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Code of Practice 281

Issue 2 April 2024

Distribution System Design – 33kV Network

Amendment Summary

ISSUE NO. DATE	DESCRIPTION
Issue 2 **April 2024**	Document combined with CP281 to create a single document for 33kV Network System Design. 33kV Network Design Policy Statement – new section added covering design practice and taken from EPD281 33kV Network Design. Other minor editorial updates made throughout the document, not marked. Prepared by: Peter Twomey Approved by: Policy Approval Panel and signed on its behalf by Paul Turner, PAP Chair

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1 Introduction

The general principles contained within this Electricity Policy Document (EPD) shall be applied to all new work on the 33kV network (Network) owned and operated by Electricity North West Limited (Electricity North West). The decision as to whether existing systems shall be brought into line with this EPD when reinforcements or material alterations are carried out (including asset replacement work and new connections) will depend on individual circumstances and each case shall be actively considered.

This document is one of the following suites of documents relating to Network Design.

CP279	-	Distribution System Design – General Requirements
CP280	-	Distribution System Design – 132kV Network
CP281	-	Distribution System Design – 33kV Network
EPD282	-	Distribution System Design – 11/6.6kV Network
EPD283	-	Distribution System Design – Low Voltage Network

This document is an amalgamation of EPD281 and CP281. The contents of EPD281 have been incorporated into Section 4 of this document, and EPD281 has been withdrawn.

2 Scope

This document describes the general distribution network design principles, at 33kV, that shall be used by the service provider Electricity North West Limited (Electricity North West) staff and any third-party connector. It will assist network designers in discharging their responsibilities for compliance with The Electricity Safety, Quality and Continuity Regulations 2002, Electricity Distribution Licence – Condition 5, The Distribution Code and appropriate safety legislation. Information and guidance on design practices is provided in Section 5 to assist staff and contractors employed by Electricity North West in the design and development of the 33kV electricity distribution network.

3 Definitions

For the purpose of this document the following definitions apply:

Approved	Approved by the Company (Electricity North West)
CP	Code of Practice
GIS	Geographical Information System
ENA	Energy Networks Association
Electricity North West	Electricity North West Limited
EPD	Electricity Policy Document
EREC	Engineering Recommendation (ENA document)
ES	Engineering Specification
HV	High Voltage. For Electricity North West, HV voltage levels are 6.6kV and 11kV.
IPSA	Interactive Power Systems Analysis (Network study software tool developed and managed by TNEI)
NGESO	National Grid Electricity System Operator
PES	Public Electricity Supplier
Primary Substation	33/11kV or 33/6.6kV Substation

4 33kV Network Design Policy Statement

4.1 General

Full use shall be made of supervisory switching to restore supplies under fault outage conditions.

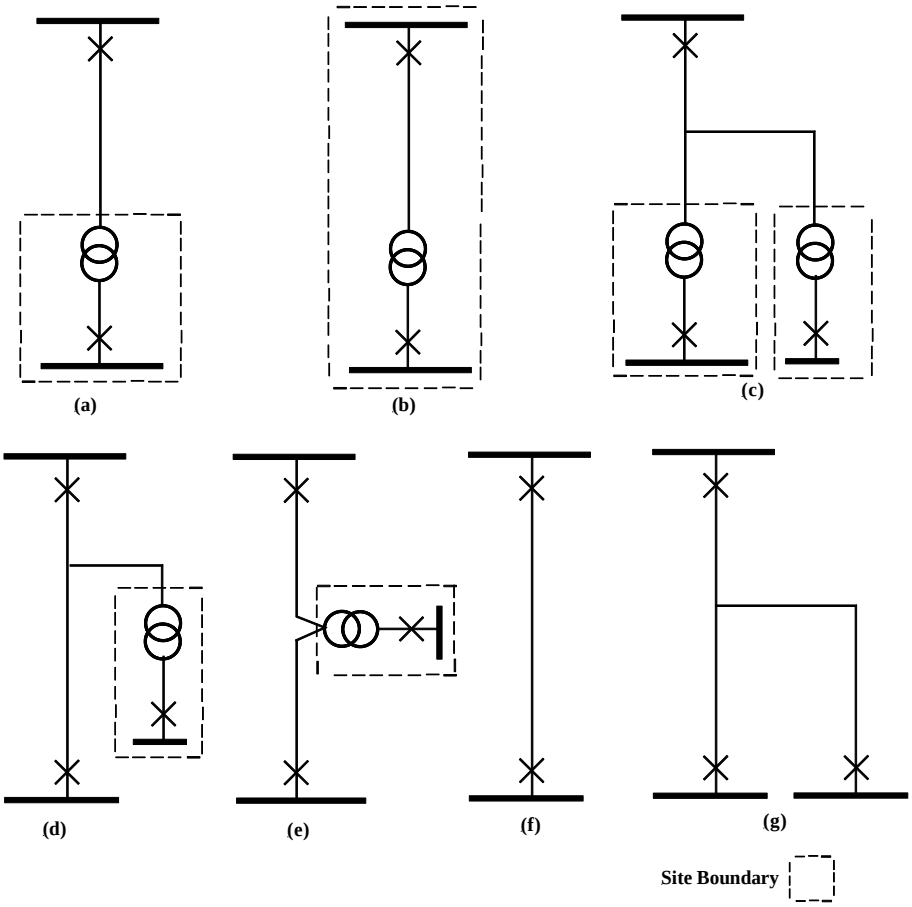
Circuit & transformer loading shall be obtained from the Feeder Load Analysis system.

