

1. SCOPE

This document details the procedures to be adopted when working on **High Voltage** Mechanically Switched Capacitors with Damping Network (MSCDN).

2. ISSUE RECORD

This is a **Reference** document. The current version is held on the EN Document Library.

It is your responsibility to ensure you work to the current version.

Issue Date	Issue No.	Author	Amendment Details
October 2012	1	William Bennett	Initial Issue
November 2017	2	Allan Holton	Remove requirement for <i>Fixed Drain Earth</i> and additional Safety Document . Updated photo of <i>Discharge Stick</i> .

3. ISSUE AUTHORITY

Author	Owner	Issue Authority
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4. REVIEW

This is a **Reference** document which has a 5 year retention period after which a reminder will be issued to review and extend retention or archive.

The proposed revision date can be viewed in the Management Safety Procedures Document Index DOC-00-238.

5. DISTRIBUTION

This document is part of the Management Safety Procedures but does not have a maintained distribution list.

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7. REFERENCE DOCUMENTS

PSSI 11 (OPSAF-10-011) – High Voltage Static Capacitors

8. DEFINITIONS

For the purpose of this Management Safety Procedure the following definitions apply:

MSCDN (Fig 1)

Manually Switched Capacitor with Damping Network

Capacitor Bank (Fig 2)

An assembly of one or more *Capacitor Stack(s)* forming the static capacitor installation.

Capacitor Stack (Fig 2)

An assembly of *Capacitor Rack(s)* connected together. If the equipment consists of only one *Capacitor Rack* the term *Capacitor Stack* will also apply. A *Capacitor Stack* may contain *Capacitor Unit(s)* from one or more discrete components of the static *Capacitor Bank*, e.g. the main and auxiliary capacitors, resistors and air-cooled reactors.

Capacitor Rack (Fig 2)

An individual framework containing *Capacitor Unit(s)* connected together.

Capacitor Unit (Fig 2)

An assembly of one or more capacitor elements in the same container with terminals brought out by one or more bushings.

Discharge Stick (Fig 5)

An **Approved** device for the purpose of discharging a *Capacitor Unit*, which may be charged.

Rack Earth(s) (Fig 4)

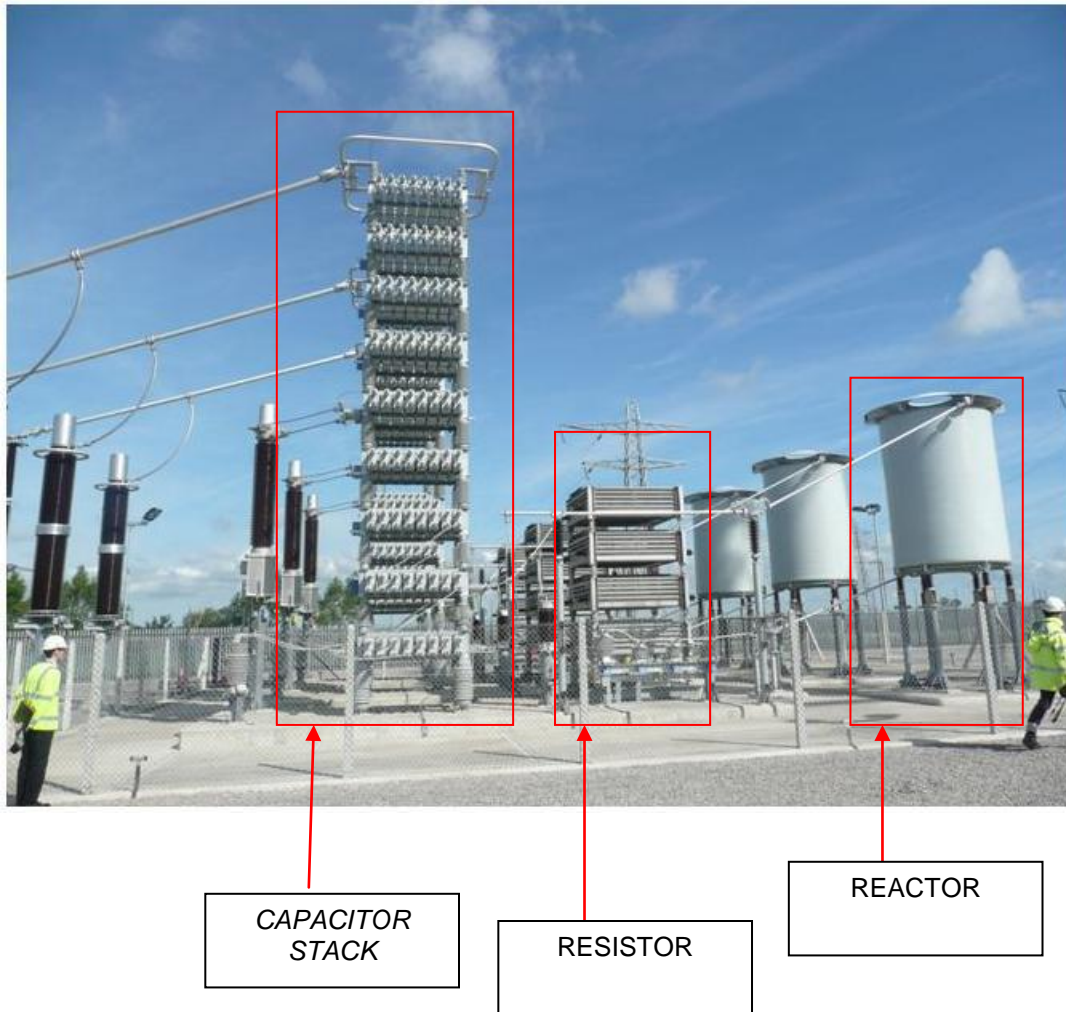
Fixed or Portable **Earthing Devices** provided for the purpose of earthing and/or short-circuiting *Capacitor* units or groups and the *Capacitor Rack* or frame supporting them. The term *Rack Earth* includes Frame Earths.

