2396-402 Level 4 Principles, Design, Erection and Verification of Electrical Installations.

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Chief Examiner's report – June 2019

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1 Introduction

The purpose of this document is to provide centres with feedback on the performance of candidates in the June 2019 examination for 2396-402 Design, Erection and Verification of Electrical Installations.

The Chief Examiners' Report has been reintroduced as a result of feedback from centres, to give them guidance in preparing candidates for the written examination.

2 Feedback on candidate performance

General feedback

The following comments are intended to help students prepare for the examination by having a better understanding of what is expected of them. The feedback within this report would also be valuable to tutors in understanding candidates' difficulties in answering questions and the areas where more guidance is required.

The June 2019 question paper was found to be in accordance with the scheme requirements. The examination entry for this series was approximately 130.

This examination contained no errors and was judged to be of the correct level, covering the required parts of the test specification.

As BS 7671:2018 became the only current version from January 2019, this assessment only permitted answers reflecting these requirements.

Candidates who simply **quote text** from permitted publications, such as BS 7671, will not score well where questions require an **explanation** or **description**. Candidates must interpret the requirements to suit any given scenario within the question.

Where questions are seeking **why** particular regulations or measures are required, candidates must take care to explain 'why' as opposed to 'what' the requirements are or 'how/where' they are applied.

Responses to questions in this series were generally very disappointing with many candidates not being able to demonstrate understanding. Questions requiring recall of a procedure generally scored fairly well. However, where understanding of factors affecting selection or protective measures were required, most responses lacked understanding - if these items were attempted at all. In addition, candidates did not seem to fully read some questions, especially where **minimum** conductor sizes were required. Instead, candidates often simply selected conductor sizes which were not necessarily the minimum.

Centres should be encouraged to teach candidates the reasons why certain regulations exist, change or are introduced to BS 7671. Understanding why regulations change gives far better insight into where these regulations are essential, and the risks associated. Centres may wish to use resources such as 'Wiring Matters' produced by IET, as well as the IET website where articles can be found giving background to some of the topics which are often raised within this assessment. These include risks such as those associated with PME arrangements, support for wiring systems in order to protect firefighters operating in buildings and structures and situations where some installations require surge protection.

Within this assessment, it was very disappointing that some of the most basic of questions were incorrectly answered even though the answers are contained in BS 7671, for example

the required location of an RCD notice. It was evident that most candidates simply assumed the location rather than having looked for the answer. This type of error costs valuable marks but is also a common error seen in industry, which is one of the reasons it is asked within this type of assessment.

Centres should encourage potential candidates to have recently achieved City & Guilds 2382: Requirements for Electrical Installations, before enrolling onto this course or include a similar course of study as an addition to this course.

Cable Design Calculations

The ability to size a simple circuit was poorly demonstrated this series, with some candidates unable to determine the csa correctly taking into consideration current capacity **and** voltage drop (see below). In addition, it was surprising to see how many candidates did not apply the rating factors correctly and some of this seems to be due to poor calculator skills. Centres should make candidates aware that brackets should be used in some calculations.

There was also a significant number of candidates using incorrect processes to determine current carrying capacity. Centres are encouraged to seek guidance from IET publications in order to instruct correctly. Where rating factors are applied to the design current, a suitable, full and correct process must be used for these marks to be awarded.

Few candidates were able to determine a minimum csa of live conductors based on voltage drop suitability. Many simply seemed to return to that part of the question, once selecting a live conductor csa based on capacity, and simply calculated the actual voltage drop. Few candidates correctly applied the power factor to the voltage drop calculation, and thus lost the associated marks. Responses such as these show candidates are recalling a procedure rather than showing understanding of the subject.

Candidates generally apply a reasonable understanding of design in regard to earth fault loop impedance and the application of the adiabatic equation as Chapter 54 of BS 7671, however responses were generally poorer than previous series.

Where a question requires the **minimum** csa for the cpc, candidates should use the maximum Z_s and work out R_1+R_2 from this, thus determining the minimum csa bearing in mind the R_1 csa was determined in question 1. If the csa in question 1 was incorrect, this would not be penalised when used to calculate answers for question 2 and whatever a candidate selects for question 1 would be marked as correct for question 2. Many candidates simply assumed the cpc size or used the tabulated figure from table 54.7, which was not the minimum, reducing marks accordingly.

Conclusions to questions are **as** important as the calculations used to arrive at an answer. A large part of the design process is justification of sizes selected. Candidates are encouraged to conclude their selections by making comparisons to permitted and/or calculated values.

Candidates must be made aware of the two forms of adiabatic equation and where it is suitable to apply each. Incorrect use of the equation requires a candidate to perform more calculations than is required for justification and, if looking at the wrong Chapter in BS 7671, incorrect values of ‘k’ may be used. Marks will be lost if the wrong data or calculation is utilised especially where a question requires calculations to a specific regulation.

Knowledge of BS 7671 (Design)

A working knowledge of BS 7671 is required by all candidates. Some candidates are able to recite the requirements of BS 7671 but are unable to demonstrate how these requirements are applied by using examples or explanations. Candidates at this level must be able to interpret requirements. Quoting regulation numbers or content only, is not a suitable response unless a question requires a candidate to **state** or **list** requirements.

A question seeking considerations relating to the external influences where socket-outlets are in proximity to a sink attracted some very basic responses with dimensions stated (which are not contained in BS 7671), rather than a proper assessment such as potential splashes of water, equipment likely to be used etc. An assessment of general characteristics (Part 3 of BS 7671) is an essential part of design and should proceed any design calculations. In particular, Chapter 32 requires an assessment of external influences and the impact this has on any installed equipment and the characteristics of that equipment to be suitable, such as IP ratings.

