

GUIDANCE FOR WORKING IN PROXIMITY TO LIVE CONDUCTORS - REDUCING THE RISKS

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PURPOSE AND SCOPE

These guidelines have been prepared for information and may be used by designers as an indication of designs that will be considered acceptable by National Grid Transco (NGT). Following these guidelines does not, however, absolve the designers of their responsibilities for their design under CDM regulations.

PART 1 – GUIDANCE

1 GENERAL

Designers are obliged to comply with all relevant health and safety legislation, particularly the designers' duties under the Construction (Design and Management) Regulations 1994 (CDM). In applying the principles of prevention and protection to the reduction of risk, designers' considerations should include the hazards of working in proximity to exposed live HV conductors (including 'oversailing' conductors) during construction, operation, maintenance, repair, replacement or demolition of electrical/mechanical equipment and civil structures.

If the designer does not eliminate hazards presented by exposed live HV conductors from the design, there is an obligation on the designer to show, by risk assessment, that the design has complied with the principles of prevention and protection, as required by CDM, in some other way. The following hierarchy of risk control shall be considered when selecting alternative control measures.

The preferred hierarchy of risk control principles are:

- Eliminate risk altogether
- Substitute equipment or activities with less hazardous ones
- Combat risk at source by engineering control measures
- Reduce risk by suitable safe systems of work
- Minimise risk by the use of Personal Protective Equipment.

[Reference National Grid National Health & Safety Standard NS-MP1]

2 DESIGN PRINCIPLES

2.1 It is essential that the Safety Distances (specified in the National Grid Safety Rules Handbook) to exposed live HV conductors are not infringed either deliberately or accidentally during any work activity.

2.2 In order to comply with 2.1 above, designers will need to establish appropriate minimum design clearances. These must take into account not only the immediate requirements of the work activity but also additional factors relating to the means of access and working methods. An indicative, but not exhaustive, list of factors to be considered when considering whether clearances are sufficient include the possibility of a Mobile Elevated Work Platform (MEWP) running out of control, passage of cranes through substations, the use and handling of scaffold poles and setting up enclosures over cable sealing ends.

The clearances recommended in these guidelines may not, in some circumstances, be sufficient to adequately mitigate hazards and designers must be prepared to use risk assessment principles to test their design decisions.

2.3 Designers must take account of relevant UK legislation, National Grid Safety Rules and relevant Technical Specifications (formerly NGTS's) when considering methods of performing work activities. The procedures defined in the National Grid National Safety Instructions (NSIs) must also be considered (although other procedures that meet the legal/Safety Rule requirements may be accepted at the discretion of NGT).

2.4 It is NGT policy to eliminate from new substation construction:

- a) Oversailing conductors (as far as is reasonably practicable).
- b) Conductors in proximity.
- c) Situations where work activities must be carried out above exposed HV conductors that are live.

2.5 In assessing what is reasonably practicable, designers may wish to use the ALARP (As Low As Reasonably Practicable) principle outlined in National Grid National Health & Safety Standard NS-MP1 and 'Tolerability of Risk From Nuclear Power Stations', (HSE Books, 1992).

A higher priority should be placed on eliminating oversailing conductors from routine work activities than from non-routine work activities. Furthermore, a higher priority should be placed on eliminating oversailing conductors where access is intended to be by MEWP (where there is a significant risk of accidentally moving out of the operating area as a result of misjudgement or mechanical failure) than from where access is by temporary fixed-height platform.

Note: The specification by the designer of a temporary fixed-height platform in place of a MEWP will not always be acceptable to NGT. Refer to Appendix A for application limitations.

2.6 Practically, it is impossible to eliminate exposed live HV conductors from a substation during work (with the exception of GIS substations). NGTS 2.1 specifies the following maximum outage conditions:

The design of the substation shall permit installation, extension, operation and maintenance (preventive and corrective) with a maximum of one circuit (including any circuit requiring intervention) and one busbar section out of service simultaneously.

Informative: A section of busbar is taken to be a part of either the main or reserve busbars or a mesh corner. Associated busbar section and busbar coupler circuits may be considered to be part of the busbar section.

Substation designs shall be based on these requirements.

- 2.7** When considering clearances from roadways to exposed live conductors for vehicle access, designers must take into account the largest load that may reasonably foreseeably need to be moved on that roadway. The designer shall also identify the proposed access/egress route for the replacement of the largest single unit of equipment installed on site (e.g. transformer or quadrature booster) taking into account all substation voltages crossing that route.

Where a transformer has failed, this will already have resulted in depletion of one circuit at a substation. It would not, therefore, be an acceptable design solution to require further circuits to be switched out to provide clearance for transporting the failed or replacement units across site.

- 2.8** Guidance for designers can be categorised according to the nature of the work activity and the type of access intended by the designer. This guidance is summarised in the table in Appendix A

