| **Modification** | At what stage is this document in the process? |
|---|---|
| # DCRP/22/04 Engineering Report (EREP) 130 Issue 4 - Guidance on the application of Engineering Recommendation P2, Security of Supply<br><br>*Revising the security of supply to high voltage feeders between 1 and 10MW, in certain situations* | 01 Modification<br>02 DCRP report<br>03 Public Consultation<br>04 Final Modification Report |

The purpose of this document is to assist the Authority in its decision to implement the proposed process within the Distribution Code of GB Licenced Distribution Network Operators of GB. .

The proposed modifications were subject to industry consultation from 27 June 2022 to 29 July 2022.

**Date of publication: 26 October 2022**

**Recommendation**

The Distribution Code Review Panel (DCRP) and distribution network licensees recommend that the proposed modifications are made to Engineering Report 130, and the Distribution Code.

| | | |
|---|---|---|
| ✔ | The DCRP and distribution network licensees recommends that this modification should be:<br><br>Submitted to the Authority for approval. | |
| ! | High Impact: | Distribution Network Operators, |
| ! | Medium Impact: | Generators, Customers, |
| ! | Low Impact: | |

## Contents



## Timetable

| | |
|---|---|
| Initial Report presented to DCRP | 03 December 2020 |
| Draft report issued for public consultation | 27 June 2022 |
| Consultation Closed | 29 July 2022 |
| Final Modification Report available for Panel | 06 October 2022 |
| Final Modification Report submitted to Authority | 26 October 2022 |

**Any questions?**

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# 1 Background

In 2016 a cost benefit study carried out for the DCRP by Imperial College London (ICL) considered several areas of Engineering Recommendation P2 'Security of Supply' for possible changes. One of the outcomes of this report focused on the reduction in the minimum level of security on selected feeder circuits.

A working group was formed to assess the impact of a reduction in the security of supply to demand groups between 1MW and 300MW and which carried out a review of the savings and benefits identified in the ICL report. This review considered the the wider societal implications of a reduction in supply security as well as the potential network reinforcement cost savings. After discussions by the workgroup and assessment of the outcomes, it was proposed that a reduction in the security of supply to demand groups between 10MW and 300MW was not a viable option as the increased risk of loss of supply had the potential to impact large parts of the networks and large numbers of customers, with little financial savings. However, the workgroup cnsidered that it would be reasonable to reduce the security of the security of supply to HV feeder circuits supplying demand between 1 and 10MW in some limited situations.

The majority of HV feeders in GB are operated as 'radial' circuits, with connection to alternative points of supply used to maintain customer supplies during planned circuit outage or to restore customer supplies during unplanned circuit outages.

In addition to the analysis of this HV feeder data, a further large representative sample of DNO data was collated to study the maximum demand on HV feeders. This data showed that 82% of HV feeders have a maximum demand in the range 0 - 4MW. The predominant maximum demand on an HV feeder is in the range of 1.5 - 2MW.

EREP 130 is a supporting document to EREC P2 and part of the DCode Annex 1 framework, as such a review of this document has been undertaken to update both documents to reflect the reduction in supply to HV feeder circuits under certain circumstances.

A more general review of formatting and non-material editorial changes have been made to the document as part of this modification proposal. A full set of the changes can be found in a track changed copy of EREP 130, referenced in this document as Appendix 4 and provided on a separate document accompanying this report.

# 2 The Defect

This defect in the existing version of EREC P2 (issue 7) has been highlighted through the initial Imperial College London (ICL) study, and subsequent evaluation by the EREC P2 working group, formed to assess the findings of the ICL study as well as any possible improvements in the operational running of the networks.

As part of the evaluation carried out, the P2 working group proposed amendments to EREP 130 in lock step with the reduction of security of supply. New figures and text outlining group demand figures for radial HV circuits, as well as updates to interconnected HV circuits to ensure the most relevant information of the change within EREC P2 to be reflected in the supporting document.

Reducing the redundancy on specified HV feeder circuits will mean that in the event of a loss of DNO supply this may result in an extended period of power outage experienced by customers connected to these circuits. Previous stakeholder engagement by DNOs, as part of their RIIO-ED1 and DCRP stakeholder engagement activities, clearly demonstrated that GB customers do not support a reduction in supply security. However, by implementing this change it will be possible to reduce the need for reinforcement on the networks with a significant benefit in cost while minimising the impact on the resilience and recovery of the network.

## 3 Details of the Proposal

After detailed assessment of the group demand restoration figures for specific types of feeder circuits (with a demand between 1 and 12MW) described in table 1 of EREC P2, The working group has proposed to amend the current recommended figure of 'Within 3 hours group demand minus 1MW' to minus 1.2MW for circuits with a total connected demand between 1 and 10MW, and no longer than 1km in lengh.

As part of this proposal Engineering Report 130 has been revised to support this change. Several areas of the document have been updated, specifically reffering to the group demand of certain circuits (defined as A and B in the document). the criteria for to be met for the reduction in the security of supply to certain circuits has been listed within the document (Clause 6.5.1) and are shown below;

a) Where the Group Demand is supplied by a HV Circuit which is designed and operated as radial HV Circuit and not an interconnected HV Circuit

b) Where the Group Demand is not supplied by a primary substation comprising a single EHV/HV transformer (an example of a primary substation comprising a single EHV/HV transformer is a substation with a single incoming 33 kV supply equipped with one 33/11 kV transformer supplying one or more 11 kV Circuits).

c) Where the total length of the radial HV Circuit is less than 1 km i.e., the length of all cable/overhead line connected, including tee-offs, between the supplying circuit-breaker at the primary substation and the open point(s).

d) The 1.2 MW of demand that may remain off supply for up to 3 hours after a First Circuit Outage (FCO) shall not be part of a single class of supply A demand group i.e., the 1.2 MW of demand off supply shall be formed from two or more class of supply A demand groups..

The main benefit of reducing the minimum security of supply level is facilitating an increase in network capacity that can be 'released' within the normal network configuration, as opposed to network capacity being reserved for use in outage scenarios. In the proposal, up to an 11% increase in customer demand could be accommodated on specified HV feeders without incurring reinforcement costs. This could facilitate the connection of low carbon technology with their associated increase in network demand. Determining the extent of cost savings on HV feeder upgrades is complex as a number of factors determine whether and when reinforcement may be required (e.g. the location, magnitude and timing of future load growth, the diversity between the new and existing feeder load, the capacity of existing HV feeder and the HV feeder topology) – such factors may be generalised if the proposed security of supply criteria is applied nationwide, but for HV feeders of interest, specific data and analysis would be needed to determine a meaningful value for any cost saving.

Durring the development of the modification a meeting with the Authority was held were a detailed brief on the background information and supporting figures regarding the proposed change in demand was presented. A summary of that report has been provided seperatly under Appendix 3 of this report.

A minor editorial changes to the EREP 130 issue number will need to be made within the Distribution Code. This editorial change to the Annex 1 – Qualifying Standards section is shown below:

4 **Engineering Report 130 Issue ~~3~~ 4**

Guidance on the application of Engineering Recommendation P2, Security of Supply.

Approved modifications to the DCode relating to DCRP/MP/22/03 and 22/04 shall be issued in a single revision of the DCode for efficiency.

All key proposed amendments to EREP P130 are detailed in Appendix 1, with a track change version including these and all minor editorials has been referenced in Appendix 4, and provided as a separate document accompanying this Reprot.

# 4 Impacts and Other Considerations

## Impacts on Users of The Distribution Code

The proposed revision will have a positive impact on users by providing a clear approach to the re-supply of customers supplied from HV feeder circuits in the specific circumstances described.

## Impacts on Total System and the DNOs System

This proposal will have a positive effect on the DNO system by reducing the requirement for re-enforcement and hence a reduction in the cost to develop the network.

## Environmental Impact Assessment

The impact on the environment as a result of this modification is positive due to reduction in reinforcement and release of network capacity for normal network configuration.

# 5 Impact on other Industry documents

There are implications for Engineering Recommendation (EREC) P2 (issue 8) which sets out the minimum level of Security of Supply that DNOs are required to provide and which has been revised in parallel with this modification proposal.

As this is the first modification which will have an impact on EREC P2, since EREP 130's inclusion into the Annex 1 framework of the DCode it was decided to run parallel consultation processes for each document. any future revision impacting on both documents will be combined into a single modification.

# 6 Assessment against Distribution Code Objectives

The proposed amendments better facilitate the Distribution Code objective:

(i) to permit the development, maintenance and operation of an efficient, coordinated and economical system for the distribution of electricity.

*The proposal is positive against this objective as the main benefit of reducing the minimum security of supply level is facilitating an increase in network capacity that can be 'released' for normal network configuration, as opposed to network capacity being reserved for use in outage scenarios, thus reducing the need for reinforcement.*

(ii) to facilitate competition in the generation and supply of electricity.

