INDEX

Access security
As a core attribute, 51(2.3.2), 120(3.5.3)
Contribution to human error, 63(Table 2.4)
Designing for, 83(3.1), 94(2.3.2), 107(3.5), 118(3.5.2), 122(3.5.4), 153(4.0), 207(4.5.13), 218(2.3.2), 221(2.3.2), 225(2.3.2), 248(2.3.2)
Hazards identification, 56(2.4.1)
Risk management, 61(2.4.2), 70(2.4.4), 83(3.0)
Roles and responsibilities, 93(3.3.2)
See Administrative controls, IPL

Administrative control
As a management system, 107(3.5), 118(3.5.2), 120(3.5.3), 128(3.5.6), 131(3.5.7), 133(3.6), 220(5.2), 225(5.2.2), 242(5.2.7), 265(6)
As a safeguard, 23(2.1), 39(2.2.2), 42(2.3), 47(2.3.1), 61(2.4.2), 70(2.4.4), 95(3.3.5)
Lifecycle cost, 42(2.3)
Versus an engineered system, 23(2.1), 39(2.2.2), 42(2.3)
See Management system, Procedure

Alarm system
Human machine interface
design, 30(2.1.2), 424(D.3.1), 534(G.4), 539(G.5.1), 545(G.6)
Influence of process safety time, 109(3.5.1.2), 429(D.3.4), 436(D.4), 437(D.5)
Inherently safer practices, 104(3.4), 541(G.52)
Justification, 171(4.3.4), 423(D.2), 541(G.5.2)
Management, 95(3.3.5), 423(D.3)

Process alarms, 538(G.5)
Rationalization, 91(3.2), 181(4.4.6.1), 285(6.4.8.3), 429(D.3.4)
Risk reduction, 167(4.3.1), 189(4.4.7.1), 225(5.2.2)
Safety alarm, 109(3.5.1.2), 120(3.5.3), 181(4.4.6.1), 217(5.1.2), 285(6.4.8.3), 436(D.4), 545(G.6)
Technologies, 543(G.5.3), 546(G.8)
See Process safety time

Application program
Advanced control topics, 170(4.3.3), 188(4.4.6.5), 202(4.5.8)
Basic functions, 162(4.2)
Control objectives, 165(4.3), 557(H.5)
Designing for, 133(3.6), 194(4.5), 242(5.2.7), 556(H.4)
Differences between process control and safety, 557(H.5)
Languages, 554(H.3)
Requirements specification, 194(4.5), 557(H.5), 563(H.6)
SCAI, 557(H.5), 563(H.6)
Software types, 551(H.1)
See Inherently safer practices

Architecture (of industrial automation systems)
Control system, 42(2.2.3), 83(3.1), 165(4.3), 172(4.4)
Network, 133(3.6), 391(C)
Overall system, 94(3.3.3)
Separation, 133(3.6)
See Communications, Hardware fault tolerance

