IMP/001/921 - Code of Practice on Fusing

1. Purpose

The purpose of this document is to provide standard fuse data for the application of fuses on the distribution systems of Northern Powergrid.

This document supersedes the following documents, all copies of which should be withdrawn from circulation.

Reference	Version	Date	Title
IMP/001/921	2.0	August 2021	Code of Practice on Fusing

2. Scope

This document applies to:

- The protection by fuses of High Voltage (HV) overhead lines, HV to LV distribution transformers and Low Voltage (LV) circuits;
- The LV and HV systems of Northern Powergrid Northeast and Northern Powergrid Yorkshire;
- All HV or LV distribution system development including, new connections, system reinforcement and asset replacement; and
- Situations where the fuse or Auto Sectionalising Links (ASL) needs to be installed or replaced.

This document describes the application and selection of fuses, and it should be read in conjunction with the following Codes of Practice:

- IMP/001/911 - Code of Practice for Economic Development of the LV System; and
- IMP/001/912 - Code of Practice for Economic Development of the HV System.

2.1. Table of Contents

2.2. List of Tables

3. Policy

This section provides the maximum ratings of various fuse types and states the principles governing the selection of fuse ratings. For information relating to the availability of fuse type and their corresponding commodity code, refer to Appendix 1.

3.1. HV Fuses

HV fuses are a cost effective way of protecting overhead lines, cables and transformers.

- Pole Mounted (PM) transformers supplied from either underground or overhead networks can be protected using HV expulsion fuses or current limiting fuses.
- Ground Mounted (GM) distribution transformers can be protected by HV circuit breakers with TLF fuses or PM HV expulsion fuses.

Notes:

HV switch fuse protection (discussed in Appendix 14) and Fused Cable End Boxes are legacy type items of plant which shall no longer be used to protect GM distribution transformers.

Automatic Sectionalising Links can be used in conjunction with pole mounted auto recloser (PMAR) for transient fault segregation and protection of HV overhead lines.

3.1.1. Protection of Distribution Transformers

Where the HV fuse option is used, it shall normally be required to protect both the distribution transformer and the connection between the transformer LV terminals and the LV substation fuses. As such the HV protection must have a sufficient time delay to allow for protective discrimination with LV substation fuses for faults on the LV circuit. In the case of PM substations where the LV conductors and fuses are arranged in accordance with modern practice[1], it is not considered essential that the HV fuses protecting the transformer should operate for all LV faults. Under these conditions, considerations of HV/LV discrimination should determine the current rating of the HV fuse, subject to a minimum value depending on the type of fuse. This minimum current rating has been selected in order to reduce the possibility of premature failure of fuse elements. The HV/LV fuse selection theory is outlined in Appendix 2. PM fuses controlling a ground mounted (GM) substation must be selected to operate for three phase faults in the transformer LV terminal zone within 1 sec[2].

Time limit fuses (TLF) are utilised in conjunction with circuit breaker type ring main units to provide a cost effective and reliable method of providing fault protection for three phase faults on a standard three phase transformers in the range of 315kVA to 1500kVA[3]. In this arrangement the time limit fuse link is shunted with a trip coil which is supplied from the protection current transformer. In the event of a fault, the fuse ruptures and the fault current is diverted through the trip coils, which in turn trip the circuit breaker. It should be noted that the TLF protection system is not a device for limiting overload levels of individual transformers as such it should be used for fault protection only.

TLF fuses for HV transformer protection are specified in accordance with ENATS 12-6. The maximum overcurrent TLF fuse/CT combinations to be employed on HV circuit breakers for transformers of standard ratings and voltages are given in Table 2. TLF fuse ratings will clear phase to phase and phase to earth faults

[1] This refers to the use of double insulated transformer LV tails that provide a more robust form of protection as opposed to some legacy single insulated variants. With double insulated LV tails, each layer provides a separate function of electrical and mechanical protection thus reducing the risk of faults in the LV Zone. It could also be said that overall fault risk close to the transformer LV zone would be protected still further by the use of ABC LV network conductors as opposed to legacy open wire network conductors.

[2] Clearance time of 1sec for three phase faults is reasoned in ACE Report, No.86

[3] Three phase 1600kVA distribution transformer will be protected by relays.

within the LV terminal zone in less than 5sec[4] and will discriminate with the respective LV distribution fuses up to the rating shown in Table 2. The TLFs legacy table of O.551 for different CT ratios, system voltage and transformer rating is provided on the Table 30 to Table 37 of Appendix 13 as information for existing sites. The use of TLF fuse ratings in excess of those provided in Table 2 for new sites and Table 30 to Table 37 for existing sites is not permitted as this may result in the LV terminal zone being unprotected. Care must also be given to ensure that the use of LV substation fuses rated in excess of those given in the tables mentioned above will not result in a failure of HV/LV discrimination.

For modern switchgear with limited CT ratio options, separate ratings for non-re-wireable cartridge type TLF fuses are provided in Table 2. Separate current ratings are given in Table 41 and Table 42 of Appendix 16 for the two types of TLF fuses in use i.e. the non-re-wireable cartridge type time fuses designed in accordance with ENATS 12-6 and provided for switchgear, e.g. GEC Type XF or the re-wireable pure tin time fuses of twisted wire construction, e.g. Reyrolle pattern, with which many older circuit breakers are equipped. Table 41 gives the size of pure tin fuse wire used in re-wireable type time fuses and Table 42 gives the ratings of Switchgear and Cowans (GEC Switchgear Ltd) time fuses equivalent to the tin time fuses given in Table 30 to Table 37.

The time limit fuse ratings shown in Table 30 to Table 37 are suitable for positions on the system where the HV fault level exceeds 40MVA. Below this level, however, the specified settings may not permit the clearance of some LV phase to phase faults, when standard two pole overcurrent and earth fault protection is used on the HV circuit breaker. Northern Powergrid protection staff should be consulted regarding the rating of overcurrent TLF fuses to be used whenever the HV fault level is less than 40MVA or whenever transformers or CTs having ratings not included in this document are to be employed.

3.1.2. Transformers Protected By HV Drop Out Expulsion Fuses (DOEF)

Pole mounted drop out expulsion fuses (DOEF) are used to protect HV overhead line circuits as well as PM and GM distribution transformers whilst also providing a means of isolation for operational purposes. DOEFs consist of a back portion/fuse mount which is mounted onto the pole which can accommodate either fuse tubes containing fuse-links, solid links or automatic sectionalising links (ASLs). When choosing a fuse-link or ASL, it is important that the fuse be properly coordinated with other protective devices located upstream and downstream.

HV expulsion fuses can be used to protect the spur, small section conductors on spurs and tee connection to substations. Refer to the tables on the Economic Development of HV policy IMP/001/912 which shows the appropriate protection and/or isolation to be used for the HV systems in the two license areas. Existing sites fitted with solid links shall be reviewed when work is carried out at the site to determine if any particular site specific risks warrant local protection with Drop Out Expulsion Fuse (DOEF) rather than protection via remote group fuse/solid links. Where multiple existing PM transformers are connected via solid jumper connections onto a group protected tee, it shall always be possible to achieve HV isolation to any individual PM transformer without the need to cut jumpers. In most cases, this may require the installation of local HV isolation via the installation of fuse mounts fitted with solid links.

Expulsion fuse-links are housed within the fuse carriers/tubes which are installed into the fixed contacts of the DOEF back potion/fuse mount using insulated rods from the ground level. DOEF are designed such that rupturing of the fuse link inside the tube will cause the upper contact of the unit to disengage from the upper fixed contact of the fuse mount. This then allows the fuse carrier to pivot under the influence of gravity, to a horizontal axis on the lower fixed contact of the fuse mount and come to rest hanging vertically from the lower fixed contact of the fuse mount. The current design of expulsion fuse-links are required to be interchangeable with legacy manufacturers DOEF mounts hence now referred to as a Universal fuse-links. The fuse link has a tail at each end when installed in porcelain J&P fuse tubes, with one end being removable when fitted within a Linegear or Pfisterer composite tube. On these units, the fuse link is attached via a ¼” UNF screw thread at one end and tail at the other to an arc shorting rod. Table 4 provides

[4] ENATS 12-6 provides 5sec as the maximum operating time of TLF fuse-links for phase to neutral fault in secondary terminal zone.

the recommended rating and stock commodity code of fuse-Links to be employed in the range of PM transformers.

Where distribution networks have expulsion fuse-links in series on the same HV circuit, upstream and downstream expulsion fuse-links needs to be coordinated otherwise they will potentially operate at the same time. The time-current characteristics of expulsion fuse-links are “Type T” which complies with ANSI C 37-42 requirement for slow-blowing T characteristics. The time current characteristics curve of the fuses showing the pre-arcing time and prospective current shall be within ±20% as per BS 2692-2:1956. These are applicable provided the HV fault level is not less than 20MVA. For pole mounted substations a minimum fuse size of 25A has been selected on the assumption that normal construction will be such as to minimise the risk of faults developing between transformer LV terminal and the HV fuse.

Expulsion fuses shall be selected to ensure the discrimination with LV fuses for the most onerous LV fault condition. In the case of GM transformer, the HV fuse rating has been selected using similar criteria to those in ENATS 12-8, the exception being that the allowable clearance time for three phase LV terminal zone faults has been set at 1.0 second in ENATS 12-8. This is necessary in order to achieve co-ordination with a reasonable size LV fuse and can be justified on the basis of the less steep characteristic compared to the ENATS 12-8 fuses. This characteristic will ensure that reasonable clearance times are achieved for phase to earth terminal zone faults and other faults which may be of a more restricted value. Where the fault level is less than 20MVA, a lower fuse than shown in Table 4 may be required. In this instance, the fuse size should be chosen to give a clearance time of less than 3 seconds for a three phase fault on the LV busbars. The fault current should be calculated using the true HV source impedance assuming an X/R ratio of 1.0 and the transformer impedance. The current calculated should be further reduced by a factor of 0.6 to cater for arc impedance. In all instances and particularly where the HV fault level is less than 20MVA, the LV cable between the transformer and the LV board should be kept to a minimum and providing its length is less than 10m its impedance can be neglected.

Where protection is adopted for OH line spur with expulsion fuses in accordance with IMP/001/912, the rating of the group fuse should be determined by adding together the rated full load current of the individual transformers, taking care to allocate the currents to the appropriate phase where single phase transformers are connected to three phase lines. The highest of the resulting phase currents is then divided by a factor of 1.5 to take account of the diversity of the feeder load.

Table 4 should be used to ensure that the group fuse selected is not less than the rating required for the largest transformer in the group. The maximum rating of fuses used on the overhead system will normally be less than 50A. The same method is utilised to determine the sectionaliser rating and expulsion fuses for the protection of small conductor sections on spurs which is covered in Appendix 5.

Where triggered spark gaps (TSG) are designed into an overhead network to create a co-ordinated protection policy, then in accordance with IMP/007/011, upstream HV fuses shall be removed and replaced with ASLs as the operation of a TSG creates a temporary earth fault on the system which may result in incorrect operation of a standard fuse-link. Note - HV fuses cannot be replaced with ASL if sections of small section conductor are being protected from the fuses.

Table 4 provides fuse ratings for pole mounted transformers up to 315kVA however it is not possible to protect the standard LV cable for transformer sizes above 315kVA at 11kV and 500kVA at 20kV. The larger transformers also increase the risk of ferroresonance which can occur under light load conditions during faults, switching or hot line working when the transformers may be fed via one or two phases only. The probability of the phenomena occurring is greatly increased by the presence of cable between the fuse and the transformer. For these reasons the protection of these large transformers by overhead fuses should be avoided where possible, air break switch disconnector (ABSD) or pole mounted reclosers being acceptable alternatives.

3.1.3. Current Limiting Fuse Links

The overhead current- limiting drop out fuse is designed to be mounted in interchangeable and open distribution cut-outs and is similar to DOEF fuse but operates silently and is totally self-contained within the fuse housing. In addition, the expulsive shower due to the release of exhaust gases, molten metal and fuse link fragments during fuse operation is eliminated.

The current-limiting fuse provides overload protection, noiseless interruption, no expulsion violence, current-limiting action and very high current interrupting capability. It operates to clear both low and high fault currents quickly and limits current and energy let-through levels during the fault clearance. The fuse element construction consists of two separate sections (low-current section and high-current section) which are self-contained within the same housing. The low-current section provides consistent, reliable clearing of all currents high enough to melt the element. The high-current section is a punched-hole ribbon design capable of controlling the peak arc voltage level and limits both current and energy let-through (I^2t) levels during high-current fault clearing operations. The fuse is designed to provide a fault interrupting breaking capacity of 43kA rms symmetrical. The reduced amount of energy that is passed into the circuit after a fault occurs prevents the damage of apparatus especially in the areas where the system fault current exceeds the maximum interrupting break rating of an expulsion fuse (i.e.8kA[5]) and can be used to protect pole mounted transformer, spur lines and small section conductors on spurs. However, current-limiting fuse will not improve the fault make capabilities, as they are not designed for fault make operation.

The drop-open design of current-limiting fuse is similar to the expulsion fuse and indicates operation and simplifies fault location. These units can be removed in a similar way as the existing expulsion fuses (i.e. J&P, Linegear and Pfisters) and can be inserted and closed with rods from the ground.

