C&G 2391 Inspection & Testing Revision

Test Summaries

Including:

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Continuity of Circuit Protective Conductors (CPC's)

- **This is a Dead Test – so Safe Isolation is Required**
- Involves testing the continuity of cpc's, main equipotential bonding conductors and any supplemememtary bonding conductors.
- Use a 'Low Ohm Meter'.
- In order to provide protection against electric shock using automatic disconnection of supply, each point and accessory within the installation should incorporate a cpc connected to earth. (Exception made for lampholder with no exposed parts connected to such a point).
- Such a test ensures conductors are electrically sound and correctly connected.
- Due to the existence of parallel paths it is only simple in all insulated circuits. If other systems of wiring are utilised (conduit/trunking) this test should be carried out at stages during construction such that parallel paths are not in place when testing.
- Two methods may be adopted for this test but it is important to note that when testing the continuity of cpc's with respect to supplementary bonding and equipotential bonding conductors that in order to avoid parallel paths it is necessary to disconnect one end of the conductor in each case to obtain an accurate value. (See full method descriptions p.34-35 GN3).
- Test method 1 will yield (R1+R2) for the circuit whilst test method 2 will yield the R2 value.

Continuity of Ring Final Circuit conductors

- **This is a Dead Test – so Safe Isolation is Required**
- Involves ensuring cpc is continuous and connected to each outlet, there are no interconnections, and to verify polarity.
- Use a 'Low Ohm Meter'.
- It is a three step test:
- End to end resistance measurements are made of phase, neutral, cpc yielding r1, r2, r3 values.
- Cross couple phase and neutral conductors and measure resistance at each socket outlet and the origin. All readings on a full ring should be substantially the same.
- Cross couple phase and cpc conductors and measure resistance at each socket outlet and the origin. All readings on a full ring should be substantially the same. The highest recorded value is the value of (R1+R2) for the circuit.
- For detail see page 36-37 GN3.

Insulation Resistance Test (IR)

- **This is a Dead Test – so Safe Isolation is Required**
- This test verifies that the insulation of conductors and accessories is satisfactory and that the insulation is not in any way defective.
- It is a dead test (However, due to the voltages associated with the test equipment it is important that appropriate safety measures are undertaken in a situation where such testing is to be carried out).
- An insulation resistance tester will be used for the test. (Range selected will be dependant on the operating voltage level of the circuit under test)
- Prior to the test it is necessary to disconnect pilot/indicator lamps and capacitors from circuits in order to avoid inaccuracies.
- Similarly, unless undertaking a shortened version of the test it will be necessary to disconnect certain voltage sensitive electronic components.
- For the detail of the actual tests see GN3 p.37-40.
- Note the following in conducting the test:
- Main switch off (Dead Test)
- All Fuses/Circuit Breakers in place/closed
- All switches closed
- Lamps removed
- Flo & discharge lamps disconnected (or local switches open)

- To conduct the test circuits may be sub-divided (in large installations)

- Can connect phase and neutral together when testing to earth if certain equipment is otherwise vulnerable. (Same for 3 phase equipment).

Protection by Separation of Circuits

- The voltage of the SELV supply should be checked as being ≤50v a.c (120v d.c).
- If ≥25v a.c (70v d.c (60v ripple free)) then means of basic protection must be verified.

- SELV testing should first take the form of an IR test (See table of test voltage values for SELV systems).
- The second test takes place between the SELV circuit and other circuits see GN3 p.41.
- In the case of PELV all tests are as SELV but no IR test is made between PELV & earth.
- FELV circuits are tested as for L.V circuits.
- For Elec Separation (see p.41 GN3) verify voltage to ensure it does not exceed 500v.
- Verify elec separation with other circuits using an IR test (500v d.c, 1MΩ).
- See GN3 for extra detail.

Barriers or Enclosures

- This test is not applicable to factory built barriers or enclosures but only those actually constructed on site.
- For the details see GN3. The test is undertaken to ensure the adequate degree of IP rating for the assembly.

Non-Conductive Location

- Insulation of non-conducting floors and walls.
- Where fault protection is provided then:
- Within the location a person should not be able to simultaneously contact two exposed conductive parts or an exposed and extraneous part at the same time.
- There should be no protective conductors
- Socket outlets should not incorporate a c.p.c.
- Resistance tests between walls and floors to the main protective conductor should be undertaken (see GN3 for details). If at any point R<50kΩ for a system where Uo<500v then floors and walls are classified as extraneous conductive parts.
- Instrument used is a magneto-ohm meter or battery powered IR tester.
- If any extraneous conductive part is insulated it must be tested at a voltage of at least 2kV without breakdown and must not leak more than 1mA.
- The instrument used to complete this test high output applied voltage tester.
- Detail of technique is demonstrated in GN3 (p.44)

Polarity

- **This is a Dead Test – so Safe Isolation is Required**
- To be verified prior to connection of supply using a low-ohm meter.
- To confirm:
- All protective devices are in the phase conductor
- All single pole control devices are in the phase conductor
- The centre contact of Edison screw lamp holders should be connected to the phase conductor (exception wrt E14 & E27).
- Phase connection in socket outlets is to the phase conductor.
- Should then connect the supply and confirm above tests using approved volts tester between phase, neutral and earth.