*This modification has a positive impact against this objective, network capacity which is reserved for outages will be released through the reduction in the security of supply on certain feeder circuits, thus allowing competition for the additional connection of LV generation to be connected to the additional capacity available on network.*

(iii) to efficiently discharge the obligations imposed upon distribution licensees by the distribution licences and comply with the Regulation and any relevant legally binding decision of the European Commission and/or the Agency for the Co-operation of Energy Regulators; and

*The proposal has a neutral effect on this objective.*

(iv) to promote efficiency in the implementation and administration of the Distribution Code.

*The proposal has a positive impact on this objective as it will provide the most recent guidance on EREC P2 and provide affective administration of the DCode.*

# 7 Recommendations

It is recommended EREP 130 Issue 4 replace the existing version currently in use.

It is recommended to make the consequential changes to the Distribution Code.

# 8 Implementation

If approved by the Authority an implementation date 6 months after the date of Authority decision is proposed. This will be to allow DNOs time to put in place all necessary systems of work before compliance is required.

The attached version of EREP 130 Issue 4 included in this RTA submission if approved, will be the version published.

# 9 Consultation

The public consultation for this modification proposal received a total of 3 responses. All three were from Distribution network Operators and though brief in nature, they were supportive of the proposed changes. A summary of each response received are shown below,

### 9.1 GTC

This response was fully supportive of the proposals in response to all questions posed in the public consultation paper.

### 9.2 SP Energy Network

Broadly supportive of the proposed changes and did not offer any further comment outside of their support of the changes.

### 9.3 Western Power Distribution

The response received from WPD was supportive of the proposal and offered some proposals relating to sections of the document that they wish to be considered for the scope of a future revision to the document, namely around EV charging units and security demands on Energy Storage System (ESS) site connections to the distribution system.

In summary all responses from the public consultation were supportive of the proposed amendments to Engineering Report 130 (Issue 4). A complete set of responses has been included in Appendix 2 of this document for reference.

## 10 Distribution Code Review Panel Discussion

The Final Modification Report was presented to the DCRP at the Panel meeting held on 06 October 2022. The Panel agreed to submit this report to the Authority during October 2022. As a part of the modification process a Track Changed version of EREP 130 Issue 4 will be included in the document submission to the Authority, if approved this will be this version which will be published.

## 11 Recommendation

The Distribution Code Review Panel and licenced Distribution Network Operators recommend that this modification report should:

- be submitted to the Authority for approval; and
- subject to the agreement of the Authority the modification should be implemented 6 months from the date of the Authority Decision.

## 12 Appendices

Appendix 1 - Key Changes to EREP130 Issue 4

Appendix 2 - DCRP/22/04/PC Consultation Responses Received

Appendix 3 - Report on Class B circuits - Summary paper

Appendix 4 - EREP 130 Issue 4 TC Copy (Separate document provided)

ERECP 130 Issue 4 has undergone a general revision including and minor editorial and formatting changes, shown below are the material change to the document with a direct impact relating to the assessment work undertaken to review and revise the security of supply under the circumstances stated in this report.

**Material Amendments to EREP 130**

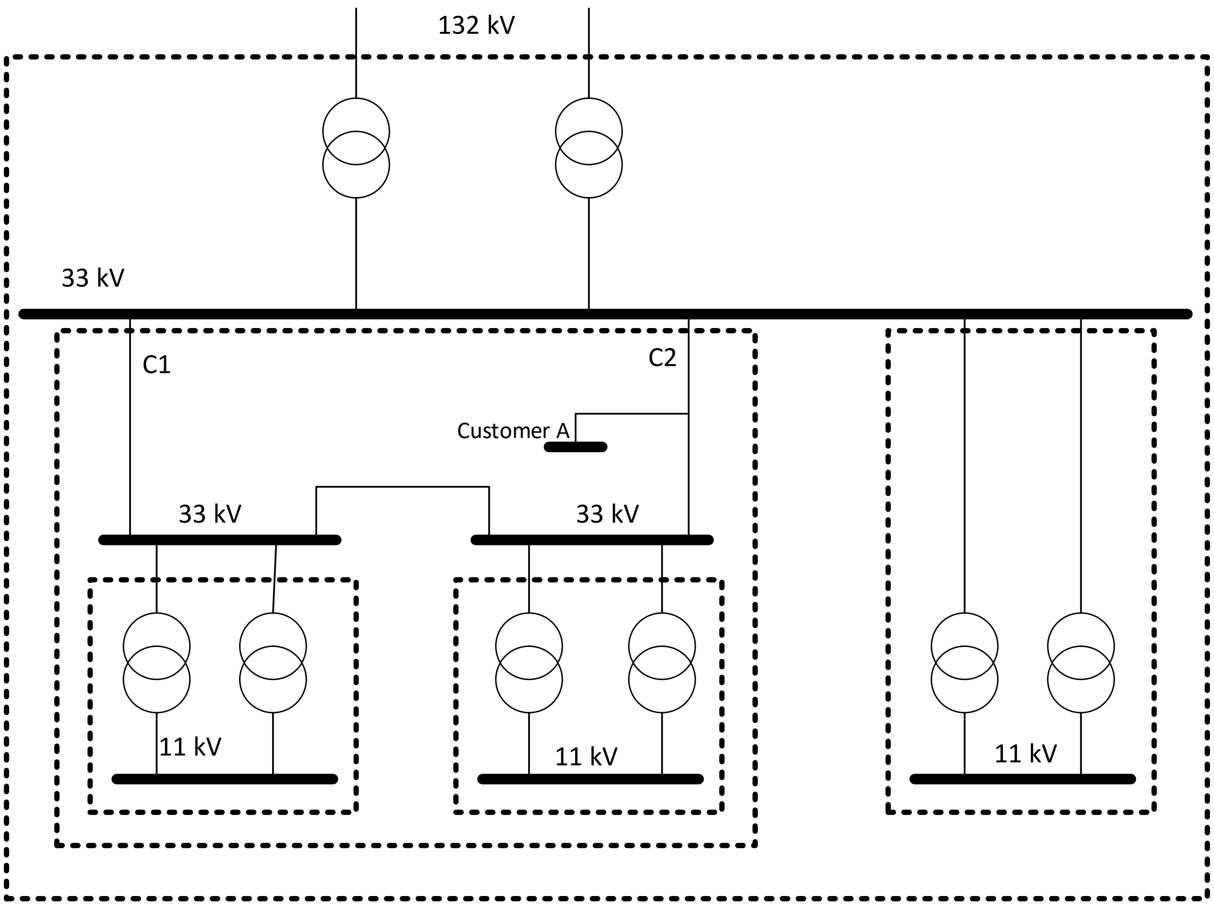
explanation of Group Demand for class of supply A (Clause 5.2 added) and class of supply B (Clause 5.3 added). Description of HV Circuit types added ('interconnected' and 'radial').

## 5 Determine the Group Demand and class of supply

### 5.1 General

Considering a section of network, a **DNO** should identify the demand groups within its network where a security of supply assessment should be carried out. There will be numerous demand groups in a **DNO** network and lower voltage demand groups will combine to form larger demand groups, as illustrated in Figure 2. Not shown in Figure 2 are **HV** and **LV Circuits** forming demand groups in class of supply A and B: Clauses 5.2 and 5.3 respectively covers these classes of supply.

The **DNO** should carry out a bespoke assessment of the **Latent Demand** based on the principles in ~~this clause~~Clause 5.4.




NOTE: 'Dashed' lines indicate a section of network and hence a demand group.

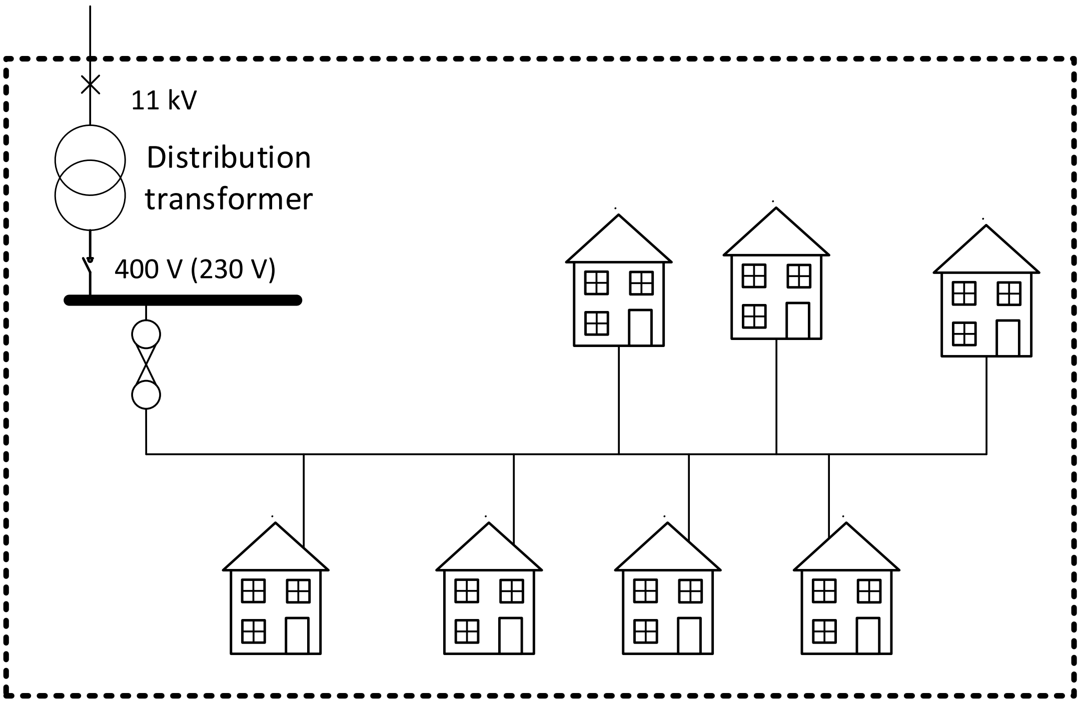
**Figure 2 – Typical demand groups (section of network) in a network**

To identify the class of supply (see Table 1 in EREC P2/~~7~~8 [N1]) for each demand group, the **Group Demand** first needs to be established – Figure ~~3~~6 outlines the process and the need to determine the **Measured Demand**, any **Latent Demand** and the effects of **Cold Load Pickup**.

