

1. SCOPE

This document sets out the requirements for ensuring substations are resilient to flooding from various sources, and that the installation of flood protection measures is provided where appropriate.

This document applies to substations at all voltages within SP Energy Networks.


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
September 2013	1	John Russell	Initial Issue.
May 2017	2	Mark Stewart	Document updated to reflect new business structure.
November 2023	3	Euan Sutherland	Updated following RIIO-ED2 plan submission and change in guidance.

3. ISSUE AUTHORITY

Author	Owner	Issue Authority
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4. REVIEW

This is a Reference document which has a 3-year retention period after which a reminder will be issued to review and extend retention or archive.

5. DISTRIBUTION

This document is not part of a Manual maintained by Document Control and does not have a maintained distribution list.

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7. RELATED DOCUMENTS

SUB-03-017	General Specification for the Civil Engineering and Building Design and Construction of Secondary Substations
SUB-03-025	General Specification for the Civil Engineering and Building Design and Construction of Primary and 33kV Switching Substations
SUB-03-026	General Specification for the Civil Engineering and Building Design and Construction of 132kV Grid Substations
SUB-03-034	General Specification for the Civil Engineering and Building Design and Construction of 275kV & 400kV Substations

8. REFERENCE DOCUMENTS

ENA ETR138 – Resilience to Flooding of Grid and Primary Substations (Issue 3 – Published June 2018)

SEPA Flood Maps (includes flood risk breakdown for Scotland)

SEPA Technical Flood Risk Guidance for Stakeholders (includes climate change allowance and freeboard allowance guidance)

EA Flood Maps (includes flood risk breakdown for England)

EA Preparing a flood risk assessment: standing advice (includes climate change allowance and freeboard allowance guidance)

NRW Flood Maps

NRW Flood Map for Planning / Development Advice Map (includes climate change allowance guidance, freeboard allowance and flood risk breakdown for Wales)

SP Energy Networks Climate Resilience Strategy (Published December 2021)

EPS-01-002 Hazard & Defect Management Policy (Issue 13)

9. DEFINITIONS

For the purpose of this document, the following definitions shall apply:

Critical plant level	The level at which flooding will impact the operation of the substation.
Flood level	The maximum predicted water level for a location during a flood event.
Design flood level	The flood level plus an allowance for climate change. The allowance for climate change shall be 50 years for new substations and the forecast remainder of the major asset's life for existing substations.
Freeboard	An allowance added to the design flood level for uncertainties in data modelling and local effects of flooding such as wind induced waves.
Coastal flooding	Flooding from the sea.

Fluvial flooding	Flooding from rivers and streams.
Pluvial flooding	Flooding from surface water run-off.
SP Energy Networks	The brand name of the division of ScottishPower Energy Networks Group of Companies that encompasses SP Distribution plc (SPD), SP Transmission plc (SPT), SP Manweb plc (SPM) and SP Power Systems Ltd.
Grid substation	A site at which energy is transformed or switched and/or contains electrical plant at an operating voltage in excess of 33kV (including 25kV traction supplies and 132/11kV GSP).
Primary substation	A site at which energy is transformed or switched at 33kV.
Secondary substation	A site at which energy is transformed or switched at any voltage less than 20kV.
Site	The existing, or best available view of the proposed-, land registry boundary of the substation buildings and compound in totality.
Topography	The arrangement of the natural and artificial physical features of an area.
EA	Environmental Agency – environment agency for England.
NRW	Natural Resources Wales – environment agency for Wales.
SEPA	Scottish Environment Protection Agency – environment agency for Scotland.
NP&R	Network Planning & Regulation – department in SP Energy Networks.
DFRA	Detailed Flood Risk Assessment

10. INTRODUCTION

Substation sites include various items of plant and equipment that are susceptible to failure when subject to flooding, including indoor/outdoor switchgear, relay panels, marshalling kiosks, transformer fans & pumps etc.