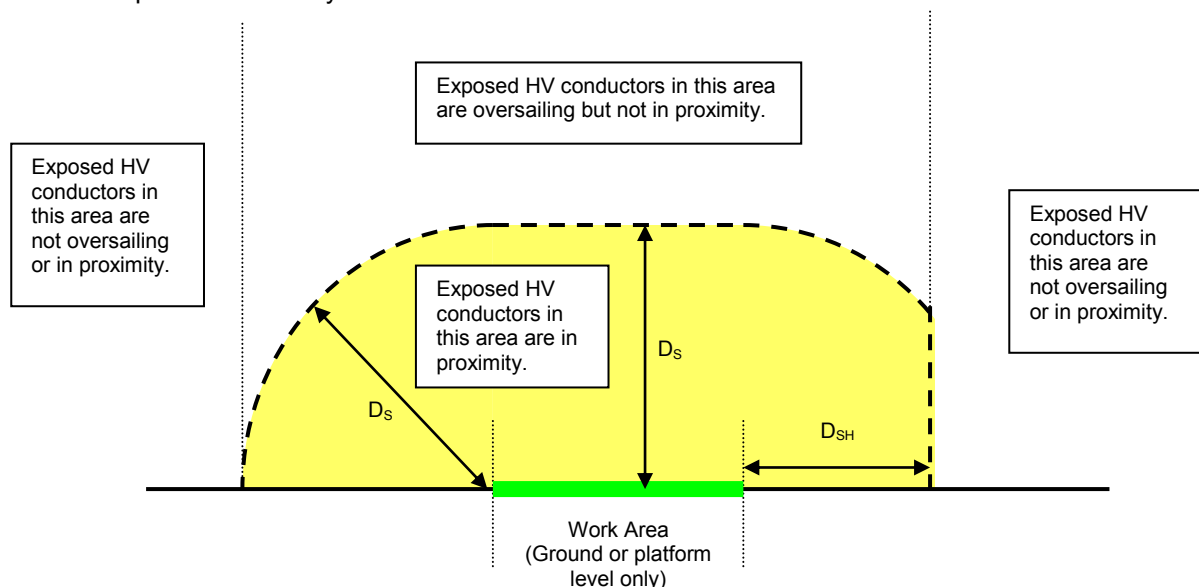
3 DESIGN GUIDANCE FOR ACCESS FROM GROUND LEVEL OR PERMANENT PLATFORM

The design objective is to allow personnel to move freely around the substation at ground level and to safely use:

- a) any permanently installed access platforms, or
- b) mobile steps which have been specifically designed to access specific plant or equipment whilst live.

Conductors in proximity to any reasonably foreseeable work area shall be eliminated by ensuring that the appropriate design clearance for safety D_S (as specified in Table 1) has been achieved from all exposed live conductors.

Conductors that are not in proximity but still oversail the work area shall be accepted by NGT (since elimination is not considered reasonably practicable) and the designer will not be required to take any measures to avoid them.



D_S is the design clearance for safety (section clearance) specified in NGTS 2.1.

The reduced horizontal design clearance for safety D_{SH} may be utilised in the substation design where the designer can demonstrate that it would not be reasonably practicable to incorporate the specified vertical clearance.

The above diagram has been simplified for clarity and no means is shown of defining the boundary of the work area. In practice, the work area would need to be bounded by a handrail or fence. A handrail is only acceptable for an elevated platform and designers must consider the possibility of the rail being used as a step – a minimum vertical clearance of D_S must therefore be allowed from the top of the handrail to any exposed live conductor. The required minimum horizontal clearance is D_S (or D_{SH}). Where an earthed fence or barrier meeting the requirements of protection class IP2X as defined in IEC 60529 (and which is not readily climbable) is provided then the minimum horizontal clearance to an exposed live conductor may be reduced to minimum or type tested phase to earth electrical clearance. The required vertical clearance is D_S from floor level of the work area. Where a non-IP2X fence or barrier (which is not readily climbable) is provided then minimum clearances are as shown in the diagram above. Fences that are climbable must be treated as handrails.

- 3.1 Reasonably foreseeable work areas shall be taken to include any part of the substation at ground level or any part of a permanently installed access platform, except where access to the area is specifically restricted (e.g. fenced compounds around capacitor banks).
- 3.2 The designer must consider whether any hazards are present which may not have been adequately controlled by the use of standard design clearances and, where necessary, carry out a specific risk assessment. Any additional prevention and protection measures identified by this specific risk assessment must be implemented.
- 3.3 In areas where conductors in proximity cannot be eliminated then access shall be limited as specified in NGTS 2.1 Clause 4.4. Such a limitation will not be accepted by NGT where access is required for switching, routine inspections/patrols or fault finding on secondary equipment.

Under circuit outage conditions that permit access to the restricted area, exposed HV conductors of other circuits which may remain energised shall not be in proximity to that area.

- 3.4 The use of mobile steps for operational access in substations is non-preferred. Where the use of such access is agreed by NGT, then the designer shall ensure that clearances (D_S) as defined in Table 1 are provided from the platform level in any position in which the steps might reasonably foreseeably be located.

Details, including a dimensioned drawing, of the steps on which the design is based shall be recorded in the site Health & Safety file.

4 DESIGN GUIDANCE FOR ACCESS BY TEMPORARY FIXED-HEIGHT PLATFORM

- 4.1 The design objective is to allow for safe erection, use and dismantling of the temporary fixed-height platform without exceeding the specified maximum outage criteria.
- 4.2 The presence of oversailing and/or proximity conductors shall be identified as follows:
 - a) Identify (in plan view) the position (or positions) of the temporary platform required to carry out the work activity.

