraction, 139	Pressure pipe flow measurement, 218, 233, 234
industry specific, 120	Pressure, transmembrane, 455
loading of material and product, 118	Pretreatment, 249–308
management support, 118	application, 93–97
material distribution systems, 118	categorical standards, 88–97
material storage and loading, 118	feed, 458
material substitution, 118	
meat packing, beef, 135	general regulations, 84 industrial, 33
metal fabrication, 136–137	industrial, 33 industrial categories, 89, 93
metal finishing, 120, 137–138	industrial categories, 89, 99
milk processing, 133–134	inspection, 161
min processing, 155–151	inspection, 101

Pretreatment, 249–308 (continued)	casing, 753, 757, 761, 762
metal finishing standards, 92	cavitation, 760
prohibited discharge standards, 87	centrifugal, 753, 759, 761–767, 783, 830
regulation development, 91	chemical feed, 348, 349, 350
regulations, 84, 92, 93–97	circuit breakers, 795, 796, 797, 798–801
standards, 92, 93	cleaning pump, 831
Also see Chapter 4, OPERATION OF WASTEWATER	connecting rods, 835, 838, 839
TREATMENT PLANTS, Volume I	coupling, 756, 769, 782, 846, 847, 848
Preventing wastes	cross connections, 716, 830
See Pollution prevention	description, 753
Preventive maintenance	discharge, 753, 759, 782, 783, 784, 786, 839
program, 749, 830, 865	drain, 775, 785, 834
records, 749	draining pumps, 775, 785, 834
variable-speed AC motors, 777	driving equipment, 775
Primary element, pH adjustment, 298	eccentric, 835, 838
Primary elements, 221–230	electric motors, 776, 803–826
Primary sludge flow measurement, 244	energy, 759, 782, 786
Prime, centrifugal pump, 757, 758, 775, 782, 783, 785	flow equalization, 266
Printed circuit board manufacturing, 60–62, 63, 146–147	friction, 759
Printing, 148	fuses, 781
Priority toxic pollutants, 90	gasket, 835
Probes, 290–294, 560–566, 591, 592	gear reducer, 835
Probes, electrical, 633, 634	general, 753, 830
	<u>v</u>
Process analytical instrumentation, 642	gland, 758, 781, 784, 786
Process modification, waste reduction, 119	greasing, 839
Process operations, waste reduction, 118	head, 758
Processes, treatment, metals, 533–558	impeller, 753, 759, 761, 762, 763, 764, 766, 782, 784, 833
Product recovery, air stripping, 492	incline screw, 768, 769
Product reformulation, 119	lantern ring, 831, 833
Product storage and loading, 118	Let's Build a Pump, 754
Programmable controllers, 567	lubrication, 756, 768, 774, 775, 782, 831, 839, 853
Programmable logic controller (PLC), 458, 812	maintenance, 829
Programs	metal treatment, 585–590, 593
NPDES permit, 83	motor, 785
National pretreatment, 83, 84	multi-stage, 759
Progressive cavity pumps, 768, 770, 771, 786, 839	noisy, 782, 835
Prohibited discharge standards, 87	oil change, 835
Propeller meter, 238, 239, 583, 584	operation, 774, 782
Propeller pumps, 759, 765, 766, 839	packing, 770, 781, 782, 786, 830, 831, 833, 834, 836–837,
Protection devices, motor, 796, 800, 801	838, 839
Protective clothing, 676, 679, 682, 688, 707, 710, 713, 714,	plunger, 835, 838
720, 862	pneumatic ejectors, 768, 772, 839
Protective coating, 709	positive displacement, 759, 786, 835, 838
Prussian blue, 853	power, 759, 782, 786
Public relations, 8, 750, 751, 752	pressure filters, 418
Publicly Owned Treatment Works (POTW), 7, 33	prime, 757, 758, 775, 782, 783, 785
Pulp and paper manufacturing, Kraft segment, 149	progressive cavity, 768, 770, 771, 786, 839
Pump capacity, 759, 833	propeller, 759, 765, 766, 839
Pumping stations, 701, 867	pump-driving equipment, 775
Pumps and pump parts	radial flow, 759, 766
air chamber, 835, 838	reciprocating, 759, 786, 835, 838
alignment, 756, 782, 831, 847, 848	records, 826, 827
axial flow, 759, 766	reducer, gear, 835
ball valves, 835, 838	repair shop, 753
bearings, 753, 756, 761, 762, 764, 765, 767, 768, 769, 774,	rings, 757, 761, 782, 784, 831, 833
775, 785, 831, 834, 839	rods, 835, 838, 839
belts, 782, 843–844, 845, 846	rotation, 775, 782
capacity, 759, 833	rotor, 768, 770, 776
* · ·	

