ENSURING THE
EXPERTISE TO GROW
SOUTH AFRICA

Sub Discipline-specific Training Guide for Registration as Enterprise Integration Practitioners

R-05-EIP-SC

REVISION: 3. 18 May 2023

ENGINEERING COUNCIL OF SOUTH AFRICA
Tel: 011 607 9500 | Fax: 011 622 9295
Email: engineer@ecsa.co.za | Website: www.ecsa.co.za

ECSA

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

DEFINITIONS

Alternative Route: The term “alternative route” refers to an applicant who aspires to become registered in a Specified Category and who has acquired experience as stipulated in document **R-01-POL-SC**.

Base-Layer: Includes DCS, SIS, field devices and other DCS subsystems, such as analysers, equipment health systems and PLCs.

Benchmark Route: The normal process required to attain registration that consists of the completion of an accredited, recognised qualification for the category of registration.

Competency area: The performance area where all the outcomes can be demonstrated at the level prescribed in a specific technology in an integrated manner.

Engineering science: A body of knowledge, based on the natural sciences and using mathematical formulas where relevant, that extends knowledge and develops models and methods to support its application, solve problems and provide the knowledge base for engineering specialisations.

Engineering problem: A problematic situation that is amenable to analysis and solution using engineering sciences and methods.

Genealogy: Genealogy allows the user to track backwards through the manufacturing history of a product batch to the original materials used to manufacture the batch and thus rebuilds the manufacturing history of a product.

Graphical User Interface (GUI): A connection between the computer and the user employing a mouse and icons to allow the user to make selections to execute actions. A GUI thus allows the use of graphics such as icons and buttons to execute actions and also uses drag-and-drop to perform actions. Computer interfaces are normally associated with operating systems like Windows and Macintosh where a mouse can be used to navigate the screen.

Human Machine Interface (HMI): An operator control and monitoring system that interfaces between machine operator and machine. It works with a dedicated electronic operator panel and PC based visualisations.

Ill-posed problem: Problems lacking clear requirements and thus are not fully defined or may be defined erroneously by the requesting party.

Integrated performance: An overall satisfactory outcome of an activity requires several outcomes to be satisfactorily attained, for example a design requires analysis, synthesis, analysis of impacts, checking of regulatory conformance and judgement in decisions.

Interoperability: The ability of a system or a product to work with other systems or products without special integration efforts on the part of the customer. This generally requires the compliance with common standards. The collaborating systems or products become compatible.

Key Performance Indicator (KPI): Indicators with which the progress toward the attainment of objectives and/or critical success factors within a company can be detected to support important and fast decision-making.

While the majority of companies rely on ERP and database management capabilities to accomplish manufacturing enterprise tasks today, emerging technologies, such as next generation MES, manufacturing intelligence (Intelligence Suite) and business analytics are playing an increasing role to realise mature real-time manufacturing KPI solutions for continuous improvement programmes.

For instance, Overall Equipment Effectiveness (OEE) checks as one possible KPI the real machine efficiency compared to the theoretical one. Such KPIs can also be standardised across different locations through Manufacturing Enterprise level initiatives to create operational benchmark levels.

Level descriptor: A measure of performance demands at which outcomes must be demonstrated.

Management of engineering works or activities: The coordinated activities required to:

(a) direct and control everything that is constructed or results from construction or manufacturing operations;

(b) operate engineering works safely and in the manner intended;

(c) return engineering works, plant and equipment to an acceptable condition by the renewal, replacement or mending of worn, damaged or decayed parts;

(d) direct and control engineering processes, systems, commissioning, operation and decommissioning of equipment;

(e) maintaining engineering works or equipment in a state in which it can perform its required function.

Manufacturing Execution System (MES): An integrated hardware and software solution designed to measure and control critical activities in the production environment. An MES is a dynamic information system that drives effective execution of manufacturing operations using current and accurate data, MES guides, triggers and reports on plant activities as events occur.

MES is a set of functions that manages production operations from the point of order release into manufacturing to the point of product delivery of finished goods.

State-of-the-art MES provide and work with mission-critical information before, during and after production activities and also connect to other systems across the organisation and supply chain via bi-directional communication.

The ISA organisation has defined standards regarding the scope and character of MES and its integration into a larger company-wide IT architecture independent of a particular solution vendor.

Open Platform Communications (OPC): The interoperability standard for the secure and reliable exchange of data in the industrial automation space and in other industries. It is platform independent and ensures the seamless flow of information among devices from multiple vendors. The OPC Foundation is responsible for the development and maintenance of this standard.

Outcome: The specified category level means a statement of the performance that a person must demonstrate to be judged competent.

Over-determined problem: A problem for which requirements are defined in excessive detail, making the required solution impossible to attain in all of its aspects.

Overall Equipment Effectiveness (OEE): Calculation method that focuses on individual items of process or manufacturing equipment at a finite level and allows their 'effectiveness' to be measured individually or in groups (i.e., with other equipment items). The OEE calculation is based on the ratio of the three key production parameters: availability, performance, and quality with time (e.g., planned shift time/s). It can be viewed as the percentage of time that equipment would need to run at its maximum speed to attain the actual output of the tool or machines. OEE acts as a measure for the control and management of the life cycle of manufacturing plants.

Practice area: A generally recognised or distinctive area of knowledge and expertise developed by an engineering practitioner by virtue of the path of education, training and experience followed.

Range statement: The required extent of or limitations on expected performance stated in terms of situations and circumstances in which outcomes are to be demonstrated in a particular competency area.

Specified Category: A category of registration for persons who must be registered through the Engineering Profession Act or a combination of the Engineering Profession Act and external legislation as having specific engineering competencies normally at NQF 5 related to an identified need to protect the public safety, health and interest or the environment, in relation to an engineering activity.

Sustainable development: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

ABBREVIATIONS

APC	Advanced process control, including feedforward, decoupling, inferentials, and custom algorithms; usually implies DCS-based.
ARC	Advanced regulatory control, including adaptive gain, override, logic, fuzzy logic, sequence control, device control, and custom algorithms; usually implies DCS-based.
APS	Advanced Product Scheduling.
BPCS	Basic process control system (see “base-layer”).
DCS	Distributed control system, often synonymous with BPCS.
ISA	International Society for Automation.
ISA-95	ISA-95 is an international industry standard that was defined by the Instrument Society of America (ISA, founded in 1945 in the USA) to set standards for automation. ISA-95 defines the terminology between an ERP system and a MES framework down to the Control level. This standard has been developed for global manufacturers to be applied in all industries and in all sorts of processes (batch, continuous, discrete). Part of that framework relies heavily on the World Batch Forum (WBF) standard, called the B2MML, which provides the appropriate context around the data. As long as the ERP system and the MES system both comply with these standards, they speak the same language. This standard helps address questions such as which tasks can be executed by which function and what information must be exchanged between the applications.
MPC	Multivariable Model predictive control.
MPO	Manufacturing planning optimisation.
PLC	Programmable Logic Controller.
SCADA	Supervisory Control and Data Acquisition.
SIS	Safety instrumented system.
SME	Subject matter expert.
WMS	Warehouse Management System.

BACKGROUND

The document that defines the Engineering Council of South Africa (ECSA) system for registration in specified categories is shown below, also locating the current document.

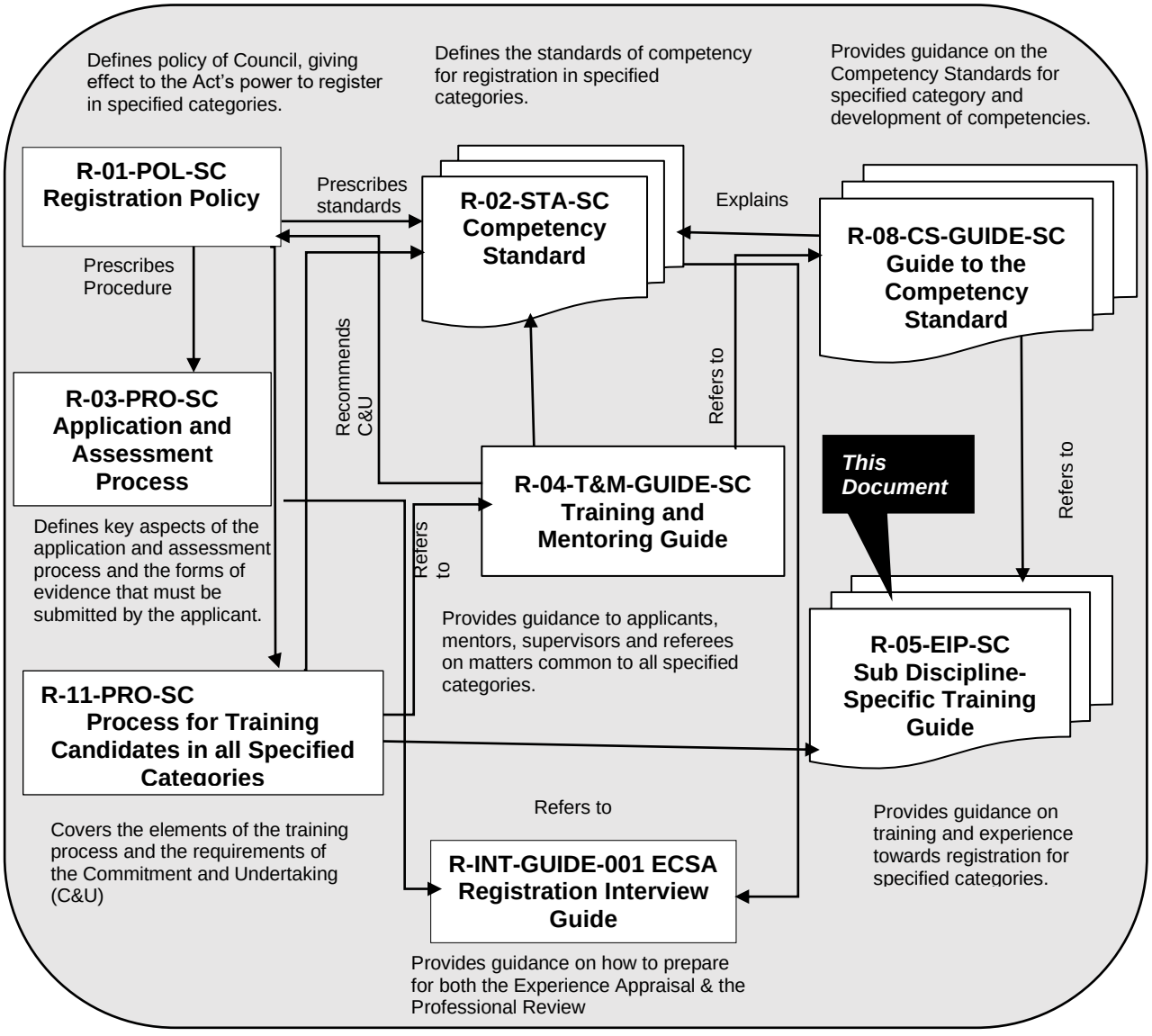

Figure 1: Documents defining the ECSA registration system

1. PURPOSE OF THIS DOCUMENT

The Engineering of Enterprise Integration system relies on collaboration among various engineering disciplines to achieve a satisfactory outcome. It is common practice that those working towards achieving this integrated system are professional persons who have no formal education, training or experience in the field of the engineering.

During the definition of Identification of Engineering Work (IDoEW) regulations, it became obvious that Enterprise Integration Practitioner falls in the ambit of Engineering Work, even though few of them have engineering qualifications.

People working as **Enterprise Integration Practitioners** are not subject to any professional regulatory authority and their competency varies. The work being conducted by such persons influences the health and safety of persons inside manufacturing facilities as well as the community at large.

Manufacturing processes are becoming more complex and integrated. Processes are manipulated automatically on the fly depending on the parameters set with the result that the work done by these practitioners falls squarely within the definition of Engineering Work although they may not all be eligible for registration in the existing framework. This specified category of Engineering Work provides the pathway for professionals practising in **Enterprise Integration** to be recognised and to register with ECSA.

In formalising the specified category for Enterprise Integration Practitioner, the Competency Model of the Automation Federation was used together with the knowledge obtained from specialists in this field. The Enterprise Integration Practitioner forms part of the Automation field as defined by the Automation Federation.

This document supplements the generic *Training and Mentoring Guide* **R-04-T&M-GUIDE-SC**, *Guide to the Competency Standards for Registered Specified Category Practitioners* **R-STA-08-SC** and Proc*ess for Training Engineering Candidates towards Specified Category Registration* **R-11-PRO-SC**.

In document **R-04-T&M-GUIDE-SC**, attention is drawn to the following sections:

- Duration of training and period working at level required for registration

- Principles of planning training and experience
- Progression of training programme
- Documenting training and experience
- Demonstrating responsibility.

The second document **R-08-CS-GUIDE-SC** provides both a high-level and an outcome-by-outcome understanding of the competency standards as an essential basis for this sub discipline-specific training requirements document.

The third document **R-11-PRO-SC** elaborates on the elements of the training process and the requirements of the Commitment and Undertaking (C&U).

These requirements, as well as **R-04-T&M-GUIDE-SC**, **R-08-CS-GUIDE-SC** and **R-11-PRO-SC**, are subordinate to the Policy on Registration, document **R-01-POL-SC**, the Competency Standard (**R-02-STA-SC**) and the application process definition (**R-03-PRO-SC**).

2. AUDIENCE

These requirements are directed to applicants and their supervisors and mentors working as practitioners in the specified category of Enterprise Integration. The requirements are intended to support a programme of training and experience incorporating good practice elements.

Table 1 below contains the different categories in the engineering team of registered practitioners accepting full responsibility for their area of work and adhering to ECSA's Code of Conduct. (EPA = Engineering Professions Act, 46 of 2000)

Table 1: Engineering Categories

Category	Authority	Underpinning knowledge	Area of responsibility
Professional Engineer (EPA Section 18(1)(a)(i))	Educated, trained and experienced to carry out complex-defined engineering work.	Graduate Attributes acquired in education at NQF 8 level (560 credits)	Complex interaction between professions and disciplines. Justify work outside codes, standards and procedures.

Category	Authority	Underpinning knowledge	Area of responsibility
Professional Certificated Engineer (EPA Section 18(1)(a)(iii))	Educated, trained and experienced to carry out broadly defined engineering work	Graduate Attributes acquired in education at NQF 7 level (420 credits) and Government Certificate of Competency	Interaction with other professions and disciplines. Authorisation required to work outside codes, standards and procedures after conducting research and investigation. Legal responsibility (OH&S Act)
Professional Engineering Technologist (EPA Section 18(1)(a)(ii))	Educated, trained and experienced to carry out broadly defined engineering work	Graduate Attributes acquired in education at NQF 7 level (420 credits)	Interaction with other professions and disciplines. Authorisation required to work outside codes, standards and procedures after conducting research and investigation.
Professional Engineering Technician (EPA Section 18(1)(a)(iv))	Educated, trained and experienced to carry out well-defined engineering work	Graduate Attributes acquired in education at NQF 6 level (280 to 360 credits)	Mostly working within a single discipline. Strict adherence to codes, standards and procedures. Repetitive work.
Specified Category Practitioner (EPA Section 18(1)(c))	Educated, trained and experienced to carry out specifically defined engineering work	Graduate Attributes acquired in education at NQF 5 level (140 credits)	Working within a single discipline in a specific field. May be legally responsible for work.