4.2 Network Development

The approved Network configurations shall be as shown in Figure 1 with primary substations designed on the feeder transformer principle. No other arrangement shall be installed without the agreement, in writing, of the Planning Policy Manager, Electricity North West Limited.

The protection arrangements for the network configurations shown in Figure 1 are provided in ES312 - 36kV Single Busbar Indoor Switchgear (Cable Connected).

Figure 1



A sample network, utilising all the above arrangements is shown in Figure A - Appendix A and Figure B - Appendix B

4.3 Voltage Step Change and Voltage Collapse

The Network shall be designed to limit voltage step changes and to avoid voltage collapse. Reference shall be made to EPD279, Section 4.6.

4.4 Network Extensions and Alterations

Extensions to the Network shall be designed on the feeder transformer principle. Closed ring or mesh arrangements, which enable load transfers between supply points to increase firm capacity and increase plant utilisation, shall be considered only if they can be supported by an acceptable cost benefit analysis.

Extensions and alterations to the Network shall take account of the existing protection arrangements and shall not degrade system performance.

The following restrictions shall be applied to Network extensions and alterations (aligning with ENA EREC P18):

(a) No item of equipment shall have isolating facilities at more than four different sites.

(b) Under normal running arrangements the normal operating procedure for making dead any 33kV circuit shall not require the opening of more than seven circuit-breakers.

(c) There shall not be more than 3 transformers at any one site.

4.5 Substations and Security of Demand

4.5.1 Primary substations shall be designed in accordance with current Electricity North West practice.

4.5.2 33kV switchgear shall generally be suitable for indoor installation.

4.5.3 Normally each primary substation shall be designed to accommodate up to two transformers of 23MVA peak capacity, or, where justified, 32MVA or 38MVA peak capacity. A single transformer installation may be appropriate initially, preferably operating in parallel with an adjacent primary substation over the 11/6.6kV network.

4.5.4 Only in exceptional circumstances, e.g. high-density load or for customers with large loads, shall new primary substations be designed for more than 2 transformers.

4.5.5 Where more than two transformers are to be operated normally in parallel with each other, consideration shall be given to the capability of the stranded copper earth screens of cables to carry the possible earth-fault currents.

4.5.6 Single transformer sites shall be installed only if requirements for capacity after a first circuit outage can be met. Consideration shall also be given to maintenance requirements.

4.5.7 The approved transformer arrangements are as shown in Figure C1 and Figure C2 - Appendix C.

4.5.8 For teed arrangements supplying sites with two (or three) transformers Substation Types C and F shall be the preferred options.

4.5.9 For teed arrangements supplying sites with a single transformer (as described in Section 4.5.3) Substation Types B and E shall be the preferred options.

4.5.10 Only combinations of the arrangements shown in Appendix C shall be used to construct two and three transformer sites.