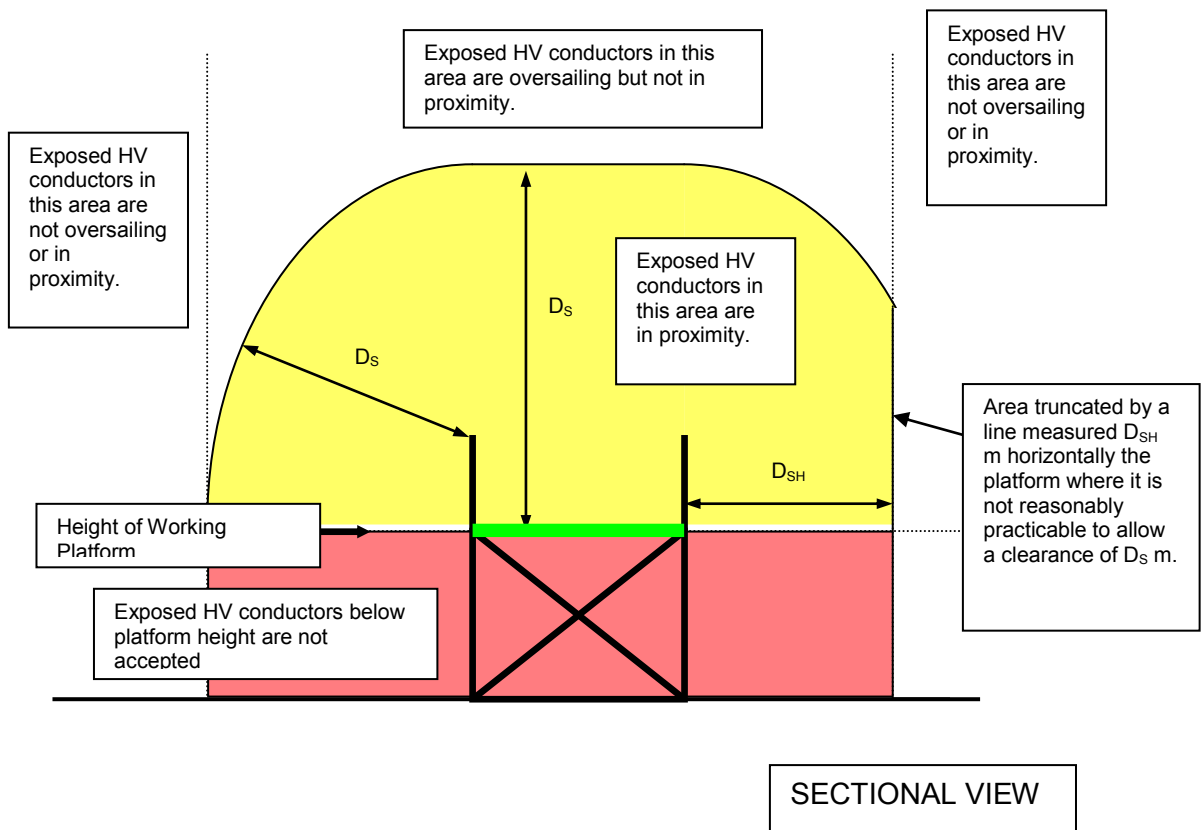
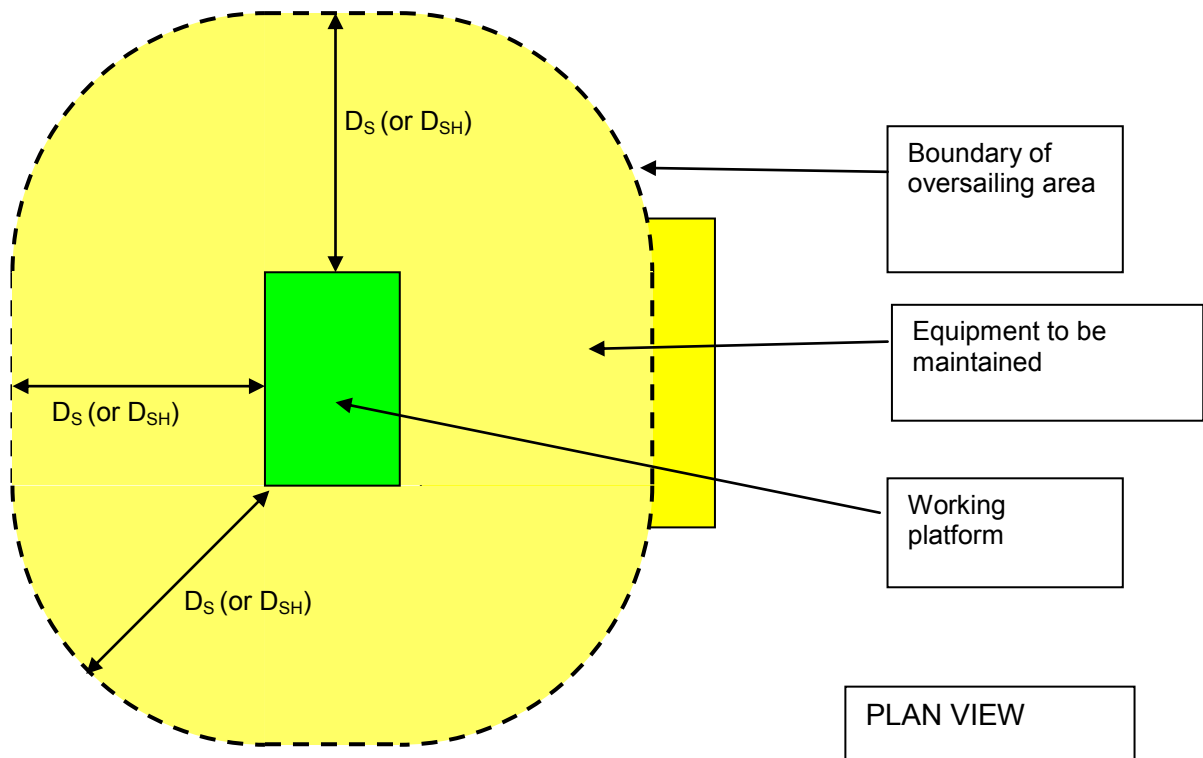
- b) Plot an area around the platform with its perimeter measured D_S from the edge of the platform (where D_S is the design clearance for safety specified in Table 1 and in NGTS 2.1).