Pumps and pump parts (continued)	Reciprocating pumps, 759, 786, 835, 838
screw-flow, 768, 770, 771, 786	Recirculation flow, membranes, 455
seal cage, 758	Recorders, instrumentation, 646
seals, 768, 773, 782, 783, 784, 785, 830, 831, 833	Recordkeeping
shaft, 753, 754, 761, 762, 781, 782	electrical equipment, 826, 827, 828
shear pin, 835, 849	membranes, 463
shutdown, 775, 782, 784, 786	motors, 826, 828
single-stage, 759, 767	preventive maintenance, 749
sleeves, 754	pumps, 826, 827
sludge pump, 759, 786, 835, 838	Recovery, backwash, 425
start-up, 759, 774, 781, 782, 785	Recovery, reverse osmosis, 469
stator, 768, 770, 786	Recreation, 35
stuffing boxes, 758, 761, 831	Recycle, 115
submersible pump, 759, 764	Reduction, chemical, pH adjustment, 301
suction, 753, 756, 759, 782, 784, 786	Reducer, gear, 835
troubleshooting, 781	Reduction of hexavalent chromium, 547
_	Reference electrode, pH, 291
turbine pumps, 759, 767	•
valve chamber gasket, 835	References, industrial wastewaters, 62
vanes, 753	Reformulation of product, 119
vertical wet well, 759, 767	Refractory, 527
vibrations, 783, 785	Refractory materials, 160
volute, 753, 783, 784, 785	Regeneration of carbon, 508
wearing rings, 757, 761, 782, 784, 833	Regulated dischargers, 82
wet well pumps, 759, 764, 767, 783, 784	Regulation of high flows, 180
	Regulations
Q	abbreviations, 79–80
	Clean Air Act, 103
Qualifications for jobs, 6, 7	Clean Water Act, 103
	Department of Transportation, 104
R	development, 91
	EPA, 81, 94, 98
RCRA, 86, 101	federal, 101-104
Radial flow pumps, 759, 766	hazard communication, 103
Radiator repair, 150	hazardous material regulations, 104
Radioactive contamination, 35	history, 81
Radioactive wastes, 28, 183	NPDES permit program, 83
Radiological hazards, 682	Occupational Safety and Health Act (OSHA), 103
Rapid sand filter, 396, 402	pollution control, 81
Rate control valve, gravity filters, 405	pretreatment, 84, 92, 93–97
Rate-of-flow controller, 423	Resource Conservation and Recovery Act (RCRA), 86, 101
Raw material purchasing, 118	statutes, 101–104
	stormwater, 103
Raw sludge, pumps, 753	
Raw wastewater, pumps, 753	Superfund Amendment Reauthorization Act (SARA), 102
Reactivation of carbon, 508	Regulatory requirements, 116
Reagent, 56	Rejection, mineral, 466, 467, 468
Reagents, neutralizing, 286	Removal credits, 97
Receiving waters	Report forms, accident, 720
algae, 32	Reports
definition, 7	baseline monitoring (BMR), 87, 95
human health, 29	compliance, 95
nutrients, 30	EPA, 94
odors, 28	hazardous waste disposal, 96
oxygen depletion, 28	slug load, 95
pathogenic bacteria, 29	Representative samples, 162
sludge and scum, 28	Representative sampling, metals, 579
toxic substances, 30	Resampling, violation, 96

Residence time, pH adjustment, 296	drums, traffic control, 178
Resistance measurements, 567	electricity, 788
Resource Conservation and Recovery Act (RCRA), 86, 101	gravity filters, 414
Response time, pH adjustment, 293	instrumentation, 628–630
Responsibility, operator's, 46	membrane filters, 463
Return activated sludge flow, 245	metal treatment, 549, 590, 595-600
Reuse, 115	motors, 813
Reverse osmosis (RO)	OSHA, 677, 688
brine, 474	operator, 9
calculations, 466–474	policy statement, 720
"Christmas Tree" arrangement, 474, 475	pressure filters, 427
concentration polarization, 474	screens, 284
definition, 463	traffic cones, 178
flow diagram, 464	tubular markers, traffic control, 178
flux, 465, 466	upflow filters, 445
flux decline, 466	vertical panels, traffic control, 178
hydrolysis, 469, 473	warning tag, 685, 702, 788, 789, 831, 832
membrane, 449, 463, 465, 466	Safety equipment
mineral rejection, 466, 467, 468	air gap device, 716, 717, 862, 863
osmosis, 463, 464	air supply, 708
permeate, 466	blowers, 681, 862
pH effects, 469, 473	breathing apparatus, self-contained, 688, 719
recovery, 469, 555	chlorine monitor, 678
rejection, mineral, 466, 467, 468	combustible gas monitor, 678, 682, 710
temperature effects, 469, 472, 473	dosimeter, 682
Also see Demineralization and Electrodialysis	ear protecting devices, 688
Review of plans and specifications	eye protection, 713, 714
electrical systems, 867	face shield, 708, 713
equipment, 867	fall arrest system, 676, 704, 706, 729
lift stations, 867	fans, 681, 862
pump stations, 867	film badges, 682
safety, 720	fire extinguishers, 701, 714, 715, 719, 862
Right-To-Know (RTK) Laws, 721–729	fire-fighting equipment, 684, 701, 715, 720, 862
Rings, pump, 757, 761, 782, 784, 831, 833	first-aid kit, 717, 862
Rinse waters, 530, 532	fume hood, 713
Rising sludge, 369, 408	gas testing, 678, 679, 680, 681, 682, 683
Rods, pump, 835, 838, 839	gloves, 676, 713
Rotameter, 235, 236, 419, 582, 583, 636, 637	hard hat, 720
Rotary chemical feeder, 352	harness, 676, 679, 862
Rotating screens, 275–282	hearing protection devices, 688
Rotation, motors, 817	hydrogen sulfide monitor, 678
Rotation, pump, 775, 782	lifeline, 676
Rotor, 768, 770, 776, 843	lockout tag, 685, 702, 788, 789, 831, 832
C	measurement of gases, 678, 679, 680, 681, 682, 683, 703
S	nonsparking tools, 704
CADA 102	oxygen deficiency/enrichment indicator, 678
SARA, 102	pocket dosimeter, 682
SPC, 462	protective clothing, 676, 679, 682, 688, 707, 710, 713, 714,
SCFM, 370	720, 862
Safety	purchase, 720
air stripping, 494	respirators, 688
carbon adsorption, 509 chemical treatment, 340, 377	safety barness 676, 679, 862
clarifiers, 377	safety harness, 676, 679, 862 self-contained breathing apparatus, 688, 719
cones, traffic, 178	storage containers, 708, 710
confined spaces, 441, 445, 704	tag, 685, 702, 788, 789, 831, 832
commed spaces, 111, 117, 701	<i>a</i> , 000, 702, 700, 707, 001, 002

