



## Higher National Unit specification

### General information for centres

**Unit title:** Process System: Maintenance Routines and Fault Diagnosis

**Unit code:** F80X 35

**Unit purpose:** This purpose of this Unit is to provide candidates with the knowledge and understanding to be able to develop implement and evaluate maintenance and fault diagnosis routines for new and existing process plant and equipment. In order to achieve this, candidates will develop knowledge and understanding of general approaches to plant and equipment maintenance and factors associated with maintenance scheduling, condition monitoring and diagnostic testing. The Unit may be taken as a stand alone Unit or be used as part of a group award relevant to the process industry.

On completion of the Unit the candidate should be able to:

- 1 Explain the factors associated with devising a maintenance strategy.
- 2 Analyse the general approaches used in process system maintenance.
- 3 Analyse the diagnostic techniques used for fault finding in process systems.
- 4 Evaluate a Computer Maintenance Management System (CMMS) for a process system.

**Credit points and level:** 1HN credit at SCQF level 8: (8 SCQF credit points at SCQF level 8\*)

*\*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 Access 1 to Doctorates.*

**Recommended prior knowledge and skills:** It is recommended that candidates have a basic knowledge of process plant and equipment. This may be evidenced by the possession of the Units:

*F815 34: Process Operations: Utilities*

*F80Y 34: Operations: Plant and Equipment Operating Practices*

**Core Skills:** There are opportunities to develop the Core Skills of *Communication, Problem Solving* and *Information and Communication Technology* at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

## General information for centres (cont)

**Context for delivery:** This Unit was developed as a stand alone Unit as part of the restricted core options within the context of the HNC/HND award in Petroleum Process Technology, Operations and Control. If this Unit is delivered as part of another group award, it is recommended that it should be taught and assessed within the subject area of the group award to which it contributes.

**Assessment:** The assessment on Outcome 1, 2 and 3 may be conducted individually or integrated into a single assessment. Assessments for Outcomes 1, 2 and 3 should be composed of short answer, restricted response and/or structured essay type questions. The assessment for Outcome 4 should be an assignment.

Candidates must achieve all of the minimum evidence specified for each outcome in order to pass the Unit.

## **Higher National Unit specification: statement of standards**

**Unit title:** Process System: Maintenance Routines and Fault Diagnosis

**Unit code:** F80X 35

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 factors associated with devising a maintenance strategy

#### **Knowledge and/or Skills**

- ◆ System maintenance
- ◆ Strategic factors
- ◆ Operational factors

#### **Evidence Requirements**

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can explain the factors associated with devising a maintenance strategy.

Evidence for the knowledge and/or skills items in Outcome 1 will be assessed through sampling. Candidates will be assessed on two of the three items in the knowledge and skills list for this Outcome.

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

- ◆ Explain the types of process system maintenance in terms of electrical, mechanical, instrumentation, process controllers and logic sub-systems in the context of operational requirements for system performance and reliability.
- ◆ Explain the strategic factors associated with system maintenance with reference to regulatory requirements, asset management, fault management approaches and cost.
- ◆ Explain the operational factors associated with system maintenance in respect of resource availability, operating environment, scheduling and HSE implications.

#### **Assessment Guidelines**

The assessment for Outcome 1 can be a separate assessment of approximate planned duration of no more than one hour. The separate assessment for Outcome 1 should be conducted on completion of this Outcome. Alternatively, the assessment for Outcome 1 may be combined with that for Outcome 2 and/or Outcome 3 and undertaken after the delivery of these 3 Outcomes with a planned duration of no more than three hours.

Evidence of candidate knowledge and understanding may take the form of short answer, restricted response and/or structured essay type questions. Assessment should be carried out under controlled, closed-book supervised conditions.

## **Higher National Unit specification: statement of standards (cont)**

**Unit title:** Process System: Maintenance Routines and Fault Diagnosis

### **Outcome 2**

Analyse the general approaches used in process system maintenance

#### **Knowledge and/or Skills**

- ◆ Reactive Maintenance (RM) — principles, applications, advantages, and disadvantages
- ◆ Planned Preventative Maintenance (PPM) — principles, applications, advantages, and disadvantages
- ◆ Total Productive Maintenance (TPM) — principles, applications, advantages, and disadvantages
- ◆ Reliability Centred Maintenance (RCM) — principles, applications, advantages, and disadvantages
- ◆ Condition Based Maintenance (CBM) — principles, applications, advantages, and disadvantages

#### **Evidence Requirements**

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can analyse the general approaches used in process system maintenance.

Evidence for the Knowledge and/or Skills items in Outcome 2 will be assessed through sampling. Candidates will be assessed on three of the five items in the Knowledge and Skills list. Assessment must be carried out under supervised conditions.

