

15E. Targets ----- 465	16G. Heavy Ion Beams ----- 506
exploding pushers	required parameters
ablative compression	emittance
ion beam targets	rf linacs
target specifications	induction linacs
fabrication	design considerations
characterization	16H. Chambers ----- 515
positioning	general considerations
15F. Diagnostics ----- 473	dry walls
laser-plasma interactions	wetted walls
x-ray measurements	magnetically protected
charged particle	walls
measurements	liquid metal streams
neutron measurements	gas-protected walls
neutron activation analysis	comparisons
Bibliography ----- 479	Bibliography ----- 522
16. ICF Drivers and Chambers	17. Other Fusion Concepts
16A. Glass Lasers ----- 482	17A. Radiofrequency Confinement 524
fluence limitations	cavity modes and Q
amplifiers	quasipotential wells
parasitic oscillations	power requirements
spatial filters	high-pressure discharges
isolators	17B. Radiofrequency Plugging --- 527
glass properties	theory
frequency shifting	experiments
16B. CO ₂ Lasers ----- 487	17C. Electrostatic Confinement - 531
amplifiers	17D. Electrostatic Plugging ---- 533
optics	particle loss processes
power supplies	power gain ratio
efficiency	experiments
16C. Rare Gas Halide Lasers ----- 489	17E. Wall Confinement ----- 537
characteristics	17F. Imploding Liner ----- 539
pumping other lasers	17G. Colliding-beam Mirror ----- 541
backward wave Raman	17H. Hypervelocity Impact ----- 543
scattering	required parameters
pulse stacking	accelerators
16D. Other Lasers ----- 493	Bibliography ----- 546
HF lasers	
iodine lasers	
Group VI lasers	
excimer lasers	
solid state lasers	
16E. Electron Beams ----- 496	
pulse formation	
insulation	
diodes	
beam propagation	
applications	
16F. Light Ion Beams ----- 501	
production	
focusing and transport	
Particle Beam Fusion	
Accelerator (PBFA)	
high average power systems	

TECHNOLOGY

18. Fusion Engineering Problems
18A. Problem Areas ----- 550
plasma
vacuum
materials
blanket and shield
magnets
environment
economics
18B. Maintenance ----- 554
general principles
scheduled and unscheduled
maintenance

18C. A Tokamak Reactor Design ---- 557	20C. Coil Forces ----- 608
STARFIRE design features	long, parallel wires
plasma	coaxial circular loops
limiter and vacuum system	solenoids
first wall, blanket, and	force-reduced torsatron
shield	coils
magnets	coil design
environment	considerations
economics	20D. Power and Cooling Water
18D. A Mirror Reactor Design ---- 565	Requirements ----- 612
WITAMIR-I	relation of magnetic
plasma	field to coil power
blanket and shield	cooling water
environment and economics	20E. Coil Windings ----- 615
Bibliography ----- 571	Problems ----- 617
19. Vacuum Systems	Bibliography ----- 619
19A. Background ----- 572	21. Pulsed Magnet Systems
historical development	21A. Introduction ----- 620
need for ultra-high vacuum	21B. RLC Circuit Equations ---- 620
19B. Viscous and Molecular Flow -- 574	resistance and inductance
types of flow	21C. Distribution of \vec{J} and \vec{B} --- 624
throughput	single-turn high-field
flow equations	solenoids
conductance	21D. Energy Storage Systems ---- 626
pumpdown time	21E. Switching and Transmission 629
19C. Pumps ----- 580	21F. Magnetic Flux Compression - 631
mechanical pumps	21G. Component Reliability ---- 632
jet pumps	Problems ----- 634
ionization pumps	Bibliography ----- 635
sublimation pumps	22. Superconducting Magnets
cryosorption pumps	22A. Superconductivity ----- 636
cryogenic pumps	domain of
19D. Pressure Gages ----- 585	superconductivity
19E. Chambers and Components ---- 589	electron pairing
19F. Techniques ----- 591	energy gap
monolayers	diamagnetism
cleaning	flux quantization
leak detection	Type I and Type II
diffusion	superconductors
Problems ----- 594	critical current density
Bibliography ----- 595	in Type II materials
20. Water-Cooled Magnets	magnet coils
20A. Background ----- 596	22B. Superconductors ----- 642
20B. Magnetic Field Calculations - 597	22C. Stabilization ----- 645
basic equations	need for stabilization
straight wires	methods of stabilization
toruses and solenoids	22D. Coil Protection ----- 648
circular loops	fault conditions
circular coils with	protection circuitry
rectangular cross	fault detection
sections	22E. Coil Design Considerations 650
axial field of solenoid	conductor design
complex coil shapes	heat removal
	structural design