Note: The reduced horizontal design clearance for safety D_{SH} may be utilised in the substation design where the designer can demonstrate that it would not be reasonably practicable to incorporate the specified vertical clearance.

- c) Any exposed HV conductor that crosses this area (at any height) will be considered to be oversailing.

Note: Exposed conductors which are not live by virtue of the isolation procedures necessary to carry out the work activity are excluded from this definition.

- d) Any exposed HV conductor that crosses this area at a distance $\leq D_S$ (measured vertically or at any angle) from any part of the floor of the fixed-height platform will be considered a conductor in proximity.



The diagrams above have been simplified for clarity. When preparing designs, designers must consider the possibility of the platform handrail being used as a step. Unless alternative control measures are proposed a minimum vertical clearance of D_S must thus be allowed from the top of the handrail to any exposed live conductor.

- 4.3** The designer must consider whether any hazards are present which may not have been adequately controlled by the use of standard design clearances and, where necessary, carry out a specific risk assessment. Any additional prevention and protection measures identified by this specific risk assessment must be implemented.

Additional risks to be considered might be erection of temporary platforms and, where applicable, handling long objects such as scaffold poles. Possible variations in the location of the temporary platform must also be considered.

- 4.4** Where a design does not eliminate oversailing conductors, this may still be acceptable. In these cases the designer will be required to demonstrate:
- That the conductors are not in proximity, and
 - That it is not reasonably practicable to eliminate the oversailing condition or to further increase the clearance from the working platform.
 - That a suitable and sufficient risk assessment of the design has been documented and implemented.

- 4.5** Where designers intend temporary fixed-height platforms to be used for fault investigation of secondary equipment or routine maintenance then details shall be included in the site Health & Safety file of the height, size and location of the platform on which the design is based together with any special requirements for erection or dismantling.

The Health & Safety file must also contain details of access arrangements for reasonably foreseeable non-routine work activities (e.g. repair/replacement of major substation components) where the access requirements are critical to the substation design. These details must include requirements for additional circuit outages beyond those that would be assumed from the electrical diagram of the substation.

5 DESIGN GUIDANCE FOR ACCESS BY MEWP

- 5.1** The design objective is to allow for safe use of a MEWP without exceeding the specified maximum outage criteria. Because of the risk of misjudgement or mechanical failure, NGT consider it necessary to provide an additional design margin when allowing clearances for use of a MEWP. As a minimum, designers must ensure that their design does not require any part of the MEWP or of the operator's body to infringe the 'vicinity zone' (as defined in BS EN 50110) surrounding exposed HV conductors which remain energised during the work activity.

Designers should note that the minimum clearances to exposed live conductors suggested in these guidelines provide a margin to allow for misjudgement or mechanical failure.

- 5.2** The presence of oversailing/proximity conductors shall be identified as follows:
- Identify (in plan view) the area that will be traversed by the platform of the MEWP during the work activity. Also identify the area occupied by the MEWP base unit and that area which will be traversed by any overhanging parts of the MEWP (e.g. booms). Together, these areas form the MEWP operating area.

- b) Plot an additional area around the MEWP operating area with its perimeter measured D_A from the edge of the area (where D_A is the horizontal design clearance for safety specified in NGTS 2.1 + 2 m).

Note: D_A incorporates safety distance + personal reach + 2 m margin and thus exceeds the vicinity zone perimeter clearance D_V suggested in some other documents such as draft IEC 61936.

- c) Any exposed HV conductor that crosses this area (at any height) will be considered to be oversailing.

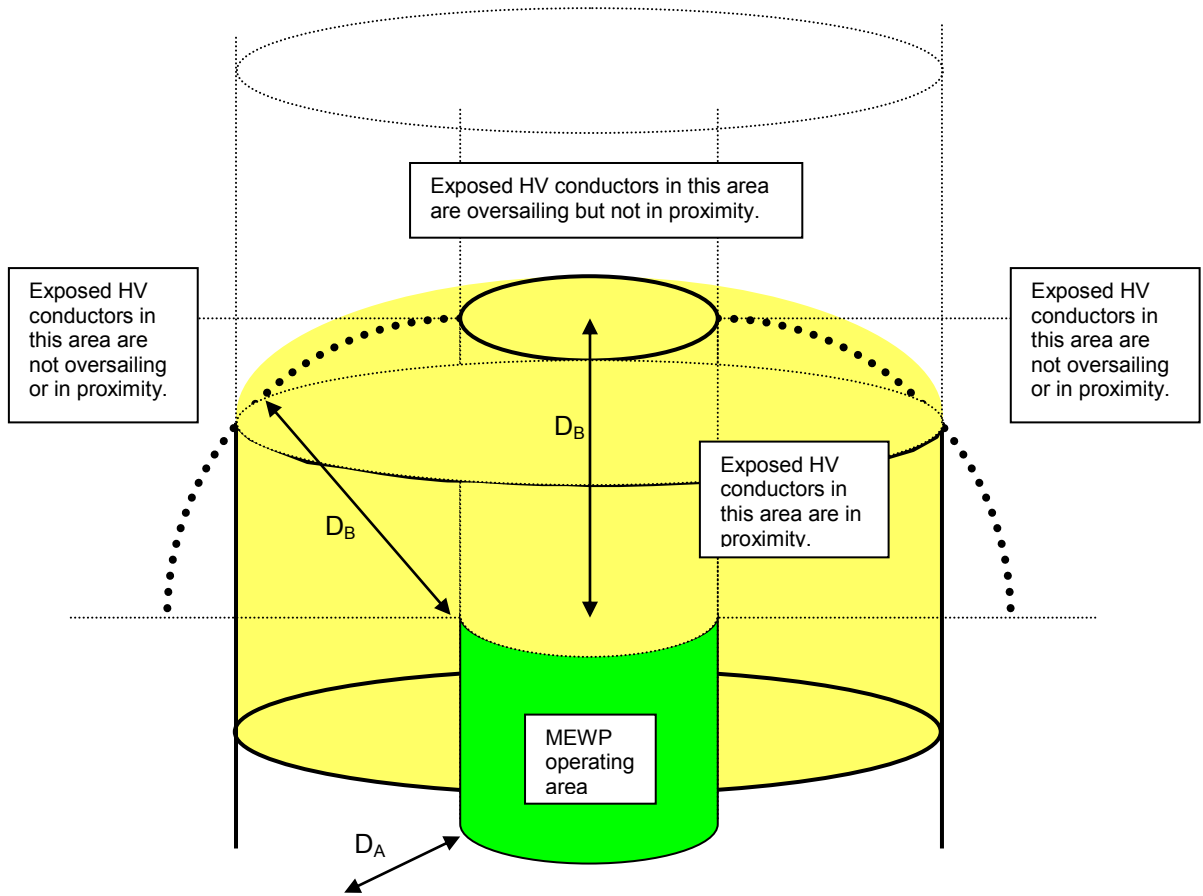
Note: Exposed conductors which are not live by virtue of the isolation procedures necessary to carry out the work activity are excluded from this definition.

