Summary of Changes
Automation Model

The Automation Model was updated in November 2018. The update contains a realignment of skills and knowledge requirements including automation dynamics, latest industry standards, and updates to reflect performance management and decision support for industrial automation and control systems.

The revisions also incorporate foundational health and safety skills from the National Institute for Occupational Safety and Health’s (NIOSH) Safe Skilled and Ready Workforce Program, an initiative designed to help protect America's workforce and create safe, healthy, and productive workplaces.

# Tier 1 – Personal Effectiveness Competencies

* No changes were made to the Tier 1 Competencies.

# Tier 2 – Academic Competencies

* No changes were made to the Tier 2 Competencies.

# Tier 3 – Workplace Competencies

* No changes were made to the Tier 3 Competencies.

# Tier 4- General Technical Competencies

* Removed *4.4 Production in the Supply Chain* block.

# *4.1 Design and Development Lifecycles*

* + Technical Content Areas
		- 4.1.6 Design Lifecycle
			* Deleted:
				+ 4.1.6.5 Utilization
				+ 4.1.6.6 Research and development fundamentals

Print reading

* + - 4.1.7 Development Lifecycle
			* 4.1.7.1 Commissioning
				+ Added: Field and Input/Output (IO) installation checks
				+ Deleted: Loop checks
			* 4.1.7.2 Periodic Testing (previously called Testing)
				+ Added: Configuration functionality

# *4.2 Operations Management*

* + Technical Content Areas
		- *4.2.7 Industrial production and process basics*
			* Deleted: Hybrid manufacturing – the packaging or bottling of manufactured goods
		- *4.2.8 Production/process monitoring*
			* Edited: 4.2.8.3 Controlling process ~~flow~~ efficiency and capacity
		- *4.2.9 Industry-wide standards*
			* Deleted: Manufacturing and control systems security (ISA 99)
			* Added:
				+ 4.2.9.3 ISA/IEC 62443 – Security for Industrial Automation and Control Systems
				+ 4.2.9.4 ISA 61511 – Safety Instrumented Systems
				+ 4.2.9.5 ISA 88 – Production and Batch Standards
				+ 4.2.9.6 ISA 18.2 – Alarm Management for Packaged Systems
			* *4.2.10 Project management and execution*
				+ Edited:

4.2.10.4 ~~Personnel~~ Project team management methods

# *4.3 Maintenance, Installation and Repair*

* + Technical Content Areas
		- *4.3.9 General Skills*
			* Edited:
				+ 4.3.9.7 Use of ~~hand~~ hardware and software tools
		- *4.3.10 Maintenance, installation, and repair skills*
			* Edited:
				+ 4.3.10.7 Piping operations and equipment installation best practices

# *4.4 Operational Quality Assurance*

* + Critical Work Functions
		- Edited: *4.4.3 Use quality management to ensure quality levels ~~are maintained~~*
		- Deleted: *Support and maintain quality systems*
	+ Technical Content Areas
		- *4.4.7 Corrective and preventive actions*
			* Edited:
				+ 4.4.7.1 Documentation ~~creation~~
				+ 4.4.7.3 Verification ~~and documentation~~
		- *4.4.10 Quality assurance audits*
			* Edited:
				+ 4.4.10.2 ISO 9000 – Quality management systems – Fundamentals and vocabulary
		- *4.4.11 Statistical process control methods*
			* Added:
				+ 4.4.11.6 Measurement uncertainty and dead time

# *4.5 Process and Equipment Health, Safety, and Environment*

* + Technical Content Areas
		- *4.5.11 Safety procedures*
			* Edited:
				+ 4.5.11.5 ~~Material~~ Safety Data Sheets ~~(MSDS)~~ (SDS)
			* Deleted: Response to shop emergencies