Assessments
See Assessment under Risk, Functional safety assessment under Management system
As good as new
Discussion, 23(2.1), 73(2.4.5), 128(3.5.6), 131(3.5.7), 241(5.2.6), 291(6.5), 298(6.5.6)
See Monitoring and metrics, Prior use, Useful life, Wear-out
Audits
As a core attribute, 7(1.1), 51(2.3.2), 93(3.3.2), 120(3.5.3), 127(3.5.5), 131(3.5.7), 133(3.6), 170(4.3.3), 220(5.2), 563(H.6)
See Auditing under Management system
Automation organization
Competency, 1(1), 30(2.1.2), 70(2.4.4), 93(3.3.2), 120(3.5.3), 131(3.5.7), 133(3.6), 165(43), 207(45.13), 220(5.2), 267(6.2.2), 563(H.6)
Roles and responsibilities, 11(1.4), 93(3.3.2)
Staffing, 267(6.2.1)
See Training
Basic process control system (BPCS)
See Process control system
Batch process operation
Multiple product management, 282(6.4.7.2)
Recipe management, 282(6.4.7.2), 286(6.4.8.5)
See Procedure, Process operating mode
Bypass
Compensating measures, 99(3.3.6), 128(3.5.6), 244(5.2.8), 279(6.4.4), 300(6.5.7)
Impact on risk, 33(2.1.3), 56(2.4.1), 167(4.3.1), 225(5.2.2), 230(5.2.4.2), 244(5.2.8)
Maintenance, 95(3.3.5), 191(4.4.7.4), 244(5.2.8), 283(6.4.8), 300(6.5.7)
See Management of change, Procedures
Common cause failure
Effect on risk, 37(2.2.1), 51(2.3.2), 52(2.3.3), 73(2.4.5), 120(3.5.3)
Sources, 120(3.5.3), 169(4.3.2), 184(4.4.6.3), 196(4.5.3), 238(5.2.5), 352(A.1.3.6.3), 465(E.2.3), 518(F.2.1), 525(F.2.7)
See Diversity, Human factors, Independence, Integration, Separation, Systematic error
Communications
Between process control and safety, 133(3.6), 412(C.7)
Designing for, 391(C.1), 397(C.3), 403(C.5), 407(C.6)
Network, 133(3.6), 183(4.4.6.2), 395(C.2)
SCAI, 258(5.3.5), 419(C.8)
Wireless, 109(3.5.1.2), 207(4.5.13), 352(A.1.3.6.3), 378(B.1.4), 393(C.1.1), 395(C.2), 400(C.4), 407(C.6), 441(E.1), 453(E.1.3.3)
See Cybersecurity
Compensating measures
Bypassing, 99(3.3.6), 128(3.5.6), 167(4.3.1), 244(5.2.8), 279(6.4.4), 300(6.5.7)
Detected fault, 99(3.3.6), 198(4.5.5), 238(5.2.5), 244(5.2.8), 283(6.4.8), 388(B.4), 520(F.2.3)
Impact on risk, 128(3.5.6), 191(4.4.7.4), 225(5.2.2), 244(5.2.8), 429(D.3.4)
See Management of change, Monitoring and metrics, Procedure
Competence
See Automation organization
Configuration Management
Designing for, 7(1.1), 133(3.6), 153(4.0), 188(4.4.6.5), 202(4.5.8), 244(5.3), 316(6.7), 346(A.1.3.4)
See Management of change
Continuous process operation
See Maintenance planning, Process operating mode
INDEX

Control system
Data quality, 203(4.5.10)
Function type, 153(4.0),
162(4.2), 176(4.4.3),
190(4.4.7.2), 329(4.0),
359(4.2)
See Architecture,
Communication, Controller
technologies, Integration, Signal
types

Controller technologies
Analog, 173(4.4.1), 331(A.1.1)
Discrete, 176(4.4.2), 334(A.1.2)
Hybrid, 181(4.4.5), 358(A.1.5)
Pneumatic/hydraulic,
331(A.1.1.1)
Programmable, 176(4.4.3),
341(A.13)
Response time, 109(3.5.1.2),
173(4.4.1), 176(4.4.3),
189(4.4.7.1), 190(4.4.7.2),
205(4.5.11), 238(5.2.5),
352(A.1.3.6.3), 354(A.1.3.6.4),
355(A.1.3.6.5)
Supervisory, 180(4.4.4)
Technology selection, 172(4.4),
244(5.3), 300(6.5.8), 330(A.1)

Core attributes
Access security, 51(2.3.2),
118(3.5.2)
Auditability, 51(2.3.2), 127(3.5.5)
Designing for, 39(2.2.2), 107(3.5)
Functionality, 51(2.3.2),
108(3.5.1)
Independence, 51(2.3.2),
120(3.5.3)
Integrity, 512.3.2()(), 131(3.5.7)
Introduction, 51(2.3.2)
Management of change (MOC),
51(2.3.2), 122(3.5.4)
Reliability, 51(2.3.2), 128(3.5.6)
See Independent protection layer

Cybersecurity
Designing for, 70(2.4.4),
118(3.5.2), 207(4.5.13),
221(5.2.1), 351(A.1.3.6.2),
358(A.1.4), 411(C.6.3)
Examples, 33(2.1.3), 56(2.4.1),
61(2.4.2)
Zone (of security), 91(3.2),
133(3.6)
See Access security, Equipment
selection, Maintainability,
Management of change,
Separation

Dangerous failure rate
Impact on integrity, 39(2.2.2),
104(3.4), 120(3.5.3),
146(3.6.5), 189(4.4.7.1),
218(5.1.4), 228(5.2.4),
230(5.2.4.2), 244(5.3),
515(F.1.2)

