The Voice of the Networks

Energy Networks Association

ENA EREC P28 Issue 2 2018 Key Technical Modifications

Version 1 (ISSUED)

Agenda

- Background to revision of ER P28 Issue 1
- Key technical modifications in EREC P28 Issue 2
- Other modifications
- Draft proposed changes to the Distribution Code (DCODE)
- Public consultation.

Background

- ENA Engineering Recommendation (ER) P28 Issue 1 1989 sets *planning limits for voltage fluctuations caused by customer connected disturbing equipment*
- Qualifying Standard in the DCODE and a licence standard in the Grid Code
- Has been under review/revision by a joint DCRP & GCRP Working Group
- P28 Issue 2 2018 constitutes a full technical revision
  - **New document structure, format and reworded requirements**
  - **Fully updated to reflect the UK implementation of IEC 61000 series of Standards (so far as they relate to voltage fluctuation)**
  - **Addresses connection of distributed/embedded generation equipment**
  - **Includes limits and requirements for rapid voltage changes (RVCs).**

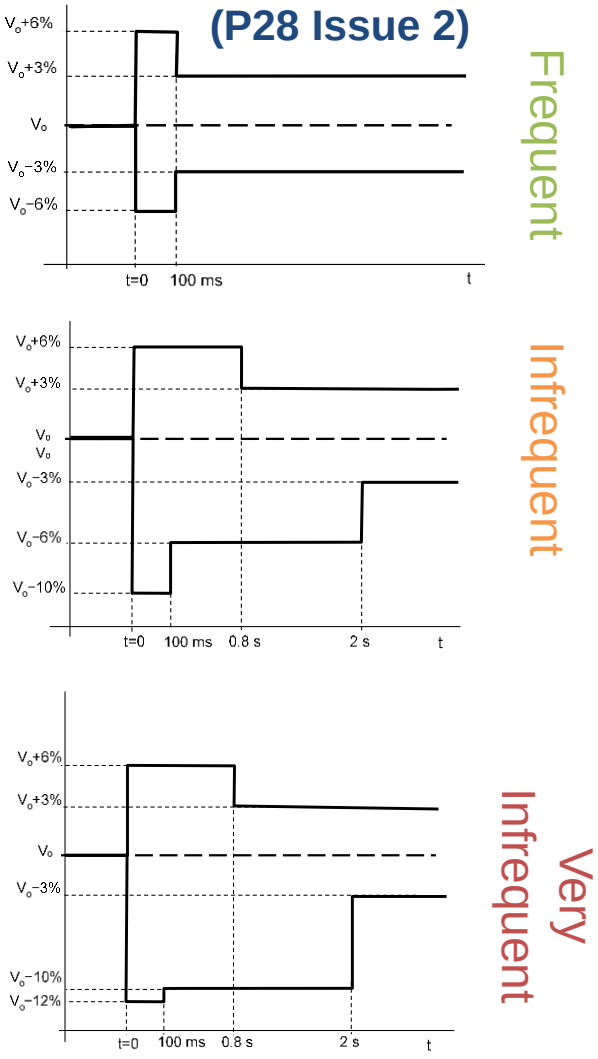
Summary of Key Technical Modifications

- Introduction of requirements and planning levels for RVCs
- An intermediate planning level and associated flicker severity limits *for supply systems with nominal voltages of 3.3 kV, 6.6 kV, 11 kV, 20 kV and 33 kV*
- Improved definition and clarity of worst case operating conditions to be used in the assessment of voltage fluctuations
- Improved definition of voltage step change
- Other modifications

Other requirements for assessment of flicker related voltage fluctuations have <u>not</u> changed including: the three-stage assessment for flicker, allocation of remaining headroom (flicker severity) on a 'first come first served' basis.

