July 2011

Examiners' Report

NEBOSH National Diploma in Occupational Health and Safety - Unit C

Examiners' Report

NEBOSH NATIONAL DIPLOMA IN OCCUPATIONAL HEALTH AND SAFETY

Unit C: Workplace and work equipment

JULY 2011

CONTENTS

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Introduction

NEBOSH (The National Examination Board in Occupational Safety and Health) was formed in 1979 as an independent examining board and awarding body with charitable status. We offer a comprehensive range of globally-recognised, vocationally-related qualifications designed to meet the health, safety, environmental and risk management needs of all places of work in both the private and public sectors. Courses leading to NEBOSH qualifications attract over 25,000 candidates annually and are offered by over 400 course providers in 65 countries around the world. Our qualifications are recognised by the relevant professional membership bodies including the Institution of Occupational Safety and Health (IOSH) and the International Institute of Risk and Safety Management (IIRSM).

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Candidates' scripts are marked by a team of Examiners appointed by NEBOSH on the basis of their qualifications and experience. The standard of the qualification is determined by NEBOSH, which is overseen by the NEBOSH Council comprising nominees from, amongst others, the Health and Safety Executive (HSE), the Confederation of British Industry (CBI), the Trades Union Congress (TUC) and the Institution of Occupational Safety and Health (IOSH). Representatives of course providers, from both the public and private sectors, are elected to the NEBOSH Council.

This report on the Examination provides information on the performance of candidates which it is hoped will be useful to candidates and tutors in preparation for future examinations. It is intended to be constructive and informative and to promote better understanding of the syllabus content and the application of assessment criteria.

Any enquiries about this report publication should be addressed to:

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General comments

Many candidates are well prepared for this unit assessment and provide comprehensive and relevant answers in response to the demands of the question paper. This includes the ability to demonstrate understanding of knowledge by applying it to workplace situations.

There are always some candidates, however, who appear to be unprepared for the unit assessment and who show both a lack of knowledge of the syllabus content and a lack of understanding of how key concepts should be applied to workplace situations.

In order to meet the pass standard for this assessment, acquisition of knowledge and understanding across the syllabus are prerequisites. However, candidates need to demonstrate their knowledge and understanding in answering the questions set. Referral of candidates in this unit is invariably because they are unable to write a full, well-informed answer to one or more of the questions asked.

Some candidates find it difficult to relate their learning to the questions and as a result offer responses reliant on recalled knowledge and conjecture and fail to demonstrate a sufficient degree of understanding. Candidates should prepare themselves for this vocational examination by ensuring their understanding, not rote-learning pre-prepared answers.

Common pitfalls

It is recognised that many candidates are well prepared for their assessments. However, recurrent issues, as outlined below, continue to prevent some candidates reaching their full potential in the assessment.

- Many candidates fail to apply the basic principles of examination technique and for some candidates this means the difference between a pass and a referral.
- In some instances, candidates are failing because they do not attempt all the required questions or are failing to provide complete answers. Candidates are advised to always attempt an answer to a compulsory question, even when the mind goes blank. Applying basic health and safety management principles can generate credit worthy points.
- Some candidates fail to answer the question set and instead provide information that may be relevant to the topic but is irrelevant to the question and cannot therefore be awarded marks.
- Many candidates fail to apply the command words (also known as action verbs, eg describe, outline, etc). Command words are the instructions that guide the candidate on the depth of answer required. If, for instance, a question asks the candidate to ‘describe’ something, then few marks will be awarded to an answer that is an outline. Similarly the command word ‘identify’ requires more information than a ‘list’.
- Some candidates fail to separate their answers into the different sub-sections of the questions. These candidates could gain marks for the different sections if they clearly indicated which part of the question they were answering (by using the numbering from the question in their answer, for example). Structuring their answers to address the different parts of the question can also help in logically drawing out the points to be made in response.
- Candidates need to plan their time effectively. Some candidates fail to make good use of their time and give excessive detail in some answers leaving insufficient time to address all of the questions.
- Candidates should also be aware that Examiners cannot award marks if handwriting is illegible.
- Candidates should note that it is not necessary to start a new page in their answer booklet for each section of a question.

UNIT C – Workplace and work equipment

Section A – *all questions compulsory*

Question 1 ***Outline*** *the issues that need to be addressed when planning a fire evacuation procedure for a multi-storey office building.* ***(10)***

An initial issue that would have to be addressed would be the means of raising the alarm when a fire or other emergency is discovered and the summoning of the emergency services. In order to achieve the safe evacuation of both employees and members of the public some of whom may have sensory or physical disabilities, consideration would have to be given to physical measures such as travel distances and alternative routes, emergency lighting, clear signage of exit routes, the location of assembly points, the provision of access for emergency services and the provision of refuges and evacuation equipment as well as procedural measures such as clarifying staff responsibilities, training fire wardens, accounting for personnel and providing door marshals to prevent entry or re-entry to the office building. Security considerations such as minimising the opportunity for theft would also be an issue here. Liaison with the emergency services should form part of the planning process since they can help with advice on issues such as response times, their access requirements and appropriate locations of assembly areas. There should also be liaison with neighbouring businesses that could be affected by an emergency within the office building. The procedures, once drawn up, would need to be summarised on prominently displayed fire notices and tested with regular fire drills.

Most candidates got off to a good start in answering this question though there was only the occasional reference to important matters such as the possibility of a phased evacuation or liaison between tenants. Those who did not do so well concentrated on hardware issues such as the provision of fire fighting equipment, or general fire risk assessment issues, rather than the required organisational issues whilst a few focussed on one or two areas only providing excessive detail for little reward.

