

Index

- 3D printing. *See* Additive manufacturing
 3PRH. *See* three-pressure reheat
 40 CFR Part 50. *See* National Ambient Air Quality Standards
 7HA.01, 120, 243–244, 254–255, 257, 357–358, 633–634
 7HA.02, 87–89, 120, 161, 166, 168, 254–255, 257, 357–358, 517, 526, 633–635
 9HA.01, 410, 500, 627, 633
- active generator, 644
 adaptive real-time engine simulation. *See* ARES
 Additive manufacturing, 696
 adiabatic efficiency, 139
 adiabatic wall temperature, 166, 197
 advanced-class gas turbines, 37
 Aegidius Elling, 210
 aeroderivative gas turbine, 665
 combined cycle, 671
 gas turbine–battery hybrid, 673
 history, 669
 Intercooled aeroderivative gas turbine, 677
 LMS100, 677
 Recuperated gas turbine, 183
 SPRINT, 678
 STIG, 189
 vs. industrial gas turbine, 679
 aerodynamic buffeting, 394
 aeroelastic flutter, 390
 AFS. *See* axial fuel staging
 AGT-1500 (Textron Lycoming), 488
 alarm signals, 475
 Allam cycle, 661–662
 Alstom, 33, 45, 58, 61, 63, 135, 138, 147, 172, 188, 224, 241, 322–324, 349, 352, 370, 399–400, 408–410, 525, 548, 571, 642–643, 646, 648–649, 675, 693, 706
 AM. *See* Additive manufacturing
 AN², 258–259, 634–635, 659–660
 Ansaldo Energia, 34, 45, 58, 61, 148, 352, 409, 626, 642–645, 649, 693
 Anselm Franz, 47–48, 488
 anti-icing system, 546
 API 616, 479
 APM. *See* Asset performance management
apparent power, 430
aspect ratio (blade), 246
 asset performance management, 480
 Atkinson cycle, 44, 76
 autoignition, 340
 availability, 362, 455, 605
 guarantees, 459
 axial fuel staging, 323, 325, 331–332, 630, 647
- Baglan Bay, 63, 210
 bearing lift oil pump, 567
 Beznau gas turbine, 404
 BFG (blast furnace gas), 348–349, 695
 Biot number, 199, 384–385
 blade twist (compressor), 283
 blowout (combustor), 338
 BMW 003 003, 488
 bottoming cycle, 76
 evolution (efficiency), 127
 exergetic efficiency, 161, 506
 exergy balance, 504
 ideal efficiency, 90
 incremental cost, 493
 maximum possible work, 134
 price, 597
 technology factors, 125
 Brayton cycle, 76, 80–81, 121, 183–185, 188, 213, 401, 490, 523, 646, 656–657, 672, 677–678, 703–704
 ideal cycle variants, 28
 improvement of, 178
 Brown Boveri Company, 210
 bulk power system, 451
- camber angle (blade), 246
 Campbell diagram, 390
 capacitive circuit, 430
 capex, 594, 610, 620
 capital charge factor, 598, 619, 624
 Carnot cycle, 44–45, 76, 80, 86, 91–92, 94, 109, 119, 123, 152