Current limiting fuses are not interchangeable with DOEF's, solid links or sectionalisers as they are of a different length[6]. The fuse isolator back portion for the current-limiting fuse is different to the expulsion fuse and has a different trunnion to that of a standard fuse isolator back portion which excludes the use of DOEF's, solid links or sectionalisers. A new common 11/20kV fuse isolator back portion is available to take both the 11kV and 20kV current limited fuses with a single 25A rated fuse for use at 11kV and a 20A rated fuse for use at 20kV being available. Currently, only three items have been added to the range of available items namely (i) fuse isolator back portion rated up to 27kV (ii) 25A single barrel current-limiting fuse link for 11kV and (iii) 20A single barrel current-limiting fuse link for 20kV.Table 22 provides the details of current limiting fuses for DOEF on Overhead Lines including their commodity codes.

The guidance on the application of the current limiting fuses is provided on the Appendix 6.

3.1.4. Automatic Sectionalising Links (ASL)[7]

ASLs are protective devices that are designed to operate after a pre-determined sequence of pules of fault current. They are intended to operate in conjunction with a pole mounted reclosing circuit breakers (PMAR) as specified in NPS/001/009 and are used to identify permanent spur-line faults and then during a period when the upstream protective device is open, to disengage the ASL which opens into an isolated position thus reducing the risk of transient faults causing a spur-line outage. ASLs do not require a time current base for its operation and is easily coordinated with other protective devices on the system.

ASLs shall have the same dimensional and mounting requirements as HV Expulsion Fuse-Links and be physically interchangeable. The ASLs specified within NPS/001/032 shall comply fully with, and meet all the requirements of, the current version of "ENATS 41-47 – Pole Mounted, Non-Enclosed: Switch-Disconnectors, Disconnectors, Earthing Switches, Fuse Switches (Expulsion fuses), Solid Links and Automatic Sectionalising Links (ASLs)", except where varied by this specification. ASLs are designed to operate on both the 11kV and 20kV systems and designed to allow them to be reset via the use of large spanner for leverage.

[5] The legacy porcelain J & P units were limited to a fault break current of 5kA at 20kV or 8kA at 12kV.

[6] The stand-alone current limiting set has an insert length of 385mm.

[7] ASLs are sometimes referred as "smart fuses" but in fact they are not fuses in the senses of operating through the fusion of metallic elements. ASLs are a self-contained HV circuit opening device used in drop-out expulsion fuse mounts which can only be used in association with PMARS's. The ASL differentiates between the transient and permanent faults greatly reducing the number of transient faults on the overhead line network.

The minimum actuating current of the ASL is typically set at 80% of the minimum trip setting of the upstream reclosing device, be this a recloser or a circuit breaker. Since, the ASL minimum actuating current is 1.6 times the continuous current, the value of the continuous current equates to 50% of the minimum trip current of the upstream reclosing device. The sectionaliser is designed to continuously carry 200% of its rated continuous current. If the load current exceeds 1.6 times the continuous rating of the ASL and if the upstream reclosing device operates due to an overcurrent elsewhere in the system, then the sectionaliser will falsely register a count.

ASL must be capable of operating on networks where the minimum continuous load current available at the point of installation is 300mA as per NPS/001/032. ASL should be set to operate in at least one less count than the upstream recloser e.g. a 4 shot recloser would require a maximum of 3 shot sectionaliser downstream. Where multiple ASLs are used on the OH circuit, the downstream sectionaliser should have one less count than the upstream sectionaliser. 3 shot ASL should only be used if there is another protective device downstream. The current ratings for ASLs provided in Table 6. Colour bands are located on the body of the ASL for easy identification of the count and pick-up current rating. The guidance on sizing an ASL on the OH network is provided in Appendix 5.

3.2. LV Fuses

LV networks are protected mechanically by construction and installation as well as electrically by fuses generally to BS HD 60269-2:2013, BS 88-2:2013 or LV circuit breaker[8].

Northern Powergrid has a policy for mechanical protection, through construction and installation that will avoid danger so long as the asset remains undisturbed. However, the ESQC regulations require Northern Powergrid to:

- prevent danger, so far as is reasonably practicable; and
- ensure that no current (including earth faults) flows which the network cannot carry without danger, i.e. to protect the asset.

Taking actions to prevent danger must pass the ‘reasonably practicable’ test (see appendix 3), i.e. not present a cost that is grossly disproportionate to the benefits. It is, therefore, reasonable to set a standard for applying fusing that balances flexibility in design and operation which takes into account the policy for mechanical protection based on the construction and installation of equipment.

Effective utilisation of cables and transformers requires that 400A fuses be used in the majority of situations, leading to a standard of clearing faults at the end of services in 60sec or, if systems are laid out in the absence of detailed knowledge of services, clearing faults at the end of the main in 30sec.

Where point demands above 139kVA are connected, the cut-out fuse will be greater than 200A. This will not discriminate effectively with a 400A fuse at the substation. Therefore, point demands above 139kVA should be connected to discrete feeders, and the following fusing adopted to provide discrimination:

Table 1: Fusing and Capacity Values for Greater Than 139kVA

Distribution capacity (kVA)	Cut-out fuse (A)	Substation fuse (A)	Maximum loop impedance to cut-out (ohms)
139	200	400	0.21
173	250	500	0.16
218	315	500	0.16
276	400	500	0.16

[8] For an individual customer, LV CBs are used only at the point of connection and not to control circuits.

Guidance above applies to ground-mounted transformers from 200kVA upwards and pole-mounted transformers from 100 to 315kVA. Rural systems fed from transformers of 50kVA or less shall be controlled by 160A fuses, as:

- anything larger would be superfluous, as the transformer capability would be no more than 100A continuous; and
- anything smaller would not discriminate with domestic 80A cut-out fuses.

The one exception to the 60sec rule is for eaves mains (under-eaves wiring). As these assets are installed on buildings, and there is greater potential for inadvertent contact, best practice is to apply the 5sec rule in BS7671 in most cases this can be achieved by installing a 200A fuse (in a wall box).

3.2.1. LV Substation Fuse

The LV fuse provides protection against both overload and fault current (short-circuit current). LV fuse sizes specified on this document provides protection of LV circuits and discrimination with HV fuses. LV fuse-link selection for fuse boards, feeder pillars, cabinets and pole mounted cut outs must be selected with the nameplate rating of the transformer and the outgoing LV circuit protected.

An LV substation fuse must carry maximum anticipated load current without deterioration and must operate under short circuit conditions to prevent further damage being caused to the cable or overhead line by excessive temperature or mechanical stress; ideally, it ought to be capable of carrying without deterioration the intermittent overload capacity of the circuit. The maximum ratings of the fuse-links for the short circuit protection of the more common sizes of low voltage cables and overhead line conductors are specified in Table 11 and Table 12. Their selections have been based on the considerations detailed above.

As per BS HD 60269-2:2013IEC 60269-2:2013, the time current characteristics of the LV fuses shall be within ±10% in terms of current. The time-current characteristics of LV fuses in Appendix 9 provide the data for the magnitude of the fault current required for fault clearance. The magnitude of the fault current (single phase faults) which effectively depends upon the earth loop impedance is the crucial factor in achieving the disconnection time. Table 7 summarise the fault current magnitudes required to disconnect/clear the fault for different clearance times.

Reference to the time/current characteristics of the fuse under consideration will show whether the calculated phase to neutral fault current will cause operation in less than 30sec. Table 10 provides the maximum equivalent length of 95mm^2 WNE and 300mm^2 WNE cable for which the corresponding fuse should operate in 30sec (Refer Table 7).

A LV substation fuse should also discriminate with the HV transformer protection. For TLF fuses, the maximum rating of LV substation fuse which should be used in conjunction with the HV protection settings for the standard sizes of network transformers is provided in Table 2, and for expulsion fuses in Table 4.

The maximum LV fuse rating for 6kV network can be found in Table 30 to Table 37. The substation fuse rating should be selected to ensure that it will operate within 30sec when carrying the fault current resulting from a phase to neutral short circuit at the remote end of the LV main. When this last requirement precludes the use of a fuse based on circuit rating, consideration of the maximum anticipated load current may permit the use of a lower rated fuse. If a 30sec operating time cannot be met by the use of a lower rated fuse then section fuses or an alternative system design becomes necessary. The maximum fuse sizes provided in Table 11 and Table 12 should always be used with discretion. For example in those cases where a short length of relatively large cross-section cable leaving a substation is jointed to a smaller cross-section cable, then the rating of the substation fuse should be related to the rating of the smaller cable or to the prospective phase to neutral fault current, whichever is the limiting condition.

"J" type fuse-links[9] can be installed on the distribution boards, feeder pillars, link boxes, pole mounted cutouts and heavy duty service intakes. The standardized current ratings of fuse-links with centres at 82mm (JPU) and 92mm (JSU) are 80A, 100A, 160A, 200A, 250A, 315A, 355A and 400A, 500A and 630A.

Fuses currently being supplied are Type "J" conforming to above mentioned standards and having time/current characteristics which comply with ENATS 12-8. The maximum fuse ratings given in Table 3 and Table 30 to Table 37 are based on Lawson fuses and do not necessarily apply to similarly rated fuses of other manufacturers.

Bidoyng[10] (smart LV fuse) from Kelvatek are generally only used for intermittent fault management on the LV network. A Bidoyng unit comprises two LV fuses in parallel with a maximum fuse size of 400A JPU fuse-links due to the rating of the equipment itself.

3.2.2. LV Earth Loop Impedance (ELI)

The earth loop impedance (ELI) is the impedance of the earth fault current loop starting and ending at the point of an earth fault. The value of earth loop impedance determines the ability of fuses to operate effectively such that they can protect the network and should be included during the design stage for a new connection or expansion of the network. The measured value of ELI will change depending on the earthing system, network configuration, network alteration and fault repair.

Phase to neutral loop resistance on new systems shall not exceed 250mΩ including the transformer, main and service, in accordance with Engineering Recommendation P5. LV mains cables laid in advance of providing services should be designed to a maximum of 200mΩ through the transformer and main which is outlined on the code of practice for the Economic Development of LV System. Table 8 provides the maximum earth loop impedance values at the end of the single phase services. Table 9 provides the maximum ELI values for different type of fuse-links both at the end of the services and the mains. The clearance time to determine the ELI is based on 60sec for LV services and 30sec for LV mains and is explained in Appendix 3. The fault current or the fusing current determines the operating time of a fuse and 230V should be used as supply source voltage.

For LV mains controlled by 315A fuses, the maximum cumulative phase to neutral loop impedance must not exceed 242mΩ at the end of the mains. The phase to neutral loop impedance at the service position must not exceed 280mΩ.

3.2.3. Positioning of Section Fuses

The first section fuse on the LV circuit should be installed at a suitable position where a phase to neutral fault will cause the substation fuse to operate in not more than 30sec at the end of the main and within 60sec at the end of the services (subject to loading). The rating of the section fuse will be determined by the maximum anticipated load current at that position. When the zone protected by the first section fuse is inadequate to cover the whole of the distributor, further section fuses become necessary.

On overhead LV network, one set of 200A section fuses shall be provided in series with the substation fuse. Eaves mains (surface wiring) shall be protected by 200A fuses; any upstream section fuses shall be deemed to satisfy this requirement.

On underground LV network, section fuse can be inserted on the Link Box to fuse down a small section mains cable to meet the fusing needs either with 200A or 160A only. A fuse of a higher rating is not allowed to be utilised on the link boxes due to the heat generated by the LV fuses within the link boxes. Both 2 way and 4 way link boxes can be fused; the incoming side shall be installed with solid links whereas fuses will be installed on the outgoing side wherever necessary.

[9] J type LV fuse is described as "Fuse system I, gU fuse-links with wedge tightening contacts".

[10] Bidyong is a single shot-recloser designed to remove intermittent faults from the Low voltage network.

Due to the installation challenges and safety risks, the installation of a fuse on a link box shall be limited to 200A. Alternatively, a feeder pillar can be used which can provide a point of isolation and be supplied with LV fuse up to 400A fuse. The fused link boxes cannot be used for interconnection. Link Boxes if required to provide an interconnection shall be provided with solid links; interconnection is not permitted between three phase and split phase networks due to different voltage level and phase angle shift.

3.2.4. Discrimination Between Fuse in Series

Where section fuses are used to provide protection on different segments of the same LV feeder, discrimination between the fuse-links can be checked by ensuring that the time/current characteristics do not overlap at any point. Due allowance should be made for ±10% tolerance with respect to the current. The LV fuses in series can most conveniently be graded using their I^2t characteristic which is provided in Figure 5. To grade successfully the total operating time I^2t of the downstream fuse must not exceed the pre-arcing time of the upstream fuse. LV fuse-links discriminate in a ratio of 1.6:1[11]. Therefore to achieve discrimination or selectivity, the upstream fuse-link must have a current rating of at least 1.6 times or higher current rating of the downstream minor fuse-links e.g. if a 315A fuse is used on the LV fuse board then the next minor fuse that could discriminate would be 200A. For networks feeding domestic supplies with a service fuse of 60/80/100A then the minimum section fuse should be 160A. It should be possible, in general, to protect any LV circuits by a sequence of section fuses with the ratings 160A and 200A.