Question 2 *In order to install a large item of machinery such as a turbine rotor, it is sometimes necessary to perform adjustments while the rotor is in motion. These adjustments are necessarily undertaken with the rotor in an unguarded condition.*

Outline** the elements of a safe system of work for this activity.* ***(10)

The elements of a safe system of work for carrying out the operation described in the question include: the use of experienced workers fully trained in the systems to be adopted since this is not a task to be carried out by the young or inexperienced; the provision and use of a single one piece close fitting overall with no external pockets together with arrangements to ensure there are no other entanglement hazards present such as the wearing of jewellery, pendants for example, or long hair; the use of temporary guards or the isolation of parts of the machine which are unnecessarily exposed; where practicable the use of jigs to ensure workers' hands are distanced from the unguarded rotor; the provision of a "stand by" man in direct contact with the person carrying out the work with means of immediate communication such as telephone or radio to ensure an emergency response should the need arise; the provision, close at hand, of an emergency stop or braking arrangements; the use of an inching device to minimise the free rotation period or using the slowest speed possible consistent with the task; the provision of non-stroboscopic lighting; the introduction of a permit to work to formalise the establishment of the safe system of work and the erection of barriers and signs to prevent the close approach of non-involved personnel.

Whilst there were some good answers produced for this question, though on occasions, little attention was paid to the command word 'outline' there were some candidates who seemed to be hampered by their lack of familiarity with the machinery mentioned in the scenario and did not realise that the question was concerned with precautions to be taken when work was carried out on any unfenced machinery. A few candidates answered on the basis that the machine would be isolated and locked off – the question suggests otherwise – while others, probably as a last resort, proposed avoiding the work if possible.

Question 3 *Maintenance work on electrical distribution panels and control circuitry commonly involves diagnostic testing and fault finding on live systems.*

Outline** the requirements of the Electricity at Work Regulations 1989 that apply to this situation **AND** the practical precautions that should be in place before the work is undertaken.* ***(10)

Regulation 14 of EAWR sets out three conditions for working on a live system, the first two of which – that it is unreasonable for it to be made dead and that it is reasonable to work on it while it is live – are clearly met in this case since much diagnostic work will require this. Therefore, the third condition – that suitable precautions are take – requires attention and overlaps with other requirements of the Regulations, in particular Regulation 4 relating to electrical systems, work activities and protective equipment. In this respect, distribution panels should have protection rating of at least IP2X by the provision of test points that do not allow access to fingers or tools other than test probes. for example test points of 2mm in diameter. The test probes should be insulated and fused and the test meter must be checked prior to use. The area should be cordoned off by the use of barriers to prevent unauthorised access and, depending on the circumstances, insulating mats and/or gloves may be required. All live working should be subject to a permit to work system.

Regulation 16 of EAWR requires the engineer to be technically competent or to be closely supervised, having regard to the nature of the work, by someone who is competent. Persons involved with the work should therefore possess recognised qualifications and have experience in the type of work being undertaken. In order to comply with Regulation 7 relating to the protection of conductors, all incoming and outgoing supplies should be suitably insulated and shrouded. Additional shrouding may be required. With regard to earthing – Regulation 8 – the cabinet should be connected to the main earth and the cabinet door earth-bonded to the cabinet. The other main concern is to ensure that there is sufficient working space, suitable access and adequate lighting, as required by Regulation 15.

Answers to this question varied in quality. Some candidates showed a good knowledge of the Regulations, addressed their requirements, referred to the 'three conditions' and outlined the controls to be put in place. There were others, however, who did not appear to have an understanding of the requirements for working on live equipment or did not realise that the question was concerned with these precautions since they suggested that the circuit should be isolated. A few relied on the provision of information and training without supplying any further detail.

Question 4 *X-ray radiography is a non-destructive testing (NDT) technique that is sometimes used to examine the internal structure of fuel tanks in the wings of large passenger aircraft.*

(a) ***Outline*** *the principles of operation when using X-ray radiography for this application.* ***(4)***

(b) *Other than visual inspection,* ***explain*** *why different forms of NDT might not be appropriate for this application.* ***(4)***

(c) ***Identify TWO*** *disadvantages in the application of X-ray radiography.* ***(2)***

In answering part (a) of the question, Examiners expected candidates to outline how radiation would be generated by a portable electrically powered machine such as a generator focussed into a beam by lead shielding. The beam would be directed to penetrate the wing skin to reach a film or electronic sensor placed inside the tank on the opposite side of the wing. An image of the intervening structure within the wing is created on film after photographic development or on the electronic sensor after electronic processing, with defects being revealed by the contrast between light and dark areas. The image has light areas where less radiation reaches the film or sensor after passing through unbroken or sound structure, whereas the image has darker areas where more radiation reaches the film or sensor through voids or cracks in a structural element which is faulty. This part of the question was not well answered with many candidates showing confusion between radioactive sources and x-rays generated by a machine.

For part (b), candidates should have selected at least four other forms of NDT and explained why each might not be appropriate for the scenario described. For example, gamma radiography would be impractical and too expensive; eddy current can experience spurious defect indications and does not provide a permanent record; dye penetrant shows only surface cracks with accessibility to tanks being impossible; magnetic particle testing does not work on non-ferrous metal and there would again be the problem of tank inaccessibility; while there would be no indication of fault location from tap testing. There was the occasional reference to dye penetrant and tap testing but in general answers were to a poor standard. While candidates did seem to be aware of some different forms of NDT, they did not seem to know how they worked or why they could not be applied in the circumstances described.

Answers to part (c), however, were to a better standard with candidates identifying disadvantages in the application of x-ray radiography such as the manual handling of heavy equipment; there is the possibility of exposure to x-rays; training in interpretation skills is necessary for the operators and its use is relatively expensive.

Question 5 ***Outline*** *the key safety features of a facility that is to be used for the storage of highly flammable solvents in 200 litre drums.* ***(10)***

In answering this question, marks were available for outlining features such as bunding to contain spills, including a facility to collect and dispose of spillages; the building to be erected on an impermeable base with an adequate separation distance from other buildings and constructed of fire resistant materials with a light weight roof or blast panels; a facility for the segregation of materials; adequate access and egress including a ramp to facilitate the handling of drums; the provision of high/low ventilation and of sprinklers/ fire extinguishers to be used in the event of an emergency; the clearance of vegetation round the storage area and finally security features such as the provision of locks and warning signs.

Most safety features were mentioned though occasionally the provision of an impermeable base and clearance of vegetation were omitted. A few candidates did rely on generalised statements such as 'ventilation' and 'suitable fire fighting equipment' without supplying the additional detail necessary to gain the marks.