Planning Levels for Rapid Voltage Changes (RVCs)

Proposed RVC Limits (P28 Issue 2)



P28 Issue 1 permits design for:

- step voltage changes of ±3% for infrequent planned events
- voltage depression >3% but ≤6% permitted for very infrequent motor starting

DCODE DPC4.2.3.3 permits voltage depression of around 10% for transformer energisation (once per year)

Modifications in P28 Issue 2 (Section 5.3 Table 4)

- Basis was Grid Code Modification GC0076
- No change to general step voltage change ($\Delta V_{steadystate}$) limit of ±3%
- 3 categories of RVC events (number of occurrences)
  - Frequent (single or repetitive RVC)
  - Infrequent (Max of 4 events per calendar month)
  - Very Infrequent (Max of 1 event in 3 calendar months)
- No more than 1 event per day, with up to 4 RVCs, separated by at least 10 minutes, with all switching completed within a 2 h window.

Planning Levels for Rapid Voltage Changes (RVCs)

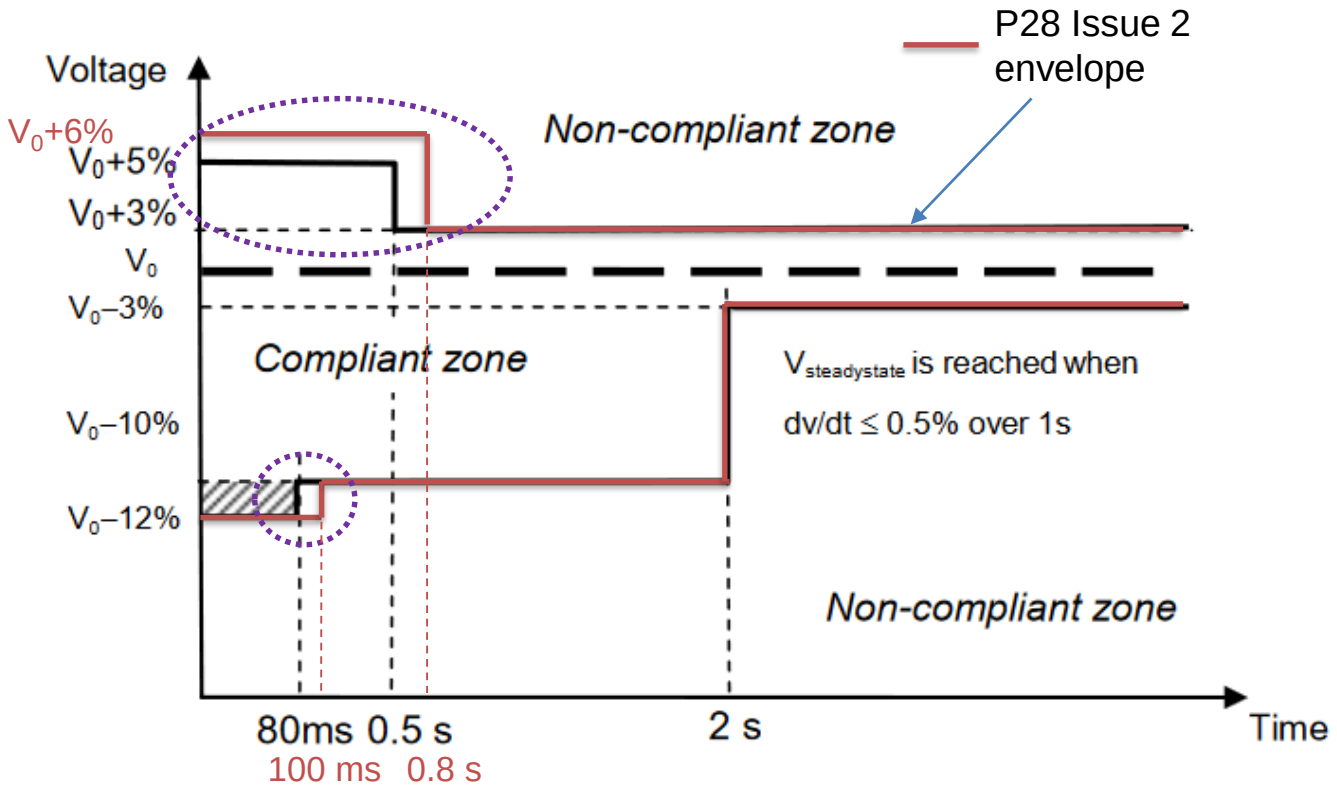


Figure CC.6.1.7 -
Time and magnitude limits for a category 3 Rapid Voltage Change

