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NATIONAL SAFETY INSTRUCTION

UK BP/SE/NSI 12 LOW VOLTAGE EQUIPMENT

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LOW VOLTAGE EQUIPMENT

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1 SCOPE

This National Safety Instruction applies the principles established by the Safety Rules to achieve **Safety from the System** for personnel working on **Low Voltage (LV) Equipment**.

The preferred method shall be to work on or near to **LV Equipment**, which is **Dead**. This procedure does not allow personnel to work **live** when it is reasonably practical to work **Dead**.

See Section 5 below.

2 DEFINITIONS

Terms printed in bold type are as defined in the Safety Rules.

3 EQUIPMENT IDENTIFICATION

Equipment on which work is to be carried out must be readily identifiable. Where necessary a means of identification must be fixed to it, which will remain effective throughout the course of the work.

4 DANGERS

The main **Dangers** to personnel working on **LV Equipment** are electric shock or burns arising from

- the possibility of personnel mistaking **Equipment** on which it is unsafe to work, for that on which it is safe to work.
- the possibility of the **Equipment** being worked on accidentally or inadvertently being made **Live**.
- inadequate precautions being taken under **Live** conditions.
- dangerous voltages on open-circuited current transformers.

5 GENERAL REQUIREMENTS

Many electrical accidents can be attributed to failure to plan ahead. Safe working practices rely on clearly thought out systems of work, carried out by adequately trained and competent personnel. This process is described within Flow chart 1 and is to be used in conjunction with the processes established within this Procedure.

- 5.1 Where reasonably practicable the preferred method is to work on or near to **LV Equipment**, which is **Dead**. Work on or near to **Live LV Equipment** should rarely be permitted.

- 5.2 Regulation 14 of the Electricity at Work Regulations 1989 lays down the following process that must be followed before **Live** working can be carried out.

No person must be engaged in any work on or so near any **Live** conductor that **Danger** may arise unless

- a) It is unreasonable in all circumstances for it to be **Dead**; and
 - b) It is reasonable in all the circumstances to be at work on or near it while it is **Live**; and
 - c) Suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury.
- 5.3 The above three conditions must all be met for **Live** working to be permitted where **Danger** may arise. If just one of the conditions cannot be met, **Live** working cannot be permitted and **Dead** working is essential.
- 5.4 A **Senior Authorised Person** must carry out an assessment to determine under what conditions the work is to take place and if a **Safety Document** is to be issued.
- 5.5 Although work, which includes Live testing, may be justifiable it does not follow that there will necessarily be justification for repair work to be carried out **Live**.
- 5.6 When work is to be carried out on **LV Equipment**, which is part of **High Voltage (HV) Equipment**, adequate precautions must be taken to achieve **Safety from the System** from the **HV Equipment** as laid down in Rule R3.2 of the NGC Safety Rules.
- 5.7 When work is to be carried out on **LV Equipment** which is in proximity to exposed **HV Equipment** which may be **Live**, or become **Live**, the relevant requirements of UK BP/SE NSI 6, "Demarcation of Work Areas in Substations", must be met.
- 5.8 When work on **Live Equipment** requires portable instruments to be used for voltage or resistance measurements, the instruments must be provided with insulated probes, fused test leads and have a valid test/calibration certificate.
- 5.9 When working on protection or metering **Equipment** great care must be taken not to open-circuit current transformers. These must be short-circuited before work is carried out.

6 WORK ON OR NEAR TO DEAD EQUIPMENT

- 6.1 A **Senior Authorised Person** must assess the work required on or near to the **Dead LV Equipment** and decide whether it must be carried out under
- a) oral instructions, or where these are considered insufficient
 - b) a **Permit for Work**, or
 - c) **Personal Supervision**.
- 6.2 **Equipment** must be **Isolated**. Note: time switches float switches, thermostats, sequence switching devices or similar automatic switching devices are not **Isolating Devices**.
- 6.3 Where work is to be carried out on portable or hand-held **LV Equipment**, isolation must be achieved by the removal of the plug from the socket outlet.