- Carnot factor, 123
- Carnot-equivalent cycle, 79, 86, 92, 124, 126
- cascaded bypass, 573
- cascaded HAT. *See* CHAT cycle
- CDA. *See* Controlled diffusion airfoil
- chargeable
 - calculating with COMBUST, 358
 - definition, 35
 - performance derivatives, 174
 - steam cooling, 68
- CHAT cycle, 186
- CHEMKIN, 316
- Cheng cycle, 188
- CHP. *See* Cogeneration
- clashing, 306
- CLE curve. *See* Cyclic life expenditure
- closed-loop steam cooling, 68, 94, 154, 211, 213, 647, 693
- CO emissions, 314
- CO₂ emissions, 321
- COG (coke oven gas), 348–349, 695
- cogeneration, 53, 56, 95–96, 184, 189, 349, 668, 673, 694, 710
- combined cycle, 44, 349, 693
 - 2016 OEM ratings, 64
 - average outage factors, 460
 - efficiency, 499
 - efficiency derivatives, 174
 - evolution (efficiency) 1985–2016, 66
 - field performance, 67
 - gross output, 498
 - Historic data, 69
 - hot start, 573
 - ideal efficiency, 90
 - net output, 499
 - origin of the concept, 52
 - shaft output, 494
 - shutdown, 578
 - start times, 575
 - startup, 569, 573
 - technology factors, 124
- combined heat and power. *See* Cogeneration
- combustion inspection, 466
- Combustor
 - annular, 324
 - can-annular, 325
 - cold tones, 336
 - DLN, 325
 - DLN 2.6+ (GE), 325
 - hot tones, 336
 - humming, 322
 - screech, 336
 - silo-type, 323
 - tuning, 328
 - types, 322
- combustor bypass valve, 637
- commercial margin, 614
- compressor fouling, 469–470, 472, 478–479
- condition monitoring, 474
- constant-pressure sequential combustor, 643
- constant-volume combustion, 49, 694
- control volume, 136
- controlled diffusion airfoil, 266
- controls
 - ARES, 543
 - exhaust temperature isotherm, 542
 - MBC, 544
 - Part-load control curves, 543
 - schedules, 540
 - temperature control curves, 542
- convection cooling, 196
- cooling air cooler, 35, 148, 150, 213
- cooling air cooling, 94–95, 127, 149, 412, 628
- cooling effectiveness, 166–167, 197, 199–200, 202, 204–206, 208, 210
- cooling efficiency, 200
- corn-cobbing, 387, 463
- corona, 443
- cost estimate classification
 - AACE, 595
 - EPRI, 595
- cost of failure, 606
- CPSC. *See* Constant-pressure sequential combustor
- criteria air pollutants, 341
- critical point, 101–102, 104–105
- CrMoV, 378, 384, 386–387, 392, 400, 561, 628
- cromadur, 196
- Crystal Ball, 9, 615, 618
- CVC. *See* Constant-volume combustion
- cycle deck, 615–617
- cycle factor, 120
- cycle pressure ratio, 78
 - optimum, 87, 113
- cyclic life expenditure, 386
- Damköhler number, 340
- data analytics, 698
- data reconciliation, 481
- DCS, 419, 467, 475, 479–480, 570–571, 574, 578–579, 698, 700
- de Haller number, 275
- dead state, 93
- degree of reaction. *See* Stage reaction (turbine)
- delta connection, 442
- dense vertically cracked (TBC), 630
- diffusion factor, 275
- Digital Factory (Siemens), 698
- directional solidification (DS). *See* Vacuum casting
- dissociation of CO₂, 315
- DLE combustor, 667, 684–685
- DLN 2.6+ combustor, 325
 - fuel nozzle arrangement, 326
- drag coefficient, 280
- Dresser–Rand, 188

- droop, 532, 536, 538, 556, 583–584, 586, 589
 governor, 532, 537, 556, 586
 dry air composition, 309, 311
 dry reheater, 560
 dual-fuel capability, 351
 DVC. *See* Dense vertically cracked
 dynamic temperature, 30–31
- E class, 62, 122, 158, 270, 276, 279, 296, 322,
 349–350, 398, 409, 456–458, 463, 514–515,
 525, 527–528, 599, 680–681, 683
 EAC. *See* Enhanced air cooling
 effusion cooling, 212
 EGT. *See* Evaporative gas turbine
 EIA-923, 66, 690–691
 EINOx. *See* Emissions index
 Electric Power Research Institute, 594
 emissions guarantees, 346
 emissions index, 345
 EN 1822, 470
 end region heating limit, 441
 engine order, 389
 enhanced air cooling, 639
 enthalpy, 107, 113, 116, 251, 267
 EOH. *See* Equivalent operating hours
 EPRI. *See* Electric Power Research Institute
 equation of state, 102
 cubic, 103
 ideal gas, 97
 van der Waals, 104
 virial, 102
 equilibrium constant (chemical reaction),
 315
 equivalence ratio, 308, 318, 331–335, 571
 equivalent operating hours, 322
 equivalent start, 465
 Esson formula, 440
 Euler turbine equation, 226
 European gas turbines, 121, 675
 EV combustor, 647
 evaporative cooler, 30, 137, 312, 380, 417, 520–521,
 529, 588
 effectiveness, 312
 evaporative gas turbine, 185
 excess air ratio, 309
 excitation, 435
 brushless exciter, 437
 static exciter, 436
 excitation of a mode, 390
 exergy, 92, 151, 503
 exergy destruction, 100, 151–152
 exhaust diffuser, 260
 exhaust frame blower, 137, 408
 exhaust gas recirculation, 330
 exhaust isotherm, 525, 588
 exit annulus area (turbine), 257
 exponential decay function, 554
- F class, 45, 57, 60, 62, 67, 112–113, 122, 132, 138,
 144, 150, 186, 208–209, 211, 240–241,
 248–249, 258, 266, 288, 292, 300, 330,
 338, 340, 350, 353–354, 445, 456–460, 463,
 468, 498, 514–515, 517–519, 521, 525,
 543, 571, 575, 599, 605, 628, 630, 632,
 636, 678
 factored fired hours, 466
 factored starts, 460, 468
 failure mechanisms, 362, 461
 fatigue
 fracture, 391
 LCF vs. HCF, 392
 limit, 392
 S–N curve, 392
 strength, 392
 Fenimore mechanism. *See* Prompt NO
 field current heating limit, 441
 film cooling, 196
 firing temperature, 35, 121, 709
 first Tds equation. *See* Gibbs equation
 fixed O&M costs, 598
 flame speed
 laminar, 340
 turbulent, 341
 flame temperature, 35, 308–309, 313
 flared (compressor), 279
 flashback, 340
 FlexEfficiency (GE), 691
 flow coefficient, 227
 flow deflection (turbine stage), 232
 flutter, 394
 forced outage factor, 454
 Fourier number, 558
 Frame 3 (GE), 403
 Frank Whittle, 41–42, 51, 223, 228, 411
 free vortex (design), 223
 frequency control, 581–582, 584–585
 FT8, 671, 684
 fuel control block diagram, 538
 fuel moisturization, 331
 fuel split (DLN combustor), 329
 fuel staging sequence (DLN combustor), 328
 fuel stroke reference, 325, 535
 fuel-lean, 309
 fuel-rich, 309
- G class, 637
 GADS. *See* Generating availability data system
 gas control valve, 539
 gas fuel control system, 540
 gas generator, 33, 186, 246, 666, 669–670, 676, 680,
 682, 684
Gas Turbine World, 16
 GCV. *See* Gas control valve
 GE. *See* General Electric
 GEC-Alsthom, 675

