C&G 2395 Exam Paper – Dec 2012

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

Q.1 The electrical installation in a commercial premise is scheduled for a periodic inspection and test for insurance purposes.

a) List the three documents to be completed and handed to the client on completion of the periodic inspection and test.

b) State the action to be taken by the inspector before the inspection and test can be undertaken where there are no previous documents, details or circuit charts available for the installation.

c) Describe the procedure for isolating a single phase isolator controlling a remote distribution board, once permission to isolate has been given.

Q.2 A periodic inspection is to be carried out on an electrical installation forming part of a TN-S system in a 20 year old dwelling.

a) State ten items to be verified and recorded during the inspection of the all insulated consumer unit before the cover is removed.

b) State five further inspection items to be verified and recorded relating to the earthing and bonding arrangements.

Q.3 A test is to be carried out to establish the resistance of a single 3 metre earth electrode for a generator providing an alternative source of supply to a data storage facility. Describe in detail, with the aid of a fully labelled diagram, how this test would be carried out.

SECTION B - QUESTIONS 4 TO 6 (SCENARIO)

The electrical installation in a vacant seven year old retail outlet requires inspection before the new tenant occupies the building.

The supply and installation form part of a three-phase 400/230 V TN-C-S system having a Ze and PFC of 0.15 Ω and 3.1 kA respectively. All circuits are installed using thermoplastic 70°C insulated and sheathed flat multicore cables, having copper conductors enclosed in surface mounted, PVC conduit and trunking and cable tray within the ceiling voids.

One additional circuit was installed five years ago to supply security lighting at the rear of the premises. There is no evidence of any other alterations or additions to the installation.
The certification from the initial verification of both the original installation and the additional circuit and suitable circuit charts are available to the inspector.
Metallic gas and water installation pipework is installed within the building and 10 mm^2 main protective bonding conductors are installed within the building fabric.

All testing will be carried out at a temperature of 20°C.

Figure 1 shows information taken from the circuit schedule which is adjacent to the metal-clad distribution board containing Type B, BS EN 60898 circuit breakers and BS EN 61009 RCBOs.

Figure 2 below shows the resistance of conductors in mΩ/m at 20 °C.

Circuit No.	Device rating	Description	Conductor csa in mm²	
			Live	cpc
R1	32 A*	Ring final circuit 1 for socket-outlets shop	2.5	1.5
Y1	32 A*	Ring final circuit 2 for socket-outlets staff area	2.5	1.5
B1	16 A	Water heater	2.5	1.5
R2	16 A	Boiler	2.5	1.5
Y2	10 A	Lights shop area A	2.5	1.5
B2	10 A	Lights shop area B	2.5	1.5
R3	6 A	Lights staff area	1.5	1.0
Y3	6 A	Rear security lights	1.5	1.0
B3	-	Spare	-	-
R4	-	Spare	-	-
Y4				
B4				

*** indicates RCBO**

Figure 1

Conductor csa in mm²	Resistance in mΩ/m at 20 °C
1.5	12.1
2.5	7.41
6.0	3.08
10.0	1.83

Conductor resistance in mΩ/m at 20 °C

Figure 2

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

Questions 4 to 6 all refer to the enclosed scenario. 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) List **two** supply parameters, which can **only** be obtained by enquiry, that an inspector needs to record on the main documentation issued following the periodic inspection and test.

b) Explain why it would be permissible for the inspector to carry out a sample inspection and testing of this installation.

c) Explain why the continuity of ring final circuit tests could be omitted from the extent

of the inspection and test.

d) List four items to be verified and recorded during the inspection of the DNO's supply intake equipment.

Q.5 The continuity of main protective bonding conductors is to be confirmed.

a) List the two methods which can be used to confirm continuity of main protective bonding conductors.

b) Explain, giving reasons, which of the methods in a) above must be used for this installation

c) State the main hazard that needs to be considered when using this method.

d) Explain why a main protective bonding conductor is disconnected at one end prior to testing.

e) Determine, showing all calculations, whether a test result of 0.06 Ω is acceptable if the main protective bonding conductor is 33 m long.