3. ENTERPRISE INTEGRATION

3.1 The nature and organisation of the industry

The industry in which the Enterprise Integration Practitioners operate is a sub-section of Automation and may be employed in both the private and the public sector. The Automation industry is a cross functional industry, i.e., it spans electrical, chemical, mechanical and all other traditional engineering industries as components that are able to communicate and infiltrate these traditional industries.

More and more components, parts and complete units are able to communicate via the Internet, creating the buzzword “Internet of Things”. In this section of Automation, we are only concerned with industrial automation and how this impacts the “Smart Factory” and “Smart Industry”.

Smart factories and Smart Industries are industries that take advantage of new technologies, for example:

- Big Data
- Augmented Reality – 3D view of product
- Simulation and digital twins
- Internet of Things
- Cloud Computing
- Cyber Security
- Systems Integration
- Additive Manufacturing – building 3D in layers
- Autonomous Systems
- Crypto currencies.

This industry spans the public and private sectors:

Private sector

Typically in the private sector, Enterprise Integration Practitioners are involved in consulting, engineering activities, procurement and/or contracting (CEPC). Engineering contractors are responsible for project implementation and activities include planning, design, construction, labour and resource management. Those working in operations or manufacturing companies could be involved in research and development and would be involved in production, supply, maintenance and quality control.

Public sector

The public sector is responsible for service delivery and is usually the client. The Enterprise Integration Practitioner's activities normally include engineering activities, procurement, operations and maintenance.

3.2 Engineering activities

The following engineering activities are undertaken by Enterprise Integration Practitioners that require expert levels of understanding.

Individuals need to provide evidence of competence to prove that they can apply the correct level of expertise in any or all the undermentioned activities, and that they understand the risks involved.

3.2.1 Description

- Enterprise Integration Practitioners devise strategy definitions (competitive, supply chain, operational), performance evaluation systems, process design/re-design, enabling technologies to align the company strategy with process improvement projects to achieve excellent performance.
- They consider all these issues in an integrated way to align the company strategy with process improvement projects to attain performance excellence.
- They provide prompt, accurate system integration and support to a client's customers, locally and often globally.
- Activities can range from assistance with using client products, complex software engineering analysis, and integration of client software onto different set-top boxes, to developing test programmes to validate porting interfaces.
- In general, engineers should be familiar with several areas of client technology and be able to intelligently assess specific problems encountered in the field and determine an appropriate path to resolution.

3.2.2 Performance domains

Domain I: Define customer requirements

Task 1: Determine the type/degree of integration required through cost/benefit analysis to meet the business need.

Task 2: Conduct technical studies for the preliminary integration strategy by gathering data and conducting an appropriate analysis relative to requirements to define development needs and risks.

Task 3: Perform a justification analysis by generating a feasibility cost estimate and using an accepted financial model to determine project viability.

Domain II: Business and physical integration

Task 1: Design and implement solutions to integrate business systems with information and operations systems.

Task 2: Perform security analyses and regulatory compliance assessments by identifying key issues and risks to comply with applicable standards, policies and regulations.

Task 3: Establish standards, templates and guidelines as applied to the automation system using the information gathered in the definition stage and consider human-factor effects to satisfy customer design criteria and preferences.

Task 4: Create detailed equipment specifications and data sheets based on vendor selection criteria, characteristics and conditions of the physical environment, regulations and performance requirements to purchase equipment and support system design and development.

Task 5: Select the physical communication media, network architecture, and protocols based on data requirements to complete system design and support system development.

Task 6: Develop a functional description of the automation solution (e.g., control scheme, alarms, HMI, reports) using rules established in the definition stage to guide development and programming.

Task 7: Perform the detailed design for the project by converting the engineering and system design into purchase requisitions, drawings, panel designs and installation details consistent with the specification and functional descriptions to provide detailed information for development and deployment.

Domain III: Application integration

Application Integration – direct development of necessary software, programming of databases and configuration of networks to allow efficient and secure transactions among computer systems.

Task 1: Establish detailed requirements and data including network architecture, communication concepts, safety concepts, standards, vendor preferences, instrument and equipment data sheets, reporting and information needs and security architecture through established practices to form the basis of the design.

Task 2: Define the data structure layout and data flow model considering the volume and type of data involved to provide specifications for hardware selection and software development.

Task 3: Develop Human Machine Interface (HMI) in accordance with the design documents to meet the functional requirements.

Task 4: Develop database or data warehouse and reporting functions in accordance with the design documents to meet the functional requirements.

Task 5: Develop control configuration or programming in accordance with the design documents to meet the functional requirements.

Task 6: Implement data transfer methodology that maximises throughput and ensures data integrity using communication protocols and specifications to assure efficiency and reliability.

Task 7: Implement security methodology in accordance with stakeholder requirements to mitigate loss and risk.

Task 8: Review configuration and programming using defined practices to establish compliance with functional requirements.

Task 9: Test the system using the test plan to determine compliance with functional requirements.

Task 10: Assemble all required documentation and user manuals created during the development process to transfer essential knowledge to customers and end users.

Domain IV: Testing and technical support

Task 1: Execute system-level tests in accordance with the test plan to ensure the entire system functions as designed.

Task 2: Perform periodic inspections and tests in accordance with written standards and procedures to verify system or component performance against requirements.

Task 3: Provide technical support for facility personnel by applying system expertise to maximise system availability.

Task 4: Perform continuous improvement by working with facility personnel to increase capacity, reliability and/or efficiency.

Task 5: Document lessons learned by reviewing the project with all stakeholders to improve future projects.

3.2.3 Standards

C&I Standards

- IEC60534 – Industrial-process control valves
- IEC60584 – Thermocouples – Part 1: EMF specifications and tolerances
- IEC60654 – Industrial-process measurement and control equipment
- IEC61131 – Programmable Controllers
- IEC61158 – Industrial communication networks
- IEC61326 – Electrical equipment for measurement, control and laboratory use – EMC requirements
- IEC61512 / ISA 88 – Batch control
- IEC61513 – Nuclear power plants – Instrumentation and control important to safety

- IEC62337 – Commissioning of electrical, instrumentation and control systems in the process industry
- IEC62381 – Automation systems in the process industry – Factory acceptance test (FAT), site acceptance test (SAT), and site integration test (SIT)
- IEC62382 – Control systems in the process industry – Electrical and instrumentation loop check
- IEC62541 – OPC Unified Architecture
- ISA-95 Enterprise-Control System Integration.

Reference Architecture Model Industry 4.0 (RAMI4.0)

- Digital Factory
    - IEC TR 62794 Process Measurement

Description

Industrial-process measurement, control and automation – Reference model for representation of production facilities (digital factory).

Motivation

The standards for Digital Factory define methods and information models that are required for self-description of I40-components.

- IEC TS 62832 Digital Factory

Description

Digital Factory Reference model TS

Motivation

The standards for Digital Factory define methods and information models that are required for self-description of I40-components. IEC TS 62832 defines methods, which allow validation or planning connections between assets.

- Security

- ISO / IEC 27000 – Information Security and Management Systems
- IEC62443 – Network and System Security

- Safety
  - IEC 61511 – Functional Safety
  - IEC62061 – Safety of machinery: Functional safety of electrical, electronic and programmable electronic control systems

- Configuration
  - IEC 61804 – Function Blocks
  - IEC 62453 – Field Devices

- Lifecycle
  - IEC 62890 – Lifecycle Status

- Condition
  - VDMA 24582 Condition Monitoring

- Engineering
  - IEC 62714 – Automation Markup Language
  - IEC 61131 – PLC Open XML
  - IEC 61987 – Industrial process measurement and control
  - IEC 61360 – Industrial automation systems and integration

- Communication Layer
  - IEC 62514 – Machine to Machine
  - IEC 61784 – Industrial Communication Networks

- Information Layer
  - IEC 61360 – Classification and Product Description

- Hierarchy Levels

- IEC 61512 – Batch Control
- IEC 62264 – Enterprise control system integration

3.3 Automation Types

3.3.1 Factory Automation

Factory Automation is used for discrete industries like the automotive industry.

Factory Automation consists of the following:

- Digital twin: A digital twin is a virtual representation of a physical product or process, used to understand and predict the physical counterpart's performance characteristics. Digital twins are used throughout the product lifecycle to simulate, predict, and optimise the product and production system before investing in physical prototypes and assets.
- Production Lifecycle Management (PLM): PLM is the process of managing the entire lifecycle of a product from inception through engineering design and manufacture to service and disposal of manufactured products. PLM integrates people, data, processes and business systems and provides a product information backbone for companies and their extended enterprise.
- Manufacturing Operation Management
- Quality Management
- Supply and Demand Chain Management
- Automation of the mechanical production lines also known as Mechatronics
- Optimisation of the Production Lines i.e., OEE etc.

3.3.2 Process Automation

Process Automation is used for continuous industries like petrochemical, nuclear and other process industries.

Process Automation includes the following:

- Digital twin: A digital twin is a virtual representation of a physical product or process, used to understand and predict the physical counterpart's performance characteristics. Digital

twins are used throughout the product lifecycle to simulate, predict, and optimise the product and production system before investing in physical prototypes and assets.

- Designing, implementing, controlling and optimising industrial process controls, especially continuous ones within the chemical, petrochemical, agriculture, mineral processing, advanced material, food, pharmaceutical and biotechnological industries.
- Production Lifecycle Management (PLM): PLM is the process of managing the entire lifecycle of a product from inception through engineering design and manufacture to service and disposal of manufactured products. PLM integrates people, data, processes and business systems and provides a product information backbone for companies and their extended enterprise.
- Manufacturing Operation management
- Quality management
- Supply and Demand Chain management
- Optimisation of the production lines i.e., OEE etc.

3.4 Categories and Knowledge Requirements

3.4.1 Competent Person

SAIMC defines a competent person as “a person who is qualified by virtue of his or her education, training, experience and contextual knowledge to make a determination regarding the performance of a process or part thereof in relation to a functional specification”.

SAIMC defines a competent person in Enterprise Integration as “a person who is registered in terms of the Engineering Professions Act, 46 of 2000 as either a Professional Engineer, a Professional Engineering Technologist, a Professional Engineering Technician or an Enterprise Integration Practitioner and has suitable experience in computerised systems used in manufacturing, tracking and documenting the transformation of raw materials to finished goods.

Competent Enterprise Integration Practitioners registered by ECSA will assist in further education, development and training to ensure competency and the acceptance of work responsibility. Participating in ECSA’s candidacy scheme with the C&U, adhering to ECSA’s Continued Professional Development requirements and complying with ECSA’s Code of

Conduct (CoC) will improve the service to the public and promote the standing of these practitioners.

3.4.2 Domain I: Define Customer Requirements

Enterprise Integration Practitioners (EIPs) are required to:

Task 1: Determine Degree of Integration

Determine the type/degree of integration required through cost/benefit analysis to meet the business need.

Knowledge of:

- Business integration
- Physical integration
- Application integration
- Various cost/benefit tools
- Control and information technologies (MES) and equipment
- Information technology and equipment
- Company procedures
- Performance metrics

Skill in:

- Analysing cost versus benefit (e.g., life cycle analysis)
- Choosing the type/degree of integration
- Estimating the cost of control equipment and software
- Leading a individual or group discussion
- Communicating effectively
- Writing in a technical and effective manner
- Building consensus

Task 2: Conduct Studies

Conduct technical studies for the preliminary integration strategy by gathering data and conducting an appropriate analysis relative to requirements to define development needs and risks.

Knowledge of:

- Process control theories
- Machine control theories and mechatronics
- Risk assessment techniques

Skill in:

- Conducting technical studies
- Conducting risk analyses
- Defining primary control strategies
- Writing in a technical and effective manner
- Compiling and summarising information efficiently
- Presenting information

Task 3: Justification Analysis

Perform a justification analysis by generating a feasibility cost estimate and using an accepted financial model to determine project viability.

Knowledge of:

- Financial models (e.g., Return on Investment, Net Present Value)
- Business drivers
- Costs of control equipment
- Estimating techniques

Skill in:

- Estimating the cost and scope of the system
- Running the financial model

- Evaluating the results of the financial analysis for the automation portion of the project

3.4.3 Domain II: Integration

Determine solutions to integrate physical and business systems to increase interoperability, usability and security.

Task 1: Design and Implement

Design and implement solutions to integrate business systems with information and operations systems.

Knowledge of:

- Business Integration and Manufacturing Operations Management (MOM)
    - Detailed Production Scheduling
    - Integration with Business Planning and Logistics
    - Level 3 Equipment Hierarchy
    - Level 3-4 Boundary
    - Other Manufacturing Activities
    - Production Operations Management
- Supply Chain Logistics

Skill in:

- Evaluating strategies
- Design

Task 2: Security and Compliance

Perform security analyses, and regulatory compliance assessments by identifying key issues and risks to comply with applicable standards, policies and regulations.

Knowledge of:

- Applicable standards (e.g., ISA S84, IEC 61508, 21 CFR Part 11, NFPA)
- Company standards

Skill in:

- Assessing security requirements or relevant security issues
- Applying regulations to design

Task 3: Establish Standards

Establish standards, templates, and guidelines as applied to the automation system using the information gathered in the definition stage and considering human-factor effects to satisfy customer design criteria and preferences.

Knowledge of:

- Process Industry Practices (PIP) (Construction Industry Institute)
- IEC 61131 programming languages
- Customer standards
- Vendor standards
- Template development methodology
- Field devices
- Electrical codes and standards (e.g., NEC, UL, FM, etc.)
- ISA standards (e.g., S88)

Skill in:

- Developing programming standards
- Selecting and sizing equipment
- Designing low-voltage electrical systems
- Preparing drawing using CAD software

Task 4: Create Detailed Specifications

Create detailed equipment specifications and data sheets based on vendor selection criteria, characteristics and conditions of the physical environment, regulations and performance requirements to purchase equipment and support system design and development.

Knowledge of:

- Computer and server hardware
- Network hardware & components
- Electrical codes and standards (e.g., NEC, UL, FM, etc.)
- Vendors' offerings

Skill in:

- Designing low-voltage electrical systems
- Selecting and sizing computers
- Selecting and sizing network hardware and components
- Selecting and sizing control equipment
- Evaluating vendor alternatives

Task 5: Select Communication Systems

Select the physical communication media, network architecture and protocols based on data requirements to complete system design and support system development.

Knowledge of:

- Vendor protocols
- Object Linked Embedding for Process Control (OPC)
- Ethernet and other open industrial and enterprise networks
- Physical requirements for networks/media
- Physical topology rules/limitations
- Network design
- Security requirements
- Grounding and shielding practices

Skill in:

- Designing networks based on chosen protocols

Task 6: Develop Functional Description

Develop a functional description of the automation solution (e.g., control scheme, alarms, HMI, reports) using rules established in the definition stage to guide development and programming.