# Tier 5 – Specific Technical Competencies

* Added new block: ***5.7 Performance Management and Decision Support*** – please refer to the model for block content.
* ***5.1 Context of Automation***
	+ Critical Work Functions
		- Edited:
			* *5.1.1 Understand the role and impact of automation to increase process performance*
			* *5.1.3 Integrate automation in various manufacturing, industrial, utility, scientific, and technical applications*
	+ Technical Content Areas
		- New Technical Content Areas:
			* *5.1.9 Standards*
				+ 5.1.9.1 IEC 62381 – Factory Acceptance Test
				+ 5.1.9.2 IEC 62337 – Commissioning of Electrical, Instrumentation and Control Systems in the Process Industry
		- *5.1.6 Automation types*
			* + Added: 5.1.6.4 Building (e.g., commercial)
				+ Deleted: Hybrid (e.g., food, beverage packaging, printing, consumer packaging, pharmaceutical packaging)
			* *5.1.7 Automation project phases*
				+ Added: 5.1.7.12 Continuous improvement
			* *5.1.8 Codes, standards, and regulatory bodies*
				+ Added:

5.1.8.9 Occupational Safety and Health Administration (OSHA)

5.1.8.10 Environmental Protection Agency (EPA)

* ***5.2 Field Devices*** (previously titled Measurement, Sensors, and Actuation): The sensing, measurement, and final control elements necessary for automation.
	+ Critical Work Functions
		- Edited:
			* 5.2.4 Calibrate, troubleshoot, test, repair, and improve sensing, measurement, and ~~actuation devices~~ final control elements
			* 5.2.5 Document measurement, final control elements, and ~~actuation devices and~~ communications from these devices
	+ Technical Content Areas
		- Added new Technical Content Areas:
			* *5.2.14 Documentation*
				+ 5.2.14.1 Installation details
				+ 5.2.14.2 Instrument lists
				+ 5.2.14.3 Location plans (instrument location drawings)
				+ 5.2.14.4 Piping and Instrument Diagrams (P&ID)
				+ 5.2.14.5 Specification forms
			* *5.2.16 Standards*
				+ 5.2.16.1 ISA-RP105.00.01-2017 – Management of Calibration Program of an Industrial and Automation Control System
				+ 5.2.16.2 ISA-TR108.1-2015 Intelligent Device Management Part 1 Concepts and Terminology
				+ 5.2.16.3 IEC 60654 – Industrial-Process Measurement and Control Equipment
				+ 5.2.16.4 IEC 60770 – Transmitters for Use in Industrial-Process Control System
				+ 5.2.16.5 IEC 61069 – Industrial-Process Measurement, Control and Automation – Evaluation of System Properties for the Purpose of System Assessment
				+ 5.2.16.6 IEC 61298 – Process Measurement and Control Devices
		- *5.2.6 General*
			* Added:
				+ 5.2.6.5 Performance (e.g., drift linearity, offset reliability, precision, repeatability, rangeability, deadtime, and lag time)
			* Edited:
				+ 5.2.6.2 ~~Sample~~ Installation point selection
		- *5.2.7 Basic process instrumentation*
			* Added:
				+ 5.2.7.5 pH
				+ 5.2.7.6 Conductivity
		- *5.2.8 Specialized process instrumentation*