4.6 Cables & Lines

New 33kV underground or overhead feeder circuits shall be designed to one of the following standards unless special circumstances apply e.g. a high load factor: -

(a) Where there is no expected increase in capacity, feeder transformer circuit ratings shall match the required transformer emergency rating.

(b) Feeders that may be used for interconnection, mesh circuits or for a possible increase in transformer capacity shall be rated at 38MVA (or nearest equivalent) regardless of the method of installation or the proximity to other circuits and services.

(c) For special circumstances guidance shall be sought from the Network Planning Policy Manager.

Where two underground circuits are to be laid to one substation along a common route then they may be laid in the same trench. If a third circuit is required to a substation or a mutually dependent group, then it shall be laid on an independent route if economically practical. Where cables are particularly exposed to common mode failure, e.g. on cable bridges, to which the public has access, a risk assessment shall consider the need for independent routes or additional mechanical protection.

Consideration shall be given to circuit de-rating when two high load factor circuits run together.

4.7 Protection

Protection of the 33kV system shall be in accordance with EPD350 – Protection for 132kV, 33kV and 11kV Systems.

Standard diagrams in use by Electricity North West are included in ES312 – 36kV Single Busbar Indoor Switchgear (Cable Connected).

The protection to be applied to automatic reclosing circuit-breakers controlling overhead lines shall be as described in EPD321 - Automatic Reclosing of Overhead Lines.

New 33kV underground cables shall have pilot circuits laid with them or provision (e.g., ducts and pits) made for the future installation of pilot cables. The design of such duct and pit installation shall take account of any need of telecommunication cables, either operational or non-operational, on the same route. The pilot cable shall be installed at the time of the work, only if it can be utilised within the pilot system within 12 months of the proposed commissioning date of the cable. New and refurbished 33kV overhead lines may require pilot circuits to be installed with them. The specifications for such pilot circuits shall be agreed, for each individual cable or overhead line, with the Protection Policy Manager.

5 33kV Network Design Practice

In implementing the design policy, staff and others working directly for Electricity North West on Network design shall adhere to the guidance as follows:

5.1 Network Design Studies

All proposals for Network alterations shall be subject to design studies, to examine load flow, fault level, power swing and stability, and voltage, including voltage step change. Studies shall be carried out by adequately trained users of IPSA, a proprietary software package. Studies shall be based on Electricity North West's IPSA Network Model, as described in EPD241. Source data for this model are taken from MAMS and EGIS, as described in CP241 - IPSA Network Model - Management.

5.2 Protection

Protection schemes shall be designed in accordance with CP373 – Protection Settings for 33kV and HV Systems, using the same sources of data as the IPSA Network Model.

Earth fault protection for 33kV overhead lines shall be as described in CP373 - Protection Settings for 33kV and 11/6.6kV Systems.

5.3 Substations and Security of Demand

5.3.1 Substation Design

Primary substations shall be designed in accordance with CP351 – Design Aspects of Primary Substations.

5.3.2 Loadings and Ratings

Primary substations and groups of primary transformers, operating in parallel, may be loaded beyond the capacity, which would remain after a first circuit outage. In order to achieve this, full account shall be taken of the emergency overload capabilities of the transformers and of any transfer capacity, which can be made available. The loading of transformers shall be in accordance with the ratings given in CP382 - Transformer Ratings. It shall be borne in mind that the use of emergency overload ratings incurs loss of transformer life. Care shall be taken to avoid unacceptable load levels on plant remaining in service for extended periods following unplanned circuit outages and the need for Automatic Load Reduction Schemes shall be considered.

5.3.3 Restoration of Demand

The demand to be met, after a first circuit outage affecting the capacity of the network at a primary substation busbar, shall be designed to be 100% of the normal maximum demand on that busbar. Where this group demand exceeds 12MW, it may be met, either continuously (no break) or by using transfer capacity between primary substations (at 11kV or 6.6kV), restoration being normally achievable within 15 minutes, i.e. by automatic or telecontrolled switching. Where restoration switching is to be by control-room staff using telecontrol, it shall be normally achievable by the closing of no more than two normally open points. For group demands less than 12MW, designs shall minimise customer interruptions (Cis) and customer minutes lost (CMLs) by means of Normally Open Points and Remote Control HV switches deployed in accordance with EPD282, Sections 4.2, 4.3 and 4.4.

