WESTERN POWER DISTRIBUTION

Serving the South West and Wales

Company Directive

STANDARD TECHNIQUE : TP4B/2

Relating to 11kV and 6.6kV Transformer Protection

Policy Summary

This document describes the detailed requirements for 11kV/415V and 6.6kV/415V distribution transformer protection. It includes requirement for pole mounted transformers, conventional ground mounted transformers and pad mounted transformers.

This document introduces changes to some fuse-link ratings used in South Wales and in the South West. Whenever fuse links are replaced they shall be in accordance with this Standard Technique.

There is no requirement for existing fuse-links to be replaced unless one or more have operated or substantial modifications are carried out on site.

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Approved by: PJ Wain
Policy Manager

Date: 11/10/01

Document Revision & Review Table		
Date	**Comments**	**Author**
14/01/14	• Table B2:- CT ratios associated with the TLF protection for 500kVA 6.6kV transformers have been corrected.	Andy Hood
14/01/14	• Table B3:- Fuse ratings and CT ratios associated with TLF protection for 500kVA 6.6kV transformers have been corrected.	Andy Hood

1.0 INTRODUCTION

1.1 This document describes the detailed HV protection requirements for Company Standard pole mounted, ground mounted and pad mounted 11kV and 6.6kV distribution transformers. These requirements apply to all Company owned transformers and Customer owned transformers supplied directly from Company owned switchgear.

2.0 GROUND MOUNTED AND PAD MOUNTED TRANSFORMERS

2.1 The supply to every 11kV and 6.6kV ground mounted transformer and 11kV pad mounted transformer shall be protected by a dedicated protection device or set of fuses. It is not possible to adequately protect more than one transformer from a single protection device or set of fuses.

2.2 The LV network supplied from each 11kV and 6.6kV ground mounted transformer shall be protected either by LV fuses or an LV circuit breaker. The LV fuse cabinet or circuit breaker can either be mounted on the transformer or be connected to the transformer by LV cables. The length of these LV cables shall be kept to a minimum and will not normally exceed 10m. Standard Technique ST:SD6B (as amended) includes some exceptions to this requirement.

2.3 When an HV circuit breaker is used to protect WPD owned transformers these shall normally be fitted with time limit fuses (TLFs). If both phase fault and earth fault trip coils are installed, fuse-link shall only be fitted across the phase fault trip coils. No fuse-link shall be installed across the earth fault trip coil. GEC XF TLF fuse-links shall be used in preference to the rewireable type.

2.4 Standard Oil Fuse Switch (OFS) fuse-link ratings are specified in Table A1 (Appendix A) and Table B1 (Appendix B).

2.5 Standard TLF fuse-link ratings and CT ratios are specified in Tables A2 and A3 (Appendix A) and Tables B2 and B3 (Appendix B).

2.6 In some situations there are advantages in protecting ground mounted transformers, rated at 315kV or less, by HV overhead expulsion fuses instead of an OFS or circuit breaker. This is acceptable as long as the HV fuses are located within 100 metres of the transformer and they are reasonably accessible from the transformer site. The applicable transformer sizes, fuse-link types and ratings are specified in Table A4 (Appendix A) and Table B4 (appendix B).

2.7 Pad mounted transformers shall be protected by two sets of HV fuse-links connected in series. These fuse-links consist of one set of dual sensing bayonet fuse-links, rated to operate at low fault currents and one set of current limiting ruse-links, rated to operated at high fault currents. The combination of fuse-links provide adequate protection over the full range of possible fault current. Table A5 (Appendix A) specifies the fuse-links to be used for 11kV pad mounted transformers. 6.6kV pad mounted transformers are not currently approved for use within Western Power Distribution.

2.8 Where reasonably practicable, LV fuse-links shall be used which grade with the HV protection. It is recognized that in some situations larger sizes of LV fuse-link may be required. These cases should be kept to a minimum. The largest size of LV fuse-link which grades with the HV protection is specified in the tables.