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

- ◆ Evaluate the principles, applications, advantages and disadvantages of Reactive Maintenance
- ◆ Evaluate the principles, applications, advantages and disadvantages of Planned Preventative Maintenance
- ◆ Evaluate the principles, applications, advantages and disadvantages of Total Productive Maintenance
- ◆ Evaluate the principles, applications, advantages and disadvantages of Reliability Centred Maintenance
- ◆ Evaluate the principles, applications, advantages and disadvantages of Condition Based Maintenance

#### **Assessment Guidelines**

The assessment for Outcome 2 can be a separate assessment of approximate planned duration of no more than one hour. The separate assessment for Outcome 1 should be conducted on completion of this Outcome. Alternatively, the assessment for Outcome 1 may be combined with that for Outcome 2 and/or Outcome 3 and undertaken after the delivery of these 3 Outcomes with a planned duration of no more than three hours.

Evidence of candidate knowledge and understanding may take the form of short answer, restricted response and/or structured essay type questions.

Evidence should be generated through assessment undertaken in controlled supervised conditions. Assessments should be conducted under closed-book conditions and as such candidates should not bring text books, course notes, programmable calculators or mobile communication devices to the assessment. Any reference materials, such as data, tables and charts, relevant to the assessment should be incorporated into the assessment paper.

## **Higher National Unit specification: statement of standards (cont)**

**Unit title:** Process System: Maintenance Routines and Fault Diagnosis

### **Outcome 3**

Analyse the diagnostic techniques used for fault finding in process systems

#### **Knowledge and/or Skills**

- ◆ Fault categories
- ◆ Fault management techniques
- ◆ Fault diagnostic techniques

#### **Evidence Requirements**

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

Analyse the diagnostic techniques used for fault finding in process systems.

Evidence for the knowledge and/or skills items in Outcome 3 will be assessed through sampling. Candidates will be assessed on two of the three items in the knowledge and skills list. Assessment must be carried out under supervised conditions.

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

- ◆ Analyse faults likely to occur in process systems of a random, systematic or design fault nature.
- ◆ Analyse fault management techniques in the categories of fault avoidance, tolerance, removal and detection.
- ◆ Analyse diagnostic techniques of half-split, emergent problem sequence, six point, equipment self diagnosis, functional/performance mapping, injection and sampling and Unit substitution.

#### **Assessment Guidelines**

The assessment for Outcome 3 can be a separate assessment of approximate planned duration of no more than one hour. The separate assessment for Outcome 3 should be conducted on completion of this Outcome. Alternatively, the assessment for Outcome 3 may be combined with that for Outcome 1 and/or Outcome 2 and undertaken after the delivery of these 3 Outcomes with a planned duration of no more than three hours.

Evidence of candidate knowledge and understanding may take the form of short answer, restricted response or structured essay type questions.

Evidence should be generated through assessment undertaken in controlled supervised conditions. Assessments should be conducted under closed-book conditions and as such candidates should not bring text books, course notes, programmable calculators or mobile communication devices to the assessment. Any reference materials, such as data, tables and charts, relevant to the assessment should be incorporated into the assessment paper.

## **Higher National Unit specification: statement of standards (cont)**

**Unit title:** Process System: Maintenance Routines and Fault Diagnosis

### **Outcome 4**

Evaluate a Computer Maintenance Management System (CMMS) for a process system

#### **Knowledge and/or Skills**

- ◆ CMMS specification
- ◆ Software solution

#### **Evidence Requirements**

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can evaluate a CMMS for a process system.

Candidates will be assessed on all of the items in the Knowledge and Skills list. Assessment must be carried out under supervised conditions.

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

- ◆ Evaluate the specification for a CMMS for a process system to include the processes and their variables, operational requirements, scope of maintenance functions, inputs/outputs, reports and documentation.
- ◆ Evaluate a CMMS against specification requirements for a particular process system in respect of system implementation, ease of use and effectiveness

Candidates are required to produce evidence for all items listed in the knowledge and skills for Outcome 4. The evidence should be presented in the form of a report of an assignment in which candidates undertake a practical evaluation of a CMMS for a particular process system.

#### **Assessment Guidelines**

Assessment for Outcome 4 will take the form of an assignment involving the evaluation of a selected CMMS solution against the specification of a particular process system maintenance requirement. The selected process system must be complex and involve the integration of electrical, mechanical, measurement and control devices. Candidates' assignment work should be presented in a 1,000 word report. A suggested format of the report is:

- ◆ Introduction
- ◆ Description of the process plant/equipment and operational requirements
- ◆ Description of maintenance requirements, including resources and scheduling
- ◆ Description of the CMMS solution
- ◆ Evaluation of the software solution
- ◆ Conclusions

## Administrative Information

**Unit code:** F80X 35

**Unit title:** Process System: Maintenance Routines and Fault Diagnosis

**Superclass category:** VG

**Original date of publication:** August 2009

**Version:** 01

### History of changes:

| Version | Description of change | Date |
|---------|-----------------------|------|
|         |                       |      |
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## Higher National Unit specification: support notes

### Unit title: Process System: Maintenance Routines and Fault Diagnosis

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

This Unit was developed as part of the restricted core options within the context of the HNC/HND award in Petroleum Process Technology, Operations and Control. It may also be delivered as a stand-alone Unit.