Question 6 *The use of a tower crane on a construction site must be notified to the Health and Safety Executive before it is brought into first use.*

Outline *the safety concerns in relation to the use of tower cranes on construction sites that have influenced the introduction of this legal requirement.* ***(10)***

In answering this question, candidates might first have referred to the safety concerns connected with the initial erection of the crane such as the mis-assembly of structural components, undetected component defects and a failure to carry out a pre-use inspection of the crane which would have identified defects such as the incorrect installation of the slewing ring and/or jib, and the mis-specification of the independent crane to be used in the erection. Additionally, there were concerns regarding the inadequate support of components during extension or dismantling with stability being compromised during an extension operation often because of poor communication as a result of the distance from the ground. There were also instances of inadequate clearance zones where more than one tower crane was used on a site and over flight of areas outside the curtilage of the construction site. Finally there were concerns about the access to the control cab, often by climbing vertical ladders which required a high standard of fitness and that inadequate cab welfare such as heating and the ability to take refreshment might lead to human error.

This question proved troublesome for the majority of candidates. There seemed little knowledge of the notification procedures or of the reasons why they were brought into force, despite tower cranes being the only category of lifting equipment with specific legal requirements beyond the general application of LOLER Many candidates approached the question purely from a LOLER point of view and did not consider the specific concerns associated with the use of tower cranes.

Section B – *three from five questions to be attempted*

Question 7 *A storage tank requires inspection, cleaning and repair. It is 6 metres in diameter and 10 metres high and was previously used for storing leaded petrol.*

Outline** the arrangements that should be considered in order to comply with the Confined Spaces Regulations 1997.* ***(20)

Good answers to this question were those that approached the proposed work in a logical and sequential way, clearly outlining with examples what would be required at each stage in order to comply with the relevant legislative requirements, in this case those of the Confined Spaces Regulations (CSR).

Regulation 4(1) requires that no person should enter a confined space unless it is not reasonably practicable to achieve the intended purpose without such entry. Candidates should therefore have considered whether the work or any part of it, could be done without entering the tank for example by using remotely controlled cameras, robotic inspection systems or a cleaning lance operated from outside the tank. If this were not possible, a safe system of work in relation to any of the relevant specified risks would have to be provided. In this case the relevant risks relate to fire and explosion and loss of consciousness due to asphyxiation or high temperatures. In order to develop the safe system of work, a full risk assessment would have to be carried out when consideration would have to be given to the likelihood of flammable atmospheres from the previous contents of the tank, the possibility of air contamination from the cleaning or repair methods used and the build-up of heat within the tank. The assessment would also need to look at other issues from the work to be carried out including working from height and the toxic effects of lead.

The arrangements that the risk assessment might find to be necessary relate to the possible need to purge the tank with an inert gas, the use of forced ventilation, atmospheric testing before and during entry and the provision of personal protective equipment possibly including air-fed breathing apparatus. Attention would also need to be paid to the requirements for electrical equipment (for example intrinsically safe or flameproof) and earthing arrangements. If heat were to be a foreseeable problem, then consideration should be given to issues such as job rotation and fluid intake. Additionally, consideration should be given to the prevention of falls from height and the means of access and egress in the event of escape and rescue. Procedural arrangements would centre on the establishment of well-defined systems of work, the implementation of an entry permit system, limiting the number of people working in the tank, communication with standby personnel and drawing up the emergency arrangements required by Regulation 5 of the CSR.

The emergency arrangements to be considered, and which should be in place before entry is allowed would include issues such as the provision and maintenance of cutting equipment, hoists for top entry rescue, fire-fighting equipment, personal protective equipment such as breathing apparatus, first aid facilities including resuscitation apparatus and liaison with the emergency services. Additionally, arrangements should be in place to ensure that all personnel involved in the operation including the emergency response team, have received sufficient training in the work methods, the precautions needed and the procedures to be followed in the event of an emergency.

This was a popular question and answers were generally to a reasonable standard. If there were deficiencies, it was that few candidates actually referred in any detail to the hazards that were present in the task and many missed the reference to its former use in storing leaded petrol. Examiners did comment that in many cases answers provided were unstructured. Had more care been taken with their structure, this would have ensured that nothing was missed in the answer, and additional marks might well have been gained.

Question 8

(a) *With reference to the Pressure Systems Safety Regulations 2000,* ***explain*** *what is meant by a 'pressure system'.* ***(4)***

(b) ***Outline FOUR*** *examples of the mechanisms of mechanical failure in pressure systems.* ***(8)***

(c) ***Outline*** *the technical* ***AND*** *procedural measures to minimise the likelihood of failures in pressure systems.* ***(8)***

A 'pressure system' is a system comprising one or more pressure vessels of rigid construction, any associated pipe work and protective devices; the pipe work with its protective devices to which a transportable pressure receptacle is, or is intended to be connected; or a pipeline and its protective devices which contains or is liable to contain a relevant fluid, but does not include a transportable pressure receptacle. Better responses included examples of a 'relevant fluid' such as steam; a liquid which has a pressure 0.5 bar above atmospheric at the temperature of the liquid or at 17.5º C; a fluid or mixture of fluids which is at a pressure greater than 0.5 bar above atmospheric pressure when in equilibrium with its vapour at either the actual temperature of the liquid or at 17.5 degrees Celsius; or a gas dissolved under pressure in solvent contained in a porous substance at ambient temperature and which could be released from the solvent without the application of heat. Answers to this part of the question were to a reasonable standard with many candidates showing a good recall of the definition of a 'pressure system'.

The second part of the question required candidates to outline four examples of the mechanisms of mechanical failure in pressure systems such as excessive external stress; overheating; ductile failure; mechanical fatigue; thermal fatigue; brittle fracture; creep; hydrogen embrittlement at welding repairs; corrosion with internal fluids; water/steam hammer and caustic embrittlement. Few candidates were able to provide the required four examples and there seemed to be a general lack of understanding of the term 'mechanical failure' with some offering nothing more than broken pipes with no suggestion of how the breakage might have occurred.