2.9 When Western Power Distribution owned switchgear is used to protect a customer's transformer the standard fuse-links and CT ratios may not be applicable. Protection requirements for customer owned transformers shall be determined by the Primary System Design Department.

2.10 When one or more fuse-link which provides HV protection for a transformer operates all the fuse-links shall be replaced, not just the one's which have operated.

2.11 Standard Protection settings and supply arrangements for LV circuit breakers are specified in the latest version of ST:SD6B.

2.12 SHOPS item numbers for the OFS fuse-links, TLF fuse-links and fuse-links for pad mounted transformers are included in Appendix C.

3.0 POLE MOUNTED TRANSFORMERS

3.1 Overhead systems within Western Power Distribution are either designed to be group fused or solid. In the South Wales Area solid system are normally used whilst in the South West Area group fusing predominates.

Group fused systems require each spur, group of transformers or single transformer connected to the main line to be protected by a fuse unit. Fuse-links used for this purpose are normally:

- 50A slow blow fuses (Type T) in the South West
- 50A extra fast blow (Type XA) in South Wales

Solid systems rely on the source circuit breaker and/or intermediate ground mounted or pole mounted circuit breakers to protect the overhead lines, spurs and transformers. Automatic sectionalisers or automatic sectionalising links (ASLs) may be used to limit the number of customers affected by a fault.

3.2 No additional high voltage protection is required for pole mounted transformers.

3.3 LV fuses shall be used to protect the network supplied by each pole mounted transformer. These LV fuse units shall be mounted on the same pole as the transformer. ST:OH4H specifies standard LV fuse ratings and LV tail sizes, applicable to each type of pole-mounted transformer.

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4.0 BACKGROUND INFORMATION

4.1 ESI Standards 12-6 and 12-8 provide recommendations for the protection of 11kV and 6.6kV transformers by TLFs and by high voltage fuse-links. These documents base their recommendations on the following principles.

- Fuses shall withstand magnetising inrush assumed to be 10x rated current for 0.1 second.
- Transformer overloads up to 150% of nameplate rating shall be possible
- Discrimination with LV fuses shall be possible
- 3 phase faults at the transformer LV terminals terminal zone shall be cleared within 5 seconds by TLFs (ESI 12-6) and 1 second by high voltage fuses (ESI 12-8).
- Phase to earth faults and phase to neutral faults at the transformer LV terminals shall be cleared by TLFs within 5s (ESI 12-6). No time limit is recommended for high voltage fuse links.

Both ESI 12-8 and ESI 12-6 assume that transformer impedances are 5% (based on the transformer name plate rating). These documents also assume that phase to earth fault current is 0.6x the 3 phase fault current. All fault calculations ignore the source impedance.

4.2 The assumptions for transformer impedances and source impedance do not adequately reflect the rural HV networks in both the South Wales and South West areas of Western Power Distribution.

Fault levels on WPDs high voltage system have been calculated at less than 15MVA in some locations. For the purpose of this document a minimum source fault level of 15MVA has been assumed. Earth fault levels have been calculated directly assuming no additional arc fault impedance. The 0.6x factor for phase to earth fault and phase to neutral fault used in the ESI documents has not been applied.

As far as possible, high voltage fuses and TLFs have been chosen to operate within 1 second for 3 phase faults and 5 seconds for phase to neutral and phase to earth faults at the transformer LV terminals at the minimum source fault level.