Knowledge of:

- Control theory
- Visualisation, alarming, database/reporting techniques
- Documentation standards
- Vendors' capabilities for their hardware and software products
- General control strategies used within the industry
- Process/equipment to be automated
- Operating philosophy

Skills in:

- Writing functional descriptions
- Interpreting design specifications and user requirements
- Communicating the functional description to stakeholders

Task 7: Detailed Design

Perform the detailed design for the project by converting the engineering and system design into purchase requisitions, drawings, panel designs and installation details consistent with the specification and functional descriptions to provide detailed information for development and deployment.

Knowledge of:

- Field devices, control devices, visualisation devices, computers and networks
- Installation standards and recommended practices
- Electrical and wiring practices
- Specific customer preferences
- Functional requirements of the system/equipment to be automated
- Applicable construction codes

- Documentation standards

Skill in:

- Performing detailed design work
- Documenting the design

3.4.4 Domain III: Application Integration

Direct development of necessary software, programming of databases and configuration of networks to allow efficient and secure transactions among computer systems.

Task 1: Establish Detailed Requirements

Establish detailed requirements and data including network architecture, communication concepts, safety concepts, standards, vendor preferences, instrument and equipment data sheets, reporting and information needs and security architecture through established practices to form the basis of the design.

Knowledge of:

- Network architecture
- Network Configuration
    - Cable (wire and fibre optic) Networks
    - Network Component Configuration
    - Network Diagnostics
    - Network Management
    - Wireless Networks
- Communication protocols, including field level
- Safety concepts
- Industry standards and codes
- Reliability concepts and standards.
- Security requirements
- Safety standards (e.g., ISA, ANSI, NFPA)

- Control systems security practices

Skill in:

- Conducting safety analyses
- Determining which data is important to capture
- Selecting applicable standards and codes
- Identifying new guidelines that need to be developed
- Defining information needed for reports
- Completing equipment data sheets

Task 2: Define Data Structure Layout

Define the data structure layout and data flow model considering the volume and type of data involved to provide specifications for hardware selection and software development.

Knowledge of:

- Data requirements of system to be integrated
- Data structures of control systems
- Data flow of controls systems
- Productivity tools and software
- Entity relationship diagrams
- Data Management
    - Data Documentation
    - Data Quality Issues
    - Data Security
    - Data Storage and Retrieval
    - Database Operations and Maintenance
    - Database Software
    - Database Structure and Types
    - Special Requirements of Real-Time Process Databases
- Data integration
- Web-based systems

- Metadata

Skill in:

- Modelling data
- Tuning and normalising databases

Task 3: Develop HMI

Develop Human Machine Interface (HMI) in accordance with the design documents to meet the functional requirements.

Knowledge of:

- Specific HMI software products
- Tag definition schemes
- Programming structure techniques
- Network communications
- Alarming schemes
- Report configurations
- Presentation techniques
- Database fundamentals
- Computer operating systems
- Human/ergonomic factors
- HMI supplier options

Skill in:

- Presenting data in a logical and aesthetic fashion
- Creating intuitive navigation menus
- Implementing connections to remote devices
- Documenting configuration and programming
- Programming configurations

Task 4: Develop Data Storage and Reporting Functions

Develop database or data warehouse and reporting functions in accordance with the design documents to meet the functional requirements.

Knowledge of:

- Relational database theory
- Specific database software products
- Specific reporting products
- Programming/scripting structure techniques
- Network communications
- Structured query language
- Report configurations
- Entity diagram techniques
- Computer operating systems
- Data mapping
- Meta data

Skill in:

- Presenting data in a logical and aesthetic fashion
- Administrating databases
- Implementing connections to remote applications
- Writing queries
- Creating reports and formatting/printing specifications for report output
- Documenting database configuration
- Designing databases
- Interpreting functional description

Task 5: Develop Control Configuration

Develop control configuration or programming in accordance with the design documents to meet the functional requirements.

Knowledge of:

- Specific control software products
- Tag definition schemes
- Programming structure techniques
- Network communications
- Alarming schemes
- I/O structure
- Memory addressing schemes
- Hardware configuration
- Computer operating systems
- Processor capabilities
- Standard nomenclature (e.g., ISA)
- Process/equipment to be automated

Skill in:

- Interpreting functional description
- Interpreting control strategies and logic drawings
- Programming and/or configuration capabilities
- Implementing connections to remote devices
- Documenting configuration and programs
- Interpreting P&IDs
- Interfacing systems

Task 6: Implement Data Transfer Methodology

Implement data transfer methodology that maximises throughput and ensures data integrity using communication protocols and specifications to assure efficiency and reliability.

Knowledge of:

- Specific networking software products (e.g., I/O servers).
- Network topology
- Network protocols
- Physical media specifications (e.g., copper, fibre, RF, IR)

- Computer operating systems
- Interfacing and gateways
- Data mapping

Skill in:

- Analysing throughput
- Ensuring data integrity
- Troubleshooting
- Documenting configuration
- Configuring network products
- Interfacing systems
- Manipulating data

Task 7: Implement Security Methodology

Implement security methodology in accordance with stakeholder requirements to mitigate loss and risk.

Knowledge of:

- Basic system/network security techniques
- Customer security procedures
- Control user-level access privileges
- Regulatory expectations (e.g., 29 CFR Part 11)
- Industry standards (e.g., ISA)

Skill in:

- Documenting security configuration
- Configuring/programming of security system
- Implementing security features

Task 8: Review for Compliance with Functional Requirements

Review configuration and programming using defined practices to establish compliance with functional requirements.

Knowledge of:

- Specific control software products
- Specific HMI software products
- Specific database software products
- Specific reporting products
- Programming structure techniques
- Network communication
- Alarming schemes
- I/O structure
- Memory addressing schemes
- Hardware configurations
- Computer operating systems
- Defined practices
- Functional requirements of system/equipment to be automated

Skill in:

- Programming and/or configuration capabilities
- Documenting configuration and programs
- Reviewing programming/configuration for compliance with design requirements

Task 9: Test System Using Test Plan

Test the system using the test plan to determine compliance with functional requirements.

Knowledge of:

- Testing techniques
- Specific control software products
- Specific HMI software products
- Specific database software products
- Specific reporting products
- Network communications
- Alarming schemes

- I/O structure
- Memory addressing schemes
- Hardware configurations
- Computer operating systems
- Functional requirements of system/equipment to be automated

Skill in:

- Writing test plans
- Executing test plans
- Documenting test results
- Programming and/or configuration capabilities
- Implementing connections to remote devices
- Interpreting functional requirements of system/equipment to be automated
- Interpreting P&IDs

Task 10: Assemble Documentation for Transfer

Assemble all required documentation and user manuals created during the development process to transfer essential knowledge to customers and end users.

Knowledge of:

- General understanding of automation systems
- Computer operating systems
- Documentation practices
- Operations procedures
- Functional requirements of system/equipment to be automated

Skill in:

- Documenting technical information for non-technical audience
- Using documentation tools
- Organising material for readability

3.4.5 Domain IV: Testing and Technical Support

Task 1: Execute System-Level Tests

Execute system-level tests in accordance with the test plan to ensure the entire system functions as designed.

Knowledge of:

- Test methodology
- Field devices
- System/equipment to be automated
- Networking and data communications
- Safety systems
- Security systems
- Regulatory requirements relative to testing

Skill in:

- Executing test plans
- Documenting test results
- Testing of entire systems
- Communicating final results to facility personnel
- Troubleshooting (i.e., resolving issues and retesting)
- Writing test plans

Task 2: Perform Periodic Inspections

Perform periodic inspections and tests in accordance with written standards and procedures to verify system or component performance against requirements.

Knowledge of:

- Performance requirements
- Inspection and test methodologies
- Acceptable standards

Skill in:

- Testing and inspecting
- Analysing test results
- Communicating effectively with others in written or oral form

Task 3: Provide Technical Support

Provide technical support for facility personnel by applying system expertise to maximise system availability.

Knowledge of:

- All system components
- Processes and equipment
- Automation system functionality
- Other support resources
- Control systems theories and applications
- Analytical troubleshooting and root-cause analyses

Skill in:

- Troubleshooting (i.e., resolving issues and retesting)
- Investigating and listening
- Programming and configuring automation system components

Task 4: Perform Continuous Improvement

Perform continuous improvement by working with facility personnel to increase capacity, reliability, and/or efficiency.

Knowledge of:

- Performance metrics
- Control theories
- System/equipment operations
- Business needs

- Optimisation tools and methods

Skill in:

- Analysing data
- Programming and configuring
- Communicating effectively with others
- Implementing continuous improvement procedures

Task 5: Document Lessons Learnt

Document lessons learned by reviewing the project with all stakeholders to improve future projects.

Knowledge of:

- Project review methodology
- Project history
- Project methodology and work processes
- Project metrics

Skill in:

- Communicating effectively with others
- Configuring and programming
- Documenting lessons learned
- Writing and summarising

4. TRAINING PROGRAMME

The design, manufacture, use, maintenance, inspection and testing of automation systems must be in accordance with accepted prescribed regulations and standards, and audits to verify this must be undertaken. Work performed and consultant activities must be recorded according to the requirements.

All ECSA-registered Enterprise Integration Practitioners are allocated a registration number after assessment. A portfolio of evidence is placed on file together with a letter detailing their competency in design, installation, commissioning, maintenance and/or inspection of the specific automation systems for which their registration permits them to work. All stakeholders, manufacturers, operations and maintenance staff agree that registration of ethically bound Enterprise Integration Practitioners after evaluation is a tremendous advantage to the industry.

4.1 Training objectives

To achieve ECSA registration, the trainee's employer should design the training programme to enable the trainee to recommend, control, administer and implement known or novel technologies in an innovative manner in the automation field.

This programme needs to include the elements discussed below:

4.1.1 Exposure

Expose applicants to experience and training, enabling them to apply the theory acquired during educational development to practical workshop situations for the prescribed period and or to expand the practical knowledge and skills obtained at the workplace.

4.1.2 Increasing responsibility

Incorporate an increasing level of responsibility to enable applicants to submit evidence in the training and experience reports of achieving the required duration and level.

4.1.3 Ability to obtain complete training

Depending on where the Applicant is employed, there may be situations where the in-house opportunities are insufficiently diverse to develop all the competencies required in all the groups noted in document **R-02-STA-SC** and in the Sub Discipline-specific Requirements Report (Form R-05-SDSRR-AP as shown in **Appendix B**).

For example, the opportunities for developing problem-solving competence (including design and developing solutions) and for managing engineering activities (including implementing and constructing solutions) may not both be available to the Candidate. In such cases, employers are encouraged to appoint an external mentor.

In situations where an organisation is unable to provide training in certain areas, secondments should be arranged with other organisations so that Candidates are able to develop all the competencies required for registration. These secondments are usually reciprocal in nature, so both employers and their respective employees mutually benefit. Secondments between consultants and contractors and between the public and private sectors are allowed.

Problem-solving is the core of engineering. It is a logical thinking process that requires Enterprise Integration Practitioners to apply their minds diligently in bringing solutions to technically specifically defined problems. This process involves the analysis of automation systems or the assembly of mechanical, electrical and computer components and the integration of various elements of engineering as applied to automation systems through the application of basic and engineering sciences.

4.1.4 Experience appraisal

When conducting Experience appraisal applicants and their mentors should take into consideration the outcomes below include the

Table 2: Experience appraisal

No.	Outcome
1	Define, investigate and analyse well defined engineering problems.
2	Design or develop solutions to well defined engineering problems.
3	Comprehend and apply advanced knowledge: principles, specialist knowledge, jurisdictional and local knowledge.
4	Manage part or all of one or more well defined engineering activities.
5	Communicate clearly with others in the course of engineering activities.
6	Recognise and address the reasonably foreseeable social, cultural and environmental effects of well-defined engineering activities.
7	Meet all legal and regulatory requirements and protect the health and safety of persons in the course of well-defined engineering activities.
8	Conduct engineering activities ethically.
9	Exercise sound judgement in the course of well-defined engineering activities.
10	Be responsible for making decisions on part or all of well-defined engineering activities.
11	Undertake professional development activities sufficient to maintain and extend competence.

4.1.5 Specific Enterprise Integration systems

Depending on the particular requirements for an **enterprise integration** system (the requirements for design, installation, commissioning and/or maintenance), Applicant Enterprise Integration Practitioners will select one or more of the Enterprise Integration systems for the purpose of registration as knowledge for the Applicant Enterprise Integration Practitioner through the full career path of the Registered Enterprise Integration Practitioner. The present systems identified by ECSA are listed and described in **Appendix A**, with the applicable standards given, if available.

4.2 Minimum experience and training requirements

Candidates are required to provide evidence of training in supplier applications used in the business integration effort that is presented as evidence of experience obtained. Training is required in all the modules used during the integration effort.

Candidates must select at least one of the Enterprise Integration Practitioner categories for the purpose of registration:

- Identify and analyse customer requirements to determine optimal integration solutions.
- Determine solutions to integrate physical and business systems to increase interoperability, usability and security.
- Direct development of necessary software, programming of databases and configuration of networks to allow efficient and secure transactions among computer systems.
- Execute system-level tests in accordance with the test plan to ensure the entire system functions as designed.

The present systems identified by the ECSA are listed and described in **Appendix A**, with the applicable standards given if available.

4.3 Recommended formal learning activities

No NQF registered qualifications are currently available for the Enterprise Integration Engineer. There are, however, other recommended training courses available depending on the applications used:

4.3.1 ISA

Safety Instrumented Systems

- Certificate 1: ISA/IEC 61511 SIS Fundamentals Specialist
- Certificate 2: ISA/IEC 61511 SIL Selection Specialist
- Certificate 3: ISA/IEC 61511 SIL Verification Specialist
- ISA/IEC 61511 SIS Expert

Cybersecurity

- Certificate 1: ISA/IEC 62443 Cybersecurity Fundamentals Specialist
- Certificate 2: ISA/IEC 62443 Cybersecurity Risk Assessment Specialist
- Certificate 3: ISA/IEC 62443 Cybersecurity Design Specialist
- Certificate 4: ISA/IEC 62443 Cybersecurity Maintenance Specialist
- ISA/IEC 62443 Cybersecurity Expert

4.3.2 SAP

Analytics

Business Intelligence (BI)

- Web Intelligence
  - Training For Web Intelligence in BI
  - Learn to create, manage and distribute complex Web Intelligence documents using multiple data sources and advanced query and reporting techniques, such as combined queries and sub-queries and variables.
- Crystal Reports
  - Training For Crystal Reports in BI
  - Learn basic functions and navigation options and then move on to special functions and layout design possibilities, plus foundations of Visual Basics for Applications (VBA) programming.
- SAP Analytics Cloud

- Training For Analysis, Edition for Microsoft Office in BI
- Learn basic functions and navigation options and then move on to special functions and layout design possibilities, plus foundations of VBA programming.

- SAP BI Platform Administration

  - Training For SAP BI Platform Administration in BI
  - This training path is aimed at experienced BI system architects, solution architects, and system administrators responsible for designing and deploying SAP Business Objects BI 4 solutions.