Data source
Calculation, 67(2.4.3), 73(2.4.5),
572(I.6)
Delphi, 73(2.4.5), 569(I.4)
Expert judgement, 73(2.4.5),
515(F.1.2), 569(I.4)
Generic data, 569(I.4)
Perdicted data, 513(F.1.1)
Site-specific data, 515(F.1.2),
566(I.2), 568(I.3)
Uncertainty, 73(2.4.5),
524(F.2.4), 572(I.6), 576(I.7)
Verification, 576(I.7)

Demand rate
Impact on mode of operation,
215(5.1), 218(5.1.4)
Impact on risk, 37(2.2.1),
47(2.3.1), 61(2.4.2), 73(2.4.5),
153(4.0), 196(4.5.3),
319(6.7.2)
See Monitoring and metrics,
Prior use

Detected fault
Impact on risk, 238(5.2.5)
See Compensating measure,
Diagnostics, Procedures

Diagnostics
Discussion, 238(5.2.5)
Equipment selection, 520(F.2.3)
Relationship with demand rate,
520(F.2.3)
Relationship with test interval,
525(F.2.6)

Diversity
Impact on potential failure,
52(2.3.3), 133(3.6), 153(4.0),
234(5.2.4.3), 248(5.3.1),
358(A.1.5), 460(E.2.2),
465(E.2.3), 519(F.2.2)
See Inherently safer
Engineered systems
As a safeguard, 23(2.1), 39(2.2.2), 42(2.3), 47(2.3.1), 61(2.4.2), 67(2.4.3), 70(2.4.4), 95(3.3.5)
Lifecycle cost, 42(2.3)
Versus an administrative control, 232.1  
See Instrumented protection layers

Equipment selection
Certification, 517(F.1.3)
Claim limit, 513(F.1.1), 517(F.1.3)
Control, 165(4.3), 172(4.4), 193(4.4.7.5)
Evidence to support, 518(F.1.4), 525(F.2.6)
IEC 61508 compliance, 513(F.1.1), 524(F.2.5)
IEC 61511 compliance, 218(5.1.4), 244(5.3)
Safety, 39(2.2.2), 167(4.3.1), 244(5.3.5), 419(C.8), 511(F.0), 515(F.1.2)
Safety manual, 221(5.2.1), 225(5.2.2), 252(5.3.2), 319(6.7.2), 350(A.1.3.5.2), 511(F.1), 513(F.1.1), 520(F.2.3), 524(F.2.4), 525(F.2.5), 554(H.3), 557(H.5), 563(H.6)
Sharing, 52(2.3.3), 94(3.3.3), 104(3.4), 120(3.5.3), 146(3.6.5), 356(A.1.3.6.7), 410(C.6.2), 412(C.7)
See Fit for purpose, Hardware fault tolerance, Operating environment, Prior use, Proof testing, Separation

Existing systems
Assessment, 78(2.5), 225(5.2.2), 313(6.6.6), 315(6.6.8), 321(6.8.1)
See Fit for purpose, Management of change, Prior use

Fail Safe
See Safe state

Failure
See Integrity, Monitoring and metrics, Reliability, Testing

Failure rate
Calculation, 572(I.6)
Estimating when failure has not yet occurred, 572(I.6)
Examples of data, 572(I.6)
Uncertainty, 73(2.4.5), 576(I.7)
See As good as new, Data source, Fit for purpose, Instrument reliability, Operating environment, Prior use, Useful life, Wear-out

Field devices
Data errors, 203(4.5.10)
I/O interfacing, 352(A.1.3.6.3), 393(C.1.1)
Power loss to intelligent devices, 122(3.5.4)
Process network level, 133(3.6)
Sharing, 146(3.6.5), 221(5.2.1)
Signal filtering and characterization, 363(A.2.2.9)
See Equipment selection, Motors, Redundancy, Sensors, Signal types, Valves

Fit for purpose
Importance of, 52(2.3.3), 73(2.4.5), 78(2.5), 83(3.1), 107(3.5), 131(3.5.7), 193(4.4.7.5), 225(5.2.2), 230(5.2.4.2), 234(5.2.4.3), 241(5.2.6), 298(6.5.6), 302(6.5.10), 306(6.6.1), 511(F.0), 515(F.1.2), 517(F.1.3), 518(F.1.4), 565(I.1), 566(I.2)
See As good as new, Equipment selection, Prior use, Testing, Useful life