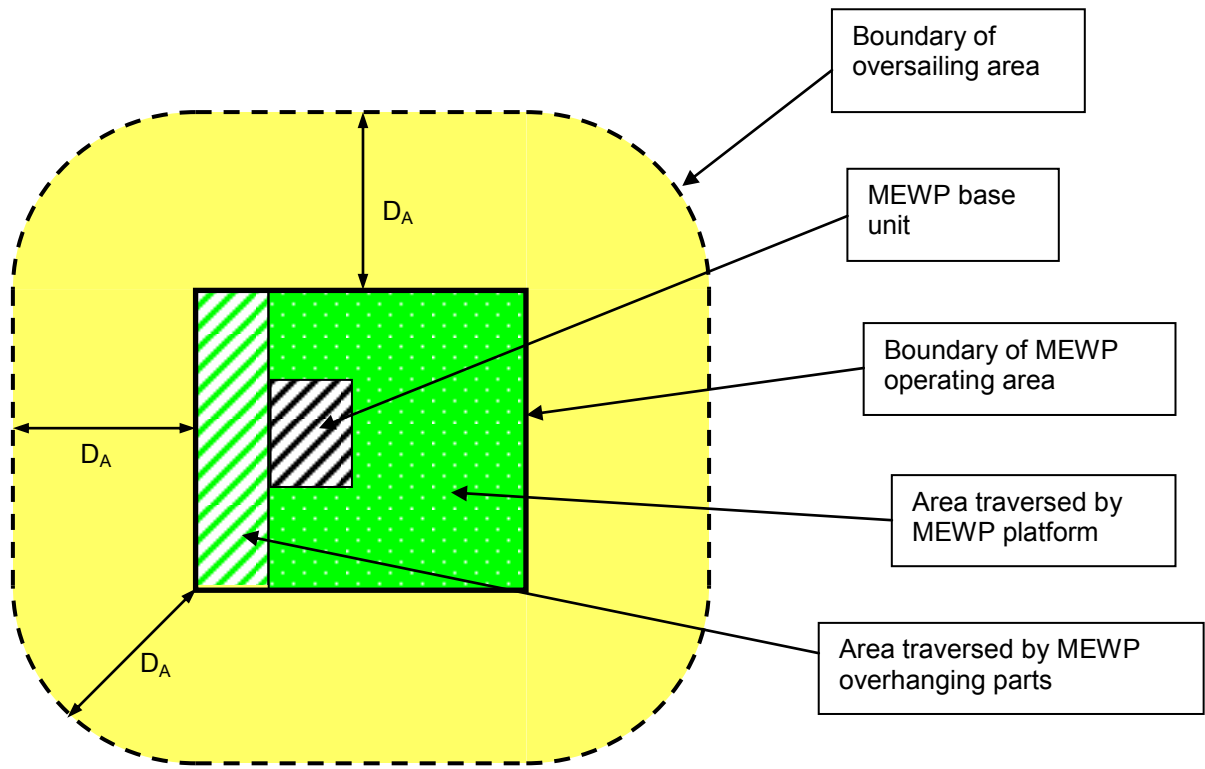
- d) The vertical dimension of the MEWP operating area will be determined by the maximum height that the base of the MEWP platform is required to reach to carry out the work activity. Unless otherwise defined, this height will be taken to be the maximum height of the equipment being maintained.

- e) Any exposed HV conductor that crosses the zone at a distance $\leq D_B$ (measured vertically or at any angle) from any part of the MEWP operating area will generally be considered a conductor in proximity, (where D_B is the vertical design clearance for safety specified in NGTS 2.1 + 2 m).