- General Electric, 13–14, 33, 45, 50, 55, 58, 61–63, 71, 120, 161, 166, 179, 265, 285, 299, 306, 371, 410, 456, 631, 665–666, 675, 677, 705
- generating availability data system, 456
- generator cooling, 442
- direct vs. indirect, 442
- open ventilated, 442
- TEWAC, 442
- generator design data, 444
- Gibbs equation, 96
- Goodman line, 393
- Great Northeast Blackout, 56, 670
- grid (system) faults, 581
- grid code, 580
- grid events, 581
- GT-101, 488
- GT24, 61, 127, 134–135, 138, 147–148, 150, 172, 188, 224, 241, 279, 323, 340, 370, 408–409, 421, 571, 626, 642–643, 645, 647, 693
- GT26, 61, 134–135, 138, 148, 150, 323, 408–409, 421, 571, 642, 645, 693
- GT36 (Alstom/Ansaldo), 642
- GTW. *See Gas Turbine World*
- GTW 2016, 17
- H class, 48–49, 59, 62–63, 67–69, 122, 146, 154, 186, 211, 213, 243, 258, 270, 272, 278, 287–288, 290, 300, 330, 538, 626, 630, 636, 655, 684, 699
- HA class, 62, 64–65, 67, 84, 86, 120, 124, 128, 195, 276, 323, 325, 516–519, 525–526, 528, 626, 630–633
- Hans von Ohain, 40–41, 221, 351
- HAT cycle, 185
- Haynes 263 369
- HCF. *See* High-cycle fatigue
- HCO. *See* Hydraulic clearance optimization
- heat and mass balance, 136, 138, 144–148
- heat consumption, 24
- heat rate, 24
- heat recovery steam generator, 23, 91, 213, 417, 460, 492
- heavy residuals and crude oil, 349
- HHV. *See* Higher heating value
- high-cycle fatigue, 247, 364, 462, 569
- higher heating value, 23
- Hirth serrations, 193, 400
- HL class, 626
- Holzwarth, 41–42, 44–45, 50, 52, 77, 124, 135, 193, 210
- hot gas path inspection, 466
- Houdry turbo-compressor, 46
- HRSG. *See* Heat recovery steam generator
- HRSG effectiveness, 497, 502–503
- H-System, 54, 62–63, 68–69, 127, 138, 150, 185, 195, 210–214, 243, 370, 376, 408, 626, 630, 632, 636, 638, 692
- hub-tip ratio, 234
- Humidified air turbine. *See* HAT cycle
- humidity ratio, 310–311
- Huntorf, 645
- hybrid bypass system, 573
- hydraulic clearance optimization, 627
- hydrogen (as gas turbine fuel), 351
- IBH. *See* Inlet bleed heat
- IGCC, 94, 348, 352, 599, 695
- IGVs. *See* Inlet guide vanes
- impulse stage, 228
- Inconel 617, 369
- Inconel 700, 371
- Inconel 738, 378
- inductive circuit, 430
- inertia constant, 589
- inertia time constant (turbine rotor), 553
- Inland Empire Energy Center, 64, 185, 332
- inlet air filter, 30, 380, 471, 477
- inlet bellmouth, 476
- inlet bleed heat, 267, 409, 540
- inlet fogger, 137, 529
- inlet fogging with overspray, 137, 529, 531
- inlet guide vanes, 27, 267
- intercooling, 179
- irreversibility, 100, 135, 150–152, 179, 286
- cycle heat addition, 81
- cycle heat rejection, 81, 89
- Irsching, 63, 70
- ISA 18.2 475
- isentropic efficiency, 140
- evolution, 133
- total-to-total, 176
- ISO base load, 27
- ISO conditions, 27
- ISO-21789, 463
- ISO-2314, 36, 38, 138, 145, 636, 641
- isochronous, 532, 536, 586
- governor, 536–537, 586
- J class, 49–50, 61–62, 64, 122, 127, 132, 134–135, 137–138, 150, 152, 158, 160, 211, 224, 247, 250, 276, 279, 296, 314, 338, 344, 352, 375, 408, 443, 458, 468, 492–493, 497, 499, 501, 509, 543, 599, 636–637, 639, 656–657, 690, 693, 700
- JANAF, 16, 107
- Jumo-004, 41–42, 47, 49, 51, 132, 193, 196, 278, 332, 400, 636, 665, 688
- Kalaeloa cogen plant, 349
- Kalina cycle, 491
- Kalman filter, 481, 544
- Kelvin–Planck statement, 76, 80, 91, 93
- kilowatt (thermal), 95–96
- kilowatt machines, 183, 401