Functional safety
Discussion, 1(1.0), 7(1.1), 23(2.1), 47(2.3.1), 54(2.4)
Impact on lifecycle cost, 42(2.3)
Relationship to inherently safer, 1(1.0), 23(2.1), 42(2.3)
See Management systems

Good engineering practices
Importance of, 73(2.4.5), 78(2.5), 107(3.5), 218(5.1.4), 265(6.1), 511(F)
Operating objectives, 93(3.3.1)
Standards and practices, 7(1.1), 218(5.1.4)

Grandfathering
See Existing system

Grounding
See Power

Hardware fault tolerance
Architecture, 120(3.5.3), 230(5.2.4.2), 524(F.2.4)
Discussion, 228(5.2.4), 524(F.2.4)
Safety integrity level, 230(5.2.4.2)
Uncertainty, 229(5.2.4.1)
See Compensating measures, Equipment selection

High demand
See Mode of operation (SCAI)

Human error
Access security, 118(3.5.2)
Design, 33(2.1.3)
Hazard identification, 56(2.4.1)
Impact on risk, 225(5.2.2)
Inherently safer, 1(1.0), 23(2.1), 47(2.3.1)
lifecycle, 1(1.0)
Safety controls, alarms, and interlocks (SCAI), 2215.2.1(/)
Systematic error, 30(2.1.2), 303(6.6)
See Administrative controls, Diversity, Functional safety management, Interface, Management systems

Human factors
Cognitive phenomena, 306(6.6.1)
Error likely situations, 61(2.4.2)
Managing organizational changes, 316(6.7)
Negative and positive factors, 33(2.1.3)
Remote operations, 30(2.1.2)
Response time impact, 30(2.1.2), 47(2.3.1)
Safety culture, 1(1.0)
See Automation organization, Common cause, Communication, Cybersecurity, Interface, Performance shaping factors, Procedures, Training

Human machine interface (HMI)
See Interface

Incidents that define safe automation
Bayamon, 212
Belle, 76
Bhopal, 110
Channelview, 236
Discussion, 13(1.5)
Hebei, 44
Hemel Hempstead, 296
Illiopolis, 260
Institute, 88
Longford, 174
Macando, 304
Mexico City, 28
Milford Haven, 154
Ontario, 288
Pasadena, 246
Pascagoula, 100
Petrolia, 124
Point Comfort, 64
Sunray, 16
Texas City, 276
Valley Center, 186

Independence
As a core attribute, 51(2.3.2), 120(3.5.3)
Designing for, 120(3.5.3), 133(3.6), 221(5.2.1), 518(F.2.1)

Independent protection layer
Discussion, 1(1.0), 51(2.3.2)
Sustainability, 1(1.0)
Versus inherently safer design, 1(1.0), 23(2.1), 42(2.3)
See Instrumented protection layer, Safety controls, alarms, and interlocks (SCAI), Safety instrumented systems

Inherently safer
Automation, 104(3.4)
Lifecycle cost, 42(2.3)
Opportunities, 23(2.1)
Process design, 1(1.0), 47(2.3.1)
Relationship to functional safety, 1(1.0), 47(2.3)
GUIDELINES FOR SAFE AUTOMATION OF CHEMICAL PROCESSES

Instrument reliability
Data collection, 127(3.5.5), 128(3.5.6), 515(F.1.2), 566(I.2), 569(I.4)
Data taxonomy, 568(I.3)
Failure investigation, 571(I.5)

Instrumented protection layer
Discussion, 52(2.3.3), 67(2.4.3)
See Safety controls, alarms, and interlocks (SCAI)

Integration
Air gapped, 140(3.6.1)
Combined, 146(3.6.5)
Common cause, 133(3.6), 146(3.6.5)
Discussion, 133(3.6)
Interfaced, 142(3.6.2)
Isolated networks, 144(3.6.3)
Shared networks, 145(3.6.4)
See Communication, Cybersecurity, Separation

Integrity
As a core attribute, 51(2.3.2), 131(3.5.7)
Designing for, 131(3.5.7), 225(5.2.2)
See Management system, Monitoring and metrics, Safety controls, alarms, and interlocks (SCAI), Specification, Testing

