

National Grid UK Electricity Transmission plc

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NATIONAL SAFETY INSTRUCTION



Guidance Notes

NSI 2 EARTHING HIGH VOLTAGE EQUIPMENT

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DOCUMENT HISTORY

Issue	Date	Summary of Changes / Reason	Author(s)	Approved By (Title)
1	01/08/08	New Guidance Document to follow 3 rd edition Electricity Safety Rules layout. Safety notes and safety bulletins SEB 130, 146, 18/2006, 02/2006, 22/2005, 27/2003 incorporated.	NSI Working Group	MDE Manager Les Adams 
2	14/11/08	Appendix A amended	Gary Thornton	MDE Manager Les Adams 

KEY CHANGES

Section	Amendments
Appendix A	Bicker Fenn 400 & 132, Grain 132 added. Bolney PPE amended to 2. Skelton Grange B removed

EARTHING HIGH VOLTAGE EQUIPMENT

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1 Purpose and Scope

To provide guidance on National Safety Instruction 2, when applying principles established by the Safety Rules on the use of **Earthing Device(s)** to achieve **Safety from the System** for **Personnel** working on or near to **High Voltage Equipment** in substations.

Earthing is carried out as part of the application of safety precautions. It protects **Personnel** against the effects of inadvertent energisation and **Equipment** that may be **Charged**.

The management of earthing **High Voltage Equipment** on overhead lines and substation terminal **Equipment** is covered by the Management Procedure – NSI 4 “Work on or Near High Voltage Overhead Lines”.

National Grid **Personnel** when applying principles established by the Safety Rules on the use of **Earthing Device(s)** to achieve **Safety from the System** shall be appointed to this NSI. For Contractor appointment see Appendix C.

The layout of this guidance note reflects that of legislative codes of practice, where the rule (or mandatory obligation) is identified by a green panel on the left-hand side. The guidance follows after the rule and is identified by a blue panel.

Within National Grid the guidance notes hold equivalent status of an Approved Code of Practice (ACOP) in law. If not followed, you will be required to demonstrate that your safe system of work is of an equal or higher standard.

2 Definitions

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

3 Dangers

The **System Danger(s)** to **Personnel** applying or removing **Earthing Device(s)** to **HV Equipment** are electrocution, burns and effects on eyes arising from:-

- Inadvertent infringement of **Safety Distance** by **Personnel**
- The application of **Earthing Device(s)** to **Live HV Equipment**
- Badly connected or insecure **Earthing Device(s)**
- The incorrect sequence or method of application or removal of portable **Earthing Device(s)**
- **Charged Equipment** and the voltage difference across a break in electrical conductors
- Incorrect management of circulating currents
- The arc drawn by the application or removal of an **Earthing Device**
- The application of **Earthing Device(s)** to an inadequate or defective earth system

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4.1 to 4.6

4 General Requirements for Primary Earths

- 4.1 **Primary Earth(s)** shall be of adequate strength and capability to provide an efficient connection between earth and the **HV Equipment**. **Primary Earth(s)** and the associated **Equipment** they are connected to shall be capable of safely discharging any resultant fault current due to any inadvertent energisation.
- 4.2 A fixed **Earthing Device**, shall where reasonably practicable be used to make the first and break the last earth connection. Where this is not reasonably practicable the **Senior Authorised Person** shall carry out a written risk assessment to determine the safest way to apply / remove portable **Earthing Device(s)** to / from the **HV Equipment**.
- 4.3 **Primary Earth(s)** shall be positioned within the zone established by the **Point(s) of Isolation**. They shall, where reasonably practicable, be positioned between the point of work and all **Point(s) of Isolation**. This should include, where applicable, the **Point(s) of Isolation** from common neutral earthing equipment.

Where it is not reasonably practicable to apply **Primary Earth(s)** between the point of work and the **Point(s) of Isolation** they may be placed in an alternative position so as to have a similar electrical effect. Such a position could be one of the following:-

- a) On a permanent connection teed between the point of work and the **Point of Isolation** at a distance not exceeding 9m from the tee point, or
- b) At a permanent connection point not more than 9m beyond the point of work from the **Point of Isolation**, or
- c) As detailed in an **Approved** procedure

For SF₆ Gas Insulated Switchgear (GIS) the distance of 9m quoted above can be extended to 30m provided the full intent of this section is met.

- 4.4 **Primary Earth(s)** shall be applied to all phases except where work is carried out on phase segregated **HV Equipment**.
- 4.5 Before a **Safety Document** is issued on an overhead line circuit, **Primary Earth(s)** are to be initially connected to the overhead line at all ends.
- 4.6 The **Senior Authorised Person** shall ensure that no work will be undertaken that may prevent a **Primary Earth** from being effective.

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4.1

4 General Requirements for Primary Earths

4.1 **Earthing Device(s)** used as a **Primary Earth** and associated portable application devices shall be type registered.

At certain **Location(s)** it is necessary to apply multiple portable **Earthing Device(s)** per phase, at each point of earthing, to cater for the maximum fault level of the **HV Equipment**. These **Location(s)** and the number of earths required are specified in Appendix A. During the switching instruction preamble the number of portable **Earthing Device(s)** required per phase shall be confirmed between both the **Control Person (Safety)** and the **Senior Authorised Person**.

Primary Earth(s) subjected to short circuit fault current shall be inspected for damage prior to re-use. In the case of portable **Primary Earth(s)** the **Senior Authorised Person** shall immediately arrange disposal of the portable **Primary Earth(s)**.

Portable **Earthing Device(s)** used as a **Primary Earth(s)** shall not be connected to arcing horns, corona rings, hollow Holtom conductor etc.

Portable **Earthing Device(s)** used as a **Primary Earth(s)** may be applied to solid stranded aluminium conductors or internally supported (This can be verified by local knowledge or reference to engineering drawings), tinned, copper, Holtom type conductors.

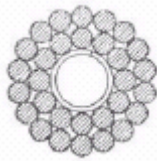


Figure 4.1A - Holtom Type Copper Conductor

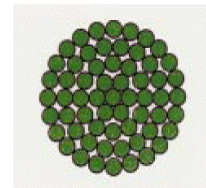


Figure 4.1B – Aluminium Alloy Stranded Conductor

When applying portable **Primary Earth(s)** to braid / shunts the following shall be confirmed by the **Senior Authorised Person** prior to application:-

- Braid / Shunt shall have a round profile, refer to Figure 4.1C
- Ensure the line end clamp is the correct size for the cross sectional area of the conductor
- Only one portable **Primary Earth** to be applied to each braid / shunt
- If a short circuit fault was to occur the busbar connector will require replacement



Figure 4.1C – Braid Example

Guidance

NSI 2

4.1 Cont: to 4.2

For work involving line end **Equipment** it is also recognised that a potential hazard may exist under certain **System** configurations from high circulating currents. In line with Management Procedure – NSI 4 “Work on or Near High Voltage Overhead Lines” a substation Drain Earthing Shorting Scheme (DrESS) to the overhead line entry point may need to be applied.

- 4.2 An example of where it is not reasonably practicable to apply a fixed **Earthing Device** is a mesh bus section where there are no fixed **Earthing Device(s)** by design. As **Point(s) of Isolation** are visible from the point of work, the correct circuit can be identified. **Danger** from **Charged** conductors is minimal due to the short length of busbar. There is therefore a reduced risk and it is acceptable to apply portable **Earthing Device(s)**, refer to Guidance Section 7.2 for information on written risk assessments.