In Figure 2, consider the scenario where the supply to Customer A has been interrupted due to a fault on **Circuit** C2. In this case, where Customer A has agreed to a single **Circuit** risk agreement, EREC P2/8 [N1] states that this customer's supply is considered to be restored when there is an outage on **Circuit** C2. Customer A's demand is included in the **Group Demand** and used to establish the class of supply. However, where such a customer has a connection agreement with the **DNO** requiring only single **Circuit** security, EREC P2/8 [N1] considers this to be a form of a **DSR Scheme** contract between the customer and the **DNO** and that for the purpose of complying with the requirement to supply the 'minimum demand to be met', activation of this **DSR Scheme** is equivalent to restoration of demand.

## 5.2 Class of supply A

EREC P2/8 [N1] class of supply A relates to **Group Demand**s up to 1 MW. A (11/0.4 kV) distribution transformer supplying one or more **LV Circuit**s is normally covered by this size of **Group Demand**. The maximum rating of a distribution transformer typically deployed when there is no contribution to security of supply from **Transfer Capacity**, **DG**, **DSR Scheme**s, or **ES**, is 1 MVA (nameplate rating). Higher rated distribution transformers are available and may be installed, but the requirements of class of supply A are only applicable if the **Group Demand** is less than or equal to 1 MW, regardless of transformer rating. There is a note in EREC P2/8 Table 1 which permits the **Group Demand** to exceed of 1 MW provided that it is within the overload capacity (cyclic load capacity) of a 1 MVA transformer. In all other situations where the **Group Demand** is greater than 1 MW, the **Group Demand** shall be considered as being a class of supply B.



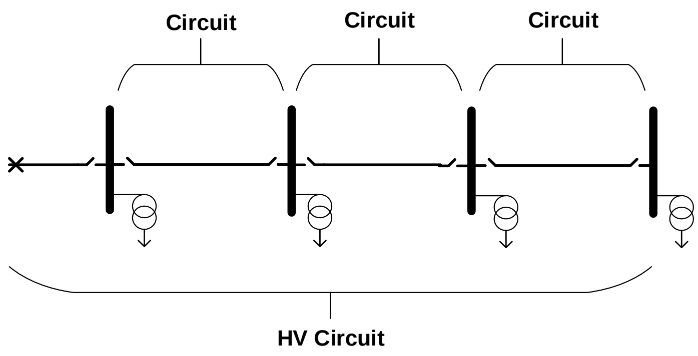

NOTE: Dashed line indicates a section of network and hence a demand group.

**Figure 3 – Typical Class of Supply A demand group**

## 5.3 Class of supply B

EREC P2/8 [N1] class of supply B relates to **Group Demand**s over 1 MW and up to 12 MW. **HV Circuit**s normally supply a **Group Demand** in the range 1-12 MW, which is considered to be a class of supply B. **HV Circuit**s are typically supplied from primary substations and provide supplies to customers in an area local to the primary substation.

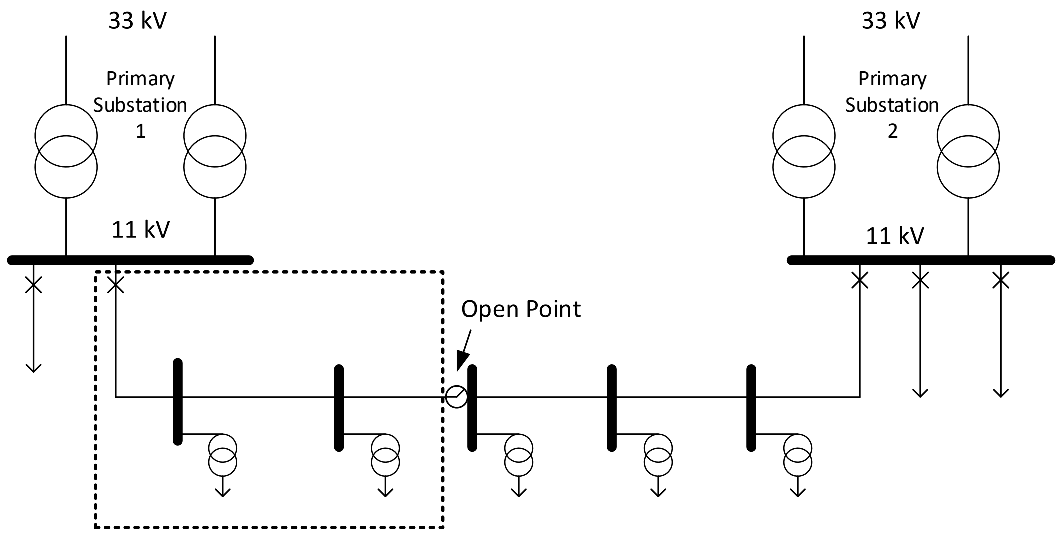
NOTE: The term **HV Circuit** refers to a series of underground cables and/or overhead lines, together with the associated switchgear, connecting distribution substations to one or more primary substations. Hence, a **HV Circuit** is made up of a series of individual **Circuit**s between substations.




e)

**HV Circuit**s will be configured either as a 'radial' or 'interconnected' **Circuit**:

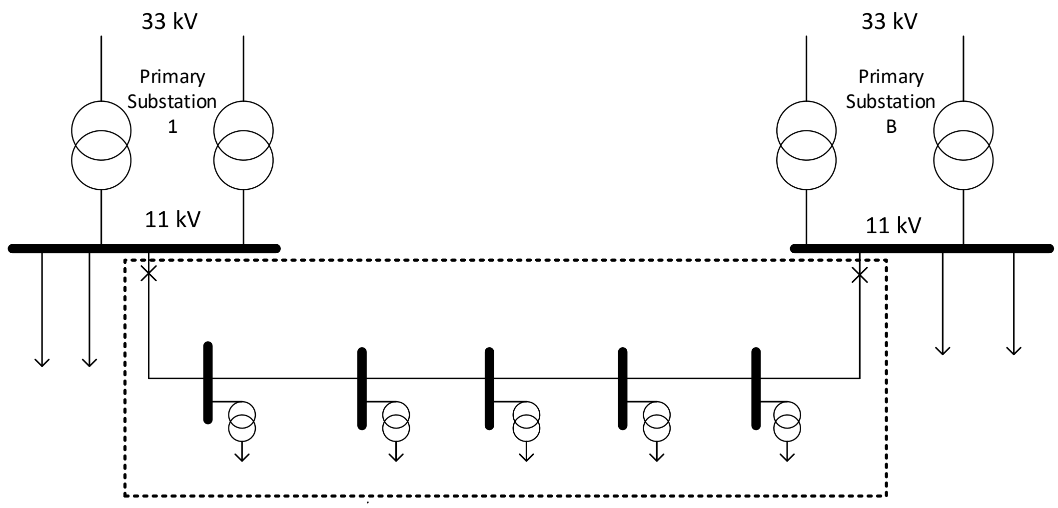
a) Radial **HV Circuit** – a series of **Circuit**s (each comprising underground cables and/or overhead lines and associated switchgear) with a single point of supply, with connection to one or more alternative points of supply via 'open' points to one or more **HV Circuit**s used to maintain customer supplies during outages. The majority of **HV Circuit**s in GB are designed and operated as radial **Circuit**s.




NOTE: Dashed line indicates a section of network and hence a demand group.