Interface
Control system, 181(4.4.6.1), 200(4.5.7)
Engineering workstation, 293(6.5.1)
Future, 546(G.9)
Impact of safety on HMI design, 257(5.3.4), 545(G.6)
Instrument panels, 533(G.3)
Maintenance workstation, 293(6.5.1)
Operator workstation, 30(2.1.2), 280(6.4.6), 534(G.4), 547(G.10)
See Alarm system

IPL response time (IRT)
Discussion, 91(3.2), 103(3.3.6.2), 109(3.5.1.2), 131(3.5.7), 176(4.4.3), 238(5.2.5)
Influence on alarm effectiveness, 109(3.5.1.2), 429(D.3.4), 436(D.4)

Lifecycle
Automation, 83(3.1)
Relative cost, 1(1.0)

Low demand
See Mode of operation (SCAI)

Maintainability
Cybersecurity, 99(3.3.6), 291(6.5), 320(6.7.4)
Discussion, 99(3.3.6), 181(4.4.6.1), 191(4.4.7.4), 194(4.5.2), 241(5.2.6)

Maintenance
Planning, 73(2.4.5), 128(3.5.6), 291(6.5)
Preventive maintenance, 39(2.2.2), 47(2.3.1), 70(2.4.4), 73(2.4.5), 99(3.3.6), 104(3.4), 128(3.5.6), 265(6.1), 291(6.5), 295(6.5.4), 316(6.7)
See Bypass, Procedure, Testing

Management of change
Access security, 320(6.7.3)
Cybersecurity, 320(6.7.4)
Designing for, 127(3.5.5), 429(D.3.4)
Process control, 318(6.7.1)
SCAI, 319(6.7.2)

Management system
Access security, 293(6.5.1), 308(6.6.2), 320(6.7.3)
Administrative controls versus engineered systems, 42(2.3)
Auditing, 127(3.5.5), 323(6.8.2)
Functional safety assessment, 78(2.5), 83(3.1), 127(3.5.5), 225(5.2.2), 313(6.6.6), 315(6.6.7-8)
Pre-start-up review, 315(6.6.7)
Procedures, 286(6.4.9)
Verification, 306(6.6.1)
See Automation organization, Human factors, Management of change, Monitoring and metrics, Systematic error

Metrics
See Monitoring and metrics
Mode of operation (SCAI)
Continuous mode in shared logic solver designs, 146(3.6.54)
Credit for instrument diagnostics in SIS design, 520(F.2.3)
Impact on valve solenoid failures, 502(E.8.4)
Proof testing for high demand/continuous mode SIS, 525(F.2.6)
Relative to SCAI classification, 215(5.1)
Selection of digital communication protocols, 397(C.3)

Monitoring and metrics
Demand rate, 78(2.5), 265(6.1), 291(6.5), 319(6.7.2), 321(6.8.1), 323(6.8.2), 329(4.0), 566(I.2)
Discussion, 23(2.1), 321(6.8.1), 429(D.3.4), 566(I.2)
Frequency of failure, 91(3.2), 189(4.4.7)
Probability of failure on demand (PFD), 67(2.4.3), 73(2.4.5), 91(3.2), 128(3.5.6), 131(3.5.7), 218(5.1.4), 572(I.6)
Process availability, 83(3.1), 91(3.2), 95(3.3.4), 99(3.3.6), 128(3.5.6), 131(3.5.7), 133(3.6), 153(4.0)
Risk reduction, 1(1.0), 23(2.1), 39(2.2.2), 42(2.3), 47(2.3.1), 51(2.3.2), 52(2.3.3), 56(2.4.1), 61(2.4.2), 67(2.4.3), 70(2.4.4), 78(2.5), 83(3.1), 96(3.3.5.1), 99(3.3.6), 120(3.5.3), 127(3.5.5), 211(5.0), 215(5.1), 220(5.2), 225(5.2.2), 228(5.2.4), 230(5.2.4.2), 244(5.2.8)
Spurious trip rate, 67(2.4.3), 73(2.4.5), 91(3.2), 227(5.2.3), 228(5.2.4), 229(5.2.4.1), 230(5.2.4.2), 240(5.2.5.2), 241(5.2.6), 242(5.2.7), 244(5.3), 259(5.3.7), 271(6.3.2), 306(6.6.1), 319(6.7.2), 511(F.1), 565(I.1), 569(I.4)