			* Added:
				+ 5.2.8.4 Dissolved oxygen
		- *5.2.10 High performance sensors*
			* Edited:
				+ 5.2.10.3 Specialized technologies (e.g., ~~Chemical~~ focused beam reflectance and laser based)
		- *5.2.11 Other measurements/sensors*
			* Deleted: Discrete
		- *5.2.15 Installations*
			* Edited:
				+ 5.2.15.2 Physical installation reliability and maintainability
			* Deleted:
				+ Grounding
				+ Power
				+ Surge suppressors
				+ Power quality/harmonics
				+ Uninterruptible Power Systems (UPS)
* ***5.3 Control***
	+ Critical Work Functions
		- Added:
			* 5.3.3 Programming/Configuration
		- Edited:
			* 5.3.2 Procedure development (e.g., startup and shutdown sequences) ~~Startup and shutdown sequences (procedural)~~
			* 5.3.4 Testing/Simulation/Training
		- Deleted:
			* Error handling
			* Basic control (regulatory)
			* Coordination control
			* Safety
			* Alarm handling
			* Development
	+ Technical Content Areas
		- Deleted Technical Content Areas *Motion Control,* *Robotics,* and *Visualization and display*
		- New Technical Content Areas:
			* *5.3.15 Mechatronics*
				+ 5.3.15.1 Robotic control
				+ 5.3.15.2 Machine control
				+ 5.3.15.3 Motion control
				+ 5.3.15.4 Automated guided vehicles (AGV)
			* *5.3.18 Human Machine Interface (HMI) Lifecycle*
				+ 5.3.18.1 System standards
				+ 5.3.18.2 Design
				+ 5.3.18.3 Implement
				+ 5.3.18.4 Operate
				+ 5.3.18.5 Continuous work processes
			* *5.3.19 Standards*
				+ 5.3.19.1 ISA 101 – Human Machine Interfaces
				+ 5.3.19.2 IEC 61131 – Programmable Controllers
				+ 5.3.19.3 IEC 61158 – Digital Data Communications for Measurement and Control
				+ 5.3.19.4 ISA 88 – Batch Control
				+ 5.3.19.5 IEC 61499 – Function Blocks
				+ 5.3.19.6 ISA-TR106 – Procedure Automation for Continuous Operations
				+ 5.3.19.7 ISA 112 – SCADA Systems
		- *5.3.7 Continuous control* (previously titled *Continuous and process control*)
			* Added:
				+ 5.3.7.3 Basic regulatory control
				+ 5.3.7.5 Parameter identification and adjustment
		- *5.3.8 Discrete and sequencing control*
			* Added:
				+ 5.3.8.2 Motion control system design
				+ 5.3.8.3 Performance V
		- *5.3.9 Batch control*
			* Added:
				+ 5.3.9.4 Error handling
			* Edited:
				+ 5.3.9.1 ~~Control~~ Activity management
		- *5.3.10 Advanced control*
			* Added:
				+ 5.3.10.1 Inferential measurement
				+ 5.3.10.2 Model predictive control
			* Deleted:
				+ Fuzzy logic
				+ Non-linear
				+ Optimal control
				+ Robust control
				+ Expert systems
				+ Multivariable controls
				+ Model-based control
				+ Neural nets
		- *5.3.11 Building automation*
			* Edited:
				+ 5.3.11.1 Building environment~~al~~ monitoring
				+ 5.3.11.3 Building security (e.g., access control, cameras)
		- *5.3.12 Control equipment* (previously titled Controller equipment)
			* Edited:
				+ 5.3.12.1 ~~Distributed~~ Control systems: hardware and configuration