- SAP Lumira

  - Training For SAP Lumira in BI
  - Learn how to create applications for desktop and mobile devices using SAP Lumira 2.0 Designer or upgrade your knowledge from SAP Business Objects Design Studio

Business Warehouse (BW)

- SAP BW on any Database

  - Training For SAP BW on any Database in BW
  - Gain the skills in SAP Netweaver BW required for successful database planning, design, implementation, administration and performance optimisation.

- SAP BW powered by SAP HANA

  - Training For SAP BW powered by SAP HANA in BW
  - Learn basic functions and navigation options and then move on to special functions and layout design possibilities, plus foundations of VBA programming.

- SAP BW/4HANA

  - Training For SAP BW/4HANA in BW
  - Learn the key capabilities of SAP HANA, how to run and work with SAP BW/4HANA, and how to convert an SAP BW architecture to SAP BW/4HANA. Upskill from BW powered by HANA to BW/4HANA, including data warehousing

- Data Warehouse (SAP HANA)

Table 3: Applications

Asset Management • SAP ERP • SAP S/4HANA	**Customer Relationship Management (CRM)** • SAP CRM	**Enterprise Portfolio & Project Management (EPPM)** • SAP ERP • SAP S/4HANA
Financial Accounting • SAP ERP • SAP S/4HANA • SAP S/4HANA - Delta	**Human Capital Management (HCM)** • SAP ERP	**Industry Solutions** • SAP Consumer Products • SAP Defense and Security • SAP Higher Education & Research • SAP Oil&Gas • SAP Public Sector • SAP Retail
Integration • SAP ERP • SAP S/4HANA • Small and Medium Enterprise (SME)	**Logistics Execution & Warehouse Management** • SAP ERP • SAP EWM • SAP S/4HANA	**Management Accounting** • SAP BPC • SAP ERP • SAP S/4HANA • SAP S/4HANA - Delta
Planning, Manufacturing, Execution • SAP ERP • SAP ME and MII • SAP S/4HANA • SAP S/4HANA - Delta • SAP SCM	**Procurement** • SAP ERP • SAP S/4HANA • SAP S/4HANA - Delta • SAP SRM	**Quality Management** • SAP ERP • SAP S/4HANA
R&D Engineering • SAP ERP • SAP S/4HANA	**Real Estate** • SAP ERP • SAP S/4HANA	**Receivables Management** • SAP ERP
Sales • SAP ERP • SAP S/4HANA • SAP S/4HANA – Delta	**Transportation Management** • SAP TM	**Treasury Management** • SAP ERP • SAP S/4HANA

Table 4: Cloud

SAP Ariba • Buy Side Integration • Contracts • Integration • SAP Ariba Procurement • SAP Ariba Supplier Management • Sourcing • Spend Analysis • Supplier Enablement - Buy Side • Supplier Enablement - Sell Side • Supply Chain Collaboration	**SAP Customer Experience (C/4HANA)** • C/4HANA Lead to Cash • Commerce Cloud – Business User • Commerce Cloud – Development • Customer Data Cloud • Marketing Cloud • Sales – Commissions • Sales – CPQ • Sales – Producer Pro • Sales – Workflow • Sales – Sales Cloud • Service – Field Service Management • Service – Service Cloud
SAP Cloud Platform • Development	**SAP Enable Now** • Manage Sustainable Content
SAP Integrated Business Planning • Supply Chain Planning	**SAP Learning Hub** • Subscriptions
SAP Leonardo • Digital Manufacturing • Internet of Things	**SAP S/4HANA Cloud** • Enterprise Asset Management • Finance • Manufacturing • Onboarding • Procurement • Professional Services • Sales • SAP Cloud SDK Extensibility Developer
SAP Success Factors • Integration • SF Human Capital Management (SF-HCM)	

Table 5: Database & Technology

Administration • Change & Transport (CTS) • Database • Database Migration • SAP Fiori • SAP HANA • SAP Mobility • SAP NetWeaver • SAP S/4HANA • Design • Design Thinking • User Experience	**Development** • ABAP Core • ABAP Creating Forms • ABAP Dialog Programming • Application Development for SAP HANA • HANA Programming • SAP Cloud Platform • SAP Fiori • SAP Fiori for IOS • SAP Mobility • SAP S/4HANA Programming • SAP Screen Personas • SAP Work Manager
Solution Manager • SAP Application Lifecycle Management (ALM)	**Security & Authorisation** • Administration
Modelling • SAP HANA	**Integration** • SAP NetWeaver
Implementation & Administration • SAP Activate	
Technology Consultant • Associate OS DB Migration • Associate with Database	

4.3.3 MESA International

- MES/MOM* Methodologies Certificate of Competency (CoC01)
    - 401. Manufacturing Operations Standards and Strategic Initiatives
    - 402. Adaptive Manufacturing 2.0 Architecture
    - 403. Continuous Improvement and the Collaborative Pull Supply Chain
    - 404. Manufacturing Transformation Strategy
    - 405. MES/MOM Implementation & Governance
    - 406. Aligning Financial and Operations Metrics

- 407. Justifying MES/MOM
- 408. Statement of Requirement, Request for Proposal and Product Evaluation Method
- 409. MES/MOM Project Management Techniques

- B2MML & Integration Fundamentals Certificate of Competency (CoC02)
  - Typical IT environment used in integration projects and the IT tools used for integration
  - A discussion on typical business process that require integration, the business terminology typically used and how shop floor/operations systems work through transactions that support the business processes
  - A definition of the B2MML elements used in integration projects, including Process/Operations Segments, Properties, Schedules, Product/Operations Definitions and Material
  - Methods and techniques for mapping data from modern and legacy systems into the common B2MML format
  - A definition of the ways to extend the basic B2MML definitions for projects.

4.3.4 Vendor Specific

Depending on the particular requirements for an **Enterprise Integration** system (the requirements for design, installation, commissioning and/or maintenance), Applicant Enterprise Integration Practitioners must select one or more of the Enterprise Integration systems for the purpose of registration as knowledge for the Applicant Enterprise Integration Practitioner through the full career path of the Registered Enterprise Integration Practitioner. The present systems identified by ECSA are listed and described in **Appendix A**, with the applicable standards given, if available.

5. EVALUATION AND REPORTS

The evaluation/assessment is detailed in document **E-17-PRO-SC**.

This Automation systems category is dedicated to people who cannot register in one of the normal engineering categories due to their qualifications and thus, the procedure is written as an alternative route.

To prove that the applicant has the competence to register in this Specialized Category, any lack in education needs to be compensated for by extended periods of engineering experience. The exact periods will depend upon the level of qualifications held by the applicant.

To provide evidence of the work Candidates are doing or have done and correctly completed, Training and Experience Reports and the Engineering Report (forms R-03-TER/TEO-SC and R-03-ER-SC respectively) must be submitted. The Initial Professional Development Report (Form R-03-IPD-SC) that must also be presented should incorporate developmental evidence of meeting the educational requirements.

6. DEVELOPING COMPETENCY: DOCUMENT (R-08-CS-GUIDE-SC).

This elaborates on sections in the Guide to the Competency Standard (**R-08-CS-GUIDE-SC**).

6.1 Requirements

Applicants are required to demonstrate the insight and ability to use and interface various aspects through verifiable performance of providing engineered solutions to practical, specifically defined problems experienced in their operating work environment. In addition, applicants must develop the skills required to demonstrate the use of applicable engineering knowledge in optimising the efficiency of operations.

Applicant Enterprise Integration Practitioners must be able to demonstrate that they have been actively involved in an Automation environment, participating in the execution of practical work to the extent that they have learnt sufficient detail regarding basic Automation procedures to be able to exercise judgement in the workplace thereafter.

Candidates are expected to be aware of the requirements of the engineering profession. The recognised VA applicable to Enterprise Integration Practitioners and its functions and services to members, for example, provide a broad range of contextual knowledge for Applicant Enterprise Integration Practitioners through the full career path of the Registered Enterprise Integration Practitioner. The practice area of EIPs identifies specific contextual activities that are considered an essential component of the development of competence of Enterprise Integration Practitioners. These include awareness of basic IT, manufacturing and operations processes and on-site activities and the competencies required of the engineer, technologist, technician, Enterprise Integration Practitioner and artisan. Exposure to practice in these areas must be identified in each programme within the employer environment.

The Registration Committee for Specified Categories with its sub discipline-specific assessing committee on Enterprise Integration Practitioners performs the review of the Candidate's portfolio of evidence at the completion of the training period.

6.2 Contextual Knowledge

Candidates are expected to be aware of the requirements of the engineering profession. The SAIMC, a recognised VA applicable to the Enterprise Integration Practitioner and its functions and services to members, provides a broad range of contextual knowledge for Applicant Enterprise Integration Practitioners and through the full career path of the Registered Enterprise Integration Practitioner.

The practice area of the Enterprise Integration Practitioner identifies specific contextual activities that are considered an essential component of the development of competence of the Automation Professional. These activities include awareness of IT, factory automation, process automation, processes of manufacturing and operations and on-site activities, providing evidence of the competencies required of the Enterprise Integration Practitioner. Exposure to practice in these areas will be identified for each programme within the employer environment.

The ECSA Registration Committee for Specified Categories with its sub discipline-specific assessing committee on automation systems performs the review of the portfolio of evidence of the Applicant Enterprise Integration Practitioner at the completion of the training period.

6.3 Evidence of Competence

All applicants for registration must present the evidence of competence and be assessed against the applicable standards and requirements, irrespective of the development path followed.

Application for registration as a Specified Category Practitioner is permitted without being registered as an Applicant in a Specified Category and without training under a C&U. Mentorship and adequate supervision are, however, key factors in the effective development to the level required for registration.

A C&U indicates that a company is committed to mentorship and supervision. If the trainee's employer does not offer C&U, the trainee should establish the level of mentorship and supervision that the employer is able to provide. In the absence of an internal mentor, the services of an external mentor should be secured.

The recognised VA for the sub-discipline should be consulted for assistance in locating an external mentor. A mentor should be in place at all stages of the developmental process. The requirements indicated in this document are written for graduates wishing to enter this discipline but are also applicable to persons who are in the industry and have been doing the work of an Automation Professional but do not have the necessary qualifications to register in any of the engineering categories.

Mature applicants for registration may apply the requirements retrospectively to identify possible gaps in their development. Applicants who have not enjoyed mentorship are advised to request an experienced mentor (internal or external) to act as an application adviser while they prepare their application for registration.

6.4 Problem Solving

Problem-solving experience may be obtained in any of the following work categories:

6.4.1 Design or Development

Examples of acceptable design or development include but are not limited to:

- Modifications of the design after an automation system design has been approved.

- Modifications of the automation system after the automation system implementation has been approved and commissioned.
- Modifications of commissioning and testing procedures where these have been approved.

6.4.2 Operations

Operations mainly deal with investigating failure or under performance of automation systems and the synthesis of previously implemented and proven solutions to avoid recurrence of the problem. In addition, this category of work also involves the practical improvement recommended for optimising operational efficiencies.

In performing the abovementioned work, Enterprise Integration Practitioners must apply engineering judgement to all work they do in the management of automation systems. This includes the ability to assess design work against the following criteria: Conformance to design specifications, health and safety regulations.

- Constructability
- Maintainability
- Conformance to environmental requirements
- Ergonomic considerations
- Life cycle costs
- Alternative solutions.

6.4.3 Research and development

This type of work is performed in the research and product development centres of organisations.

Applicant Enterprise Integration Practitioners participate by applying research and development work in production with version control. This work must include the application of the various aspects of operations management, including product or system testing under controlled experimental conditions.

6.4.4 Functions performed

In the automation group and in each specific type of system or speciality, special consideration must be given to the competencies specified in the following groups, as described in the Degree of Responsibility scales in document **R-04-T&M-GUIDE-SC**:

- Group A: Knowledge-based engineering problem-solving
- Group B: Manage engineering activities
- Group C: Impacts of engineering activity
- Group D: Exercise judgement, take responsibility and act ethically
- Group E: Continuing Professional Development.

It should be noted that the Applicant EIP working at Responsibility Level E on the Degree of Responsibility Scale carries the level of responsibility for work performed that is appropriate to that of a registered person except that the supervisor of the Applicant Enterprise Integration Practitioner is accountable for the Candidate's recommendations and decisions.

6.4.5 Automation Sub Discipline-specific Requirements Industry-related statutory and other requirements

Candidates are expected to have a working knowledge of the following regulations, Acts and standards, and how they affect their working environment:

- OHS Act – Occupation Health and Safety Act, 85 of 1993, as amended by Act 181 of 1993.
- Environment Conservation Act, 73 of 1989, as amended by Act 52 of 1994 and Act 50 of 2003.
- Labour Relations Act
- Industry specific work instructions
- ISA and other international standards. Also refer to **Appendix A**.

Many other Acts not listed here may also be pertinent to a Applicant EIP's work environment. Applicant EIPs are expected to have a basic knowledge of the applicable Acts and to investigate whether any Acts are applicable to a particular work environment.

7. PROGRAMME STRUCTURE AND SEQUENCING

International training programme structures, which constitute best practice, are available to assist the Applicant Enterprise Integration Practitioner. The local training programme for each Applicant Enterprise Integration Practitioner depends on the work opportunities available for the employer to assign to the Applicant at the time.

It is suggested that Applicant Enterprise Integration Practitioners work with their mentors to select appropriate projects for gaining exposure to the eventual responsibility for the design, installation, commissioning and/or maintenance of the automation systems that are selected.

The training programme should be such that the Applicant Enterprise Integration Practitioner progresses through levels of work capability (as described in document **R-04-T&M-GUIDE-SC**) so that by the end of the training period, the Applicant Enterprise Integration Practitioner can perform individually and as a team member, meet the engineering outcomes and the discipline-specific requirements at the level required for registration and exhibit the degree of responsibility.

7.1 Best practice

The nature of work and degrees of responsibility defined in document **R-04-T&M-GUIDE-SC**, Table 6 are used here (and in Sub Discipline-specific Requirements Report: Form R-05-SDSRR- EIP):

Table 6: Degree of responsibility scales

A: Being Exposed	B: Assisting	C: Participating	D: Contributing	E: Performing
Undergoes induction, observes processes, work of competent practitioners.	Performs specific processes, under close supervision.	Performs specific processes as directed with limited supervision.	Performs specific work with detailed approval of work outputs.	Works in team without supervision, recommends work outputs, responsible but not accountable
Responsible to supervisor	Limited responsibility for work output	Full responsibility for supervised work	Full responsibility to supervisor for immediate quality of work	Level of responsibility to supervisor is appropriate to a registered person, supervisor is accountable for applicant's decisions

The mentor and Applicant EIP must identify at which level of responsibility an activity provides compliance with and demonstration of the various outcomes. The evidence of the Candidate's activities must be recorded on the appropriate system such that it meets the requirements of the Training Elements, Sub Discipline-specific Requirements Report Form R-05-SDSRR-EIP.

ECSA specifies the applicable recording system in the Application for Registration form (usually an Engineering Report and a Sub Discipline-specific Requirement Report with the associated calculations, sketches, installation schedules, maintenance schedules, commission results, etc for each selection applied for).

7.2 Orientation requirements

- Introduction to Company
- Company Safety Regulations
- Company Code of Conduct
- Company business processes
- Company Staff Code and Regulations
- Company records and record keeping
- Typical functions and activities.