APPENDIX A

PROTECTION OF 11Kv GROUND MOUNTED TRANSFORMERS

TABLE A1 :- OFS Fuse-link Requirements

Transformer Size	OFS Protection		Maximum LV fuse which grades (BS88 part 5)
	Fuse-link rating	Fuse-link type	
1000 kVA	80A	12kV OEFMA (254mm) 12kV OHGMA (359mm)	630A
750 & 800 kVA	63A	12kV OEFMA (254mm) 12kV OHGMA (359mm)	500A
500 kVA	50A	12kV OEFMA (254mm) 12kV OHGMA (359mm)	400A
300 & 315 kVA	31.5A	12kV OEFMA (254mm) 12kV OHGMA (359mm)	315A
200 kVA	25A	12kV OEFMA (254mm) 12kV OHGMA (359mm)	250A
100 kVA	20A	12kV OHFMA (254mm) 12kV OHGMA (359mm)	200A

TABLE A2 :- Cartridge TLF Requirements

Transformer Size	TLF Protection – Cartridge Type			Maximum LV fuse (to BS88 part 5) which grades
	TLF rating	CT Ratio	TLF type	
1000 kVA	7.5 A 10A	100/5 80/5	XF7.5 XF10	500A
750 & 800 kVA	5A 7.5A	100/5 80/5	XF5 XF7.5	500A
500 kVA	10A 12.5A	50/5 40/5	XF10 XF12.5	400A
300 & 315 kVA	5A 7.5A	50/5 40/5	XF5 XF7.5	315A
200 kVA	3A 3A	50/5 40/5	XF3 XF3	200A 160A

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PROTECTION OF 11KV GROUND MOUNTED TRANSFORMERS

TABLE A3 :- Rewireable TLF Requirements

Transformer Size	TLF Protection – Rewireable Type			Maximum LV fuse (to BS88 part 5) which grades
	TLF rating	CT ratio	Fusewire Type	
1000 kVA	5A 5A	100/5 80/5	24 SWG pure tin 24 SWG pure tin	400A
750 & 800 kVA	5A 5A	100/5 80/5	24 SWG pure tin 24 SWG pure tin	400A
500 kVA	7.5A 7.5A	50/5 40/5	23 SWG pure tin 23 SWG pure tin	355A
300 & 315 kVA	5A 5A	50/5 40/5	24 SWG pure tin 24 SWG pure tin	200A
200 kVA	5A 5A	50/5 40/5	24 SWG pure tin 24 SWG pure tin	200A

TABLE A4 :- O/H Expulsion Fuse-link Requirements

Transformer Size	OFS Protection	Maximum LV fuse (to BS88 part 5) which grades
300 & 315 kVA	25A Type K (fast blow)	250A
200 kVA	25A Type K (fast blow)	250A
100 kVA	15A Type K (fast blow)	160A
50 kVA	10A Type K (fast blow)	100A

PROTECTION OF 11kV PAD MOUNTED TRANSFORMERS

Table A5 :- Pad Mounted Transformer Fuse-link Requirements

Transformer Size	Bay-O-Net Fuse-link	ELSP Fuse-link	Maximum LV fuse (to BS88 part 5) which grades
200 kVA 3ph	25A	100A	315A
100 kVA 3ph	12A	40A	160A
50 kVA 3ph	5A	30A	100A (may not grade with Bay-O-Net fuse under some fault conditions)
50 kVA 1ph	5A	30A	100A

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APPENDIX B

PROTECTION OF 6.6kV GROUND MOUNTED TRANSFORMERS

TABLE B1 :- Fuse-link Requirements

Transformer Size	OFS Protection		Maximum LV fuse which grades (BS88 part 5)
	Fuse-link rating	Fuse-link type	
1000 kVA	140A	7.2kV OHGMA (359mm)	630A
750 & 800 kVA	100A	7.2kV OEFMA (254mm)	500A
500 kVA	80A	12kV OEFMA (254mm)	400A
300 & 315 kVA	50A	12kV OEFMA (245mm)	315A
200 kVA	31.5A	12kV OEFMA (254mm)	200A
100 kVA	20A	12kV OEFMA (254mm)	100A

TABLE B2 :- Cartridge TLF Requirements

Transformer Size	TLF Protection – Cartridge Type			Maximum LV fuse (to BS88 part 5) which grades
	TLF rating	CT Ratio	TLF type	
1000 kVA	12.5A 15A	100/5 80/5	XF12.5 XF15	500A
750 & 800 kVA	10A 12.5A	100/5 80/5	XF10 XF12.5	400A
500 kVA	7.5A 10A	100/5 80/5	XF7.5 XF10	400A
300 & 315 kVA	10A 12.5A	50/5 40/5	XF10 XF12.5	250A
200 kVA	5A 7.5A	50/5 40/5	XF5 XF7.5	160A

