SMART AUTOMATION CERTIFICATION ALLIANCE

C-101 Certified Industry 4.0 Associate-Basic Operations Skill Standards

Abstract

Defines the basic operations knowledge, skills, and abilities required to succeed in a modern production environment that uses Industry 4.0 automation technologies.

Version 1.0

Introduction to SACA

The Smart Automation Certification Alliance (SACA) is a non-profit foundation whose mission is to develop and deploy modular Industry 4.0 certifications for a wide range of industries. The vision is to provide highly affordable, accessible certifications that significantly increase the number of individuals who possess the skills represented by these credentials, thereby ensuring that companies have the highly skilled workers they need, and individuals are prepared to be successful in a "connected enterprise" world.

Industry-Driven Quality

SACA certifications are industry-driven, developed by industry for industry. They use a rigorous process that starts with the development of truly international skill standards, developed and endorsed by leading experts in Industry 4.0 technology throughout the world. Certifications examinations are created based on these standards, pilot-tested and statistically analyzed to ensure quality. Each certification includes a proctored hands-on evaluation and an online test to ensure that candidates for certification can "do" as well as "know." SACA uses an annual standards and examination review process for all certifications to ensure that the certifications continue to remain highly up-to-date.

Preparing Students

No specific training program, curriculum, or equipment is required to prepare individuals for certification. The SACA certifications only evaluate the skills and knowledge of the individual, regardless of the method used to obtain them.

Institutions interested in preparing individuals for the certifications should reach out to major training providers for information on courses and equipment aligned with the SACA standards.

Certifying Individuals

Individuals can receive certifications through authorized SACA certification centers. SACA ensures these certification centers maintain high standards with proctored exams, certified evaluators, and approved equipment for consistent hands-on evaluation.

Certification Structure

SACA certifications use a modular structure to enable them to fit into wide range of individual needs and industries and educational environments. The three SACA certification categories include:

- Associate
- Specialist
- Professional

Industry 4.0 Systems Occupational Certifications

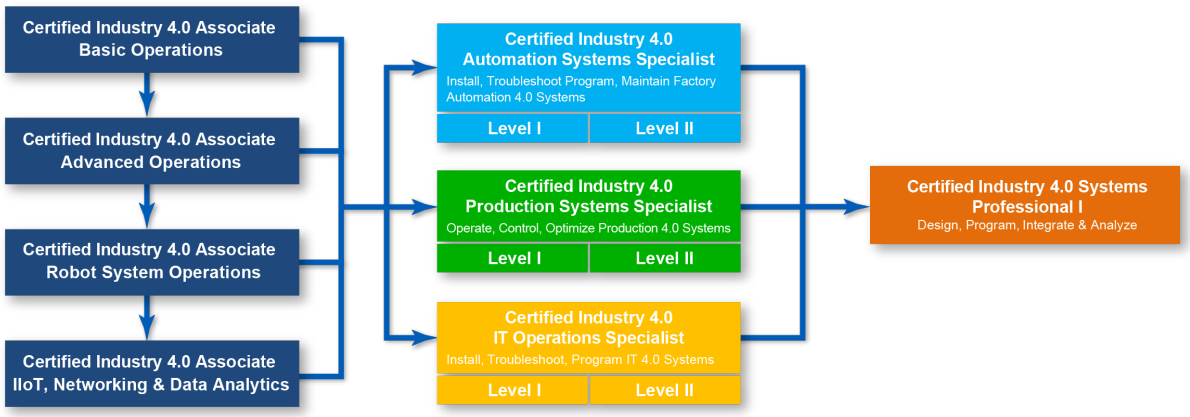

Figure 1 SACA Industry Certification Structure

Each certification is stackable. Individuals can start with one certification and add other certifications to customize their documented skills. Certifications are occupationally focused so they prepare individuals for specific occupations.

Associate Certifications

The Associate certifications include the following four (4) credentials:

- C-101 Certified Industry 4.0 Associate-Basic Operations
- C-102 Certified Industry 4.0 Associate-Advanced Operations
- C-103 Certified Industry 4.0 Associate-Robot System Operations
- C-104 Certified Industry 4.0 Associate-IIoT, Networking and Data Analytics

The Associate certifications are introductory certifications for those individuals working in an Industry 4.0 environment. These certifications are ideal for production technicians, IT professionals, and industrial maintenance technicians seeking to acquire Industry 4.0 skills.