Short-Circuiting Lead (Figs 6 and 7)

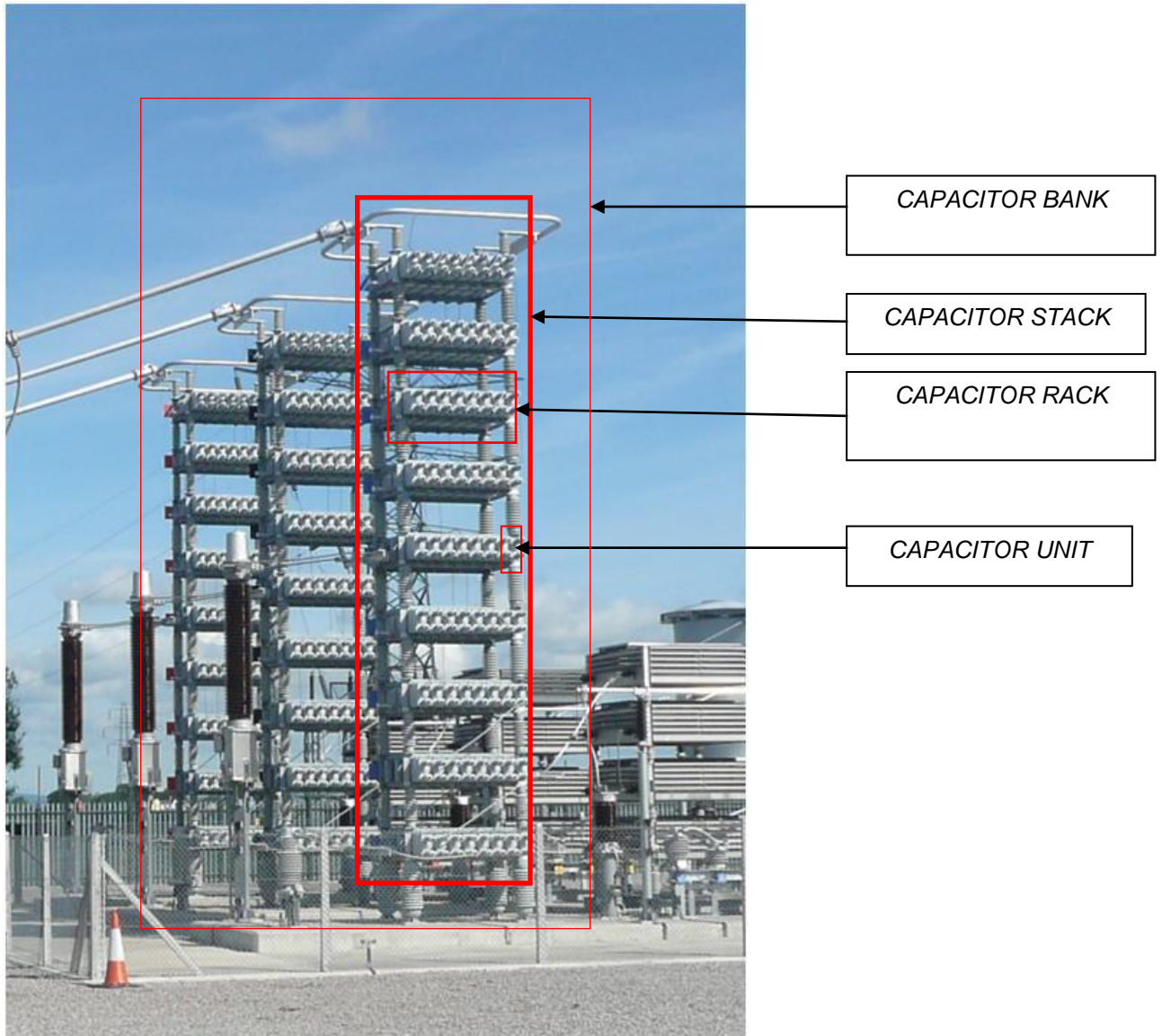
An **Approved** lead used for short-circuiting an individual *Capacitor Unit*. This can be a clip-on short used during the disconnection of a *Capacitor Unit* or a bolt-on short used during removal transportation and storage.