3.2.5. Low Voltage Domestic Fuse-Links

Fuse-links shall be suitable for use in cut-outs designed to provide power supplies to commercial or domestic premises with loads up to 100A per phase complying with the design requirements of NPS/001/017 and typical design requirement of BS HD 60269-3:2010+A1:2013, BS 88-3:2010 , Figure 303. Table 18 provides a list of domestic fuse-links.

3.2.6. Low Voltage Street Lighting Fuse-Links

Fuse-links shall be suitable for use in cut-outs designed to accommodate standardised fuses systems with offset tag contacts based on a 38mm fixing centres and a max current rating of up to 25A. Table 19 provides a list of Street Lighting fuse-links.

[11] Beama, "Guide to Low-Voltage Switch and Fusegear Devices," BEAMA Ltd, London, 2016

Table 2: Fuse Rating for Overcurrent Protection on GM Network Transformer with Time Limit Fuses

Voltage	CT Ratio	1500kVA Transformer			1250kVA Transformer		
		TLF Fuse Rating	TLF Commodity Code	Max 415V Fuse Rating	TLF Fuse Rating	TLF Commodity Code	Max 415V Fuse Rating
20kV	40/5	-	-	-	-	-	-
	70/5	10A	289088	630A[a]	7.5A	289073	630A[a]
11kV	50/5	-	-	-	-	-	-
	100/5	12.5A	289092	630A[a]	12.5A	289092	630A[a]
Voltage	CT Ratio	1000kVA Transformer			800kVA Transformer		
		TLF Fuse Rating	TLF Commodity Code	Max 415V Fuse Rating	TLF Fuse Rating	TLF Commodity Code	Max 415V Fuse Rating
20kV	40/5	10A	289088	630A[a]	10A	289088	630A[a]
	70/5	-	-	-	-	-	-
11kV	50/5	-	-	-	-	-	-
	100/5	10A	289088	630A[a]	7.5A	289073	630A[a]
Voltage	CT Ratio	500kVA Transformer			315kVA Transformer		
		TLF Fuse Rating	TLF Commodity Code	Max 415V Fuse Rating	TLF Fuse Rating	TLF Commodity Code	Max 415V Fuse Rating
20kV	40/5	5A	289090	400A	3A	289054	315A
	70/5	-	-	-	-	-	-
11kV	50/5	10A	289088	500A	5A	289090	315A
	100/5	-	-	-	-	-	-

Note:

a) This table provides the maximum distributor LV fuse rating for HV/LV discrimination. The maximum allowed fuse size to utilise on the LV system is 500A[12] whereas 630A LV fuse mentioned on table above is the maximum permissible LV fuse for grading with HV system.

b) Time Limit Fuse to ENATS 12-6 refers to the cartridge type time limit (XF type) fuse.

c) Any new GM transformer to be installed should be protected from ring main unit (if previously protected from expulsion fuses). This also applies to three phase GM transformers converted to GM split phase as well.

d) For three phase transformers connected single phase, use the CT ratio and fuse size recommended for the three phase transformer rating.

e) For existing Ring Main Unit with legacy type CT ratio please refer tables in Appendix 13.

Table 3: Fuse Rating for Earth Fault Protection on GM Circuit Breaker with HV Time Limit Fuses

Voltage	CT Ratio	Transformer kVA Rating	TLF Fuse Rating	Commodity Code
Any Voltage	Any CT Ratio	All Sizes	3A	289054

Note:

a) The TLF fuse for earth fault protection shall be provided with the ratings in all cases irrespective of the transformer ratings and HV voltage levels.

[12] Refer: IMP/001/911: Code of Practice for the Economic Development of the LV System

Table 4: Expulsions Fuse-Link Ratings for Various 11kV and 20kV Pole Mounted Transformers

Transformer Rating to be protected				PM Transformer			
				Universal Expulsion HV Fuse		LV Fuse	
Voltage	Phases	kVA	Amps	Fuse Size	Commodity Code	Fuse Size	Commodity Code
11kV	3 Phase	50	2.6	25A[b]	245018	100A	280721
		100	5.3	25A[b]	245018	200A	280774
		200	10.5	25A[b]	245018	400A	280666
		315[C]	16.5	25A[b]	245018	400A	280666
	Split Phase (1 Phase 3 Wire)	50	4.6	25A[b]	245018	160A	280740
		100	9.1	25A[b]	245018	315A	280632
		200	18.2	25A[b]	245060	400A	280666
	Single Phase (1 Phase 2 Wire)	25	2.3	25A[b]	245018	200A	280774
		50	4.5	25A[b]	245018	200A	280774
		100	9.1	25A[b]	245018	400A	280666
		200	18.2	25A[b]	245018	400A	280666
20kV	3 Phase	50	1.4	25A[b]	245018	100A	280721
		100	2.9	25A[b]	245018	200A	280774
		200	5.8	25A[b]	245018	400A	280666
		315[C]	9.1	25A[b]	245018	400A	280666
	Split Phase (1 Phase 3 Wire)	50	2.5	25A[b]	245018	160A	280740
		100	5	25A[b]	245018	315A	280632
		200	10	25A[b]	245018	400A	280666
	Single Phase (1 Phase 2 Wire)	25	1.3	25A[b]	245018	200A	280774
		50	2.5	25A[b]	245018	315A	280632
		100	5.0	25A[b]	245018	400A	280666
		200	10.0	25A[b]	245018	400A	280666

Note:

a) This table provides the maximum distributor LV fuse rating for HV/LV discrimination other than mentioned above. The maximum allowed fuse size for use on the pole mounted LV system is 400A as the JPU fuse (PM LV fuse) carrier fixed contacts are rated at 400A.

b) As there are different practices across the two business licenses about the fusing of pole mounted and inverted pole mounted transformers. Please refer to Table 2 and Table 3 of IMP/001/912 which outlines the protection requirements in the Northern Powergrid Northeast and Northern Powergrid Yorkshire.

c) Refer to drawing 1091471503 sheet 3 (also provided on Appendix 7) for details on modifying the universal fuse elements to fit into historical legacy fuse carriers.

Table 5: Fuse-Link Ratings for Various 11kV and 20kV Pad Mounted Transformers

Transformer Rating to be protected				Pad Mounted Transformer				
				Bay-O-Net HV Fuse[a]		Current Limiting Back–Up Fuse[b]	LV Fuse	
Voltage	Phases	kVA	Amps	Fuse Size	Commodity Code	Fuse Size	Max LV Fuse Size	Commodity Code
11kV	3 Phase	315	16.5	90A	381470	65A	400A	280863
		200	10.5	80A	381576	65A	315A	280844
		100	5.3	50A	381696	30A	160A	280793
		50	2.6	30A	381748	30A	100A	280789
	Split Phase (1 Phase 3 Wire)	100	9.1	80A	381576	65A	315A	280863
		50	4.6	50A	381696	30A	160A	280793
	Single Phase (1 Phase 2 Wire)	50	4.5	50A	381696	30A	160A	280793
20kV	3 Phase	315	9.1	80A	381576	65A	400A	280863
		100	2.9	30A	381748	30A	160A	280793
	Split Phase (1 Phase 3 Wire)	100	5	50A	381696	40A	200A	280825
	Single Phase (1 Phase 2 Wire)	50	2.5	50A	381696	30A	160A	280793

Note:

a) A Bay-O-Net current sensing fuse is connected in series with each current limiting back-up fuse and operates for any HV over current including a secondary fault that is not cleared by the LV fuse. If required Bay-O-Net fuses can be replaced with the use “hot stick” without removing the transformer lid.

b) The current limiting back-up fuse (HV fuse) only operates for a failure within the transformer tank and cannot be replaced.

c) The pad mounted transformers listed in this table are rationalised from the number of variants available on the NPS document NPS/003/041.

d) This table provides the maximum distributor LV fuse rating for HV/LV discrimination. No higher LV fuses other than the specified on this table can be utilised for each transformer type.

Table 6: List of Auto Sectionaliser Links[13]

Sectionaliser Continuous Rating			Sectionaliser Counts		Commodity Number
Rating (A)	Colour Scheme	Minimum actuating currents based on a 1.6 ratio	Number of Counts	Colour Scheme	
15A	Purple	24	2	No Band	246839
15A	Purple	24	3	Green	247297
25A	Red	40	2	No Band	246824
25A	Red	40	3	Green	247140
35A	Brown	56	2	No Band	247263
35A	Brown	56	3	Green	247314
50A	Green	80	2	No Band	247441
50A	Green	80	3	Green	247511
70A	No Colour	112	2	No Band	247315
70A	No Colour	112	3	Green	247516
100A	White	160	2	No Band	247317
100A	White	160	3	Green	247318

Note:

a) The ASLs in this table can be applied to both 11kV and 20kV systems.

Table 7: Time Current-Characteristics for J Type Electricity Supply Distribution Fuse-Links, System I (LAWSON Fuses)

LV Fuse Rating	Fusing Current in Amp											
	Hours		Minutes			Seconds						
A	6	3	100	50	1	30	20	10	5	3	1	0.5
100	140	142	145	157	266	300	320	360	410	455	570	620
160	216	218	226	238	395	443	470	536	613	690	867	1000
200	280	284	290	300	503	565	600	690	795	895	1107	1300
250	346	348	359	380	645	722	780	885	1030	1250	1410	1640
315	434	436	460	495	820	950	1010	1150	1340	1450	1900	2170
355	500	502	521	550	950	1084	1155	1300	1520	1600	2125	2480
400	560	563	580	600	1080	1200	1290	1472	1700	1950	2400	2900
500	720	725	740	790	1400	1565	1710	2000	2300	2600	3150	4000
630	900	905	910	995	1950	2260	2400	2900	3200	3850	4800	5500

Note:

a) The fusing current at different clearance time is obtained from Time/Current characteristic of Lawson J type fuse-links.

b) Time/Current Characteristics of J type fuse-links are faster in operation in comparison to the Time/Current characteristics for the Industrial Range of fuse-links.

c) Lawson J Type 400/415V electricity supply distribution fuse-links has the time/current characteristics according to the time-current zones of BS 88-2:2010 ad IEC60269-2: 2013-07 standards given in the figures 901, 902, 903 and 904.

[13] Refer NPS/001/032: Technical Specification for 11 & 20kV Pole Mounted Auto Sectionalising Links

Table 8: Maximum Earth Loop Impedance Values at the End of Single-Phase Services[14]

Service Type	Connection to New Circuits (mΩ)	Connection to Existing Circuits (mΩ)
CNE Service Phase-neutral and Phase-earth loop impedance	250	400
SNE Service Phase-neutral loop impedance	-	400
SNE Service Phase-earth loop impedance	-	800

Note:

a) Phase to neutral Loop impedance and phase to earth loop impedance will differ for CNE and SNE networks.

b) Phase to neutral loop impedance on a new system shall not exceed 250mΩ including the transformer, mains and service. It also includes the extension of existing systems.

c) The loop impedance values may need to be reduced to meet the fusing requirement for a specific part of the LV system.

Table 9: Maximum Loop Impedance Values

Fuse-Link Rating (A)	Loop Impedance to end of the service (mΩ)	Loop Impedance to the end of the main (mΩ)
160	582	519
200	457	407
250	356	318
315	280	242
355	242	212
400	212	191
500	164	146

Note:

a) The above calculation is based on the clearance time of 30sec and 60sec at the end of the LV mains and service respectively to meet the fusing current of the fuse.

b) All the calculation on this table above to determine the maximum loop impedance both at the end of the mains and services is based on 230V supply voltage.

[14] Refer IMP/001/911 Code of Practice for the Economic Development of the LV System.

Table 10: Maximum Length of WNE Cable for Fusing In 30 Seconds for Different LV Fuse Rating

LV Fuse Rating (A)	Fusing Current in 30 seconds (A)	95mm^2 Al PILC cable (Meter)	95mm^2 WNE cable (Meter)	300mm^2 WNE cable (Meter)
100	300	948	915	1636
160	443	642	619	1107
200	565	503	486	868
250	722	394	380	679
315	950	299	289	516
355	1084	262	253	452
400	1200	237	228	408
500	1565	181	175	313

Note:

a) The maximum length of the cable mentioned above is based on the loop impedance of the cable only and does not include the impedance of the transformer.

b) The cable length mentioned above does not include the cable loading hence it is required to check the loading to install the appropriate fuse size and determine the maximum cable length based on statutory voltage limits.

c) The above calculation is based at 230V.

Table 11: Fuse-Link Ratings for LV Overhead Line Conductor

Open wire Conductor				Bundled Conductor	400V Fuse-Link (JPU Type)	
Copper		Aluminium		ABC		
Type (in^2)	Type (mm^2)	Type (in^2)	Type (mm^2)	Type (mm^2)	Rating (A)	Commodity Code
-	-	-	-	**50**	200	280774
0.05	**32**	**0.05**[15]	**50**	**70**	250	280628
-	**70**	-	-	**95**	315	280632
-	-	-	-	-	355	280416
0.1 **0.15**	- **100**	**0.1**[15] -	**100** -	- **120**	400	280666
0.2	**125**	**0.15**[15]	**150**	-	500	035568

Note:

a) The fuse-link current ratings are to cater to the highest ratings expected of an overhead conductor installed in optimum conditions and operating low ambient temperatures. In practice, in order to cover average conditions, fuse-link ratings lower than those shown may be used. The fuse-link must be of such a rating as to ensure that it will operate satisfactorily for a short circuit at the furthest point in the distributor.

b) A fuse-link of a lower rating than indicated may also be used if the conductor is installed for voltage drop conditions rather than for current carrying capacity.

c) A fuse-link should not be used continuously above its rated current because the excessive temperature rise encountered under this condition may lead to deterioration causing premature operation or permanent change in its operating characteristic.

d) Where the fuse will not operate within 30sec for faults at the remote end of the distributor, the use of a fuse of a lower rating, when load permits, may obviate the need for a section fuse.