Part (c) of the question required candidates to outline the technical and procedural measures that should be taken to minimise the likelihood of failures in pressure systems. These include a correct design specification ensuring the system was fit for purpose; fitting specific safety features such as pressure relief valves and level sensors; ensuring quality control during the manufacture; the introduction of inspection and maintenance procedures including statutory examination with the scheme of examination being prepared by a competent person; the role of non-destructive testing; ensuring the system operates within its design parameters and, in the case of boilers, the filtering and treatment of water. Answers generally contained only a limited number of measures with most candidates relying on maintenance and the training of staff.

Question 9

(a) ***Describe*** *the effects of a fire in a workplace on the following structural materials:*

(i) *steel;* ***(4)***

(ii) *concrete;* ***(4)***

(iii) *wood.* ***(4)***

(b) ***Outline*** *the precautions that could be taken to prevent failure of these materials in the event of fire.* ***(8)***

In answering part (a) of the question, candidates should have recognised that steel expands on heating, loses strength as the temperature rises and tends to deform and buckle. It regains strength on cooling but its properties may have changed. Concrete on the other hand exhibits limited expansion and has a tendency to spall and crack which can be exacerbated by the expansion of steel reinforcement within the concrete. The structural strength of concrete is lost on cooling and it loses structural integrity. As for wood, while thin sections will burn and promote fire, the charred surface of thicker structural members may act as an insulator to protect the inner timber. However, burning timber generates smoke and fumes and allows the surface propagation of fire. Some varieties of timber are more resistant to fire than others while large timbers generally tend to retain their structural integrity. This part of the question was generally well answered though some did have difficulty in describing the effects of fire on concrete, suggesting that it would revert to sludge.

Part (b) was concerned with the precautions that could be taken to prevent failure of the materials in the event of fire. Steel might be protected by the use of sprayed concrete or fibre board of an appropriate rating, while for concrete, the selection of the type of mix to improve fire resistance and increasing the thickness of concrete between the external face and reinforcement bars would provide some protection. Failure of wood may be prevented by selecting fire resistant timber, increasing the thickness used to allow for a charring outer layer or impregnating it with fire retardant. Other general precautions include the provision of means such as compartmentalisation to prevent heat transfer through long steel members in the event of fire; automatic means of applying water to structural members should fire occur and the use of fire resistant surface claddings or flammable sacrificial cladding. Answers to this part of the question were sometimes limited with for example, candidates not recognising the importance of providing an insulating barrier for steel, of the role of intumescent material or the importance of compartmentation.

Question 10 *Part 4 of the Construction (Design and Management) Regulations 2007 require that certain places of construction work are to be inspected by a competent person.*

(a) ***Identify****:*

(i) *when statutory inspections of supported excavations must be carried out;* ***(3)***

(ii) *the information that should be recorded in a statutory excavation inspection report.* ***(5)***

(b) ***Outline*** *the particular features of an excavation that could result in it being considered unsafe.* ***(12)***

NEBOSH acknowledges the error that appeared on the question paper incorrectly making reference to The Construction (Health, Safety and Welfare) Regulations 2007 instead of Part 4 of the Construction (Design and Management) Regulations 2007, in introducing a question on statutory inspection of excavations.

NEBOSH apologise for this error but wish to assure candidates & accredited course providers that the mark scheme for this part question (worth 8 out of 120 marks on the paper) would be identical if it was answered with regard to the provisions of the current or the previous Regulations.

This error and candidates' responses have been reviewed by the examining team and the NEBOSH Diploma Panel, the outcome being that all candidates sitting the Unit C paper were awarded special consideration primarily to address the impact of the error on their choice of questions in Section B.

Under the Regulations, an inspection of an excavation must be carried out at the start of every shift before work commences, after an event that may have affected the stability of the excavation and following an unintentional fall of material.

For part (a)(ii), information that should be recorded in the inspection report includes the name and position of the person making the report; the name and address of the person on whose behalf the work was carried out; a description of the place of work inspected including the plant and equipment in use; the date and time of the inspection; the details of any matter identified that could lead to risk, the action to be taken to prevent the risk and the details of any further action necessary.

In answer to part (b), required candidates to outline a number of reasons that could lead to an excavation being considered unsafe such as its proximity to adjoining structures; the inadequacy or incomplete nature of the means of support for the type of soil where the excavation was sited; damage to or the dislodgement of the supports provided such as metal sheets or walings; the presence of excess water either from damaged pipes or land drains; damaged services and the presence of fallen rock, earth or other materials in the excavation; a failure to provide adequate means of access and egress; the presence of spoil or materials placed too close to the edge of the excavation; a failure to provide stop blocks despite the use of vehicles in close proximity to the excavation; the presence of gas or fumes or biological or chemical hazards and a failure to provide adequate barriers and warning signs to prevent persons from approaching and falling into the excavation.

Question 11

(a) *With respect to UK mains voltage electricity, **outline** the factors that determine the severity of the effects of an electric shock.* ***(6)***

(b) *For **EACH** of the following protective devices, **describe** their principles of operation:*

(i) *residual current devices;* ***(3)***

(ii) *fuses;* ***(3)***

(iii) *110v centre tapped to earth reduced voltage systems.* ***(3)***

(c) ***Outline** other design features of electrical systems intended to improve safety.* ***(5)***

In answering part (a) of this question, credit was given for reference to factors including the voltage, the nature of the current (whether alternating or direct), the body resistance of the individual with reference to age, gender, the amount of moisture (perspiration) on the body and the type of footwear worn, the route taken by the current through the body, the speed of action of any protective measures and the environmental conditions, such as the floor material and the presence of water. Knowledge of Ohm's Law was useful in relating the size of current to voltage and resistance.

In answering part (b), candidates were expected to describe that a residual current device is designed as a shock limiting device and not for system protection. It operates on an earth leakage fault. Any differential in the current passing through the line (neutral) and phase (live) conductors is detected, operating a switch to cut off the electrical supply to the apparatus and preventing severe electric shock. The nominal operating current is 30mA and the device should operate within 30 to 50 milliseconds of the fault being detected.