5.3.4 33kV Switchgear Replacement

During refurbishment or when any material alteration is made to the network every opportunity shall be taken to remove switchgear. A sample 33kV network with switchgear reduction is shown Appendix B, Figure B.

Switchgear may be added or replaced in the following situations:

(a) In rural locations where the loss of a transformer or feeder, under normal conditions (e.g. switching for maintenance) or fault conditions, would cause a significant voltage depression outside the limits described in ENA EREC P28.

(b) Where there are significant customer benefits.

(c) Where a customer is prepared to pay.

(d) Where it can be cost justified.

The appropriate capital scheme shall include detailed evidence to support the above criteria.

5.4 Switchgear at Tee-off Positions

Where it is expedient to retain switchgear (ground-mounted or pole-mounted) at or close to tee-off positions within the Network, the switchgear shall be fitted with remote control facilities. Proposals for work on the Network shall include the installation of such facilities, whenever such a teed circuit is to be permanently

reconfigured, such switchgear is to be replaced, or such an overhead circuit is to be extensively rebuilt or reconductored. Where necessary, such proposal shall include any necessary modifications to the circuit protection, such that the tee-off switchgear may be operated, without the need to change protection settings or otherwise reconfigure the protection.

5.5 Cables and Lines

5.5.1 Circuit Ratings

When selecting the type and size of cable or overhead conductor required for a particular application reference shall be made to CP203 – Cable Current Ratings, CP206 – Overhead Line Current Ratings, and appropriate ESs and Electricity North West policies ruling at the time of tendering and purchase.

5.5.2 Negative Phase Sequence Voltage

To keep negative phase sequence voltages within 0.5%, for flat formation overhead lines, phase transposition shall be undertaken where the MVA km product is 180 or more. The MVA km product shall be assessed from each end of a 33kV ring-main system, neglecting any included cable lengths.

5.6 Metering

Metering current transformers, voltage transformers and associated test blocks shall be to the requirements of CP514 - Industrial & Commercial Metering.

6 Documents Referenced

DOCUMENTS REFERENCED	
Non-Electricity North West Documents The following documents, legislation, national standards and ENA publications, cannot be supplied by Electricity North West Limited to persons outside those companies:	
Electricity Safety, Quality and Continuity Regulations 2002	
Grid Code	
The NGET Connection and Use of System Code	
ENA EREC P1/3	275/33kV, 132/33kV and 132/11kV Supply Point Transformers
ENA EREC P2/8	Security of Supply
ENA EREC P18	Complexity of 132kV Circuits
ENA EREC P28	Planning Limits for Voltage Fluctuations Caused by Industrial, Commercial and Domestic Equipment in the UK