This Unit has been designed to contribute to the broad capacity building context of process operations within the petrochemical process industry. It has specially been designed to provide knowledge, understanding and skills to support operations in the specialist disciplines of system maintenance and fault diagnosis within the upstream and downstream sectors of this key industry. The Unit deals with the factors affecting maintenance strategies and management, maintenance approaches, diagnostic techniques and the implementation of a Computer Maintenance Management System (CMMS).

The Unit is at SCQF level 7 and has been developed as part of the HNC/HND awards in Petroleum Process Technology, Operations and Control. In this context, the Unit has been designed to link to appropriate National Occupational Standards that form part of the suite of Scottish/National Vocational Qualifications (S/NVQs) in Process Operation: Hydrocarbons and Process Engineering Maintenance at Technician level. However this does not preclude the use of this Unit in other awards where it is appropriate and contributes relevance and added value. The Unit may also be delivered as a stand-alone Unit.

Access to this Unit fully inclusive and at the discretion of the SQA approved delivery centre. However, candidates may find it beneficial to have a prior knowledge of this area as provided by the SQA HN Unit *F811 34: Petroleum Industry: Organisation, Products and Processes*.

This Unit has been written in order to allow candidates to develop knowledge, understanding and skills to allow candidates to achieve the following Outcomes:

- 1 Explain the factors associated with devising a maintenance strategy
- 2 Analyse the general approaches used in process system maintenance
- 3 Analyse the diagnostic techniques used for fault finding in process systems
- 4 Evaluate a Computer Maintenance Management System (CMMS) for a process system

A list of topics for each Outcome is given below:

## Higher National Unit specification: support notes (cont)

**Unit title:** Process System: Maintenance Routines and Fault Diagnosis

### Outcome 1

- ◆ Explain:
  - operational requirements of process system maintenance
  - types of process system maintenance in terms of electrical, mechanical, instrumentation, process controllers and logic sub-systems
  - system performance and reliability
  - strategic factors such as regulatory requirements, asset management, fault management approach and cost.
  - operational factors such as resource availability, operating environment, scheduling and HSE implications

### Outcome 2

- ◆ Evaluate
  - principles, applications, advantages and disadvantages of different types of maintenance approaches
  - Reactive Maintenance
  - Planned Preventative Maintenance
  - Total Productive Maintenance
  - Reliability Centred Maintenance
  - Condition Based Maintenance

### Outcome 3

- ◆ Analyse
  - faults likely to occur in process systems of a random, systematic or design fault nature
  - fault management techniques in the categories of fault avoidance, tolerance, removal and detection
  - diagnostic techniques of half-split, emergent problem sequence, six point, equipment self diagnosis, functional/performance mapping, injection and sampling and unit substitution.

### Outcome 4

- ◆ Evaluate
  - CMMS specification and operational requirements for a process system
  - CMMS processes and their variables, scope of maintenance functions, inputs/outputs, reports and documentation of a CMMS
  - a CMMS solution against specification requirements for a particular process system in respect of system implementation, ease of use and effectiveness

## **Higher National Unit specification: support notes (cont)**

**Unit title:** Process System: Maintenance Routines and Fault Diagnosis

### **Guidance on the delivery and assessment of this Unit**

This Unit was developed as a stand alone Unit as part of the restricted core options within the context of the HNC/HND award in Petroleum Process Technology, Operations and Control. It may also be used as a stand-alone Unit.

The content of the Outcomes of this Unit follows a logical delivery sequence.

This Unit may be delivered on a full-time, block release, open or blending learning, part-time day or part-time evening basis at the discretion of the SQA approved delivery centre. Learning and teaching methods may include a combination of lectures, tutorials, group work, practical assignments, computer-based simulations, case studies and industrial visits.

The use of flexible learning through on-line materials and methodologies is encouraged wherever possible to supplement and support the learning that takes place in the delivery centre. It is also recommended that candidates are directed to undertake internet research where a rich amount of material can be found that is relevant to the content of this Unit to support their learning. Wherever appropriate, it is recommended that relevant practical learning activities are used to support the development of the knowledge and understanding requirements of this Unit. At every appropriate opportunity, it is recommended that the delivery of this Unit reflects on the health, safety and environment implications relevant to the content and context of this Unit.

Formal assessment of this Unit may take a number of different forms such as written and numerical tests, laboratory work, simulation exercises, practical exercises and case studies. Assignments may be conducted as group endeavours to allow candidates to develop teamwork skills. In such cases, assessment work should be that of the individual candidates.