Where **Point(s) of Isolation** are not visible from the point of work and fixed **Earthing Device(s)** are not available, the indirect earthing of **HV Equipment** may be achieved by the operation of a circuit breaker or a disconnector to indirectly make the first and break the last earth connection to the **HV Equipment**.

Where reasonably practicable a circuit breaker shall be used in preference to a disconnector for indirect earthing. In this instance any disconnector between the **Earthing Device**, the circuit breaker and the planned point of work, shall be closed prior to the closure of the circuit breaker.

Where reasonably practicable local operation (e.g. at the CB or disconnector local control cubicle) to provide an earth, shall be avoided.

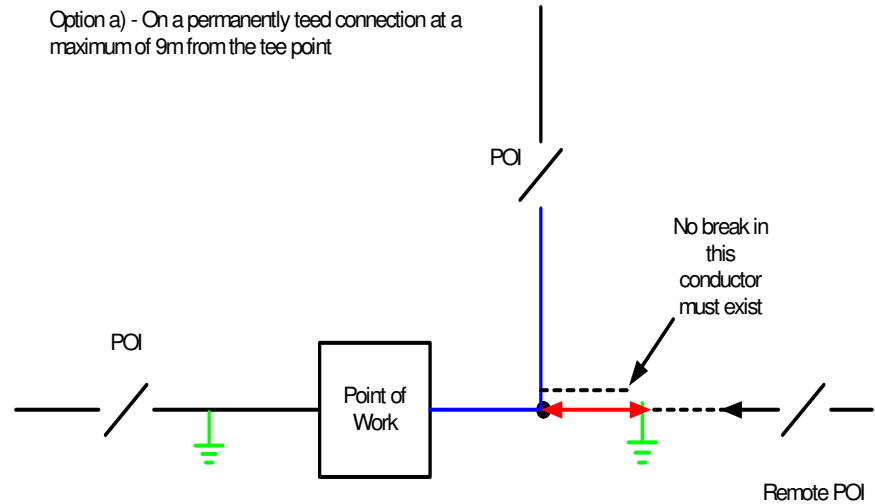
Line end disconnectors are not designed to make or break circulating currents created by overhead line circuits and shall not be closed / opened to indirectly make / break the first / last connection to earth which may interrupt circulating currents.

If a fixed **Earthing Device** has a technical limitation, stating it is not fully rated as a **Primary Earth**, it shall still be used to make the first and break the last earth connection, prior to the application or removal of portable **Primary Earth(s)**.

Guidance
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4.3

4.3 **Primary Earth(s)** should be close to and visible from the point of work. If not, the **Senior Authorised Person** shall consider the application of additional **Earthing Device(s)** at the point of work.

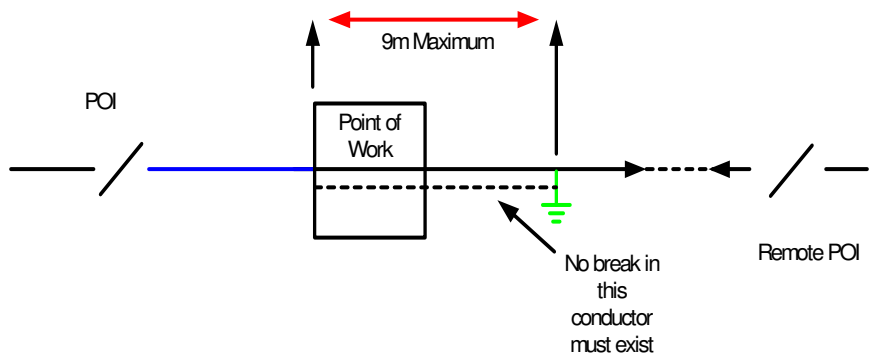
Schematic diagram for Option (a) and (b)



←→ Alternative position for **Primary Earth** on a permanent connection teed between the point of work and the POI at a distance not exceeding 9m from the tee point

— Not reasonably practicable to apply **Primary Earth** between the point of work and POI e.g. busbars are vertical or angle is too steep

Option b) - Maximum of 9m beyond the point of work from the **Point of Isolation**



←→ Alternative position for **Primary Earth** a point not more than 9m beyond the point of work from the POI

— Not reasonably practicable to apply **Primary Earth** between the point of work and POI e.g. busbars are vertical or angle is too steep

Guidance
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4.4 to 4.5

- 4.4 When earthing against a single phase VT **Primary Earth(s)** shall be applied to all 3 phases.

Examples of phase segregated **HV Equipment** are 400 kV metal enclosed SF₆ Gas Insulated Switchgear and generator terminal connections, where conductors are in individual single phase **Earthed** metal enclosures.

- 4.5 For the management of circulating currents as described within Management Procedure - NSI 4 "Work on or Near High Voltage Overhead Lines" a **Primary Earth** shall be initially applied line side of any **Point(s) of Isolation** in a substation and not separated from the overhead line by any temporary or permanent disconnection including **Equipment** in the open position. When this is not reasonably practicable the **Senior Authorised Person** shall discuss and agree alternative earth arrangements with the overhead line engineer.

NSI 2
5.1 to 5.2

5 General Requirements for Drain Earths

- 5.1 Where **Charged Equipment** may cause **Danger**, **Drain Earth(s)** shall be applied in accordance with an **Earthing Schedule** that will be issued along with the **Safety Document**.
- 5.2 The recipient of the **Safety Document** is responsible for the control and safe custody of **Drain Earth(s)** and associated application device issued with an **Earthing Schedule**.

The **Competent Person**, or a **Person** under his **Personal Supervision** may apply and remove **Drain Earth(s)** in accordance with an **Earthing Schedule** under a **Safety Document**.

Guidance
NSI 2
5.1 to 5.2

5 General Requirements for Drain Earths

- 5.1 **Earthing Device(s)** to be used as **Drain Earth(s)** shall be type registered.
- 5.2 Portable **Drain Earth(s)** where reasonably practicable shall be applied to a main current carrying conductors. Where this is not reasonably practicable, **Drain Earth(s)** may be applied to arcing horns, corona rings etc, this excludes **HV Equipment** which is electrically connected to the overhead line due to high circulating currents.

To ensure **Drain Earth(s)**, when not in use, are kept in safe custody, the **Safety Document** recipient shall keep them in a locked vehicle, box, cupboard or room etc. which can only be unlocked by himself, or:-

- (a) For substation earths, by securing the earths together by a lockable strap e.g. earth strap

Fixed **Earthing Device(s)** shall not be used on an additional **Earthing Schedule**.

For the application / removal of **Drain Earth(s)** the recipient of the **Earthing schedule** shall undertake a personal risk assessment to control the risks associated with weather conditions, ground conditions and manual handling etc. Where a Contractor is authorised to apply **Drain Earth(s)** they shall produce the risk assessment which shall be reviewed as acceptable by the **Senior Authorised Person** for safety from the system issues, e.g. detached **Drain Earth**.

For the application and removal of **Drain Earth(s)**, refer to Section 7.3.

In order to hold a **Safety Document** where the **Earthing Schedule** is issued to a Contractor, the Contractor shall be authorised in accordance with Appendix C. The recipient of the **Safety Document** is responsible for the control and safe custody of **Drain Earth(s)**.

