

Distribution Code Consultation DCRP/22/04/PC

Engineering Report (ERE) 130 Issue 4 – Guidance on the application of Engineering Recommendation P2, Security of Supply

Modifications to permit the reduction in the security of supplies to customers in a limited number of targetted situations

Target Audience:

The modifications will be of interest to all Distribution Code Stakeholders & Users including Distribution Network Operators, Generators, Customers, Demand Side Response providers, Distribution Energy Resource.

Date Published: 27th June 2022

Deadline for responses: 17:00 on Friday, 29th July 2022

Summary:

This consultation is intended to seek the views of stakeholders on proposed changes to Engineering Report (ERE) 130 Issue 4, in alignment with the amendments to Engineering Recommendation (ERE) P2 Issue 8, by revising the security of supply to high voltage feeders of class B, with a group demand minus 1.2MW.

A study from 2016 produced by Imperial College London (ICL) and their partners considered several areas of possible changes to EREC P2 based on a cost benefit analysis. The reduction in the minimum level of security of supply was one of several recommendations from this work, and the Distribution Code Review Panel (DCRP) EREC P2 workgroup was formed to conduct further analysis of the ICL findings.

The workgroup assessed the impact of a reduction in the security of supply to demand groups between 1MW and 300MW and carried out a review of the savings and benefits identified in the ICL report. This review considered the wider societal implications of a reduction in supply security as well as the potential network 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 considered that it would be reasonable to reduce the security of the security of supply to HV feeders supplying demand between 1 and 10MW in some limited situations.

The workgroup has developed a revised version of ERE 130 which, if approved by the Authority, would implement the proposed arrangements.

This consultation is being run in parallel with DCRP/MP/22/03 as EREP 130 is the accompanying document to EREC P2. As both documents are Distribution Code Annex 1 documents, each document will have its own consultation.

1. Introduction

EREK 130, Guidance on the application of Engineering Recommendation P2, Security of Supply, is a document which supports the Distribution Network Operators in allowing for efficient and consistent operation of the network in relation to the security of supply. It has been in use now for over 10 years and has served the industry well over that time. EREC P2 does this by stipulating minimum restoration times for customer supplies to be restored following a planned or unplanned outage on the network. The extent and nature of distribution networks mean that faults occur from time to time, and EREP 130 is used to provide guidance on the interpretation of EREC P2 at such times,

High Voltage (HV) feeders supply a neighbourhood area (200 – 2,000 customers). There are approximately 30,000 faults p.a. on HV networks. In the event of HV feeder faults the restoration times stipulated in P2 require that the vast majority of customers be restored by network switching within three hours.

The Extra High Voltage (EHV) network is made up of Primary Substations and Bulk Supply Points (BSPs), and supply whole towns and large parts of cities. There are approximately 3,500 faults p.a. on EHV networks. The majority of Primary Substation and BSP faults go unnoticed by customers as EREC P2 ensures there is sufficient redundancy to maintain customer supplies.

One of the objectives of P2 is to strike a balance between the cost of providing redundancy in distribution networks (which reduces the impact of planned and unplanned outages on customers), and the costs to customers and society generally of interruptions to electricity supplies.

The work carried out by ICL suggested that it was uneconomic to continue to develop distribution networks to provide the level of supply security required by EREC P2.

Two pieces of work were subsequently carried out by the EREC P2 workgroup, the first being a more general security of supply analysis for a range of demand groups (summarised in the paper included in Appendix A). This work concluded that it was reasonable to continue to apply P2 to the EHV network, but in some situations relaxing the security of supply requirements for smaller demand groups supplied from HV feeders would be reasonable.

This consultation paper therefore focussed on a proposal to relax the security requirement for some HV feeders.

2. The Defect

A view of the work carried out by ICL suggested that it was uneconomic to continue to develop distribution networks to provide the level of supply security required by P2. The P2 workgroup reviewed this analysis and carried out further work which concluded that this was not the case when the wider societal implications arising from widespread extended power outages were considered, but agreed that in some situations relaxing the security of supply requirements for smaller demand groups would be reasonable.

The defect addressed by this consultation therefore relates to a proposal to relax the security requirement for some HV feeders.

3. Proposal

The proposed modification is to permit an increase in customer demand that doesn't need to be restored within 3 hours following a first circuit outage on any HV feeder (supplying demand of between 1MW and 10MW) where the feeder has a total length not more than 1km, from 1MW to 1.2MW. This represents an increase of 0.2MW in the demand that might not be restored within 3 hours.