Rack Earth Spigot (Fig 9)

Earthing point positioned at the end of each *Capacitor Rack* for the purpose of connecting *Rack Earths*.



(Fig 1) Typical layout of *MSCDN* showing components.



(Fig 2) Typical layout of *Capacitor Bank* showing components.

9. HANDLING STORAGE AND TRANSPORTATION OF CAPACITOR UNITS

- 9.1 *Capacitor Units* that are to be disconnected from *Capacitor Stacks* shall be short-circuited using a *short-circuiting lead* and remain short-circuited during transportation and storage.
- 9.2 Where there is a potential for *Capacitor Units* to become charged they shall not be handled unless they are short-circuited.
- 9.3 Before the application of a *Short-Circuiting Lead* to a *Capacitor Unit* the *Capacitor Unit* shall be discharged using a *Discharge Stick(s)*.
- 9.4 If a clip-on *Short-Circuiting Lead* has been applied then before a *Capacitor Unit* is removed from a *Capacitor Rack* the clip-on lead shall be replaced by a bolt-on *Short-Circuiting Lead*.

10. PROCEDURE FOR WORK ON HIGH VOLTAGE MECHANICALLY SWITCHED CAPACITORS WITH DAMPING NETWORK (MSCDN).

GENERAL REQUIREMENTS FOR ALL WORK (CAPACITOR, REACTOR, RESISTOR)

- 10.1 The *Capacitor Bank* shall be **Isolated**, **Points of Isolation** established and **Primary Earths** applied.
- 10.2 The **Control Person** shall ensure that the time delay between de-energisation and the first **Primary Earth** being applied via the earth switch is a minimum of 20 minutes.
- This is to allow sufficient time for the *Capacitor Bank* to discharge via the *Capacitor Unit* discharge resistors.
- 10.3 Only when **Isolation** has been completed and **Primary Earths** applied can access to the *MSCDN* enclosure be gained by the use of a Castell key arrangement and demarcation erected in accordance with PSSI 6 (OPSAF-10-006).
- 10.4 A **Permit for Work** shall be issued.
- 10.5 Apply a **Drain Earth** between the capacitor and the reactor on all three phases. (See Fig 3)
- 10.6 At no time shall a distance of 0.8m be encroached to any **High Voltage** conductor until earths are applied and capacitors discharged.