See As good as new, Failure rate, Fit for purpose, Prior use

Motors
Electric, 504(E.9)
Energized-to-trip/de-energized-to-trip, 259(5.3.7)
Response time, 109(3.5.1.2)
Steam turbine, 505(E.10)
Voltage ride through, 375(B.1.3)
See Equipment selection, Power

Never exceed limit
Discussion, 109(3.5.1.2)
See Process safety time

Operability
Discussion, 95(3.3.5)
Operator interaction, 98(3.3.5.2)
Role of operators in process safety, 23(2.1), 33(2.2), 47(2.3.1), 52(2.3.3), 54(2.4), 78(2.5), 83(3.0), 153(4.0), 211(5.0), 265(6.0), 354(A.1.3.6.4), 355(A.1.3.6.5), 356(A.1.3.6.7), 359(A.2), 412(C.7), 423(D.1, D.3), 436(D.4), 437(D.5), 458(E.2), 475(E.4), 476(E.5.1), 485(E.5.9), 487(E.6), 493(E.8), 529(G.0), 557(H.5), 566(I.2), 568(I.3), 593(J.4.5)

Operating environment
Discussion, 39(2.2.2), 95(3.3.5), 525(F.2.7)

Performance
See Integrity, Monitoring and metrics, Reliability, Specification

Performance shaping factors (PSF)
Discussion, 47(2.3.1), 131(3.5.7), 303(6.6), 423(D.1)

Power
Considerations in design, 252(5.3.2), 253(5.3.3), 259(5.3.7)
Distribution, 184(4.4.6.3)
Energized-to-trip/de-energized-to-trip, 259(5.3.7)
Ground loops, 184(4.4.6.3), 352(A.1.3.6.3), 371(B)
Grounding and shielding, 371(B)
Hazardous area classification, 444(E1.2.2.1)
Interference in signal wiring, 454(E.1.4), 456(E.1.7)
Live zero, 442(E.1.1)
Loss of power to programmable devices, 122(3.5.4)
Shielding for safety, 379(B.2)
Verification during SAT, 589(J.4)
See Motors

Prior Use
Data collection, 83(3.0), 127(3.5.5), 128(3.5.6), 181(4.4.6.1), 188(4.4.6.5), 244(5.3), 306(6.6.1), 569(I.4)
Importance of, 27(2.1.1), 39(2.2.2), 52(2.3.3), 54(2.4), 67(2.4.3), 70(2.4.4), 73(2.4.5), 78(2.5), 153(4.0), 211(5.0), 228(5.2.4), 241(5.2.6), 244(5.3), 252(5.3.2), 295(6.5.4), 298(6.5.6), 313(6.6.6), 323(6.8.2), 460(E.2.2)
Performance assessment, 511(F.1), 515(F.1.2), 565(I.1)
Relationship with IEC 61508, 104(3.4)
See As good as new, Demand rate, Fit for purpose, Useful life

Probability of failure on demand
See Monitoring and metrics

Procedures
Abnormal, 278(6.4.3)
Alarm response, 285(6.4.8.3)
Batch, 281(6.4.7)
Bypass, 284(6.4.8.1)
Compensating measure, 284(6.4.8.1), 311(6.6.54)
Normal, 274(6.4.1)
On-line calibration, 285(6.4.8.2), 298(6.5.6)
Operator/process control interaction, 280(6.4.6)
Operator/SCAI interaction, 283(6.4.8), 286(6.4.8.5)
Safe, 47(2.3.1), 275(6.4.2), 285(6.4.8.3)
Security, 280(6.4.5), 320(6.7.3-4)
Turnover, 279(6.4.4)
See Testing

Process control system
Control loop failure, initiating event, 56(2.4.1), 67(2.4.3)
Counting multiple functions in risk analysis, 47(2.3.1), 52(2.3.3), 120(3.5.3), 146(3.6.5)
Discussion, 37(2.2.1), 153(4.0)
Inherently safer automation, 104(3.4)
Mirroring (a.k.a. shadowing), 238(5.2.5), 412(C.7)
See Alarm system, Application program, Controller technologies, Cybersecurity, Interface, Separation, Systematic error