Reducing the redundancy of HV feeders would mean power outages experienced by customers would 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, however the workgroup agreed that an increase of 10 minutes in the average time that a customer was off supply would generally be acceptable to consumers, provided that there are some tangible benefits for customers.

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 it 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. Theoretically this would facilitate the connection of low carbon technology with their associated increase in network demand.

Relaxing the security of supply as proposed would result in a financial saving when the demand on a HV feeder increases above that which would be compliant with the P2/7 minimum level because no reinforcement works would be necessary to either reduce the demand on the HV feeder or to increase the capacity of the transfer circuits. The extent of the financial savings is dependent on a number of factors including the following:

- a) the extent, location and timing of demand growth, e.g. low carbon technology (LCT) connections;
- b) the topology of the network;
- c) the network operator's losses strategy; and
- d) the network operator's policy regarding system operation, e.g. focus on improvements to network to further reduce customer interruptions and customer minutes lost to meet customer expectations

Because the proposed changes would be applied to a specific set of HV feeders, as opposed to all HV feeders, determining how the above factors will affect those HV feeders is complex and would require bespoke detailed analysis of their existing design and projected demand growth. So, while the number of reinforcement schemes that will potentially be saved each year cannot be easily devised, the P2 workgroup have determined that the potential cost saving for a HV feeder, if facilitated by the proposed reduction in security of supply, could be significant as a HV feeder reinforcement scheme typically costs in the region of £100k.

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

If the proposal was to be implemented the expected maximum increase in customer minutes lost (CML) associated with HV faults would increase by is 1.8%. For example, 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 minimum criteria proposed in relaxed P2 requirement.

The proposal would be implemented by amending both Engineering Recommendation P2, and the accompanying Engineering Report 130 guidance document.

Any revision to these documents would form only a small part in the wider approach distribution network operators are taking to achieve net zero. By allowing for increased capacity on HV feeders, this will promote the connection of low carbon technologies, increasing the amount of renewable generation connected to the GB network.

It is proposed to amend the document titles for both EREC P2 and EREP 130 listed in the Annex 1 – Qualifying Standards section of the DCode as shown below;

3 Engineering Recommendation P2 Issue ~~7~~ 8

4 Engineering Report 130 Issue ~~3~~ 4

4. Applicable Distribution Code Objectives

The Applicable Distribution Code Objectives are to:

- a) permit the development, maintenance, and operation of an efficient, co-ordinated, and economical system for the distribution of electricity; and
- b) facilitate competition in the generation and supply of electricity; and
- c) 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
- d) promote efficiency in the implementation and administration of the Distribution Code.

5. Consultation Questions

1. Do you agree with the general intent of the proposed modification? If not, please explain your view.
2. Do you believe that the proposed modification, as set out in the DCRP/22/04/PC Consultation Pack, better facilitate the Applicable Distribution Code Objectives?
3. 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.
4. Do you have any other relevant comments?

6. Next Steps

Responses to this consultation should be sent to the Distribution Code Review Panel Secretary at dcode@energynetworks.org by **17:00 on Friday, 29th July 2022** on the pro-forma provided expressly for the purpose, or via any other convenient means. The pro-forma can be found in the Consultation Pack. Responses after this date may not be considered.

7. Consultation Pack

The DCRP/22/04/PC Consultation Pack can be found here - <http://www.dcode.org.uk/consultations/open-consultations/>

The Consultation Pack includes:

- This Consultation Paper
- Draft Engineering Report 130 Issue 4
- Response Proforma

For more information, please contact:

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Appendix A - ENA Paper P2_8

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 2020³ 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

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 data⁴ 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 ($\leq 20\%$ 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
<p>Demand to be restored within 3 hours (MW) =</p> <p>Group Demand (MW) – 1MW</p>

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

$$\text{Demand to be restored within 3 hours (MW)} = 0.9 \times \text{Group Demand (MW)} - 1\text{MW}$$

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:

$$\text{EENS} = \text{Group Demand (MW)} \times \text{Restoration time (hr)} \times \text{Fault rate (f/a/km)} \times \text{HV feeder length (km)} \times \text{Load probability (\%)}$$

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 customer⁵, connected to a circuit that was compliant 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 minutes⁷.

Findings

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 £100ks.

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) = 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 130⁹ 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