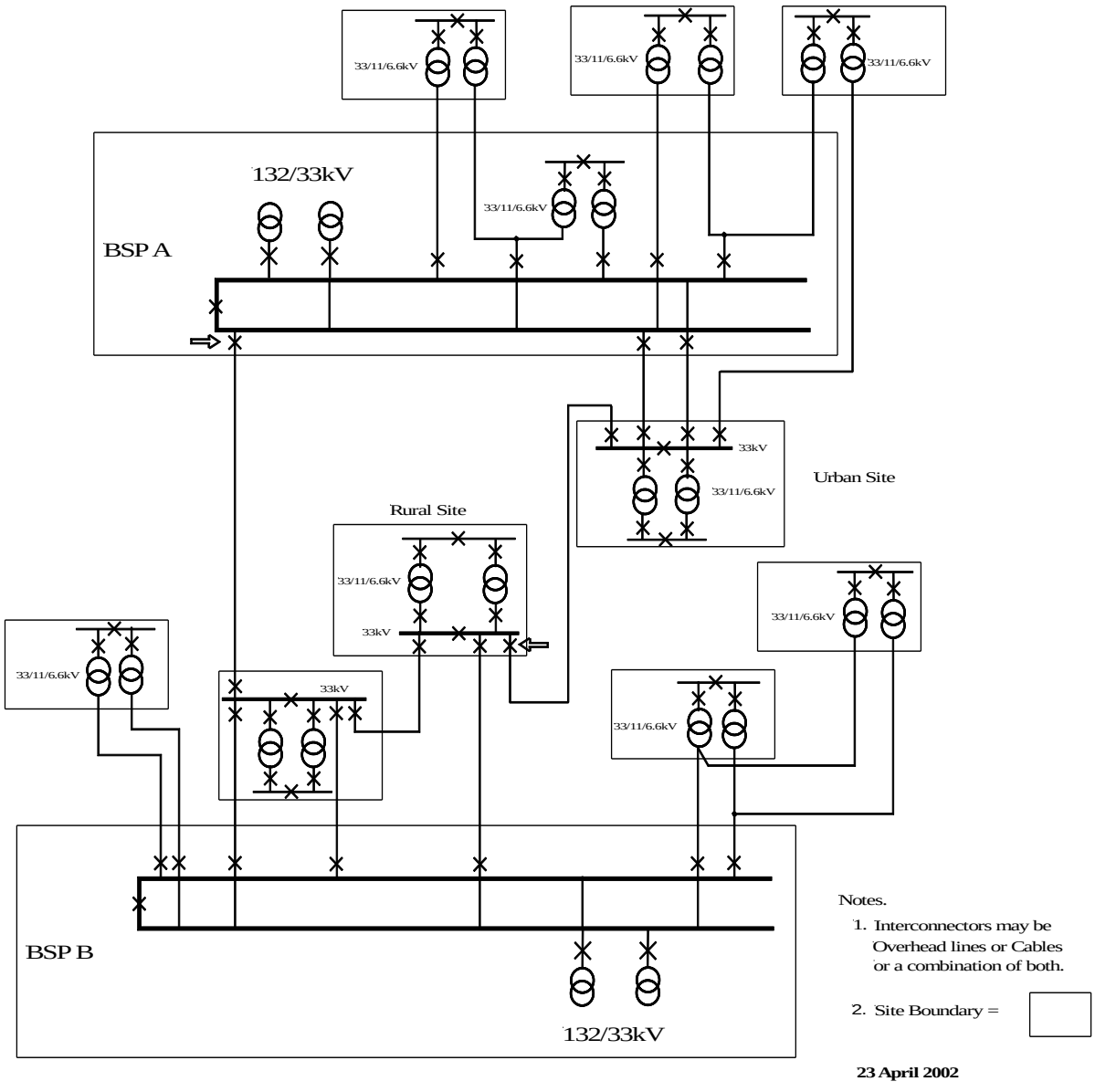
Electricity North West Limited Published Documents The following documents are available from Electricity North West Limited:	
The Distribution Code	
Electricity Distribution Licence	
EPD241	IPSA Network Model
CP279	Distribution System Design – General Requirements
CP280	Distribution System Design – 132kV Network
EPD282	Distribution System Design – 11/6.6kV Network
EPD283	Distribution System Design – Low Voltage Network
EPD321	Automatic Reclosing of Overhead Lines
EPD350	Protection for 132kV, 33kV and 11kV Systems
ES312	36kV Single Busbar Indoor Switchgear (Cable Connected)
The following document is available to Electricity North West Limited staff:	
CP203	Current Ratings - Underground Cables
CP206	Current Ratings of Overhead Line Conductors
CP241	IPSA Network Model - Management
CP351	Design Aspects of Primary Substations
CP373	Protection Settings for 33kV and 11/6.6kV Systems
CP382	Transformer Ratings
CP514	Industrial and Commercial Metering