The assessment of individual outcomes of this Unit may be conducted separately. Outcome 1, Outcome 2 and Outcome 3 may each be assessed separately using a suitable balance of short answer, restricted response and structured questions with each individual assessment having a planned duration of no more than one hour.

Alternatively Outcomes 1, 2 and 3 may be a combined assessment of planning duration of no more than two hours.

Outcome 4 may be assessed by a report of an assignment or case study involving the investigation and evaluation of a selected CMMS solution against the specification of a particular process system maintenance requirement. The assignment report may be supported with recorded responses to assessor questions. Candidates could be allocated two hours to produce the assignment report. Any assessment should be conducted under controlled, supervised conditions.

Where evidence requirements call for a practical assignment, such as in Outcome 4 of this Unit, it may better suit the learning needs of candidates for centres to use a case study in conjunction with a relevant industry partner to provide a realistic working environment with industrial realism. Such a case study may be conducted as a group endeavour to allow candidates to develop teamwork skills. In such cases, assessment work should clearly identify the contribution of individual candidates, and the case study/investigation report must entirely the work of the individual candidate.

## Higher National Unit specification: support notes (cont)

**Unit title:** Process System: Maintenance Routines and Fault Diagnosis

Individual Outcome assessments should be carried out at the end of the delivery of the respective outcome material. Combine Outcome assessments should be completed at the end of the delivery of the contributing outcome material.

It should be noted that the candidates must achieve all the minimum evidence specified for each Outcome in order to pass the Unit. Where sampling of knowledge and skills items is used for assessment, the sampling should be selected to meet the specific needs of the candidate cohort within the context of their current employment or progression goals.

Details on approaches to assessment are given under Evidence Requirements and Assessment guidelines under each Outcome in the Higher National Unit specification: Statement of Standards section. It is recommended that these sections be read carefully before proceeding with assessment of candidates.

### *Opportunities for developing Core Skills*

There may be opportunities to gather evidence toward the following Core Skills within this Unit, although there is no automatic certification of Core Skills or Core Skills components in this Unit:

|   |              |
|---|--------------|
| <i>Communication</i>                            | SCQF level 6 |
| <i>Problem Solving</i>                          | SCQF level 6 |
| <i>Information and Communication Technology</i> | SCQF level 6 |

### **Open learning**

This Unit could be delivered by distance learning, which may incorporate some degree of on-line support. 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 assessments were conducted under controlled, supervised conditions. Agreement would have to be made to ensure that a single assessment for the end test is delivered in a supervised environment under controlled conditions.

### **Disabled candidates and/or those with additional support needs**

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website [www.sqa.org.uk/assessmentarrangements](http://www.sqa.org.uk/assessmentarrangements)

## General information for candidates

### Unit title: Process System: Maintenance Routines and Fault Diagnosis

This Unit has been designed to allow you to develop the knowledge, understanding and skills involved in the routine maintenance and fault diagnosis of petrochemical process systems. As such, this Unit will contribute to your development as a process operations technician or a measurement and control technician within this key industry. The vocational focus of this Unit combines the necessary blend of key system maintenance and diagnostic related technological principles with knowledge of their industrial process applications in a safety and environmentally critical context.

The Unit comprises the following broad outcomes:

- 1 Explain the factors associated with devising a maintenance strategy
- 2 Analyse the general approaches used in process system maintenance
- 3 Analyse the diagnostic techniques used for fault finding in process systems.
- 4 Evaluate a Computer Maintenance Management System (CMMS) for a process system.

These outcomes are linked to National Occupational Standard that form part of the suite of Scottish/National Vocational Qualifications (S/NVQs) in Process Operation: Hydrocarbons and Process Engineering Maintenance at Technician level.

Within this Unit, you will also have opportunities to develop the transferable Core Skills of *Communication, Information and Communication Technology, Problem Solving* and *Working with Others*, although these are not separately certificated.

Access to this Unit is fully inclusive and at the discretion of your SQA approved delivery centre. However, you may find it beneficial to have a prior knowledge of this area as provided by the SQA HN Unit *F811 34: Petroleum Industry: Organisation, Products and Processes*.

This Unit can be delivered on a full-time, block release, open or blending learning, part-time day or part-time evening basis at the discretion of your SQA approved delivery centre. Learning and teaching methods may include lectures, tutorials, group work, practical/laboratory assignments, computer-based simulations and case studies. The use of flexible learning through on-line materials and methodologies may be used to supplement and support the learning that takes place in the delivery centre.

Formal assessment of this Unit may take a number of different forms such as short response or structured questions, simulation exercises, practical exercises and case studies. Assessments will normally be conducted at the end of the delivery of each Outcome. Where assessments are combined, these may be conducted toward the end of the Unit.