22F. Large Coils ----- 653	24G. Impurity Introduction ----- 700
MFTF magnets	physical sputtering
Large Coil Test Facility	physicochemical sputtering
(LCTF)	chemical erosion
22G. Superconducting Magnetic	desorption
Energy Storage ----- 656	vaporization
Problems ----- 658	blistering and flaking
Bibliography ----- 659	unipolar arcs
23. Cryogenics	synergistic effects
23A. Introduction ----- 662	24H. Near-Surface Wall
23B. Properties of Materials at	Modifications ----- 710
Low Temperatures ----- 663	phase changes
mechanical properties	alloy composition changes
thermal properties	microstructural changes
electrical resistivity	macrostructural changes
cryogenic liquids	property changes
23C. Refrigeration and	24J. Special Purpose Materials - 711
Liquefaction ----- 668	graphite and silicon
23D. Insulation ----- 670	carbide
23E. Cryostat Design ----- 672	heat-sink materials
23F. Cryogenic Systems ----- 673	ceramics
Problems ----- 676	superconducting magnet
Bibliography ----- 677	materials
24. Materials Problems	Problems ----- 717
24A. Introduction ----- 678	Bibliography ----- 718
24B. Damage Analysis and	25. Plasma Purity and Fueling
Fundamental Studies ----- 678	25A. Impurities ----- 722
damage production	impurity effects
damage microstructure	impurity concentrations
evolution	helium accumulation
24C. Analysis and Evaluation ---- 682	equilibrium helium
structural life	concentration
predictions	modes of operation
thermal stress	25B. Divertors ----- 727
test procedures	types of divertors
compatibility	plasma flow
fabrication	divertor target and
24D. Mechanical Behavior ----- 687	pumping
strength	tokamak divertors
ductility	other divertors
fatigue	25C. Neutral Gas Blankets ----- 734
thermal creep	25D. Other Impurity Control
24E. In-Reactor Deformation ----- 694	Techniques ----- 736
swelling	impurity injection
irradiation creep	gas flow
24F. Hydrogen Recycling ----- 696	neutral beam injection
reflection	pumped limiters
spontaneous desorption	25E. Fueling ----- 738
stimulated desorption	gas blankets
applications	plasma guns
	neutral beam injection
	cluster injection
	pellet injection
	Problems ----- 743
	Bibliography ----- 745

26. Blankets	27D. Blanket and Shield Designs 791
26A. Introduction ----- 747	flux distribution and
energy conversion	neutron balance
efficiencies	tritium breeding
blanket design problems	energy deposition
26B. Blanket Materials ----- 751	radiation damage
neutron multipliers	benchmark calculations
breeding materials	neutron streaming
coolants	Problems ----- 798
structural materials	Bibliography ----- 799
26C. Heat Transfer Processes ----- 755	28. Environment and Economics
radiation	28A. Introduction ----- 801
convection	28B. Tritium ----- 802
conduction	biological hazard
26D. Coolant Tube Stresses ----- 760	production rate
26E. Coolant Flow Rate and Pumping	tritium inventory
Power ----- 762	routine releases
flow rates	tritium permeation rates
pressure drop and pumping	tritium recovery systems
power	accidental tritium
power flux limitations	release
26F. Blanket Designs ----- 765	28C. Other Radioisotopes ----- 811
coolant flow configurations	production
flowing blanket designs	afterheat and biological
pressure tube designs	hazard
pressurized module designs	disposal
26G. Direct Energy Conversion ---- 770	recycling
principles	28D. Hazards and Materials
plasma direct convertors	Shortages ----- 818
beam direct convertors	hazards
26H. Fuel Production ----- 773	materials shortages
Problems ----- 774	helium
Bibliography ----- 775	summary
27. Neutronics	28E. Economics ----- 821
27A. Introduction ----- 777	electrical power cost
goals	cost scaling
methods	Problems ----- 827
27B. Transport Theory ----- 778	Bibliography ----- 828
Boltzmann equation	29. Fusion-Fission Hybrids
Legendre expansion	29A. Need ----- 830
discrete ordinates method	depletion of fissile
27C. The Monte Carlo Method ----- 783	fuel supplies
decisions	fissile fuel production
location of next	comparison with fusion
interaction	and fission
type of interaction	29B. Blanket Design ----- 832
new direction and energy	considerations
tallying	neutron interactions
error estimates	fuel forms
number of case histories	cost goals
needed	29C. Tokamak Hybrids ----- 835
variance reduction	large tokamaks
techniques	small beam-driven
	tokamaks

29D. Mirror Hybrids -----	840
other types of hybrids	
29E. Catalyzed DD Hybrids -----	844
advantages	
neutronics	
advantage of ^{233}U fuel	
economics	
Bibliography -----	847

30. The Future

30A. Experimental Progress -----	848
30B. Remarks -----	849
Edwin E. Kintner	
Stephen O. Dean	
Tihiro Ohkawa	
Harold P. Furth	
T. Kenneth Fowler	
Gerold Yonas	

Appendices

Appendix A. SI Units -----	A-1
Appendix B. Fundamental Constants	A-4
Appendix C. Integrals -----	A-5
Appendix D. Important Plasma	
Equations -----	A-6
Appendix E. Error Function -----	A-8
Appendix F. Vector Relations ----	A-9
Appendix G. Table of Symbols ----	A-11
Appendix H. Abbreviations -----	A-25
Appendix I. Answers to Problems -	A-28

Name Index -----	I-1
------------------	-----

Subject Index -----	I-15
---------------------	------

About the Author	I-27
------------------	------