- 6.4 Before commencing work on exposed **LV** overhead conductors, which have been **Isolated**, in addition to proving that they are not **Live** in accordance with Section 6.7 below, the conductors, including the neutral, must be short circuited and where reasonably practicable, **Earthed**.
- 6.5 **Points of Isolation** must be established. Any fuses and links and/or **Safety Keys** used to secure the **Points of Isolation** must be retained in safe custody.
- 6.6 The work must be carried out by, or under the **Supervision** of, a **Competent Person**.
- 6.7 Before commencing work the **Competent Person** must check, by means of an **Approved** voltage testing device, that the **LV Equipment** on which he is to work is not **Live**. The device must be tested immediately before and after use.
- 6.8 If the work is interrupted the **Competent Person** who is to continue the work must re-check that the **Equipment** is not **Live** as in 6.7 above.

7 WORK ON OR NEAR TO LIVE EQUIPMENT

- 7.1 Work on or near to **Live LV Equipment** must only proceed after a satisfactory assessment by a **Senior Authorised Person** using the justification laid down within Section 5 of this procedure.
- 7.2 The **Senior Authorised Person** must assess the work required on or near to **Live LV Equipment** and decide whether it shall be carried out under
- a) precautions specified in a Local Management Instruction, or
 - b) a **Certificate for Live LV Work**
- 7.3 If the **Senior Authorised Person** considers it necessary, adjacent metal which is electrically bonded to earth or conductors which are at a difference potential to that on which work is to be carried out should be screened with insulating material to avoid **Danger**. The properties of materials used for screening are detailed in Appendix 1 Section 4.
- 7.4 Before commencing work in areas where there is a possibility of the presence of gas, which might be inadvertently ignited by electric sparks, an appropriately qualified specialist must be consulted. This may require the production of a "Recommendations for **General Safety Report**".
- 7.5 The work must only be carried out by a **Competent Person** who has completed an appropriate course of training.
- 7.6 The **Competent Person** who is to carry out this work must first remove any metallic objects such as wristwatch, rings, wristlets, cufflinks, pendants etc.
- 7.7 Consideration must be given to the **Competent Person** being accompanied by another **Competent Person** if the presence of such a person could contribute significantly to ensuring that injury is prevented. Any accompanying **Competent Person** must be trained to recognise **Danger** and if necessary to render assistance in the event of an emergency.
- 7.8 Where necessary to prevent injury, **Approved** insulated tools, insulating stands, mats or gloves, as appropriate, must be used.

- 7.9 Only suitable test instruments for the purpose of measurement fitted with insulated test probes and fused leads must be used.