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PROTECTION OF 6.6kV GROUND MOUNTED TRANSFORMERS

TABLE B3 :- Rewireable TLF Requirements

Transformer Size	TLF Protection –Rewireable Type			Maximum LV fuse (to BS88 part 5) which grades
	TLF rating	CT Ratio	Fusewire type	
1000 kVA	10A 10A	100/5 80/5	21 SWG pure tin 21 SWG pure tin	500A
750 & 800 kVA	7.5A 10A	100/5 80/5	23 SWG pure tin 21 SWG pure tin	400A
500 kVA	5A 7.5A	100/5 80/5	24 SWG pure tin 23 SWG pure tin	400A
300 & 315 kVA	7.5A 10A	50/5 40/5	23 SWG pure tin 21 SWG pure tin	250A
200 kVA	5A 7.5A	50/5 40/5	24 SWG pure tin 23 SWG pure tin	160A

TABLE BR :- O/H Expulsion Fuse-link Requirements

Transformer Size	O/H Expulsion Fuse-link	Maximum LV fuse (to BS88 part 5) which grades
300 & 315 kVA	40A Type K (fast blow)	250A
200 kVA	40A Type K (fast blow)	250A
100 kVA	25A Type K (fast blow)	160A

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APPENDIX C

EQUIPMENT SCHEDULE

FUSE RATING AND DESCRIPTION		FUSE TYPE	SHOPS CODE
TLF Fuse-links			
3A	Time Limit Fuse-link (TLF) to ESI 12-6	XF3	36263
5A	Time Limit Fuse-link (TLF) to ESI 12-6	XF5	34740
7.5A	Time Limit Fuse-link (TLF) to ESI 12-6	XF7.5	34738
10A	Time Limit Fuse-link (TLF) to ESI 12-6	XF10	34739
12.5A	Time Limit Fuse-link (TLF) to ESI 12-6	XF12.5	36264
15A	Time Limit Fuse-link (TLF) to ESI 12-6	XF15	36265
OFS Fuse-links (12 kV, 254mm (10 inch)			
20A	12kV OFS Fuse-link to BS 2692, 254mm (10 inch)	12kV OEFMA 20A	31694
25A	12kV OFS Fuse-link to BS 2692, 254mm (10 inch)	12kV OEFMA 25A	39032
31.5A	12kV OFS Fuse-link to BS 2692, 254mm (10 inch)	12kV OEFMA 31.5A	31695
50A	12kV OFS Fuse-link to BS 2692, 254mm (10 inch)	12kV OEFMA 50A	34418
63A	12kV OFS Fuse-link to BS 2692, 254mm (10 inch)	12kV OEFMA 63A	31697
80A	12kV OFS Fuse-link to BS 2692, 254mm (10 inch)	12kV OEFMA 80A	31699
OFS Fuse Links (12kV, 359mm (14 inch)			
20A	12kV OFS Fuse-link to BS2692, 359mm (14 inch)	12kV OHGMA 20A	39033
25A	12kV OFS Fuse-link to BS2692, 359mm (14 inch)	12kV OHGMA 25A	37137
31.5A	12kV OFS Fuse-link to BS2692, 359mm (14 inch)	12kV OHGMA 31.5A	37139
50A	12kV OFS Fuse-link to BS2692, 359mm (14 inch)	12kV OHGMA 50A	37141
63A	12kV OFS Fuse-link to BS2692, 359mm (14 inch)	12kV OHGMA 63A	39034
80A	12kV OFS Fuse-link to BS2692, 359mm (14 inch)	12kV OHGMA 80A	37148
OFS Fuse-links (7.2kV)			
100A	7.2kV OFS Fuse-link to BS2692, 254mm (10 inch) For use on 6.6ykV system only	7.2kV OEFMA 100A	34416
140A	7.2kV OFS Fuse-link to BS2692, 254mm (10 inch) For use on 6.6ykV system only	7.2kV OHGMA 140A	34417