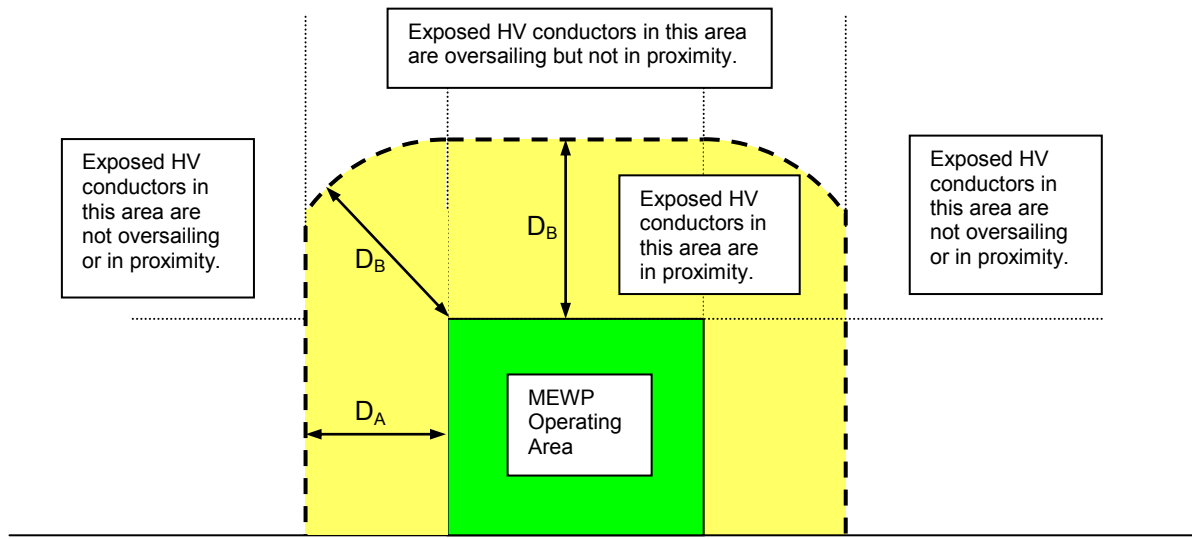
Note: In some cases it may be acceptable to consider different platform operating heights in parts of the MEWP operating area (e.g. the area traversed by overhanging parts of the MEWP). Designers using this approach must, however, demonstrate that it is not reasonably practicable to design on the basis of a uniform worst-case MEWP operating area height.

Note: It is not generally necessary to take account of the possibility of staff climbing on the handrail of the MEWP platform. The 2 m margin is considered adequate to manage this risk since it is considered unlikely that personnel will climb on the handrail whilst the platform is in motion.





PLAN VIEW



SECTIONAL VIEW

- 5.3** In determining the MEWP operating area, designers may base their design on a generic MEWP or a specific MEWP. Designs based on a generic MEWP are preferred.

A generic MEWP shall be taken to have the worst-case characteristics of MEWP types normally hired by NGT, details of which can be obtained from NGT's procurement section.

It is not intended that the designer should automatically take account of the full operating envelope of a generic or specific MEWP. It is sufficient to identify the required envelope of operation to perform the work activity in determining the MEWP operating area. However, where the operating area of a MEWP is to be limited, it is important to identify the limits of operation in the site Health & Safety file.

- 5.4** The designer must consider whether any hazards are present which may not have been adequately controlled by the use of standard design clearances and, where necessary, carry out a specific risk assessment. Any additional prevention and protection measures identified by this specific risk assessment must be implemented.

- 5.5** Where a design does not eliminate oversailing conductors, this may still be acceptable. In these cases the designer will be required to demonstrate:

- a) That the conductors are not in proximity, and
- b) That it is not reasonably practicable to eliminate the oversailing condition or to further increase the clearance from the MEWP operating area.
- c) That a suitable and sufficient risk assessment of the design has been documented and implemented.

- 5.6** If a designer bases the substation design on the use of a MEWP then full details of the characteristics of this MEWP shall be provided in the site Health & Safety file

The Health & Safety file must also contain details of access arrangements for reasonably foreseeable non-routine work activities (e.g. repair/replacement of major substation components) where the access requirements are critical to the substation design. These details must include requirements for additional circuit outages beyond those that would be assumed from the electrical diagram of the substation.

- 5.7** For new substation work or work that necessitates a change to the established maintenance practices on an existing site a complete set of maintenance access drawings shall be provided. These shall be produced in conjunction with operations and maintenance staff and consider the requirements for normal maintenance activities undertaken by MEWP and those which require the deployment of cranes for heavy lifting. Where sites are to be shared with third parties then maintenance access drawings shall be produced with due consideration given to how works being undertaken by the different parties affect one another.

For partial substation replacement work i.e. new bays or bay refurbishments then the existing maintenance access drawings are to be reviewed and modified to suit the revised design or new provided if none exist.

Drawings should be based on the following basic principles

- Any equipment not highlighted on drawing to be assumed live and in service
- Access route shown from normal substation access gate to equipment
- Maintenance work area to be highlighted
- Section drawings required where access routes pass under / in proximity to live equipment
- Section and plan drawings required to show position of access vehicles in work area

6 FORMS AND RECORDS

Not applicable.