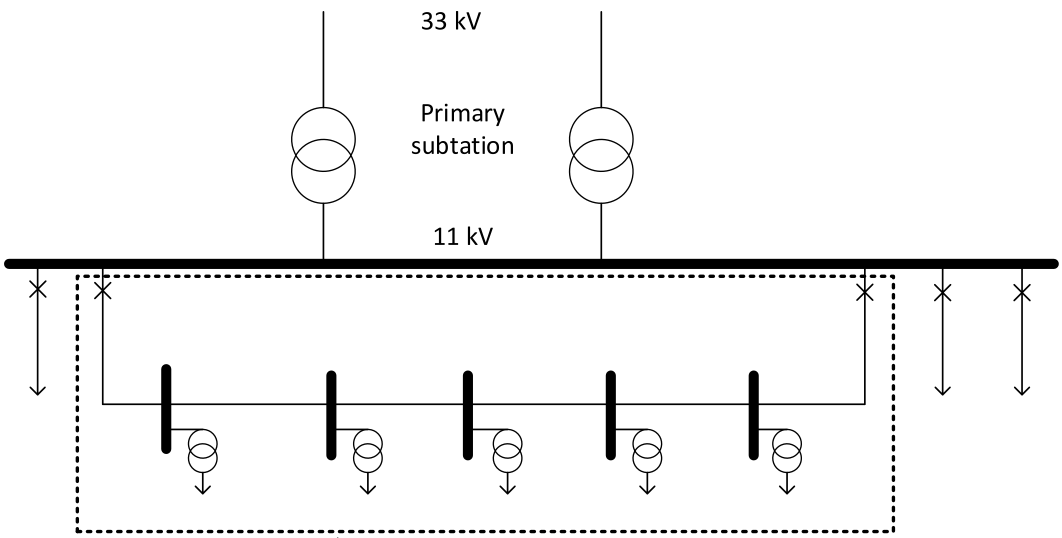
**Figure 4 – Typical radial HV Circuit**

b) Interconnected **HV Circuit** – a series of **Circuit**s (each comprising underground cables and/or overhead lines and associated switchgear) with two or more points of supply. This commonly entails primary substations operating in parallel, which requires more complex **Circuit** protection arrangements compared to radial **HV Circuit**s.



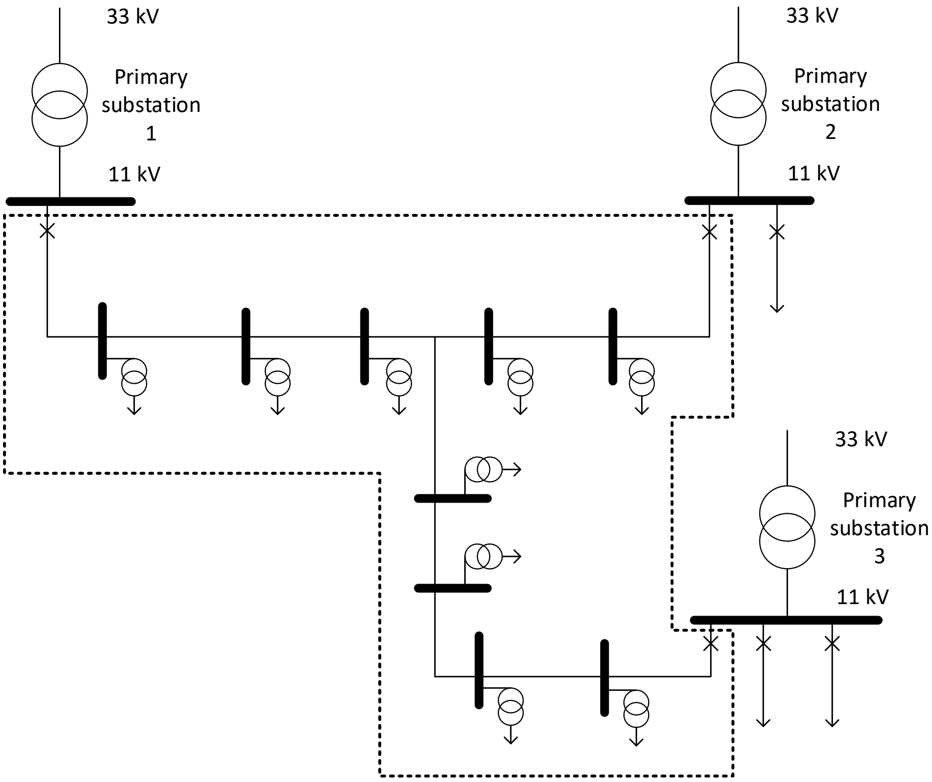

NOTE: Dashed line indicates a section of network and hence a demand group. The demand group may include the primary substation transformers if the load on all **HV Circuit**s is within the class of supply.

**Figure 5A – Typical interconnected HV Circuit (between two primary substations)**




NOTE: Dashed line indicates a section of network and hence a demand group.

**Figure 5B – Typical interconnected HV Circuit (loop on one primary substation)**




NOTE: Dashed line indicates a section of network and hence a demand group. The demand group may include the primary substation transformers if the load on all HV Circuits is within the class of supply.

**Figure 5C – Typical interconnected HV Circuit (between three primary substations)**

Determination of **Group Demand** for a demand group comprising a **HV Circuit** firstly requires identification of the **Circuit**s supplying a group of customers. By way of example in Figure 4 the relevant **Circuit** is that between and including the **Circuit**-breaker at primary substation 1 and the open point, in Figure 5A the relevant **Circuit** is that between and including the two **Circuit**-breakers at the primary substations.

Guidance on implementing the reduced security of supply for specific class of supply B demand groups in accordance with the reduction included in EREC P2/8 (new Clause 6.4 and 6.5 added).

## 6.4 Class of supply B

Assessing the compliance of an **HV Circuit** with EREC P2/8 [N1] requires a determination of the intrinsic network capacity, in accordance with Clause 6.2, and the **Transfer Capacity**, in accordance with Clause 6.3, under the appropriate network conditions. In the case of a class of supply B demand group, this is under **First Circuit Outage (FCO)** conditions.

For a radial **HV Circuit** the intrinsic network capacity is zero, and the **Transfer Capacity** depends on the capacity of the interconnecting **HV Circuit**s together with the associated time required to make this **Transfer Capacity** available (including time for network switching to isolate the faulted **Circuit** and restore supplies from healthy **Circuit**s). The presence of remote control/automation of switching will significantly influence the time to restore supplies.

For an interconnected **HV Circuit** the intrinsic capacity of the **Circuit** is relied upon to maintain supplies in the event of a **FCO**, rather than the **Transfer Capacity**. Hence, network switching to isolate the fault and re-supply customers from adjacent **HV Circuit**s is not relevant for interconnected **HV Circuit**s. However, because the interconnected **HV Circuit** is supplied from multiple sources, the capacity will need to be established using network modelling (determining the most onerous **Circuit** fault within the interconnected **Circuit**s).

Annex F.2 and F.3 detail typical security of supply assessments for a **HV Circuit**.

## 6.5 Reduction for Class of Supply B

### 6.5.1 Introduction

In Table 1 of EREC P2/8 [N1] there is an option to permit a reduced security of supply for a class of supply B demand group.

The intention of permitting a reduction in the security of supply for some class of supply B demand groups is to increase the efficiency of the network by accommodating additional load without the need for reinforcement that would otherwise be required where the adverse impact associated with such additional load on customers is expected to be small.

The reduction in the security of supply in class of supply B demand groups is:

- For a **First Circuit Outage (FCO)**, the minimum demand to be met within 3 hours: **Group Demand** minus 1.2 MW.

This reduction in security of supply can only be applied where the following criteria are satisfied.

a) Where the **Group Demand** is supplied by a **HV Circuit** which is designed and operated as radial **HV Circuit** and not an interconnected **HV Circuit** (see Clause 5.3).

b) Where the **Group Demand** is not supplied by a primary substation comprising a single **EHV/HV** transformer (an example of a primary substation comprising a single **EHV/HV** transformer is a substation with a single incoming 33 kV supply equipped with one 33/11 kV transformer supplying one or more 11 kV **Circuit**s).

c) Where the total length of the radial **HV Circuit** is less than 1 km i.e., the length of all cable/overhead line connected, including tee-offs, between the supplying **Circuit**-breaker at the primary substation and the open point(s).

d) The 1.2 MW of demand that may remain off supply for up to 3 hours after a **First Circuit Outage (FCO)** shall not be part of a single class of supply A demand group i.e., the 1.2 MW of demand off supply shall be formed from two or more class of supply A demand groups. To explain this further, consider a fault on the first **Circuit** section from primary substation 1 in Figure 7 – the reduction in security of supply would permit 1.2 MW of demand at two or more demand groups (e.g. $W_{SUB}$ and $X_{CCT}$) not to be restored within 3 hours. The **HV Circuit** would not be compliant if more than 1 MW of demand at a single substation or on a single teed **Circuit** could not be restored within 3 hours as that demand group would not comply with the requirements of class of supply A demand groups.

New examples added to Annex F (F.2 and F.3) to clarify assessment of HV Circuits.

## ~~F2 Transfer Capacity~~

## F2 Interconnected HV Circuit assessment example – class of supply B

This example is intended to demonstrate ~~consideration of Transfer Capacity (see F.6.1 and F.7.2 for other examples).~~the EREC P2/8 [N1] compliance assessment of a typical interconnected **HV Circuit** – it does not consider the class of supply C demand group comprising the three primary substations.

