C&G 2395 Exam Paper – April 2013

Section A - All questions carry equal marks. Answer all three questions. Show all calculations.

Q.1 The electrical installation in a small food retail outlet is scheduled for a periodic inspection and test for local authority licensing.

a) Describe how the safe isolation of the single-phase distribution board located in the office area is to be carried out.

b) Explain why the sequence of testing for this periodic inspection may be different to that given in BS 7671 for initial verification.

Q.2 a) A periodic inspection is to be undertaken in a large community centre whic is open to the public.

i) State what must be agreed with the client and recorded before any work is undertaken.

ii) State who else must be considered by the inspector in respect to their safety whilst carrying out this work.

iii) State three actions the inspector must take to ensure the safety of people using the building during the inspection and testing process.

iv) List three documents that should be available to the inspector in order for the inspection and testing to be carried out safely.

b) An inspection is being undertaken within a single phase consumer unit which has been safely isolated and the cover removed. The original certification is available for the inspector.
State five inspection checks to be made which relate to the circuit breakers within the consumer unit.

Q.3 a) i) Explain the cause of voltage drop within an installation.

ii) State the two methods, as given in BS 7671, of determining voltage drop.

b) i) A radial circuit has a load current (I_b) of 40 A at 230 V a.c. and has a combined live conductor resistance of 0.23Ω at 20°C. Determine the voltage drop for this circuit. Show all calculations.

ii) The radial circuit in (bi) above, supplies a single phase heater. Determine whether the voltage drop in(bi) complies with BS 7671. Show all calculations

SCENARIO (SECTION B - QUESTIONS 4 TO 6)

(SOURCE DOCUMENT - DO NOT RETURN TO CITY & GUILDS)

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The new owners of a 10 year old light engineering workshop require a periodic inspection to comply with their statutory obligations. The operation of the workshop is to continue during the inspection and test.

The installation forms part of a single-phase 400/230 V TN-S system having a Ze and PFC of 0.3 Ω and 2.3 kA respectively.

All circuits are installed using thermoplastic 70°C single core cables, having copper conductors, enclosed in surface mounted steel conduit and trunking. **Separate cpc's, having the same csa as the live conductors, are installed throughout the installation.**

A circuit schedule is located adjacent a metal-clad distribution board containing a mixture of BS EN 60898 circuit breakers and BS EN 61009 RCBOs.

All documentation from the initial verification of the original installation and suitable circuit charts have been made available for the inspector. One additional radial power circuit was installed approximately five years ago to supply a sand blasting machine. There is no evidence of any other alterations or additions to the installation and no previous periodic inspections have been carried out.

All the lighting within the building is provided by fluorescent luminaires. Within the toilets and canteen area, the lighting is controlled by presence sensors.

Metallic gas and water installation pipework is installed within the building and 10 mm^2 main protective bonding conductors are concealed within the building fabric and connected to the pipework.

All testing is carried out at a temperature of 20°C.
Figure 1 overleaf shows the results for some of the tests carried out during the periodic inspection.

