Higher National Unit Specification

General information for centres

Unit title: Process Safety Engineering

Unit code: F43J 34

Unit purpose: This Unit is designed to provide candidates with an understanding of safety engineering in the oil refining and chemicals processing industries.

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

1 Explain the management of fire and explosion hazards.
2 Explain the management of occupational and environmental hazards when handling harmful materials.
3 Explain the methods and techniques used in Quantitative Risk Assessment.
4 Analyse a hazardous incident.

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

Recommended prior knowledge and skills: Access to this Unit will be at the discretion of the centre, though it is recommended that candidates have prior knowledge of health and safety at SCQF level 6, or equivalent.

Core Skills: There are opportunities to develop the Core Skills of *Numeracy* and *Problem Solving* and the component Written Communication, all at SCQF level 6 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.

Assessment: Outcomes 1, 2 and 3 may be assessed together or individually. Assessment could be composed of an appropriate balance of short answer, restricted response and structured questions, though a case study approach may be useful for Outcome 4. Assessment must be carried out under supervised conditions.

Higher National Unit specification: statement of standards

Unit title: Process Safety Engineering

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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 management of fire and explosion hazards

Knowledge and/or Skills

- Flammable and explosive materials
- Hazardous zones
- Safety Equipment
- Sources of static electrical discharge
- Pressure vessels and their regulation

Evidence Requirements

Evidence for this Outcome will be provided on a sample basis with candidates being required to provide evidence for three of the five Knowledge and/or Skills items. Assessment must be carried out under supervised conditions.

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

- classify gases, dusts, liquids and solid materials according to their fire and explosion hazards
- explain the reasons behind the classification of gases, dusts, liquids and solid materials. The explanation must include combustion reactions, vapour pressure, activation energy and ignition temperature, and dust explosions. The approved codes of practice applicable to each classification must also be included.
- the classification of hazardous zones around flammable and explosive materials and the approved codes of practice for safety equipment installations within each zone.
- explain at least three sources of static electrical discharges and procedures for their prevention.
- explain the management of fire and explosion hazards of Pressure Vessels. The explanation must include the mechanical features of pressurised equipment, properties of materials and tensile stresses in curved walls, pressure relief valves and containment protection and the requirements of current legislation and Approved Codes of Practice.

Assessment Guidelines

Outcomes 1, 2 and 3 may be assessed together or individually. Assessment could be composed of an appropriate balance of short answer, restricted response and structured questions.

Outcome 2

Explain the management of occupational and environmental hazards when handling of harmful materials.

Knowledge and/or Skills

- Classifications of harmful materials
- Methods of monitoring occupational exposure
- Maintenance of safe standards
- Methods of monitoring environmental exposure
- Methods of reporting
- Regulatory control of substances hazardous to health

Evidence Requirements

Evidence for this Outcome will be provided on a sample basis with candidates being required to provide evidence for two of the six Knowledge and/or Skills items. Assessment must be carried out under supervised conditions.

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

- classify toxic, irritant, corrosive and radioactive materials by chemical and physical types.
- explain the reasons behind the classification of toxic, irritant, corrosive and radioactive materials by chemical and physical type. The explanation must include acute, chronic and physical toxicity, cumulative poisons, carcinogens, heavy metals, aggressive particles, acidity and alkalinity and radioactive materials and provide at least one example of each.
- explain the methods of monitoring and reporting occupational exposure to harmful materials and the sources of reliable information on safe limits.
- the methods of monitoring and reporting environmental exposure to harmful materials and the sources of reliable information on safe limits.
- explain the current legislative requirements for the control of substance hazardous to health and the implications for the management of hazardous materials. The explanation must include recent revisions, supporting regulations and Approved Codes of Practice.

Assessment Guidelines

Outcomes 1, 2 and 3 may be assessed together or individually. Assessment could be composed of an appropriate balance of short answer, restricted response and structured questions.

Higher National Unit specification: statement of standards

Unit title: Process Safety Engineering

Outcome 3

Explain the methods and techniques used in Quantitative Risk Assessment

Knowledge and/or Skills

- Levels of risk
- Manual and automated activities
- The estimation of probability in random processes
- The estimation of failure rates in complex assemblies

Evidence Requirements

Evidence for this Outcome will be provided on a sample basis with candidates being required to provide evidence for three of the four Knowledge and/or Skills items. Assessment must be carried out under supervised conditions.