- late lean injection, 631
 LBO. *See* Lean blowout
 LCF. *See* Low-cycle fatigue
 LCI. *See* Load commutated inverter
 LCM. *See* Lumped capacitance method
 lean blowout, 338, 534
 levelization factor, 598
 leveled cost of electricity, 593, 597
 LHV. *See* Lower heating value
 Lieblein's diffusion factor. *See* Diffusion factor
 lift coefficient, 239, 280
 line current, 440
 LLI. *See* Late lean injection
 LM2500, 184, 189, 665, 667–669, 671–673, 675, 678–679, 684
 LM6000, 189, 433, 666–667, 673, 677–678, 680, 682, 684
 load commutated inverter, 448
 load factor, 134, 577, 603, 605, 691
 load shedding, 588
 locational marginal pricing, 610
 long-term service agreements, 460, 599
 loss mechanisms (compressor stage), 287
 lost work, 82
 low-cycle fatigue, 461
 low-Btu gaseous fuels, 348
 lower heating value, 23, 156
 LTSA. *See* Long-term service agreements
 lumped capacitance method, 551, 562
 Lyul'ka, 41, 51
- MACC. *See* Maximum acceptable capital cost
 maintainability, 407
 maintenance interval. *See* Major inspection
 maintenance outage hours, 454
 major inspection, 465–467, 599
 mass flow parameter (turbine), 257
 maximum acceptable capital cost, 611
 Maxwell's relations, 106–107
 mean diameter, 224
mean effective heat addition temperature, 79–80, 90, 92, 129, 152, 646
mean effective heat rejection temperature, 80, 90
 measurement errors, 484
 measurement of inlet airflow, 476
 Mercury 50, 181, 184–185, 402–403, 675, 705
 MERV. *See* Minimum efficiency reporting value
 MHL. *See* MHPS
 MHPS, 54, 58, 61–62, 68, 127, 134, 138, 314, 325, 330, 352, 399, 500, 627, 636, 639–641, 665, 671, 693, 696, 698
 minimum efficiency reporting value, 470
 Mitsubishi. *See* MHPS
 mode transfer points (DLN combustor), 327
 model-based control. *See* MBC
 modes of vibration, 388
- Monte Carlo simulation, 9, 614–615, 618–620
 MWI. *See* Wobbe index: modified WI
- NAAQS. *See* National Ambient Air Quality Standards
 NACA-65, 278, 281, 291–292
 National Ambient Air Quality Standards, 341
 National Grid Code, 581
 natural frequency, 387
 negative aerodynamic damping, 395
 NEMA temperature classifications, 445
 NERC. *See* North American Electric Reliability Corporation
 net thrust, 51, 665
 Neuchâtel, 41, 45–46, 49, 332, 400
 new and clean, 120, 471–472, 598
 NGC. *See* National Grid Code
 Nimonic 80, 193, 368, 372
 nitrogen oxide emission limits, 343
 nonchargeable
 definition, 35
 performance derivatives, 174
 North American Electric Reliability Corporation, 456
 NOx emissions, 316
 fuel NO, 320
 prompt NO, 319
 thermal NOx, 316
 nozzle passing frequency, 244, 247, 393
 NPF. *See* Nozzle passing frequency
- offline washes, 472–473
 OLL. *See* Operating limit line
 online washes, 470, 472
 operating limit line, 299, 305, 588
 ORAP, 456–460
 output factor, 455, 603
 overexcited, 438
 overload valve, 585
- P cut (design fix), 285
 Panther tank, 488
 part-load control, 543
 particulate matter (PM), 469
 PM10, 469
 PM2.5, 470
 performance degradation, 472, 606
 period hours, 454–455, 459, 623
 PI historian, 474
 pitch–chord ratio, 275
 pitch-line diameter. *See* Mean diameter
 planned starts, 578
 plant operating regimes, 601
 polytropic efficiency, 140
 heat recovery effect, 141
 reheat effect, 141
 Port Mann Power Plant (BBC), 406