A fuse is a device placed in the live side of a circuit, designed to automatically cut off the power supply to the circuit within a given time when the current flow in the circuit exceeds a given value and produces sufficient heat to melt the fuse which is designed to do so at a predetermined temperature. It prevents the overload of an electrical system and overheating of electrical wiring. However, its speed of operation is generally too slow to protect people from electric shock. There are still candidates, however, who claim that fuses are a protection device for humans rather than the system.

One of the better ways of reducing the risk from electricity is to reduce the voltage, achieved by the use of a step down transformer. A common reduction is to 110volts and a transformer used to attain the reduction is described as centre tapped to earth in that the secondary winding of the transformer is earthed to its centre thus ensuring that the maximum voltage from live to earth involved in an electric shock will be 55 volts.

For part (c), candidates could have outlined other design features intended to improve safety such as the selection and colour coding of cables and placing them out of reach wherever possible; the provision of effective means of isolation to ensure the secure disconnection and separation of electrical equipment from every source of energy; the use of earthed systems and Class 1 equipment or double insulated Class 2 equipment; the use of circuit breakers and the introduction of earth free zones. Few candidates were able to come up with anything more than circuit breakers or double insulation.

This question again showed that many candidates do have difficulty in answering a question where electricity is involved. Examiners have suggested that this subject should be given more attention by providers since all candidates will have to contend with the risks associated with electricity at some time in their working life.

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Common pitfalls

It is recognised that many candidates are well prepared for their assessments. However, recurrent issues, as outlined below, continue to prevent some candidates reaching their full potential in the assessment.

- Many candidates fail to apply the basic principles of examination technique and for some candidates this means the difference between a pass and a referral.
- In some instances, candidates are failing because they do not attempt all the required questions or are failing to provide complete answers. Candidates are advised to always attempt an answer to a compulsory question, even when the mind goes blank. Applying basic health and safety management principles can generate credit worthy points.
- Some candidates fail to answer the question set and instead provide information that may be relevant to the topic but is irrelevant to the question and cannot therefore be awarded marks.
- Many candidates fail to apply the command words (also known as action verbs, eg describe, outline, etc). Command words are the instructions that guide the candidate on the depth of answer required. If, for instance, a question asks the candidate to ‘describe’ something, then few marks will be awarded to an answer that is an outline. Similarly the command word ‘identify’ requires more information than a ‘list’.
- Some candidates fail to separate their answers into the different sub-sections of the questions. These candidates could gain marks for the different sections if they clearly indicated which part of the question they were answering (by using the numbering from the question in their answer, for example). Structuring their answers to address the different parts of the question can also help in logically drawing out the points to be made in response.
- Candidates need to plan their time effectively. Some candidates fail to make good use of their time and give excessive detail in some answers leaving insufficient time to address all of the questions.
- Candidates should also be aware that Examiners cannot award marks if handwriting is illegible.
- Candidates should note that it is not necessary to start a new page in their answer booklet for each section of a question.

UNIT C – Workplace and work equipment

Section A – *all questions compulsory*

Question 1 ***Outline*** *the issues that need to be addressed when planning a fire evacuation procedure for a multi-storey office building.* ***(10)***

An initial issue that would have to be addressed would be the means of raising the alarm when a fire or other emergency is discovered and the summoning of the emergency services. In order to achieve the safe evacuation of both employees and members of the public some of whom may have sensory or physical disabilities, consideration would have to be given to physical measures such as travel distances and alternative routes, emergency lighting, clear signage of exit routes, the location of assembly points, the provision of access for emergency services and the provision of refuges and evacuation equipment as well as procedural measures such as clarifying staff responsibilities, training fire wardens, accounting for personnel and providing door marshals to prevent entry or re-entry to the office building. Security considerations such as minimising the opportunity for theft would also be an issue here. Liaison with the emergency services should form part of the planning process since they can help with advice on issues such as response times, their access requirements and appropriate locations of assembly areas. There should also be liaison with neighbouring businesses that could be affected by an emergency within the office building. The procedures, once drawn up, would need to be summarised on prominently displayed fire notices and tested with regular fire drills.

Most candidates got off to a good start in answering this question though there was only the occasional reference to important matters such as the possibility of a phased evacuation or liaison between tenants. Those who did not do so well concentrated on hardware issues such as the provision of fire fighting equipment, or general fire risk assessment issues, rather than the required organisational issues whilst a few focussed on one or two areas only providing excessive detail for little reward.

Question 2 *In order to install a large item of machinery such as a turbine rotor, it is sometimes necessary to perform adjustments while the rotor is in motion. These adjustments are necessarily undertaken with the rotor in an unguarded condition.*

Outline** the elements of a safe system of work for this activity.* ***(10)

The elements of a safe system of work for carrying out the operation described in the question include: the use of experienced workers fully trained in the systems to be adopted since this is not a task to be carried out by the young or inexperienced; the provision and use of a single one piece close fitting overall with no external pockets together with arrangements to ensure there are no other entanglement hazards present such as the wearing of jewellery, pendants for example, or long hair; the use of temporary guards or the isolation of parts of the machine which are unnecessarily exposed; where practicable the use of jigs to ensure workers' hands are distanced from the unguarded rotor; the provision of a "stand by" man in direct contact with the person carrying out the work with means of immediate communication such as telephone or radio to ensure an emergency response should the need arise; the provision, close at hand, of an emergency stop or braking arrangements; the use of an inching device to minimise the free rotation period or using the slowest speed possible consistent with the task; the provision of non-stroboscopic lighting; the introduction of a permit to work to formalise the establishment of the safe system of work and the erection of barriers and signs to prevent the close approach of non-involved personnel.

Whilst there were some good answers produced for this question, though on occasions, little attention was paid to the command word 'outline' there were some candidates who seemed to be hampered by their lack of familiarity with the machinery mentioned in the scenario and did not realise that the question was concerned with precautions to be taken when work was carried out on any unfenced machinery. A few candidates answered on the basis that the machine would be isolated and locked off – the question suggests otherwise – while others, probably as a last resort, proposed avoiding the work if possible.