Circuit Designation			Protective device				Conductor details			Maximum BS 7671 Tabulated Z_s	Test Results								
											Continuity Ω		Insulation Resistance MΩ		Polarity	Z_s	RCD		
																	ms		Function
Way	Phase	Description	BSEN	Type	I_n	kA	Reference Method	Live	CPC		R_1+R_2	R_2	L-L	L-E	✓	Ω	$5I_{\Delta n}$	$I_{\Delta n}$	✓
1	L1	Radial socket left	60898	B	32	3	B	6.0	2.5	1.44	0.26		230	230	✓	0.46	N/A	N/A	N/A
	L2	Radial Socket right	60898	B	32	3	B	6.0	2.5	1.44	0.31		199	199	✓	0.51	N/A	N/A	N/A
	L3	General ring circuit	61009	B	32	3	B	2.5	1.5	1.44	0.39		>299	>299	✓	0.69	25	180	✓
2	L1	Lighting left & Canteen	60898	C	10	3	B	1.5	1.0	2.3		0.72	LIM	99	LIM	2.11	N/A	N/A	N/A
	L2	Lighting centre	60898	C	10	3	B	1.5	1.0	2.3		0.72	LIM	99	LIM	2.11	N/A	N/A	N/A
	L3	Lighting right & toilets	60898	C	10	3	B	1.5	1.0	2.3		0.6	LIM	99	LIM	1.81	N/A	N/A	N/A
3	L1																N/A	N/A	N/A
	L2	Power saw	60898	D	16	3	B	4.0	1.5	0.72	0.33		>299	30	✓	0.53	N/A	N/A	N/A
	L3																N/A	N/A	N/A
4	L1																N/A	N/A	N/A
	L2	Lathe	60898	D	16	3	B	4.0	1.5	0.72	0.5		>299	>299	✓	0.7	N/A	N/A	N/A
	L3																N/A	N/A	N/A
5	L1																N/A	N/A	N/A
	L2	Welder	60898	D	16	3	B	6.0	2.5	0.72	0.15		>150	120	✓	0.35	N/A	N/A	N/A
	L3																N/A	N/A	N/A
6	L1	Fire alarm	60898	B	6	3	B	2.5	1.5	Limitation									
	L2	Security lighting	60898	B	10	3	B	2.5	1.5	4.6		1.09	LIM	90	LIM	1.2	N/A	N/A	N/A
	L3	Sand blaster	60898	C	20	1	B	4.0	1.5	1.15	0.33		>299	>299	✓	0.53	N/A	N/A	N/A

Z_e = 0.3 Ω and PFC = 2.3 Ka

Figure 1

Section B - All questions carry equal marks. Answer all three questions. Show all calculations.

Questions 4 to 6 all refer to the scenario (see source document). Ensure you read this scenario before attempting these questions. Answers you provide must reflect the detail and information given in the scenario.

Q.4 a) State the additional documentation relating to the electrical installation that should be made available for the inspector.

b) State the documents to be completed by the inspector and given to the client on completion of the inspection and test

c) An inspection is being carried out on the main trunking run within the workshop.

i) State three areas that are to be inspected.

ii) State what is being looked for by the inspector for each item in i) above.

iii) State the human sense that will be used during each check in ii) above.

Q.5 Describe how an insulation resistance test is to be carried out on Circuit 2L3.

Q.6 a) Determine, using the information provided in Figure 1 (see source document) showing all calculations, whether the earth fault loop impedance values are acceptable for circuits.

i) 2L1

ii) 2L2

iii) 2L3

b) i) Identify one item on the schedule of test results, in addition to any identified in 6a), which must be recorded as an observation.

ii) State the classification code for any item in (bi) above.

c) i) Determine the earth fault loop impedance value for the power saw circuit, if a direct measurement was not possible.

ii) Explain the reasons for any difference between the measured earth fault loop

Answers

A.1 a) Safe Isolation Procedure

- Identify the equipment to be worked on and its means of isolation.
- Unplug the equipment if possible.
- Isolate and lock off.
- Prove the voltage tester.
- Prove the equipment is dead (phase to neutral and phase to earth).
- Re-prove the voltage tester.
- Attach temporary earth leads if necessary.
- Post caution notices.
- Consider the need for additional precautions.

Further safety procedures may be set in place. Permits to work come into their own when dealing with an electrical piece of equipment or installation and are part of an overall strategy for safety, called a 'safe system of work'.

NOTE See the Electrical Safety Council website 'Guidance on the management of electrical safety and safe isolation procedures for low voltage installations' for comprehensive details.

b) The tests need not be carried out in the order as for the initial verification procedure as the installation will have been in operation for some time.

The same range and level of testing as for initial testing is not necessarily required, or indeed possible. Installations that have been previously tested and for which there are comprehensive records of test results may not need the same degree of testing as installations for which no such records exist.

The person carrying out the testing should decide which of the above tests are appropriate by using their experience and knowledge of the installation being inspected and tested and by consulting any available records.

The inspector will need to set a sample size for testing. Where a sample test indicates results significantly different to those previously recorded, further investigation is necessary. Also, if during the course of testing a sample, significant errors were found that would suggest that the same problems may exist in untested items, then the inspector has to take appropriate action.

This action needs to be either increasing the sampling or referring back to the client; it may be that the inspector recommends that 100 per cent testing is carried out in that area.