8 CONSTRUCTION AND COMMISSIONING WORK

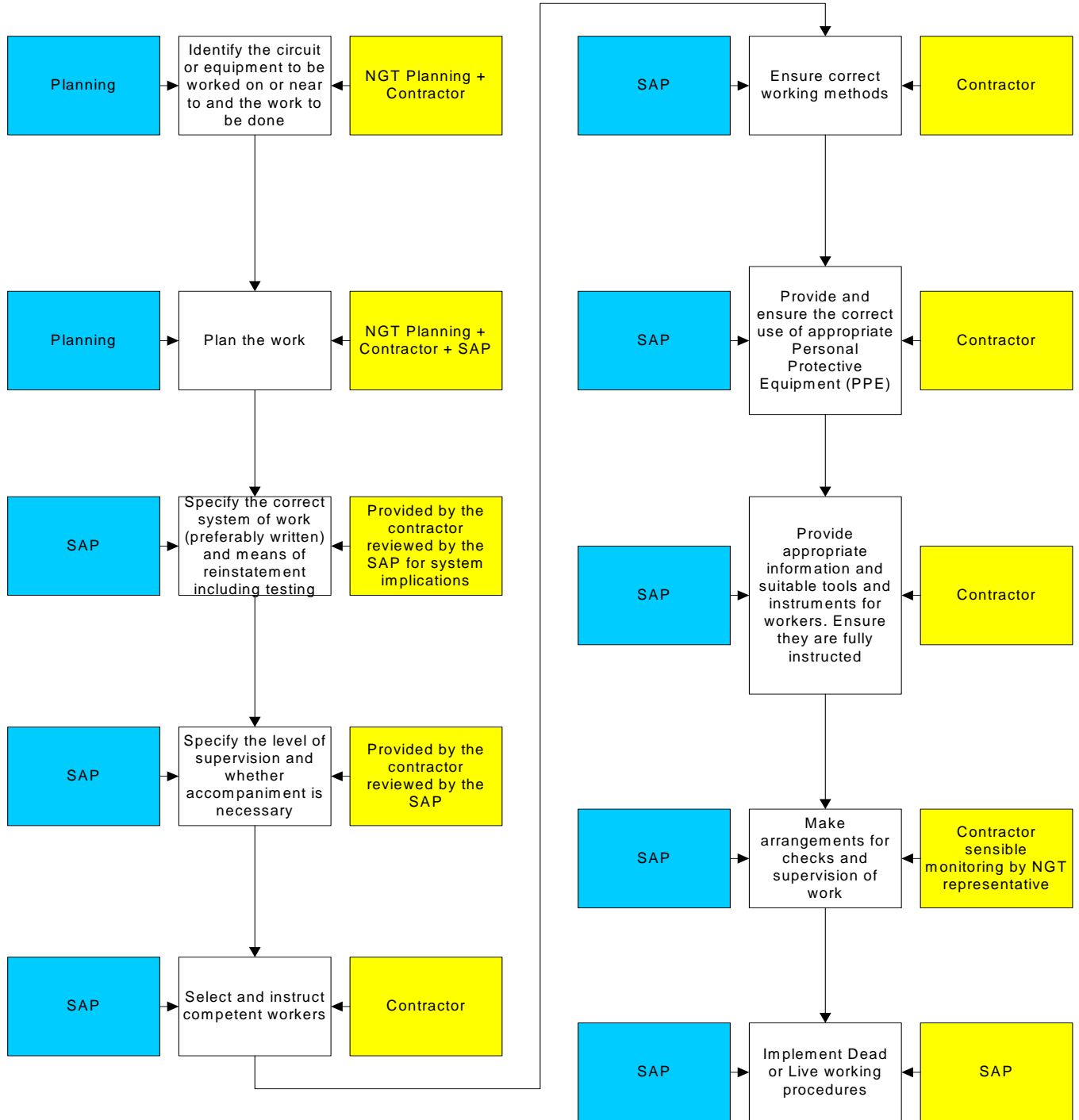
- 8.1 There are some circumstances where it is unreasonable to make equipment dead because of the difficulties it would cause. For example, it may be difficult, if not impossible, to commission, monitor the performance of a system or to trace malfunctions without having the appropriate part of the circuit energised at some point during the activity. However, although the required part of the appropriate circuit is required to be live, action should be taken to ensure that the exposed parts are not easily touched during the process and those parts / areas not required for testing remain dead where reasonably practicable.

During this type of work the processes established within this National Safety Instruction should be used as a best practice and guidance.

9 WORK ON CURRENT TRANSFORMER CIRCUITS

- 9.1 When work is to be carried out on Current Transformer Circuits the **Senior Authorised Person** setting staff to work shall ensure a suitable and sufficient Risk Assessment and Method Statement has been produced prior to work commencing.
- 9.2 Special precautions are required when working on Current Transformer Circuits. The driving flux of a current transformer (CT) is always present when load current is flowing and therefore, if the secondary load is inadvertently disconnected, very high voltages will be developed across the secondary winding with the risk of injury to personnel and damage to the equipment. Even with the primary circuit out of service a hazard may still be present because of the potential for current to flow in the CT in the event of a system fault or if the primary circuit is **Earthed** for maintenance.
- 9.3 When working on protection or metering **Equipment** great care must be taken not to open-circuit current transformers. These must be short-circuited before work is carried out.
- 9.4 Appendix 2 of this Procedure specifies the procedure that must be adopted when working on Current Transformer Circuits.

Flow Chart 1 Planning and Preparation Guide as described in Section 5



When work being undertaken by contractors

When work being undertaken by NGT staff

Appendix 1 – Guidance on **LV System** work

1 **LV SYSTEMS UP TO 240V**

1.1 50 Volt Equipment

Equipment operating at 50 volts or less does not normally have a sufficient energy level to cause harm. **Equipment** operating at a nominal 50 volts may be worked on without the need to issue a **Certificate for Live LV Work** provided that:

- a) The **Equipment** does not operate at higher energy levels than that normally expected of such **Equipment**.
- b) The **Equipment** being worked on is not near other **Equipment** of a higher voltage or energy level that could give rise to **Danger**.