Centres are encouraged to research the risks associated with PME earthing arrangements and the reason for additional source electrodes. With requirements relating to this subject being introduced into BS 7671, such as foundation electrodes, this is a subject that needs designers to have a full grasp of, as are the risks associated with an open circuit PEN conductor. This is an area of great concern within the electrical industry.

One very simple question relating to extraneous conductive parts attracted varied responses. Knowing the difference between exposed and extraneous is essentially a Level 2 subject and should be seen as a simple question at Level 4.

Once again, the vast majority of candidates determined **earth fault loop impedance** values when asked to determine **short-circuit current protection**. Centres need to pay particular attention to this during delivery. A short circuit is between live conductors and an earth fault is between Line and Earth. Using an earth loop impedance value to determine short circuit will not attract marks. In addition, the correct adiabatic equation used for short circuit protection is contained in Chapter 43 and should not be confused with the one in Chapter 54 and its values of k.

In addition, some candidates seemed to confuse the fact that the question related to an electric vehicle charging point. In cases relating to short circuits, the equipment has very little bearing on the short circuit protection for the circuit as a circuit is a circuit no matter what it supplies.

Knowledge of BS 7671 (Selection and Erection)

Many candidates seemed to confuse the requirements for the supporting of wiring systems (Chapter 52) with those around escape routes (Chapter 42), with many reciting requirements for escape routes in general rather than those associated with supporting systems against premature collapse. Once again, understanding the reasons behind certain regulations would greatly assist candidates. Knowing that the requirements of Chapter 42 are to ensure the evacuation of persons is not hindered by electrical equipment and that the requirements of Chapter 52 are to protect firefighters who enter a building after people are evacuated would assist better understanding.

Selection of surge protection device types and connection type seemed to confuse some candidates even though Chapter 53 contains much guidance for this.

Some questions feature in this assessment to challenge higher scoring candidates and in this series, a question relating to the effects of lightning strikes proved to be a challenge. Whilst it is accepted that SPDs do not feature in many installations, the need for this form of protection is growing and in many commercial installations, assessments for their need is becoming more common place.

What was very disappointing was how few candidates understood what precautions are needed when AC circuits pass through ferromagnetic enclosures.

One set of questions attracting 20 marks were considered fairly basic. However, whilst many candidates could list methods of connecting lighting to a fixed installation, as detailed in Section 559, few could explain why RCDs are ineffective when connected to a PEN conductor, with a significant number of candidates stating it would cause nuisance tripping. This shows candidates have a fundamental lack of understanding of these principles.

The reasons why separate conductors are employed where high earth leakage currents are expected was also poorly answered by many candidates. Few candidates could also successfully size minimum csa for an SWA using Table 54.7, although many of these errors appear to have been caused by not reading the question properly and as a result using the wrong cable type.

Verification

Whilst candidates did demonstrate some knowledge and understanding of insulation resistance testing, few could fully explain why all protective conductors should be connected during this test. A large number of candidates gave the same incorrect reasoning for this and centres are encouraged to ensure candidates are correctly taught the vital reason behind testing to the global earth, not an isolated cpc. Many dropped marks for not fully explaining the correct procedure for testing, especially where sensitive devices exist. Detail was lacking for this scenario with many simply stating ‘remove sensitive items’ which would leave circuits open and un-tested. The key is in the detail for these items. Quantity of an answer is not important but quality and key detail is. Bullet point type answers are normally a good way to explain a procedure providing the points contain key information. In questions relating to testing **new** circuits it is not necessary to explain the isolation procedure; candidates waste time by doing so.

Special Locations

As well as having an understanding of the requirements of BS 7671 for Special Installations or Locations, candidates at this level need to demonstrate a knowledge of the risks which lead to these further measures. A good understanding of the risks enables designers to select suitable measures including a better understanding of why certain requirements must be met.

On average, most candidates answered these questions to a reasonably good standard in relation to a marina. It should however be noted that many candidates begin their responses well detailing some of the risks, such as ‘impact to wiring and accessories from boats’ or corrosion from salt water’ but end up reciting requirements. The intention of the questions is to address why the requirements are there, not what each requirement states.

Appendices

Whilst it is not the intention of this qualification to assess the detail of energy efficiency as detailed in Appendix 17, it is not unreasonable for questions to seek understanding of the causes of energy losses in fixed wiring. As the material, length and csa of a conductor all contribute to voltage loss, this in turn leads to energy losses and designers should always be aware of the potential overall losses and seek ways to reduce losses in installations.

3 National pass rate

The national pass rate for the 2396-402 June examination is as follows:

Exam series	Distinction (%)	Merit (%)	Pass (%)	Fail rate (%)
June 2019	**0**	**4.6**	**30.3**	**65.1**

Past examination series

Exam series	Distinction (%)	Merit (%)	Pass (%)	Fail rate (%)
June 2018	**4.8**	**15.7**	**27.2**	**52.3**
December 2018	**2.8**	**7.8**	**29.1**	**60.3**
March 2019	**0.9**	**12.2**	**22.6**	**64.3**

4 Forthcoming Exam Dates are:

Thursday 5th December 2019
Thursday 12th March 2020
Thursday 11th June 2020

5 Note regarding 18th Edition of IET Wiring Regulations

Please note that all 2019 series will only accept answers versioned to the 18th Edition of the IET Wiring Regulations (BS 7671:2018). Candidates are encouraged to ensure they have received a copy of the corrigendum to BS 7671:2018 published by IET and available at **https://electrical.theiet.org/bs-7671/updates/**

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