[15] The value is only a copper equivalent not the actual size.

Table 12: Fuse-Link Ratings for LV Underground Cable [16]

PILC Cable			Consac	XLPE Cable	400V Fuse-Link (JSU Type)	
Copper	Aluminium		Aluminium	Waveform		
Type (in^2)	Type (in^2)	Type (mm^2)	Type (mm^2)	Type (mm^2)	Rating (A)	Commodity Code
0.06	**0.06**	-	-	-	200	280825
0.06	**0.1**	**70**	**70**	-	250	280384
0.1	**0.15**	**95**	**95**	**95**	315	280844
-	**0.2**	**120**	-	-	355	280399
0.15	-	-	-	-	400	280863
- **0.2**	**0.25** **0.3**	- **185**	- **185**	- **185**	500	280878
0.25 **0.3**	**0.4** **0.5**	**240** **300**	**240** **300**	- **300**	630	280952

Note:

a) The fuse-link current ratings are to cater to the highest ratings expected of a cable installed in optimum conditions and operating low ambient temperatures. In practice, in order to cover average conditions, fuse-link ratings lower than those shown may be used. The fuse-link must be of such a rating as to ensure that it will operate satisfactorily for a short circuit at the furthest point in the distributor.

b) A fuse-link of a lower rating than indicated may also be used if the cable is installed for voltage drop conditions rather than for current carrying capacity.

c) A fuse-link should not be used continuously above its rated current because the excessive temperature rise encountered under this condition may lead to deterioration causing premature operation or permanent change in its operating characteristic.

d) Where the fuse will not operate within 30sec for faults at the remote end of the distributor, the use of a fuse of a lower rating, when load permits, may obviate the need for a section fuse.

[16] This table is prepared referring to ENATS 12-8: The Application of Fuse links to 11kV/400V and 6.6kV/400V Underground Distribution Networks.

4. References

4.1. External Documentation

Reference	Title	Version and/or date
ACE Report 75	Report on the Characteristics and Performance of Fuses for use on 11kV Overhead Lines.	1980
ACE Report 86	Report on HV Fuse Links for the Protection of Ground Mounted Distribution Transformers.	1983
BS 2692-2:1956	Specification for Fuses for voltages exceeding 1000 V a.c. — Part 2: Expulsion fuses	1976
BS HD 60269-2:2013, BS 88-2:2013	Low-voltage fuses. Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application). Examples of standardized systems of fuses A to K.	2013
Book: Electric Fuses	A. W. a. G. Newbery, Electric Fuses, London: The institution of Engineering and Technology, 2008.	2008
ENATS 12-6	Time fuse-links for use with current transformer releases on circuit-breakers.	Issue 3,2021
ENATS 12-8	The Application of Fuse links to 11kV/400V and 6.6kV/400V Underground Distribution Networks.	Issue 4, 2021
ENA TS 41-47	Pole Mounted, Non-Enclosed: SwitchDisconnectors, Disconnectors, Earthing Switches, Fuse Switches (Expulsion fuses), SolidLinks and Automatic Sectionalising Links (ASLs)	Issue 1: 2021

4.2. Internal Documentation

Reference	Title
IMP/001/010	Code of Practice for Standard Arrangements for Customer Connections.
IMP/001/011	Code of Practice for Overhead Line Ratings and Parameters.
IMP/001/013	Code of Practice for Underground Cable Ratings and Parameters.
IMP/001/911	Code of Practice for the Economic Development of the LV System.
IMP/001/912	Code of Practice for the Economic Development of the HV System.
IMP/007/011	Code of Practice for the Application of Lightning Protection
NPS/001/004	Technical Specification for 11kV, 20kV and 33kV Pole Mounted Expulsion Switch, Fuse Tube and Solid Link.
NPS/001/009	Technical Specification for 11kV, 20kV and 33kV Pole Mounted Auto-reclose Circuit Breakers and Enclosed Switch Disconnectors
NPS/001/017	Technical Specification for Low Voltage and High Voltage Fuse Links.
NPS/001/032	Technical Specification for 11 & 20kV Pole Mounted Auto Sectionalising Links.
NPS/002/006	Technical Specification for Service Cutouts, Terminal Blocks, Meter Tail Protectors and Pole Mounted Fuse Units.
NPS/003/011	Technical Specification for Ground Mounted Distribution Transformers up to and including 20kV.
NPS/003/034	Technical Specification for 11kV & 20kV Pole-Mounted Distribution Transformers.
NPS/003/041	Technical Specification for 11kV & 20kV Pad Mounted Transformers

4.3. Amendments from Previous Version

Reference	Title
Table 2	Added section to provide TLF fuse rating for overcurrent protection of 1500kVA GM network transformer.

5. Definitions

5.1. Glossary

Reference	Title
ABSD	Air Break Switch Disconnector
ASL	Automatic Sectionalising Link
DOEF	Drop Out Expulsion Fuse-Link
ELI	Earth Loop Impedance
ENATS	Energy Networks Association Technical Specification
FLC	Full Load Current
GM	Ground Mounted
HV	High Voltage
LV	Low Voltage
NPg	Northern Powergrid
OH	Overhead
PM	Pole Mounted
PMAR	Pole Mounted Auto Recloser
TLF	Time Limit Fuse
UG	Underground

5.2. Description

Reference	Title
Arcing Time	This is defined as the period between the instant of arc appearance following the melting of fuse element and its total extinction (zero current). Arcing time is dependent of voltage.
Breaking Capacity/ Interrupting Capacity	A fuse must be able to open the circuit under a short circuit condition without endangering its surroundings. The breaking capacity or interrupting rating of a protective device is the maximum available current, at rated voltage, that the device can safely operate or interrupt a fault current without rupturing. The breaking capacity or interrupting rating of a fuse must be equal to or greater than the available short circuit current of the circuit. All utility fuses have at least 80kA breaking capacity.
Continuous Current Carrying Capacity	Continuous current values that are shown on the fuse represent the level of current the fuse can carry continuously without deterioration and without exceeding the temperature rise limits. An application that exposes the fuse to a current slightly above its continuous rating but below its minimum interrupting rating, may damage the fuse due to excessive heat.
Cut-off Characteristic (Peak Current)	A curve showing the cut-off current as a function of prospective current. Cut-off current is the maximum instantaneous value of current let-through by the fuse during one half cycle of operation under the most onerous conditions of power factor and asymmetry. Note prospective current is expressed in kA (r.m.s) whereas the cut-off current is in peak kA[11]. See Appendix 11**.**
Clearing Time / Operating time / Disconnection Time	The total interval between the fault inception and final opening of a circuit at a rated voltage by a protective device. Clearing time is the total of the melting and the arcing time[11].
Drop-out Expulsion Fuse (DOEF)	An expulsion fuse in accordance with the latest version of BS 2692 Part 2 in which the fuse carrier automatically drops into a position providing an isolating distance after the fuse has operated and can be operated as a disconnector by means of a portable operating rod.
Earth Loop Impedance (ELI)	The impedance of the earth fault current loop starting and ending at the point of an earth fault. This impedance is denoted by the symbol Zs.
Expulsion Fuse	A vented fuse in which the expulsion effect of gasses produced by the arc and lining of the fuse holder, either alone or aided by a spring, extinguishes the arc results in current interruption[17].

[17] Cooper Bussmann, "Fuseology Medium Voltage Fuses," Cooper Bussmann, 2005.

Fuse	An overcurrent protective device with a fuse-link that operates and opens the circuit when fault current exceeds a fusing current for a sufficient time.
Fusebank	A combination of fuse holders mounted onto a rear fixing rail and having their incoming terminals connected by a common LV busbar[11].
Fuseboard	A combination of fusebank mounted in an enclosure together with ancillary equipment (earth/neutral bars) protecting a number of individual circuits[11].
Fuse Element	A calibrated conductor inside a fuse which melts when the fuse operates i.e. when the fuse is subjected to excessive current. The fuse-link may comprise several fuse elements. Fuse element is enclosed by the fuse body and may be surrounded by an arc quenching medium such as silica sand.
Fuse-Link	The part of the fuse including the fuse element intended to be replaced after the fuse has operated.
Fuse Carrier	The movable part of a fuse designed to carry a fuse link.
Fusing Current	Value of current specified as that which cause operation of the fuse link within a specified time.
Fuse Rating (A)	A value of current that the fuse-link can carry continuously without deterioration under specified conditions.
I^2t Characteristics	A curve or chart showing values of pre-arcing and operating let through energy as a function of current and voltage. I^2t is proportional to energy and measured in amperes-squared-second A^2S. (Refer Appendix 10)
I^2t Rating (A^2S)	A measure of heat energy developed within a circuit during the fuse's melting or arcing. The melting, arcing, or clearing integral of a fuse, termed I^2t is the thermal energy required to melt, arc or clear a specific current. The sum of melting and arcing I^2t is generally stated as total clearing I^2t. It can be expressed as melting I^2t, arcing I^2t or the sum of them, clearing I^2t. I^2t characteristics is called as Let-through characteristics which is a curve or chart showing values of 'pre-arcing' and 'operating' let through energy as a function of current and voltage[11].
Pre-arcing Time / Melting Time	The interval of time between the beginning of a current large enough to cause a break in the fuse element and the instant when an arc is initiated[11]. Pre-arcing time is independent of the network voltage.
Prospective Short Circuit Current	Possible short circuit currents which would have existed when there was no short circuit limitation device.
Slow Blow Fuse	A fuse with a built-in delay that allows temporary and harmless inrush currents to pass without opening, but is designed to open on sustained overloads and short circuits.
Time-Current Characteristic	A curve providing the pre-arcing or operating time as a function of prospective current. The time current characteristics have a basic tolerance of ±10% in terms of current (Refer Appendix 8).
Time Limit Fuse (TLF)	Time limit fuse is utilised in conjunction with circuit breaker type ring main units which provides a cost effective method of providing fault protection for overcurrent and earth faults to a transformer of 1500kVA or less. The time limit fuse-link is shunted with a trip coil which is fed from the protection current transformer. In the event of a fault, the fuse ruptures and the fault current is diverted through trip coils, which trip the circuit breaker. It should be noted that the TLF protection system is not a device for limiting overload levels of individual transformers.

6. Authority for Issue

6.1. CDS assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

		Date
Liz Beat	Governance Administrator	29/06/2022

6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

Review Period - This document should be reviewed within the following time period.

Standard Review of 3 Years	Non Standard Review Period & Reason		
Yes	Period: n/a	Reason: n/a	
Should this document be displayed on the Northern Powergrid external website?			Yes
			Date
Anuj Chhettri	Smart Grid Development Engineer		29/06/2022

6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.

		Date
Jim Paine	Technical Policy Manager	13/07/2022
Michael Crowe	Technical Services Manager	22/07/2022

6.4. Authorisation

Approval is granted for publication of this document.

		Date
Mark Callum	Smart Grid Development Manager	04/07/2022

Appendix 1 – Schedule of Items[18]

Table 13: HV Non-Current Limiting Fuses in Oil

System Rated Voltage (kV)	Current Rating (A)	ENATS 12-8 rating Ref.	Length -Dimension D (mm)	Commodity Code
6.6	50	O6	359	287612
11	80	O4	359	287788
11	90	O5	359	287805
11	80	O4	254	038620
11	31.5	O2	254	287699
11	40	O3	254	083604
11	63	O4	254	038612
11	50	O3	254	287716
11	20	O1	254	288009
20	10	N/A	361	280011
20	20	N/A	361	287824
20	31.5	N/A	361	287839
20	50	N/A	361	287843

Table 14: HV Non-Current Limiting Fuses in Air

System Rated Voltage (kV)	Current Rating (A)	ENATS 12-8 rating Ref.	Length -Dimension D (mm)	Commodity Code
11	6.3	A1	359	362207
11	10	A1	359	362194
11	20	A1	359	287595
11	31.5	A2	359	287608
11	50	A3	359	287612
11	71	A4	359	287627
11	90	A5	359	287665

Table 15: HV Expulsion Fuse-Links

Current Rating (A)	Fuse Type	System Voltage (kV)	Length (mm)	Commodity Code
100	Slow Blow, Fixed Button Head	11	550	037879
100	Slow Blow, Fixed Button Head	33	800	037895
6	Slow Blow, Universal	11, 20, 33	787	245840
10	Slow Blow, Universal	11, 20, 33	787	245037
12	Slow Blow, Universal	11, 20, 33	787	245041
15	Slow Blow, Universal	11, 20, 33	787	245056
25	Slow Blow, Universal	11, 20, 33	787	245018
30	Slow Blow, Universal	11, 20, 33	787	242518
40	Slow Blow, Universal	11, 20, 33	787	245060
50	Slow Blow, Universal	11, 20, 33	787	245111
65	Slow Blow, Universal	11, 20, 33	787	245446
80	Slow Blow, Universal	11, 20, 33	533	259114
100	Slow Blow, Universal	11, 20, 33	533	259129

[18] This section has been obtained from the NPS/001/017 –Technical Specification for Low Voltage and High Voltage Fuse Links.