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

- explain methods for the quantification of risk in human activities and the observed levels of risk for a range of industrial and other activities. Explanation must include Fatal Accident rate, Acceptable risk, ALARP, life cost estimates and cost-benefit analysis.
- apply basic probability theory for independent and simultaneous random events. The application must include the calculation of Failure rates of mechanical and electrical equipment, intervals between inspections, demand rate, fractional dead time and hazard rate.
- estimate the frequency of occurrence of hazardous conditions in a proposed manufacturing process. The estimation must include Fault tree analysis, logical gates, probability of top event duplication of safety equipment and the reduction of top event probability.

Where calculations are performed the candidate must:

- apply appropriate formulae.
- apply the principles of the calculation.
- show all working through a calculation.
- provide reasonable answers to the questions asked. The answer should derive from the application of the formulae and correct application of the principles of the calculation.

Assessment Guidelines

Outcomes 1, 2 and 3 may be assessed together or individually. Assessment could be composed of an appropriate balance of short answer, restricted response and structured questions.

Higher National Unit specification: statement of standards

Unit title: Process Safety Engineering

Outcome 4

Analyse a hazardous incident

Knowledge and/or Skills

- Analysis
- Models
- Causes
- Prevention
- Improvements
- Recommendations

Evidence Requirements

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

- systematically analyse a hazardous incident to identify the causes of the incident. The systematic analysis must use a case study approach or other acceptable model such as systems failure, fault tree analysis or cause and effect diagrams.
- recommend improvements or actions to prevent a recurrence of the incident.
- present the findings and recommendations.

Findings and recommendations must be presented in a format that would be in line with industry standards.

Assessment Guidelines

Assessment for this Outcome could be in the form of a case study where candidates are presented with a real life 'historical' hazardous incident and asked to investigate and analyse the information presented. Candidates could be required to present a report of their findings and recommendations and assessed by the appraisal of the finished report.

Administrative Information

Unit code: F43J 34

Unit title: Process Safety Engineering

Superclass category: XA

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Version	Description of change	Date

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Higher National Unit specification: support notes

Unit title: Process Safety Engineering

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 may be delivered on a stand alone basis. However, it has been designed as part of the HNC/HND Chemical Process Technology and HNC Chemical Engineering awards.

The following areas may be covered in the delivery of the Unit:

Outcome 1

The classifications of flammable and explosive materials, the methods used to describe the level of hazard and the recommended procedures for safe operations:

- combustion reactions and the fuel-air-ignition triangle
- vapour pressure, explosive limit and flash point
- gas grouping by activation energy and ignition temperature
- dust explosions
- storage of oils, volatile flammable liquids and LPGs

The classification of hazardous zones around flammable and explosive materials and the selection of equipment for use within them:

- zones 0, 1 and 2 (BS 5345)
- standard methods of explosion protection in electrical equipment
- intrinsic safety

The common causes of static electrical discharges and methods for their prevention:

- basic theory of static electrical charge accumulation and discharge
- conveyor belts as static generators
- pumping of liquids into free space or insulated containers
- electrical earthing of pipework and equipment

Pressure vessels and their associated safety equipment and the pressure vessel regulations:

- mechanical features of pressurised equipment, properties of materials and tensile stresses in curved walls.
- pressure relief valves and containment protection.
- pressure Systems Safety Regulations 2000. Approved Codes of Practice (HSE) or whatever regulations are equivalent.

Higher National Unit specification: support notes (cont)

Unit title: Process Safety Engineering

Outcome 2

Classifications of toxic, irritant, corrosive and radioactive materials by chemical and physical types:

- acute chemical toxicity, chlorine, hydrogen sulphide, carbon monoxide, cyanides, biocides and any other relevant materials
- chronic chemical toxicity, cumulative poisons, carcinogens, heavy metals, arsenic, benzene and any other relevant materials
- physical toxicity, aggressive particles, asbestos and other mineral fibres
- corrosive materials, acids and alkalis and the pH scale
- radioactive materials, levels of activity and safe limits of exposure

The methods of monitoring and reporting occupational exposure to harmful materials and the sources of reliable information on safe limits:

- LD50, OES, TWA, STEL, MEL, and any other index of exposure
- calculation of TWA from continuous records
- reliable sources of MSDS information

The methods of monitoring and reporting environmental exposure to harmful materials and the sources of reliable information on safe limits:

- the carbon cycle and atmospheric warming
- CFC refrigerants and ozone depletion
- cooling towers and legionellosis
- reporting levels of contamination in atmospheric and aquatic samples
- SEPA and any other approved sources of environmental guidelines

The COSHH Regulations and any other relevant legislation:

- Control of Substances Hazardous to Health Regulations 2002 (HSE) or any more recent revisions
- approved Codes of Practice for substances of special interest

Outcome 3

Methods for the quantification of risk in general activities and the observed levels of risk associated with a variety of activities:

- the Fatal Accident Rate for a range of industrial and other activities
- acceptable risk, the ALARP concept, ‘as low as reasonably possible’, life cost estimates and cost-benefit analysis

Basic probability theory for single random events and multiple simultaneous random events:

- probability of random Outcomes, coin tossing, dice, gender of offspring and any other random events
- failure rates of mechanical and electrical equipment, intervals between inspections, demand rate, fractional dead time and hazard rate
- combining probabilities of independent and simultaneous events

The estimation of the frequency of occurrence of hazardous conditions in a proposed manufacturing process:

- fault tree analysis, logical gates, probability of top event
- duplication of safety equipment and the reduction of top event probability

Outcome 4

Preparation and presentation of a clear and concise report based on an historical hazardous incident:

- on-line and off-line literature searching
- authentication and referencing of source materials
- identification of causes
- recommendations for the prevention of recurrence

Guidance on the delivery and assessment of this Unit

This Unit will probably be delivered as part of a Group Award designed to provide candidates with technical knowledge and skills for employment in the oil refining and chemicals manufacturing industries.

Assessment of Outcomes 1, 2 and 3 must be conducted under supervised conditions.

The choice of hazardous incident in the Outcome 4 report may be at the discretion of the candidate and the work may be completed individually with partial supervision, or a specific manufacturing process may be studied in detail as a group exercise and reports prepared under supervised conditions, or any combination of these.

The assessor should be satisfied that the reports presented by each candidate are authentic.

A note on the Evidence Requirements

The Evidence Requirements state that candidates must ‘provide reasonable answers’ derived ‘from the application of the formulae and correct application of the principles of the calculation’. This allows for acknowledgement of the correct working and application of formulae, even where candidates’ final answer may be inaccurate.

The statement allows for the eventuality where a single error at one stage in an extended calculation sequence has a cumulative effect on the final answer, even though working/formulae are otherwise correctly applied. Acknowledgement of the correct working should be given in such cases.

Opportunities for developing Core Skills

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

Throughout the Unit there are opportunities to develop Core Skills in *Numeracy*, *Communication* and *Problem Solving*. In Outcome 3 candidates will calculate risk probabilities, failure rates and other risk assessment calculations, as well as use fault trees and logic gates which will develop Numeracy skills. If findings are submitted as written reports for Outcome 4, this may develop Written Communication skills. Outcome 4 also requires analysis of a hazardous situation which may develop Problem Solving skills.

Open learning

If this Unit is delivered by open or distance learning methods, additional planning resources may be required for candidate support, assessment and quality assurance.

Candidates with disabilities and/or additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering alternative Outcomes for Units. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* **(www.sqa.org.uk)**.

General information for candidates

Unit title: Process Safety Engineering

This Unit is intended primarily for candidates who are working towards the HNC and HND in Chemical Engineering and Chemical Process Technology. If the Unit is taken as part of these awards, it may contribute towards entry to degree studies in Chemical Engineering at second or third year level.

The Unit is designed to provide you with an overview of hazard management in the oil-refining and chemicals industries, with special emphasis placed on the scientific and technical details on which best practice is based. The level of detail should be useful to you if you are employed or expecting employment in these industries at process operator or process technician level.

On completion of the Unit, you should be able to:

- describe the various types of flammable and explosive materials and explain the approved procedures for safe storage and handling
- describe the various types of harmful materials and explain the approved procedures for the prevention of occupational and environmental hazards
- estimate the level of risk in proposed manufacturing processes
- prepare and present a case study of a specific hazardous incident, including analysis of causes and recommendations for the prevention of occurrence

To achieve the Unit, you must successfully complete the assessments that will require you answer a number of questions requiring descriptions and explanations of approved codes of practice for hazard management and methods for the estimation of hazard levels. The assessments for the first three Outcomes may be assessed individually, or at one event under closed-book assessment conditions. For Outcome 4 you could be required to analyse a real life historical incident and present your findings and recommendations.

Throughout the Unit there are opportunities to develop Core Skills in *Numeracy*, *Communication* and *Problem Solving*. In Outcome 3 you will be estimating levels of risk using probabilities and other techniques which will develop Numeracy skills; if you submit your findings as a written report for Outcome 4 you may also have the opportunity to develop the Written Communication skills. Outcome 4 also requires analysis of a hazardous situation which may develop Problem Solving skills.