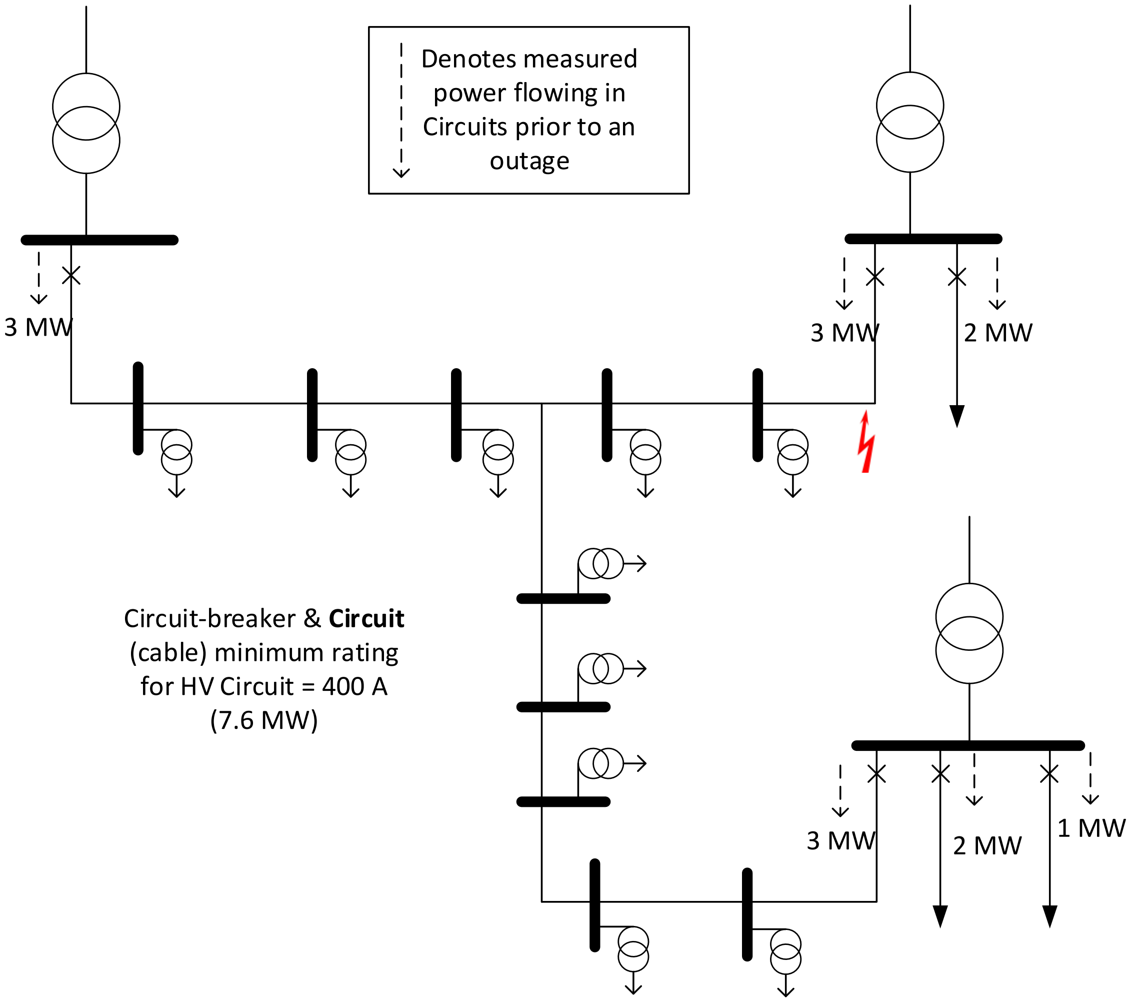



**Figure F.2 – ~~Transfer Capacity example~~Assessing an interconnected HV Circuit**

The **Circuit** being assessed is the interconnected **HV Circuit** supplied from the three primary substations.

a) Determine **Group Demand**

i. **Measured Demand** = ~~10~~9 MW

ii. **Latent Demand**

**Contracted DG/DSR Schemes/ES** – none

**Non-Contracted DG/DSR Schemes/ES** – none

iii. **Cold Load Pickup** = 0 MW

iv. **Group Demand** = ~~10~~9 MW (Class B)

b) Determine Network Capacity

i. Intrinsic network capacity

**FCO** capacity = ~~0~~15.2 MW ~~(from~~, available immediately. (From Table 1 of EREC P2/~~7~~8 [N1] under an **FCO**, ~~Class B requires restoration for~~there is a requirement to restore **Group Demand** minus 1 MW [~~9~~8 MW] of demand within 3 hrs and restoration of the remaining demand within repair time).

NOTE: Network modelling would be required to corroborate the value of 15.2 MW i.e., to confirm load sharing is equal between the primary transformers.

**SCO** capacity = ~~0 MW~~not determined (from Table 1 of EREC P2/8 [N1] under a **SCO**, there is no requirement to secure any demand).

The intrinsic network capacity of 15.2 MW under an **FCO** is sufficient to meet the 9 MW of **Group Demand**. There is no requirement to consider **Transfer Capacity** or contribution from **DG/DSR Schemes/ES**.

Given that intrinsic network capacity is greater than **Group Demand**: the system is compliant with Table 1 of EREC P2/8 [N1].

## F3 Radial HV Circuit assessment example

This example is intended to demonstrate the EREC P2/8 [N1] compliance assessment of a typical radial **HV Circuit**.

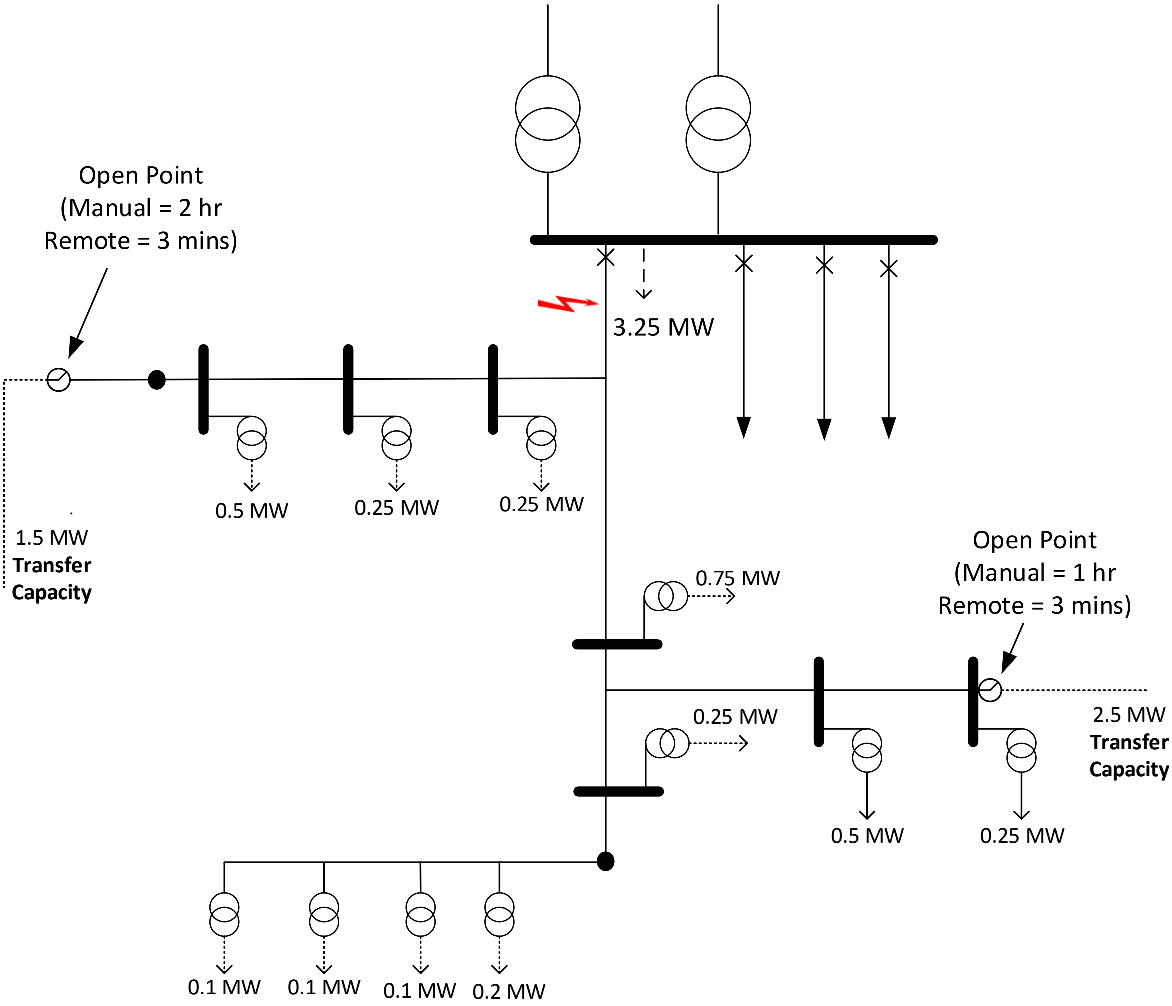



**Figure F.3 – Assessing a radial HV Circuit**

a) Determine **Group Demand**

i. **Measured Demand** = 3.25 MW

ii. **Latent Demand**

**Contracted DG/DSR Scheme**s/**ES** – none

**Non-Contracted DG/DSR Scheme**s/**ES** – none

iii. **Cold Load Pickup** = 0 MW

iv. **Group Demand** = 3.25 MW (Class B)

b) Determine Network Capacity

i. Intrinsic network capacity

**FCO** capacity = 0 MW. (From Table 1 of EREC P2/8 [N1] under an **FCO**, there is a requirement to restore **Group Demand** minus 1 MW [2.25 MW] of demand within 3 hrs and restoration of the remaining demand within repair time)

**SCO** capacity = not determined (from Table 1 of EREC P2/8 [N1] under a **SCO**, there is no requirement to secure any demand).