NSI 2
6.1 to 6.2

6 General Requirements for Portable Earths

6.1 Portable **Earthing Device(s)** and their associated application devices shall be inspected and maintained.

Earthing Device(s) shall be examined immediately before and after use for defects. Defective Portable **Earthing Device(s)** and application devices shall be immediately withdrawn from service.

6.2 Type registered Portable **Earthing Device(s)** shall be applied and removed using a type registered application device.

In any cell or cubicle, all exposed conductors shall be **Isolated** and **Point(s) of Isolation** established before any portable **Earthing Device(s)** are applied.

Guidance
NSI 2
6.1 to 6.2

6 General Requirements for Portable Earths

- 6.1 Portable **Earthing Device(s)** and their associated type registered application devices shall be maintained. Maintenance shall be carried out in accordance with Management of Maintenance Policy NSPM203 for all portable **Earthing Device(s)**.

A **Senior Authorised Person** shall immediately arrange to withdraw from service and dispose of any Portable **Primary Earth(s)** subjected to short circuit fault current.

When portable **Earthing Device(s)** are to be applied, or issued under an **Earthing Schedule**, only those necessary for the immediate operations shall be removed from the store.

It is essential that low resistance connections be established with the portable **Earthing Device**, to ensure any voltage differences present are limited to within safe levels. Prior to the application of the earth end clamp, the portion of the earth tape to which the earth clamp is to be applied shall be inspected and cleaned to remove paint etc, refer to Figure 6.1B, to encourage a low resistance connection between the clamp and the earth tape.

When the line end clamp is being applied to the busbar appropriately sized earthing clamps shall always be used to ensure an adequate connection is made. Refer to the Type Registration list for details of clamp sizes and the busbar sizes they are designed for. Figure 6.1A shows incorrect application.

When fitting the line end clamp it should be partially rotated in both directions during tightening process to encourage a low resistance connection between the clamp and the busbar.

When applying or removing large head clamps, application device S2 Sockets, refer to figure 6.1C are more suitable as they have a spigot retaining spring, for applying earths in downward direction or at an angle, whilst allowing clamps free to rotate.

S1 Socket - has a slot, stopping the smaller clamps from rotating, but has no spigot retaining spring.

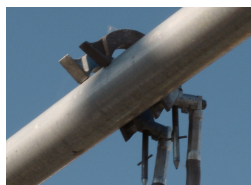


Figure 6.1A



Figure 6.1B



Figure 6.1C "S2" clamp top

Portable **Earthing Device(s)** shall be returned to the storeroom as soon as practicable after use.

- 6.2 Portable **Earthing Device(s)** and their associated application / removal devices are identified in Type Registered List TRL 2.2 Part 4 – Substation Portable Earthing Equipment.

http://infonetuk/assetmgt/default.asp?action=list&nameid=360&turbo=on&name=type_registration_lists_trl_tal&bhcp=1

NSI 2
7.1 to 7.6

7 Application / Removal of Earthing Devices

- 7.1 (a) Fully or partially interlocked fixed **Earthing Device(s)** when used as **Primary Earth(s)** shall be applied and removed by an **Authorised Person**, under the instructions of a **Control Person (Safety)**.
- (b) Non interlocked fixed **Earthing Device(s)** when used as **Primary Earth(s)** shall be applied and removed by a **Senior Authorised Person**, under the instructions of a **Control Person (Safety)**.

7.2 Application or removal of portable **Earthing Device(s)** to be used as **Primary Earth(s)** shall be carried out by:-

- The **Senior Authorised Person** who has received the instruction from a **Control Person (Safety)**
- A **Competent Person** under the **Personal Supervision** of the **Senior Authorised Person**. The **Senior Authorised Person** will have received the instruction from a **Control Person (Safety)**

Where additional **Personnel** are required to assist in the application or removal of portable **Earthing Device(s)** their role is to provide physical assistance only. This activity shall be carried out under the **Personal Supervision** of the **Senior Authorised Person**.

7.3 Before **Earthing Device(s)** are connected to the earth system the earth system should be inspected to ensure it is intact.

When a portable **Earthing Device** is to be applied the following sequence shall be undertaken:-

- All earth end clamps shall be applied first
- All line end clamps can then be applied

For removal of a portable **Earthing Device** the following sequence shall be undertaken:-

- All line end clamps shall be removed first
- All earth end clamps can then be removed

At no time shall the line end clamp of a portable **Earthing Device** be allowed to remain connected when its earth end clamp has become detached. An additional earth shall be applied in parallel before the faulty **Earthing Device** is removed.

7.4 An appropriately authorised **Competent Person** may remove and apply **Primary Earth(s)** as defined on a **Sanction for Work**.

7.5 Before a break is made in an electrical conductor or a connection is made across a break, **Danger**, which could arise from voltage difference, shall be excluded. **Earthing Device(s)** shall be applied on both sides of, and in close proximity to, the point where a break or connection is to be made, except where work is carried out in accordance with an **Approved** Procedure or a Management Procedure.

7.6 **Equipment** connected to line end circuits are subject to circulating currents due to earthing arrangements. Before a break is made consultation shall be sought from an overhead line engineer.

Guidance
NSI 2
7.2

7 Application / Removal of Earthing Devices

7.2 A **Senior Authorised Person** shall receive the instruction for the application or removal of portable **Primary Earth(s)**. Switching Instructions for earthing shall be carried out in accordance with the requirements of Management Procedure - NSI 1 "Operational and Safety Switching".

Before applying portable **Primary Earth(s)** the **Senior Authorised Person** shall make reference and make job specific the Generic risk assessment "SITE 007 – Application and Removal of Portable Primary Earths". To achieve this, the **Senior Authorised Person** shall carry out a visual risk assessment at the point of earthing.

Senior Authorised Person shall consider the following as part of their risk assessment:-

- Condition of portable **Primary Earth(s)** inspected for damage and within inspection date
- Condition of earth tape at point of application
- **Point(s) of Isolation** confirmed
- Point at which **Earthing Device(s)** are to be applied
- Proximity of adjacent **Live HV Equipment**
- Proximity of lower level exposed conductors e.g. stress shields, corona rings, CT housing etc.
- Ground conditions at point of application
- Height at which portable **Earthing Device** has to be applied
- Prevailing weather conditions



Figure 7.2A – Example of proximity of lower level equipment - **Safety Distance** to be maintained when applying portable **Earthing Device(s)** will be from the bottom of the CT housing not the conductor as indicated by the red arrows.

The control measures shall include, where appropriate:-

- Switching out adjacent **Live Equipment**
- Ensuring that electrical protective devices are in service on adjacent busbars and circuits
- Number of portable **Earthing Device(s)** required
- Deciding whether additional **Personnel** should be used to assist with the application or to help prevent loss of control
- Reference to dimensional drawings
- Use of Optical measuring devices
- Use MEWP for application / remove of **Earthing Device** at height

Guidance
NSI 2
7.2 Cont. to 7.3

If a MEWP is used for high level application/removal of portable **Earthing Device(s)**, **Safety Distance** shall be maintained at all times. The controls for this shall be identified in the generic risk assessment "SITE 007 – Application and Removal of Portable Primary Earths", which is made site specific by the **Senior Authorised Person**.

The risk assessment shall be retained in an A4 folder titled "Portable Earthing Devices Risk Assessments" located within the substation switching office for a period of 3 years.

Contractors shall not apply, remove or assist in the application or removal of portable **Primary Earth(s)** to or from the **System** unless they are under the instructions specified with a **Sanction for Work Safety Document** and have the appropriate authorisations to do so.