7 Keywords

Design; Network; Planning; Policy; System; 33kV

Appendix A

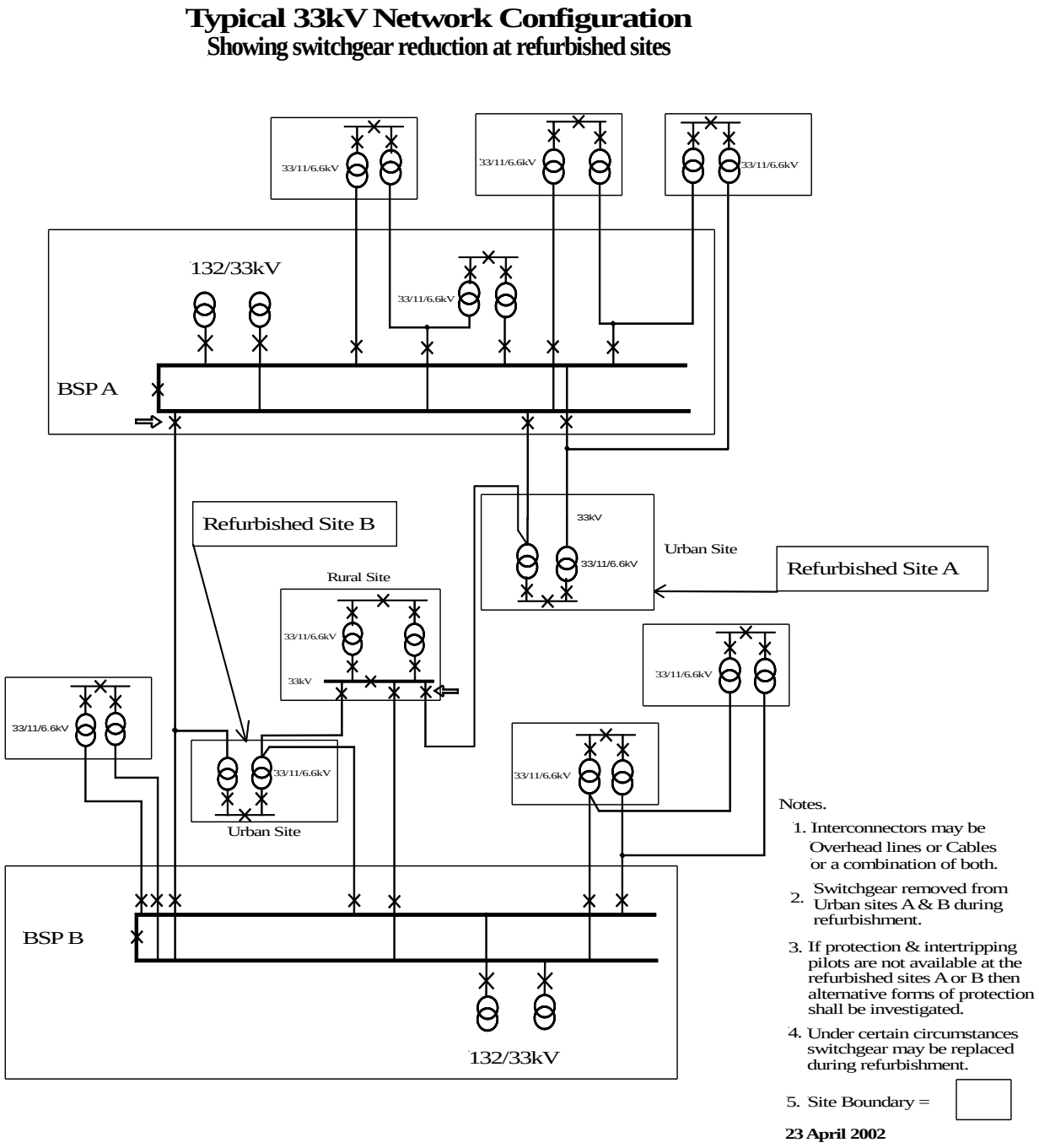
Figure A – Typical 33kV Network Configuration



(Compare with Figure B – Appendix B for the network configuration after refurbishment)

Appendix B

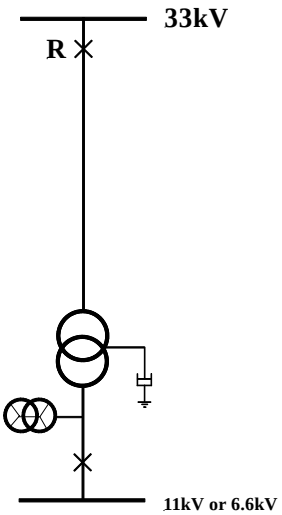
Figure B – Typical 33kV Network Configuration