1.2 Batteries

Normal maintenance work to measure voltage and specific gravity on batteries may be carried out as a routine without reference to a **Senior Authorised Person** provided that the provisions of 7.5, 7.6 and 7.9 of this procedure are applied and appropriate personal protective equipment is worn.

1.3 Other LV Systems

Diagnostic Testing on **LV Systems** up to a nominal voltage of 240 volts may be carried out without the issue of a **Certificate for Live LV Work** provided that the precautions specified in Sections 7.3 to 7.9 of this procedure are complied with.

Minor work may be carried out live on 110 volt systems (e.g. cleaning contacts on auxiliary switches) without the issue of a **Certificate for Live LV Work** when **Danger** has been excluded by complying with the precautions specified in Sections 7.3 to 7.9 of this procedure.

2 **VOLTAGES EXCEEDING 240 VOLTS**

- 2.1 Where work on **LV System** requires safety precautions on the **HV System** a RISSP will be required. The **LV Control Person (Safety)** shall contact **HV Control Person (Safety)** at NOC and arrange for a RISSP in accordance with UK BP/SE 301
- 2.2 Working live at these voltages will only be carried out after the production of a detailed method statement, which must be approved by the appropriate **Senior Authorised Person** and the issue of a **Certificate for Live LV Working**. Refer to Section 5.2 of this procedure for justification.
- 2.3 Special consideration must be given to the training and competence of any person engaged in this work.

3 SCREENING PROCEDURE

- 3.1 When working on **Dead LV Equipment** it may be necessary to exclude **Danger** from **Live LV Equipment** in or near the work area by screening. The screening may be carried out in the following ways:
- Under oral instructions.
 - After issue of a **Permit for Work** to work on **Dead LV Equipment**. In this case the **Senior Authorised Person** would enter in Section 2 under "Further precautions to be taken during the course of work to avoid **System** derived hazards" the words "screening to be fixed in accordance with UK BP/SE/NSI 12 Appendix 1 Section 5 to the following **Live LV Equipment** before work commences" he will then list all **Live LV Equipment** near to the **Dead Equipment** that requires screening.
 - A **Certificate for Live LV Work** to erect the screens. After the erection of the screens the **Certificate for Live LV Work** would be cancelled and a **Permit for Work** issued on the **Dead Equipment** as the working area has had **Danger** excluded by the application of screens.

This option can be used when, after carrying out a risk assessment, the **Senior Authorised Person** decides that the hazards are such that extra special precautions need to be taken to exclude **Danger**.

4 SUITABLE SCREENING MATERIAL

- 4.1 The screening material shall be able to withstand a voltage up to and including 1000 volts and shall have sufficient mechanical strength to withstand an accidental blow from a tool without tearing or ceasing to be effective.
- 4.2 The screening material shall be secured in such a way that it cannot become dislodged accidentally and in accordance with the manufacturer recommendations where reasonably practicable. The use of appropriate fixings i.e. those recommended by the supplier of the material and those suitable for the work being undertaken is recommended in preference to spring clips, tape or similar fixing methods.

The picture below depicts suitable screening material and manufacturers approved securing devices it does not show the demarcation requirements of UK/BP/SE NSI 6.



5 SCREENING PROCESS

- 5.1 The screening material shall be secured at the top of the panel and at intermediate positions to ensure that it remains an effective barrier for the duration of the work.
- 5.2 Where necessary, to avoid danger, insulated tools, mats and gloves shall be used whilst erecting screens.
- 5.3 The method of erection of the screens shall be such that the sides or nearest section of the panel to the access will be screened first and the remainder of the screens erected in that sequence.
- 5.4 Where the working area is contained in a section of **Live** panel, the screening may be adjusted to allow access to the working area through the screening. The edges of the screening should be secured to ensure that no access is allowed to any **Live Equipment** near to the **Equipment** on which work is to be carried out.
- 5.5 All exposed studs and terminal strips must be included in the screening.
- 5.6 During the work, the **Competent Person** shall inspect the screening to ensure that it remains undisturbed and that condensation is not forming on the screen. Any change in these conditions and the **Working Party** shall be withdrawn and the **Senior Authorised Person** informed.
- 5.7 The removal of screening should be carried out to the same standards as the original application.