7.3 Realities

Generally, irrespective of the system type, it is unlikely that the period of training will be 3 years, the minimum time required by ECSA. Typically, it will be longer and would be determined among others by the availability of functions in the actual work situation.

Each Applicant effectively undertakes a unique programme where the various activities carried out at the discipline-specific level are then linked to the generic competency requirements of **R-08-CS-GUIDE-SC** and the Compulsory Sub Discipline-specific Requirements to be met during the candidacy.

7.4 Considerations for generalists, specialists, researchers and academics

Document **R-08-CS-GUIDE-SC** adequately describes what would be expected of persons whose formative development has not followed a conventional path, for example academics, researchers, specialists and those who have not followed an Applicant training programme.

The overriding consideration is that, irrespective of the route followed, the applicant must provide evidence of competence against the Standard and the Sub Discipline-specific Requirements.

7.5 Moving into or changing candidacy programmes

This guide assumes that the Applicant EIP enters a programme after graduation and continues with the programme until ready to submit an application for registration. It also assumes that the Applicant EIP is supervised and mentored by persons who meet the requirements in document **R-04-T&M-GUIDE-SC**. In the case of a person changing from one candidacy programme to another or moving into a candidacy programme from a less structured environment, it is essential that the following steps are completed:

- The Applicant EIP must complete the Training and Experience Summary (TES) and Training and Experience Reports (TER) for the previous programme or unstructured experience. In the latter case, it is important to reconstruct the experience as accurately as possible. The TERs must be signed off.
- On entering the new programme, the mentor and supervisor should review the Applicant EIP's development in the light of the past experience and opportunities and the requirements of the new programme and plan at least the next phase of the Candidate's programme.
- The Applicant EIP must complete the Sub Discipline-specific Requirements Report (SDSRR) on elements already covered during the first part of the candidacy.

7.6 Compulsory Sub Discipline-specific Requirements to be met during the candidacy

There is a critical need in the industry to identify people who can conduct the essential operations associated with efficient and safe Enterprise Integration systems design,

installation, commissioning and maintenance. An additional need exists to identify competent persons in **Enterprise Integration** able to implement integration across multiple enterprises. This will lead to competence in the field of work and thereby add value to the industry and improve the economy of the country. It will also lead to a balanced society in that learners will understand how the work they do fits into the greater engineering industry.

Candidates, assisted by mentors and supervisors, must during candidacy ensure that they are conversant with the practical knowledge set out in the forms below, and submit evidence as such as part of the *Application for Registration* form. Applications for specified category practitioner in Enterprise Integration design, installation, commissioning, maintenance and inspection must submit the SDSRR form R-05-SDSRR-EIP.

REVISION HISTORY

Revision number	Revision date	Revision details	Approved by
Concept A	17 July 2017		MJ Maarens
Revision 1	30 January 2018		PDSG Committee
Concept B	7 October 2019	Industry has developed an Automation Competence Model. The Manufacturing Operations Management position has been included in the definition of the new Enterprise Integration Engineer, one of seven positions defined by the new Model. This Revision has now made provision for this change.	MJ Maartens
Revision 2	05 November 2019	Approval	RPSC
Rev 3 Draft A	12 April 2023	Reviewed in line with the four-year review cycle There are no material changes as there are currently no registration activities. Definition of '***Alternative Route'*** and ***'Benchmark Route'*** have been aligned to the R-01-POL-SC. The document revision history and revision number were also revised to align with the internal document control requirements.	RDDR
Rev 3 Draft B	25 April 2023	Submitted to registration for inputs and comments	RDDR & Registration BU
Rev 3 Draft C	08 May 2023	Review and Recommendation for Approval	Executive RPS: EL Nxumalo
Rev 3	18 May 2023	Approval	RPSC

The Sub Discipline-specific Training Guide for:

Registration as an Enterprise Integration Practitioners

Revision 4 dated 18 May 2023 and consisting of 97 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research Policy and Standards **(RPS)**.

..... 29 May 2023.....

Business Unit Manager Date

..... 2023/06/05.....

Executive: RPS Date

This definitive version of this policy is available on our website.

APPENDIX A: TRAINING ELEMENTS

This guide is written for the mature applicants for registration ("Alternative Route") may apply the guide retrospectively to identify possible gaps in their development.

Synopsis: An Applicant specified category practitioner should achieve specific competencies at the prescribed level during his/her development towards registration, at the same time accepting more and more responsibility as experience is gained. The outcomes achieved and established during the candidacy phase should form the template to all engineering work performed after registration, regardless of the level of responsibility at any particular stage of an engineering career:

1. Confirm understanding of instructions received and clarify if necessary.
2. Use theoretical training to develop possible approaches to do the work: select the best and present to the recipient.
3. Apply theoretical knowledge to justify decisions taken and processes used.
4. Understand role in the work team, and plan and schedule work accordingly.
5. Issue complete and clear instructions and report comprehensively on work completed.
6. Be sensitive about the impact of the engineering activity and take action to mitigate this impact.
7. Consider and adhere to legislation applicable to the task and the associated risk identification and management.
8. Adhere strictly to high ethical behavioural standards and ECSA's Code of Conduct.
9. Display sound judgement by considering all factors, their interrelationship, consequences, and evaluation when all evidence is not available.
10. Accept responsibility for own work by using theory to support decisions, seeking advice when uncertain, and evaluating shortcomings.
11. Become conversant with employer's training and development program and develop own lifelong development program within this framework.

Specifically defined engineering work is usually restricted to applying standard procedures, codes and systems, i.e., work that was done before within the narrow field of application.

Responsibility Levels: A = Being Exposed; B = Assisting; C = Participating; D = Contributing; E = Performing.

1. Purpose This standard defines the competence required for registration as a Specified Category Practitioner. Definitions of terms having particular meaning within this standard are given in text at the end of this Annexure and in document **R-01-POL-SC**.	Discipline Specific Training Guides (DSTG) gives context to the purpose of the Competency Standards. Registered Specified Category Practitioner operate within the nine disciplines recognised by ECSA. Each discipline can be further divided into sub-disciplines and finally into specific workplaces or competency areas DSTGs are used to facilitate experiential development towards ECSA registration and assist in compiling the required portfolio of evidence (Specifically the Engineering Report in the application form). **Note:** The training period must be utilised to develop the competence of the trainee towards achieving the standards below at a responsibility as indicated (mostly level E, i.e., Performing. Refer to **R-04-SC**, Table 4)
2. Demonstration of Competence Competence must be demonstrated within ***specifically defined engineering activities,*** defined below, by integrated performance of the outcomes defined in section 3 below at the level defined for each outcome. Required contexts and functions may be specified in the applicable Sub-Discipline Specific Training Requirements. **Level Descriptor:** ***Specifically defined engineering activities have*** several of the following characteristics: a) Scope of specific practice area is defined by specific techniques applied; change by adopting new specific techniques into current practice; b) Practice area is located within a wider, complex *context,* with specifically defined working relationships with other parties and disciplines; c) Work involves specific familiar *resources,* including people, money, equipment, materials, technologies; d) Require resolution of interactions manifested between specific technical factors with limited impact on wider issues;	Engineering activities can be divided into (approximately): • 5% Complex (Professional Engineers) • 5% Broadly Defined (Professional Engineering Technologists) • 10% Well-defined (Professional Engineering Technicians) • 15% Specifically defined (Registered Specified Categories) • 20% Skilled Workman (Engineering Artisan) • 45% Unskilled Workman (Artisan Assistants) The activities can be in-house or contracted out; evidence of integrated performance can be submitted irrespective of the situation. **Level Descriptor:** ***Specifically defined engineering activities*** in the specific discipline is characterised by several or all of: a) *Scope* of practice area does not cover the entire field of the specific discipline (exposure limited to the relevant components of the specific sub-discipline and specific workplace). Techniques applied are largely well established and change by adopting new specific techniques into current practice is the exception; b) Practice area varies substantially with unlimited location possibilities and an additional responsibility to identify the need for *complex, broadly defined and/or well-defined* advice to be included in the specifically defined working relationships with other parties and disciplines; c) The bulk of the work involves familiar, defined range of resources, including people, money, equipment, materials, technologies;

e) Are constrained by operational context, defined work package, time, finance, infrastructure, resources, facilities, standards and codes, applicable laws; f) Have risks and consequences that are locally important but are specifically defined. ***Activities*** include but are not limited to: planning; investigation and problem resolution; improvement of materials, components, systems or processes, engineering operations, maintenance, project management, development and commercialisation.	d) Most of the impacts in the specific discipline are on wider issues, and although occurring frequently, are specifically- defined and can be resolved by following established procedures. e) The work packages and associated parameters are *constrained* by operational context with variations limited to different locations only. (Cannot be covered by laws, standards and codes only). f) Even locally important minor risks can have far reaching consequences. ***Activities*** include but are not limited to: design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; engineering operations; maintenance; project management and general management. For Specifies Category Practitioners, research, development and commercialisation happen more frequently in some disciplines and are seldom encountered in others.
3. Outcomes to be satisfied	**Explanation and Responsibility Level**
Group A: Engineering Problem Solving.	
Outcome 1: Define, investigate and analyse specifically defined engineering problems (tasks	**Responsibility level E** Analysis of an engineering problem means the "separation into parts possibly with comment and judgement".
Level Descriptor: Specifically defined engineering problems have the following characteristics: a) Can be solved mainly by specific practical engineering knowledge, underpinned by related theory; ***and one or more of:*** b) Are fully defined but require feedback; c) Are discrete, specifically focused tasks within engineering systems; d) Are routine, frequently encountered and in familiar specified context; ***and one or more of:*** e) Can be solved by standardized or prescribed ways; f) Are encompassed by specific standards, codes and documented procedures; requires authorization to work outside limits; g) Information is concrete, specific and largely complete, but requires checking and possible supplementation;	a) Practical problems for Specified Category Practitioners mean the problems encountered cannot be solved by artisans because theoretical calculations and engineering decisions are necessary to substantiate the solution proposed; b) Further investigation to identify the nature of the problem is seldom necessary; c) Discrete means *individually distinct*: The problem is easily recognised as part of the larger engineering task, project or operation; d) Recognised that the problem is within the specific scope and occurred in the past, or the work to be done is a standard operation – seldom something new; e) Solving the problem does not require the development of a new solution – find out how it was solved/done before; f) Encompassed means *encircled:* The standards, codes and documented procedures must be obtained to solve the problem and; authorisation from Professionals responsible must be obtained to wave the stipulations; g) The responsibility lies with the Specified Category Practitioner to check that the information received as part of the instruction is correct, and added to as is necessary to ensure the correct and complete execution of the work;

h) Involve specific issues but few of these imposing conflicting constraints and a specific range of interested and affected parties; ***and one or both of:*** i) requires practical judgement in specific practice area in evaluating solutions, considering interfaces to other role- players; j) Have consequences which are locally important but within a specified category (wider impact are dealt with by others).	h) The problem handled by a Specified Category Practitioner must be limited to well know specific matters needing standardised solutions without possible complications; i) Practical solutions to problems include knowledge of the skills displayed by Practical Specialists and Engineering Artisans without sacrificing theoretical engineering principles and / or cutting corners to satisfy parties involved; j) Specified Category Practitioners must realise that their engineering actions might seem to be of local importance only, but may develop into further problems where support from Engineering Professionals might be needed to deal with these consequences.
Competency Indicators: A structured analysis of specifically- defined problems typified by the following performances within the competency area is expected: 1.1 State how you interpreted the work instruction received, checking with your client or supervisor if your interpretation is correct 1.2 Describe how you analysed, obtained and evaluated further clarifying information, and if the instruction was revised as a result.	To perform an engineering task a Specified Category Practitioner will typically receive an instruction from a senior person (customer) to do this task, and must: 1.1 Make very sure that the instruction is complete, clear and within his/her capability and that the person who issued the instruction agrees with his/her interpretation. 1.2 Ensure that the instruction and information to do the work is fully understood and is complete, including the engineering theory needed to understand the task and to carry out and/or check calculations, and the acceptance criteria. If needed supplementary information must be gathered, studied and understood.
Range Statement: The problem (task) may be part of a larger engineering activity or may be stand alone. The design (planning) problem is amenable to solution by specific techniques practiced regularly. This outcome is concerned with the under-standing of a problem: Outcome 2 is concerned with the solution.	**Please refer to clauses 5 to 8 of the applicable Sub-discipline Specific Training Guide, document R-05-EIP-SC**

Outcome 2: Design or develop (plan) sustainable solutions to specifically defined engineering problems (tasks).	**Responsibility level C** Design means "drawing or outline from which something can be made". Develop means "come or bring into a state in which it is active or visible".
Competency Indicators: This outcome is normally demonstrated after a problem analysis as defined in outcome 1. Working systematically to synthesise a solution to a well-defined problem, typified by the following performances is expected: 2.1 Describe how you designed or developed and analysed alternative approaches to do the work. Impacts and sustainability checked. Calculations attached. 2.2 State what the final solution to perform the work was, client or your supervisor in agreement.	The task given must be fully understood and interpreted; solutions developed (designed) to execute. To synthesise a solution means "the combination of separate parts, elements, substances, etc. into a whole or into a system" by: 2.1 The development (design) of more than one way to do an engineering task or solve a problem should always be done, including the costing and impact assessment for each alternative. All the alternatives must meet the requirements set out by the instruction received, and the theoretical calculations to support each alternative must be done and submitted as an attachment. The alternatives must be within the legal boundaries imposed. 2.2 The Specified Category Practitioner will in some cases not be able to support proposals with the complete theoretical calculation to substantiate every aspect, and must in these cases refer his / her alternatives to a Professional for scrutiny and support. The alternatives and alternative recommended must be convincingly detailed to win customer support for the alternative recommended. Selection of alternatives might be based on tenders submitted with alternatives submitted deviating from those specified.
Range Statement: The solution conforms to specific established methods, techniques or procedures within the specifically defined competency area. Engineering should not look only to decrease impacts, but also to restore and regenerate through design.	Applying theory to *specifically defined engineering* work is done in a way that's been used before, probably developed by Professionals in the past, and documented in written procedures, specifications, drawings, models, examples, etc. Specified Category Practitioners must seek approval and engineering verification for any deviation from these established methods.
Outcome 3: Comprehend and apply knowledge embodied in established specific engineering practices and knowledge specific to the field in which he/she practices.	**Responsibility level E** Comprehend means "to understand fully". The jurisdiction in which a Specified Category Practitioner practices is given in Clauses 5 to 8 of the applicable Discipline Specific Training Guide, document R-05-nnn-SC

Competency Indicators: This outcome is normally demonstrated in the course of design, investigation or operations, confined to the competency area. 3.1 State what HCert level engineering standard procedures and systems you used to execute the work, and how HCert level theory was applied to understand and/or verify these procedures. 3.2 Give your own HCert level theoretical calculations and/or reasoning on why the application of this theory is considered to be correct (actual examples).	Design (development) work for Specified Category Practitioners is mostly to utilise, configure, certify, test, verify, etc. manufactured components or proven engineering or management systems, and repetitive design (development) work using an existing design (development) as an example. Specified Category Practitioners apply existing codes, policies and procedures in their design (development) work. Investigations on specifically defined incidents and condition monitoring and operations mostly on controlling, maintaining and improving engineering systems and operations. 3.1 The understanding of specifically defined procedures and techniques must be based on fundamental mathematical, scientific and engineering knowledge. Specific procedures and techniques applied to do the work accompanied by the underpinning theory must be given. 3.2 Calculations confirming the correct application and utilisation of equipment and/or systems listed in the Sub-Discipline-specific Training Guide **R-05-nnn-SC** must be done on practical *specifically defined* activities. Reference must be made to standards and procedures used and how it was derived from HCert level theory.
Range Statement: Applicable knowledge includes: a) Technical knowledge that is applicable to the practice area irrespective of location, supplemented by locally relevant knowledge, for example established properties of local materials. b) A working knowledge of interacting disciplines confined to the competency area. Codified knowledge in related areas: financial, statutory, safety, management and sustainability. c) Jurisdictional knowledge includes legal and regulatory requirements as well as prescribed codes of practice.	a) The specific location of a task to be executed is the most important determining factor in the layout design and utilisation of equipment and/or systems. A combination of educational knowledge and practical experience must be used to substantiate decisions taken including a comprehensive study of laws, policies, procedures, standards, environment, manpower, materials, components and projected customer requirements and expectations. b) In spite of having a working knowledge of interacting disciplines, Specified Category Practitioners must appreciate the importance of working with specialists like Civil Engineers on structures and roads, Mechanical Engineers on fire protection equipment, Architects on buildings, Electrical Engineers on communication equipment, etc. The codified knowledge in the related areas means working to and understanding the requirements set out by specialists in the areas mentioned. c) Jurisdictional in this instance means “having the authority”, and Specified Category Practitioners must adhere to the terms and conditions associated with each task undertaken. They may even be appointed as the “responsible person” for specific duties in terms of the OHS Act.