Safety equipment (continued)	physical injuries, 676
traffic control devices, 689, 690–694	polymers, 709
ventilation, 681, 682, 702, 704, 708, 710	ponds, 707
Safety harness, 676, 679, 862	protective coatings, 709
Safety hazards	pumping stations, 701
acids, 681	radiological, 682
aeration tanks, 707	sampling, 175, 713
amines, 711	sedimentation basins, 704
applying protective coatings, 709	sewer cleaning, 700
back strains, 695	slippery surfaces, 701, 703, 706, 707
bar screens, 701	spills, 706, 710
biocides, 711	start-up, 701
blowers, 681, 862	stored energy, 685
carcinogens, 709, 711	suffocating gases or vapors, 675, 678, 681, 682, 709, 711, 713
chemicals, 681, 708, 713	sulfur dioxide, 678, 708, 729
chlorine, 678, 703, 708, 729	surface-active agents, 711
clarifiers, 704	tetanus, 676
collection systems, 689, 710	toxic chemicals, 681
comminutors, 702	toxic gases or vapors, 675, 678, 681, 682, 709, 711, 713
confined spaces, 675, 676–681, 689, 703, 707, 862	traffic, 689
cross connections, 716, 830	treatment plants, 701
digesters, 704	trickling filters, 706
digestion equipment, 704	typhoid fever, 676
drowning, 707	vapors, 675, 678, 681, 682, 709, 711, 713
dysentery, 676	wet wells, 701, 702
electrical, 684, 788	Safety, OSHA standards, 735–738
emergencies, 719	Safety program
empty digesters, 751	accident report form, 720
excavations, 696	accidents, 718, 720
explosive gas mixtures, 678, 682, 710	backflow prevention, 716
falls, 676	conditions for program, 718
fire, 714, 715	confined spaces, 676–681
flammable atmospheric condition, 679	cross connections, 716
foam, 711	development, 718
fuels, 710	drills, 719
gasoline vapors, 678, 681, 682	effectiveness, 718
grit channels, 703	emergencies, 719
hepatitis, 676	entry of confined spaces, 676–681
hydrogen sulfide, 678, 681, 701, 711	equipment use, 713, 717, 719
ice, 704, 708, 710	fire control methods, 715
industrial waste sampling, 175	fire drills, 719
industrial waste treatment, 681, 710, 711	fire prevention, 714, 715, 716
infections, 676	forms, accident, 720
infectious diseases, 676	hazard communication program, 721–729
laboratory, 713	hearing protection program, 688
lift station, 701	housekeeping, 701, 702, 704, 710
manholes, 689, 695	immunization shots, 676
methane, 678, 704	importance of program, 718, 720
monitoring, 175	information, 717–721
natural gas, 682	inoculations (immunizations), 676
noise, 685	laboratory, 713
oil and grease soaked rags, 710	laundry service, 676
oil and grease spills, 710	library, 752
oxygen deficiency/enrichment, 675, 676, 678, 681	locker room, 676
pH, 712	management responsibility, 675, 718

	. (1 171	
Safety program (continued)	security of samples, 171	
manhole entry, 689, 695	storage of samples, 171	
material safety data sheets, 681, 710, 712, 723–725, 777, 865	techniques, 713	
meetings, 718	temperature of stored samples, 171	
need, 675	time of sample storage, 171	
operator responsibility, 675	Sampling location, 162	
paper work, 720	Sand filter, metals, 545	
personal hygiene, 676	Sanitary sewer codes, 100	
planning, 719	Schedule, compliance, 95	
policy, 720	Scouring, media, 400	
procedures, 713, 714	Screening	
promotion, 719	bar screens, 268–272	
protective clothing, 676, 679, 682, 688, 707, 710, 713, 714,	coarse screens, 268–272, 283	
720, 862	fine screens, 273–282, 283	
purchase of equipment, 720	maintenance, screens, 282–284	
purpose, 675	mechanical bar screen, 269	
report form, 720	purpose, 268	
respiratory protection, 679	rotating screens, 275–282	
review of plans and specifications, 720	safety, screens, 284	
safety policy, 720	shutdown procedures, 269, 281	
safety rules, 720	start-up procedures, 269, 281	
sampling techniques, 713	static screens, 273–274	
sewer-use ordinance, 710	troubleshooting, 271–272	
starting program, 718, 720	types, 268–282	
storage of chemicals, 713	wedgewire screen, 273	
supervisor's role, 719	why, 268	
tailgate safety meetings, 718	Screw-flow pumps, 768, 770, 771, 786	
testing procedures, 713	Screw-lift pumps, 768, 770, 771, 786	
training programs, 717, 718, 720	Scum	
uniforms, 676	problem, 775	
water supply protection, 716	receiving water, 28	
work clothes, 676	unplugging pipes, 865	
Safety rules, 720	Seal cage, pump, 758	
Samplers, 163	Seals, pump, 768, 773, 782, 783, 785, 830, 831, 833	
Sampling	Secondary elements/devices, flows, 230–235	
activated carbon, 508	Security of samples, 171	
chain of custody, 172	Sedimentation	
chemical preservation of samples, 171	physical–chemical treatment, 321, 358–377	
composite samples, 163, 580	safety, 704	
continuous sampling, 161	Sedimentation basins, safety, 377	
devices, 580	Segregation of wastes, 118	
equipment, 163, 166	Self-contained breathing apparatus (SCBA), 719	
<u> </u>		
grab samples, 162, 580	Self-monitoring, 161	
industrial wastes, 159, 161	Sensors, pH adjustment, 290–294	
jar test, 335	Sensors/transducers, 630–642	
labeling samples, 172	Septic, 265, 366, 32	
location of sampling points, 162	Service record card, 749, 750	
maintenance of equipment, 170	Sewer cleaning, 700	
membrane filtration, 462	Sewer gases, characteristics, 682	
portable equipment, 163	Sewer service charges, 160	
preservation of samples, 171, 173, 580	Sewer-use ordinance, 160, 197, 710	
procedures, 579–581	Sewer-use permit, 187	
representative samples, 162	Shaft, pump, 753, 754, 761, 762, 781, 782	
representative sampling, 579	Shear pins, 835, 849	
safety, 713	Sheaves, 844	