PART 2 - DEFINITIONS AND DOCUMENT HISTORY

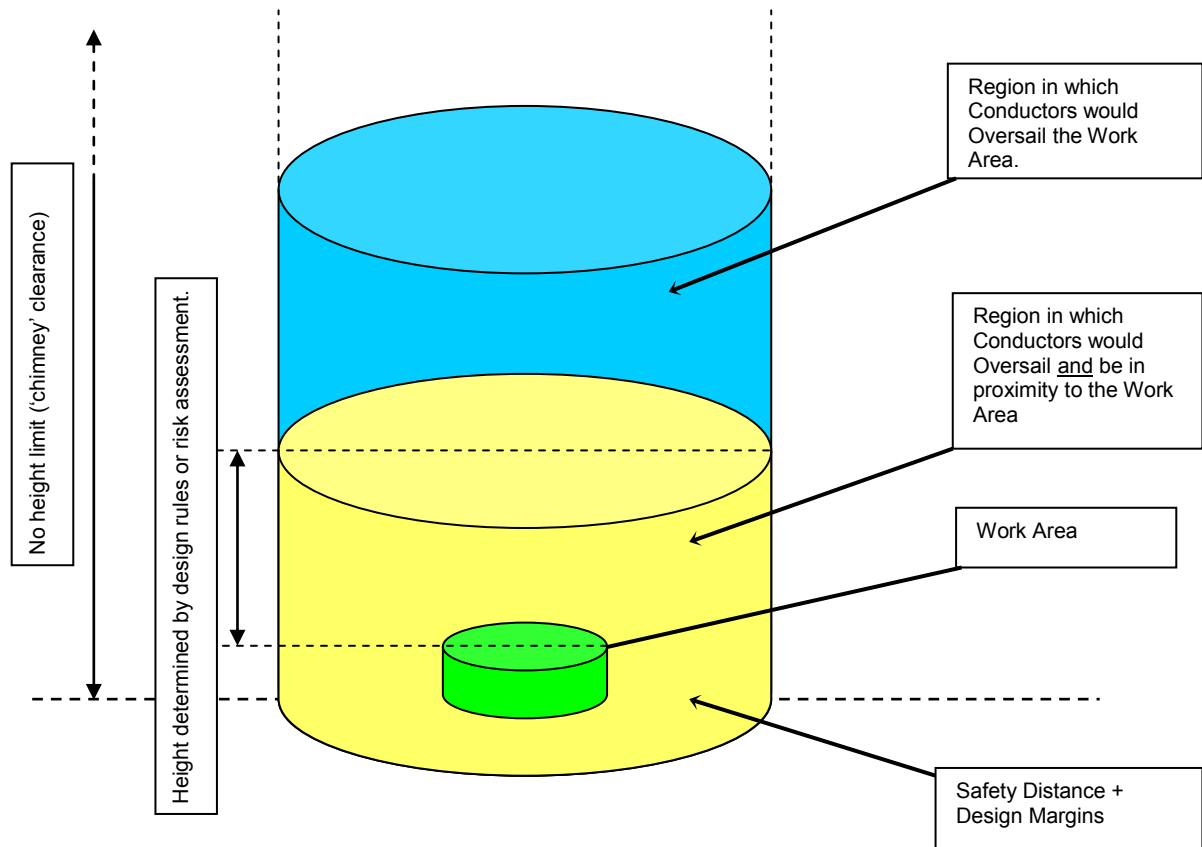
7 DEFINITIONS

7.1 Oversailing Conductors

Are exposed HV conductors which are above or in proximity to any reasonably foreseeable work area and which would normally remain energised during such work activities.

7.2 Conductors in proximity

Are exposed HV conductors with insufficient clearance to a reasonably foreseeable work area to avoid danger and which would normally remain energised during work activities.



7.3 Design Clearance for Safety (Vertical) [D_S]

The sum of the relevant Safety Distance (from the National Grid Safety Rules) and the maximum vertical reach of a person (taken to be 2.4 m) previously known as Section Clearance.

7.4 Design Clearance for Safety (Horizontal) [D_{SH}]

The sum of the relevant Safety Distance (from the National Grid Safety Rules) and the maximum horizontal reach of a person (taken to be 1.5 m).

Note: The horizontal reach dimension adopted in NGT substation design practice is 100 mm greater than that specified in BS7354.

7.5 Design Clearance for MEWP Operation (Horizontal) [D_A]

The sum of the relevant Safety Distance (from the National Grid Safety Rules), a margin to allow for operator error or equipment maloperation (2m) and the maximum horizontal reach of a person (taken to be 1.5m).

Note: The Safety Distance + 2 m margin, when measured from an exposed live conductor, defines the boundary of the Vicinity Zone (as specified in BS EN 50110). The design philosophy is that neither the MEWP, any part of the operators body or any object held by the operator should infringe the Vicinity Zone.

7.6 Design Clearance for MEWP Operation (Vertical) [D_B]

The sum of the relevant Safety Distance (from the National Grid Safety Rules), a margin to allow for operator error or equipment maloperation (2 m) and the maximum vertical reach of a person (taken to be 2.4 m).

Values of D_A, D_B, D_S and D_{SH} for NGT system voltages are tabulated in Table 1 below.

Nominal System Voltage (kV)	11/22/33	66	132	275	400
NG Safety Rules, Safety Distance	0.8	1.0	1.4	2.4	3.1
Design Clearance for Safety (Vertical) [D _S]	3.2	3.4	3.8	4.8	5.5
Design Clearance for Safety (Horizontal) [D _{SH}]	2.3	2.5	2.9	3.9	4.6
Design Clearance for MEWP Operation (Vertical [D _B])	5.2	5.4	5.8	6.8	7.5
Design Clearance for MEWP Operation (Horizontal) [D _A]	4.3	4.5	4.9	5.9	6.6
Minimum Height of Conductors Above Roadways **	5.8	6.0	6.7	7.0	7.3

Table 1 - Values of minimum clearances (mtrs) for NGT system voltages

*** Informative: Values given above are based upon the Electricity Safety, Quality & Continuity Regulations 2002. NGTS 2.1 also permits a value based upon the maximum vehicle height + 0.5m + safety distance. Actual values to be used shall be the greater of the two values.*

7.7 Non-Primary System Work

Any work in a substation which is not directly associated with equipment forming part of the NGT system.