Process operating mode
Batch, 96(3.3.5.1), 99(3.3.6), 164(4.2.4), 172(4.4), 196(4.5.3), 198(4.5.4), 281(6.4.7), 329(A.0)
Continuous process operation, 96(3.3.5.1), 99(3.3.6), 172(4.4), 176(4.4.3), 196(4.5.3), 329(A.0), 370(A.2.4)

Process safety time
Discussion, 109(3.5.1.2)
Examples, 227(5.2.3), 230(5.2.4.2), 238(5.2.5)
Influence on alarm design, 429(D.3.4), 436(D.4)

Proof test
See As good as new, Fit for purpose, Monitoring and metrics, Prior use, Procedure, Testing

Quality assurance
See Monitoring and metrics

Quantitative risk assessment (QRA)
Types of methodologies, 67(2.4.3), 73(2.4.5)

Redundancy
Control, 191(4.4.7.4)
Safety, 230(5.2.4.2)
Schemes, 230(5.2.4.2)
Uncertainty, 244(5.3), 524(F.2.4)
See Diversity, Hardware fault tolerance
Reliability
   As a core attribute, 51(2.3.2), 128(3.5.6)
   Designing for, 99(3.3.6), 153(4.0), 173(4.4.1), 184(4.4.6.3), 191(4.4.7.4), 227(5.2.3), 460(E.2.2)
   See Monitoring and metrics, Specification
Remote access
   Cybersecurity, 103(3.3.6.2)
   External connectivity, 103(3.3.6.1-2), 258(5.3.6), 293(6.5.2)
Response time
   Control, 190(4.4.7.2)
   Safety, see IPL Response time
   Simulation, 185(4.4.6.4)
   See Specification
Risk
   ALARP, 23(2.1), 61(2.4.2)
   Analysis, 61(2.4.2)
   Assessment, 67(2.4.3)
   Management, 70(2.4.4)
   Monitoring, 73(2.4.5)
   Process hazard identification, 56(2.4.1)
   Uncertainty, 47(2.3.1), 67(2.4.3), 73(2.4.5)
   See Inherently safer
Risk Reduction
   See Alarm system, Competency under Automation organization, Integrity, Management system, Monitoring and metrics, Risk
Safe state
   Discussion, 39(2.2.2), 211(5.0), 228(5.2.4), 253(5.3.3)
   Energized-to-trip/de-energized-to-trip, 259(5.3.7)
   Loss of communications, 404(C.5.5), 419(C.8)
   Verification during SAT, 593(J.4.5)
   See Application program, Compensating measures, Equipment selection, Independent protection layer, Inherently safer practices, Specification
Safeguard
   Discussion, 1(1.0), 23(2.1), 42(2.3), 47(2.3.1), 51(2.3.2), 61(2.4.2), 67(2.4.3), 70(2.4.4)
   See Administrative control, Engineered system, Inherently safer, Instrumented protection layer, Safety control, alarms, and interlocks (SCAI)
Safety controls, alarms, and interlocks (SCAI)
   Classification, 39(2.2.2), 211(5.0), 215(5.1)
   Critical features, 83(3.0)
   See Separation
Safety instrumented system (SIS), 120(3.5.3), 146(3.6.5), 215(5.1), 216(5.1.1), 217(5.1.2-3), 218(5.1.4), 221(5.2.1), 225(5.2.2), 229(5.2.4.1), 230(5.2.4.2), 242(5.2.7), 244(5.2.8-5.3), 271(6.3.2)
Safety manual
   See Equipment selection
Safety systems
   Discussion, 39(2.2.2)
Sensors
   Accuracy, 460(E.2.2)
   Discussion, 248(5.3.1)
   Flow measurement technologies, 465(E.3)
   Level measurement technologies, 476(E.5)
   On-stream analyzer technologies, 489(E.7)
   Pressure measurement technology, 475(E.4)
   Response time, 109(3.5.1.2), 248(5.3.1), 460(E.2.2)
   Smart transmitters, 459(E.2.1)
   Temperature measurement technologies, 487(E.6)
   See Equipment selection
Separation
   Designing for, 133(3.6), 221(5.2.1), 293(6.5.2), 518(F.2.1)
   Functional, 52(2.3.3), 120(3.5.3), 133(3.6), 142(3.6.2), 165(4.3), 221(5.2.1), 412(C.7), 518(F.2.1)
GUIDELINES FOR SAFE AUTOMATION OF CHEMICAL PROCESSES