Sheeting, 696 Shielding, 696 Shock loads, 51, 159 Shockcor, Joe, 534–536, 551 Shoring, excavations, 696, 697 Short-circuiting Carifier, 366 equalization tank, 266 filter, 408 Shutdown carbon adsorption, 506 chemical treatment, 355 dissolved air flotation (DAF) thickeners, 372 draining pump, 834 gravity filters, 412 instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Sieve analysis, 516 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silver wastestreams, 528 Source control, 528 Source control, 528 Source control, 528 Sources, metal wastestreams, 528 Sources, metal wastestreams, 528 Sources, metal wastestreams, 528 Spare parts inventory, 591 Specific gravity, 407 Specific gra
Shock loads, 51, 159 Shockcor, Joe, 534–536, 551 Shoring, excavations, 696, 697 Sources, metal wastestreams, 528 Sources, metal wastestreams, 528 clarifier, 366 cqualization tank, 266 filter, 408 Shutdown carbon adsorption, 506 chemical treatment, 355 dissolved air flotation (DAF) thickeners, 372 draining pump, 834 gravity filters, 412 instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silver wastestreams, 532 Sleeves, 754 Sloping, excavations, 696, 699 Log and sources, metal wastestreams, 528 Sources, netal wastestreams, 521 carbon adsorption, 590 Sources, metal wastestreams, 528 Sources, metal wastestreams, 528 Sources, parts inventory, 591 Sources, metal wastestreams, 520 Sources, metal wastestreams, 528 Log and parts inventory, 591 Sources, metal wastestreams, 521 Staffing needs, 9 Standard deviation, 259 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Log and sources, metal wastestreams, 521 Instrumentation, 657–659 pumps, 759, 774, 781, 782, 785 Log and starters, 28 unplugging pipelines, 866 Solvent Management Plan, 94 Solvent, 152 Solvent controlled rectifier (SCR), 419 Slake, 328 Instrumentation, 657–659 Instrumentation, 657, 774, 781, 782, 785
Shockor, Joe, 534–536, 551 Shorting, escavations, 696, 697 Source control, 528 Short-circuiting Sources, metal wastestreams, 528 clarifier, 366 squalization tank, 266 filter, 408 Specific gravity, 407 Specific gravity, 407 Shutdown carbon adsorption, 506 chemical treatment, 355 dissolved air flotation (DAF) thickeners, 372 draining pump, 834 gravity filters, 412 gravity filters, 412 gravity filters, 412 gravity filters, 412 spent baths, 531 instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Sieve analysis, 516 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Slace, 328 Sleeves, 754 Sloping, escavations, 696, 699 Log and the substance of
Shoring, excavations, 696, 697 Short-circuiting clarifier, 366 equalization tank, 266 filter, 408 Shutdown carbon adsorption, 506 chemical treatment, 355 dissolved air flotation (DAF) thickeners, 372 draining pump, 834 gravity filters, 412 instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Signal transmitters/transducers, 642 Signal transmitters/transducers, 642 Signal transmitters/transducers, 642 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sludge receiving waters, 28 unplugging pipelines, 866 Spare parts inventory, 591 Specific gravity, 407 Specific gravity filters, 412 uplow
Short-circuiting clarifier, 366 squalization tank, 266 filter, 408 Shutdown carbon adsorption, 506 chemical treatment, 355 dissolved air flotation (DAF) thickeners, 372 draining pump, 834 gravity filters, 412 gravity filters, 412 instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 528 Spare parts inventory, 591 spare parts inventory, 591 specific gravity, 407 specification, 510 gravity filters, 414 pressure filters, 419 specific gravity, 407 specification, 510 gravity filters, 414 pressure filters, 419 specification, 510 specific gravity, 407 specification specification, 510 specification, 510 specific gravity, 407 specification specifica
clarifier, 366 equalization tank, 266 filter, 408 Specific gravity, 407 Specific gravity, 407 Specific gravity, 407 Specifications Shutdown carbon adsorption, 506 chemical treatment, 355 dissolved air flotation (DAF) thickeners, 372 draining pump, 834 gravity filters, 412 gravity filters, 412 gravity filters, 412 gravity filters, 412 spent activated carbon, 510 Spent activated carbon, 510 Spent baths, 531 Spent baths, 531 Spent baths, 531 Spent baths, 531 Spent ambranes, 451 Spent baths, 531 Spent ambranes, 451 Spent baths, 531 Spent ambranes, 451 Spent baths, 531 Staffing needs, 9 Staffing needs, 9 Staffing needs, 9 Staffing needs, 9 Standard deviation, 259 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Standard deviation, 259 Silver wastestreams, 532 Standard industrial classification, 160, 198 Silver wastestreams, 532 Single-stage pumps, 759, 767 Start-up Slake, 328 Single-stage pumps, 759, 767 Start-up Slake, 328 Sleeves, 754 Carbon adsorption, 498–505 Chemical treatment, 355, 374, 375 Sloping, excavations, 696, 699 Chemical treatment, 355, 374, 375 Chemical treatment, 355, 374, 375 Sloping, excavations, 696, 699 Unplugging pipelines, 866 pumps, 759, 774, 781, 782, 785
equalization tank, 266 filter, 408 Shutdown carbon adsorption, 506 chemical treatment, 355 dissolved air flotation (DAF) thickeners, 372 draining pump, 834 gravity filters, 419 instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Sieve analysis, 516 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sludge receiving waters, 28 unplugging pipelines, 866 Specific gravity, 407 Specifications carbon adsorption, 510 gravity filters, 412 upflow filters, 412 upflow filters, 429 upflow filters,
filter, 408 Shutdown carbon adsorption, 506 chemical treatment, 355 dissolved air flotation (DAF) thickeners, 372 draining pump, 834 gravity filters, 412 instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Sieve analysis, 516 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sludge receiving waters, 28 unplugging pipelines, 866 Specifications carbon adsorption, 510 gravity filters, 414 pressure filters, 412 pressure filters, 419 specifications specificati
Shutdown carbon adsorption, 506 chemical treatment, 355 dissolved air flotation (DAF) thickeners, 372 draining pump, 834 gravity filters, 412 instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Sieve analysis, 516 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Long and sorption, 510 gravity filters, 414 pressure filters, 429 upflow filters, 445 pressure filters, 429 upflow filters, 419 Spent activated carbon, 510 Spent baths, 531 Spent baths, 531 Spiral membranes, 451 Spiral membranes, 451 Spoil, 696 Staff gauge, flow, 230, 231 Staffing needs, 9 Staffing needs, 9 Staffing needs, 9 Standard deviation, 259 Silicon controlled rectifier (SCR), 419 Standard industrial classification, 160, 198 Silver wastestreams, 532 Start-up Slake, 328 single-stage pumps, 759, 767 Start-up Slake, 328 air stripping, 492 carbon adsorption, 498–505 chemical treatment, 355, 374, 375 Sludge dissolved air flotation (DAF) thickeners, 371 receiving waters, 28 unplugging pipelines, 866 pumps, 759, 774, 781, 782, 785
carbon adsorption, 506 chemical treatment, 355 dissolved air flotation (DAF) thickeners, 372 draining pump, 834 gravity filters, 415 draining pump, 834 gravity filters, 412 instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Sieve analysis, 516 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Label Standard industrial treatment, 355, 374, 375 Sludge receiving waters, 28 unplugging pipelines, 866 gravity filters, 414 pressure filters, 429 upflow filters, 445 Spent activated carbon, 510 Spent activated carb
chemical treatment, 355 dissolved air flotation (DAF) thickeners, 372 draining pump, 834 gravity filters, 412 instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Sieve analysis, 516 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Legisland transmitter, 28 unplugging pipelines, 866 Spent activated carbon, 510 Spent baths, 531 Spiral membranes, 451 Spoil, 696 Squirrel-cage induction motor (SCIM), 775, 803, 804 Staff gauge, flow, 230, 231 Staffing needs, 9 Staffing needs, 9 Standard deviation, 259 Standard deviation, 259 Standard industrial classification, 160, 198 Start-up Start-up Slake, 328 Single-stage pumps, 759, 767 Start-up Slake, 328 Sieves, 754 Sloping, excavations, 696, 699 Scarbon adsorption, 498–505 Chemical treatment, 355, 374, 375 Sludge dissolved air flotation (DAF) thickeners, 371 instrumentation, 657–659 pumps, 759, 774, 781, 782, 785