Distributed control systems (DCS)

Programmable logic controllers (PLC)

Process automation controllers (PAC)

Supervisory Control and Data Acquisition (SCADA)

* + - * Added:
				+ Packaged systems (e.g., Refrigeration, UPS, Burner Management)
			* Deleted:
				+ Embedded systems
		- *5.3.13 Control system documentation*
			* Deleted:
				+ Installation details
				+ Instrument lists
				+ Location plans (instrument location drawings)
				+ Operating instructions
				+ Specification forms
				+ Standards and regulations
		- *5.3.14 Modeling and simulation*
			* Added:
				+ 5.3.14.1 Measurement and final control element dynamics
				+ 5.3.14.2 Loop tieback models
				+ 5.3.14.3 First principle models
				+ 5.3.14.4 Virtual plant (digital twin)

Real-time

Accelerated time

Replay scenarios

* + - * Deleted:
				+ Hardware device emulation
				+ Integration simulation
				+ Co-simulation
				+ Linear dynamic estimators
				+ First principle models
				+ Techniques for running simulations
				+ Virtual plant

Actual control system configuration

Advanced control tools

Process model

* + - *5.3.16 Software development*
			* Deleted:
				+ Basic software engineering
				+ Programming mobile systems
		- *5.3.17 Programming languages*
			* Added:
				+ Common programming languages (e.g., C/C++, HTML, Java, Visual Basic)
				+ Computer Numerical Control (CNC) (e.g., G-Code)
			* Deleted:
				+ Procedural (FORTRAN, C/C++, PASCAL)
				+ Functional (e.g., LISP, HASKELL)
				+ Declarative (e.g., SQL)
				+ Object oriented (e.g., .NET, Java)
				+ G-Code (CNC)
				+ Visual basic
				+ Electronic Device Description Language (EDDL)
* ***5.4 Infrastructure*** (previously titled Communication, Integration, and Software): Design and implement the operational technology infrastructure for Automation Systems.
	+ Critical Work Functions
		- Added:
			* 5.4.3 Address environmental aspects of equipment installation
			* 5.4.4 Specify and select networking and communication hardware
			* 5.4.5 Utilize system virtualization appropriately
		- Deleted:
			* Perform data historian duties: data curation, archiving, retrieval
			* Integrate real-time data with enterprise systems
			* Apply Manufacturing Operations Management systems (MOM)
	+ Technical Content Areas
		- Deleted Technical Content Areas *Manufacturing operations management (MOM) and business integration* and *Data management*
		- Added new Technical Content Areas:
			* *5.4.9 Radio Communications*
				+ 5.4.9.1 Cellular, UHF, VHF, microwave, satellite
				+ 5.4.9.2 Path study
				+ 5.4.9.3 Noise handling
			* *5.4.10 System virtualization*
				+ 5.4.10.1 Hardware requirements
				+ 5.4.10.2 Operating system
			* *5.4.11 Server hardware*
				+ 5.4.11.1 Closet layout
				+ 5.4.11.2 Installation best practice
			* *5.4.12 Standards*
				+ 5.4.12.1 ANSI/ISA 50 Parts 2-6 – Fieldbus Standard for Use in Industrial Control Systems
				+ 5.4.12.2 IEC 61158 – Digital Data Communications for Measurement and Control
				+ 5.4.12.3 IEC 61784 – Industrial Communication Networks
				+ 5.4.12.4 IEC 61987 – Industrial-Process Measurement and Control
		- Edited Technical Content Areas
			* *5.4.6 Network Configuration*
				+ Edited 5.4.6.5 ~~Large scale sensor~~ Wireless networks
			* *5.4.7 Digital Device Communication Protocols* (previously titled Industrial digital field protocols
				+ Added:

5.4.7.9 BACnet

5.4.7.10 ControlNet

5.4.7.11 LonWorks

5.4.7.12 PROFINET

* + - * *5.4.8 Open Connectivity Protocols* (previously titled Industrial communication protocols)
				+ Added:

5.4.8.4 Open Platform Communications (OPC)

* + - * + Deleted:

BACnet

Common industrial protocols

ControlNet

LonWorks

Object-linked Embedding for Process Control (OPC)

