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

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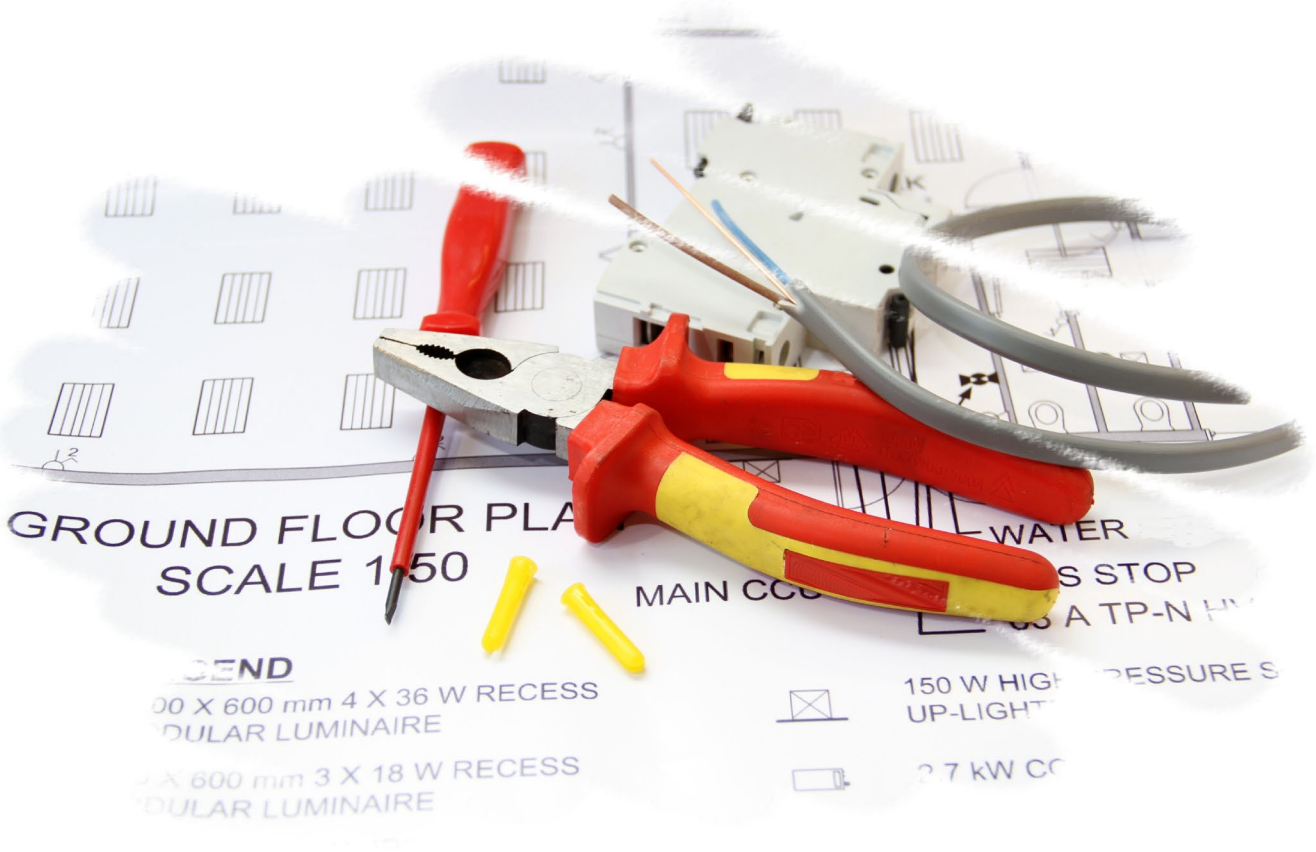
Chief Examiner's report – December 2023



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City & Guilds
5-6 Giltspur Street
London, UK
EC1A 9DE
T +44 (0)192 4930 801 **www.cityandguilds.com**
F +44 (0)192 4930 800 **centresupport@cityandguilds.com**

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1 Introduction

The purpose of this document is to provide centres with feedback on the performance of candidates in the December 2023 examination for 2396-402 Design, Erection and Verification of Electrical Installations.