Key differences with Grid Code CC 6.1.7

- $\Delta V_{max} \leq 5\%$ for a maximum duration of 0.5 s for increases in voltage
- Maximum permitted voltage change of -12% for 80 ms for decreases in voltage
  Maximum of 4 RVCs in one day typically not planned for more than once per year on average
- No 'Infrequent' events category
- % voltage change based on V_0 not V_n.

Planning Levels for Rapid Voltage Changes (RVCs)

JUSTIFICATION

- General alignment with the approach in Grid Code CC.6.1.7
- Limits are absolute and fall within:
  - EREC G59 and grid connected protection & TGN 288 for overvoltage
  - Immunity levels of customer equipment
- RVCs should not result in un-acceptable disturbance provided
  - events are sufficiently spaced apart
  - Multiple RVCs are completed within a small time window
  - There is no damage to or tripping of customer equipment

IMPACTS

- Potentially greater no. of RVCs permitted at any given PCC over a calendar year
- Permits greater no. of transformers to be energised at same time
- In practice will simplify restoring distributed generation following G59 event
- No material impact on ΔV_{max} for decreases in voltage.

Planning Levels for Flicker

Table 1 of ER P28 Issue 1

Supply system Nominal voltage	Planning level	
	P_{st}	P_{lt}
132 kV and below	1.0	0.8
Above 132 kV	0.8	0.6

Table 2 of EREC P28 Issue 2

Supply system Nominal voltage	Planning level	
	P_{st}	P_{lt}
LV	1.0	0.8
3.3 kV, 6.6 kV, 11 kV, 20 kV, 33 kV	0.9	0.7
66 kV, 110 kV, 132 kV, 150 kV, 200 kV, 220 kV, 275 kV, 400 kV	0.8	0.6

New intermediate planning level proposed

Re-assignment of supply system voltages

No other changes to planning levels

JUSTIFICATION

- To improve co-ordination of flicker transfer
- To allow margin for transfer of flicker severity from higher voltage to lower voltage systems

IMPACTS

- Will reduce the possibility of compatibility levels being exceeded at LV
- Possible impact on proposed Stage 3 HV customer connections with high background levels of flicker severity.

Applicability to Operating Conditions and Fault Outages

- EREC P28 Issue 2 now requires assessment under worst case normal operating conditions
- Normal operating conditions include:
  - Credible outage conditions that the system has been designed to operate within acceptable limits
  - Planned and fault outages consistent with securing demand under relevant security of supply standards
- Does not apply to:
  - transient voltage fluctuations between fault initiation and fault clearance
  - during any reconfiguration of the public electricity supply system immediately following a fault

Table 6 — System/network conditions - Normal operating conditions

System/network operating condition	Description
Normal network configuration	Normal running arrangement with normal open point(s). No network assets out-of-service for construction, maintenance or faults
Alternative network configuration(s)	Alternative running arrangement(s) with substitute open point(s). No network assets out-of-service for construction, maintenance or repair
Planned outages (see NOTE)	Planned outages of specific network assets for construction, maintenance or repair activities
Fault outages (see NOTE)	Running arrangement taking into account credible fault outage scenario(s) for normal/alternative network configuration(s). Compliant with network design limits before fault outage and within a short time after fault outage, where reconfiguration of network is required
Switching operations (including reactive compensation)	Energisation and de-energisation of network assets. Reactive compensation. Reconfiguration of network
Protection operation (including G59 [4] protection operation)	Operation of protection and disconnection of load/generation for which the network is designed to cater for
Demand / generation variations	Variations in demand/generation within rating of network under normal and alternative network configurations
Local embedded/distributed generation	Generally, can be ignored unless there is a long-term guarantee that this generation would be operating at the same time as the disturbing equipment and/or fluctuating installation (see 6.1.5)
NOTE: For various credible planned/fault outage scenarios the scenario that results in the maximum supply system impedance should be generally chosen.	