Appendix 2 – Process for working on Current Transformer circuits.

The following procedure describes the work method that must be followed when working on Current Transformer Circuits. When working on protection or metering **Equipment** great care must be taken not to open-circuit current transformers. These must be short-circuited before work is carried out.

1 PLAN THE WORK

- 1.1 The preferred option for any work involving the disconnection of CT secondary wiring is to have the primary circuit out of service and the criteria contained within section 5 of this procedure.
- 1.2 Existing site circuit and wiring drawings should be referred to so that the electrical and physical run of the CT wiring is known between all termination points and the sequence of all the series connected devices established. Any discrepancies between the circuit diagram, the wiring diagram and the physical installation must be resolved before proceeding. The location of the star point (if any), residual/neutral return and earthing point must be established. A working sketch of the existing wiring must be made. This may be hand drawn provided it is clear. An example is attached as Figure 1.
- 1.3 On completion of the work the working sketch should be retained on site in the appropriate maintenance record file.
- 1.4 Electricity National Control Centre (ENCC) **Control Person (Operation)** must be consulted with regards to the provision of protection outage booking and agree to any loss of function(s): both protection and measurement. The application and removal of shorts must be done with the permission of ENCC **Control Person (Operation)**. The work should be arranged so that the outage of the CT secondary and any associated protection is kept to a minimum.
- 1.5 Most CT 'stacks' have several cores to give different protection functions e.g. 1st Main, 2nd Main, Measurements, Busbar Discrimination and Busbar Check. The function to be worked on must be correctly identified. The most common requirement is to carry out work on the Measurements CT Circuits. Work should only be carried out on one protection function at a time.

2 PREPARATION

- 2.1 CT wiring can be worked on provided a short circuit path, which is in parallel with (or bypasses) the point of work, is maintained at all times and where reasonably practicable a disconnection made between the short(s) and the point of work. Various methods of shorting are available depending on the site installation, the position of the proposed changes and any requirement to maintain existing equipment in service during the work. Care must be taken not to apply a second earth to the CT secondary system due to the attendant risk of earth loop currents.
- 2.2 The actual position of the proposed work and its effect on the existing equipment must be clearly understood. The position of the required temporary short(s) should then be marked on the sketch. The sketch should be checked independently by a **Competent Person** who understands the nature of the work being carried out. (This will normally be the recipient of the **Safety Document**).

- 2.3 If it is necessary for some of the existing equipment to continue in service, e.g. tariff metering or circuit breaker fail, then shorts will have to be applied which bypass the point of work. Wherever possible these must be positioned in, or between, panels or racks that do not contain any of the new wiring work. Particular care must be exercised if it is proposed to work on wiring associated with circulating current protection schemes to avoid unnecessary tripping. 'A Risk of Trip' should nevertheless be agreed with ENCC **Control Person (Operation)** for this work.
- 2.4 The application of the temporary short(s) and where reasonably practicable the making of a disconnection in the CT wiring between the short(s) and the intended point of work must be carried out under a **Certificate for Live LV Work**.

WARNING: The application and removal of shorting connections one phase at a time will result in significant currents flowing in residually connected equipment e.g. System Backup Protection. This should be assessed from the working sketch and the outputs of any such devices temporarily inhibited while shorts are being applied and removed.

Temporary labels shall be added to the shorting connection(s) carrying the warning: -

DANGER: TEMPORARY CT SHORTING CONNECTION DO NOT REMOVE WITHOUT INSTRUCTION	
Site SAP Name:	
ENCC Name:	
Date & Time:	