Group B: Managing Engineering Activities.	Explanation and Responsibility Level
Outcome 4: Manage part or all of one or more *specifically defined* engineering activities.	**Responsibility level E** Manage means "control".
Competency Indicators: The display of personal and work process management abilities within the competency area is expected: 4.1 State how you managed yourself, priorities, processes and resources in doing the work (e.g., bar chart); 4.2 Describe your role and contribution in the work team.	In engineering operations and projects Specified Category Practitioners will typically be given the responsibility to carry out specific tasks and/or complete projects. 4.1 Resources are usually subdivided based on availability and controlled by a work breakdown structure and scheduling to meet deadlines. Quality, safety and environment management are important aspects. 4.2 Depending on the task, Specified Category Practitioners can be the manager, team leader, a team member, or can supervise appointed contractors.
Outcome 5: Communicate clearly with others in the course of specifically defined engineering activities	**Responsibility level E**
Competency Indicators: Demonstrates effective communication by: 5.1 State how you presented your point of view and compiled reports after completion of the work. 5.2 State how you compiled and issued instructions to entities working on the same task	5.1 Refer to Range State for Outcome 4 and 5 below. Presentation of point of view mostly occurs in meetings and discussions with immediate supervisor. 5.2 Refer to Range State for Outcome 4 and 5 below.
Range Statement for Outcomes 4 and 5: Management and communication in *specifically defined engineering* involves: a) Planning activities b) Organising activities c) Leading activities d) Implementing activities, e) Controlling activities. Communication relates to technical aspects and wider impacts of professional work. Audience includes peers, other disciplines, clients and stakeholder's audiences. Appropriate modes of communication must be selected. The Specified	a) Planning means "the arrangement for doing or using something, considered in advance". b) Organising means "put into working order; arrange in a system; make preparations for". c) Leading means to "guide the actions and opinions of; influence; persuade". d) Implementing means to "carry an undertaking, agreement, or promise into effect". e) Controlling means the "means of regulating, restraining, keeping in order; check". Specified Category Practitioners participate in writing or adhere to specifications for the purchase of materials and/or work to be done, recommendation on tenders received, place orders and variation orders, write work instructions, report back on work done, draw, correct and revise drawings, compile test reports, use operation and maintenance manuals to write or apply work procedures, write inspection and audit reports, write commissioning reports, prepare and present motivations for new projects, compile budgets, report on studies done and calculations carried out, report on customer

Category Practitioner is expected to perform the communication functions reliably and repeatedly confined to the competency area,	requirements, report on safety incidents and risk analysis, report on equipment failure, report on proposed system improvement and new techniques, report back on cost control, report on environmental impact and sustainability, etc.

Outcome 6: Recognise the foreseeable social, cultural, environmental and sustainability effects of *specifically defined* engineering activities generally	**Responsibility level D** Social means “people living in communities; of relations between persons and communities”. Cultural means “all the arts, beliefs, social institutions, etc. characteristic of a community”. Environmental means “surroundings, circumstances, influences”. Sustainable is defined in the definitions below.
Competency Indicators: This outcome is normally displayed in the course of analysis and solution of problems within the competency area, by typically: 6.1 Describe the social, cultural, environmental impact and long-term sustainability of this engineering activity. 6.2 State how you communicated mitigating measures to affected parties and acquired stakeholder engagement.	6.1 Engineering impacts heavily on the environment e.g. servitudes, expropriation of land, excavation of trenches with associated inconvenience, borrow pits, dust and obstruction, street and other crossings, power dips and interruptions, visual and noise pollution, malfunctions, oil and other leaks, electrocution of human beings, detrimental effect on animals and wild life, dangerous rotating and other machines, demolishing of structures, etc. 6.2 Mitigating measures taken may include environmental impact studies, environmental impact management, community involvement and communication, barricading and warning signs, temporary crossings, alternative supplies (ring feeders and bypass roads), press releases, compensation paid, etc.

Outcome 7: Meet all legal and regulatory requirements, protect the health and safety of persons and adhere to sustainable practices in the course of his or her specifically defined engineering activities.	**Responsibility level E**
Competency Indicators: 7.1 List the major laws and regulations applicable to this particular activity and how sustainability practices and health and safety matters were handled. 7.2 State how you obtained advice in doing risk management for the work and elaborate on the risk management system applied.	7.1 The OHS Act is supplemented by a variety of parliamentary acts, regulations, local authority by-laws, standards and codes of practice. Places of work might have standard procedures, instructions, drawings and operation and maintenance manuals available. These documents, depending on the situation (emergency, breakdown, etc.) are consulted before work is commenced and during the activity. 7.2 It is advisable to attend a Risk Management (Assessment) course, and to investigate and study the materials, components and systems used in the workplace. The Specified Category Practitioners seeks advice from knowledgeable and experienced specialists if any doubt exist that safety and sustainability cannot be guaranteed.

Range Statement for Outcomes 6 and 7: Impacts and regulatory requirements include: a) Impacts to be considered are generally those identified within the established methods, techniques or procedures used in the specific practice area; b) Regulatory requirements are prescribed; c) Apply prescribed risk management strategies; d) Effects to be considered and methods used are defined; e) Prescribed safe and sustainable materials, components and systems. f) Prescribe maintenance protocols; g) Persons whose health and safety are to be protected are both inside and outside the workplace.	a) The impacts will vary substantially with the location of the task, e.g., the impact of laying a cable or pipe in the main street of town will be entirely different to construction in a rural area. The methods, techniques or procedures will differ accordingly, and is identified and studied by the Specified Category Practitioners before starting the work. b) The Safety Officer and/or the Responsible Person appointed in accordance with the OHS Act usually confirm or check that the instructions are in line with regulations. The Specified Category Practitioners is responsible to see to it that this is done, and if not, establishes which regulations apply, and ensure that they are adhered to. Usually, the people working on site are strictly controlled w.r.t. health and safety, but the Specified Category Practitioners checks that this is done. Tasks and projects are mostly carried out where contact with the public cannot be avoided, and safety measures like barricading and warning signs must be used and maintained. c) Risks are mostly associated with elevated structures, subsidence of soil, electrocution of human beings, moving parts on machinery, fraud and corruption and theft. Risk management strategies are usually done by more senior staff but are understood and applied by the Specified Category Practitioners. d) Effects associated with risk management are mostly well known if not obvious, and methods used to address, clearly defined. e) Usually the safe and sustainable materials, components and systems are prescribed by professionals or other specialists. It is the responsibility of the Specified Category Practitioners to use his/her knowledge and experience to check and interpret what is prescribed and report anything that he/she is not satisfied with. f) Draw up maintenance systems and procedures from Codes of Practice and Manufacturer's Instructions. g) Staff working on the task or project as well as persons affected by the engineering work being carried out.

Group D: Exercise judgment, take responsibility, and act ethically.	**Explanation and Responsibility Leve**
Outcome 8: Conduct engineering activities ethically.	**Responsibility level E** Ethically means "science of morals; moral soundness". Moral means "moral habits; standards of behaviour; principles of right and wrong".
Competency Indicators: Sensitivity to ethical issues and the adoption of a systematic approach to resolving these issues is expected, typified by: 8.1 State how you identified ethical issues and affected parties and their interest and what you did about it when a problem arose.	Systematic means "methodical; based on a system". 8.1 Ethical problems that can occur include tender fraud, payment bribery, alcohol abuse, sexual harassment, absenteeism, favouritism, defamation, fraudulent overtime claims, fraudulent expenses claimed, fraudulent qualifications, misrepresentation of facts, etc.

8.2 Confirm that you are conversant and in compliance with ECSA's Code of Conduct and why this is important in your work.	8.2 ECSA's Code of Conduct, as per ECSA's website, is known and adhered to. Applicable examples given.

Outcome 9: Exercise sound judgement in the course of *specifically defined* engineering activities	**Responsibility level E** Judgement means "good sense: ability to judge".
Competency Indicators: Exhibition of judgement is expected by**:** 9.1 State the factors applicable to the work, their interrelationship and how you applied the most important factors. 9.2 Describe how you foresaw work consequences and evaluated situations in the absence of full evidence.	9.1 The extent of a project or task given to a junior Specified Category Practitioners is characterised by the limited number of factors and their resulting interdependence. He/she will seek advice if educational and/or experiential limitations are exceeded. Examples of the main engineering factors applied must be given. 9.2 Taking risky decisions will lead to equipment failure, excessive installation and maintenance cost, damage to persons and property, bankruptcy, poor service delivery, etc. Give examples.
Range Statement for Outcomes 8 and 9: Judgement is expected both within the application of the candidate's category specific methods, techniques and specific procedures and in assessing their immediate impacts. Judgement in decision making involves: a) taking limited risk factors into account some of which may be ill-defined or b) consequences are in the immediate work contexts; or c) identified set of interested and affected parties with defined needs to be taken into account.	In engineering about 15% of the activities can be classified as *specifically defined* where the Specified Category Practitioner uses standard procedures, codes of practice, specifications, etc. Judgement must be displayed to identify any activity falling outside the *specifically defined* range, as defined above by: a) Seeking advice when risk factors exceed his/her capability. b) Consequences outside the immediate work contexts, e.g. long-term, not normally handled. c) Interested and affected parties with defined needs outside the specifically defined parameters to be taken into account.

Outcome 10: Be responsible for making decisions on part or all of all of one or more *specifically defined* engineering activities	**Responsibility level E** Responsible means "legally or morally liable for carrying out a duty; for the care of something or somebody in a position where one may be blamed for loss, failure, etc."
Competency Indicators: Responsibility is displayed by the following performance: 10.1 Show how you used HCert level theoretical calculations to justify decisions taken in doing engineering work. Attach actual calculations.	10.1 The calculations, for example fault levels, load calculations, losses, return on investment, etc. are done to ensure that the correct material and components are utilized.

10.2 State how you took responsible advice on any matter falling outside your own education and experience. 10.3 Describe how you took responsibility for your own work and evaluated any shortcoming in your output.	10.2 The Specified Category Practitioner does not operate on tasks at a higher level than specifically defined and consult professionals if elements of the tasks to be done are beyond his/her education and experience, e.g., power system stability, legal actions, etc. 10.3 This is in the first instance continuous self-evaluation to ascertain that the task given is done correctly, on time and within budget. Continuous feedback to the originator of the task instruction, and corrective action, if necessary, forms an important element.
Range Statement: Responsibility must be discharged for significant parts of a one or more *specifically defined* engineering activity.	The responsibility is mostly allocated within a team environment with an increasing designation as experience is gathered.
Note 1: Responsibility for the evaluation of work in a supervisory capacity.	

Group E: Initial Professional Development (IPD)	**Explanation and Responsibility Level**
Outcome 11: Undertake independent learning activities sufficient to maintain and extend his or her competence	**Responsibility level D**
Competency Indicators: Self-development managed by typically: 11.1 Provide your strategy adopted independently to enhance professional development. (IPD report); 11.2 Be aware of the philosophy of employer in regard to professional development.	11.1 If possible, a specific field of the sub-discipline is chosen, available developmental alternatives established, a program drawn up (in consultation with employer if costs are involved), and options open to expand knowledge into additional fields investigated. 11.2 Record keeping must not be left to the employer or anybody else. The trainee must manage his/her own training independently, taking initiative and be in charge of experiential development towards Specified Category Practitioner registration level. Knowledge of the employer's policy and procedures on training is essential.
Range Statement: Professional development involves: a) Taking ownership of own professional development; b) Planning own professional development strategy; c) Selecting appropriate professional development activities; and d) Recording professional development strategy and activities; while displaying independent learning ability.	a) This is your professional development, not the organisation you are working for. b) In most places of work training is seldom organised by some training department. It is up to the Specified Category Practitioner to manage his/her own experiential development. Specified Category Practitioners frequently end up in a 'dead-end street' being left behind doing repetitive work. If self-development is not driven by him/herself, success is unlikely. c) Preference must be given to engineering development rather than developing soft skills.

	d) Developing a learning culture in the workplace environment of the Specified Category Practitioner is vital to his / her success. Information is readily available, and most senior personnel in the workplace are willing to mentor, if approached.

Appendix B SUB DISCIPLINE-SPECIFIC REQUIREMENTS REPORT

Form R-05-SDSRR-EIP

Surname and Initials:

Use this form to report in about 100 words per Requirement applicable, on **the applicant's** personal knowledge about the Section (Designer, Maintainer, Consultant, Commissioner and/or Project Manager) and on the type of ENTERPRISE INTEGRATION system selected (1 to 11).

Attach to this report the actual applicable design calculations, sketches, installation schedules, maintenance schedules, commissioning results etcetera for each selection, done by the applicant under the supervision of an ECSA registered competent practitioner.

Example: Applicant ticks "Designer", "Equipment Management" and "Production Order Management" then documentation for Equipment Management Design and Production Order Management Design is required.