8 AMENDMENTS RECORD

Issue	Date	Summary of Changes / Reasons	Author(s)	Approved By (Inc. Job Title)
1	June 2004	Document created to capture the Appendix D information which was removed from NGTS 2.1 at its revision to issue 4. Minor amendments made for clarity.	Linda Desmond Asset Policy	Trevor Jones Asset Policy Manager
2	Feb 2016	Requirements for production of MEWP access drawings	Peter Holliday	Asset Policy Manager

PART 3 - GUIDANCE NOTES AND APPENDICES

APPENDIX A - GUIDANCE FOR DESIGNERS

	Access from ground level or permanent platform **	Access by temporary fixed-height platform (e.g. pre-form/pole & clip scaffold).	Access by MEWP
Switching or Routine Inspections/ Patrols	Only method of access accepted by National Grid	Not accepted	Not accepted
	Safe access must be provided without the need for circuit outages.	N/A	N/A
	Oversailing conductors acceptable. For design guidance on avoiding conductors in proximity see Section 3.	N/A	N/A
Access to Secondary Equipment (e.g. control/interlocking circuits) for Fault Investigation	Preferred method of access.	Access by small pre-form scaffold platform ($\leq 1.8\text{m}$) may be accepted where access by permanent platform is not reasonably practicable.	Not generally acceptable. Designers must be able to justify this design decision.
	Safe access must be provided without the need for circuit outages.	Safe access must be provided without the need for circuit outages.	Safe access must be provided without the need for circuit outages.
	Oversailing conductors acceptable. For design guidance on eliminating conductors in proximity see Section 3.	Oversailing conductors acceptable. For design guidance on eliminating conductors in proximity see Section 4.	Oversailing conductors are not acceptable except where it is not reasonably practicable to eliminate them. For design guidance on eliminating conductors in proximity see Section 5.

	Access from ground level or permanent platform **	Access by temporary fixed-height platform (e.g. pre-form/pole & clip scaffold).	Access by MEWP
Routine Preventive Maintenance (any routine work activity specified in the manufacturers operating & maintenance instructions).	Preferred method of low-level access	Acceptable for low-level access ($\leq 3.6\text{m}$) and for high-level access in situations (such as indoor substations) where MEWP access cannot reasonably practicably be provided.	Preferred method of high-level access in all substations.
	The design shall be based on minimum circuit outages (i.e. a requirement for additional 'proximity' outages will generally not be acceptable).	The design shall be based on minimum circuit outages (i.e. a requirement for additional 'proximity' outages will generally not be acceptable).	The design shall be based on minimum circuit outages (i.e. a requirement for additional 'proximity' outages will generally not be acceptable).
	Oversailing conductors acceptable. For design guidance on eliminating conductors in proximity see Section 3.	Oversailing conductors are not acceptable except where it is not reasonably practicable to eliminate them. For design guidance on eliminating conductors in proximity see Section 4.	Oversailing conductors are not acceptable except where it is not reasonably practicable to eliminate them. For design guidance on eliminating conductors in proximity see Section 5.
Fault Repair/ Erection/ Extension/ Replacement /Demolition	Acceptable method of access.	Acceptable for low-level access ($\leq 3.6\text{m}$) and for high-level access in situations where MEWP access cannot reasonably practicably be provided.	Preferred method of high-level access in all substations.
	Required circuit outages must not exceed the maximum conditions as detailed in NGTS 2.1	Required circuit outages must not exceed the maximum conditions as detailed in NGTS 2.1	Required circuit outages must not exceed the maximum conditions as detailed in NGTS 2.1
	Oversailing conductors acceptable. For design guidance on eliminating conductors in proximity see Section 3.	Oversailing conductors are not acceptable except where it is not reasonably practicable to eliminate them. For design guidance on eliminating conductors in proximity see Section 4.	Oversailing conductors are not acceptable except where it is not reasonably practicable to eliminate them. For design guidance on eliminating conductors in proximity see Section 5.

	Access from ground level or permanent platform **	Access by temporary fixed-height platform (e.g. pre-form/pole & clip scaffold).	Access by MEWP
Vehicle Access (to defined roadways within the substation)	Safe access should generally be provided without the need for circuit outages.	N/A	N/A
	Oversailing conductors acceptable. Conductors in proximity shall be eliminated by providing a minimum vertical clearance from the roadway to live conductors of either: <ul style="list-style-type: none"> • Minimum height above ground of overhead lines as defined in the Electricity Safety, Quality & Continuity Regulations 2002. • Max vehicle height + 0.5m margin + Safety Distance Whichever is the greatest.		
Non Primary System Work (i.e. all reasonably foreseeable work in a substation, including repairs, other than work on primary system equipment).	Preferred means of low-level access.	Acceptable	Not generally acceptable for routine work activities. Acceptable for non-routine work activities.
	Safe access should generally be provided without the need for circuit outages.	Safe access should generally be provided without the need for circuit outages.	Safe access should generally be provided without the need for circuit outages.
	Oversailing conductors acceptable. For design guidance on eliminating conductors in proximity see Section 4.	Oversailing conductors are not acceptable except where it is not reasonably practicable to eliminate them. For design guidance on eliminating conductors in proximity see Section 5.	Oversailing conductors are not acceptable except where it is not reasonably practicable to eliminate them. For design guidance on eliminating conductors in proximity see Section 6.

** Includes mobile steps, although they are non-preferred.