Question 3 *Maintenance work on electrical distribution panels and control circuitry commonly involves diagnostic testing and fault finding on live systems.*

Outline** the requirements of the Electricity at Work Regulations 1989 that apply to this situation **AND** the practical precautions that should be in place before the work is undertaken.* ***(10)

Regulation 14 of EAWR sets out three conditions for working on a live system, the first two of which – that it is unreasonable for it to be made dead and that it is reasonable to work on it while it is live – are clearly met in this case since much diagnostic work will require this. Therefore, the third condition – that suitable precautions are take – requires attention and overlaps with other requirements of the Regulations, in particular Regulation 4 relating to electrical systems, work activities and protective equipment. In this respect, distribution panels should have protection rating of at least IP2X by the provision of test points that do not allow access to fingers or tools other than test probes. for example test points of 2mm in diameter. The test probes should be insulated and fused and the test meter must be checked prior to use. The area should be cordoned off by the use of barriers to prevent unauthorised access and, depending on the circumstances, insulating mats and/or gloves may be required. All live working should be subject to a permit to work system.

Regulation 16 of EAWR requires the engineer to be technically competent or to be closely supervised, having regard to the nature of the work, by someone who is competent. Persons involved with the work should therefore possess recognised qualifications and have experience in the type of work being undertaken. In order to comply with Regulation 7 relating to the protection of conductors, all incoming and outgoing supplies should be suitably insulated and shrouded. Additional shrouding may be required. With regard to earthing – Regulation 8 – the cabinet should be connected to the main earth and the cabinet door earth-bonded to the cabinet. The other main concern is to ensure that there is sufficient working space, suitable access and adequate lighting, as required by Regulation 15.

Answers to this question varied in quality. Some candidates showed a good knowledge of the Regulations, addressed their requirements, referred to the 'three conditions' and outlined the controls to be put in place. There were others, however, who did not appear to have an understanding of the requirements for working on live equipment or did not realise that the question was concerned with these precautions since they suggested that the circuit should be isolated. A few relied on the provision of information and training without supplying any further detail.

Question 4 *X-ray radiography is a non-destructive testing (NDT) technique that is sometimes used to examine the internal structure of fuel tanks in the wings of large passenger aircraft.*

(a) ***Outline*** *the principles of operation when using X-ray radiography for this application.* ***(4)***

(b) *Other than visual inspection,* ***explain*** *why different forms of NDT might not be appropriate for this application.* ***(4)***

(c) ***Identify TWO*** *disadvantages in the application of X-ray radiography.* ***(2)***

In answering part (a) of the question, Examiners expected candidates to outline how radiation would be generated by a portable electrically powered machine such as a generator focussed into a beam by lead shielding. The beam would be directed to penetrate the wing skin to reach a film or electronic sensor placed inside the tank on the opposite side of the wing. An image of the intervening structure within the wing is created on film after photographic development or on the electronic sensor after electronic processing, with defects being revealed by the contrast between light and dark areas. The image has light areas where less radiation reaches the film or sensor after passing through unbroken or sound structure, whereas the image has darker areas where more radiation reaches the film or sensor through voids or cracks in a structural element which is faulty. This part of the question was not well answered with many candidates showing confusion between radioactive sources and x-rays generated by a machine.

For part (b), candidates should have selected at least four other forms of NDT and explained why each might not be appropriate for the scenario described. For example, gamma radiography would be impractical and too expensive; eddy current can experience spurious defect indications and does not provide a permanent record; dye penetrant shows only surface cracks with accessibility to tanks being impossible; magnetic particle testing does not work on non-ferrous metal and there would again be the problem of tank inaccessibility; while there would be no indication of fault location from tap testing. There was the occasional reference to dye penetrant and tap testing but in general answers were to a poor standard. While candidates did seem to be aware of some different forms of NDT, they did not seem to know how they worked or why they could not be applied in the circumstances described.

Answers to part (c), however, were to a better standard with candidates identifying disadvantages in the application of x-ray radiography such as the manual handling of heavy equipment; there is the possibility of exposure to x-rays; training in interpretation skills is necessary for the operators and its use is relatively expensive.

Question 5 ***Outline*** *the key safety features of a facility that is to be used for the storage of highly flammable solvents in 200 litre drums.* ***(10)***

In answering this question, marks were available for outlining features such as bunding to contain spills, including a facility to collect and dispose of spillages; the building to be erected on an impermeable base with an adequate separation distance from other buildings and constructed of fire resistant materials with a light weight roof or blast panels; a facility for the segregation of materials; adequate access and egress including a ramp to facilitate the handling of drums; the provision of high/low ventilation and of sprinklers/ fire extinguishers to be used in the event of an emergency; the clearance of vegetation round the storage area and finally security features such as the provision of locks and warning signs.

Most safety features were mentioned though occasionally the provision of an impermeable base and clearance of vegetation were omitted. A few candidates did rely on generalised statements such as 'ventilation' and 'suitable fire fighting equipment' without supplying the additional detail necessary to gain the marks.

Question 6 *The use of a tower crane on a construction site must be notified to the Health and Safety Executive before it is brought into first use.*

Outline *the safety concerns in relation to the use of tower cranes on construction sites that have influenced the introduction of this legal requirement.* ***(10)***

In answering this question, candidates might first have referred to the safety concerns connected with the initial erection of the crane such as the mis-assembly of structural components, undetected component defects and a failure to carry out a pre-use inspection of the crane which would have identified defects such as the incorrect installation of the slewing ring and/or jib, and the mis-specification of the independent crane to be used in the erection. Additionally, there were concerns regarding the inadequate support of components during extension or dismantling with stability being compromised during an extension operation often because of poor communication as a result of the distance from the ground. There were also instances of inadequate clearance zones where more than one tower crane was used on a site and over flight of areas outside the curtilage of the construction site. Finally there were concerns about the access to the control cab, often by climbing vertical ladders which required a high standard of fitness and that inadequate cab welfare such as heating and the ability to take refreshment might lead to human error.

This question proved troublesome for the majority of candidates. There seemed little knowledge of the notification procedures or of the reasons why they were brought into force, despite tower cranes being the only category of lifting equipment with specific legal requirements beyond the general application of LOLER Many candidates approached the question purely from a LOLER point of view and did not consider the specific concerns associated with the use of tower cranes.