dissolved air flotation (DAF) thickeners, 372 draining pump, 834 gravity filters, 412 instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Sieve analysis, 516 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silver wastestreams, 532 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sludge receiving waters, 28 unplugging pipelines, 866 Spent activated carbon, 510 Spent baths, 531 Spent activated carbon, 510 Spent baths, 531 Spent activated carbon, 510 Spent baths, 531 Spent activated carbon, 510 Spent activated carbon, 521 Spent activated carbon, 510 Spent activated carbon, 521 Spent activated
draining pump, 834 gravity filters, 412 instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Squirrel-cage induction motor (SCIM), 775, 803, 804 Sieve analysis, 516 Staff gauge, flow, 230, 231 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sludge receiving waters, 28 unplugging pipelines, 866 Spent activated carbon, 510 Spent baths, 531 Spent baths, 545 Spent baths, 541 Spent baths, 521 Staffing needs, 9 Staffing
gravity filters, 412 instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Sieve analysis, 516 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sludge receiving waters, 28 unplugging pipelines, 866 Spent baths, 531 Spent baths, 531 Spent baths, 531 Spiral membranes, 451 Spoil, 696 Squirrel-cage induction motor (SCIM), 775, 803, 804 Staff gauge, flow, 230, 231 Staffing needs, 9 Staffing needs, 9 Standard deviation, 259 Standard dindustrial classification, 160, 198 Start-up Start-up Start-up Slake, 328 air stripping, 492 carbon adsorption, 498–505 chemical treatment, 355, 374, 375 dissolved air flotation (DAF) thickeners, 371 instrumentation, 657–659 pumps, 759, 774, 781, 782, 785
instrumentation, 657–659 pumps, 775, 782, 784, 786 screens, 269, 281 Sieve analysis, 516 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sludge receiving waters, 28 unplugging pipelines, 866 Squirrel-cage induction motor (SCIM), 775, 803, 804 Staff gauge, flow, 230, 231 Staffing needs, 9 Standard deviation, 259 Standard industrial classification, 160, 198 Start-up start-up start-up start-up slake, 328 carbon adsorption, 498–505 chemical treatment, 355, 374, 375 dissolved air flotation (DAF) thickeners, 371 instrumentation, 657–659 pumps, 759, 774, 781, 782, 785
pumps, 775, 782, 784, 786 screens, 269, 281 Sieve analysis, 516 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sludge receiving waters, 28 unplugging pipelines, 866 Squirrel-cage induction motor (SCIM), 775, 803, 804 Staff gauge, flow, 230, 231 Staffing needs, 9 Standard deviation, 259 Standard industrial classification, 160, 198 Start-up air stripping, 492 carbon adsorption, 498–505 chemical treatment, 355, 374, 375 dissolved air flotation (DAF) thickeners, 371 instrumentation, 657–659 pumps, 759, 774, 781, 782, 785
Screens, 269, 281 Sieve analysis, 516 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sludge receiving waters, 28 unplugging pipelines, 866 Squirrel-cage induction motor (SCIM), 775, 803, 804 Squirrel-cage induction motor (SCIM), 775, 803, 804 Staff gauge, flow, 230, 231 Staffing needs, 9 Standard deviation, 259 Standard industrial classification, 160, 198 Start-up Start-up air stripping, 492 carbon adsorption, 498–505 chemical treatment, 355, 374, 375 dissolved air flotation (DAF) thickeners, 371 instrumentation, 657–659 pumps, 759, 774, 781, 782, 785
Sieve analysis, 516 Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Stilicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sleeves, 754 Sloping, excavations, 696, 699 Sludge receiving waters, 28 unplugging pipelines, 866 Staff gauge, flow, 230, 231 Staffing needs, 9 Staffing needs, 9 Standard deviation, 259 Standard industrial classification, 160, 198 Starters, 810–813 Start-up air stripping, 492 carbon adsorption, 498–505 chemical treatment, 355, 374, 375 dissolved air flotation (DAF) thickeners, 371 instrumentation, 657–659 pumps, 759, 774, 781, 782, 785
Signal transmitters/transducers, 642 Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sloving waters, 28 unplugging pipelines, 866 Staffing needs, 9 Standard deviation, 259 Standard industrial classification, 160, 198 Starters, 810–813 Start-up air stripping, 492 carbon adsorption, 498–505 chemical treatment, 355, 374, 375 dissolved air flotation (DAF) thickeners, 371 instrumentation, 657–659 pumps, 759, 774, 781, 782, 785
Significant Industrial User (SIU), 86 Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sloving waters, 28 unplugging pipelines, 866 Standard deviation, 259 Standard industrial classification, 160, 198 Starters, 810–813 Start-up air stripping, 492 carbon adsorption, 498–505 chemical treatment, 355, 374, 375 dissolved air flotation (DAF) thickeners, 371 instrumentation, 657–659 pumps, 759, 774, 781, 782, 785
Silicon controlled rectifier (SCR), 419 Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sludge receiving waters, 28 unplugging pipelines, 866 Stantard industrial classification, 160, 198 Starters, 810–813 Start-up air stripping, 492 carbon adsorption, 498–505 chemical treatment, 355, 374, 375 dissolved air flotation (DAF) thickeners, 371 instrumentation, 657–659 pumps, 759, 774, 781, 782, 785
Silver wastestreams, 532 Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sludge receiving waters, 28 unplugging pipelines, 866 Start-up air stripping, 492 carbon adsorption, 498–505 chemical treatment, 355, 374, 375 dissolved air flotation (DAF) thickeners, 371 instrumentation, 657–659 pumps, 759, 774, 781, 782, 785
Single-stage pumps, 759, 767 Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sludge receiving waters, 28 unplugging pipelines, 866 Start-up air stripping, 492 carbon adsorption, 498–505 chemical treatment, 355, 374, 375 dissolved air flotation (DAF) thickeners, 371 instrumentation, 657–659 pumps, 759, 774, 781, 782, 785
Slake, 328 Sleeves, 754 Sloping, excavations, 696, 699 Sloudge receiving waters, 28 unplugging pipelines, 866 air stripping, 492 carbon adsorption, 498–505 chemical treatment, 355, 374, 375 dissolved air flotation (DAF) thickeners, 371 instrumentation, 657–659 pumps, 759, 774, 781, 782, 785
Sleeves, 754 carbon adsorption, 498–505 Sloping, excavations, 696, 699 chemical treatment, 355, 374, 375 Sludge dissolved air flotation (DAF) thickeners, 371 receiving waters, 28 instrumentation, 657–659 unplugging pipelines, 866 pumps, 759, 774, 781, 782, 785
Sloping, excavations, 696, 699 Sludge chemical treatment, 355, 374, 375 dissolved air flotation (DAF) thickeners, 371 receiving waters, 28 unplugging pipelines, 866 instrumentation, 657–659 pumps, 759, 774, 781, 782, 785
Sludge dissolved air flotation (DAF) thickeners, 371 receiving waters, 28 instrumentation, 657–659 unplugging pipelines, 866 pumps, 759, 774, 781, 782, 785
receiving waters, 28 instrumentation, 657–659 unplugging pipelines, 866 pumps, 759, 774, 781, 782, 785
unplugging pipelines, 866 pumps, 759, 774, 781, 782, 785
$C(1,1,1,\dots,C(0,57))$
Sludge dewatering, 568–574 safety hazards, 701
Sludge disposal effects, 53 screens, 269, 281
Sludge drying, 574 water level controls, 840
Sludge load report, 95 Static screens, 273–274
Sludge pumps, 759, 786, 835, 838 Stator, 768, 770, 786, 843
Slug discharge, 171, 192 Statutes
Slug loadings, 51 See Regulations
Sluice gates, 853, 860, 861 Stethoscope, 841
Slurry, 496 Stilling well, 230, 231
Small quantity generator, 102 Storage
Sodium sulfide, 711 bins, 677
Softening membrane, RO, 469 chemicals, 713
Solids containers, 708, 710
dissolved, 30, 31 samples, 171
floatable, 31 Storage and handling of chemicals, 597, 713
inorganic, 31 Storage of material and product, 118
nonsettleable, 30 Stored energy, 685
organic, 31 Stormwater, flow measurement, 238
settleable, 30 Straightedge, alignment, 847
suspended, 30 Strategy, pollution prevention, 115
test in wastewater, 31 Strategy
total, 30 gravity filter operation, 410
wastewater characteristics, 30 operation, flow equalization, 266
Solids contact clarifier, 362, 363 pH adjustment, 294
Solids, industrial wastes, 182 pressure filters, 426
Solids loadings, dissolved air flotation (DAF) thickeners, 369, upflow filters, 439
373 Strategy for monitoring, 179