The intrinsic network capacity is insufficient to meet the requirements of EREC P2/8 [N1] and it is necessary to consider the **Transfer Capacity**.

ii. **Transfer Capacity** = 4 MW available.

The time to provide this **Transfer Capacity** ranges from 3 minutes to over 3 hours. Before the **Transfer Capacity** can be utilised the faulty section of **Circuit** needs to be located and isolated. The time to restore supplies is therefore a combination of fault location and isolation time, and switching time.

In conclusion, if the process of locating and isolating the faulted **Circuit** and completing switching to implement sufficient **Transfer Capacity** can be completed within 3 hours, the **Circuit** is compliant with Table 1 of EREC P2/8 [N1], if not it is non-compliant.

**Additional Definitions**

The following definitions have been included in Issue 4 of EREP 130 to provide clarity to the user.

**3.13**
**Extra High Voltage (EHV)**
An alternating current (AC) voltage above 20 kV RMS up to and including 132 kV RMS.

NOTE: Typical **EHV** distribution networks operate at a nominal voltage of 33 kV, 66 kV, or 132 kV.

**3.17**
**High Voltage (HV)**
An alternating current (AC) voltage above 1 kV RMS up to and including 20 kV RMS.

NOTE: Typical **HV** distribution networks operate at a nominal voltage of 6.6 kV, 11 kV, or 20 kV.

**3.~~18~~20**
**Low Voltage (LV)**
An alternating current (AC) voltage up to and including 1 kV RMS.

NOTE: Typical **LV** distribution networks operate at a nominal voltage of 230 V (single-phase) and 400 V (three-phase).

# DCRP/22/04/PC: Engineering Report (EREP) 130 Issue 4 – Guidance on the application of Engineering Recommendation P2, Security of Supply

Stakeholders are invited to respond to this consultation, expressing their views or providing any further evidence on any of the matters contained within the consultation document. Stakeholders are invited to supply the rationale for their responses to the set questions.

Please send your responses and comments by **17:00, 29th July 2022** to dcode@energynetworks.org and please title your email 'Consultation Response DCRP/22/04/PC Engineering Report (EREP) 130 Issue 4 – Guidance on the application of Engineering Recommendation P2, Security of Supply' Please note that any responses received after the deadline may not receive due consideration by the Working Group.

Any queries on the content of the consultation pro-forma should be addressed to DCode Administrator on 020 7706 5105, or to dcode@energynetworks.org

| | |
|---|---|
| **Respondent** | Steve Mockford Head of Electricity Asset Management |
| **Company Name** | GTC |
| **No. of DCode Stakeholders Represented** | |
| **Stakeholders represented** | N/A |
| **Role of Respondent** | *IDNO* |
| **We intend to publish the consultation responses on the DCode website. Do you agree to** | Yes |

| | |
|---|---|
| **this response being published on the DCode website? [Y/N]** | |

| | Question | Response | Secretariate Response |
|---|---|---|---|
| Q1 | Do you agree with the general ~~intent~~ intent of the proposed modification? If not, please explain your view. | As a member of the ENA working group, I am fully supportive of what is being proposed | Noted. |
| Q2 | Do you believe that the proposed modifications, as set out in the DCRP/22/03/PC Consultation Pack, better facilitate the Applicable Distribution Code Objectives? | Yes | Noted. |
| Q3 | Do you agree that it is reasonable not to restore 1.2MW (increased from 1MW) of customer demand following an outage in certain defined scenarios. | Yes | Noted. |
| Q4 | Do you have any other relevant comments? | No | Noted, thank you. |

Please provide comments relating to the specific technical content of the proposed modifications[1]

| **Page / line No** | **Clause/ Subclause** | **Paragraph Figure/ Table** | **Type of comment** (General/ Technical/Editorial) | **COMMENTS** | **Proposed change** | **OBSERVATIONS OF THE SECRETARIAT** on each comment submitted |
|---|---|---|---|---|---|---|
| 21 | | Figure | | Figure at the top of the page (HV circuit) does not have a reference number 'Figure x' | Include | |
| 26 | | | General | The first process box still refers to EREC P2/7 | Change to P2/8 | |
| 39 | 10 | | General | Shouldn't the title of the heading be 'Assessing Compliance with ERECP2/8 Table 1'? | | |
| 41 | | | General | Blank page – assumption that this will be corrected once a clean version provided | | |
| 49 | C.2 | | General | ESF not shown in bold and not included in the definitions section | | |
| 51 | C6.6 | | General | No explanation for AVR and not included in the definitions section | | |
| | | | | | | |

[1] Add more rows if required

# DCRP/22/03/PC: Engineering Recommendation (EREC) P2 Issue 8 - Security of Supply

Stakeholders are invited to respond to this consultation, expressing their views or providing any further evidence on any of the matters contained within the consultation document. Stakeholders are invited to supply the rationale for their responses to the set questions.

Please send your responses and comments by **17:00, XX XXXX 2022** to dcode@energynetworks.org and please title your email 'Consultation Response DCRP/22/03/PC Engineering Recommendation (EREC) P2 Issue 8 - Security of Supply.' Please note that any responses received after the deadline may not receive due consideration by the Working Group.

Any queries on the content of the consultation pro-forma should be addressed to DCode Administrator on 020 7706 5105, or to dcode@energynetworks.org

| | |
|---|---|
| **Respondent** | Graeme Vincent |
| **Company Name** | SP Energy Networks |
| **No. of DCode Stakeholders Represented** | Two |
| **Stakeholders represented** | SP Manweb plc and SP Distribution plc |
| **Role of Respondent** | Distribution Network Operator |
| **We intend to publish the consultation responses on the DCode website. Do you agree to this response being** | Y |

| | |
|---|---|
| **published on the DCode website? [Y/N]** | |

| | Question | Response | Secretariate Response |
|---|---|---|---|
| Q1 | Do you agree with the general intent intent of the proposed modification? If not, please explain your view. | Yes, we agree with general intent of the proposed modification. | Noted, thank you. |
| Q2 | Do you believe that the proposed modifications, as set out in the DCRP/22/03/PC Consultation Pack, better facilitate the Applicable Distribution Code Objectives? | Yes, we believe that the introduction of the proposed modification will better facilitate Applicable Distribution Code Objective *(a) permit the development, maintenance, and operation of an efficient, co-ordinated, and economical system for the distribution of electricity*. | Thank you, this view will be incorporated into the final report to Authority, |
| Q3 | Do you agree that it is reasonable not to restore 1.2MW (increased from 1MW) of customer demand following an outage in certain defined scenarios. | Based on the analysis undertaken by the workgroup we believe that a pragmatic solution has been developed to provide minimum levels of security for particular parts of the distribution network. | The working group considered the options available and has proposed this solution for the same reason. |
| Q4 | Do you have any other relevant comments? | No. | Noted. |

Please provide comments relating to the specific technical content of the proposed modifications[2]

| Page / line No | Clause/ Subclause | Paragraph Figure/ Table | Type of comment (General/ Technical/Editorial) | COMMENTS | Proposed change | OBSERVATIONS OF THE SECRETARIAT on each comment submitted |
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| | | | | | | See comments above. |
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[2] Add more rows if required

# DCRP/22/03/PC: Engineering Recommendation (EREC) P2 Issue 8 - Security of Supply

Stakeholders are invited to respond to this consultation, expressing their views or providing any further evidence on any of the matters contained within the consultation document. Stakeholders are invited to supply the rationale for their responses to the set questions.

Please send your responses and comments by **17:00, 29th July 2022** to dcode@energynetworks.org and please title your email 'Consultation Response DCRP/22/03/PC Engineering Recommendation (EREC) P2 Issue 8 - Security of Supply.' Please note that any responses received after the deadline may not receive due consideration by the Working Group.