A.2 a) i) Prior to carrying out the inspection, the inspector will need to meet with the client or the client's representative to outline the scope and nature of the work required and to highlight likely items that require isolation. That is the degree of disconnection which will be acceptable before planning the detailed inspection and testing must be agreed. Also, the scope, that is, the extent and limitations

of the periodic inspection must be agreed, that is, what is to be covered and what is not covered.

ii) As required by law, it is the inspector's duty to ensure the safety of himself or herself and that of others during the test procedure.

iii)
i) The installation must be isolated before disconnecting protective conductors.
ii) Ensure people cannot access exposed/extraneous conductive parts when using test voltages greater than 50V.
iii) Use correct test equipment to ensure the test limits are met. For example, limitation of earth fault loop impedance test current to 40ms.

iv)
- Design documentation listing type of supply, earthing arrangements, etc.
- Diagrams.
- Charts or tables identifying isolation and protection devices.
- Previous periodic inspection and test results.

b)
- Correctly identified breakers (circuit details)
- Correct type and rating of main switch and breakers (check ratings against conductor sizes)
- Signs of overheating, thermal damage, etc. (no other visible damage).
- Single pole devices in line conductor
- Manual operation of breakers
- Breakers firmly fixed
- Barrier for IP 2X protection over the busbar
- BS or BS EN markings (or other recognised standard)
- All connections secure, correctly terminated and mechanically sound.

A.3 a) i) Resistance within conductors and loose terminations. Temperature fluctuations will affect resistance values.

ii)
- Voltage drop may be evaluated by measurement of circuit impedance.
- By calculation using conductor length, design current and mV Tables.

b) i) Resistance at 70°C (PVC) = 0.23 x 1.2 = 0.276Ω (both conductors)

V = IR = 40 x 0.276 = 11.04V

ii) Power allows a 5% of supply voltage = 11.5V (complies)

A.4 a)
- In addition to the initial verification any previous periodic inspection and test results
- Health and safety information file.
- A minor works certificate for the additional radial power circuit
- Relevant diagrams, tables and charts, etc. showing the installation layout.
- A copy of the EWR, BS 7671, OSG, etc. if required.
- Manufacturer's information, manuals, etc for specific items of equipment, if required.

b)
- Electrical installation condition report.

- Schedules of inspection and test results.
- Guidance for recipients.

c) i)
- Securely fixed
- Internal and external sealing where necessary
- Earthed and joints should be bridged with an earth strap
- Protection against damp and corrosion, etc.
- not overly full and space factor if trunking sizes are outside the scope of tabulated sizes
- choice of trunking finish relevant to external influences.

ii)
- Correct erection and no visible damage so as to impair safety.
- Prevention against spread of fire.
- To meet the requirements of BS 7671 earthing, bonding, earth continuity in order to comply with maximum earth fault loop impedance values.
- No visible damage or deterioration so as to impair safety and suitable for continued use.

iii)
- Visual // touch
- Visual
- Visual
- Visual // smell

A.5
- Permission to switch off required.
- Carry out safe isolation procedure.
- Disconnect presence sensor lighting control devices.
- Test instrument and GS 38 lead checks before starting tests.
- Description of insulation resistance test between L-E see GN3.
  Note: mention 500v d.c. test voltage, 1MΩ minimum resistance and 2MΩ further investigation recommendation.
- Limitation regarding L-L testing of fluorescent fittings.

A.6 a) i) 2L1 2.3 x 0.8 (rule of thumb) = 1.84 Ω

Measured Zs = 2.11 Ω (fails)

ii) 2L2 2.3 x 0.8 = 1.84 Ω

Measured Zs = 2.11 Ω (fails)

iii) 2L3 2.3 x 0.8 = 1.84 Ω

Measured Zs = 1.81 Ω (complies)

b) i) Circuit 6L3 (sand blaster). The breaking current of the Type C circuit breaker is only 1kA and therefore will not withstand the actual PFC of 2.3kA.

ii) Code C2 - unacceptable condition.

c) i) Add the value of Ze to (R_1 + R_2), that is:- Zs = 0.3 + 0.33 = 0.63Ω

ii) Direct (live) measurement of Zs would have been carried out with all bonding conductors in place creating parallel paths which would have reduced the resistance value. Also, (R_1 + R_2) would be measured at ambient temperature giving a higher reading than that under operating (live) conditions.