

Contents

Acknowledgments	xvii
Foreword	xxi
Preface	xxiii

Part I, Ground Rules

Chapter 1: Nature of Hazards Theory of Hazard Prevention	3
1.1 Introduction	3
1.2 Hazard Definition	4
1.3 Types of Hazards	6
A. Natural environment	7
B. Mechanical	8
C. Electrical	9
D. Chemical	9
E. Radiant energy	9
F. Biological	10
G. Artificial intelligence	10
1.4 Management Dysfunctions that Accommodate Hazards	10
1.5 Hazards and the Law	12
Endnotes	16
Chapter 2: System Safety Engineering	17
2.1 Introduction	17
2.2 Illustration of a Systems Approach	18
A. Evolution of system safety	18
B. Feasibility of system safety	19
2.3 Environmental Concerns	20
2.4 Mathematical Analyses of System Safety	22

2.5 Reliability and Fault Tree Sequence	25
2.6 System Safety Standards	29
2.7 The Future of Safety	30
Endnotes	31
Additional Reading	33
Chapter 3: Premise Liability	35
3.1 Introduction	35
3.2 Code References	36
Chapter 4: Regulatory Agencies	37
4.1 Introduction	37
4.2 Engineer Responsibilities	41
4.3 Code References	48
Chapter 5: Human Characteristics	49
5.1 Introduction	49
5.2 Technical Data on People	50
A. Depth perception	50
B. Hearing perception	51
C. The human response process	51
D. Memory	51
E. Visual reception	52
F. Visual acuity	52
G. Peripheral vision	53
H. Pedestrian characteristics	53
I. What constitutes a handicapped person	54
J. Code references and industry standards	54
5.4 Noise	54
A. What are the chances of injury or death?	56
B. Noise levels	57
C. How noise injuries can be prevented	58
D. Engineering controls	59
E. Administrative controls	59
F. History	61
G. Code references and industry standards	62
5.5 Dust	64
A. A human tragedy	65
B. What are the chances of injury or death?	65

C. Why dust hazards continue to occur	67
D. How dust hazards can be prevented	68
E. History	71
F. Code references and industry standards	71
Endnotes	74
Part II, Design Basic	
Section A, Interior	
Chapter 6: Means of Egress	79
6.1 Introduction	79
A. Case in point	81
B. Code references and industry standards	84
6.2 Slips and Falls on Floor Surfaces	86
A. Introduction	86
B. Case in point	89
C. Foot physiology	90
D. Code references and industry standards	91
6.3 Trips and Falls	94
A. Introduction	94
B. Case in point	96
C. Code references and industry standards	100
Endnotes	102
Chapter 7: Stairs, Steps, Ledges and Staircases	103
7.1 Introduction	103
7.2 Single Steps	105
7.3 Case in Point	105
7.3 Code References and Industry Standards	106
Chapter 8: Ramps	117
8.1 Introduction	117
8.2 Case in Point	118
8.3 Code References and Industry Standards	119
Chapter 9: Doors, Windows and Glass	123
9.1 Introduction	123
9.2 Allowable Glazing Materials	124
A. Laminated glass	124
B. Wired glass	125
C. Annealed glass	125

D. Heat-strengthened glass	125
E. Tempered glass	126
9.3 Case in Point	126
9.4 Code References and Industry Standards	127
Chapter 10: Chairs and Furniture	131
10.1 Chairs and Furniture	131
A. Introduction	131
B. Case in point	132
C. Code references and industry standards	132
10.2 Bathrooms, Showers and Vanities	136
A. Introduction	136
B. Case in point	136
C. Code references and industry standards	138
Chapter 11: Ceiling Heights, Signs, Protruding Objects and Head Clearance Awnings	143
11.1 Introduction	143
11.2 Case in Point	144
11.3 Code References and Industry Standards	146
Chapter 12: Electricity, Appliances, Kerosene Heaters, Heating Elements and Circuits	149
12.1 Introduction	149
A. Cases in point	152
B. What are the chances of injury or death?	152
C. Why electrocutions still occur	154
D. How secondary power hazards can be prevented	155
E. History	157
F. Code references and industry standards	157
12.2 Electric-Arc Welding	159
A. Typical occurrences	160
B. What are the chances of injury or death?	161
C. Why arc-welding is dangerous	162
D. Case in point	163
E. Regulations	163
F. Code references and industry standards	164
Chapter 13: Fences, Banisters, Balconies and Handrails	167
13.1 Introduction	167