- 2.5 In most cases the shorting connections will be applied to adjacent terminals or ones on the same terminal block. Where, however, wiring is used to bypass a device and is landed in different parts of a panel (or even different panels) it must be run neatly and some form of temporary cleating used (as necessary) to avoid it being accidentally pulled or tripped over.
- 2.6 The relevant requirements of UK BP/SE NSI 6, "Demarcation of Work Areas in Substations", must be met.
- 2.7 Where reasonably practicable a disconnection(s) should be made in the CT secondary wiring between the short(s) and point of work
- 2.8 Where the **Senior Authorised Person** considers it necessary, adjacent metal which is electrically bonded to earth or conductors which are at a difference potential to that on which work is to be carried out should be screened with insulating material to avoid **Danger**. The screening of any adjacent metal which is electrically bonded to earth or conductors which are at a difference potential to that on which work is to be carried out should be carried out in accordance with appendix 1 of this procedure.
- 2.9 When the short(s) have been applied a clip on ammeter should be used to monitor the current flowing in the CT circuitry to ensure that the major portion of the current has transferred to the short(s). Values should be marked on the working sketch.

3 DOING THE WORK

- 3.1 The work can then proceed under the **Certificate for Live LV Work** or preferably by cancelling the **Certificate for Live LV Work** and issuing a **Permit for Work** quoting the disconnection(s) in the CT wiring as a **Point(s) of Isolation**.

- 3.2 The recipient of the **Safety Document** is to include in the tool box talk the temporary CT shorting arrangements, even if a disconnection has been made, and the consequences of breaking them.

4 REINSTATEMENT

- 4.1 Once the work is complete and if a **Permit for Work** has been issued to carry out the work this must be cancelled and a **Certificate for Live LV Work** issued allowing the removal of any screening material used, remaking of the disconnection(s) and the removal of the short(s)
- 4.2 Before the new equipment is deemed ready for service the **Senior Authorised Person** must ensure that the continuity of the CT circuit is re-established. This should be carried out by the application of suitable testing drafted during the planning stage of the work. The disconnection(s) can now be re-made and inspected for integrity and tightness. All these actions should be checked independently by a **Competent Person** who understands the nature of the work being carried out.
- 4.3 Agreement should then be made with ENCC **Control Person (Operation)** to remove the shorting connections. A clip on ammeter should be used to establish the current(s) flowing in the existing wiring and the short(s). An **Approved** insulated tool should be used to carefully remove the nuts from the 'live' (i.e. not earthed) side on the first phase. The connection should be carefully lifted off the stud using insulated pliers whilst checking that no significant arcing is present. (A slight spark may be expected as the current transfers from the shorting to the equipment circuit.) If in doubt replace the connection and check for continuity in the circuit again. Use the clip on ammeter to confirm that the expected current is flowing in the new wiring.
- 4.4 Repeat for the other phases and finally remove the earth end. Confirm that the new and existing equipment is behaving as expected. Remove all temporary precautionary measures. Confirm to ENCC **Control Person (Operation)** that work is complete, record any exceptions and declare the circuit ready for service checking that no alarms are outstanding.

