

SQA Advanced Unit Specification

General information for centres

Unit title: Supervisory Control and Data Acquisition (SCADA)

Unit code: HV6C 47

Unit purpose: This Unit is designed to enable candidates to gain knowledge and understanding and apply supervisory control and data acquisition to industrial process measurement and control systems. The Unit also provides the candidate with the opportunity to develop practical configuration skills to enable them to apply SCADA to specified industrial systems.

On completion of the Unit candidates should be able to:

- 1 Explain the components and communications used in SCADA systems.
- 2 Apply methods of interfacing, alarms and trends.
- 3 Apply networking, fault tolerance and system configuration.
- 4 Apply SCADA features to a given specification.

Credit points and level: 1 SQA Credit at SCQF level 7: (8 SCQF credit points at SCQF level 7*).

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from National 1 to Doctorates.*

Recommended prior knowledge and skills: Access to this Unit will be at the discretion of the centre and the following recommendations are for guidance only. Candidates should have a basic knowledge of Measurement and Control Engineering. This may be evidenced by the possession of Higher Process Measurement or Higher Process Control or NQ units in Measurement and Control or NC Measurement and Control or NC Multidisciplinary Engineering.

Core Skills: There are opportunities to develop the Core Skills of Written Communication (Writing) and Written Communication (Reading) at SCQF level 5 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Context for delivery: If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

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Assessment: The assessment for Outcomes 1, 2 and 3 could be assessed separately of one hour duration OR alternatively combined together into a written assessment paper. The combined paper should be taken by candidates at one single assessment event and should last approximately two hours. The assessment paper should be composed of a balance of short answer, restricted response and structured questions. This assessment singly or combined should be conducted under controlled supervised conditions. Outcome 4 should be assessed as a practical assignment where candidates apply SCADA - methods to a specified industrial measurement and/or control system.

The assignment should involve operating a networked (Ethernet) system where remote measurement and/or control data is acquired via remote terminal units and displayed on visual display units. This data could be alarms, trends, controller tuning constants or system responses. Candidates should complete this assignment in 10 hours.

Candidates should have access to a networked measurement and control laboratory, with PCs, remote terminal units and relevant network/SCADA/ OPC software.

The combined written assessment and practical assignment should be carried out towards the end of the Unit delivery. Candidates must achieve all minimum evidence specifications for each Outcome in order to pass the Unit.

Unit specification: statement of standards

Unit title: Supervisory Control and Data Acquisition (SCADA)

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The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Explain the components and communications used in SCADA systems

Knowledge and/or skills

- ◆ Centralised as opposed to distributed processing and their component parts
- ◆ Client server approach and large SCADA applications
- ◆ Redundancy — the weak link, dual server, dual LAN and PLC redundancy
- ◆ System response times
- ◆ Expandability and MMIs
- ◆ Remote terminal units (RTUs) and communication links eg analogue, digital, fibre optic and radio/satellite

Evidence Requirements

Evidence for the knowledge and/or skills in this Outcome will be provided on a sample basis.

The evidence may be provided in response to specific questions.

Each candidate will need to demonstrate that they can answer questions based on a sample of the items shown above.

In any assessment of this Outcome four out of six knowledge and/or skills should be sampled.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample of four out of six knowledge and/or skill items is required each time the Outcome is assessed.

Candidates must provide a satisfactory response to all four items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ explain with the aid of a sketch centralised as opposed to distributed processing
- ◆ explain client server approach and large SCADA applications
- ◆ explain redundancy, dual server, dual LAN and PLC redundancy
- ◆ explain system response times

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- ◆ explain expandability and MMIs
- ◆ explain RTUs and their communication links

Evidence should be generated through assessments undertaken in controlled supervised conditions.

Assessment guidelines

Assessment should be conducted under closed book conditions and as such candidates must not be allowed any text books, handouts or notes in the assessment.

This Outcome can be assessed separately or integrated with Outcomes 2 and 3. The assessment paper should be composed of a suitable balance of short answer, restricted response and structured questions. This assessment should be conducted under controlled, supervised conditions and should last approximately two hours.

Outcome 2

Apply methods of interfacing, alarms and trends

Knowledge and/or skills

- ◆ Compatible protocols and DDE drivers supported with driver toolkit
- ◆ Interface RTUs and loop controllers, OPC to specify interfaces and logical objects
- ◆ Client server architecture, time stamped alarms and alarms in chronological order, historical alarms and event logging
- ◆ Display of alarms by category and dynamic allocation of alarm pages with event alarms
- ◆ Client server architecture, true trend points and event based trends
- ◆ Real time multi-trending, frequency of monitoring and archiving historical trends

Evidence Requirements

Evidence for the knowledge and skills in this Outcome will be provided on a sample basis.