13.2 Case in Point	170
13.3 Code References and Industry Standards	170
Chapter 14: Lighting and Emergency Lighting.....	173
14.1 Introduction	173
14.2 Case in Point	174
14.3 Code References and Industry Standards	174
Chapter 15: Sight Distance, Size, Contrast, Color and Light.....	179
15.1 Introduction	179
15.2 Examples	180
15.3 Code References and Industry Standards	182
Chapter 16: Elevators, Automatic Doors, Revolving Doors, Escalators and Conveyors.....	185
16.1 Introduction	185
16.2 Conveyors	186
A. Typical occurrences	189
B. What are the chances of injury or damage?	190
C. Why do we have so many injuries, product losses and down time from conveyors?	190
D. How can injury and damage be prevented?	191
E. History	196
F. Code references and industry standards	196
G. Representative litigation	202
16.3 Examples	203
A. Code references and industry standards	204
Chapter 17: Falling Objects.....	209
17.1 Introduction	209
17.2 Cases in Point	209
17.3 Chance of Injury or Death.....	211
A. Introduction	211
B. Why it keeps occurring	212
C. Injury prevention	212
17.4 History	215
17.5 Code References and Industry Standards	216
17.6 Patents	221
17.7 Representative Litigation	221

Chapter 18: Gases	225
18.1 Carbon Monoxide	225
18.2 Carbon Monoxide Poisoning	225
18.3 What are the Chances of Injury or Death?	226
18.4 Carbon Monoxide Poisoning Continues to Occur	229
18.5 How Carbon Monoxide can be Controlled?	231
18.6 History	233
18.7 Code References and Industry Standards	235
18.8 Representative Litigation	239
Chapter 19: Mold	241
19.1 Introduction	241
19.2 Code References	242
Chapter 20: Fires, Fire Safety, Explosions and Smoke Detectors	245
20.1 Introduction	245
20.2 Fire Prevention	246
A. Causes of fire	246
B. Case in point	248
C. What are the chances of injury or death?	249
D. How fires can be prevented	250
20.3 Fire Protection System Hazards	254
A. Carbon dioxide	254
B. Dry chemicals	254
C. Halon	254
D. Sprinkler and other water systems	254
E. Sources of ignition	254
F. Cause of fires	255
20.4 History	255
20.5 Code References and Industry Standards	257
20.6 Representative Litigation	259
Endnotes	264
 Section B, Exterior	
Chapter 21: Sidewalks, Parking Lots and Parking Garages	267
21.1 Introduction	267
21.2 Case in Point	271

21.3 Code References and Industry Standards	271
Chapter 22: Maintenance—Snow, Ice, Grease, Oil and Floor Cleaning	275
22.1 Introduction	275
22.2 Case in Point	275
22.3 Code References	276
Chapter 23: Ice Guards and Roof Drains, and Site Drainage	279
23.1 Introduction	279
23.2 Case in Point	279
23.3 Code References	282
Chapter 24: Stadiums, Grandstands and Bleachers	285
24.1 Introduction	285
24.2 Case in Point	285
24.3 Code References and Industry Standards	288
Chapter 25: Street Grates, Open Grid Floors and Joints in Walking Surfaces	291
25.1 Introduction	291
25.2 Case in Point	291
25.3 Code References and Industry Standards	293
Chapter 26: Playgrounds and Swimming Pools	295
26.1 Playgrounds	295
26.2 Swimming Pools	296
26.3 Case in Point	296
26.4 Code References and Industry Standards	298
 Part III, Construction	
Chapter 27: Construction In Occupied Buildings	303
27.1 Construction Management	303
A. Cases in point	305
B. What are the chances of injury or death when a CM fails to address safety?	308
C. Why is poor contract management becoming a significant factor in workplace injury?	309
D. How can contract operations be made safe?	311
E. History	315
F. Code references and industry standards	315
G. Representative litigation	320

27.2 Unsafe Equipment Control Systems	321
A. Dangerous occurrences	323
B. What are the chances of injury or death?	325
C. Why unsafe control systems exist	326
D. How injury can be prevented	327
E. History	330
F. Code references and industry standards	330
G. Representative litigation	333
H. Back to the future	334
Chapter 28: Mobile Equipment	337
28.1 Large Truck Hazards	338
A. Case in point	339
B. Dangerous situations	340
C. What are the chances of injury or death?	342
D. Why are so many crashes occurring?	343
E. How can heavy truck and car crashes be prevented?	347
F. History	351
G. Observations	352
H. Code references and industry standards	352
28.2 Forklift	355
A. Cases in point	356
B. What are the chances of injury or death?	358
C. Why injury or death occurs	359
D. How it can be prevented	360
E. Code references and industry standards	362
F. Patents	367
G. Representative litigation	367
H. Observations	369
28.3 Blind Zones on Moving Equipment	369
A. Cases in point	371
B. What are the chances of injury or death?	372
C. Why are people caught in blind zones?	373
D. How blind zones can be prevented	376
E. Other hazard prevention measures	377
F. Code references and industry standards	379
G. Patents	382