The Chief Examiners' Report is intended to give centres and candidates guidance in preparing 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 December 2023 question paper was found to be in accordance with the scheme requirements.

The examination entry for this series was approximately 239.

This examination was considered to be correctly levelled and compared as being very similar to other recent series.

Questions in this series covered a wide range of subjects across the assessment criteria of BS 7671. A good knowledge of BS 7671, as well as an understanding of its requirements and **why** the requirements are there would have been an advantage to many candidates.

Strengths demonstrated in this series included research of Fundamental Principles in BS 7671 as well as the requirements for the Assessments of General Characteristics.

Many candidates seemed unable to apply the correct principles when designing a ring-final circuit in Section A of the paper, and instead, applied calculations consistent with radial circuits.

As with many previous series, candidates need to scrutinise questions to ensure they are picking out the key details within the question. A good example of this is where candidates responded to a question regarding an insulation resistance test with general requirements or risks associated with a TT installation.

Section A: Cable Design Calculations

Methods of determining conductor cross-sectional area for a ring-final circuit proved to be a challenge for most candidates. Most candidates did not consider Regulation 433.1.204 and the application of 20 A into their calculations for current carrying capacity. This should be used in place of the nominal rating of protective device when applying rating factors as divisors, or as a comparison when applying rating factors as multipliers to a value of tabulated current capacity. Most candidates instead applied rating factors to the stated nominal current rating of protective device as if the circuit was a radial circuit. As a result, candidates arrived at conductor cross-sectional areas of 10 mm^2 which are simply not practical for termination into 13 A socket-outlets.

Calculations for overall voltage drop were also generally calculated as a radial circuit instead of considering the conductors being in parallel in a ring-final circuit. Some candidates did attempt to compensate for the parallel arrangement by halving the overall figure rather than dividing the value by 4. In addition, when verifying the overall voltage drop, few candidates considered the additional losses in the associated distribution circuit.

When determining the minimum cross-sectional area of protective conductor based on earth fault loop impedance, again many candidates did not consider the ring-final circuit principles of having conductors in parallel.

Despite a regulation number being given in the question indicating how the adiabatic equations should be applied, many candidates still applied the incorrect method and as a result, either made incorrect comparison with data or risked using incorrect values of *k* due to being in the wrong section of BS 7671. Centres and candidates should be reminded that Chapter 43 relates to circuit Live conductors and Chapter 54 relates to protective conductors.

Knowledge of BS 7671 (Design)

Most candidates performed well to questions relating to the Fundamental Principles in BS 7671 as well as questions relating to the Assessment of General Characteristics in Part 3.

One question focussed on basic and additional protection of an installation. Whilst many candidates were able to recall methods of basic protection, fewer were able to explain the requirements for basic protection as detailed in Regulation group 416 of BS 7671, especially those for barriers and enclosures with many straying in to fault protection requirements or quoting measures such as placing out of reach or obstacles. As the question made no mention of restricted areas or skilled persons, placing out of reach and obstacles would not be applicable.

In addition to the above, few candidates were able to explain why general socket-outlet circuits require additional protection by a 30 mA RCD with many still citing the need to meet disconnection times. Designers need to understand why appliances, location, environment and carelessness of users all play a part towards the risk of electric shock from electrical equipment, rather than the electrical installation itself.

A question relating to the calculations of short circuit current and how this is verified as suitable appears in every series of this qualification but still, the question is generally poorly responded to. Those who attempted this question generally scored reasonably well when attempting the calculation to determining the value of short circuit current, but a disappointing number are still calculating earth fault loop impedance (Z_S) rather than the short-circuit impedance even though the cpc plays no part in a short circuit.

Very few candidates were able to explain why, in this particular scenario, the calculation was necessary. Generic answers were in the majority, suggesting that candidates assumed that they have to always verify suitability for short-circuit conditions.

Many incorrectly concluded that disconnection would be achieved within permitted maximum disconnection times, rather than demonstrating the understanding that disconnection would occur before cables were heated to their limiting temperatures.