The evidence may be provided in response to specific questions.

Each candidate will need to demonstrate that they can answer questions based on a sample of the items above. In any assessment of this Outcome four out of six knowledge and/or skills items should be sampled.

In order to ensure that the candidates will not be able to foresee what knowledge and/or skills they will be questioned on, a different sample of four of the six knowledge and/or skills is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all items. Where sampling takes place a candidates response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ explain protocols and the drivers supported
- ◆ apply interfaces to RTUs, control loops, and OPC
- ◆ explain client server architecture and alarming methods
- ◆ explain alarm categories and dynamic allocation with event alarms
- ◆ explain client server architecture, true and event based trends
- ◆ apply real time multi-trending and trend archives

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Evidence should be generated through assessments undertaken under controlled supervised conditions.

Assessment guidelines

Assessment should be conducted under closed book conditions and as such candidates must not be allowed any text books, handouts or notes in the assessment.

This Outcome can be assessed separately or integrated with Outcomes 1 and 3. The assessment paper should be composed of a suitable balance of short answer, restricted response and structured questions. Practical evidence may be acquired from the application of an interface unit to RTUs and/or controller. This assessment should be conducted under controlled, supervised conditions and should last approximately two hours.

Outcome 3

Apply networking, fault tolerance and system configuration

Knowledge and/or skills

- ◆ Compatible networks such as NetWare, LAN manager, Windows for works groups and Windows NT/2000
- ◆ Support protocols eg TCP/IP, IPX/SPX and NetBEUI
- ◆ Dual network for full LAN redundancy and LAN learning based on number of users
- ◆ Support for primary/secondary equipment configurations
- ◆ Intelligent redundancy, mirrored: I/O devices, trend servers and alarm servers
- ◆ Open architecture and access to tag, trend alarm and report from any node
- ◆ Client server applications to exchange data between field devices, control applications and business/office applications (OPC)

Evidence Requirements

Evidence for the knowledge and/or skills in this Outcome will be provided on a sample basis.

The evidence may be provided in response to specific questions.

Each candidate will need to demonstrate that they can answer questions based on samples of the items above. In any assessment of this Outcome five out of seven knowledge/skills should be sampled.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different five out of seven knowledge and/or skills is required each time the Outcome is assessed. Candidates must provide a satisfactory response to all five items.

When sampling takes place a candidate response can be judged satisfactory where evidence provided is sufficient to meet the requirement for each item by showing that the candidate is able to:

- ◆ explain compatible networks
- ◆ apply support protocols
- ◆ apply dual network for full LAN redundancy and LAN learning based on the number of users
- ◆ explain support for primary/secondary equipment configurations
- ◆ apply intelligent redundancy, mirrored I/O devices, trend server devices and alarm servers
- ◆ explain methods of open architecture and access to tag, trend alarm and report from any node

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- ◆ apply methods of client server application to exchange data between field devices, control applications and business/office, applications of OPC

Assessment guidelines

Assessment should be conducted under closed book conditions and as such candidates must not be allowed any text books, handouts or notes in the assessment.

This Outcome can be assessed separately or integrated with Outcomes 1 and 2. The assessment paper should be composed of a suitable balance of short answer, restricted response and structured questions.

This assessment should be conducted under controlled, supervised conditions and should last approximately two hours.

Outcome 4

Apply SCADA features to a given specification

Knowledge and/or skills

- ◆ Preparation of a networked SCADA system with RTUs
- ◆ Configuration of network and RTUs to input analogue (4-20mA) signal data OR (4-20mA) input/output data from a PID controller
- ◆ Verify correct system operation to alarm/trend and/or record system response

Evidence Requirements

This is a practical Outcome and all the knowledge/skills should be assessed. The evidence should be presented in response to a practical assignment where the candidate is set the task of applying a SCADA system to the data acquisition of a process measurement OR process PID controller.