PROFINET

* ***5.5 System Safety and Reliability*** (previously titled Automation System Safety and Reliability
	+ Technical Content Areas
		- Deleted Technical Content Areas: *Alarm management* and *Manufacturing safety: process, discrete, and hybrid*
		- Added new Technical Content Areas:
			* *5.5.7 Alarm management lifecycle*
				+ 5.5.7.1 Philosophy
				+ 5.5.7.2 Identification
				+ 5.5.7.3 Rationalization
				+ 5.5.7.4 Detailed design
				+ 5.5.7.5 Implementation
				+ 5.5.7.6 Operation
				+ 5.5.7.7 Maintenance
				+ 5.5.7.8 Monitoring and assessment
				+ 5.5.7.9 Management of change
				+ 5.5.7.10 Audit
			* *5.5.10 Safety lifecycle*
				+ 5.5.10.1 Safety lifecycle
				+ 5.5.10.2 Allocation of safety functions to protective layers
				+ 5.5.10.3 Determination of safety integrity levels
				+ 5.5.10.4 Safety requirements specification
				+ 5.5.10.5 Design and engineering issues and system technologies
				+ 5.5.10.6 Installation, commissioning, and validation
				+ 5.5.10.7 Operations and maintenance
			* *5.5.13 Documentation*
				+ 5.5.13.1 Piping and Instrument Diagrams (P&ID)
		- *5.5.11 Safety equipment* (previously titled Safety controller equipment)
		- *5.5.12 Safe use and application of electrical apparatus*
			* Added: 5.5.12.2 Equipment selection for hazardous areas
			* Deleted:
				+ Installation design for hazardous areas
				+ General purpose requirements
		- *5.5.14 Standards*
			* Added:
				+ 5.5.14.2 ISA 18 (IEC) 62682) – Alarm Management
				+ 5.5.14.5 NFPA 497 – Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas
				+ 5.5.14.6 NFPA 499 – Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas
				+ 5.5.14.7 EIC 61508 – Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems
* ***5.6 Industrial Automation and Control Systems (IACS) Cybersecurity***
	+ Critical Work Functions:
		- Edited:
			* 5.6.5 Understand ~~Cybersecurity~~ Security Level (SL) per zone
		- Deleted Technical Content Area: *Operational Technology (OT) architecture*
	+ Technical Content Areas:
		- Edited:
			* 5.6.19.1 Response/business continuity planning/resilience ~~– understand the risks associated with OT systems and be able to identify practical mitigation measures to manage these risks~~

Summary of Changes

Automation Model

September 2017

# Tier 1 – Personal Effectiveness Competencies

* No changes were made to the Tier 1 Competencies.

# Tier 2 – Academic Competencies

* Added key behavior description to Communication block.

## 2.5 Communication

* *2.5.2 Communicating*
	+ Added key behavior description: *2.5.2.4 Ask questions or report problems or concerns to people in authority when information or procedures are unclear or need improvement, or when feeling unsafe or threatened in the workplace.*

# Tier 3- Workplace Competencies

* Added key behavior descriptions to 3.9 Personal Health and Safety block and updated several existing key behavior descriptions.
* Updated key behavior title *3.9.1 Maintaining a safe environment* to *3.9.1 Maintaining a healthy and safe environment.*

## 3.9 Personal Health and Safety

* 3.9.1 Maintaining a safe environment
	+ Updated key behavior title from *3.9.1 Maintaining a safe environment* to *3.9.1 Maintaining a healthy and safe environment.*
	+ Edited key behavior descriptions:
		- 3.9.1.1 ~~Follow~~ Take actions to ensure the safety of self and others, in accordance with established personal and jobsite safety practices.
		- ~~3.9.1.2~~ 3.9.1.3 Comply with federal, state, and local regulations and company health and safety ~~regulations~~ policies.
		- 3.9.1.5 Follow organizational procedures and protocols for workplace emergencies, including safe evacuation and emergency response.
		- 3.9.1.7 Administer first aid or CPR, if trained, and summon assistance as needed.
	+ Added key behavior descriptions:
		- 3.9.1.2 Anticipate and prevent work-related injuries and illnesses.
		- 3.9.1.4 Recognize common hazards and unsafe conditions that occur at work, their risks, and appropriate controls to address them.
	+ Deleted key behavior description:
		- 3.9.1.3 Identify unsafe conditions and take corrective action.
* 3.9.2 Safeguarding one’s person
	+ Added key behavior descriptions:
		- 3.9.2.1 Engage in safety training.
		- 3.9.2.4 Recognize how workplace risks can affect one’s life and one’s family.
		- 3.9.2.5 Understand the legal rights of workers regarding workplace safety and protections from hazards.
		- 3.9.2.6 Report injuries, incidents, and workplace hazards to a supervisor as soon as safely possible.
		- 3.9.2.7 Contribute to discussions of safety concerns in the workplace, making suggestions as appropriate.