Any queries on the content of the consultation pro-forma should be addressed to DCode Administrator on 020 7706 5105, or to dcode@energynetworks.org

| | |
|---|---|
| **Respondent** | *Andy Hood* |
| **Company Name** | Western Power Distribution (soon to be called National Grid Electricity Distribution) |
| **No. of DCode Stakeholders Represented** | 4 Distribution License Areas |
| **Stakeholders represented** | *Western Power Distribution* |
| **Role of Respondent** | *Distributor* |
| **We intend to publish the consultation responses on the DCode website. Do you agree to this response being published on the DCode website? [Y/N]** | Yes |

| | Question | Response | Secretariate Response |
|---|---|---|---|
| Q1 | Do you agree with the general intent intent of the proposed modification? If not, please explain your view. | Yes, I agree with the intent of the proposed modification. Please also see my response to Q4. | Noted, thank you. |
| Q2 | Do you believe that the proposed modifications, as set out in the DCRP/22/03/PC Consultation Pack, better facilitate the Applicable Distribution Code Objectives? | Yes | Noted. |
| Q3 | Do you agree that it is reasonable not to restore 1.2MW (increased from 1MW) of customer demand following an outage in certain defined scenarios. | Yes | Noted. |
| Q4 | Do you have any other relevant comments? | The proposed changes are fine, as far as they go, however I believe additional changes will be required in the near future to facilitate the connection of low carbon technology (LCT), e.g. electric vehicle charge points, heat pumps and electrical energy storage (EES).<br><br>The following aspects should be considered/addressed <u>after</u> this modification has been approved and implemented:<br><br>The threshold for Group A should be increased from 1MW (preferably to 2MW) to allow existing distribution substations to be replaced with larger units in order to accommodate the increase in demand due to LCT. Without this this | With a new version of EREC P2 currently in the scoping phase. We will ensure the areas you raise here are considered in the scope of future modifications to the document. |

| | Question | Response | Secretariate Response |
|---|---|---|---|
| | | change DNOs will need to find and purchase additional substation sites within existing heavily congested urban areas as the demand increases. I believe this will impractical and uneconomic.<br><br>Assuming the threshold for Group A is increased, the restoration of demand under Group B should be amended accordingly. For example, Group Demand minus 2MW restored in 3 hours and the remaining demand restored in repair time.<br><br>Consideration should also be given to relaxing the demand security requirements for electric vehicle charge-points connections. This is particularly relevant to motorway services (and equivalent) where very high capacity connections will be required over the next few years (i.e. an average of 7MVA per site and up to 50MW at some sites within Western Power Distribution's area). These values increase still further when the requirements for electric HGVs are taken into consideration, for example, if 400 HGVs need to be charged per day an additional capacity of 24MVA will be required. DNOs will need to develop simple, reliable, compact and cost effective ways of supplying this demand and implement these requirements over the next few years. If the existing Group B and Group C security standards are applied to this type of installation the complexity, space requirements | |

| | Question | Response | Secretariate Response |
|---|---|---|---|
| | | and costs will be substantial and this will have an impact on lead times.<br><br>Finally the demand security requirements for large electrical energy storage (EES) installations need to be re-considered. The demand profiles for these sites are difficult to predict (i.e. they can operate at any time of day/year, particularly where the customer secures frequency response contracts) and so these sites are typically considered to be running at maximum import when edge case demand studies are performed. This means that new EES installations often use up most or all of the remaining headroom on the network even though their utilisation is expected to be relatively low. This often means significant reinforcement is required before other types of new demand (e.g. housing developments/commercial installations etc.) can be connected. If the demand security requirements for EES installations are relaxed somewhat this will facilitate the connection of both EES and other types of demand. | |

Please provide comments relating to the specific technical content of the proposed modifications[3]

| **Page / line No** | **Clause/ Subclause** | **Paragraph Figure/ Table** | **Type of comment** (General/ Technical/Editorial) | **COMMENTS** | **Proposed change** | **OBSERVATIONS OF THE SECRETARIAT** on each comment submitted |
|---|---|---|---|---|---|---|
| | | | | | | See comments above. |
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[3] Add more rows if required

PRODUCED BY THE OPERATIONS DIRECTORATE OF ENERGY NETWORKS ASSOCIATION

# ENA Paper: Analysis of P2 Class B Security of Supply

## Executive Summary

**Background**

The purpose of this ENA Paper is to inform the discussion on proposed changes to minimum levels of security of supply for specific parts of a distribution network.

Distribution Network Operators (DNOs)[1] are mandated to design their networks to at least a level of security of supply compliant with the level set in ENA Engineering Recommendation (EREC) P2. The current version of EREC P2 is Issue 7, i.e. EREC P2/7.

EREC P2 (commonly abbreviated to ‘P2’) stipulates minimum restoration times for loss of supplies following an outage on the network, i.e. how quickly customer supplies must be restored. The requirements in P2 have been the subject of review in recent years, led by the ENA P2 Working Group (under the auspices of the Distribution Code Review Panel, DCRP). In 2015/16, a review of P2 undertaken by Imperial College London (ICL) (with assistance from DNV.GL and NERA)[2] indicated that existing networks might be able to accommodate demand growth, in the short term, by relaxing restoration times required in P2 up to the point where reinforcement becomes economically justified. In March 2020[3] the ENA P2 Working Group completed an analysis which considered the societal, economic and environmental impact of reductions in security of supply at a GB level. The findings from the analysis included the following:

- For demand groups supplied by Primary Substations and Bulk Supply Points (Class of Supply C and D) it was concluded that the security of supply requirements for these network types should remain as specified in P2/7.

- For demand groups supplied by HV feeders (Class of Supply B) the impact of reducing redundancy was less pronounced and it was concluded that there might be situations where the reinforcement savings available outweigh the increase in the societal costs of interruptions. It was recommended that further work was needed to consider network security for HV feeders to a fuller extent.

The above findings and conclusions were reported to representatives of BEIS and Ofgem, where they were fundamentally accepted. Ofgem agreed with DNO members of the ENA that work to review security of HV feeders should commence with an expectation that a reduction in the security of supply level requirement would be appropriate for some HV feeders.

The DNO members of the ENA P2 Working Group have undertaken further analysis on demand groups supplied by HV feeders (Class of Supply B) to determine:

i. Which HV feeders could be planned with a lower minimum security of supply level; and

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1 The term ‘DNO’ used in this ENA Paper also includes Independent Distribution Network Operator (IDNO).

2 DNV GL, Imperial Consulting (Imperial) and NERA Economic Consulting, Engineering Recommendation P2 Review Workstream 2.7: Alignment of Security of Supply Standard in Distribution Networks with Other Codes and Schemes, 20 November 2015.

3 ENA Paper: *P2/8 High-level Analysis*, 2020.

ii. What the lower minimum security of supply level should be.

The findings and conclusions from the HV feeder analysis are outlined in this ENA Paper.

**Overview of Class of Supply B HV feeders**

The majority of HV feeders in GB are operated as 'radial' circuits, i.e. a circuit with a single point of supply, with connection to alternative points of supply used to maintain customer supplies during planned circuit outage or to restore customer supplies during unplanned circuit outages. The analysis in this Paper focuses on these 'radial' circuits only.

Analysis of all DNO HV feeder data[4] for 2019/20 was undertaken which determined that there are approximately 32,000 HV feeders in GB. HV feeders comprise a mixture of both underground circuits (cables installed in the ground) and overhead circuits (conductors installed on poles) in both urban and rural areas. The vast majority of HV feeders may be categorised as underground circuits:

- Approximately 23,000 HV feeders are predominately underground (≤20% overhead).
- Approximately 9,000 HV feeders are predominately overhead (>20% overhead).

In addition to the analysis of this HV feeder data, a further large representative sample of DNO data was collated to study the maximum demand on HV feeders. This data showed that 82% of HV feeders have a maximum demand in the range 0 - 4MW. The predominant maximum demand on an HV feeder is in the range of 1.5 - 2MW.

**Security of supply level for Class of Supply B**

For HV feeders (Class of Supply B), P2 stipulates the following minimum requirements for a first circuit outage, e.g. a circuit fault:

| Existing EREC P2/7 minimum requirements for HV feeders |
|---|
| **Demand to be restored within 3 hours (MW) =**<br>**Group Demand (MW) – 1MW** |

In considering lower minimum levels of security for Class of Supply B, the P2 Working Group reviewed the main factors that affect the security of supply of HV feeders. In the study, these factors were identified as; fault rate/length of circuit, speed of supply restoration following a fault, the demand profile and presence of an alternative circuit to supply customers. To analyse the impact of reducing security levels for HV feeders a coefficient was applied to the minimum requirements as follows:

4 Data used was taken from the DNO Quality of Supply (QoS) HV Disaggregation reporting packs.

| Using a coefficient to study impact of reducing EREC P2/7 minimum requirements for HV feeders |
|---|
| **Demand to be restored within 3 hours (MW) =**<br>**0.9xGroup Demand (MW) – 1MW** |

A coefficient of 0.9 translates as an increase of 11% of the permitted Group Demand that could be accommodated on an existing P2/7 compliant HV feeder. For example, an existing HV feeder with a maximum demand of 1.8MW requires a minimum of 0.8MW to be restored within 3 hours, under P2/7. Applying a coefficient of 0.9, the HV feeder maximum demand can be increased to 2MW, whilst the same minimum restoration of 0.8MW applies within 3 hours.