Applicability to Operating Conditions and Fault Outages

JUSTIFICATION

- ER P28 Issue 1 is not particularly clear in respect of operating conditions under which assessment is required and is open to interpretation
- Operating conditions are subjective for certain flicker related voltage fluctuations
- In practice, network operators stipulate assessment under 'N-1' conditions
- Alignment with approach in PD IEC TR 61000-3-7
- Proposed amendment is intended to provide a more consistent understanding and application of network operating conditions for P28 assessments

IMPACTS

- More prescriptive requirements will apply for assessing voltage fluctuations
- Will permit a standardised approach to assessment across system/network operators
- Worst case normal operating conditions will apply to assessment of all voltage fluctuations
- Expectation that the risk of voltage complaints under credible outage conditions would reduce.

Voltage Step Changes

No change to general ±3% limit on the magnitude of voltage step changes

- However, the definition of 'voltage step change' has been clarified:
  - Relates to the voltage change between two steady state conditions ($V_{steadystate}$)
  - Expressed as a percentage change of nominal system voltage (V_n)
  - Voltage must now be within ±3% limit
    - 100 ms after event initiation for 'Frequent' events
    - 2s after event initiation for 'Infrequent' and 'Very Infrequent' events

JUSTIFICATION

- To distinguish step voltage change from different voltage change events
- To align with % voltage change philosophy in BS EN 61000 series standards (i.e. % change = $\Delta V/V_n$)

IMPACTS

- Will require a steady state voltage condition to be reached before and after voltage change event for assessment of step voltage change

Other Modifications

- Improved clarity concerning information requirements for assessment and responsibilities for provision of information.

Information Requirements and Responsibilities

Section 6.1.4 (Table 5) captures:

- information requirements for assessment
- responsibilities of customers and system / network operators in the assessment process

JUSTIFICATION

ER P28 Issue 1:

- Information requirements and provision of data is unclear
- Responsibilities of customer and system / network operator in assessment process is unclear

IMPACTS

- Will provide a common standard for provision of information and assignment of responsibilities at each assessment stage.

Table 5 — Information requirements and responsibilities

Information	Requirement	Assessment Stage	Responsibility
Supply system impedance - LV only	For single-phase: Measurement of supply phase to neutral loop impedance at the customer supply terminals (see NOTE 1) or Calculation of supply phase to neutral loop impedance at the customer supply terminals for normal supply arrangement (see NOTE 2) For three-phase: Measurement of supply phase to phase supply impedance at the customer supply terminals (see NOTE 1) or Calculation of supply phase to phase impedance at the customer supply terminals for normal supply arrangement (see NOTE 2)	Stage 1	 Customer Network Operator (on request) Customer Network Operator (on request)
Service current capacity	Check against Connection Agreement Check service records and/or inspection of cut-out (see NOTE 3)	Stage 1	Customer Network Operator (on request)
Disturbing equipment details:	Type of equipment Rated voltage, current, power Single-phase or three-phase connection Single-phase or three-phase impedance Starting/stopping current characteristics Operating cycle (periods of operation) Statement of EMC compliance with relevant product standards, e.g. BS EN 61000-3-3 (see NOTE 4)	Stage 1,2 & 3	Customer
P28 compliance assessment	Assess flicker/RVC emission against compatibility/planning levels in P28 Issue 2. Provide compliance report for Network Operator Assess compliance report from customer for acceptability	Stage 2 & 3	Customer (see NOTE 5) System/Network Operator
Emission measurements and validation	Measurement of customer's emission levels and validation against predicted levels in P28 compliance report	Stage 2 & 3	Customer & System/Network Operator (see NOTE 6)
Supply system impedance - except LV (see 6.1.5)	Declaration of maximum supply system impedance at the PCC	Stage 1, 2 & 3	System/Network Operator
Known future connections/ alterations (see 6.1.6)	Provide system/network information in Long Term Development Statements, where available, and similar documents Consider known future alterations to the supply system in supply system impedance information (see NOTE 7) Consider known future connection/alterations (supply system and disturbing equipment/fluctuating installation) in emissions assessment	Stage 1, 2 & 3	System/Network Operator System/Network Operator Customer
Flicker background level (see 7)	Measurement of existing flicker background level (pre-connection)	Stage 3	System/Network Operator