28.4 Unsafe Equipment Control Systems	383
A. Dangerous occurrences	384
B. What are the chances of injury or death?	387
C. Why unsafe control systems exist	389
D. How injury can be prevented	390
E. History	393
F. Code references and industry standards	394
Endnotes	396
Chapter 29: Construction Methods	397
29.1 Wood Frame Construction	398
A. Why construction of wood frame buildings results in high injury rates	398
B. How can wood frame construction injuries be prevented?	399
C. Code references and industry standards	401
D. Case in point	402
E. Product safety	403
F. Alternatives to regulation	404
29.2 Concrete Formwork	407
A. Discussion	407
B. Case in point	408
C. What are the chances of injury and death	409
D. Why falls from elevations occur on concrete formwork ..	410
E. How falls can be prevented	410
F. Code references and industry standards	411
G. Representative litigation	413
29.3 Steel Erection	414
A. Type occurrences	415
B. What are chances of injury or death?	415
C. Why injuries continue to occur	416
D. How injuries can be prevented	418
E. History	420
F. Code references and industry standards	421
G. Cases in point	429
H. Legislation	429
29.4 Masonry Failure Hazards	430
A. Typical occurrences of human tragedy	430
B. What are the chances of injury or death?	431

C. Why masonry injures and failures occur	431
D. How masonry injuries and can be prevented	433
E. History	435
F. Code references and industry standards	436
G. Representative litigation	439
H. Building cladding	439
Chapter 30: Ladders, Scaffoldings and Platforms	441
30.1 Introduction	442
30.2 Ladders	442
A. Typical occurrences	444
B. What are the chances of injury and death from ladders? ..	444
C. Why injuries continue to occur	445
D. How can ladder injuries be prevented?	446
E. History	450
F. Code references and industry standards	450
G. Representative litigation	453
30.3 Scaffolding	455
30.4 Access and Work Platforms	456
30.5 Fall Prevention vs. Fall Protection	457
A. Tragic situations	457
B. What are the chances of injury or death?	458
C. Where fatal falls most often occur	459
D. Why fatal falls keep occurring	459
E. How to be protected from falls from an elevation	459
F. History	464
G. Code references and industry standards	465
H. Representative litigation	472
I. What's new in the industry?	473
J. Times have changed	474
30.6 How to Ensure Safe Access and Working Locations	475
A. History	476
B. Code references and industry standards	477
C. Representative litigation	480
Endnotes	484
Chapter 31: Confined Spaces, Manholes, Tanks and Attics	485
31.1 Introduction	485
31.2 Confined Spaces	486

A. What is a confined space?	487
B. Typical occurrence	488
C. What are the chances of injury or death?	490
D. History	493
E. Pre-entry check list for confined space safety	493
F. Atmospheric hazards	494
G. Code references and industry standards	495
H. Representative literature	497
I. Case in point	498
31.3 Trenching	500
A. Tragic occurrences	500
B. What are the chances of injury or death?	501
C. Why trench collapse occurs	502
D. Other associated hazards	503
E. How trenching injuries and death can be prevented	504
F. Trench boxes	505
G. The history of trenching hazards	509
H. Code references and industry standards	509
I. Representative litigation	515
31.4 Hazard Isolation	516
A. Procedures for controlled entry, lockout/tagout and permits	516
B. What are the chances of injury or death?	518
C. Why isolation of dangerous energy is sometimes overlooked	521
D. How controlled entry, lockout/tagout and permits can save lives	521
E. Code references and industry standards	524
Endnotes	527
Chapter 32: Cranes, Hoist, Blocking and Rigging	529
32.1 Crane Upsets	529
A. Typical occurrences	530
B. What are the chances of injury or death?	530
C. Why crane upsets keep happening	532
D. How crane upset can be prevented	534
E. Code references and industry standards	535
F. Patents	536

32.2 Equipment Powerline Contact	536
A. What are the chances of injury or death?	536
B. Why powerline contacts keep occurring	540
C. How powerline contact can be prevented	541
D. Code references and industry standards	547
32.3 Killer Hooks	550
A. Typical occurrences of human tragedy	550
B. What are the chances of injury or death?	552
C. Why hooks failures happen	552
D. How load loss can be prevented	553
E. Recap of important safety tips:	555
F. History	556
G. Code references and industry standards	556
32.4 Crane Two-Blocking Hazard	558
A. Human tragedy	559
B. What are the chances of injury or death?	561
C. Why two-blocking keeps occurring	562
D. How two-blocking can be prevented	562
E. History	564
F. Code references and industry standards	565
 Part IV, The User/Occupant	
Chapter 33: Moving Parts of Machinery	571
33.1 Introduction	571
33.2 Case In Point	572
33.3 What are the Chances of Injury or Death?	573
A. Why it keeps occurring	575
B. Mechanical hazards	575
C. Hazardous motions and actions	576
33.4 How Injury Can be Prevented	577
A. Requirements for safeguards	578
33.5 Types of Machine Guards	578
A. Fixed guard	578
B. Point-of-operation guard	578
C. Automatic and interlocking guards	579
D. Self-adjusting guards	580

E. Other guarding	580
F. Guarding during maintenance	580
33.6 History	581
33.7 Code References and Industry Standards	582
33.8 Patents	584
33.9 Representative Litigation	585
33.10 Lessons Learned.....	585
Chapter 34: Operational Manuals and User Training	587
About the Authors	591
Index	595