Q.6 Describe, in detail, how a test of insulation resistance is to be carried out on circuit R3.

Answers:

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

A.1 a) i) Electrical Installation Condition Report
ii) Schedule of inspections
iii) Schedule of test results
Guidance for recipients' to be appended to the report.

b) Where diagrams, charts or tables are not available, a degree of exploratory work may be necessary so that inspection and testing can be carried out safely and effectively. A survey may be necessary to identify switchgear, controlgear and the circuits they control.

A note may be made in the 'Limitations' box within the periodic certificate stating the absence of any previous documentation.

Optional - Enquiries should be made to the person responsible for the electrical installation with regard to the provision of diagrams, design criteria, electricity supply and earthing arrangements. These diagrams charts or tables should be available throughout the life of the installation for reference.

c)
- Identify the DB to be isolated // Identify the correct isolator. (Do not assume that any notice identifying the equipment for which the isolator has been installed is correct.)
- Switch off and lock off the isolator retaining the key on your person. (There should be no duplicate key which is not accounted for)
- Place a warning notice on the isolator with wording similar to "Danger electrician working – do not switch on"
- Test an approved voltage indicatior using an approved voltage proving unit.
- Test for dead at the incoming cables within the DB between line and neutral and between line and earth.
- Test the voltage tester again to make sure it is still functioning.
- Consider whether any further additional precautions are required before proceeding with the work.

A.2 a)
- Suitably located and accessible for operation, inspection and maintenance, that is, adequate access and working space.
- Suitable degree of protection (IP Codes IP2X and IP4X) and appropriate for the external influences.
- Securely fixed in position.
- No visible damage or deterioration as to impair safety, including cables.
- All screws and fixings accounted for.
- Warning and other relevant labels/notices present, eg. RCD quarterly notice.
- Protection devices showing circuits suitably identified.

- Suitable main switch provided and means of isolation suitably labelled.
- Main switch to be double pole.
- Suitable glands/and or grommets at cable entry points – no sharp edges on cable entries).
- Non-sheathed cables not exposed outside the enclosure.
- Presence of RCD(s), suitable rated.
- Any suspicious smells indicating burning/overheating

b)
- Any main earth terminal outside the unit to be readily accessible and identified.
- Protective conductors correctly identified (green/yellow).
- Main earthing conductor – present // connection verified // protected against possible mechanical damage // joints electrically and mechanically sound.
- BS 951 label at terminations bearing the words “Safety Electrical Connection Do Not Remove”.
- Main bonding conductor(s) – present // connection verified // protected against possible mechanical damage // joints electrically and mechanically sound.
- All main earthing and bonding conductors of correct minimum csa.
- No paint, corrosion, etc. where bonding conductors are connected to pipework and other extraneous conductive parts, which might affect their effective electrical continuity.
- Any sleeving identified by colour.
- Single bonding conductor between pipework to be continuous (no breaks).
- Earthing and bonding conductors correctly sized.

A.3 Suitable diagram showing the electrode under test, the current test spike and the potential test spike. Show the three or four-lead test instrument connected to the electrode and test spikes. The four lead instrument may have the earth electrode C1 and P1 terminals short-circuited.

Obtaining permission to isolate the installation and carry out the correct isolation procedure before disconnecting the earthing conductor from the earth electrode.
The installation must remain isolated from the supply until all testing has been completed and the earth electrode connection reinstated.

Connection to the earth electrode is made using terminals C1 and P1 of a four-terminal earth tester as shown in the diagram. Connection to the temporary spikes is made by connecting terminal C2 to the current spike and P2 to the potential spike.

The distance between the electrode under test and the current spike, C2, to be at least ten times the maximum dimension of the electrode system, e.g. 30 m for a 3 m long rod electrode. P2 to be place half-way between the electrode under test and the current spike C2.

Three readings are taken:
Firstly, with the potential spike, T2, inserted midway between the electrode and the current spike, T1.

Secondly, with T2 moved to a position 10 per cent of the overall electrode-to-current spike distance back towards the electrode

Finally, with T2 moved to a position 10 per cent of the overall distance towards the current spike, from its initial position between the electrode and T1.