On all *Capacitor Stacks*, apply *Rack Earths* and discharge the capacitor connections in a sequential manner from ground level up to a height of 3m. The sequence to be followed is:

- (i) On the first *Capacitor Stack* earth the lowest *Rack Earth Spigot* using a *Rack Earth*. The *Rack Earth* shall be applied using an **Approved** earthing rod.
- (ii) Discharge all of the *Capacitor Units* on this *Capacitor Rack* using a *Discharge Stick* connected to the substation earth tape, the two crook ends of the *Discharge Sticks* being applied to the capacitor terminal bushings to short out *Capacitor Unit* terminals.
- (iii) Earth the next lowest *Rack Earth Spigot* and discharge the *Capacitor Units* in that *Capacitor Bank*.
- (iv) Apply the same principle to *Capacitor Rack(s)* in the same *Capacitor Stack* up to 3m from ground level. As this process extends up the *Capacitor Stack* the *Discharge Stick* may be connected to an earthed *Rack Earth Spigot* if this is more convenient, providing the distance of 0.8m is not encroached to any **High**

Voltage apparatus that is either not **Earthed** or, as in the case of *Capacitor Units*, not discharged.

- (v) Complete this sequence for the remaining *Capacitor Stack(s)*

11. PROCEDURE FOR WORK OR TESTING ON CAPACITOR BANK ASSOCIATED WITH MSCDN

In addition to the completion of section 10 above the following shall be carried out to all phases of the *Capacitor Bank*:

- 11.1 If work is to be performed on any *Capacitor Bank* component then an **Earthing Schedule** shall be issued by the **Senior Authorised Person** stating where **Drain Earths** and **Rack Earths** are to be applied and where the *Discharge Stick* needs to be used. The positions for the application of *Rack Earths* shall include:
- (i) On the *Capacitor Stack* to be worked on all *Rack Earth Spigots* from ground level to the one above the point of work.
 - (ii) Additional points where a disconnection is planned to ensure either side of the disconnection point remains connected to earth.
 - (iii) Any additional position as deemed necessary by the **Senior Authorised Person**.
- 11.2 A **Permit for Work** or **Sanction for Test** shall be issued for the capacitor components on which work or testing is to be carried out. In addition to the positions of the **Primary Earth(s)** the **Safety Document** shall also record the positions of the *Rack Earths* and **Drain Earths**; it may do this by including a cross-reference to the **Earthing Schedule**.
- 11.3 Before performing any work on a *Capacitor Bank* the recipient of the **Safety Document** shall ensure that:
- (i) *Capacitor Banks* are visually inspected at a distance greater than 0.8m from exposed capacitor components in order to identify any abnormal *Capacitor Unit(s)*.
 - (ii) **Drain Earths** and *Rack Earths* are applied in accordance with the issued **Safety Document** and **Earthing Schedule** where applicable.
 - (iii) *Capacitor Unit(s)* in a parallel group are discharged using a *Discharge Stick* connected to the *Rack Earth Spigot*, the crook ends of the *Discharge Stick* being applied to the capacitor terminal bushings. The *Discharge Sticks* shall be operated by the recipient of the **Safety Document** or a **Person** under his **Personal Supervision**.

At no time shall a distance of 0.8m be encroached to any **High Voltage** apparatus until earths are applied and capacitors discharged as described above.

- 11.4 When testing requires the removal of earths and special requirements to allow subsequent access to *Capacitor Units*, these actions shall be carried out by, or under the **Personal Supervision** of, a **Senior Authorised Person** under a **Sanction for Test**.
- 11.5 When working on any *Capacitor Rack* all *Capacitor Racks* from ground level to the one above that to be worked on shall be discharged. (See Fig 4).
- 11.6 When any **Person** is in contact with a *Capacitor Unit*, the *Capacitor Unit* shall remain shorted by the *Short Circuiting Lead* unless the testing process requires the *Short Circuiting Lead* to be removed.
- 11.7 On completion of testing, *Capacitor Units* shall be discharged using a *Discharge Stick* by a **Senior Authorised Person** or under the **Personal Supervision** of a **Senior Authorised Person** and all *Short Circuiting Lead(s)* re-applied.

12. PRECAUTIONS FOR WORKING ON A REACTOR ASSOCIATED WITH MSCDN

The requirements of Section 10 above shall be fulfilled, no additional precautions are required.