- power factor
 - lagging, 429
 - leading, 430
- power triangle, 429–430, 433, 435, 440
- Pratt & Whitney, 40, 61, 70, 370–371, 665
- Predix (GE), 698
- purge credit, 577
- purge cycle (HRSG), 568
- purge flow
 - fuel passages, 326
 - wheel spaces, 213
- purge speed, 573
- set-point, 568
- PURPA. *See* The Public Utility Regulatory Policies Act
- quaternary manifold (DLN 2.6+), 326
- RAM, 454, 456, 458, 460, 599
- random errors, 484
- Rankine cycle, 52, 76–77, 82, 91, 109–111, 128, 490–491, 657
 - mean effective heat addition temperature, 129
 - mean effective heat rejection temperature, 129
- rating performance, 36
- Rayleigh criterion, 334
- reactive capability curve, 435, 441
- reactive power, 433
- recovery factor, 31, 198, 260, 633
- recuperation, 180
- reheat gas turbine, 147, 216, 645
- reliability factor, 454, 605
- repeating stages (compressor), 270
- resonance, 388
- Rolls-Royce, 41–42, 51, 62, 70, 179, 188, 235, 237, 362, 665, 667, 669, 677, 694
- rotational energy, 590
- rotational inertia, 589
- rothalpy, 226
- rotor (shaft), 398
 - bolted disk, 399
 - central tie-bolt, 400
 - welded disk, 399
- rotor inlet temperature, 35
- rotor-relative stagnation temperature, 166, 214, 228
- Rudolf Friedrich, 48
- Ruston gas turbines, 675
- Sankey diagram, 439, 494
 - energy distribution (CC), 495
 - exergy distribution (CC), 504
- SCR. *See* Short-circuit ratio, *See* Selective catalytic reduction
- second law of thermodynamics, 76, 78, 80, 91, 93, 99, 134–135, 510
- second Tds equation, 97–99, 101
- selected data. *See* Aero-derivative gas turbine
- selective catalytic reduction, 344
- self-excitation of a mode, 391
- sensor validation, 480
- sequential combustion, 646
- service hours, 455–456, 605
- SEV combustor, 647
- short-circuit, 432, 446
- short-circuit ratio, 445
- shut-off valve, 539
- Siemens, 13–14, 40, 48–49, 51, 54, 58–61, 63–64, 68, 70, 121, 127, 138, 144, 146, 153, 171, 210–211, 241, 258, 322, 324–325, 350, 352–353, 399–400, 408, 447, 474, 500, 525, 584, 626–628, 636, 640, 643, 665, 667, 674–677, 694, 697–698
- single-crystal (SC or SX). *See* Vacuum casting
- Smith chart, 235
 - data, 236
- S–N curves, 386
- snowflake (compressor), 279, 285
- sneubbers, 391
- Solar Turbines, 181, 183, 674–675, 705
- solidity, 275
- SoLoNox, 184
- space–chord ratio. *See* Pitch–chord ratio
- specific fuel consumption, 25
- specific humidity. *See* Humidity ratio
- specific power output, 25
 - maximizing, 89
- speed governor, 538
- speed reference, 538
- squealer tip, 284
- SRV. *See* Stop/speed ratio valve
- SSS clutch, 433, 566–567, 573, 578, 669, 671
- stage loading parameter
 - compressor, 269
 - turbine, 227
- stage reaction (compressor), 270
- stage reaction (turbine), 227
 - Whittle's turbine type parameter, 228
- stagnation temperature. *See* Total temperature
- stall
 - multiple cell rotating, 305
 - single cell rotating, 305
- Stanton number, 202, 206, 212
- starting torque, 564
- startup
 - combined cycle, 569
 - conventional, 570
 - fast, 570
 - simple cycle, 563
- startup sequence, gas turbine, 568
- static pressure variation, 282
- static starter. *See* Load commutated inverter
- static temperature, 21, 30
- steam cooling flow diagram (G class), 638
- steam injection, 147