Setpoint
- Uncertainty, 109(3.5.1.2)
- See IPL response time, Process safety time

Signal types
- Analog, 161(4.1.1), 248(5.3.1), 339(A.1.2.3)
- Binary, 161(4.1.2), 339(A.1.2.3)
- Converter, 181(4.4.5), 339(A.1.2.3), 404(C.5.4)
- Differences between signal types, 161(4.1.3)
- Digital, 161(4.1.3)
- I/O, 161(4.1), 248(5.3.1), 299(6.5.6.1), 350(A.1.3.6.1), 443(E.1.2), 454(E.1.4), 460(E.2.2)
- Safety, 441(E.1), 443(E.1.2)

Software
- Advantages/disadvantages of programmable technologies, 176(4.4.3), 341(A.1.3)
- Change management, 122(3.5.4), 301(6.5.8.2), 316(6.7)
- Communication system connections, 410(C.6.2)
- Diversity, 234(5.2.4.3), 519(F.2.2)
- Intelligent device revision level, 294(6.5.3)
- Process control databases, 188(4.4.6.5), 438(D.6)
- Role in controller selection, 193(4.4.7.5)
- Types, 551(H.1)
- Verification during FAT, 582(J.3)

Specification
- Functional, 23(2.1), 70(2.4.4), 91(3.2), 96(3.5.1)
- Process control, 83(3.1), 153(4.0), 165(4.3), 194(4.5), 270(6.3.1)
- Safety requirements, 83(3.1), 220(5.2), 244(5.3), 271(6.3.2)
- See Access security, Alarm system, Application program, Cybersecurity

Spurious trip rate
- See Monitoring and metrics

Systematic error
- Discussion, 303(6.6), 315(6.6.8)
- Equipment selection, 515(F.1.2), 524(F.2.5)
- See Application program, Diversity, Hardware fault tolerance, Inherently safer design, Management systems, Monitoring and metrics, Separation, Staffing, Verification

Testing
- Application program, 302(6.5.8.3)
- Controller, 300(6.5.8.1)
- Cybersecurity, 280(6.4.5), 295(6.5.4), 311(6.6.5)
- Factory acceptance, 310(6.6.4), 582(J.3)
- Interval, 70(2.4.4), 73(2.4.5), 91(3.2), 230(5.2.4.2), 241(5.2.6), 271(6.3.2), 298(6.5.6), 316(6.7), 520(F.2.3), 525(F.2.6)
- Off-line, 299(6.5.6.1)
- On-line, 299(6.5.6.2)
- Proof, 298(6.5.6)
- Site acceptance, 589(J.4)
- Time constraints, 298(6.5.5)
- See Equipment selection, Fit for Purpose, Monitoring and metrics, Prior use, Safety manual under Equipment selection

The way things are done
- Discussion, 1(1.0), 7(1.1), 13(1.5), 23(2.1), 78(2.5), 93(3.3.1), 269(6.3), 572(1.6)
See Good engineering practices

Training
Importance of, 33(2.1.3), 47(2.3.1), 70(2.4.4), 257(5.3.4), 267(6.2.14), 268(6.2.2.1), 273(6.4), 278(6.4.3), 287(6.4.10), 291(6.5), 318(6.7.1)
Safety, 283(6.4.8), 285(6.4.8.3), 319(6.7.2)
Simulators, 70(2.4.4), 185(4.4.6.4), 290(6.4.10.2), 309(6.6.3)
See Management systems

Useful life
Discussion, 104(3.4), 228(5.24), 295(6.5.4), 441(E.1), 551(H.1)
See As good as new, Fit for purpose, Prior use

Validation
Discussion, 78(2.5), 83(3.1), 128(3.5.6), 311(6.6.5)

See Management system, Testing

Valves
Discussion, 253(5.3.3)
Instrument air quality, 371(B.1.1.), 455(E.1.6)
Response time, 109(3.5.1.2), 493(E.8)
Seat leakage, 253(5.3.3), 493(E.8)
Valve technologies, 493(E.8)
See Equipment selection, Safe state

Verification
See Management system

Wear-out
Discussion, 241(5.2.6)
See As good as new, Fit for purpose, Prior use

Wireless
See Communication