For existing substation sites, a variety of flood protection measures will be used as appropriate, to protect existing equipment to the design flood level, including freeboard where applicable, for the flood risk return period prescribed within this policy.

For new substation sites the general approach to protecting equipment will be to construct the site outside of a flood risk area. If this is not reasonably practicable, the site will be constructed at a level above the design flood level, including freeboard where applicable, for the flood risk return period prescribed within this policy.

11. FLOOD RISK

11.1 Sources of Flooding

Substations are at risk from flooding from a variety of sources.

These include:

1. Coastal (flooding from the sea)
2. Fluvial (flooding from rivers and streams)
3. Pluvial (flooding surface water run-off)
4. Reservoir failure
5. Canal bank bursts
6. Water pipe bursts (affecting underground substations)

Details on steps taken to protect against coastal, fluvial and pluvial flooding are given in Section 12, 13 and 14.

Flooding caused by reservoir failures, canal bank bursts and water pipe bursts are difficult to predict and protect against. Actions for these sources will focus on effective recovery plans to ensure that services can be restored as quickly as possible. To help with this, an impact assessment will be undertaken using available data (including asset owner's risk assessments) to predict the substation sites that are most likely to be affected by these sources of flooding. This information will be shared with the Customer Service department for them to optimise recovery plans. The impact assessment will be reviewed whenever new data becomes available.

11.2 Climate Change

The global climate is changing as a result of human activity. Past, present and future emissions of greenhouse gases, are expected to cause significant global climate change during this century.

Projections of future climate change indicate that sea levels will continue to rise, more frequent short-duration high-intensity rainfall, and more frequent periods of sustained rainfall are to be expected and will have implications for river flooding and for local flash flooding.

Climate change, therefore, may have a significant effect on flooding, however there are many different interpretations of exactly what this will mean in terms of flood protection to the network infrastructure (see SP Energy Networks Climate Change Resilience Strategy for more information).

Trigger points and adaptation pathways identified in the SP Energy Networks Climate Change Resilience Strategy will inform review and development of this Flood Resilience Policy.

11.3 Flood Risk Information

The environment agencies (EA, SEPA and NRW) provide publicly available flood risk information. This includes the risk of coastal, fluvial, and pluvial flooding in any given location (without any flood defences in place). The risks are broken down into high, medium, and low categories, with slight differences in their assigned values depending on the source of flooding and the environment agency area.

The risks for each source of flooding and environment agency area are shown below.

For example: 1:10 refers to a likelihood that there will be a level of flooding once or more in every ten years.(≥10% likelihood in a single year)

Coastal

Area	High	Medium	Low
England	1:30	1:200	1:1000
Scotland	1:10	1:200	1:1000
Wales	1:30	1:200	1:1000

Table 1: Coastal Flooding Risk Breakdown

Fluvial

Area	High	Medium	Low
England	1:30	1:100	1:1000
Scotland	1:10	1:200	1:1000
Wales	1:30	1:100	1:1000

Table 2: Fluvial Flood Risk Breakdown

Pluvial

Area	High	Medium	Low
England	1:30	1:100	1:1000
Scotland	1:10	1:200	1:1000
Wales	1:30	1:100	1:1000

Table 3: Pluvial Flooding Risk Breakdown

12. EXISTING SUBSTATIONS

With regards to the guidance set out within this policy, an “existing substation” is defined as an operational substation site which already exists on SP Energy Networks’ networks and has no major plant replacement (e.g. transformers, switchgear, reactors etc) or major civil works being undertaken.

Where major plant replacement or civil works are being undertaken at an existing substation with identified flood risk, the site should be treated as a “new substation” as defined within Section 13 where reasonably practicable to do so. Where this is not possible, guidance shall be sought from NP&R to agree any reduction to flood risk return periods.

12.1 Grid & Primary Substations

All existing grid and primary substations will be assessed using the following guidance outlined in ETR138. This process will be repeated after the release of any new flood maps from the environment agencies.