Tick off (□) your role and the specific **process** applicable to your registration application:									
Designer		Maintainer		Consultant		Commissioner		Project Manager	

1. Production Operations Management		7. Configuration Management	
2. Inventory Management		8. Document Management	
3. Quality Management		9. Regulatory Requirements Management	
4. Maintenance Management		10. Incidents and Deviation Management	
5. Security Management		11. Project Management	
6. Information Management			

Report designer:

Demonstrate knowledge of Production Operations Management Requirements		
1	**General**	**Reports**
1.1	Reporting on production including variable manufacturing costs.	
1.2	Collecting and maintaining data on production, inventory, manpower, raw materials, spare parts and energy usage.	
1.3	Performing data collection and off-line analysis as required by engineering functions. This may include statistical quality analysis and related control functions.	
1.4	Performing needed personnel functions such as: work period statistics (for example, time, task), vacation schedule, work force schedules, union line of	

	progression and in-house training and personnel qualification.	
1.5	Establishing the immediate detailed production schedule for its own area accounting for maintenance, transportation and other production-related requests.	
1.6	Locally optimising the costs for individual production areas while carrying out the production schedule established by the Level 4 functions.	
1.7	Modifying production schedules to compensate for plant production interruptions that may occur in its area of responsibility.	

2	**Product Definition Management**	**Reports**
2.1	Managing documents such as manufacturing instructions, recipes, product structure diagrams, manufacturing bills, and product variant definitions.	
2.2	Managing new product definitions.	
2.3	Managing changes to product definitions. This may include the ability to route designs and manufacturing bill changes through an appropriate approval process, management of versions, tracking of modifications, and security control of the information.	
2.4	Providing product production rules to personnel or other activities (these may take the form of manufacturing steps, master recipes, machine setup rules, and process flowsheets).	
2.5	Maintaining the feasible detailed production routings for products.	
2.6	Providing the product segment route to manufacturing operations in the level of detail required by manufacturing operations.	
2.7	Managing the exchange of product definition information with Level 4 functions at the level of detail required by the business operations.	
2.8	Optimising product production rules based on process analysis and production performance analysis.	
2.9	Generating and maintaining local production rule sets indirectly related to products, such as for cleaning, startup and shutdown.	

2.10	Managing the Key Performance Indicator (KPI) definitions associated with products and production.	
3	**Production Resource Management**	**Reports**
3.1	Providing personnel, material, and equipment resource definitions. The information may be provided on demand or on a defined schedule, and may be provided to people, to applications, or to other activities.	
3.2	Providing information on resource (material, equipment, or personnel) capability (committed, available, or unattainable). The information is based on the current statuses, future reservations, and future needs (as identified in the production plan and detailed production schedule) and is specific for resources, for defined time spans and process segments. It may include information on current balance and losses to product cost accounting and may be provided on demand or on a defined schedule, and may be provided to people, applications or other activities.	
3.3	Ensuring that requests for acquisition of resources to meet future operational capabilities are initiated.	
3.4	Ensuring that equipment is available for the assigned tasks, and that job titles are correct, and training is current for personnel assigned to tasks (i.e., checking that an equipment sterilisation status is correct (“Clean”) before it is assigned to a production operation).	
3.5	Providing information on the location of resources and assignment of resources to areas of production (i.e., providing a location for a mobile inspection machine that can be used in multiple locations).	
3.6	Coordinating the management of resources with maintenance resource management and quality resource management.	
3.7	Collecting information on the current state of personnel, equipment, and material resources and on the capacity and capability of the resources. Information may be collected based on events, on demand and/or on a defined schedule, and may be collected from equipment, people and/or applications.	

3.8	Collecting future needs such as from the production plan, current production, maintenance schedules, or vacation schedules.	
3.9	Maintaining personnel qualification test result information.	
3.10	Maintaining equipment capability test result information.	
3.11	Managing reservations for future use of resources.	

4	**Detailed Production Scheduling**	**Reports**
4.1	Creating and maintaining a detailed production schedule.	
4.2	Comparing actual production to planned production.	
4.3	Determining the committed capacity of each resource for use by the production resources management function.	
4.4	Obtaining information from maintenance operations management, quality operations management, and inventory operations management.	
4.5	Executing what-if simulations. This task may include activities such as: calculating production lead time or final completion time for each production request provided by Level 4 functions, determining bottle neck resources for each period and ensuring the time of future production availability for particular production (i.e., capable to promise inquiry from a Level 4 system).	

5	**Production Dispatching**	**Reports**
5.1	Issuing production work orders as identified by the schedule.	
5.2	Assigning local resources to production, where these are not identified as part of the detailed production schedule.	
5.3	Releasing local resources to start work orders.	
5.4	Handling conditions not anticipated in the detailed production schedule. This may involve judgment in managing workflow and buffers. This information may have to be communicated to maintenance operations management, quality operations management,	

	inventory operations management and/or production resource management operations.	
5.5	Maintaining status of work orders (i.e., approved, fixed, in process or cancelled).	
5.6	Ensuring that process constraints and ordering below the level of detail of the detailed schedule are met in production. This takes place after the schedule is created but before its elements are executed.	
5.7	Informing detailed production scheduling when unanticipated events result in the inability to meet the schedule requirements.	
5.8	Receiving information from quality operations management that indicates unanticipated conditions that may relate to scheduled events.	
5.9	Receiving information from production resource management about unanticipated future resource availability that may relate to scheduled events.	

6	**Production Execution Management**	**Reports**
6.1	Directing the performance of work, including executing the work order and initiating Level 2 activities.	
6.2	Ensuring that the correct resources (equipment, materials, and personnel) are used in production.	
6.3	Confirming that the work is performed according to the accepted quality standards. This may involve receiving information from quality activities.	
6.4	Ensuring that resources are valid for the assigned tasks (i.e., this may be ensuring that equipment sterilisation status is correct for the assigned operation (e.g., a vessel is “Clean” before use in production) or equipment certifications are current, personnel qualifications are up to date and materials are released for use).	
6.5	Assigning resources under local run time control (i.e., the assignment of units to a batch, if the detailed production schedule does not define unit allocation).	
6.6	Informing other activities when unanticipated events result in the inability to meet the work requirements.	

6.7	Receiving information from production resource management about unanticipated future resource availability.	
6.8	Providing production information and events on production execution management, such as timing, yields, labour and material used, start of runs and completion of runs.	

7	**Production Data Collection**	**Reports**
7.1	Collecting, retrieving and archiving information related to the execution of production equipment and information entered by production personnel (i.e., this could include process data, equipment status data, lot and sub-lot location and amount data collection, operations logs (plant entries and comments)).	
7.2	Providing interfaces to the basic process or manufacturing line control system, laboratory information management systems, and production management systems for automatic collection of information	
7.3	Providing standardised or on-demand reports for operations and manufacturing personnel.	
7.4	Maintaining information for local process and production analysis and for reporting to higher-level logistics systems.	
7.5	Maintaining information for product tracking to enable tracking and tracing capability such as tracing products to specific material lots, equipment and/or operators.	
7.6	Providing compliance monitoring and alarm management functionality (event logging and sequence of events).	
7.7	Providing product quality information for comparison against specifications.	

8	**Production Tracking**	**Reports**
8.1	Following the movement of material through a plant by maintaining a description of what was in each vessel at specific times and tracing the path of all materials within the production domain.	

8.2	Recording the start and end of movements and collecting updates to lot and sub-lot quantities and locations as they occur.	
8.3	Receiving information from production data collection and production analysis; for example, information on materials consumed in the production of a lot (an important part of the product tracking and tracing) and information on plant environmental conditions during the production of the lot.	
8.4	Translating process events, including production and movement events, into product information.	
8.5	Providing information for tracking (recording) and tracing (analysis).	
8.6	Generating production responses and production performance information. The information may be provided on demand or on a defined schedule, and may be provided to people, applications or other activities.	
8.7	Generating electronic records related to the production process. This may include records required for regulatory or quality management purposes.	

9	**Production Performance Analysis**	**Reports**
9.1	Producing reports of performance and cost.	
9.2	Evaluating constraints to capacity and quality.	
9.3	Performing performance tests where necessary to determine capacity.	
9.4	Comparing different production lines and creating average or target runs.	
9.5	Comparing and contrasting one run against another.	
9.6	Comparing production runs to identify “golden” runs (note: “golden” runs are runs that are the best run ever produced, where best may be the highest quality, lowest cost or any other criteria).	
9.7	Determining why the “golden” runs are exceptional.	
9.8	Comparing runs against defined “golden” runs.	

9.9	Providing changes to process and procedures based on the results of the analysis for continuing process improvements.	
9.10	Predicting the results of a production run, based on the current and past performance. This may include the generation of production indicators.	
9.11	Correlating the product segments with process conditions at the time of production.	
9.12	Key performance measurements.	

2. Inventory Operations Management

1.	Demonstrate knowledge of Inventory Operations Management	Reports
1.1	Manage and track the inventory of product and/or material (material may be production materials, maintenance materials, quality materials or any other material that needs to be tracked and managed).	
1.2	Perform periodic and / or on demand inventory cycle counts	
1.3	Manage the transfer of material between work centres.	
1.4	Measure and report on inventory and material transfer capabilities.	
1.5	Coordinate and control the personnel and equipment used in material transfer.	

2.	Inventory Definition Management Activities	Report
2.1	Managing information about how to transfer materials (i.e., this could be handling instructions and warehouse storage restrictions. For example, there may be specific handling instructions on how to handle specific toxic materials during material transfers or specific handling restrictions for controlled or regulated substances).	
2.2	Managing new inventory definitions.	
2.3	Managing changes to inventory definitions. This may include the ability to route changes through an appropriate approval process, management of	

	definition versions, tracking of modifications and security control of the definitions	
2.4	Providing inventory definitions to other applications, personnel or activities (i.e., managing information about location where storage materials usually stay, appropriate range of volume of the storage material, strategies of inventory operations that are sent to dispatching or detail scheduling activities.	
2.5	Managing the exchange of inventory definition information with Level 4 functions, at the level of detail required by the business operations.	
2.6	Optimising inventory definitions based on quality test analysis.	
2.7	Managing the Key Performance Indicator (KPI) definitions associated with inventory tests.	

3	**Inventory Resource Management**	**Report**
3.1	Providing personnel, material, and equipment resource definitions. The information may be provided on demand or on a defined schedule and may be provided to people, applications or other activities. These resources include transfer equipment (i.e., conveyors, fork lifts, trucks, railcars, valve arrays, pipes, ASRS (Automated Storage and Retrieval Systems), containers, AGV (Automated Guided Vehicles), storage location control equipment, such as heating or cooling control, positive or negative pressure control, ventilation (flow rate, humidity and particulate level) control, and electrostatic grounding), storage equipment (i.e., includes tanks, silos, containers, pallets, stock area of stocker machines, shelves and so on. Some equipment has specific ranges of capacity in terms of physical constraint and/or operational efficiency, personnel (i.e., management of skill sets, certifications, authorisations, and security clearances), material and energy used in the movement (i.e., disposable consumables like gloves, gowns, masks and ink).	
3.2	Providing information on resource capability (committed, available, or unattainable). The information is based on the current statuses, future reservations and future needs and is specific for resources and for defined time spans. It may be provided on demand or on a defined	

	schedule, and may be provided to people, applications or other activities.	
3.3	Managing stock sizes and using other means to control the amount of inventory required to meet business requirements and production requirements.	
3.4	Ensuring that requests for acquisition of resources to meet future capabilities are initiated.	
3.5	Ensuring that equipment is available for the assigned tasks, job titles are correct and training is current for personnel assigned to tasks.	
3.6	Providing information on the location of resources and assignment of resources to areas (i.e., providing a location for a forklift truck and its assignment to a movement work order).	
3.7	Collecting information on the current state of personnel, equipment, and material resources and on the capacity and capability of the resources. Information may be collected based on events, on demand and/or on a defined schedule, and may be collected from equipment, people and/or applications.	
3.8	Collecting future needs such as the production plan, current production, maintenance schedules or vacation schedules.	
3.9	Maintaining personnel qualification test information.	
3.10	Maintaining equipment capability test information.	
3.11	Managing reservations for future use of resources.	

4	**Detailed Inventory Scheduling**	**Report**
4.1	Creating and maintaining a detailed inventory schedule (i.e., scheduling and optimisation of pallet loading, optimising pick order from a warehouse, scheduling material movement equipment (forklift trucks), or determining pumping and valve arrangements, may also define movement schedules to avoid exceeding storage capacity, and to avoid exceeding environmental capabilities and capacities of storage locations).	
4.2	Comparing actual movements to planned movements.	
4.3	Determining the committed capacity of each resource for use by the inventory resource management function.	

	This information may include location of empty storage, time and route to move to the location.	
4.4	Creating inventory work orders in accordance with inventory requests from Level 4 functions.	
4.5	Determining future assignment of inventory work orders to storage zones and storage units. This task may include a decision on location of material.	
4.6	Determining start time and completion time of inventory work orders with respect to future capacity of storage resource, future availability of transfer resources, and future amount of available inventory material.	
4.7	Determining lot size of each inventory transfer order by splitting or merging inventory transfer requests with respect to constraints of the transfer resources. Constraints may include cost, capacity and due time of the corresponding inventory movement.	

5	**Inventory Dispatching**	**Report**
5.1	Assigns and sends inventory work orders to the appropriate inventory resources.	

6	**Inventory Execution Management**	**Report**
6.1	Directing the performance of work, including executing the work order and initiating Level 2 activities (i.e., when material movement is performed manually, inventory execution management activities include displaying specific work instructions to inventory personnel).	
6.2	Have the responsibility to ensure that the correct resources (equipment, material, and personnel) are used in inventory operations.	
6.3	Have the responsibility to ensure that work order procedures and regulations are followed during the transfer operations.	
6.4	Have the responsibility to document the status and results of the work performed.	
6.5	Have the responsibility to inform transfer dispatching and/or detailed transfer scheduling when unanticipated events result in the inability to meet the work requirements.	

6.6	Confirm that the work was accomplished according to the accepted quality standards.	
6.7	Verify that equipment and personnel certifications are valid for the assigned tasks.	
6.8	Verify the actual volume or quantity of particular item of inventory materials, by means of special equipment or manual operations. This task may be performed on demand or on a defined schedule provided by accounting activities as well as the detailed inventory scheduling.	

7	**Inventory Data Collection**	**Report**
7.1	Gather and report data on inventory operations and materials manipulated.	
7.2	Maintaining information for product tracking such as tracking storage used, storage conditions, equipment used in storage, and operators involved in storage and transfer.	
7.3	Maintaining information for quality tracking such as samples or reference materials produced.	
7.4	Maintaining information for maintenance tracking such as spare parts consumed.	
7.5	This information may be required for regulatory control and may have to be integrated with production data (i.e., silo or tank inventory and movement data collection, lot and sub-lot location and amount data collection, material balances and reconciled data, location of WIP, records of positive pressure in a storage building).	

8	**Inventory Tracking**	**Report**
8.1	Reports on relative transfer efficiencies and utilization of the resources used in inventory.	
8.2	Recording the start and end of movements and collecting updates to lot and sub-lot quantities and locations as they occur.	
8.3	Generates or updates records related to the transfer of material and management of the material stored (may	

	include records required for regulatory or quality management purposes).	
8.4	Provides an inventory response to Level 4 activities requesting inventory information.	

9	Inventory Analysis	Report
9.1	Analyse inventory efficiencies and resource usage in order to improve operations.	
9.2	Provides information on received material quality and time for use in supplier evaluations.	
9.3	Provides information on waste due to improper storage.	
9.4	Provides information on movement by location, equipment, or shift.	
9.5	Detects resource bottlenecks.	
9.6	Resource traceability analysis. Traces the history of all resources in terms of the inventory actions and events that dealt with the resources, which includes which materials were used in inventory activities; which equipment was used in inventory activities; which personnel were involved in inventory activities.	
9.7	Inventory Indicators. Provides summaries of past performance and indications of future performance or potential future problems.	