Table 16: HV DIN Type Fuse-Links

System Voltage (kV)	Current rating (A)	DIN 43 625 Length (mm)	Commodity Code
11	6.3	292	362207
11	10	292	362194
11	20	292	362175

Table 17: LV Fuse-Links – "J" Type Cylindrical

Current Rating (A)	Reference	Dimensions	Commodity Code
100	JF 100[19]	Length 45.7mm – Diameter 38.7mm (no tag)	031625
150	JF 150	Length 45.7mm – Diameter 38.7mm (no tag)	031633
200	JF 200	Length 45.7mm – Diameter 38.7mm (no tag)	031641
100	JHU 100	76mm - Dimension A - BS 88-2 Fig. 905	280524
160	JHU 160	76mm - Dimension A - BS 88-2 Fig. 905	280543
200	JHU 200	76mm - Dimension A - BS 88-2 Fig. 905	280562
63	JHU 63	76mm - Dimension A - BS 88-2 Fig. 905	280702
80	JPU 80	82mm - Dimension A - BS 88-2 Fig. 905	280596
100	JPU 100	82mm - Dimension A - BS 88-2 Fig. 905	280721
160	JPU 160	82mm - Dimension A - BS 88-2 Fig. 905	280740
200	JPU 200	82mm - Dimension A - BS 88-2 Fig. 905	280774
250	JPU 250	82mm - Dimension A - BS 88-2 Fig. 905	280628
315	JPU 315	82mm - Dimension A - BS 88-2 Fig. 905	280632
355	JPU 355	82mm - Dimension A - BS 88-2 Fig. 905	280416
400	JPU 400	82mm - Dimension A - BS 88-2 Fig. 905	280666
500	JPU 500	82mm - Dimension A - BS 88-2 Fig. 905	035568
630	JPU 630	82mm - Dimension A - BS 88-2 Fig. 905	034876
80	JSU 80	92mm - Dimension A - BS 88-2 Fig. 905	280717
100	JSU 100	92mm - Dimension A - BS 88-2 Fig. 905	280789
160	JSU 160	92mm - Dimension A - BS 88-2 Fig. 905	280793
200	JSU 200	92mm - Dimension A - BS 88-2 Fig. 905	280825
250	JSU 250	92mm - Dimension A - BS 88-2 Fig. 905	280384
315	JSU 315	92mm - Dimension A - BS 88-2 Fig. 905	280844
355	JSU 355	92mm - Dimension A - BS 88-2 Fig. 905	280399
400	JSU 400	92mm - Dimension A - BS 88-2 Fig. 905	280863
500	JSU 500	92mm - Dimension A - BS 88-2 Fig. 905	280878
630	JSU 630	92mm - Dimension A - BS 88-2 Fig. 905	280952

Table 18: Domestic Fuse Links

Current Rating (A)	End Cap Diameter – BS 88 - 3 Table 301 (mm)	Type – BS 88 - 3 Table 301	Commodity Code
5	22.23	IIa	282318
25	22.23	IIa	181051
30	22.23	IIa	031088
40	22.23	IIa	282360

[19] JF types fuses are used in legacy Yorkshire, LV pole mounted fuse holders.

60	22.23	IIa	282394
80	22.23	IIa	282407
30	30.16	IIb	031203
60	30.16	IIb	282430
80	30.16	IIb	282426
100	30.16	IIb	282411

Table 19: Street Lighting Fuse-Links

Current rating (A)	Dimension G – BS 7654 Fig. 102 (mm)	Tag Description	Commodity Code
6	38	Offset tags with 1 axial and 1 lateral slot	282750
10	38	Offset tags with 1 axial and 1 lateral slot	282765
16	38	Offset tags with 1 axial and 1 lateral slot	282784
20	38	Offset tags with 1 axial and 1 lateral slot	282799
25	38	Offset tags with 1 axial and 1 lateral slot	030718
32	38	Offset tags with 1 axial and 1 lateral slot	030726

Table 20: LV Industrial Fuse-Links

System Voltage (V)	Current Rating (A)	Tag Arrangement	Commodity code
440	400	BS 88-2 Special Offset 92.5mm Centres With Open Double Slot	032813
440	630	BS 88-2 Special Offset 94.0mm Centres With Open Double Slot	032870
415	6	BS 88-2 Ref. F1	032078
415	10	BS 88-2 Ref. F1	032094
415	16	BS 88-2 Ref. F1	032102
415	32	BS 88-2 Ref A2	032508
415	63	BS 88-2 Ref A2	032573
415	400	BS 88-2 Ref C1	034157
415	400	BS 88-2 Ref B4	032902
415	500	BS 88-2 Ref C2	034322

Table 21: HV – Time Limit Fuse

Current Rating (A)	Description	Commodity Code
3	3A Time limit fuse to ENATS 12-6 (XF3)	289054
5	5A Time limit fuse to ENATS 12-6 (XF5)	289090
7.5	7.5A Time limit fuse to ENATS 12-6 (XF7.5)	289073
10	10A Time limit fuse to ENATS 12-6 (XF10)	289088
12.5	12.5A Time limit fuse to ENATS 12-6 (XF12.5)	289092
15	15A Time limit fuse to ENATS 12-6 (XF15)	289105

Table 22: Current Limiting Fuses for Dropout Expulsion Fuses on Overhead Lines

System Voltage (kV)	Description	Supplier Reference	Commodity Code
11kV	25A, Single Barrel, Current Limiting Fuse Link	FAK44W25	259030
20kV	20A, Single Barrel, Current Limiting Fuse Link	FAK45W20	259035

Table 23: Chemical Actuator (for Cooper Bussmann Automatic Sectionaliser Link)

System Voltage (kV)	Supplier Reference	Commodity Code
11	E2906	102988

Table 24: Replacement Fuse for REZAP

System Voltage (kV)	Supplier Reference	Commodity Code
415 V	86TT710	280010

Appendix 2: Selection of HV Fuse-Links with HV/LV Discrimination[20]

It is usual to fuse LV feeders associated with network transformers with 100A, 160A, 315A, 355A, 400A, and 500A fuse-links. The co-ordination between the LV fuse and the protection on the HV switch fuse or circuit breaker controlling the transformer must be checked. The fuse-links controlling the network transformer should meet the following conditions as per ENATS12-8.

1. Inrush Current of the distribution Transformer

HV fuses must withstand transformer magnetising inrush current of distribution transformer. For this purpose it is deemed satisfactory if a fuse link withstands without deterioration the equivalent of ten times transformer full load for 0.1 second.

2. Overload rating of distribution transformer

The selected fuse-link should allow the distribution transformer to carry 150% of transformer full load current (FLC) at lower tap position without the continuous normal current rating of the fuse-links being exceeded.

3. Faults in distribution transformer terminal zone

In case of GM transformer, the selected fuse-link should operate in less than 1second for a three phase fault[21] in the transformer secondary terminal zone. The terminal zone fault on the secondary side of the transformer is cleared quickly either by HV fuse-link or circuit breaker even when the earth fault current is limited by source impedance, fault impedance and short length of low voltage cable /overhead line impedance to a value less than that determined from the transformer alone. The impedance multiplier factor (LV) of 0.6 is used to determine the primary current.

The primary short circuit current resulting from a fault is given by

$$I_{SC} = I_{FLA} \times \frac{100}{\%Z_{Transformer}} \times 0.6$$

For Three Phase Transformer

$$I_{FLA} = \frac{kVA \times 1000}{\sqrt{3} \times V_{L-L}}$$

For Split Phase Transformer

$$I_{FLA} = \frac{kVA \times 1000}{V_{L-L}}$$

For Single Phase Transformer

$$I_{FLA} = \frac{kVA \times 1000}{V_{L-P}}$$

4. Discrimination between LV fuse-link and HV switch fuse or circuit breaker

HV fuse-link or circuit breaker with TLF fuses should be capable of discriminating with the LV fuse-links. A phase-phase fault on the secondary side (low voltage side) of the Delta/Star distribution three phase transformer results in most onerous condition as the HV fuse operate faster than would be expected for three phase fault. This is the worst case for coordination where 2:1:1 current distribution on the HV side of the transformer results from phase to phase fault on the LV system.

For a three phase 11,000/433V Dyn11 distribution transformer, the turn's ratio would normally be:-

$$\text{Turns Ratio} = \frac{HV\ Phase\ \text{Voltage}}{LV\ Phase\ Voltage} = \frac{11000}{433} = 25.4$$

[20] Refer ENATS 12-6: Time fuse-links for use with current transformer releases on circuit-breakers.

[21] Worst case fault for split phase transformer and single phase on the HV winding will be two phase fault.

But due to the 2:1:1 split current condition on the phases the effective turn's ratio

$$\text{Turns Ratio} = \frac{25.4}{2} = 12.7$$

For three phase transformers, LV current values are divided by 12.7 to convert to HV current.

For a split phase 11,000/250-0-250V Ii0 distribution transformer, the turn's ratio would normally be:-

$$\text{Turns Ratio} = \frac{HV\ \text{Phase Voltage}}{LV\ Phase\ Voltage} = \frac{11000}{500} = 22$$

For split phase transformers, LV current values are divided by 22 to convert to HV current.

For a single phase 11,000/250V Ii0 distribution transformer, the turn's ratio would normally be:-

$$\text{Turns Ratio} = \frac{HV\ \text{Phase Voltage}}{LV\ Phase\ Voltage} = \frac{11000}{250} = 44$$

For split phase transformers, LV current values are divided by 44 to convert to HV current.

For three phase 20,000/433V Dyn11, split phase 20,000/250-0-250V Ii0 and single phase 20,000/250V Ii0 distribution transformer, the effective turn's ratio would be 40, 40And 80 respectively which could be utilised to convert to HV current.

When comparing fuse operating times for discrimination purposes, it is important to take account of the permitted tolerance on the published time/current characteristics which is ±10% of current for HV and LV fuses at any operating time.

In addition at high values of current, allowance should be made for the arcing time of the LV fuse, which represents a significant part of the total operating time. This is not normally shown on the published fuse characteristics. Arcing time is variable, but in the case of Lawson Type 'J' fuses it can be assumed that it is negligible at an operating time of 1second and that its effect at an operating time of 0.01 second is equivalent to an increase of approximately 30% on the pre arcing current value shown on the time/current characteristic.

Appendix 3: Reasonably Practical Review for LV Fusing

Taking actions to prevent danger must pass the 'reasonably practicable' test, i.e. not present a cost that is grossly disproportionate to the benefits. The danger of inadvertent contact is primarily associated with electric shock and arc flash. To avoid the danger of electric shock, the IET wiring regulations (BS 7671) suggest setting protection to secure clearance within 5sec. To avoid the danger of arc flash, IEEE 1584 recommendations for arc flash protection are to limit the product of fault current and clearance time to less than 7000A^2-sec (for 440V systems and a working distance of 0.38m). Both these sets of guidelines are intended primarily for installations in premises. The baseline for system protection is the specific instructions for construction and installation in the ESQC regulations, which will certainly protect the general public:

- an electrically continuous metallic screen connected with the earth, or some form of mechanical protection, shall be provided for underground cables so that any tool will make contact with that protection or screen before it can make contact with any live conductors (reg. 13);
- underground cables shall also be kept at such depth or be otherwise protected so as to avoid damage or danger (reg. 14)
- the height above ground of any overhead line, at the maximum likely temperature of that line, shall not be less than that specified in the regulations (reg. 17).

If this were deemed to be all that were reasonably required to avoid danger, it would leave protecting the integrity of the cable itself as the main purpose of fusing. ENATS 12-8 requires protecting only the main, but it is worth considering protecting the service as well.

Options can therefore be summarised as:

- Prevent danger through fusing to 7000A^2-sec or for a 5sec clearance; or
- Prevent danger through mechanical protection and protect the asset through fusing to a longer time.

It is theoretically possible to fuse LV systems with phase to earth loop impedance up to 250mΩ (the limit for flicker) to clear the bulk of faults within 5sec, and a fault on the end of the network within 10sec, by using 250A units. However, this would disproportionately restrict utilisation of cable and transformer capability and is therefore not reasonably practicable.

As we cannot reasonably fuse to clear faults within 5-10sec, we cannot use fuses to protect against inadvertent contact and arc flash. BS HD 60269-2:2013, BS 88-2:2013 curves rise steeply between 10sec and 100sec, so fusing standards become arbitrary, as no one setting is markedly safer than any other. That is, it makes little difference whether fuses would permit an arc to persist for 30sec or 100sec, as either could cause serious injury. Further, in practice, faults are likely to burn clear without causing operation of the fuse. It is, therefore, reasonable to set a standard that balances flexibility in design and operation, secure in the knowledge that the system is reasonably safe (primarily due to construction and installation). Effective utilisation of cables and transformers requires that 400A fuses be used in the majority of situations, leading to a standard of clearing faults at the end of services in 60sec or, if systems are laid out in the absence of detailed knowledge of services, clearing faults at the end of the main in 30sec. This requirement can be achieved under the circumstances below:

Table 25: Fusing and Capacity Values

Fuse Rating (A)	Loop impedance to end of service (mΩ)	Loop impedance to end of main (mΩ)	Capacity (kVA)
315 or less	280	242	218
400	212	191	276

The one exception to this 60sec rule is for eaves mains (under-eaves wiring). As these assets are installed on buildings, and there is greater potential for inadvertent contact, best practice is to apply the 5s rule in BS 7671.