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- **C-101 Associate-Basic Operations**

Skill Standards

- **TOPIC 101.1: INDUSTRY 4.0 CONCEPTS 1**
  - **Standard 101.1.1 Identify Industry 4.0 components and their functions**
    - Performance Indicators:
      - Identify Industry 4.0 machine components and their functions
    - Knowledge Indicators:
      - Define advanced manufacturing
      - Define Industry 4.0 and explain its impact
      - Describe the major elements of Industry 4.0 and IIoT
      - Describe emerging technologies in advanced manufacturing (additive, nano, and lightweight)
  - **Standard 101.1.2 Identify types of automation and their functions**
    - Performance Indicators:
      - Identify machine automation systems and their functions
    - Knowledge Indicators:
      - Describe types of automation and software used in Industry 4.0
      - Describe the basic functions and applications of PLC, Robots, CNC
      - Describe types of robots and their applications
  - **Standard 101.1.3 Use a cloud-based maintenance notification and SCADA system**
    - Performance Indicators:
      - Respond to a maintenance notification using a mobile device
      - Use a cloud-based notification system to request maintenance
      - View production data using a mobile device
    - Knowledge Indicators:
      - Describe basic cloud-based maintenance system functions
      - Describe basic cloud-based SCADA functions
  - **Standard 101.1.4 Perform basic lean manufacturing functions**
    - Performance Indicators:
      - Identify 8 types of manufacturing waste in an advanced manufacturing plant
      - Perform a 5S process
    - Knowledge Indicators:
      - Define Lean Manufacturing

- Describe the core elements of Lean Manufacturing
- Define value-added and non-value-added activities
- Describe the eight deadly wastes
- Describe the steps of 5S

- **Standard 101.1.5 Identify basic robot elements**
  - Performance Indicators:
    - Identify the basic parts of a robot
    - Apply robot safety procedures
  - Knowledge Indicators:
    - Describe the basic operation of a robot and simulation software
    - Describe the operation of a basic robot program
    - Describe two methods of programming robot points
    - Describe types of robot safety devices
    - Describe the function of collaborative robots

- **TOPIC 101.2: SAFETY**
  - **Standard 101.2.1 Apply workplace safety, health, and environmental regulations**
    - Performance Indicators:
      - Locate company safety regulations and policies
    - Knowledge Indicators:
      - Describe the safety roles and responsibilities of these organizations: OSHA, NIOSH, EPCRA, EPA, state safety agencies
      - Describe the safety responsibilities within a company
      - Describe how to create a culture of safety in the workplace
  - **Standard 101.2.2 Identify and correct common workplace hazards**
    - Performance Indicators:
      - Identify types of workplace hazards for welding, NFPA 70E arc flash, electrical, fire, hazardous materials, steam and compressed air, hydraulics, general machines, sheet metal, combustibles, confined spaces, walkway, work area, ergonomics, material handling, hand tools, ladders, and platform
      - Apply hazard prevention guidelines to correct common hazards
    - Knowledge Indicators:
      - Describe the basic process of a Job Safety Analysis (JSA)
  - **Standard 101.2.3 Select and use a fire extinguisher**
    - Performance Indicators:
      - Select and use a fire extinguisher for a given fire type