- steam temperature matching, 573
 STIG, 185, 189, 192
 Stodola, 3, 42–45, 47, 70, 645
 stoichiometric combustion, 308
 stop/speed ratio valve, 539
 Strouhal number, 395
 Subpart KKKK (NAAQS), 341
 Superalloys, 368
 cast, nickel-based, 369
 cobalt-based, 372
 nickel-based, 372
 turbine hot gas path, 374
 surge, 305
 margin, 306
 swirl angle, 223
 synchronization, 449
 synchronous ac motor, 438
 synchronous condenser, 432, 436
 systematic errors, 484

 TBC, 69, 195–199, 203, 209, 212, 214, 254, 363, 373, 375, 626, 630, 639, 676
 technology factor, 120
 temperature reference, 539
 temperature rise coefficient. *See* Stage loading
 parameter: compressor
 terminal attenuators, 560, 572–574
 terminal voltage, 440
 The Fuel Use Act, 56
 The Public Utility Regulatory Policies Act, 57
 thermal barrier coating, 195, 363
 thermal diffusivity, 385
 thermal stresses, 381, 550, 561–562
 infinite cylinder problem, 558
 turbine blade wall, 214
 thermomechanical fatigue, 461
 three-pressure reheat, 502, 656
 thrust collar, 398
 Tinidur, 42, 193, 362
 tip shrouds, 391
 Titan 250, 674–675
 TOMONI (MHPS), 698
 topping cycle, 76, 491
 torque (gas turbine), 552
 total as spent capital, 594
 total capital requirement, 594
 total installed cost, 413, 594, 656
 total plant cost, 593–594
 total plant investment, 594
 total pressure, 32
 total pressure-loss coefficient, 281
 total temperature, 21
 TTRF, 325, 327, 541

 turbine inlet temperature, 35, 121
 turning angle. *See* Flow deflection (turbine stage)
 turning gear, 566
 assembly, 566
 speed, 567

 Udimet 700, 371
 uncertainty interval, 485
 underexcited, 438
 unplanned starts, 577
 unrecoverable degradation, 472–473
 unstalled flutter. *See* Negative aerodynamic damping
 US EPA test methods, 346

 Vacuum casting
 with DS, 370
 with SC, 370
 vane carriers, 406
 variable O&M costs, 598, 623
 variable stator vanes, 267, 302, 516
 velocity triangles (compressor stage), 266
 velocity triangles (turbine stage), 222
 vibration monitoring, 478
 vibrations, 387
 vortex design, 223
 VSVs. *See* Variable stator vanes

 water injection, 146
 wave rotor, 135
 Westinghouse, 50–51, 53, 58–60, 62–63, 68, 76, 121, 132, 184, 186, 188, 325, 399–400, 628, 636
 wet bulb temperature, 311, 313, 521
 wet compression, 137–138, 380, 529, 531
 wet reheater, 559
whirl velocities, 223
 Wobbe index, 336
 modified WI, 336
 operability range (MWI), 346
 typical values for hydrocarbon fuels, 339
 wobulating purge, 568
 work coefficient. *See* Stage loading parameter:
 turbine
 work-done factor, 269
 wye connection. *See* Y connection

 Y connection, 441
 yellow plume, 320

 Zel'dovich, 9, 18, 316, 630
 zero enthalpy reference, 110–111, 142, 144–145, 147, 156, 495–497
 zero stage, 279, 353
 Zweifel loading coefficient, 239