13. ADDITIONAL PRECAUTIONS FOR WORKING ON A RESISTOR ASSOCIATED WITH A MSCDN

In addition to the completion of Section 10 above the following shall be carried out:

- 13.1 A **Drain Earth(s)** shall be connected at the input terminals to the resistor that are not already connected to earth.

14. PERFORMING CAPACITOR MEASUREMENTS

In addition to the completion of Section 10 and 11 above the following shall be carried out:

- 14.1 Before and after performing capacitance measurements, the *Capacitor Unit(s)* in a parallel group shall be discharged using a *Discharge Stick* by a **Senior Authorised Person** or under the **Personal Supervision** of a **Senior Authorised Person** and all *Short Circuiting Lead(s)* re-applied.

15. PROCEDURE TO BE APPLIED WHEN CAPACITOR UNIT HAS DISRUPTIVELY FAILED

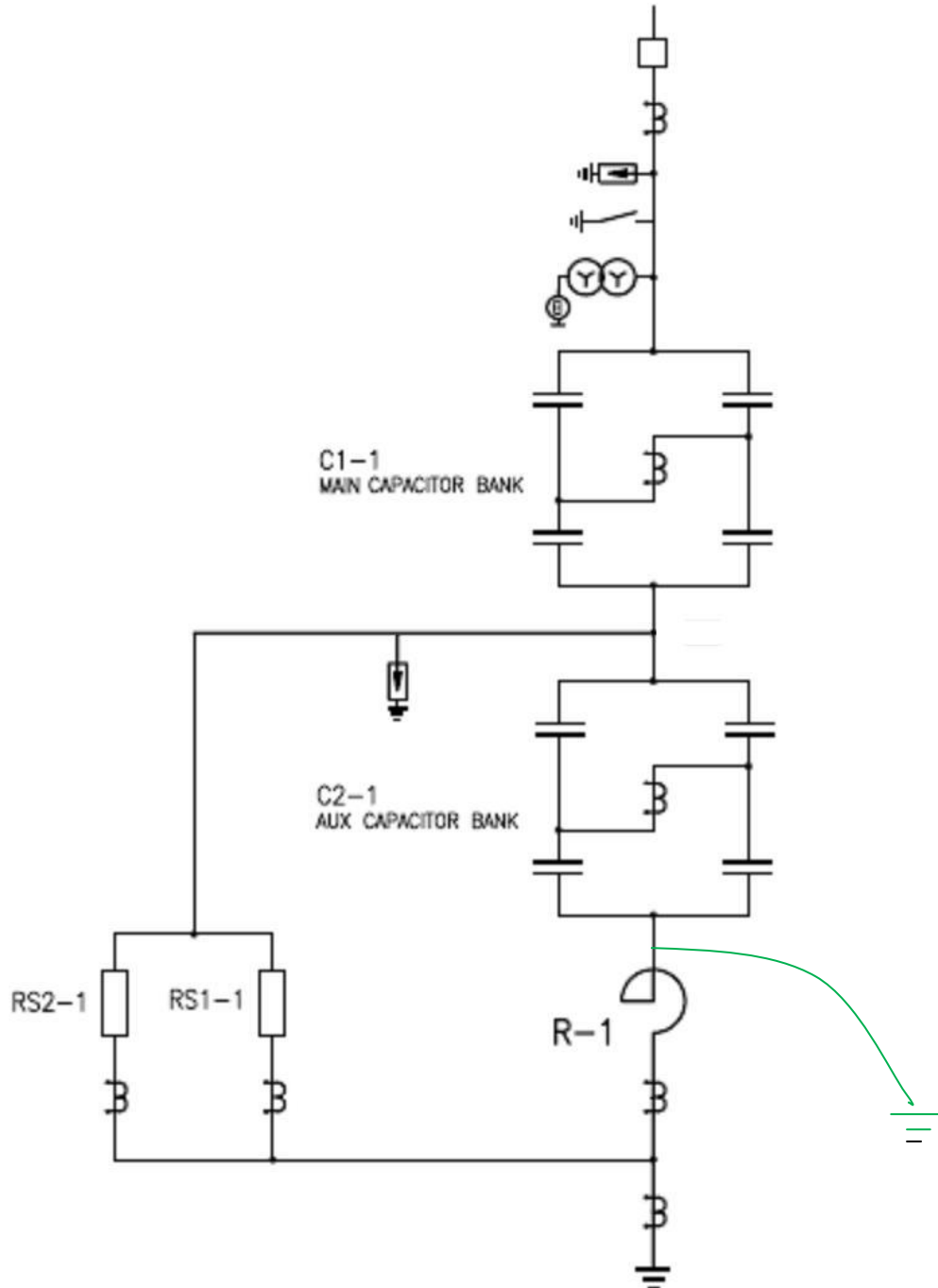
Industry experience of *Capacitor Unit(s)* suggests that there may not be visible signs of disruption on the *Capacitor Unit* case or bushings.