- Knowledge Indicators:
    - Describe the elements of fire and four types of fires
    - Describe the operation of fire extinguisher types
- **Standard 101.2.4 Select and use personal protective equipment (PPE) for workplace functions**
    - Performance Indicators:
        - Select and use 7 types of PPE for a given workplace task
    - Knowledge Indicators:
        - Describe 7 types of PPE
- **Standard 101.2.5 Locate and interpret safety data sheets (SDS)**
    - Performance Indicators:
        - Locate SDS sheets for a given material
        - Interpret the sections of a SDS
    - Knowledge Indicators:
        - Describe the purpose of a SDS and its sections
- **Standard 101.2.6 Identify and safely handle and store hazardous materials**
    - Performance Indicators:
        - Interpret the HAZCOM labeling system
        - Interpret the NFPA and HMIS hazardous material ID systems
        - Interpret the DOT hazardous material ID system
    - Knowledge Indicators:
        - Define three categories of hazardous materials
        - Describe handling and storing HAZMAT guidelines
        - Describe how to dispose of hazardous materials
        - Describe hazardous materials shipping guidelines
- **Standard 101.2.7 Perform a lockout tagout**
    - Performance Indicators:
        - Perform an electrical lockout tagout
        - Perform a pneumatic lockout tagout
    - Knowledge Indicators:
        - Describe the purpose and steps of a lockout tagout (LOTO)
        - Describe how to test for a zero energy state
- **Standard 101.2.8 Respond to a workplace accident or emergency**
    - Performance Indicators:
        - Use an eyewash station
        - Respond/report to a workplace accident
        - Locate a company emergency action plan

        - Knowledge Indicators:
            - Describe types of workplace accidents
            - Describe the categories of emergencies
            - Describe the elements of an emergency action plan
            - Describe how to respond to an emergency
- **TOPIC 101.3: QUALITY**
    - **Standard 101.3.1 Use a tape measure to measure dimensions**
        - Performance Indicators:
            - Position a tape measure to measure linear dimensions
            - Read a tape measure
        - Knowledge Indicators:
            - Describe the operation/ construction of a tape measure
    - **Standard 101.3.2 Use a machinist's rule to measure part dimensions**
        - Performance Indicators:
            - Position a machinist's rule to measure inside, outside, circular dimensions
            - Read an SI (metric), fraction inch, and decimal machinist's rule
        - Knowledge Indicators:
            - Describe the units of measure found on an SI (metric), fraction inch, and decimal inch machinist's rule
    - **Standard 101.3.3 Use dial and digital calipers to measure part dimensions**
        - Performance Indicators:
            - Zero and Read a dial caliper in SI and US Customary units
            - Zero and Read a digital caliper in SI and US Customary units
            - Position a caliper to measure inside, outside, circular dimensions
        - Knowledge Indicators:
            - Describe the operation/ construction of a digital caliper
            - Describe the operation/ construction of a dial caliper
    - **Standard 101.3.4 Use digital and Vernier micrometers to measure part dimensions**
        - Performance Indicators:
            - Read a Vernier micrometer in SI and US Customary units
            - Read a digital micrometer in SI and US Customary units
            - Check zero of an outside micrometer
            - Position an outside micrometer to measure rectangular and circular dimensions
            - Check calibration documentation of a measurement instrument

        - Knowledge Indicators:
            - Describe the operation/ construction of a Vernier micrometer
            - Describe the operation/ construction of a digital micrometer
    - **Standard 101.3.5 Determine if measured part dimensions meet specifications**
        - Performance Indicators:
            - Convert between SI fraction inch, and decimal US Systems
            - Convert conventional tolerances of circular and linear dimensions into part specification limits
            - Compare measured part dimensions of circular and linear part features to upper and lower limits on technical drawing
        - Knowledge Indicators:
            - Define conventional tolerance system
            - Define linear measurement systems conversion factor
    - **Standard 101.3.6 Select the best measurement tool for an application**
        - Performance Indicators:
            - Select a measurement tool for a given task
        - Knowledge Indicators:
            - Define accuracy, resolution, and repeatability
            - Describe accuracy/ resolution of rules, calipers and micrometers
            - Describe factors that affect measurement tool repeatability
- **TOPIC 101.4: TECHNICAL DRAWINGS**
    - **Standard 101.4.1 Interpret features in technical drawings**
        - Performance Indicators:
            - Interpret first angle and third angle multiview drawings
            - Interpret views of a multiview drawing
            - Interpret sectional and auxiliary views
            - Interpret exploded view assembly drawings
        - Knowledge Indicators:
            - Define multiview, assembly, and isometric technical drawings
            - Define the alphabet of lines and line precedence
    - **Standard 101.4.2 Interpret multiview drawing dimensions**
        - Performance Indicators:
            - Interpret part dimensions in multiview drawings for linear, circular, angular, arcs and holes in SI and US Customary units
            - Determine measurement units from notes and title blocks
        - Knowledge Indicators:
            - Describe guidelines for dimensioning drawings