Where reasonably practicable portable **Earthing Device(s)** with single earth leads shall be applied. The application of single earth leads will assist to reduce potential manual handling issues associated with the application of multiple earth leads. An example where it is not reasonably practicable is where some caged equipment have double earth leads specifically designed.

Earthing at Hall Type 132 kV Substations is controlled via an interlock system. An example is included in Appendix B for guidance.

- 7.3 Before **Earthing Device(s)** are connected to the earth system endeavours should be made to ensure the earth system is intact. This may consist of a visual inspection, communication with site representatives or viewing Technical Limitations.

Operating pole, type ESI-P1 for the application and removal of portable **Earthing Device(s)** shall not be greater than 4.88 metres in length.

Where multiple earth leads are connected in close proximity to each other at the earth end connection, and cannot be adequately separated, if one is required to be removed then both shall be removed prior to the re-application of the other.

When a portable **Earthing Device** has become detached, all work relying on the detached earth as a safety precaution or as a further precaution shall be halted, until the portable **Earthing Device** has been replaced. For **Primary Earth(s)** the **Control Person (Safety)** shall be immediately informed.

The risk assessment for the application of the additional portable **Earthing Device** shall ensure that no **Personnel** make contact with a loose earth end clamp. **Safety Distance** shall be maintained from the earth end clamp until removed from the conductor.

Guidance
NSI 2
7.4 to 7.6

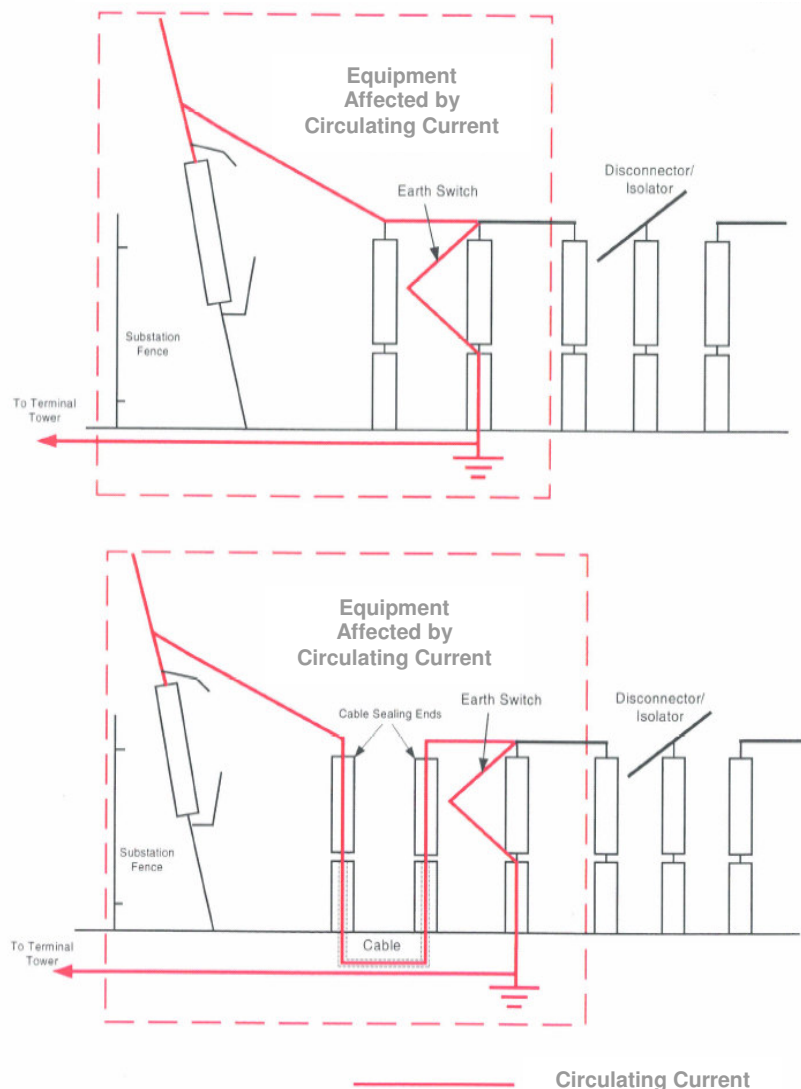
7.4 A **Competent Person** authorised to Management Procedure – NSI 9 “Testing High Voltage Equipment”, may remove and apply **Primary Earth(s)** as defined on a **Sanction for Work**.

7.6 High circulating currents may appear on substation line end **Equipment**. When working on substation line end **Equipment** the **Senior Authorised Person** shall always consult with an overhead line engineer competent to Management Procedure - NSI 4 “Working on or Near High Voltage Overhead Lines”.

High circulating currents (900 A) can flow in the **Earthing Device(s)** applied by overhead lines to a Complex Circuit. Prior to work commencing the overhead line engineer may apply additional **Primary Earth(s)** to sectionalise the circuit or by the local application of a Double DrESS.

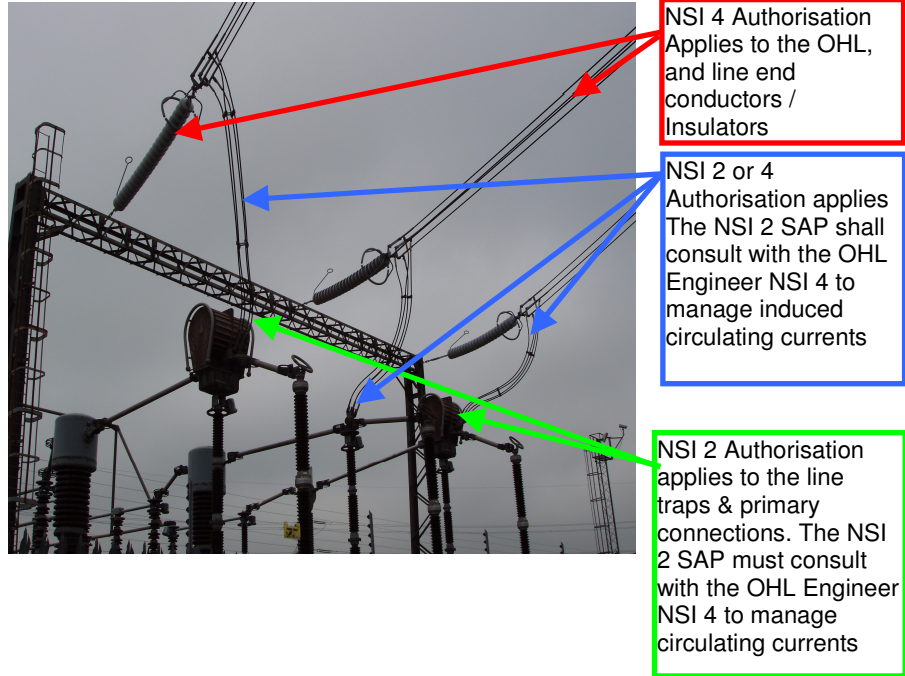
High circulating currents (450 A) can flow in the conductors of a simple circuit. The overhead lines engineer will guide and assist in the management of this current.

Typical Configurations of Circulating Current in Substations



Guidance
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7.6 Cont.

Figure 7.6A shows the overhead line and substation authorisation interface when earthing on line end **Equipment**.