5 REQUIREMENT FOR SHORTS

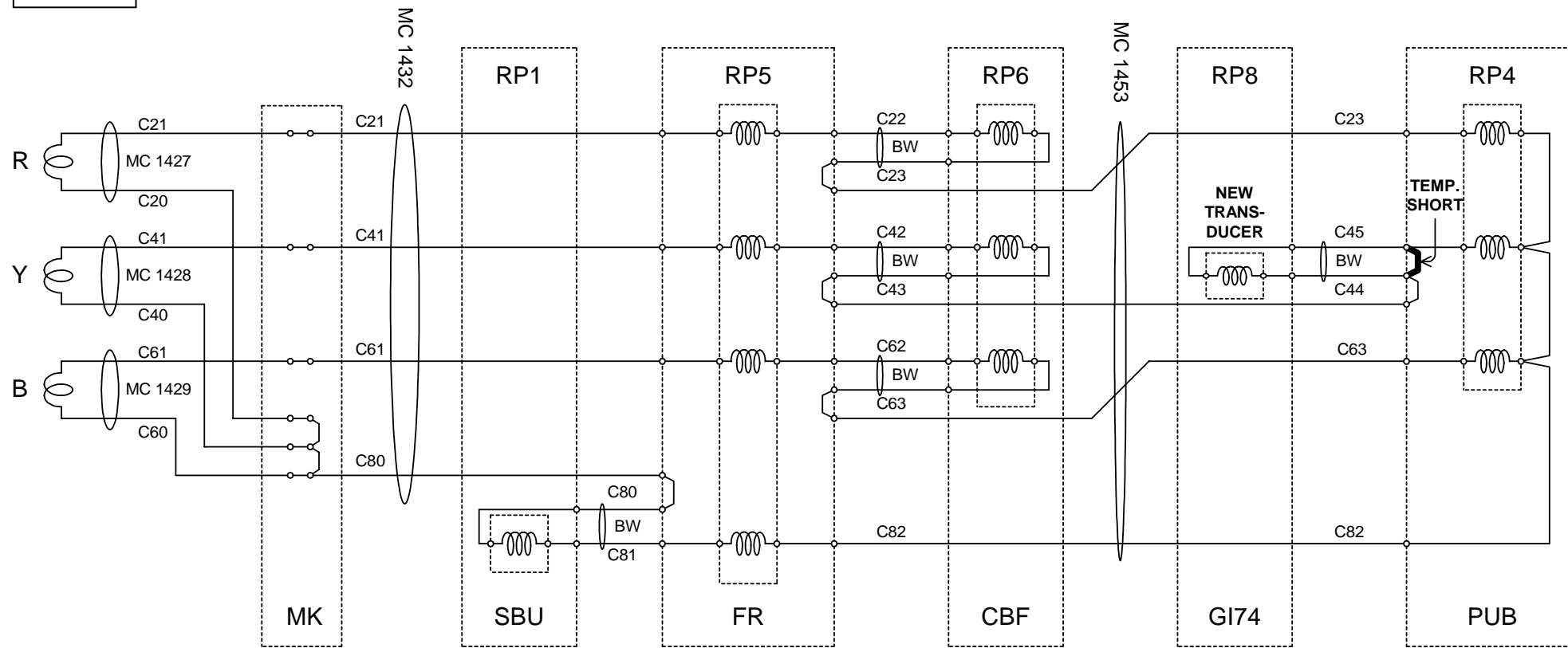
- 5.1 Existing, dedicated, bolted CT shorting links, when available, is the first choice for shorting CT secondary wiring. Failing this, stud terminals that have sufficient length to accept a ring crimp terminal(s), an anti-rotation washer and a full nut should be used. Other methods may be adopted provided they meet the fundamental principle outlined above. Crocodile clips are not 'mechanically secure' and must not be used.
- 5.2 Shorting connections shall be made from 1.5 or 2.5mm², PVC insulated, stranded copper cable with green/yellow insulation. The correct size ring terminals (for the cable cross section and the stud diameter) must be securely crimped on using the appropriate crimping tool. Two wires into one crimp are not permitted, as the crimping operation will not be correct. The completed crimp shall be examined carefully and subjected to a pull test so that the user is satisfied with its integrity.
- 5.3 The application of shorts to Klippon spring loaded and similar terminal blocks is not permitted as it cannot normally be carried out without disturbing the existing CT wiring. However, terminal blocks with facilities for screw-on links may be used provided the correct shorting links are used.

- 5.4 Another option may be the use of a MMLB01 test plug inserted into a MMLG test socket (although the use of stud connections, if available, is the preferred option). In this case the shorting connections will be flexible loops with 4mm bunch pin connectors (supplied with the plug) inserted in the appropriate terminals (check site drawings for details). The plastic 'noses' of the MMLB split plugs should be examined for damage before inserting.

WARNING: Early versions of this device had equal length contacts on both sides and these should be scrapped. The later design has an asymmetrical contact arrangement ensuring the CTs are shorted before the relay circuit is broken.

- 5.5 In all cases the current transformer shorting links should be suitable for the task they are being used for. Consultation with the manufacturers technical information needs to be undertaken to ensure that the supplied equipment is suitable for the task prior to use.

Figure 1



KEY:

MK = MASHALLING KIOSK
 SBU = SYSTEM BACKUP
 FR = FAULT RECORDER
 CBF = CIRCUIT BREAKER FAIL
 GI74 = SYSTEM METERING

PUB = PHASES UNBALANCED
 RP = RELAY PANEL
 BW = PANEL BUS WIRING
 MC = MULTICORE No

NOTE: A WORKING DRAWING WOULD NORMALLY BE HAND DRAWN BUT SHOULD CONTAIN THIS LEVEL OF DETAIL