Stuffing box, valve, 850, 851, 852	Toxic gases or vapors, 678, 681, 682, 709, 711, 713
Stuffing boxes, pump, 758, 761, 831	Toxic Organic Management Plan (TOMP), 94
Submerged pressure transducers, 233	Toxic organics, 558
Submersible pump, 759, 764	Toxic pollutants, priority, 90
Suction, pump, 753, 756, 759, 782, 784, 786	Toxic wastes
Suffocating gases or vapors, 678, 681, 682, 709, 711, 713	gases, 711, 714
Sulfide precipitation, 546	general, 28
Sulfur dioxide, 678, 708, 729	industrial, 159
Superfund Amendment Reauthorization Act (SARA), 102	materials, 711, 714
Supervisors, safety, 719	Traffic
Supervisory controls, 802	cones, 178
Surcharge, 238	drums, 178
Surface-active agents, safety, 711	tubular markers, 178
Surfactants, 119, 453, 711	vertical panels, 178
Suspended solids, 30	Traffic control devices, 689, 690–694
Switch gear, electrical, 795	Traffic hazards, 689
Switches, level control, 775, 831, 840	Training
Symbols, instrumentation, 616–620	courses, 719
	hazard communication, 721–729
T	management planning, 718
	safety, 717, 718, 719
TDH (total dynamic head), 833	Training for operators, 6, 10
TTO, 94	Tramp oil, 458
TWA (time weighted average), 688	Transducers, 233, 630–642
Tailgate safety meetings, 718	Transfer of carbon, 509
Tanks, flow equalization, 244, 260, 261–267	Transit time flow measurement, 238
Tanks, maintenance, 751	Transmembrane pressure, 455
Tastes in water, 183	Transmitter, pH adjustment, 298
Temperature	Treatment of industrial wastes, need, 32, 33
air stripping, 490	Treatment plant maintenance
pH adjustment, 293	buildings, 750
Temperature effect, plugging pipelines, 865	channels, 751
Temperature effects, reverse osmosis, 469, 472, 473	costs, 749
Temperature limits, motors, 807	general program, 749
Test equipment, 652	grounds, 751
Testers, electrical, 791–795	inspection, 751
Tetanus, 676	landscaping, 751
Thermal wastes, 28, 159, 182	library, 752
Thermophilic process, anaerobic digester	paint, 750
See Chapter 12, OPERATION OF WASTEWATER TREAT-	preventive maintenance program, 749, 830, 865
MENT PLANTS, Volume II	preventive maintenance records, 749
Thickening sludges, dissolved air flotation (DAF) thickeners,	public relations, 751, 752
367	records, 749
Thickness gauge, alignment, 847	safety, 701, 751
Thin film composite membrane, 465	tanks, 751
Time weighted average (TWA), 688	Also see Mechanical maintenance, Meter maintenance, and
Titration curves, pH adjustment, 287, 288, 290	chapters 12 (607–604) and 14 (739–875)
Total ash of regenerated carbon, 516	Treatment plants, safety, 701
Total dynamic head (TDH), 833	Treatment, preliminary, 257
Total toxic organics (TTO), 94	Treatment processes, metals, 533–558
Totalizer, gravity filters, 405	Treatment system effects, 50–54
Totalizers, instrumentation, 646	Trenching, 696, 697, 698, 699
Toxic	Trickling filters, safety, 707
chemicals, 35	Troubleshooting
organics, 558	air stripping, 492
Toxic chemicals, 681	bar screen, 271–272
Toxic compounds, 183	centrifugal pump, 593
zome compounds, roo	continugui panip, 222