Earth Electrode Resistance (T-T Systems)

- Following test carried out with an ‘Earth Electrde Resistance Tester’.
- Switch off the supply to the installation

- Disconnect earth conductor from rod (electrode)
- Try to carry out the test in the least favourable conditions (dry conditions)
- See position of electrodes in GN3
- Take readings at each of three positions.
- Do not accept readings that differ by more than 5% (if unacceptablke repeat with greater distance).
- Take an average of the three readings
- Determine the maximum deviation of the average from the 3 readings
- Express the deviation as a % of the average
- Multiply the % by 1.2
- If final figure is not greater than 5% then your average reading becomes the earth electrode resistance reading.
- When undertaking this test it is acceptable to water in the test spikes but NOT the earth electrode.
- After completion of the test reconnect earth and reinstate supply.

- If the electrode under test is being used in conjunction with an RCD then an earth loop impedance test can be carried out at the origin of the installation with the installation isolated and the earth conductor to the electrode disconnected at the main earthing terminal (to avoid parallel paths).

- For normal dry locations compliance is achieved if $Ra \times I\Delta n \leq 50v$

- See table p.2.3 GN3 (p.48) for max values of earth electrode resistance for TT installations.

Protection by Automatic Disconnection of Supply

For TN system:

- Measurement of Zs
- Confirmation by visual inspection of time and trip settings for breakers, current rating and type for fuses.
- Confirm RCD trip times, where employed, ensure compliance.

For TT system:

- Measure resistance of the earthing arrangement
- Confirmation by visual inspection of time and trip settings for breakers, current rating and type for fuses.
- Confirm RCD trip times, where employed, ensure compliance.

Earth Fault Loop Impedance (Zs)

- **This is a live test**
- Can be obtained by direct measurement using an ‘Earth Loop Impedance measuring instrument’. Or by adding (R1 +R2) obtained earlier to Ze.

Obtaining Ze (External loop impedance)

- **This is a live test**
- By measurement
- By Enquiry (Must test to ensure earth is present)

- By Calculation

- By measurement (Undertaken in order to prove an earth connection and to ensure value of Ze is in line with designers intentions).
- Test made at the source of supply between the phase and means of earthing with the means of earthing disconnected from the installation. This entails isolating the installation.
- This should yield a value that in combination with (R1+R2) ensures an appropriate value of Zs for all circuits.

- Supply authorities quote typical values of Ze for the following systems:
- TN-S 0.8Ω
- TN-C-S 0.35Ω
- T-T 21Ω

- Direct measurement of Zs can only be made on a live installation. No earthing conductors are disconnected for the purposes of the test and this may result in readings obtained which are lower than the value of Ze + (R1+R2). This is due to the parallel earth paths present within the installation.
- The measurement is undertaken with an 'Earth Fault Loop Impedance Tester'.

- When undertaking this test if Zs is high and the test duration is not limited then the cpc could theoretically rise to approach phase voiltage for the duration of the test.
- If an RCD provides protection to the circuit then a de-loc facility must be utilised in the test instrument to avoid tripping.

Additional Protection

- **This is a live test**
- Where an RCD with a residual operating current (IΔn) not exceeding 30mA and an operating time not exceeding 40mS at a residual current of 5IΔn is installed as a means of providing additional protection in line with Reg 415.1.1 (BS7671) then its operation must be confirmed by testing.

Prospective Fault Current (Ipscc & Ipefc)

- **This is a live test**
- Perform tests for both prospective short circuit current and prospective earth fault current.
- This should be undertaken at every point where a protective device is intended to operate during fault conditions. The test is undertaken to ensure that the breaking capacity of the protective device is not less than the prospective fault current at its point of installation.
- The greater value of Ipefc & Ipscc should be compared to the breaking capacity.

- For 3 phase circuits Ipscc x 2 (this is carried out in order to gauge a value for a phase to phase short circuit) will always be greater than Ipefc.

- There is no need to re-measure at other d.b's where similarly rated devices to that at the origin are used.

Phase Sequence

- The 17th Edition (BS7671) has now introduced a requirement (612.12) that phase sequence for three phase circuits is maintained through an installation. Details are included in GN3 p.54 & 55.

Functional Tests

- Although not a specific requirement of BS7671 GN3 recommends the following tests to be carried out.

- RCD's (Test for trip compliance followed by test button)(see GN3 p.56 for associated tripping times related to RCD standard).

- It is of utmost importance prior to testing an RCD that the EFLI tests have previously been carried out and the presence of an effective earth has been verified.
- The test will take place on the load side of the d.b. Disconnect any loads during testing.

- Generally RCD's will be tested using an RCD tester firstly with a test current equivalent to $0.5I\Delta n$ (no trip should take place), then a test current equivalent to $I\Delta n$ (tripping times = 200mSec for BS4293 (Gen Purpose) or = 300mSec for BSEN61008 & BSEN61009(RCBO)) (See GN3)
- Where an RCD has a rated value of $I\Delta n$ not exceeding 30mA and is used to provide additional protection to basic protection the operating time of the device must not exceed 40mSecs when subject to a test current of $5I\Delta n$.

- When testing a 3 phase 3 wire circuit connect the RCD neutral probe to earth.

- This test can place dangerous voltages on exposed parts. During the test precautions should be taken to prevent the contact of persons or livestock with such parts.

- Note. The RCD incorporates a check button which should be tested on a quarterly basis (The test button should only be checked after electrical trip testing has been carried out). However, the test button only tests the inner mechanics of the RCD and does not provide a means of checking:
- Continuity of cpc's
- Integrity of earthing within the installation
- Sensitivity or timing for the device
- It only works if the RCD is energised.

Other functional tests include

- Switchgear and control assemblies
- Interlocks etc.

Voltage Drop

- Volt drop should be such that it does not impair the safe functioning of installed equipment.
- Typically it will be evaluated (not measured) using the measured circuit impedance. (In practice this calculation must also take on details of the load impedance).