Abnormal capacitor failures are *Capacitor Units* showing signs of excessive bulging, major leaks or broken bushings. On this type of failure there could be an open circuit on the bushing connection lead internally within the *Capacitor Unit*. In this situation a dangerous voltage may be present on the lead or if the lead was to come into contact with the casing it could make the casing **Live** at some point during removal or transportation.

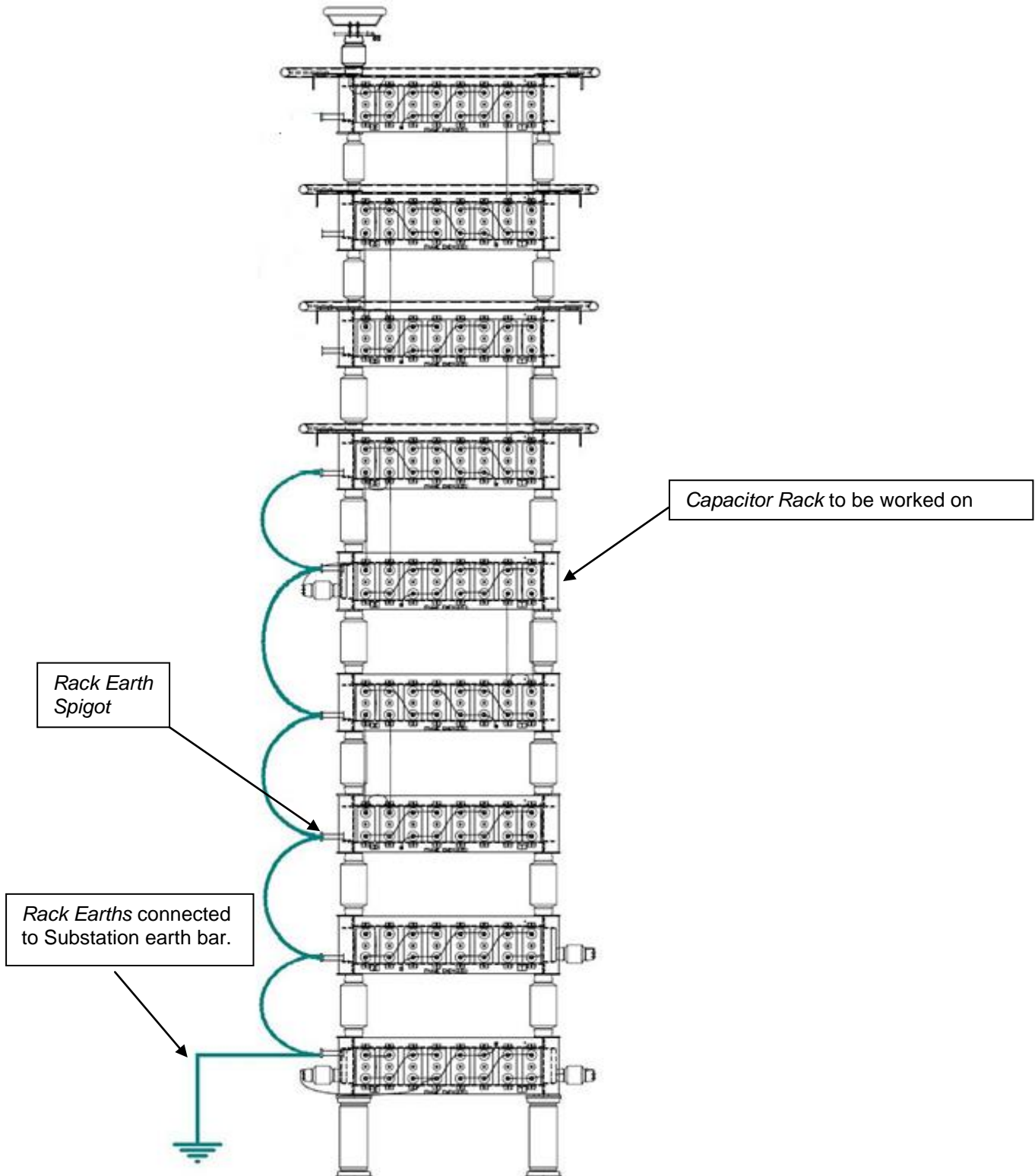
Where there is no cause for concern that an open circuit exists, the *Capacitor Unit* shall be removed using the procedure described in section 10 and 11 above.