3. Quality Operations Management

1	General	Reports
1.1	Testing and verifying the quality of materials (raw, final and intermediate).	
1.2	Measuring and reporting the capability of the equipment to meet quality goals.	
1.3	Certifying product quality.	
1.4	Setting standards for quality.	
1.5	Setting standards for quality personnel certification and training.	
1.6	Setting standards for control of quality.	

2	Quality Test Definition Management	Reports
2.1	Managing new quality test definitions.	
2.2	Managing changes to quality test definitions. This may include the ability to route changes through an appropriate approval process, management of definition versions, tracking of modifications, and security control of the definitions.	
2.3	Providing quality test definitions to other applications, personnel or activities.	
2.4	Managing the exchange of quality test definition information with Level 4 functions, at the level of detail required by the business operations.	
2.5	Optimizing quality test definitions based on quality test analysis.	
2.6	Generating and maintaining quality test definitions not related to product, such as for test equipment validation and standard sample validation.	
2.7	Managing the Key Performance Indicator (KPI) definitions associated with quality tests.	

3	Quality Test Resource Management	Reports
3.1	Providing quality personnel, material, and equipment resource definitions. The information may be provided on demand or on a defined schedule, and may be provided to people, to applications, or to other activities. These resources include test material (includes material that is consumed during the execution of a test, test equipment (includes equipment used for on-line, off-line, and at-line testing) and personnel (includes management of such attributes as skill sets, certifications, authorisations and security clearances).	
3.2	Providing information on resource capability (committed, available or unattainable). The information is based on the current statuses, future reservations, and future needs and is specific for resources and for defined time spans. It may be provided on demand or on a defined schedule, and may be provided to people, applications or other activities (i.e., a qualified scanning	

	electron microscope may be unattainable for third shift in January due to planned maintenance on the equipment).	
3.3	Ensuring that requests for acquisition of resources to meet future test capabilities are initiated.	
3.4	Ensuring that equipment is available for the assigned tasks, job titles are correct and training is current for personnel assigned to tasks.	
3.5	Providing information on the location of resources and assignment of resources to areas (i.e., providing a location for a mobile test machine that can be used in multiple locations).	
3.6	Collecting information on the current state of personnel, equipment, and material resources and on the capacity and capability of the resources. Information may be collected based on events, on demand and/or on a defined schedule, and may be collected from equipment, people and/or applications.	
3.7	Collecting future needs such as the production plan, current production, maintenance schedules, or vacation schedules.	
3.8	Maintaining test personnel qualification test information.	
3.9	Maintaining test equipment capability test information.	
3.10	Managing reservations for future use of quality test resources.	

4	**Detailed Quality Test Scheduling**	**Reports**
4.1	Creating and maintaining a detailed quality test schedule.	
4.2	Comparing actual test execution to planned test execution.	
4.3	Determining the committed capacity of each resource for use by the quality test management function.	

5	**Quality Dispatching**	**Reports**
5.1	Assign and sends quality work orders to the appropriate resources.	

5.2	Communicates the test to be run and the resources to be used and may include sending material to the testing resource for testing.	

6	Quality Test Execution Management	Reports
6.1	Directs the performance of testing.	
6.2	Ensures that the correct resources (equipment, materials, and personnel) are used. It also includes the confirmation that the quality test is performed according to the accepted quality standards and that the product can be released (within specified conditions).	
6.3	"In-Line" Testing. Performed by a machine or device integrated in the production equipment whereby the results are available immediately.	
6.4	"At-Line" Testing. Taken out of the production stream and where the production operator at the production line performs the inspection. May take a limited amount of time (seconds/minutes), allowing the process to quickly continue.	
6.5	"Off-Line" Testing. Taken out of the production execution and where the inspection is performed in the laboratory by a lab analyst. Results are not immediately available (minutes, hours, days).	
6.6	"Pass/Fail" Testing. Tells if the result of the test is acceptable (pass) or not acceptable (fail).	
6.7	"Measurement" Testing. Determines a measured value for one or more properties.	
6.8	"Retesting" Testing. Depending on the tests involved, there may be procedures that dictate whether or not there must be a re-test, a re-sample, or some other verification that the test was performed correctly and on the right sample.	
6.9	"Blind-Sample" Testing. Quality requests are often performed on known reference samples, or on “blind samples,” which are materials with known characteristics. Blind samples are typically analysed without knowledge that the samples are tests to validate test instruments and test procedures, and as a test of test-personnel performance and consistency. Tests on reference samples and blind samples are a	

	common method for testing the quality of quality assurance operations.	

7	Quality Test Data Collection	Reports
7.1	Collects test results and makes these results available (may include manually entered data or from instruments).	
7.2	Provides standardised or on-demand reports for manufacturing personnel.	

8	Quality Test Tracking	Reports
8.1	Assembles test results into test responses, send the responses, and manage the information about the utilisation of resources required to perform tests.	
8.2	Provides feedback about quality to Level 3 and Level 4 systems.	
8.3	Tracking of tests that may be done at different times and at different parts of the plant.	

9	Quality Performance Analysis	Reports
9.1	Analyses quality test results and testing performance in order to determine how to improve product quality.	
9.2	Analysis of quality variability, quality department cycle times, resource utilization, equipment utilisation, and procedure efficiencies. Quality performance analysis is often a continuous business process.	
9.3	Analyses production data for trends of critical quality indicators.	
9.4	Determines the accuracy of the quality tests execution. This includes evaluation of repeatability, suitability and efficiency of test methods.	
9.5	Determines the cause of quality analysis problems.	
9.6	Recommends actions to correct identified problems, including correlating the symptoms, actions and results.	
9.7	Provides information for use in supplier evaluations.	

9.8	Quality resource traceability analysis. Traces the history of all resources in terms of the quality actions and events that dealt with the resources, which includes which materials were used in quality activities; which equipment was used in quality activities; which personnel were involved in quality activities.	
9.9	Quality Indicators. Provides summaries of past performance and indications of future performance or potential future problems.	

4. Maintenance Operations Management

1	General	Reports
1.1	Providing maintenance responses to equipment problems (i.e., corrective maintenance & reactive maintenance response).	
1.2	Scheduling and performing maintenance on a periodic cycle based on time or cycles (i.e., preventive maintenance).	
1.3	Providing condition-based maintenance derived from information obtained from the equipment or inferred about the equipment (i.e. condition-based maintenance & predictive maintenance).	
1.4	Optimising resource operating performance and efficiencies.	

2	Maintenance Definition Management	Reports
2.1	Managing documents such as maintenance instructions, vendor documentation, CAD drawings, database records and analysis tools.	
2.2	Managing new maintenance definitions.	
2.3	Managing changes to maintenance definitions. This may include the ability to route changes through an appropriate approval process, management of definition versions, tracking of modifications and security control of the definitions.	
2.4	Providing maintenance definitions to other applications, equipment, personnel or activities.	
2.5	Managing the exchange of maintenance definition information with Level 4 functions, at the level of detail required by the business operations.	
2.6	Optimising maintenance definitions based on maintenance analysis.	
2.7	Generating and maintaining maintenance definitions not related to production equipment, such as for maintenance of maintenance equipment and validation of maintenance equipment.	
2.8	Managing the KPI definitions associated with maintenance.	

2.9	Managing maintenance definitions related to safety and environmental procedures.	
3	**Maintenance Resource Management**	**Reports**
3.1	Maintaining information about maintenance personnel, including qualification information, such as qualification status and qualification test results, as defined in the Part 1 and Part 2 personnel model.	
3.2	Maintaining information about equipment used in maintenance and equipment capability tests, as defined in the Part 1 equipment model.	
3.3	Maintaining information about maintenance supplies, defined as consumable materials, as described in the Part 1 material model.	
3.4	Maintaining information about the health and state, assignment, and availability status of resources to be used and being used in all Level 3 maintenance activities.	
3.5	Coordinating and monitoring contracted work.	
3.6	Supervising requested maintenance.	

4	**Detailed Maintenance Scheduling**	**Reports**
4.1	Reviewing maintenance requests.	
4.2	Confirming or denying the maintenance request.	
4.3	Determining the priority of the request and the level of effort and availability of all resources.	
4.4	Scheduling the maintenance request to be performed within a detailed maintenance schedule as one or more maintenance work orders.	
4.5	Coordinating planned work with operators and plant supervision.	

5	**Maintenance Dispatching**	**Reports**
5.1	Assign and send work orders for execution to maintenance resources.	
5.2	Communicate task to be performed and resources to be used.	

5.3	Dispatch work to employees and/or contractors.	

6	Maintenance Execution Management	Reports
6.1	Ensure maintenance procedures and regulations are followed during maintenance activities.	
6.2	Document the status and results of the work performed.	
6.3	Inform maintenance dispatching and/or detailed maintenance scheduling when unanticipated events result in the inability to meet the work requirements.	
6.4	Confirm the work was performed according to the accepted quality standards. This may involve receiving information from quality operations that indicated an unanticipated condition.	
6.5	Ensure the correct resources are used in maintenance.	
6.6	Verify that equipment and personnel certifications are valid for the assigned tasks.	
6.7	Assisting with product changeover needs that involve equipment changes.	

7	Maintenance Data Collection	Reports
7.1	Summarises and reports on the information and events related to the disposition of the maintenance work order.	
7.2	Information may include current status, time required, time started, current time, time estimated to completion, actual time, resources used and additional information to present an entire maintenance history for the existing work order and earlier work orders.	

8	Maintenance Tracking	Reports
8.1	Manages the information about the utilisation of resources to perform maintenance activities and the relative effectiveness of the results of the maintenance activity.	
8.2	Generates or updates records related to the maintained equipment condition and usability. This may include records required for regulatory or quality management purposes.	

8.3	Tracks the state of the equipment used to perform the maintenance.	

9	Maintenance Analysis	Reports
9.1	Examines the personnel, equipment and material history to identify problem areas or areas for improvement.	
9.2	Identifying equipment conditions such as what equipment may fail if it does not receive maintenance intervention; what intervention should be taken and how soon; where routine preventive maintenance activities can be reduced; where efforts can be focused to improve return on assets (ROA) by eliminating costly or repetitive failures.	
9.3	Assists operations and production planning in identifying conditions such as should any adjustments be made to the process to prolong the life of critical plant assets; at what level can production continue without incurring an unacceptably high risk of process slowdown, downtime, quality problems, or safety shutdowns; what is the probability of successfully producing a specified amount of product in a period of time.	
9.4	Resource traceability analysis, which traces the history of all resources in terms of the maintenance actions and events that dealt with the resources. This may include such information as which materials were used in maintenance activities; which tools were used in maintenance activities, and which equipment was maintained; which personnel were involved in maintenance activities; developing maintenance cost and performance reports; reporting on performed maintenance, including spare parts used, maintenance labour, and maintenance costs.	
9.5	Maintenance Indicators. Provides summaries of past performance and indications of future performance or potential future problems.	

5. Other Manufacturing Operations Requirements

1	Management of Security	Reports
1.1	Manages physical (site and area) security, information security, and computer security.	
1.2	Ensures that only authorised personnel may make changes or affect manufacturing in certain ways.	
1.3	Manages physical security to limit access to facilities, control of information flows out of a facility to protect intellectual property, and control of communications to ensure that unauthorised remote access does not affect operations.	
1.4	When policies and procedures for management of security do not exist on a company wide basis, then security control can be considered a manufacturing operations activity, for manufacturing security.	

2	Management of Information	Reports
2.1	Management of information storage, transmission, backup, recovery, and redundancy. These are often corporate-level functions that follow corporate, industry, national, or international standards.	
2.2	When policies and procedures for management basis, then information control can be considered a manufacturing operations activity, for manufacturing information.	

3	Management of Configuration	Reports
3.1	Manages configuration management and change control procedures that should be considered in manufacturing operations. This function may be required any place there is a semi-permanent data storage and actions can be taken based on the stored data. Often audit trails and revision management procedures are required.	
3.2	Manages the processes and procedures necessary to implement changes to configuration elements that may comprise the production operations which includes identification, surveillance and control of changes to these configurable items. This includes but is not limited	

	to equipment hardware identification and change procedures; Level 2 and Level 3 software identification and change procedures; data and record management for Level 2 and Level 3 records; version control of the configuration elements.	
3.3	Manages change control processes or procedures by which changes are initiated and managed including requests for change; analysis of the change request; impact analysis of the change; approval of the change; implementation of the change; review and approval of the change implementation; monitoring of the change.	
3.4	When policies and procedures for management of configurations do not exist on a company wide basis, then configuration control can be considered a manufacturing operations activity, for manufacturing configurations.	

4	**Management of Documents**	**Reports**
4.1	Manages documents such as SOPs (Standard Operating Procedures), work instructions, recipes, control system programs, drawings, batch records, engineering change notices, alarm logs, and exception reports. Management of this information is often required for regulatory, environmental, health and safety or certification reasons. Generally, companies have a set of procedures, policies, and software tools in place to manage all corporate documents.	
4.2	Manages disaster recovery plans/procedures.	
4.3	Contain documentation on core manufacturing processes.	
4.4	When policies and procedures for management of documents do not exist on a company-wide basis, then document control can be considered a manufacturing operations activity, for manufacturing documentation.	

5	**Management of Regulatory Compliance**	**Reports**
5.1	Employee tracking	
5.2	Industrial hygiene management	
5.3	Occupational health and safety	
5.4	Material safety data sheet authoring and labelling	

5.5	Trade & shipping tracking and compliance	
5.6	Facilities management	
5.7	Equipment safety incident tracking and prevention	
5.8	Air, waste, and water emissions tracking	
5.9	Chemical inventory management	
5.10	Hazardous materials tracking	

6	**Management of Incidents and Deviations**	**Reports**
6.1	Detecting deviation in the manufacturing process under normal conditions and recording the response to the deviation.	
6.2	Measures differences between an observed value and an expected or normal value, or an anomaly from a documented standard or process.	
6.3	Measures differences between an observed value and an expected or normal value, or an anomaly from a documented standard or process.	
6.4	Determines of the root cause of the deviation and may lead to corrective actions to remove the source of the deviation.	
6.5	Manages and records corrective actions, typically in response to an incident, deviation, or failure. Records the result of the corrective action.	
6.6	Identifies clear, appropriate, and implementable corrective actions at the conclusion of any investigation.	
6.7	Manages tracking and follow-ups ensuring that the corrective actions are implemented and verified.	
6.8	Includes improving procedures, adding maintenance procedures for equipment or implementing retest or revalidation procedures.	
6.9	Manages recommended actions which are predefined sets of actions to occur in the event of an incident or deviation.	
6.10	When policies and procedures for management of regulatory compliance do not exist on a company-wide basis, then compliance control can be considered a	

	manufacturing operations activity, for manufacturing compliance.	

Signature of Applicant:_____Date:

Signature of Mentor / Supervisor:_____

Name of Mentor/Supervisor printed: **Tel. No.:**