EQUIPMENT SCHEDULE

FUSE RATING AND DESCRIPTION		FUSE TYPE	SHOPS CODE
Overhead Expulsion Fuse-links			
10A	15kV Overhead Expulsion Fuse Type K (Fast blow) NEMA button head arrangement	15KB10	38974
10A	15kV Overhead Expulsion Fuse Type K (Fast blow) Double Tail arrangement	15KD10	39037
15A	15kV Overhead Expulsion Fuse Type K (Fast blow) NEMA button head arrangement	15KB15	39036
15A	15kV Overhead Expulsion Fuse Type K (Fast blow) Double Tail arrangement	15KD15	39035
25A	15kV Overhead Expulsion Fuse Type K (Fast blow) NEMA button head arrangement	15KB25	34419
25A	15kV Overhead Expulsion Fuse Type K (Fast blow) Double Tail arrangement	15KD25	34420
40A	15kV Overhead Expulsion Fuse Type K (Fast blow) NEMA button head arrangement	15KB40	34421
40A	15kV Overhead Expulsion Fuse Type K (Fast blow) Double Tail arrangement	15KD40	31722
50A	15kV Overhead Expulsion Fuse Type T (Slow blow) Nema button head arrangement	15TB50	31734
50A	15kV Overhead Expulsion Fuse Type T (Slow blow) Double Tail arrangement	15TD50	31735
50A	15kV Overhead Expulsion Fuse Type XA (Extra Fast blow). NEMA button head arrangement	15XAB50	37152
Pad Mount Fuse-links			
5A	15.5kV Dual Element Bay-O-Net Fuse	4038108C03	36819
12A	15.5kV Dual Element Bay-O-Net Fuse	4038108C06	36817
25A	15.5kV Dual Element Bay-O-Net Fuse	4038108C09	39039
30A	15.5kV ELSP Fuse	3544030M61M	36818
40A	15.5kV ELSP Fuse	3544040M61M	36820
100A	15.5kV ELSP Fuse	3544100M51M	39038

APPENDIX D

SUPERSEDED DOCUMENTATION

ST:TP4B/1 is superseded on issue of this document.

APPENDIX E

ASSOCIATED DOCUMENTATION

ESI Standard 12-8: The application of fuse-links to 11kV/415V and 6.6kV/415V underground distribution networks.

ESI Standard 12-6: Time fuse links (for use with current transformer releases on circuit breakers).

ACE Report 86: Report on HV fuse-links for the protection of ground mounted distribution transformers.

BS 2692 : Fuses for voltages exceeding 1000 V ac.

BS EN 60269 : Low voltage fuses.

BS88 part 5: Cartridge fuses for voltages up to and including 1000 v ac and 1500 v dc – Specification of Supplementary requirements for fuse-links for use in ac electricity supply networks.

Western Power Distribution Overhead Line Manual.

ST:SD6B/1 : Connection design for low voltage loads of 72 kVA to 720 kVA

ST:OC14 : Operation of padmount transformers

APPENDIX F

IMPACT ON COMPANY POLICY

This policy is relevant to all staff involved in the design or operation of HV and LV networks.

APPENDIX G

IMPLEMENTATION OF POLICY

This policy shall be fully implemented on issue for use and substantially modified installations.

Where it is necessary to replace existing OFS fuse-links following their operation, they shall be rated in accordance with this policy.

Where any difficulty is encountered in the application of this policy, the author should be notified, who will consider if a variation is appropriate.

APPENDIX H

KEY WORDS

Protection, OFS, fuse, fuse-link, TLF, transformer, ground mounted, pad mounted, pole mounted.

APPENDIX I

DOCUMENT LAST REVIEWED

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