DRAFT

Other Modifications

- Improved clarity concerning information requirements for assessment and responsibilities for provision of information
- Concept of transfer coefficients for determining voltage fluctuation contributions from different nodes
- Additional clarification of requirements for measurement and assessment of voltage fluctuations (section 7)
- Additional recommendations for assessing voltage fluctuations caused by renewable energy and low carbon technologies (section 8).

Draft Proposed Changes to the Distribution Code (DCODE)

Annex 1 Qualifying Standards

- Propose change to reflect amended document title

DPC4.2.3.2 Voltage Disturbances

- Propose addition of requirement for voltage fluctuations to "…comply with the applicable requirements for assessment and measurement set out in DGD Annex 1, item 8 ~~9~~ Engineering Recommendation P28".

DPC4.2.3.3 Voltage Step Changes

- Propose significant deletion of text concerning voltage step changes as now covered in EREC P28 Issue 2
- Propose retention of text relating to general acceptability of design for an expected voltage depression of around -10% for very infrequent energisation of complete sites with a significant presence of transformers (i.e. post fault switching, post maintenance switching, or carrying out commissioning tests).

See Draft Proposed Changes to DCODE_EREC P28 Issue 2 for draft proposed changes to legal text

Summary

Public Consultation:

- See http://www.dcode.org.uk/consultations.html
- Commenced on 8th January 2018
- Responses by 17:00 hrs on 31st January 2018
- Views of Grid Code stakeholders sought

4.6 Recognising that any consequential changes to the Grid Code will need to be progressed via the Grid Code governance process, the Working Group would welcome any concerns you have at this stage if the EREC P28 Issue 2 proposal was to be considered for adoption in the Grid Code?

Next Steps:

- Consider responses
- Consider likely changes to the Grid Code and other standards eg SQSS
- DCRP DCRP/MP/18/01/RTA submitted 17 May – and sent back 22 June

Ofgem Decision

- **We expect distribution licensees and the Grid Code Review Panel ('GCRP') to work together and submit any proposed Distribution and Grid Code changes to us as a package, which should include co-ordinated implementation timetables. We expect the GCRP to discuss the issues set out in this letter and DCRP/MP/18/01 at the next GCRP meeting, on 28 June 2018.**
- **We therefore direct that the FMR be sent back to the electricity distribution licensees to be reviewed once work to assess the impact of DCRP/MP/18/01 on the Grid Code is complete. To achieve this, we expect the relevant Code Administrators (CA) to follow Principle 132 of the CA Code of Practice.**

Modification required to Grid Code - Appendix A

- **GLOSSARY AND DEFINITIONS**
  - ***Flicker Severity***
    - *A value derived from 12 successive measurements of **Flicker Severity (Short Term)** (over a two hour period) and a calculation of the cube root of the mean sum of the cubes of 12 individual measurements, as further set out in **Engineering Recommendation** P28 Issue 2 as current at the Transfer Date*
    -
- **PLANNING CODE**
  - ***PC.A.4.7 General Demand Data - PC.A.4.7.1 (f)***
    - *details of all loads which may cause **Demand** fluctuations greater than those permitted under **Engineering Recommendation** P28 Issue 2, Stage 1 at a **Point of Common Coupling** including the **Flicker Severity (Short Term)** and the **Flicker Severity (Long Term)**.*
    -
  - ***Appendix C Technical Design Criteria - Part 1 SHETLs***
    - Technical Design Criteria (Item4)
    - *New Title for ER P28 Issue 2 - Voltage fluctuations and the connection of disturbing equipment to transmission systems and distribution networks in the United Kingdom*
    - *In the table column entitled "Reference No" ER P28 should be modified to state P28 Issue 2*