- **Standard 101.4.3 Interpret conventional drawing tolerances**
  - Performance Indicators:
    - Interpret a conventional tolerance on a drawing of circular, angular, arc, and linear part dimensions in SI and US Customary units
    - Interpret a tolerance note in SI and US Customary Units
    - Determine the type of fit two parts have based on tolerances
  - Knowledge Indicators:
    - Define types of fits, clearance, and allowance
    - Define baseline dimensioning and explain its benefit
    - Define maximum and minimum material conditions
- **Standard 101.4.4 Interpret a drawing scale**
  - Performance Indicators:
    - Determine actual part dimensions using a drawing and a rule
    - Determine scale of a drawing given actual part
  - Knowledge Indicators:
    - Describe the formats of drawing scales and list common scales
- **Standard 101.4.5 Interpret drawing notes and information blocks**
  - Performance Indicators:
    - Interpret drawing notes
    - Interpret change, material and title blocks
    - Interpret surface finish symbols
  - Knowledge Indicators:
    - Describe types of information found in title blocks, change blocks, material blocks, and tolerance blocks
- **Standard 101.4.6 Interpret basic geometric and dimensioning drawing tolerances**
  - Performance Indicators:
    - Interpret a basic feature control frame
  - Knowledge Indicators:
    - Define types of basic geometric features and their symbols
    - Define geometric dimensioning and tolerancing
    - Define a datum
- **Standard 101.4.7 Interpret fastener drawings and specifications**
  - Performance Indicators:
    - Interpret UNS and SI thread specifications on drawings
  - Knowledge Indicators:

- Describe types and applications of threaded fasteners

- **TOPIC 101.5: MACHINE OPERATION**
  - **Standard 101.5.1 Locate and interpret machine reference documents**
    - Performance Indicators:
      - Locate and use a machine operation manual to perform standard startup/shutdown procedures, operating procedures, safety procedures, machine performance and setting specifications, and machine adjustment
      - Locate and use machine documentation to determine the recommended preventive maintenance schedule and lubrication.
    - Knowledge Indicators:
      - Read and interpret machine reference documents
  - **Standard 101.5.2 Apply machine operation safety procedures**
    - Performance Indicators
      - Identify and correct machine operation safety hazards
      - Install a machine guard
      - Locate machine safety devices
      - Interpret machine safety documentation
    - Knowledge Indicators
      - Describe machine operation clothing safety
      - Describe machine operation safety guidelines
      - Describe types of machine guards
      - Describe machine interlock and emergency control operation
      - Describe pneumatic system safety guidelines
      - Describe hand tool safety guidelines
  - **Standard 101.5.3 Start up and shut down a computer-controlled machine**
    - Performance Indicators:
      - Perform pre-startup inspection and safety check of machine
      - Connect an air hose and adjust air pressure to specified setting
      - Perform normal machine startup and planned shutdown
      - Perform machine halt, cycle stop, and emergency stop
    - Knowledge Indicators:
      - Describe types of machine stop functions
  - **Standard 101.5.4 Use an HMI panel to manually test machine operation**
    - Performance Indicators:
      - Use HMI panel to manually operate machine actuators
      - Use HMI panel to single-step a machine sequence