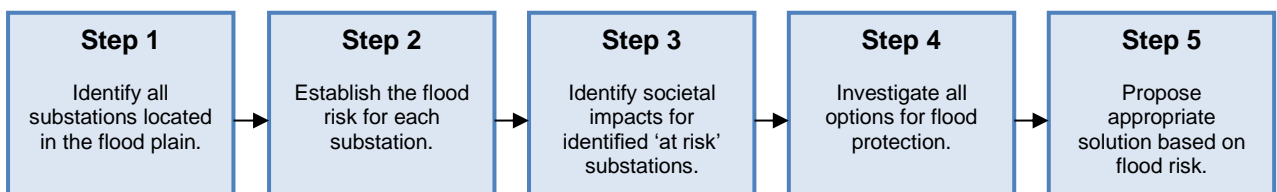


Figure 1 - Existing Substation Assessment Steps

Step 1

Substations located within a flood risk area will be identified using the latest versions of the appropriate environmental agency’s flood maps. The flood risk given will assume there are no existing flood defences in place. It is therefore necessary to assess the local flood defences and site flood defences to determine if there is already a level of protection in place.

Substations that are not already protected from the following flood risk return periods, shall be assessed, as set out in Steps 2 & 3 below.

Substation Type	Flood Risk Return Periods
Grid	1:1000-year flood event.
Primary (>10,000 unrecoverable connections)	1:1000-year flood event.
Primary (<10,000 unrecoverable connections)	1:100-year pluvial and fluvial flood event (1:200 for Scotland). 1:200-year coastal flood event.

Table 4: Flood Risk Return Periods for Existing Substations

Step 2 & 3

A DFRA shall be carried out at sites that do not meet the protection level requirements for the flood risk return periods set out in Table 4. This assessment will be completed by a specialist flood risk consultant.

The DFRA shall take account of the topography, local flood defences and site flood defences. These factors will be combined with a more detailed assessment of flood modelling, including regional environment agency guidance on climate change impact, to determine if there is a flood risk at the site and to provide a design flood level. The DFRA will undertake an impact assessment on existing sites based on the calculated flood level and critical plant level on site. This shall determine the need and requirements for intervention. If intervention is required, options for flood protection will be determined (as set out in Step 4).

Step 4

A range of options to provide the required level of flood protection will be considered.

In approximate ascending order of cost and complexity, these may include but are not limited to:

- Modification of existing or installation of new drainage.
- Raising the level of plant items and equipment.
- Barriers erected around individual plant and equipment items.
- Building only protection.
- A flood wall or embankment constructed around the site perimeter, designed to protect the entire site.
- Site/Asset relocation.

A combination of these solutions may be installed to achieve the required level of flood protection.

Plans for local flood defences in the area, and the potential to contribute to these financially, should also be considered. It is worthwhile noting that local flood defences may not be designed to the desired flood risk return periods as set out within this policy and may need to be supplemented with additional flood defences.

Flood protection installed on an existing substation shall be designed and constructed to include at a minimum freeboard level of 600mm above the design flood level. The 600mm freeboard allows for uncertainties in data modelling and local effects of flooding such as wind induced waves. Consideration must be given to the application of the allowance for freeboard and climate change – in some cases the full allowance will not be required as the flood level will never exceed a certain level (based on the topography).

Step 5

A cost/benefit assessment shall be undertaken to determine the most appropriate flood protection to meet the required level of protection.

12.2 Secondary Substations

There is no current requirement to protect existing secondary substations unless the substation has been impacted by a flood event. If the substation has been impacted by a flood event, there is requirement to protect to flood risk return periods of 1:200 (SPD) or 1:100/200 (SPM). It is recommended where necessary that a DFRA is completed, or action is taken to move the substation out of the flood risk area.

The DFRA will determine the extent of flood risk at the site and provide a design flood level. Flood resilience should be achieved by the most cost-effective intervention which may range from, but is not limited to, retrofitting protection barrier/s to lifting the full substation above design flood level.