Where there is evidence to suggest that the bushing has been damaged and an open circuit may exist in the *Capacitor Unit* casing then an **Approved** Procedure shall be written. A person with specialist knowledge of capacitors, their construction, failure modes and removal from service shall be consulted.

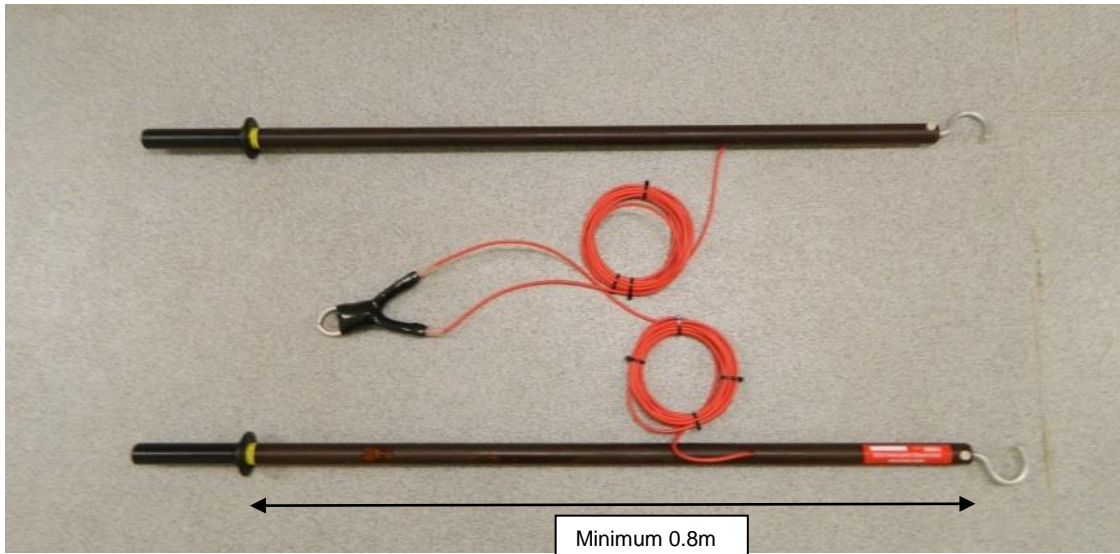
16. DIAGRAMS



(Fig 3) The position of **Drain Earths** between any *Capacitor Bank* and any *Reactor*.



(Fig 4) Diagram showing discharge & shorting arrangements



(Fig 5) *Discharge Stick.*

The *Discharge Stick* comprises two identical sticks minimum length 0.8m beyond the hand grip, with leads connected to a common clamp for attaching to the substation earth tape or *Rack Earth Spigot* which itself has been earthed. This enables the terminals of *Capacitor Units* to be shorted together and discharged simultaneously.



(Fig 6) Temporary Short- Circuiting Lead applied to *Capacitor Unit* before disconnecting capacitor unit.



(Fig 7) Bolted Short- Circuiting Lead applied to Capacitor Unit.



(Fig 8) Capacitor Unit can now be removed.



(Fig 9) Rack Earth Spigot, showing Rack Earth applied