**Assessing the impact of lowering Class of Supply B requirements**

To assess the impact for customers of lowering the security of supply requirements the concept of expected energy not supplied (EENS) is used. This is a widely applied metric when assessing network outage risk and it represents the probabilistic calculation of energy that would not be supplied to customers as a consequence of a network outage. This Paper applies the following equation to determine the EENS for a HV feeder per annum:

| EENS = Group Demand (MW) x Restoration time (hr) x Fault rate (f/a/km) x HV feeder length (km) x Load probability (%) |
|---|

As there are two predominant stages of supply restoration following a fault outage – network reconfiguration (switching) stage and fault repair stage – the EENS for each stage has been calculated and the sum used to represent the total EENS for the HV feeder. The values that have been applied for the parameters are as follows:

- Group Demand

Group Demands in the range 1.5 – 4MW have been considered, as this range represents the majority of HV feeder demands.

- Restoration time

A switching restoration time of 3 hours and a repair time of 9 hours have been applied. 3 hours relates to the present EREC P2 requirement, whilst 9 hours was established by the P2 Working Group as being a typical value.

- Fault rate

The fault rate per km for 32,000 GB HV feeders has been calculated for the two generic types of HV feeder, i.e. HV underground cable feeder and HV overhead line feeder, and the weighted average has been calculated as 0.09. It was noted that there is not a significant difference between the fault rates of HV underground cable feeders and HV overhead line feeders.

- HV feeder length

Various lengths of HV feeder have been considered in the range 0 - 50km. The average length of a HV feeder is 5.08km.

- Load probability

A load duration curve (LDC) has been used to take into account the fact that load (or demand) on a HV feeder is not constant and changes over time. An LDC is a static representation of a time-dependent load – it depicts the duration for which the load will remain above certain values, i.e. % demand vs. % time. For a HV feeder, the area under a LDC represents the total energy supplied via that feeder, to consumers, per annum; this can be used to calculate an average value for the HV feeder load. When the transfer capacity associated with an alternative supply circuit is known, then the probability that there is insufficient transfer capacity to supply the load normally supplied by the faulty feeder whilst the repair is being carried can be determined. This Paper uses a simplified piecewise linear LDC. Over 40 LDCs from a range of HV feeders were studied to determine a range of representative LDCs for HV feeders.

The EENS for a HV feeder was determined in two scenarios:

a) A group of customers (demand) supplied by a HV feeder with a security of supply level compliant with the minimum requirements of P2/7; and

b) The same group of customers (demand) supplied by a HV feeder with the same characteristics to that used in a) above, i.e. length, fault rate, LDC etc., but with a security of supply level compliant with the proposed reduction in minimum requirements, i.e. with a coefficient of 0.9 applied.

The difference in EENS between scenarios a) and b) was analysed and used to calculate the increase in average minutes off supply per annum that a customer[5], connected to a circuit that was complaint with P2/7, would experience if they were supplied by a circuit compliant with the proposed reduction in minimum requirements. It is this increase in 'average minutes without a supply' that has been the focus of this Paper.

In respect of what would be an acceptable limit, the P2 Working Group agreed to base the analysis on the assumption that an 'average increase without a supply' of 10 minutes per year for a customer is reasonable. This is on the assumption that a limited number of customers would be affected (because only specific HV feeders would meet the criteria) which in turn would have limited impact on the overall customer minutes lost (CML)[6] for GB, i.e. 1.8% increase if all of the potential 1.2 million customers were affected by the proposed change. There are approximately 30 million customers in GB. To set this additional 10 minutes that a customer would be without a supply into context, the existing average time without supply due to a fault affecting a Primary Substation or Bulk Supply Point is approximately 15 minutes, the existing average time without supply due to a HV fault is approximately 60 minutes and the average time without supply due to a LV fault is approximately 150 minutes[7].

**Findings**

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5 The 'average minutes off supply per annum that a customer experiences' in this context is specific to the group of customers being considered. It is not necessarily the same as the customer minutes lost (CML) which is a weighted average for all customers across a network (see footnote 6)

6 CML = sum of the customer minutes lost for all restoration stages / total number of connected customers

7 Based on data from the National Fault and Interruption Reporting Scheme (NaFIRS) within the last 4 years.

The application of a coefficient of 0.9 to the calculation of the minimum demand to be restored for a first circuit outage of a HV feeder (Class of Supply B), a study of the increase in EENS and the average time a customer would be off supply has been undertaken, using the following parameters:

i. Group Demand = 1.5MW (lower limit of the predominant HV feeder Group Demand);

ii. Fault rate = 0.09 faults / annum / km;

iii. Switching time = 3 hours;

iv. Fault repair time = 9 hours; and

v. The representative LDC.

Using these parameters it has been determined, to ensure that the average additional minutes a customer supplied from a HV feeder would be off supply per year is no greater than 10 minutes, that the proposed lower security of supply level should only be applied to HV feeders that are 1km long or less.

**Benefit and Impact**

Reducing the redundancy of HV feeders would mean power outages experienced by customers would on average last longer. Previous stakeholder engagement by DNOs, as part of their RIIO-ED1 and DCRP stakeholder engagement activities, has clearly demonstrated that GB customers do not support a reduction in supply security.

A reduction in security of supply levels conflicts with DNOs' focus to continually improve their 'customer minutes lost' objectives.

A reduction in security of supply levels also conflicts with DNOs' focus to reduce network losses. Those parts of the network with lower levels of supply security will have increased asset utilisation, i.e. equipment operating with more current passing through it, and a consequential increase in network technical losses.

The main benefit of reducing the minimum security of supply level is facilitating an increase in network capacity that can be 'released' for normal network configuration, as opposed to network capacity being reserved for use in outage scenarios. In the proposal, up to an 11% increase in customer demand could be accommodated on specified HV feeders without incurring upgrading costs. Theoretically this would facilitate the connection of low carbon technology with their associated increase in network demand. Determining the extent of cost savings on HV feeder upgrades is complex as a number of factors determine whether and when reinforcement may be required (e.g. the location, magnitude and timing of future load growth, the diversity between the new and existing feeder load, the capacity of existing HV feeder and the HV feeder topology) – such factors may be generalised if the proposed security of supply criteria is applied nationwide, but for HV feeders of interest, specific data and analysis would be needed to determine a meaningful value for any cost saving. The potential cost saving for a HV feeder, if facilitated by the proposed reduction in security of supply level, could be significant as a HV feeder reinforcement scheme typically costs in the region of £100k[8].

There are approximately 3,600 HV feeders in GB which are up to 1km in length which supply a total of 1.2 million customers.

On the basis that the maximum length of HV feeder is 1km for the application of the proposed '0.9 coefficient', the expected increase in customer minutes lost (CML) for HV faults is 1.8%. To put this increase into context, in 2017/18 the HV CML value was 22.3 – this may have increased to 22.7 if all 1km HV feeders had been planned to just comply with the proposed lower security of supply level.

**Simplifying the 0.9 coefficient**

The P2 Working Group considered the practical application of a co-efficient to the calculation of the minimum demand to be restored following an outage, from a network planning perspective. Applying a '0.9 coefficient' approach can mean that the size of the demand which is permitted to remain off-supply following an outage is dependent on the Group Demand; this can change over time, which could have implications for the network topology. To avoid these practical difficulties, the '0.9 coefficient' approach has been converted to an equivalent alternative representation. Using a Group Demand of 2MW to represent the most common HV feeder load, the "0.9 x 2MW – 1MW" approach equates to "Group Demand – 1.2MW" approach, such that the simplified requirement becomes:

| Proposed EREC P2 requirements for HV feeders |
|---|
| **Demand to be restored within 3 hours (MW) =**<br>**Group Demand (MW) – 1.2MW** |

**Recommendations**

It is recommended that:

i. P2/7 is amended with the inclusion of a note to indicate that the minimum demand to be restored within three hours can be reduced for specific HV feeders within Class of Supply B; and

EREP 130[9] is amended to convey that for HV feeders up to 1km in length, the demand that shall be restored within 3 hours is Group Demand minus 1.2MW. A summary of the assumptions and exclusions for this criteria should be included as well as the treatment of the Class of Supply A/B boundary.

8 Indicative cost of a reinforcement scheme addressing security of supply on a HV feeder based on GB DNO data for the current price control period (ED1).

9 ENA EREP 130, Issue 3, Guidance on the application of Engineering Recommendation P2, Security of Supply

Please see separate document provided with this report.

- ENA_EREP_130_Issue 4_TC_(2022)