Note: NSI 6 & 8 applies to all work inside the HV compound

Fig. 7.6A – OHL / Substation Interface

NSI 2
7.7 to 7.10

- 7.7 When **HV Equipment** has been disconnected from all primary and secondary supplies in preparation for temporary removal from the normal position the use of **Drain Earth(s)** is not necessary, provided that it is not **Charged** and **Danger** is excluded.
- 7.8 When **Drain Earth(s)** prevent access to the point of work, and **Danger** could arise from **Charged Equipment**, the **HV Equipment** shall be connected to earth by applying **Drain Earth(s)** at the nearest convenient point. **Drain Earth(s)** shall be applied in accordance with an **Earthing Schedule**. These **Drain Earth(s)** may be removed in turn as the work is done. Each earth removed shall be replaced before the next one is removed.
- 7.9 When working on Metalclad Switchgear and Earthing is required, reference shall be made to Management Procedure NSI 3 - High Voltage Metalclad Switchgear with Spouts.
- 7.10 **Earthing Device(s)** applied for the dissipation of trapped charge at GIS substations may only be applied to **Isolated** sections and does not require the establishment of **Point(s) of Isolation** prior to their application or removal.

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7.7

- 7.7 Management Procedure NSI 33 – “The Addition / Removal To / From The System” gives guidance on the process for temporarily removing **Equipment** from the **System** e.g. for workshop repair.

NSI 2
8.1 to 8.4

8 Special Cases of the Application of Primary Earths

8.1 Earthing at Tandem Isolators

When it is necessary to apply or remove portable **Primary Earth(s)** at Tandem Isolators and special earthing facilities are not provided, this shall where reasonably practicable be carried out with **Point(s) of Isolation** established at both sides of the Isolator. If this is not reasonably practicable the **Senior Authorised Person** shall carry out a written risk assessment and decide the appropriate control measures and safe method of applying the portable **Primary Earth(s)** to the **HV Equipment**.

8.2 Earthing Above **Live** Circuits shall not be carried out.

8.3 Indoor Type Substations

When applying **Earthing Device(s)** at hall type indoor 132 kV substations the **Senior Authorised Person** shall carry out a written risk assessment detailing the control measures required to prevent items falling out of the busbar trolley whilst traversing above **Live** circuits.



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8.4 Transformers and Reactors

Transformer and reactor windings shall be **Earthed** between the windings and all **HV Point(s) of Isolation**. Where reasonably practicable **Primary Earth(s)** should also be connected between the point of work and the **LV Point(s) of Isolation** on Auxiliary and Earthing / Auxiliary Transformers. When this is not reasonably practicable **Safety from the LV System** can be achieved by applying two **Point(s) of Isolation** in series on the **LV** side of the transformers.

If the work involves the disconnection of the Auxiliary Transformer from the earthed **HV System**, the requirement for continued earthing, will be assessed by the **Senior Authorised Person** on site and if required may be achieved by the application of either additional **Primary Earth(s)** or **Drain Earth(s)**.

When a generator transformer is connected to a generator turning on barring gear, care shall be taken that the continuity of the earth path through the windings is maintained. If work on the tap changer or windings is undertaken, any point of disconnection shall first be bridged. This is to avoid an induced decaying **High Voltage** being produced across the disconnection due to the collapse of a magnetic field associated with any small circulating current in the transformer windings.

Guidance
NSI 2
8.1 to 8.3

8 Special Cases of the Application of Primary Earths

- 8.1 The design of Tandem isolators is such that it is possible when applying or removing portable **Earthing Device(s)**, with one side of the Tandem Isolator still **Live**, for loss of control to result in inadvertent earthing of **Live Equipment**.



Figure 8.1A – End Rotating Post Busbar Isolators Arranged in Tandem

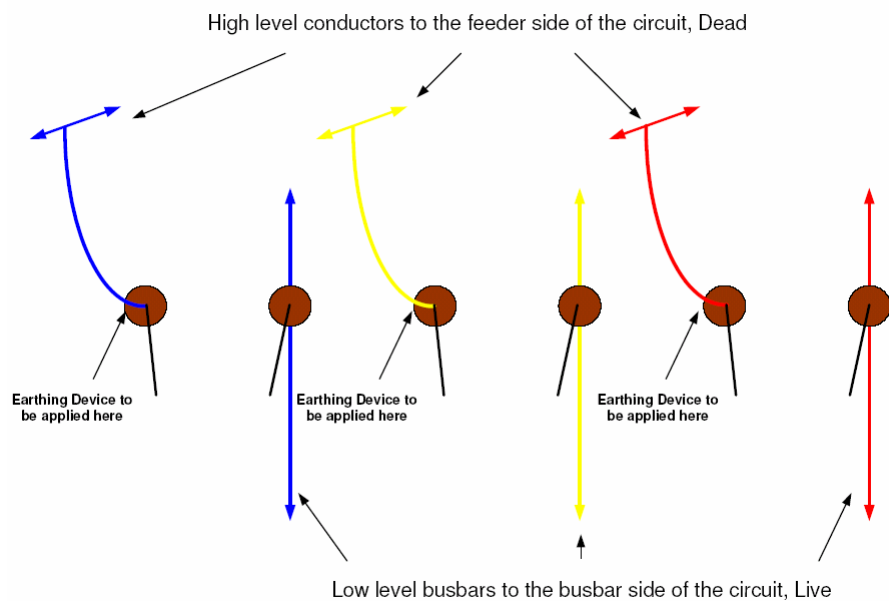


Figure 8.1B – Schematic View of Busbar Arrangement

- 8.3 The risk assessment shall take account of how all items of tools; objects etc. are to be secured within the trolley to prevent the potential for them to fall onto **Live** circuits whilst the trolley is traversing.

NSI 2
9.1 to 9.2

9 Earthing Against Points of Isolation from the LV Side of Voltage Transformers

- 9.1 Where a Voltage Transformer remains solidly connected to a **Primary Earth** on the **HV System**, throughout the course of the work, there is no need to apply further **Primary Earth(s)** to prevent **Danger** as a result of an inadvertent re-energisation through the Voltage Transformer. This is irrespective of the distance between the Voltage Transformer and the **Primary Earth**.
- 9.2 If the work involves the disconnection of the voltage transformer from the **Earthed HV System**, the preferred option to prevent **Danger** as a result of inadvertent re-energisation through the Voltage Transformer is by the application of **Drain Earth(s)** at the Voltage Transformer.

Guidance
NSI 2
9.1

9 Earthing Against Points of Isolation from the LV Side of Voltage Transformers

- 9.1 Where an **HV Capacitor** is in series between the Voltage Transformer and the **Primary Earth**, the electrical properties of the Capacitor will result in the Capacitor being a solid connection between the Voltage Transformer and **Primary Earth**.