Tarablah saira (saniasah)	V
Troubleshooting (continued)	V
chain drive, 845	VOV (V. 1. O1 - V.II) (52 (5)
chemical treatment, 377, 378	VOM (Volt-Ohm-Milliammeter), 652, 654
diaphragm pump, 593	Vacuum drying of sludge, 574
dissolved air flotation (DAF) thickeners, 373, 374	Vacuum filters, 569
gravity filters, 412	Valve chamber gaskets, 835
instrumentation, 592	Valve parts
ion exchange, 555–557	bonnet, 855, 857
metals treatment processes, 591–595	gear, 850, 855
motors, 820–826	gland, 853
ORP meter, 592	packing, 850, 851
pH adjustment, 302–304	plug, 855, 857
pH meter, 591	rising stem, 850
probes, pH and ORP, 565	seal, 855
pumps, 781	seats, 850, 853, 855, 857
rotating screen, 281	stuffing box, 850, 851, 852
static screen, 274	threads, 850
upflow filter, 441–442	Valves
variable-speed AC motors, 777–782	ball valves, 835, 838
water level controls, 840	check valves, 783, 833, 839, 853, 854
Troughs, gravity filters, 400	description, 850, 853
True color, 338	foot valves, 833
Trunk sewer, 163	gate valves, 850–853
Tube settlers, 364, 365	location, 783
Tubular markers, traffic control, 178	maintenance, 833, 835, 838, 839, 850, 853, 855-859
Tubular membranes, 449	plug valves, 853, 855–859
Turbidity, 182	unplugging, 865, 866
Turbidity meter, 433–436	Vanes, pump, 753
Turbine pumps, 759, 767	Vapor phase carbon, 491
Typhoid fever, 29, 676	Vapors, toxic or suffocating, 678, 681, 682, 709, 711, 713
- / F / - / - / - / - / - / - /	Variables, industrial wastewaters, 42–46
U	Variable-speed AC motors
C C C C C C C C C C C C C C C C C C C	description, 776
Ultrafiltration, 447	preventive maintenance, 777
Ultrasonic flow devices, 232	troubleshooting, 777–782
Unbalance, voltage, 808, 810	Variable-speed belt drives, 845
Underdrains, gravity filters, 400, 403	Variance from categorical standards, 97
Underground tank laws, 101	Velocity, face, sensors, 293
Uniformity coefficient, 515	Velocity meters, 235, 583, 584
Uniforms, 676	Ventilation and exhaust, systems, 584
Unloading station, carbon, 510	Ventilation, carbon adsorption, 511
Unplugging pipes, pumps, and valves	Ventilation, safety, 681, 682, 702, 704, 708, 710
costs, 865	Venturi meter, 640, 641
cutting tools, 866	Venturi nozzle, 218, 233, 234, 583
digested sludge lines, 865	Vertical panels, traffic control, 178
equipment, 865, 866	Vertical wet well pumps, 759, 767
high-velocity pressure units, 866	Very low flow measurements, 238
methods of unplugging, 865, 866	Vibration, motors, 817, 841, 847
pipes, 865	Vibrations, pump, 783, 785
pressure clearing methods, 865, 866	Viscosity, 336, 709
pumps, 866	Visible pollution, 36
scum lines, 865	Visual inspection, chain drive, 845
sludge lines, 865	Visual inspection, dissolved air flotation (DAF) thickeners, 373
valves, 865, 866	Volatile liquids, 39
Upflow carbon column, 503, 504	Volatile organics, 489
Upper explosive limit (UEL), 682, 683	Voltage, imbalance, 808, 810
Upstream processes, carbon adsorption, 507, 511	Voltage measurements, 567