By comparing the three readings, a percentage deviation can be determined. This is calculated by taking the average of the three readings, finding the maximum deviation of the readings from this average in ohms, and expressing this as a percentage of the average.

Example:- If three readings obtained from an earth electrode resistance test were 191Ω, 196 Ω and 189 Ω.

$$\text{Average value} = \frac{191 + 196 + 189}{3} = 192\ \Omega$$

Max deviation is 196 – 192 = 4

Percentage (4/192) x 100 = 2% (acceptable)

If the results obtained are significantly different (more than 5%), the above procedure should be repeated with test electrode T1 placed further from the electrode under test.

On completion of the test ensure that the earthing conductor is reconnected.

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A.4 a) i) Nominal supply frequency
ii) Nominal supply voltage

b) An engineering judgement may be applied when deciding upon the extent of the installation that will be subject to inspection and testing. The same range and level as for an initial inspection is not necessarily required. GN3 Table 3.3 gives suggested minimum sampling sizes for inspections. Previous reports and certificates should make a full inspection unnecessary. If no previous documentation is available a more detailed inspection may be required.It would be appropriate to increase the sample size for inspection should initial findings show the condition of the present installation to be unsatisfactory.

The same range and level of testing as for an initial verification is also usually not necessary. Previous periodic records showing satisfactory results will suggest the

installation may not need the same level of testing as installations for which there are no records of testing. If the installation has apparently not been subjected to any harsh external influences this is another reason for not doing a full a full I+T.
Table 3.4 in GN3 gives recommendations for sample testing. Again a larger test sample may be required depending upon initial results.
Alternatively a recommendation to carry out further investigation to be recorded within the periodic test documentation.

c) Factors which have a bearing on the amount of sampling include:
- having previous inspection and test documentation
- the age and general condition of the installation
- environmental conditions
- effectiveness of any ongoing maintenance
- time period since the previous test

The ring final circuit continuity test could be omitted if there are proper records of previous tests showing previous good results and if there are no signs of damage. Also, there should be no documentation to indicate that there may have been changes made to the circuit.

d)
- Condition of enclosures
- All covers and equipment in place and secure
- Accessible for inspection
- Securely fixed in position.
- No visible damage.
- Protective device adequate
- Condition of incoming cable
- Condition of earthing system // terminations // clamps
- Main earthing terminal provided
- Polarity

A.5 a) i) Visual and touch for secure connection to the MET and tightness of bonding to pipework. If one cable used for connection to several pipes check for no breaks at joints, that is, the cable must be continuous.
ii) Disconnect one end of the conductor, to avoid parallel paths, and carry out continuity test using a low reading ohmmeter.

b) Method 2 (long lead test) to ensure no conductor break(s) within the insulation.

c) Disconnection of a bonding conductor will create a potential hazard therefore the installation has to be isolated before carrying out the test.

d) To eliminate the possibility of readings due to parallel earth paths.

e) The main protective bonding conductors are $10mm^2$ with a resistance, at 20ºC, of 1.83mΩ/m.

$$\frac{1.83 \times 33}{1000} = 0.0604\Omega \quad \text{(acceptable)}$$

A.6 Circuit R3 – staff area lighting. $1.5mm^2$ / $1.0mm^2$ PVC T & E

Before testing - Carry out safe isolation procedure. Lamps, dimmer switches, capacitors, RCD's, other voltage sensitive devices, etc. to be disconnected. All switches closed. Select and check the condition of an insulation resistance tester. Check tester for current calibration date.

Assuming the line and neutral do not require connecting together the procedure will be as follows.

1. All mcb's open.
2. Select 500V and MΩ on the insulation resistance tester.
3. Test between live conductors at the outgoing line conductor of the appropriate mcb.
4. Test between line and earth and between neutral and earth.
5. If there are any two-way switches and intermediate switches then the switches must be operated, one at a time, and the tests repeated.
6. OK if the results are at least 1MΩ. Any readings lower than 2MΩ require a recommendation for further investigation.

If it is not possible to disconnect all loads then carry out the procedure with Line and neutral connected together and between them and the earth conductor.

This situation should be mentioned in the 'Limitation' box on the Condition Report.