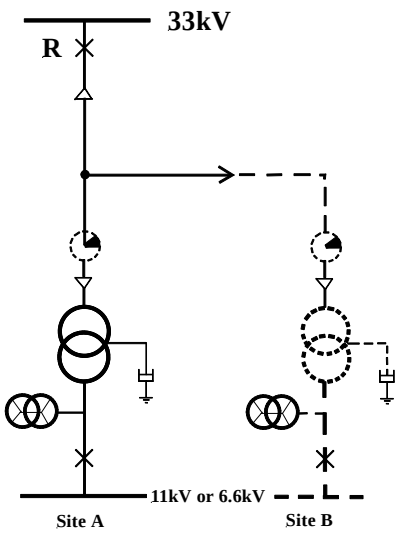
Appendix C

Figure C1 – 33kV Circuit with Intertripping

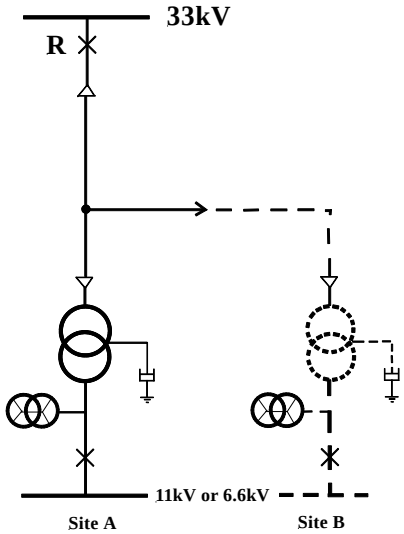
APPROVED 33/11/6.6kV TRANSFORMER ARRANGEMENTS



TYPE A



TYPE B



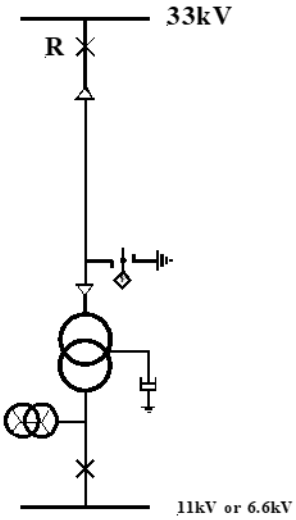
TYPE C

33kV Circuit With Intertripping

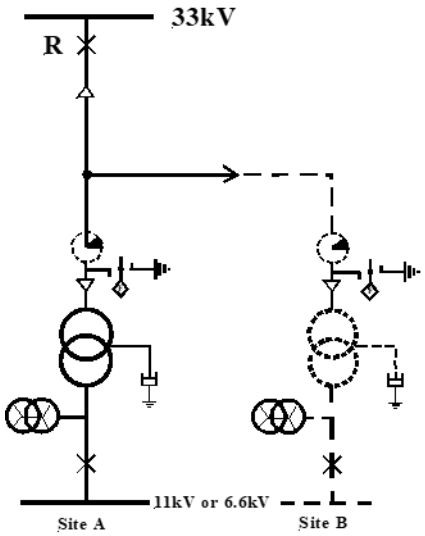
(overhead circuits fitted with autoreclose at 33kV end blocked by I/T Receive)

Figure C2 – 33kV Circuit Without Intertripping

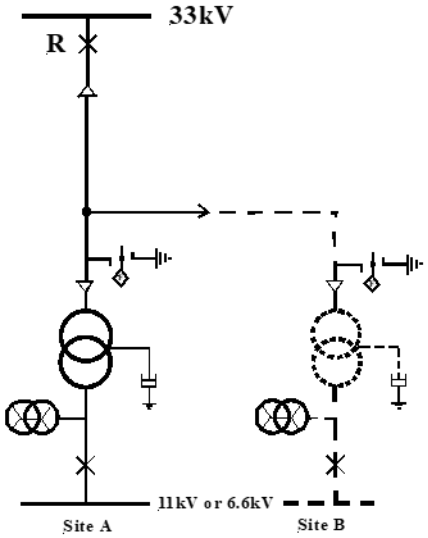
APPROVED 33/11/6.6kV TRANSFORMER ARRANGEMENTS



TYPE D



TYPE E



TYPE F

33kV Circuit Without Intertripping

(autoreclose fitted at 33kV end)