A candidate response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ correctly set up the network with support protocols
- ◆ correctly configure the RTU as an analogue 4-20mA input to alarm/trend OR as a PID controller with 4-20mA input/output to control a process variable to tuned specification AND demonstrate correct operation of the system to alarm/trend a process measured value OR for a PID controller to record system responses to input changes respectively
- ◆ produce a report that includes the following:
 - description of the RTU device
 - explanation of the network/system operation
 - explanation of alarm/trend OR PID control/tuning using SCADA
 - record of screen displays of alarms/trends/system response

The RTU should be able to input a real time process variable e.g. pressure, temperature, level or flow and be configured to the SCADA software via an Ethernet OR the RTU should be a real time process PID controller which is able to control either a pressure, temperature, level or flow and be configured to the SCADA software via an Ethernet link to download controller constants/alarms/set point changes and upload system responses/alarms.

Candidates should have access to relevant notes and reference material for the safe/correct operation of the network, RTU and software.

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Centres should provide the candidate with details of the required report format which should include as a minimum the items listed in evidence requirements bullet point four.

Candidates are not required to produce their reports under controlled supervised conditions and centres should make reasonable effort to ensure that reports are the candidates own work.

Assessment guidelines

This Outcome should be assessed at the end of the Unit delivery. The time allocated is 10 hours in total. It is recommended Centres develop checklists to support the assessment requirements for each of the knowledge and/or skills.

Centres can choose to issue candidates either with different process measured variables OR different process control specifications OR the same in every case.

If the same process measurement/control specification is given to each candidate then the specification should be such that each candidate is required to interpret it and offer his/her unique design solution.

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Administrative information

Unit code:	HV6C 47
Unit title:	Supervisory Control and Data Acquisition (SCADA)
Superclass category:	CB
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History of Changes:

Version	Description of change	Date

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Unit specification: support notes

Unit title: Supervisory Control and Data Acquisition (SCADA)

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this Unit

The Unit has been written in order to allow candidates to develop knowledge, understanding and skills in the following areas:

- 1 The components and communications used in SCADA systems.
- 2 The application of interfacing, alarms and trends.
- 3 The application of networking, fault tolerance and configuration.
- 4 The application of SCADA features to a process measurement and control.

The Unit is at SCQF level 7 and has been developed as part of the SQA Advanced Certificate/Diploma in Measurement and Control Engineering Awards. However this does not preclude the use of this Unit in other awards where award design designers feel it is appropriate.

In designing this Unit, the writer has identified the range of topics that they would expect to be covered by lecturers. The writer has also given recommendations as to how much time should be spent on each Outcome. This is done to help lecturers to decide what depth of treatment should be given to the topics attached to each Outcome.

A list of topics for each Outcome is given below.

Outcome 1

Explain the components and communications used in SCADA systems (10 hours Inc assessment)

- ◆ The components of a SCADA system.
- ◆ SCADA software packages.
- ◆ OPC benefits and scope.
- ◆ Centralised processing- where a single computer (PC) performs all plant monitoring and all plant data is stored in one database which resides in the computer. The disadvantage of this approach.
- ◆ Distributed processing- where the SCADA is shared across several small computers (PCs). The advantages/disadvantages of this approach.
- ◆ Client server approach for large systems and the tasks performed e.g. Input/output, alarms, trends, reports and displays, open architecture, tag access, data access.
- ◆ Redundancy: dual server, dual LAN and PLC.
- ◆ System response times —
 - time to display analogue and digital values from RTUs on master station display
 - central request from operator to RTUs
 - acknowledge of alarm on operator screen
 - display of entire new display on operator screen
 - retrieval of historical trends and display
 - sequence of event logging of RTU critical events

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- ◆ Expandability: SCADA systems should not require more than 60% of the processing power of the master station and RAM should be 50% of required size. Ability to cope with additional RTUs and display organisation.
- ◆ Remote terminal units: single/multi-channel analogue (4-20mA) and digital I/O devices, single ended and differential inputs, multiplexers, signal amplifiers, sample and hold, A/D conversion, bus interfaces, digital outputs(triac/TTL). Communication interfaces RS232/442/485, dialup telephone lines/dedicated land lines, microwave/MUX, satellite, radio via VHF/UHF/900MHz, X.25 packet protocols.