Appendix 4: HV Fuse Fault Level Ratings

The complete fuse assembly of expulsion type fuses, current limiting fuse, and solid links shall have the following minimum rating which is outlined on section 3.3 of NPS/001/004.

Table 26: HV Fuse Current and Fault Level ratings[22]

Voltage (kV)	Equipment Type	Rated Current (A)	3 Sec Rated Short Time Withstand Current (kA)	3 sec Rated Peak withstand Current (kA)	Rated Fault Make Current (kA)	Rated Peak Fault Make Current (kA)	Breaking capacity (kA)
12/24	Expulsion Fuse	200A (with fuse)	3[23]	7.5[23]	3[23]	7.5[23]	8
	Current Limiting Fuse	200A with fuse	3 [25]	7.5 [25]	3[25]	7.5[25]	43
	Solid	200	4	10	N/A	N/A	N/A
	ASLs	200	4 (1 sec), 3.2 (3 sec)	10 (1 sec)	N/A	N/A	N/A

Note:

a) The values detailed above refer to modern HV drop out expulsion fuse assemblies supplied in accordance with NPS/001/004 and comprising composite insulator back portions with a universal fuse links. By comparison, the legacy porcelain J & P units were limited to a fault break current of 5kA at 20kV or 8kA at 12kV. Where system fault levels in excess of those detailed in the table above are experienced, then alternative rated equipment such as current-limiting fuse shall be installed.

b) The ratings for Air Break Switch Disconnector (ABSD) both dependent manual and independent manual commonly referred as Aerial Switch is provided on the ENATS 41-47 – Pole Mounted, Non-Enclosed: Switch-Disconnectors, Disconnectors, Earthing Switches, Fuse Switches (Expulsion fuses), Solid Links and Automatic Sectionalising Links (ASLs).

[22] Refer NPS/001/004: Technical Specification for 11kV, 20kV and 33kV Pole Mounted Expulsion Switch, Fuse Tube and Solid Link.

[23] Refer ACE Report 75: Report on the Characteristics and Performance of Fuses for use on 11kV Overhead Lines.

Appendix 5: Auto Sectionalising Link Application

Circuit Fault Level Considerations

Care needs to be taken where auto sectionalising links are proposed to be installed particularly within the first protection zone to ensure that any small section conductor is adequately protected. The operation of ASL's in a typical distribution network is illustrated in Figure 1.

Where the protection on the HV source circuit breaker is 2 instantaneous shots with a final IDMT, and two shot auto sectionalising links are installed to protect a spur line comprising a small section conductor of 0.0225sq.inch Cu or less, then auto sectionalising links must not be installed where the fault level at the point on the network, where the auto sectionalising link is to be installed, exceeds 5kA. All spur lines where the fault level is above 5kA must be protected by either a PMAR or expulsion or current limiting fuses.

Where the protection on the HV source circuit breaker is time delayed then auto sectionalising links must not be installed where the fault level is above the following levels for the type of conductor being protected:

- 0.017sq.inch Cu Fault level must be below 2kA in all zones
- 0.0225sq.inch Cu – Fault level must be below 2kA in all zones
- 50mm^2 AAAC – Fault level must be below 4.5kA in all zones
- 0.05sq.inch Cu – Fault level must be below 5kA in all zones

Calculation of Auto Sectionalising Link Rating

The pick-up current of the auto sectionalising links (Actuating Current) must be greater than twice the maximum full load current of the circuit. The full load current of the circuit should be diversified where 2 or more transformers are connected to the spur line downstream of the auto sectionalising links.

The assessment of full load current must take account of three phase and single phase connections along the spur line under consideration. The maximum full load current can be calculated either by:

- Summation of the 'Transformer Rating Amp' values;

or

- Summation of the separate three phase and single phase transformer ratings and using:
  - 11kV – 5.3A per 100kVA (3-ph) and 9.1A per 100kVA (1-ph)
  - 20kV – 2.9A per 100kVA (3-ph) and 5.0A per 100kVA (1-ph)

Example:

Full load current (FLC) of spur = 40A
Diversified current = FLC/1.5 40/1.5 = 26.6A
Minimum Actuating Current 26.6 x 2 = 53.3A

The next highest auto sectionalising links actuating current is 56A (Refer Table 27 below). Auto sectionalising links must be specified based on continuous rating therefore a 35A rated unit is required.

Table 27: Table showing ASL continuous current ratings and associated actuating currents

Auto Sectionalising Link continuous current rating	Typical minimum actuating currents based on a 1.6x ratio
15A	24A
25A	40A
35A	56A
50A	80A
70A	112A
100A	160A
200A	320A

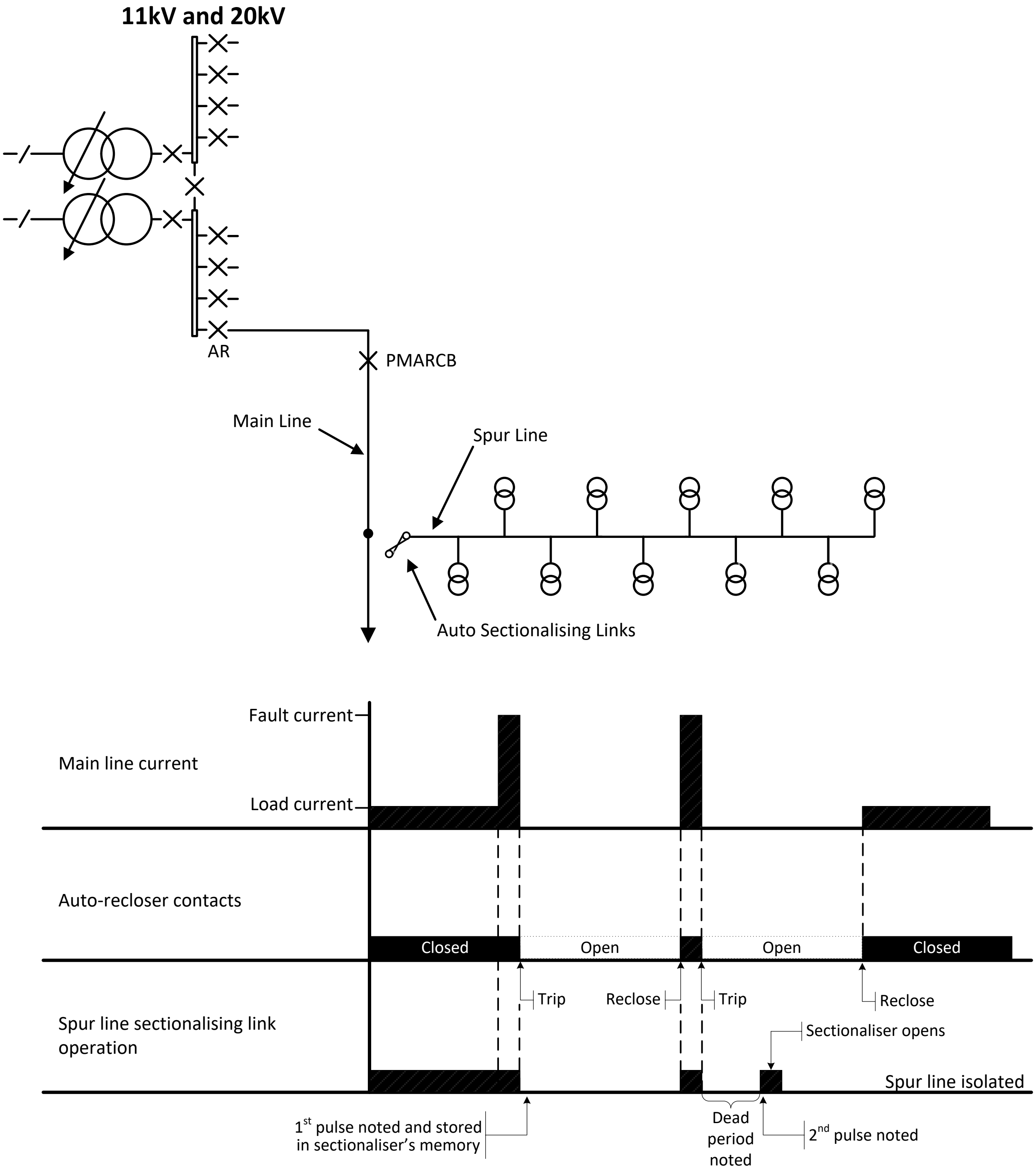


Figure 1: Typical Operation of ASL (Sequence showing 2 shot device)[24]

[24] Figure 1 is based on an extract from Cooper Bussmann, "Fuseology Medium Voltage Fuses", 2005And book from A. W. a. G. Newbery, Electric Fuses, London: The institution of Engineering and Technology, 2008.

Appendix 6: HV Circuits affected by Fault Level

This appendix illustrates where fault level duty on the overhead networks could be an issue and the application of current limiting fuse would help to manage the fault level issues associated with the drop out expulsion fuse. Figure 2 below provides the application of current limiting fuse against expulsion fuses. The current limiting fuse for overhead networks comes in two variants 25A for 11kV and 20A for 20kV networks which can fitted to the common back portion (i.e. fuse isolator) rated at 27kV.

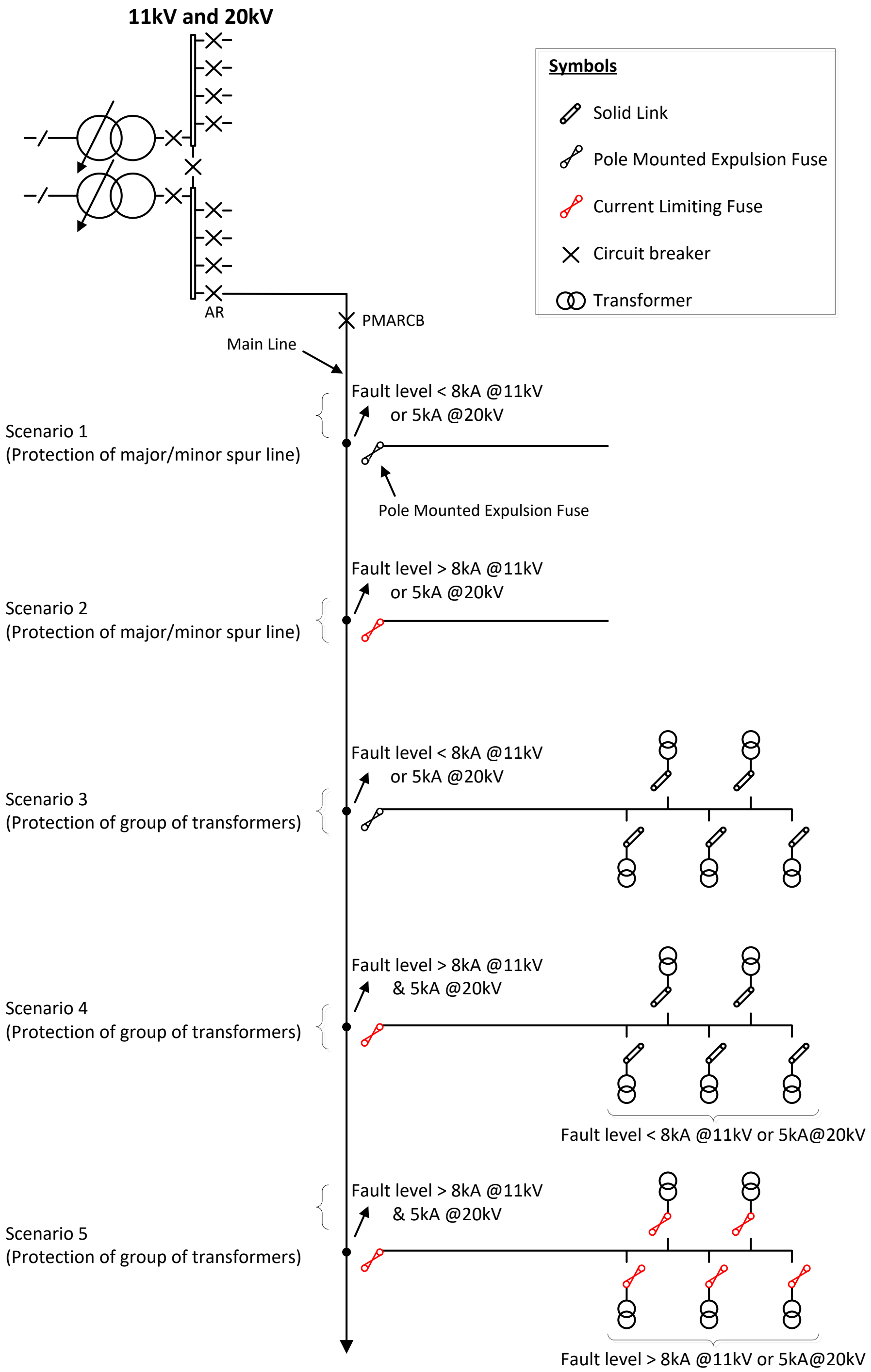
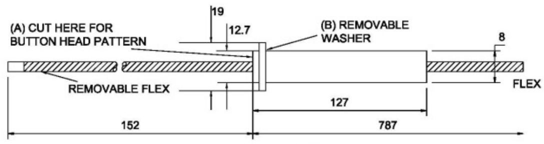