Capacitor C1 electrical properties act as a solid connection to earth switch X251A

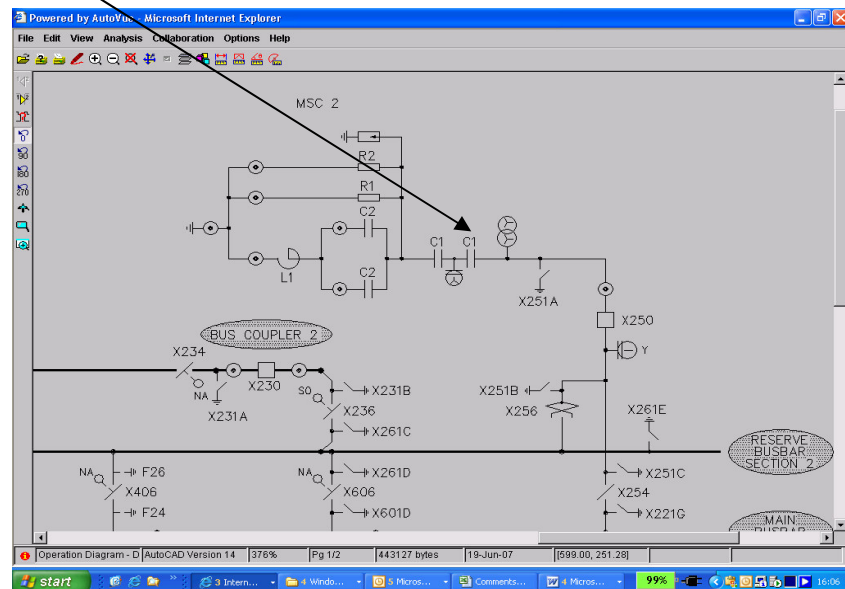


Figure 9.1A – HV Capacitor in Series between CVT and **Primary Earth**

Supergrid Double wound transformers shall not be considered as a solid connection.

Appendix A - Substation Multiple Primary Earth Requirements

- A.1 The assessment of the number of portable **Earthing Device(s)** to form a **Primary Earth** at each substation owned or operated by National Grid has been based on the projected maximum and worst case fault level for each substation.
- A.2 This assessment also included a consideration of the maximum theoretical inducted circulating current likely to be seen on circuit line ends at 400 kV and 275 kV substations against that of the continuous current rating of the portable **Earthing Device**.
- A.3 Normal running arrangement fault levels (or switchgear nameplate short circuit fault current ratings when no other information was available at the time of publication) have been used to calculate the required number of portable **Earthing Device(s)** to form a **Primary Earth** for substations at 132 kV and below which are not owned or operated by National Grid.

Where the number of portable **Earthing Devices(s)** are calculated using switchgear nameplate short circuit fault current ratings, it may be possible to reduce the number required if the maximum fault level for the site in question can be established prior to their application. The **Senior Authorised Person** should seek advice on the expected fault levels from the owner or operator of the substation and apply the appropriate number of portable **Earthing Device(s)** to cater for new fault levels.

- A.4 At sites not listed the number of portable **Earthing Device(s)** applied should be equal to or exceed the rating of the switchgear installed at the substation.
- A.5 13 kV tertiary fed busbar systems, by exception default to 4 leads.
- A.6 The short circuit capability of a portable **Earthing Device** has been reviewed and reassigned for use within 400 kV and 275 kV substations where switchgear ratings are defined against a 1 second rating. The benefits from this are an increase in short circuit capability of the portable **Earthing Device** at these voltages. The new short circuit rating of a single lead and clamp system for use at 400 kV or 275 kV is 25 kA / 1 second.
- A.7 The existing rating of 17.5 kA / 2 seconds for a portable **Earthing Device** still applies to 132 kV substations and below.
- A.8 The numbers of portable **Earthing Device(s)** declared within the lists below are based on portable **Earthing Device(s)** which have a single lead attached (150mm² flexible aluminium).
- A.9 The lists will be reviewed on an annual basis.

A.10 **Standard Number of Portable Earthing Devices**

400 kV Substations

SUBSTATION	Number of leads required per phase excluding line end equipment	Number of leads required per phase on line end equipment
Abham 400	1	2
Alverdiscott 400	1	2
Amersham 400	1	2
Axminster 400	1	2
Barking 400	2	2
Beddington 400	1	2
Bicker Fen 400	1	2
Bolney 400	1	2
Botley Wood 400	2	2
Braintree 400	1	2
Bradford West 400	1	2
Bramford 400	1	2
Brinsworth 400	2	2
Bramley 400	3	3
Burwell 400	2	2
Canterbury 400	2	2
Capenhurst 400	2	2
Carrington 400	2	2
Cellarhead 400	2	2
Chickerell 400	1	2
Cilfynydd 400	2	2
City Road 400	2	2
Connahs Quay 400	3	3
Coryton South 400	2	2
Cottam 400	3	3
Cowley 400	3	3
Creyke Beck 400	3	3
Culham Jet 400	3	3
Daines 400	3	3
Damhead Creek 400	3	3
Deeside 400	3	3
Didcot 400	3	3
Dinorwig 400	2	2
Drakelow 400	3	3
Drax 400	3	3
Dungeness 400	2	2
Eaton Socon 400	2	2
East Claydon 400	2	2
Eggborough 400	3	3
Elstree 400	2	2
Enderby 400	2	2
Exeter 400	1	2
Fawley 400	2	2
Feckenham 400	2	2
Ferrybridge 400	2	2
Fleet 400	2	2

SUBSTATION	Number of leads required per phase excluding line end equipment	Number of leads required per phase on line end equipment
Frodsham 400	2	2
Grain 400	3	3
Grendon 400	2	2
Grimsby West 400	2	2
Hams Hall 400	2	2
Harker 400	1	2
Hawthorn Pit 400	1	2
Heysham 400	2	2
High Marnham 400	2	2
Hinkley Point 400	1	2
Humber Refinery 400	3	3
Hutton 400	1	2
Imperial Park 400	1	2
Indian Queens 400	1	2
Ironbridge 400	2	2
Iver 400	1	2
Keadby 400	3	3
Kearsley 400	2	2
Kemsley 400	3	3
Killingholme 400	3	3
Kingsnorth 400	3	3
Lackenby 400	2	2
Landulph 400	1	2
Langage 400	1	2
Legacy 400	2	2
Leighton Buzzard 400	2	2
Little Barford 400	2	2
Littlebrook 400	2	2
Lovedean 400	2	2
Macclesfield 400	2	2
Mannington 400	1	2
Medway 400	2	2
Melksham 400	2	2
Minety 400	2	2
Monk Fryston 400	3	3
Neepsend 400	1	2
Northfleet East 400	2	2
Ninfield 400	1	2
Norton 400	2	2
Norwich Main 400	1	2
Nursling 400	1	2
Oldbury 400	1	2
Osbaldwick 400	2	2
Padiham 400	2	2
Patford Bridge 400	1	2
Pelham 400	3	3
Pembroke 400	1	2
Penn 400	1	2
Pentir 400	2	2

SUBSTATION	Number of leads required per phase excluding line end equipment	Number of leads required per phase on line end equipment
Penwortham 400	2	2
Rassau 400	1	2
Ratcliffe-on-soar 400	3	3
Rayleigh 400	2	2
Rochdale 400	1	2
Rocksavage 400	2	2
Rowdown 400	1	2
Rugeley 400	2	2
Rye House 400	2	2
Seabank 400	1	2
Sellindge 400	2	2
South Humber Bank 400	2	2
Shrewsbury 400	2	2
Singlewell 400	2	2
Sizewell 400	1	2
St Johns Wood 400	2	2
Spalding North 400	2	2
Stannah 400	2	2
Stalybridge 400	1	2
Staythorpe 400	2	2
Stella West 400	1	2
Stocksbridge 400	2	2
Sundon 400	3	3
Sutton Bridge 400	2	2
Swansea North 400	1	2
Taunton 400	1	2
Thorpe Marsh 400	3	3
Thornton 400	3	3
Tilbury 400	2	2
Trawsfynydd 400	1	2
Walham 400	1	2
Walpole 400	2	2
Waltham Cross 400	2	2
West Burton 400	3	3
West Ham 400	2	2
Whitson 400	1	2
Willington East 400	2	2
West Weybridge 400	1	2
Wylfa 400	1	2
Wymondley 400	2	2