Outcome 2

Apply methods of interfacing, alarming and trends (10 hours inc. assessment)

- ◆ All compatible protocols included as standard
- ◆ DDE drivers supported
- ◆ Direct real time access to data by any network user
- ◆ Third party access to real time data e.g. Excel
- ◆ DDE compatibility: read, write and execute
- ◆ DDE to all IO device point
- ◆ Use of OPC and need to not re-write drives because of feature changes or additions in new hardware
- ◆ Interface of RTUs, loop controllers and bar code readers
- ◆ Driver toolkit available
- ◆ Operation on demand basis instead of predefined scan method
- ◆ True stamped alarms to 1 milli-second precision
- ◆ Single network acknowledgement and control of alarms
- ◆ Alarms are shared to all clients
- ◆ Dynamic allocation of alarm pages
- ◆ Up to four adjustable trip points for each analogue alarm
- ◆ Deviation and rate of change monitoring for analogue alarms
- ◆ Historical alarms and event logging
- ◆ Event triggered alarms
- ◆ Alarm triggered reports
- ◆ True trend printouts not screen dumps
- ◆ Event based trends
- ◆ Real time multi-pen trending
- ◆ Short and long term trend displays
- ◆ Archiving of historical trends
- ◆ On line change of time base without loss of data
- ◆ Data transfers from PLCs, DCs, controllers, field devices and smart instruments

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Outcome 3

Apply networking, fault tolerance and system configuration (10 hours inc. assessment)

- ◆ Support for all compatible networks
- ◆ Support all protocols
- ◆ Centralised alarms, trend and report processing (data available from anywhere in the network)
- ◆ Dual network for all LAN redundancy
- ◆ No network configuration required (transparent)
- ◆ LAN leasing is based on the number of users logged onto the network, not the number of nodes on the network
- ◆ Multi-user system, full communication between operators
- ◆ PSTN dial up support
- ◆ Redundancy applied to specific hardware
- ◆ Data exchange between field system and devices, control applications and office applications (OPC)

Outcome 4

Apply SCADA features to a given specification (10 hours)

- ◆ Configuration of network to transfer data from RTUs through the interface to data processing and display
- ◆ RTU devices to be used are process measurement or process PID controller with (4-20mA) signal conditioning
- ◆ Data to be inputted from 4-20mA - measurement of a physical variable which can be alarmed and trended on screen display
- ◆ Data to be inputted from a 4-20mA process PID controller which is tuned to give specified performance Controller system response to standard inputs to be recorded and displayed
- ◆ Use of OPC to data transfer field and controller to office applications

Unit Assessment

The Outcomes 1, 2 and 3 can be assessed separately or integrated into a single, closed book end test of approximately two hours.

Outcome 4 should be assessed as a practical assignment of approximately 10 hours duration where candidates apply SCADA - methods to a specified industrial measurement and/or control system.

Guidance on the delivery and assessment of this Unit

It is intended that this Unit is presented in the context of applying SCADA systems to Industrial Measurement and Control Engineering applications.

Closed book- Written paper (combined) — 2 hours

Practical assignment — 10 hours

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In the delivery candidates should have the opportunity to gain as much hands on experience as possible a networked SCADA system would be essential for the delivery of the Unit. Candidates working in small groups (pairs) can get the opportunity to configure and set up a networked SCADA and see applications of OPC.

Opportunities for developing Core Skills

There are opportunities to develop the Core Skills of Written Communication (Writing) and Written Communication (Reading) at SCQF level 5 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Open learning

The Unit could be delivered by distance learning which may incorporate some degree of on line support.

The candidate would require access to a suitable networked SCADA system. With regard to assessment, planning would be required of the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that written assessment was conducted under controlled conditions.

Arrangements would also need to be made to ensure that the candidate could practically demonstrate the operation of his/her solution to the practical assignment required as assessment evidence for Outcome four. This would involve the candidate attending the centre or utilizing video conferencing. Alternatively special arrangements would be made for the candidate to demonstrate the practical work to a designated responsible person local to the candidate.

For information on open learning, please refer to *SQA guide assessment and quality assurance of open and distance learning (A1030, Feb 2001)*.

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

General information for candidates

Unit title: Supervisory Control and Data Acquisition (SCADA)

This Unit has been designed to provide you with the knowledge and/or skills that will enable you to understand the basic construction and operation of a networked SCADA system as applied in the Industrial Measurement and Control Engineering area.

The Unit will allow you to develop practical skills that will enable you to configure a networked system and operate to a given specification.

The final assessment for this Unit consists of a written assessment and a practical assignment. The written paper will last for two hours and take place under controlled conditions. It will be carried out under closed book conditions in which you will not take notes, handouts, textbooks, etc. into the assessment.

Your practical skills will be assessed by means of the practical assignment in Outcome 4 that will enable you to apply a networked SCADA system to measure/control an industrial process. This assignment will normally be completed in ten hours. Your centre will provide you with access to a networked SCADA and you should be able to use any relevant notes, textbooks and reference material for the system.

Normally the combined written assessment and practical assignment will be carried out towards the end of the Unit assessment.