Section B – *three from five questions to be attempted*

Question 7 *A storage tank requires inspection, cleaning and repair. It is 6 metres in diameter and 10 metres high and was previously used for storing leaded petrol.*

Outline** the arrangements that should be considered in order to comply with the Confined Spaces Regulations 1997.* ***(20)

Good answers to this question were those that approached the proposed work in a logical and sequential way, clearly outlining with examples what would be required at each stage in order to comply with the relevant legislative requirements, in this case those of the Confined Spaces Regulations (CSR).

Regulation 4(1) requires that no person should enter a confined space unless it is not reasonably practicable to achieve the intended purpose without such entry. Candidates should therefore have considered whether the work or any part of it, could be done without entering the tank for example by using remotely controlled cameras, robotic inspection systems or a cleaning lance operated from outside the tank. If this were not possible, a safe system of work in relation to any of the relevant specified risks would have to be provided. In this case the relevant risks relate to fire and explosion and loss of consciousness due to asphyxiation or high temperatures. In order to develop the safe system of work, a full risk assessment would have to be carried out when consideration would have to be given to the likelihood of flammable atmospheres from the previous contents of the tank, the possibility of air contamination from the cleaning or repair methods used and the build-up of heat within the tank. The assessment would also need to look at other issues from the work to be carried out including working from height and the toxic effects of lead.

The arrangements that the risk assessment might find to be necessary relate to the possible need to purge the tank with an inert gas, the use of forced ventilation, atmospheric testing before and during entry and the provision of personal protective equipment possibly including air-fed breathing apparatus. Attention would also need to be paid to the requirements for electrical equipment (for example intrinsically safe or flameproof) and earthing arrangements. If heat were to be a foreseeable problem, then consideration should be given to issues such as job rotation and fluid intake. Additionally, consideration should be given to the prevention of falls from height and the means of access and egress in the event of escape and rescue. Procedural arrangements would centre on the establishment of well-defined systems of work, the implementation of an entry permit system, limiting the number of people working in the tank, communication with standby personnel and drawing up the emergency arrangements required by Regulation 5 of the CSR.

The emergency arrangements to be considered, and which should be in place before entry is allowed would include issues such as the provision and maintenance of cutting equipment, hoists for top entry rescue, fire-fighting equipment, personal protective equipment such as breathing apparatus, first aid facilities including resuscitation apparatus and liaison with the emergency services. Additionally, arrangements should be in place to ensure that all personnel involved in the operation including the emergency response team, have received sufficient training in the work methods, the precautions needed and the procedures to be followed in the event of an emergency.

This was a popular question and answers were generally to a reasonable standard. If there were deficiencies, it was that few candidates actually referred in any detail to the hazards that were present in the task and many missed the reference to its former use in storing leaded petrol. Examiners did comment that in many cases answers provided were unstructured. Had more care been taken with their structure, this would have ensured that nothing was missed in the answer, and additional marks might well have been gained.

Question 8

(a) *With reference to the Pressure Systems Safety Regulations 2000,* ***explain*** *what is meant by a 'pressure system'.* ***(4)***

(b) ***Outline FOUR*** *examples of the mechanisms of mechanical failure in pressure systems.* ***(8)***

(c) ***Outline*** *the technical* ***AND*** *procedural measures to minimise the likelihood of failures in pressure systems.* ***(8)***

A 'pressure system' is a system comprising one or more pressure vessels of rigid construction, any associated pipe work and protective devices; the pipe work with its protective devices to which a transportable pressure receptacle is, or is intended to be connected; or a pipeline and its protective devices which contains or is liable to contain a relevant fluid, but does not include a transportable pressure receptacle. Better responses included examples of a 'relevant fluid' such as steam; a liquid which has a pressure 0.5 bar above atmospheric at the temperature of the liquid or at 17.5º C; a fluid or mixture of fluids which is at a pressure greater than 0.5 bar above atmospheric pressure when in equilibrium with its vapour at either the actual temperature of the liquid or at 17.5 degrees Celsius; or a gas dissolved under pressure in solvent contained in a porous substance at ambient temperature and which could be released from the solvent without the application of heat. Answers to this part of the question were to a reasonable standard with many candidates showing a good recall of the definition of a 'pressure system'.

The second part of the question required candidates to outline four examples of the mechanisms of mechanical failure in pressure systems such as excessive external stress; overheating; ductile failure; mechanical fatigue; thermal fatigue; brittle fracture; creep; hydrogen embrittlement at welding repairs; corrosion with internal fluids; water/steam hammer and caustic embrittlement. Few candidates were able to provide the required four examples and there seemed to be a general lack of understanding of the term 'mechanical failure' with some offering nothing more than broken pipes with no suggestion of how the breakage might have occurred.

Part (c) of the question required candidates to outline the technical and procedural measures that should be taken to minimise the likelihood of failures in pressure systems. These include a correct design specification ensuring the system was fit for purpose; fitting specific safety features such as pressure relief valves and level sensors; ensuring quality control during the manufacture; the introduction of inspection and maintenance procedures including statutory examination with the scheme of examination being prepared by a competent person; the role of non-destructive testing; ensuring the system operates within its design parameters and, in the case of boilers, the filtering and treatment of water. Answers generally contained only a limited number of measures with most candidates relying on maintenance and the training of staff.

Question 9

(a) ***Describe*** *the effects of a fire in a workplace on the following structural materials:*

(i) *steel;* ***(4)***

(ii) *concrete;* ***(4)***

(iii) *wood.* ***(4)***

(b) ***Outline*** *the precautions that could be taken to prevent failure of these materials in the event of fire.* ***(8)***

In answering part (a) of the question, candidates should have recognised that steel expands on heating, loses strength as the temperature rises and tends to deform and buckle. It regains strength on cooling but its properties may have changed. Concrete on the other hand exhibits limited expansion and has a tendency to spall and crack which can be exacerbated by the expansion of steel reinforcement within the concrete. The structural strength of concrete is lost on cooling and it loses structural integrity. As for wood, while thin sections will burn and promote fire, the charred surface of thicker structural members may act as an insulator to protect the inner timber. However, burning timber generates smoke and fumes and allows the surface propagation of fire. Some varieties of timber are more resistant to fire than others while large timbers generally tend to retain their structural integrity. This part of the question was generally well answered though some did have difficulty in describing the effects of fire on concrete, suggesting that it would revert to sludge.