275 kV Substations

SUBSTATION	Number of leads required per phase excluding line end equipment	Number of leads required per phase on line end equipment
Aberthaw 275	2	2
Aldwarke 275	2	2
Baglan Bay 275	1	2
Barking 275	2	2
Beddington 275	2	2
Berkswell 275	1	2
Birkenhead 275	1	2
Bishops Wood 275	1	2
Blyth 275	2	2
Bradford West 275	2	2
Bredbury 275	2	2
Brimsdown 275	2	2
Brinsworth 275	2	2
Bridgwater 275	1	2
Bushbury 275	1	2
Bustleholm 275	2	2
Capenhurst 275	2	2
Cardiff East 275	1	2
Carrington 275	2	2
Chessington 275	2	2
Chesterfield 275	2	2
Cilfynydd 275	1	2
Coventry 275	1	2
Cowbridge 275	1	2
Creyke Beck 275	2	2
Drakelow 275	2	2
Dungeness 275	1	2
Ealing 275	2	2
Elland 275	2	2
Elstree 275	2	2
Feckenham 275	1	2
Ferrybridge 275	2	2
Ffestiniog 275	1	2
Fiddlers Ferry 275	2	2
Fourstones 275	1	2
Frodsham 275	2	2
Grangetown 275	1	2
Greystones 275	3	3
Hackney 275	2	2
Hams Hall 275	2	2
Harker 275	2	2
Hart Moor 275	2	2
Hartlepool 275	2	2
Hawthorn Pit 275	2	2
High Marnham 275	2	2
Hinkley Point 275	1	2
Hurst 275	2	2
Iron Acton 275	1	2

SUBSTATION	Number of leads required per phase excluding line end equipment	Number of leads required per phase on line end equipment
Iver 275	2	2
Jordanthorpe 275	2	2
Kearsley 275	2	2
Kirkby 275	2	2
Kirkstall 275	1	2
Kitwell 275	2	2
Knareborough 275	1	2
Lackenby 275	2	2
Laleham 275	2	2
Lister Drive 275	2	2
Littlebrook 275	1	2
Macclesfield 275	1	2
Margam 275	1	2
Melksham 275	1	2
Mill Hill 275	1	2
Monk Fryston 275	2	2
Nechells 275	2	2
Neepsend 275	2	2
New Cross 275	2	2
North Hyde 275	1	2
Norton Lees 275	2	2
Norton 275	2	2
Ocker Hill 275	2	2
Offerton 275	2	2
Oldbury 275	1	2
Penn 275	2	2
Penwortham 275	2	2
Pitsmoor 275	2	2
Poppleton 275	1	2
Pyle 275	1	2
Rainhill 275	2	2
Ratcliffe-on-soar 275	1	2
Redbridge 275	2	2
Rochdale 275	2	2
Rowdown 275	2	2
Salt End North 275	1	2
Salt End South 275	1	2
Saltholme 275	2	2
Sheffield City 275	2	2
St Johns Wood 275	2	2
Skelton Grange 275	2	2
South Manchester 275	2	2
Spennymoor 275	1	2
South Shields 275	1	2
Stalybridge 275	2	2
Stella West 275	2	2
Swansea North 275	1	2
Templeborough 275	2	2
Thorpe Marsh 275	2	2

SUBSTATION	Number of leads required per phase excluding line end equipment	Number of leads required per phase on line end equipment
Thurcroft 275	2	2
Tilbury 275	2	2
Tinsley Park 275	2	2
Tod Point 275	2	2
Tottenham 275	2	2
Trawsfynydd 275	1	2
Tremorfa 275	1	2
Tynemouth 275	1	2
Upper Boat 275	1	2
Uskmouth 275	1	2
Waltham Cross 275	2	2
Warley 275	2	2
Washway Farm 275	2	2
Watford South 275	2	2
West Boldon 275	2	2
West Ham 275	1	2
Whitegate 275	2	2
Whitson 275	2	2
Wincobank 275	2	2
Willenhall 275	1	2
Willington 275	1	2
Wilton 275	2	2
Wimbledon 275	2	2
Willesden 275	2	2
West Melton 275	2	2
West Thurrock 275	1	2
West Weybridge 275	2	2

132 kV Substations and Below

SUBSTATION	Number of leads required per phase including line end
Aberthaw 132	1
Abham 132	1
Aldwarke 33	1
Alverdiscott 132	1
Amersham 132	1
Axminster 132	1
Barking 132	1
Barking 33	1
Beddinton 132	1
Berkswell 132	1
Bicker Fen 132	1
Birkenhead 132	1
Bishops Wood 132	1
Blyth 132	3
Blyth 66	2
Bolney 132	2
Botley Wood 132	1
Bradford West 132	1
Braintree 132	1
Bramford 132	2
Bramley 132	1
Bredbury 132	1
Bridgwater 132	1
Brimsgate 132	2
Burwell 132	1
Bushbury 132	1
Bustleholm 132	1
Camblesforth 66	2
Canterbury 132	2
Capenhurst 132	1
Cardiff East 132	2
Carrington 132	2
Cellarhead 132	2
Chessington 132	1
Chesterfield 132	1
Chickerell 132	1
City Road 132	1
Connahs Quay 132	2
Coventry 132	1
Cowes 132	2
Cowley 132	2
Creyke beck 132	1
Drakelow 132	1
Drax 132	1
Ealing 66	2
East Claydon 132	1

SUBSTATION	Number of leads required per phase including line end
Eaton Socon 132	1
Elland 132	1
Elstree 132	1
Enderby 132	1
Exeter 132	1
Fawley 132	1
Feckenham 66	2
Ferrybridge 132	2
Fleet 132	2
Fourstones 22	2
Frodsham 132	1
Gloucester 132	1
Grain 132	2
Grendon 132	2
Greystones 66	3
Grimsby West 132	1
Hackney 66	2
Hams Hall 132	1
Harker 132	1
Hart Moor 66	2
Hawthorn Pit 66	2
Heysham 132	1
Hurst 132	1
Hutton 132	1
Ince 132	1
Indian Queens 132	1
Iron Acton 132	2
Iron Bridge 132	1
Iver 132	1
Iver 66	2
Jordanthorpe 33	1
Keadby 132	2
Kearsley 132	1
Kearsley 33	1
Kemsley 132	1
Kingsnorth 132	1
Kirkby 132	1
Kirkstall 132	1
Kitwell 132	1
Lackenby 66	2
Laleham 132	1
Landulph 132	1
Lea Marston 132	2
Legacy 132	1
Lister Drive 132	1
Littlebrooke 132	1
Lodge Road 66	2