Volume, flow equalization, 261–265	polli
Volumetric screw chemical feeder, 350	recei
Volute, 753, 783, 784, 785	supp
	uses
W	wild
	Water
Walk-through, 120	Water
Warning tag, 685, 702, 788, 789, 831, 832	Water
Wash water troughs, gravity filters, 400	Watts,
Waste activated sludge flow, meter, 245	Wearii
Waste discharges, 28	Wedge
Waste minimization, 528	Weirs,
Waste segregation, 118	Well, s
Wastes	Wet w
biological, 33, 35	Wet w
chemical, 35	Wet w
dissolved, 33	Wildli
industrial, 32	Work
inorganic, 36	Worke
need to treat, 32, 33	
oxygen consuming, 36	
suspended, 33	
Wastestreams	(NO I
industrial, 42–46	
metal, 531–533	
types, 94	
Wastewater	
definition, 5	
effluent, 9	
facilities, 98	
generation, 39, 54–62	
ordinances, 98–100	
pumps, 753, 759	
Wastewater characteristics, 28	
Wastewater treatment objectives, 27	
Wastewaters, industrial	
See Industrial wastewaters	
Water	

Volts, 790

aquatic vegetation, 36 contact recreation, 35

level controls, 775, 840

fish, 36

non-body contact recreation, 36 pollution, 7, 27 iving, 7 ply protection, 716 s by industry, 32, 34, 36 llife, 36 hammer, 407, 585, 835 meters, 175 quality protector, 6 ng rings, pump, 757, 761, 782, 784, 833 ewire screen, 273 $218,\,220,\,221\text{--}224,\,582,\,583$ stilling, 230 vell, pressure filter, 416 vell pumps, 759, 764, 767, 783, 784 vells, 701, 702, 783, 784 ife, 36 clothes, 676 er Right-to-Know (RTK) Laws, 721–729

X, Y, Z

(NO LISTINGS)