        - Knowledge Indicators:
            - Describe the operation of an HMI panel
    - **Standard 101.5.5 Operate and monitor a computer-controlled machine**
        - Performance Indicators:
            - Operate machine in automatic cycle, single cycle and continuous
            - Monitor HMI for correct machine operation
            - Monitor pressure, voltage, current, and temperature indicators
        - Knowledge Indicators:
            - Define common production statistics of machine or system, including quantity produced, rejects, and cycle times
    - **Standard 101.5.6 Interpret machine fault conditions and restart operation**
        - Performance Indicators:
            - Clear faults and reset machine operation in response to alarm conditions on HMI
            - Locate and interpret fault history on HMI menus
        - Knowledge Indicators:
            - Describe types of machine alarm conditions
- **TOPIC 101.6: HAND TOOLS**
    - **Standard101.6.1 Use screwdrivers to assemble/disassemble/ tighten components**
        - Performance Indicators:
            - Select and use slotted screwdriver to tighten fasteners
            - Select and use Phillips screwdriver to tighten fasteners
        - Knowledge Indicators:
            - Describe types of screwdrivers and their applications
            - Define screws and bolts and their applications
    - **Standard 101.6.2 Use wrenches to assemble/disassemble/tighten components**
        - Performance Indicators:
            - Select and use hex key wrench to tighten fasteners
            - Select and use combination wrench to tighten fasteners
            - Select and use ratchet wrench to tighten fasteners
            - Select and use backup wrench to tighten fasteners
        - Knowledge Indicators:
            - Describe common wrench types and their applications
    - **Standard 101.6.3 Use a torque wrench to tighten a fastener**
        - Performance Indicators:

            - Use a click-type torque wrench to tighten a fastener to specified torque in N-M and foot-pounds
        - Knowledge Indicators:
            - Describe the operation of a click-type torque wrench
            - Describe the operation of a threaded fastener
            - Define torque and explain its importance with fasteners
- **TOPIC 101.7: MACHINE MAINTENANCE**
    - **Standard 101.7.1 Determine correct oil or grease machine lubrication**
        - Performance Indicators:
            - Interpret oil and grease label specifications
            - Use reference manuals to determine correct oil/ grease
        - Knowledge Indicators:
            - Describe the operation and application of oils and grease
    - **Standard 101.7.2 Perform basic preventive machine maintenance**
        - Performance Indicators:
            - Check and refill oil and grease in reservoir levels
            - Drain pneumatic filters
            - Check and refill pneumatic lubricator levels
            - Clean machine surfaces
        - Knowledge Indicators:
            - Describe elements of a preventive maintenance schedule
    - **Standard 101.7.3 Verify AC and DC power**
        - Performance Indicators:
            - Use a digital multimeter to measure AC/ DC supply voltage
            - Verify that machine voltage readings match specifications
            - Reset a circuit breaker
            - Identify a fuse
        - Knowledge Indicators:
            - Define voltage, resistance, current, and power and give units
            - Describe the relationship of power, resistance, current, and voltage
            - Describe the operation of fuses and circuit breakers
            - Define overload and overcurrent conditions
    - **Standard 101.7.4 Interpret basic electrical power and control schematics**
        - Performance Indicators:
            - Interpret basic electrical power schematics
            - Interpret basic electrical ladder control schematics

- Knowledge Indicators:
    - Describe the operation of basic electrical circuits, motors, pushbutton switches, selector switches, resistors, relays, motor contactors, indicators, instrumentation, power supplies, series and parallel circuits.
    - Describe the schematic symbols for components for basic electrical power and control circuits
    - Describe the operation of basic control logic
    - Describe basic electrical power and ladder schematic guidelines

- **Standard 101.7.5 Adjust machine limit switches, inductive and capacitive sensors**
    - Performance Indicators:
        - Adjust and test trip point of a limit switch
        - Adjust and test trip point of an inductive and capacitive sensors
    - Knowledge Indicators:
        - Describe the operation of limit switches, inductive and capacitive sensors
- **Standard 101.7.6 Interpret pneumatic schematics**
    - Performance Indicators:
        - Interpret a basic pneumatic schematic in NFPA/ISO symbols
    - Knowledge Indicators:
        - Describe the guidelines for drawing pneumatic schematics
        - Describe the operation of basic pneumatic circuits, directional valves, conductors, actuators, gauges, regulators, filters, and lubricators.
        - Describe the NFPA/ISO pneumatic component schematic symbols
- **Standard 101.7.7 Operate and adjust basic machine pneumatic components**
    - Performance Indicators:
        - Operate a basic pneumatic valve circuit with manual operator
        - Use pneumatic valve manual overrides to test actuators
        - Adjust the stroke length of a pneumatic cylinder
        - Connect and disconnect pneumatic hoses using push-lok fittings
    - Knowledge Indicators:
        - Describe how compressed air is generated and its characteristics
        - Calculate pneumatic pressure given force and area
        - Define pneumatic pressure