Figure 2: Schematic arrangement for HV Circuits to Manage Fault Level with HV fuses

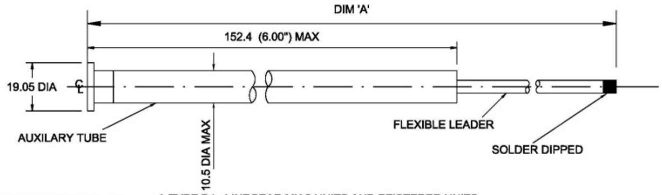
Appendix 7: Fuse Elements for 11kV and 20kV Fuse Units

ITEM	FUSE TUBE	FUSE RATING	CAT. No.	DESIGN TYPE
1	J & P & LINEGEAR Mk 1	6	245840	TYPE A
2		10	245037	
3		12	245041	
4		15	245056	
5		25	245018	
6		30	242518	
7		40	245060	
8		50	245111	
9		65	245446	
10		80	246580	
11		100	245183	
12	LINEGEAR Mk 2 & PFISTERER	6	245840	TYPE B
13		10	245037	
14		12	245041	
15		15	245056	
16		25	245018	
17		30	242518	
18		40	245060	
19		50	245111	
20		65	245446	
21		80	259114	
22		100	259129	



FUSE ELEMENT

(TYPE A) HISTORICAL 11/20kV J & P'S AND 20kV LINEGEAR MK 1



(TYPE B) LINEGEAR MK 2 UNITS AND PFISTERER UNITS

NOTES

GENERAL NOTES

1. ALL FUSE LINKS SHALL COMPLY WITH ANNSI C37-42 REQUIREMENTS FOR SLOW BLOWING T CHARACTERISTICS
2. SEE OPS INSTRUCTION 0.551 AND 0.554 FOR DETAILS OF CORRECT FUSE SIZES.

INSTALLATION OF FUSE LINKS IN HISTORICAL 11/20kV J & P'S OR LINEGEAR MK 1 20kV FUSE TUBES (TYPE A)

1 TO INSTALL THE UNIVERSAL FUSE LINK INTO LINEGEAR MK 1 TYPE FUSE TUBES, CUT OFF THE TOP PORTION OF THE FUSE ELEMENT FLEX - MARKED (A) ON THE DRAWING. THIS WILL RESULT IN A BUTTON STYLE LINK BEING LOCATED AT THE APPROPRIATE POSITION IN THE TUBE.
2 TO INSTALL THE UNIVERSAL FUSE LINK INTO HISTORICAL 11/20kV J & P FUSE TUBES, REMOVE THE WASHER MARKED (B) AND INSERT THE DOUBLE TAILED LINK INTO THE FUSE TUBE. LOCATE THE LINK APPROX. 1/2" FROM THE END OF THE TUBE IN ACCORDANCE WITH OHI 20 AND TRIM EXCESS FLEX TO SUIT

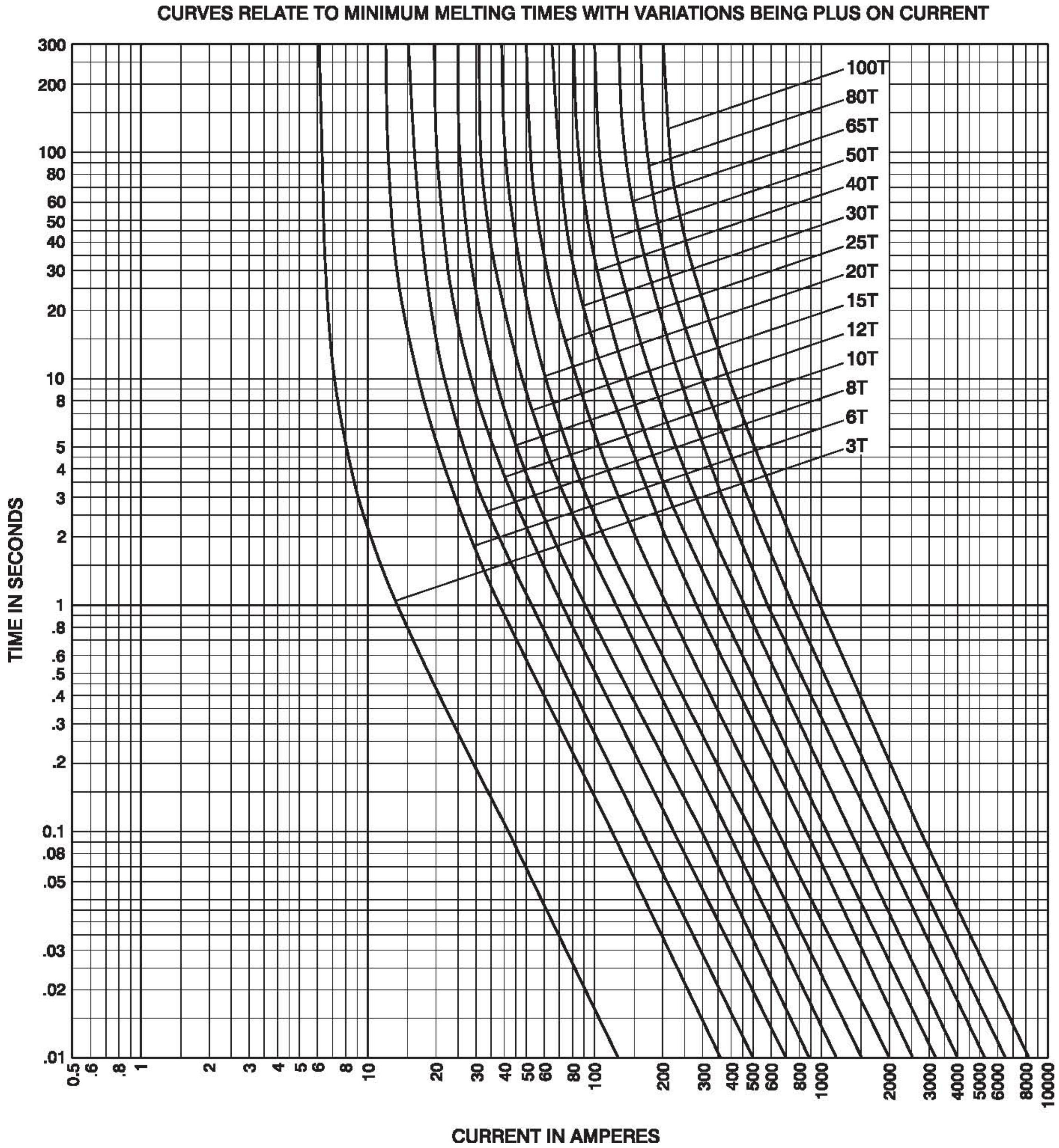
INSTALLATION OF FUSE LINKS IN LINEGEAR MK 2 AND PFISTERER UNITS C/W CHANCE TYPE 8kA 11/20kV FUSE TUBES. (TYPE B)

1 THIS FUSE LINK SHALL BE ATTACHED TO THE ARC SHORTENING ROD SUPPLIED WITH THE FUSE TUBE VIA THE 1/4" UNF THREAD.
2 THREAD IS REVEALED WHEN BUTTON END IS UNSCREWED

NORTHERN POWERGRID	Lloyds Court, 78 Grey Street, Newcastle Upon Tyne, NE1 6AF		
Manufacturer Details	FUSE ELEMENTS FOR 11 AND 20KV FUSE UNITS		
Sheet No. 3 / Scale N.T.S.			
Prepared By Barbara.Gordon	Type OVERHEAD	LINES	
Revised 18/10/16 / Grid Reference	Ref No. C1064218	Historic Drg.No.	1091471503
Date Issued 17/10/16 / Checked By S SALKELD	Revision	Notes	

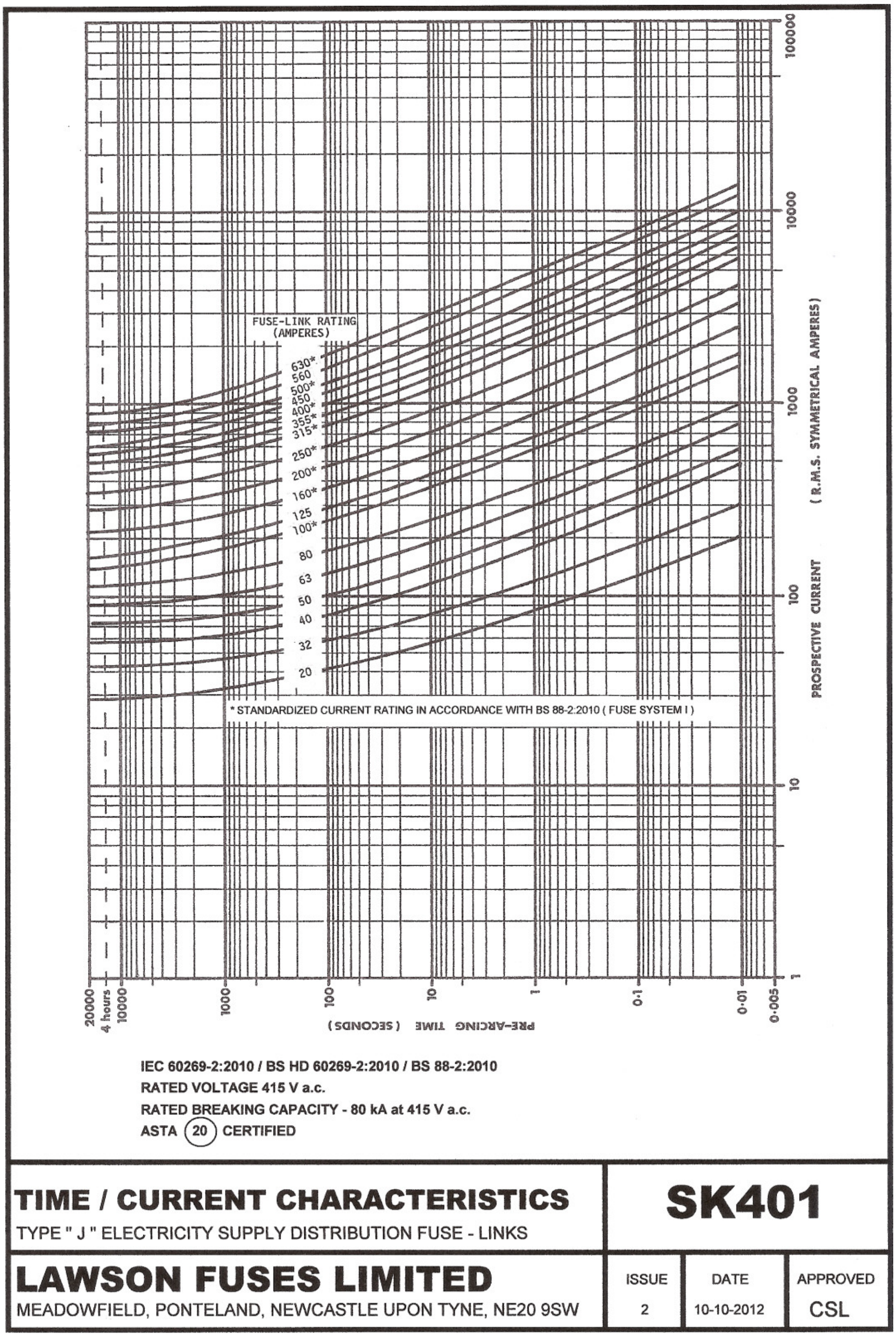
Appendix 8: Time-Current Characteristics of HV Expulsion Fuse-Links

Figure 3: Time-Current Characteristics for Bussmann Type 'T' Expulsion Fuse-Links