Knowledge of BS 7671 (Selection and Erection)

Part of one question, which focussed on a particular cable installed in a warehouse, attracted a mixture of responses with some candidates mistaking the factors that limit the use of a 90 ºC cable at its maximum temperature rating with rating factors that determine a cable current carrying capacity. If a cable was allowed to operate at its maximum temperature and not limited, this could lead to issues with associated equipment or systems, such as the temperature rating of terminals or adjacent cables.

Part of this question focussed on emergency switching arrangements and this attracted some very basic responses which only focussed on the stop buttons with some very vague responses or loosely related quotes from BS 7671. Few candidates focussed on the whole system such as suitable methods of safely resetting the conveyor system. High risks will exist if the re-setting system is not suitable for the given scenario.

The first part of another question asked about the reasons for BS 7671 recommending the connection of an earth electrode to the main earthing terminal (MET) in a TN-C-S earthing arrangement. Few candidates were able to demonstrate a clear understanding of the dangers arising from the use of distributors' PEN conductors, and many stated that the electrode was necessary for an alternative fault path in the event of a PEN failure. The risks associated with diverted neutral currents are increasing so the need for designers and electricians in general to be aware of these also increases. Centres and candidates are encouraged to research the IET guides and videos available explaining these risks.

One question relating to the requirements of BS 7671 for mounting heights of socket-outlets to BS 1363 attracted responses linked to Approved Document Part M rather than BS 7671. Candidates need to focus on the detail in the question and that this question related to BS 7671 rather than Document M.

A question which focussed on escape routes attracted some basic responses with some simply quoting BS 7671 or regulation numbers rather than providing descriptions. Other responses were well detailed but candidates seemed to wander off the topic of cables and instead start describing the requirements of switchgear. Candidates are encouraged to keep descriptions to the subject of the question.

A question regarding arc fault detection devices (AFDDs) in a particular installation also attracted some vague responses rather than specific to the scenario given. If a question has a scenario, responses should always link to this and not generalise about other types of building.

Verification

The first part of this question related to an insulation resistance test in an installation forming part of a TT earthing arrangement, it was disappointing that few candidates were able to identify why all protective conductors should be connected and therefore tested against during this test. Many responses seemed to ignore that it was an insulation resistance test that was the focus of the question and instead attempted to describe why all protective conductors should be connected, in general, whilst the installation is in use.

The second part of the question focussed on explaining how to undertake an **external** earth fault loop impedance test accurately for this TT installation. Many candidates however, described how to undertake an earth electrode resistance test which is a completely different test. Candidates need to understand the clear differences between these two tests and what the results represent.

Special Locations and Appendices

In this section, one question explored how to facilitate energy efficiency as part of the design process, and this is the focus of Appendix 17 of BS 7671. Whilst some candidates did give some consideration to the installation, its wiring and systems, some candidates seemed to focus on reducing the reliance of electricals installations on public supplies by methods such as the use of Solar PV systems etc. Whilst this does reduce the energy consumed from the public supply, it doesn't actually reduce the energy lost in the installation.

Many candidates were able to list some additional risks associated with electric vehicle charging point installations, but few could actually describe them in any sort of detail.

National pass rate

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

Exam series	Distinction (%)	Merit (%)	Pass (%)	Fail rate (%)
December 2023	**0**	**2.60**	**19.79**	**77.60**

Past examination series

Exam series	Distinction (%)	Merit (%)	Pass (%)	Fail rate (%)
December 2022	**2.72**	**9.78**	**20.11**	**67.39**
December 2021	**0.57**	**5.71**	**29.71**	**64.00**

The grade boundaries for this paper are as follows:

Distinction 150 marks
Merit 125 marks
Pass 100 marks

3 Forthcoming Exam Dates

14th March 2024
13th June 2024
5th December 2024

4 Note regarding 18th Edition of IET Wiring Regulations 2022

Centres must be reminded that permitted materials for this examination must comply with the requirements within the permitted materials document on the qualification webpage. This means that notes or sheets giving design calculation procedures should not be allowed. The permitted publications for this exam are BS 7671, IET GN3 and the IET On-site Guide **only.**

As Amendment 2 of BS 7671 is now established. This must be used for all assessments within this qualification.

Published by City & Guilds
1 Giltspur Street
London
EC1A 9DD
T +44 (0)844 543 0000
F +44 (0)20 7294 2413
www.cityandguilds.com

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