If it is not practical to apply the guidelines Sections 12.1 or 12.2, or the costs of doing so are considered to be uneconomic, contact NP&R for further guidance.

13. NEW SUBSTATIONS

With regards to the guidance set out within this policy, a “new substation” refers to a substation site that will be new to SP Energy Networks’ networks or a substation site on the SP Energy Networks’ networks that has major plant replacement or civil works being undertaken, as set out in Section 12.

13.1 Primary & Grid Substations

All grid and primary substations shall be protected to a 1:1000-year flood risk return period.

For any new substation site, the general approach to protecting plant, and equipment, will be to construct the site, or install the plant and equipment, above any potential flood levels.

For all proposed substation sites, a preliminary flood risk assessment shall be completed by determining the flood risk in the area using the appropriate environmental agency’s flood maps. A comparison can then be made on the proposed sites (paying particular attention to the proposed location of electrical plant and equipment) and the potential flood levels.

A DFRA shall be carried out when the new substation location lies within:

- an identified flood risk area, or
- a more complex location or site, where interpretation of the environment agency’s flood risk map is difficult/ambiguous.

This assessment will be completed by a specialist flood risk consultant.

The DFRA will take account of the topography and local flood defences. These factors will be combined with a more detailed assessment of flood modelling, including regional environment agency guidance on climate change impact, to determine if there is a flood risk at site and to provide a design flood level.

A range of options to provide the required level of flood protection will be investigated.

In approximate ascending order of cost and complexity, these may include but are not limited to:

- Evaluate alternative locations
- Installation of drainage.
- Raising the level of plant items and equipment.
- Barriers erected around individual plant and equipment items.
- Building only protection.
- A flood wall or embankment constructed around the site perimeter, designed to protect the entire site.

A combination of these solutions may be installed to achieve the required level of flood protection.

Plans for local flood defences in the area, and the potential to contribute to these financially, should also be considered. It is worthwhile noting that local flood defences may not be designed to the desired flood risk return periods as set out within this policy.

Flood protection installed on a new substation shall be designed and constructed to include at a minimum freeboard level of 600mm above the design flood level. The 600mm freeboard allows for uncertainties in data modelling and local effects of flooding such as wind induced waves. Consideration shall be given to the application of the allowance for freeboard and climate change – in some cases the full allowance will not be required as the flood level will never exceed a certain level (based on the topography).

A cost/benefit assessment shall be undertaken to determine the most appropriate flood protection to meet the required level of protection.

13.2 Secondary Substations

There is defined requirement to protect new secondary substations to the flood risk return periods of 1:200 (SPD) or 1:100/200 (SPM).

It is more difficult to construct a secondary substation, or install the plant and equipment, above any potential flood levels as they need to be located close to the load centre, which may often be in a flood risk area.

It is accepted that it will not be economical to carry out a DFRA for each secondary substation. Instead, a preliminary flood risk assessment shall be completed by determining the flood risk in the area using the appropriate environmental agency's flood maps.

If the substation is outside a flood risk area, then no further action is required. If the substation site lies within a flood risk area, then further information will be required to establish the design flood level. Flood resilience should be achieved by the most cost-effective intervention which may range from, but not limited to, installing protection barrier/s to constructing the full substation above design flood level.

If it is not practical to apply the guidelines Sections 13.1 or 13.2, or the costs of doing so are considered to be uneconomic, contact NP&R for further guidance.

14. MAINTENANCE OF FLOOD PROTECTION SYSTEMS

Flood protection systems will be regularly inspected and part of a maintenance schedule. Hazard and defects raised will be addressed in line with EPS-01-002 Hazard & Defect Management Policy. This will ensure the level of protection at the site is maintained.

15. MANAGEMENT OF FLOOD DATA

Data on flood risk will be managed on a central database owned by the respective Distribution and Transmission teams within NP&R. This should include information on flood risk and flood source for each site. This information will be updated after the release of any new flood maps from the environment agencies. The database will also contain DFRA's and site drawings with implemented flood protection systems, where applicable.