- ***Appendix C Technical Design Criteria Part 2 - SPT's Technical and Design Criteria***
  - *New Title for ER P28 Issue 2 - Voltage fluctuations and the connection of disturbing equipment to transmission systems and distribution networks in the United Kingdom*
  - *In the table column entitled "Reference No" Engineering Recommendation ER P28 should be modified to state Engineering Recommendation P28 Issue 2*
- ***Appendix E – Offshore Transmission System and OTSDUW Plant and Apparatus Technical Design Criteria – PC.E.2 (Table)***
  - *New Title for ER P28 Issue 2- Voltage fluctuations and the connection of disturbing equipment to transmission systems and distribution networks in the United Kingdom*
  - *In the table column entitled "Reference No" Engineering Recommendation P28 should be modified to state Engineering Recommendation P28 Issue 2*

- **CONNECTION CONDITIONS (CC)**
  - CC.6 Technical, Design and Operational Criteria
    - Voltage Fluctuations CC6.1.7
    - ***Please refer to Appendix B***
- **EUROPEAN CONNECTION CONDITIONS (ECC)**
  - ECC.6 Technical, Design and Operational Criteria
    - Voltage Fluctuations ECC.6.1.7
    - ***Please refer to Appendix B***

- **OPERATING CODES (OC)**
  - OC5.5.4 Test And Monitoring Assessment (Test Criteria)
    - In the parameter column the rows entitled *Voltage Fluctuation* and *Flicker* Engineering Recommendation P28 should be modified to state Engineering Recommendation P28 Issue 2
    -
- **SCHEDULE 7 – LOAD CHARACTERISTICS AT GRID SUPPLY POINTS**
  - At the foot of the column entitled Data Description Engineering Recommendation P28 should be modified to state Engineering Recommendation P28 Issue 2

Appendix B - Proposed Legal Text to modify the following sections of The Grid Code Connection Conditions

- **CC.6 Technical, Design and Operational Criteria Voltage Fluctuations CC6.1.7**
- **ECC.6 Technical, Design and Operational Criteria Voltage Fluctuations ECC.6.1.7**

Voltage Fluctuations

Voltage changes at a **Point of Common Coupling** on the **Onshore Transmission System** shall not exceed:

(a) The limits specified in **Engineering Recommendation** P28 Issue 2 as current at the **Transfer Date**, where:

- (i) Voltage changes in category 3 are typically notified to **NGET,** such as for example commissioning in accordance with a commissioning programme, implementation of a planned outage notified in accordance with **OC2** or an **Operation** or **Event** notified in accordance with **OC7**; and
- (ii) For connections with a **Completion Date** after X September 201X and where voltage changes would constitute a risk to the **National Electricity Transmission System** or, in **NGET**'s view, the **System** of any **User**, **Bilateral Agreements** may include provision for **NGET** to reasonably limit the number of voltage changes in Category 2 or 3 to a lower number than specified in Table 4 of Engineering Recommendation P28 Issue 2 as current at the Transfer Date to ensure that the total number of voltage changes at the **Point of Common Coupling** across multiple **Users** remains within the limits of Table 4 .

(b The limits for **Flicker Severity (Short Term)** and a **Flicker Severity (Long Term)** as set out in **Engineering Recommendation** P28 as current at the **Transfer Date**.

SQSS

- SQSS Figure 6.1 references ER P28 (Issue 1) Figure 4. Figure 4 in ER P28 Issue 1 has been replaced by a slightly different Figure B.1.2 in ER P28 Issue 2. Therefore the GCRP will need to consider a mod to the SQSS also.