SUBSTATION	Number of leads required per phase including line end
Lovedean 132	1
Macclesfield 33	1
Mannington 132	2
Margam 132	1
Marylebone 132	2
Melksham 132	2
Mill Hill 132	1
Minety 132	1
Nechells 132	1
Neepsend 33	1
New cross 132	2
New Cross 66	2
Ninfield 132	1
North Hyde 66	1
Northfleet East 132	1
Norton 132	2
Norton Lees 33	1
Norwich Trowse 132	2
Norwich Main 132	2
Nursling 132	1
Ocker Hill 132	1
Offerton 33	1
Oldbury 132	1
Oldbury-on-Seven 132	1
Osbalwick 132	1
Padiham 132	1
Pelham 132	1
Pembroke 132	1
Penn 132	1
Penrhos 132	1
Pentir 132	1
Penwortham East 132	1
Penwortham West 132	1
Pitsmoor 33	1
Poppleton 33	1
Port Ham 132 (Walham)	3
Port Ham 33	3
Pyle 132	1
Rainhill 132	1
Rassau 132	1
Ratcliffe-on-Soar 132	2
Rayleigh Local 132	1
Redbridge 132	1
Redbridge 33	1
Rochdale 132	1
Rugeley 132	1
Rye House 132	1

SUBSTATION	Number of leads required per phase including line end
Saltend North 132	2
Saltend South 33	1
Saltholme 132	1
Sellindge 132	1
Sheffield City 33	1
Shrewsbury 132	1
Sizewell 132	1
Skelton Grange 132	1
South Manchester 132	1
South Shields 33	1
Spennymoor 66	2
St Johns Wood 132	1
Stalybridge 132	2
Stannah 132	1
Staythorpe 132	2
Stella North 132	2
Stella South 132	1
Stella West 132	2
Stocksbridge 66	2
Sundon 132	2
Swansea North 132	1
Taunton 132	1
Templeborough 33	1
Thorpe Marsh 66	2
Thurcroft 66	2
Tilbury 132	1
Tinsley Park 33	2
Tod Point 66	2
Tottenham 132	1
Trawsfynydd 132	1
Tremorfa 33	1
Tynemouth 132	1
Uskmouth 132	2
Walpole 132	2
Warley 132	1
Washway Farm 132	1
Watford South 132	1
West Boldon 66	2
West Burton 132	1
West Ham 132	1
West Melton 132	2
West Melton 66	2
West Thurrock 33	2
West Weybridge 132	1
Whitegate 132	1
Whitson 33	2
Willenhall 132	1

SUBSTATION	Number of leads required per phase including line end
Willesden 132	1
Willesden 66	1
Willington 132	2
Wimbledon 132	2
Wincobank 33	1
Wylfa 132	1
Wymondley 132	1

25 kV Network Rail Substations

SUBSTATION	Number of leads required per phase
All applications	Default to 1

Tertiary Fed Systems

SUBSTATION	Number of leads required per phase
All applications	Default to 4

Appendix B - Example of Application of Earthing Devices in Hall Type 132 kV Substations

B.1 This appendix is for the guidance for applying **Earthing Device(s)** to the busbar side of busbar isolators in 132 kV Hall Type substations with a full interlocking system of busbar isolators, busbar fixed earths and bascule / trolley doors. Actual switching sequence may vary depending upon the interlocking design for the substation in question.

B.2 With reference to Figure B1, to apply the first fully rated **Earthing Device** to the appropriate section of busbar after **Point(s) of Isolation** have been established to the appropriate section of busbar. **Safety Distance** shall be maintained at all times for the application of the first fully rated **Earthing Device**:-

- To earth busbar adjacent to isolator 414
- 413, 416, 514, 154, 314, 184, 104, 136, 128 all **Point(s) of Isolation**
- Close and lock isolator 134
- Close the appropriate fixed **Earthing Device** i.e. earth switch 131B
- Close bus coupler circuit breaker 130
- Close the appropriate fixed **Earthing Device** i.e. earth switch 131A
- Open the bus coupler circuit breaker 130

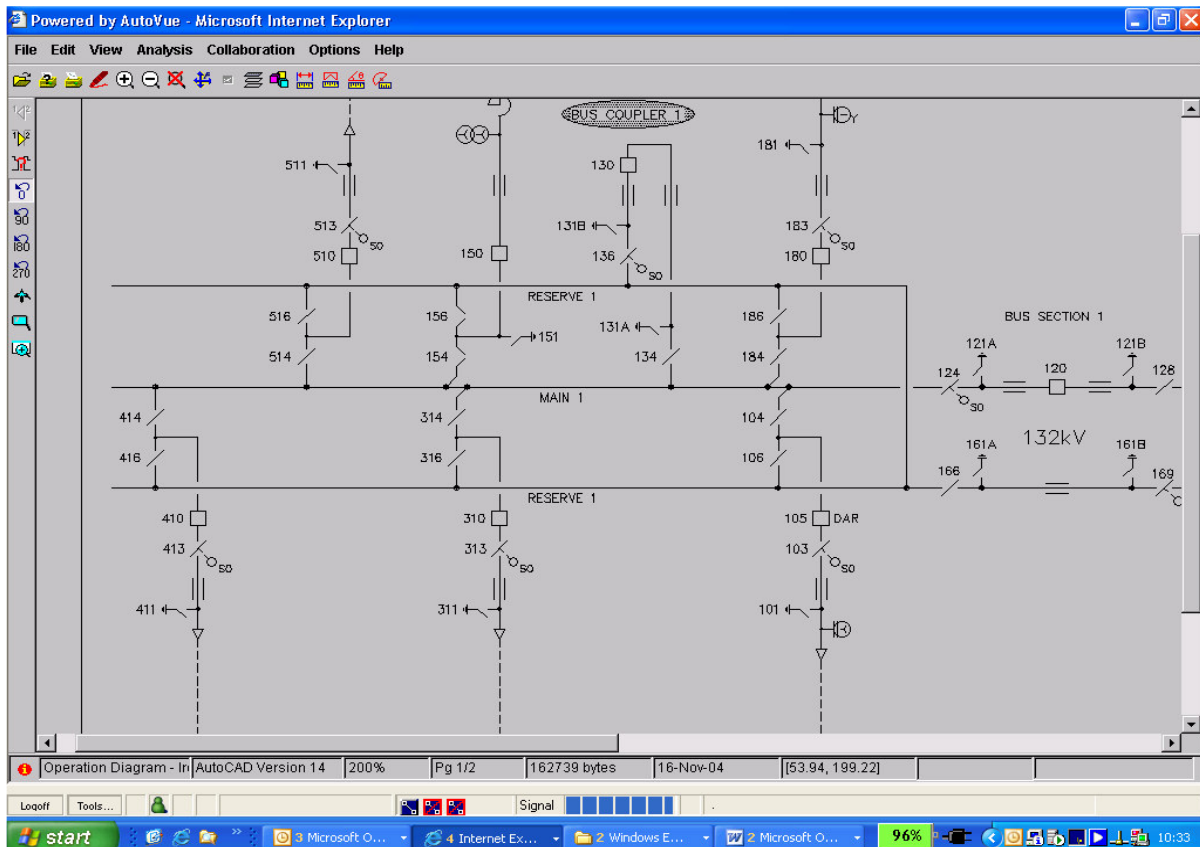


Figure B1 – Hall Type 132 kV Substation

B.3 Once the above sequence has been followed and the appropriate section of busbar has been **Earthed** via a fully rated **Earthing Device**, where it is not reasonably practicable to maintain **Safety Distance**, encroachment within the specified **Safety Distance** may now be allowed for the application / removal of type resigtered **Earthing Device(s)** and their associated application devices under rule R2.3b of the National Grid UK Electricity Transmission plc Safety Rules.

Appendix C - Authorisation Matrix for Contractors Personnel

Contractors appointment under this NSI shall be limited to the following sections.

Contractor Personnel	Person	Competent Person	Authorised Person	Senior Authorised Person
Sections		5.2 6.1 6.2 7.3		