Part (b) was concerned with the precautions that could be taken to prevent failure of the materials in the event of fire. Steel might be protected by the use of sprayed concrete or fibre board of an appropriate rating, while for concrete, the selection of the type of mix to improve fire resistance and increasing the thickness of concrete between the external face and reinforcement bars would provide some protection. Failure of wood may be prevented by selecting fire resistant timber, increasing the thickness used to allow for a charring outer layer or impregnating it with fire retardant. Other general precautions include the provision of means such as compartmentalisation to prevent heat transfer through long steel members in the event of fire; automatic means of applying water to structural members should fire occur and the use of fire resistant surface claddings or flammable sacrificial cladding. Answers to this part of the question were sometimes limited with for example, candidates not recognising the importance of providing an insulating barrier for steel, of the role of intumescent material or the importance of compartmentation.

Question 10 *Part 4 of the Construction (Design and Management) Regulations 2007 require that certain places of construction work are to be inspected by a competent person.*

(a) ***Identify****:*

(i) *when statutory inspections of supported excavations must be carried out;* ***(3)***

(ii) *the information that should be recorded in a statutory excavation inspection report.* ***(5)***

(b) ***Outline*** *the particular features of an excavation that could result in it being considered unsafe.* ***(12)***

NEBOSH acknowledges the error that appeared on the question paper incorrectly making reference to The Construction (Health, Safety and Welfare) Regulations 2007 instead of Part 4 of the Construction (Design and Management) Regulations 2007, in introducing a question on statutory inspection of excavations.

NEBOSH apologise for this error but wish to assure candidates & accredited course providers that the mark scheme for this part question (worth 8 out of 120 marks on the paper) would be identical if it was answered with regard to the provisions of the current or the previous Regulations.

This error and candidates' responses have been reviewed by the examining team and the NEBOSH Diploma Panel, the outcome being that all candidates sitting the Unit C paper were awarded special consideration primarily to address the impact of the error on their choice of questions in Section B.

Under the Regulations, an inspection of an excavation must be carried out at the start of every shift before work commences, after an event that may have affected the stability of the excavation and following an unintentional fall of material.

For part (a)(ii), information that should be recorded in the inspection report includes the name and position of the person making the report; the name and address of the person on whose behalf the work was carried out; a description of the place of work inspected including the plant and equipment in use; the date and time of the inspection; the details of any matter identified that could lead to risk, the action to be taken to prevent the risk and the details of any further action necessary.

In answer to part (b), required candidates to outline a number of reasons that could lead to an excavation being considered unsafe such as its proximity to adjoining structures; the inadequacy or incomplete nature of the means of support for the type of soil where the excavation was sited; damage to or the dislodgement of the supports provided such as metal sheets or walings; the presence of excess water either from damaged pipes or land drains; damaged services and the presence of fallen rock, earth or other materials in the excavation; a failure to provide adequate means of access and egress; the presence of spoil or materials placed too close to the edge of the excavation; a failure to provide stop blocks despite the use of vehicles in close proximity to the excavation; the presence of gas or fumes or biological or chemical hazards and a failure to provide adequate barriers and warning signs to prevent persons from approaching and falling into the excavation.

Question 11

(a) *With respect to UK mains voltage electricity, **outline** the factors that determine the severity of the effects of an electric shock.* ***(6)***

(b) *For **EACH** of the following protective devices, **describe** their principles of operation:*

(i) *residual current devices;* ***(3)***

(ii) *fuses;* ***(3)***

(iii) *110v centre tapped to earth reduced voltage systems.* ***(3)***

(c) ***Outline** other design features of electrical systems intended to improve safety.* ***(5)***

In answering part (a) of this question, credit was given for reference to factors including the voltage, the nature of the current (whether alternating or direct), the body resistance of the individual with reference to age, gender, the amount of moisture (perspiration) on the body and the type of footwear worn, the route taken by the current through the body, the speed of action of any protective measures and the environmental conditions, such as the floor material and the presence of water. Knowledge of Ohm's Law was useful in relating the size of current to voltage and resistance.

In answering part (b), candidates were expected to describe that a residual current device is designed as a shock limiting device and not for system protection. It operates on an earth leakage fault. Any differential in the current passing through the line (neutral) and phase (live) conductors is detected, operating a switch to cut off the electrical supply to the apparatus and preventing severe electric shock. The nominal operating current is 30mA and the device should operate within 30 to 50 milliseconds of the fault being detected.

A fuse is a device placed in the live side of a circuit, designed to automatically cut off the power supply to the circuit within a given time when the current flow in the circuit exceeds a given value and produces sufficient heat to melt the fuse which is designed to do so at a predetermined temperature. It prevents the overload of an electrical system and overheating of electrical wiring. However, its speed of operation is generally too slow to protect people from electric shock. There are still candidates, however, who claim that fuses are a protection device for humans rather than the system.

One of the better ways of reducing the risk from electricity is to reduce the voltage, achieved by the use of a step down transformer. A common reduction is to 110volts and a transformer used to attain the reduction is described as centre tapped to earth in that the secondary winding of the transformer is earthed to its centre thus ensuring that the maximum voltage from live to earth involved in an electric shock will be 55 volts.

For part (c), candidates could have outlined other design features intended to improve safety such as the selection and colour coding of cables and placing them out of reach wherever possible; the provision of effective means of isolation to ensure the secure disconnection and separation of electrical equipment from every source of energy; the use of earthed systems and Class 1 equipment or double insulated Class 2 equipment; the use of circuit breakers and the introduction of earth free zones. Few candidates were able to come up with anything more than circuit breakers or double insulation.

This question again showed that many candidates do have difficulty in answering a question where electricity is involved. Examiners have suggested that this subject should be given more attention by providers since all candidates will have to contend with the risks associated with electricity at some time in their working life.

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