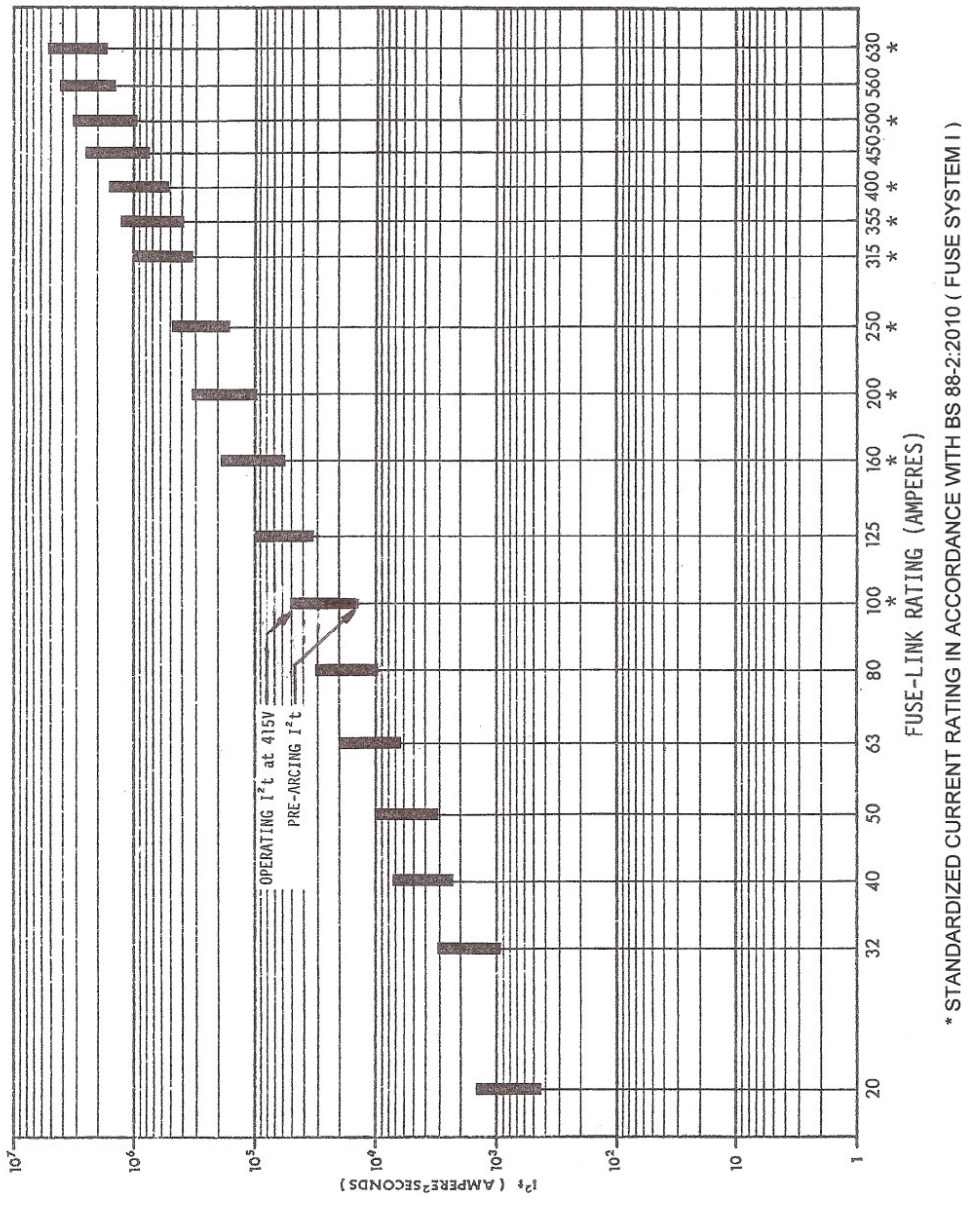
Appendix 9: Time-Current Characteristics of LV fuses

Figure 4: Lawson "J" Type LV Fuse-Links Time-Current Characteristics



Appendix 10: I^2t Characteristics of LV Fuses

Figure 5: Lawson "J" Type LV Fuse-Links I^2t Characteristics

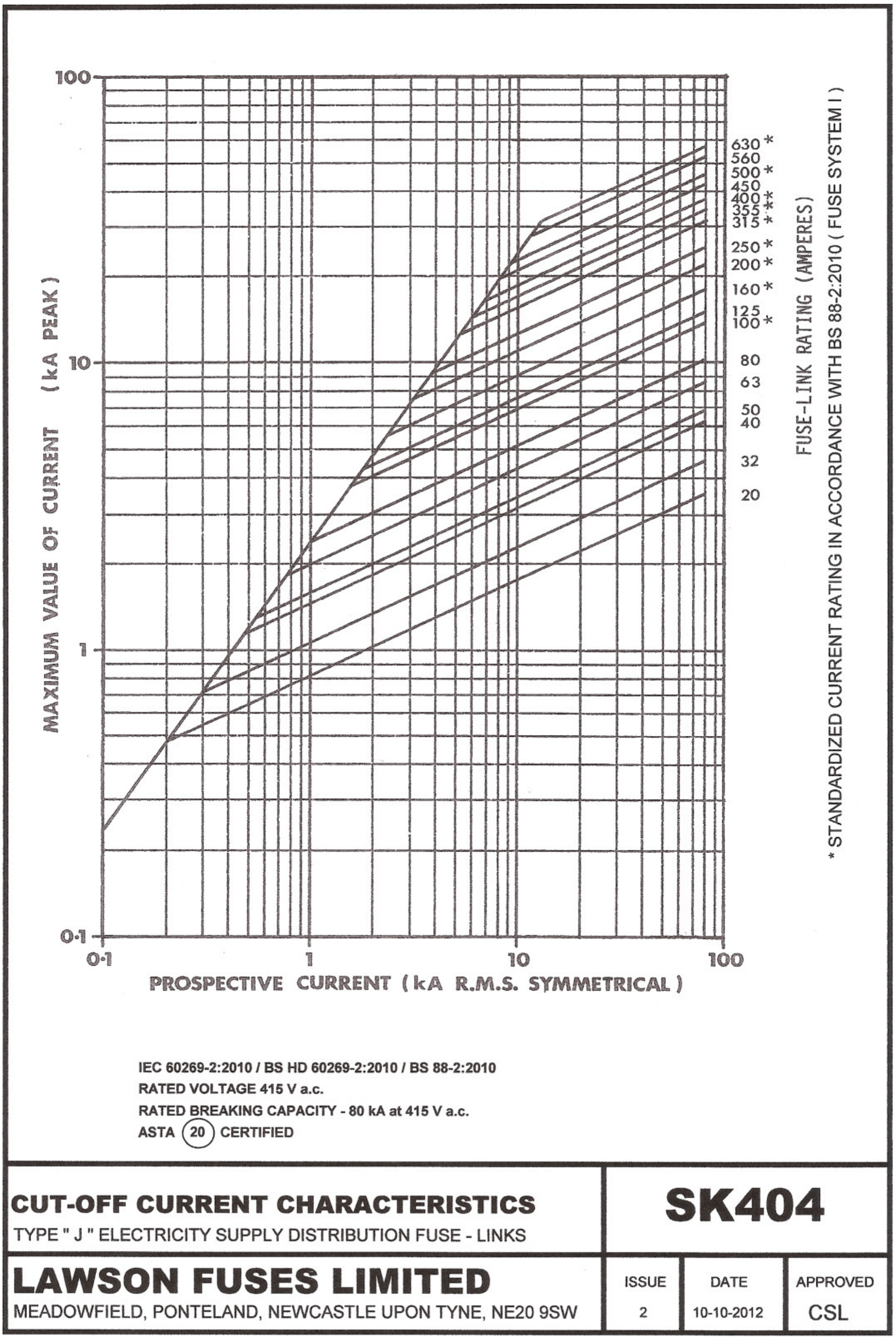


IEC 60269-2:2010 / BS HD 60269-2:2010 / BS 88-2:2010
RATED VOLTAGE 415 V a.c.
RATED BREAKING CAPACITY - 80 kA at 415 V a.c.
ASTA 20 CERTIFIED

I^2t CHARACTERISTICS TYPE " J " ELECTRICITY SUPPLY DISTRIBUTION FUSE - LINKS	SK405		
LAWSON FUSES LIMITED MEADOWFIELD, PONTELAND, NEWCASTLE UPON TYNE, NE20 9SW	ISSUE 3	DATE 10-10-2012	APPROVED CSL

Appendix 11: Cut-Off Current Characteristics of LV Fuses

Figure 6: Lawson "J" Type LV Fuse-Links Cut-off Characteristics



Appendix 12: Expulsions Fuse-Link Ratings

Table 28: Expulsions Fuse-Link Ratings for Various 11kV Pole Mounted Transformers

Transformer Rating to be protected				Universal Expulsion HV Fuse				LV Fuse	
				PM Transformer		GM Transformer		PM Transformer	GM Transfor
Voltage	Phases	kVA	Amps	Fuse Size	Commodity Code	Fuse Size	Commodity Code	Fuse Size	Fuse S
11kV	3 Phase	25	1.3	25A[b]	245018	-	-	100A	-
		50	2.6	Refer Table 4	Refer Table 4	-	-	Refer Table 4	-
		75	4	25A[b]	245018	-	-	160A	-
		100	5.3	Refer Table 4	Refer Table 4	10A	245037	Refer Table4	160A
		150	7.9	25A[b]	245018	12A	245041	315A	200A
		200	10.5	Refer Table 4	Refer Table 4	15A	245056	Refer Table 4	250A
		300	15.8	25Ab	245018	25A	245018	400A	400A
		315[C]	16.5	Refer Table 4	Refer Table 4	25A	245018	Refer Table 4	400A
		500[C]	26.5	-	-	40A	245060	-	500A
		800[C]	42.4	-	-	65A	245446	-	630A
		1000[C]	53	-	-	65A	245446	-	630A
	1 Phase 3 Wire	25	2.3	Refer Table 4	Refer Table 4	-	-	Refer Table 4	-
		50	4.6	Refer Table 4	Refer Table 4	-	-	Refer Table 4	-
		75	6.8	25A[b]	245018	-	-	315A	-
		100	9.1	Refer Table 4	Refer Table 4	15A	245056	Refer Table 4	315A
		150	13.6	40A[b]	245060	15A	245056	400A	400A
		167	15.2	40A[b]	245060	25A	245018	400A	400A
		200	18.2	Refer Table 4	Refer Table 4	25A	245018	Refer Table 4	400A
		225[C]	20.5	-	-	30A	242518	-	400A
		375[C]	34.1	-	-	40A	245060	-	500A
		580[C]	52.8	-	-	65A	245446	-	630A
	1 Phase 2 Wire	5	0.5	25A[b]	245018	-	-	100A	-
		15	1.4	25A[b]	245018	-	-	160A	-
		25	2.3	Refer Table 4	Refer Table 4	-	-	Refer Table 4	

Note:

a) This table provides the maximum distributor LV fuse rating for HV/LV discrimination other than mentioned below. The maximum permitted fuse size for the ground mounted LV system is 500A[12] less than the 630A LV fuse which would be permissible for grading with the HV. The maximum permitted fuse size on the pole mounted LV system is 400A as JPU fuse (PM LV fuse) are restricted to the 400A rated fixed contacts.

b) As there are different practices across the two business licenses for fusing pole mounted and inverted pole mounted transformer. Please refer to Table 2 and Table 3 of IMP/001/912 which outlines the protection requirements in the Northern Powergrid Northeast and Northern Powergrid Yorkshire.

c) Any new ground mounted transformer installed should be protected from ring main unit (if previously protected from expulsion fuses). This also applies to split phase ground mounted transformers.

d) Refer to drawing 1091471503 sheet 3 for details on modifying the universal fuse elements to fit into historical legacy fuse carriers.

Table 29: Expulsions Fuse-Link Ratings for Various 20kV Pole Mounted Transformers

Transformer Rating to be protected				Universal Expulsion HV Fuse				LV Fuse	
				PM Transformer		GM Transformer		PM Transformer	GM Transformer
Voltage	Phases	kVA	A	Fuse Size	Commodity Code	Fuse Size	Commodity Code	Fuse Size	Fuse Size
20kV	3 Phase	25	0.7	25A[b]	245018	-	-	100A	-
		50	1.4	Refer Table 4	Refer Table 4	-	-	Refer Table 4	-
		75	2.2	25A[b]	245018	-	-	160A	-
		100	2.9	Refer Table 4	Refer Table 4	6A	245037	Refer Table 4	160A
		150	4.3	25A[b]	245018	10A	245037	315A	315A
		200	5.8	Refer Table 4	Refer Table 4	10A	245037	Refer Table 4	315A
		300	8.7	25A[b]	245018	15A	245056	400A	400A
		315[C]	9.1	Refer Table 4	Ref Table 4	15A	245056	Refer Table 4	400A
		500[C]	14.5	-	-	25A	245018	-	500A
		800[C]	23.2	-	-	40A	245060	-	500A
		1000[C]	29	-	-	40A	245060	-	630A[a]
	1 Phase 3 Wire	25	1.3	Refer Table 4	Refer Table 4	-	-	Refer Table 4	-
		50	2.5	Refer Table 4	Refer Table 4	-	-	Refer Table 4	-
		75	3.8	25A[b]	245018	-	-	315A	-
		100	5	Refer Table 4	Refer Table 4	10A	245037	Refer Table 4	315A
		150	7.5	25A[b]	245018	10A	245037	400A	400A
		167	8.4	25A[b]	245018	10A	245037	400A	400A
		200	10	Refer Table 4	Refer Table 4	15A	245056	Refer Table 4	400A
		225[C]	11.3	-	-	15A	245056	-	400A
		333[C]	16.7	-	-	15A	245056	-	500A
		375[C]	18.8	-	-	25A	245018	-	500A
		580[C]	29.1	-	-	40A	245060	-	630A[a]
	1 Phase 2 Wire	5	0.3	25A[b]	245018	-	-	100A	-
		15	0.8	25A[b]	245018	-	-	160A	-
		25	1.3	Refer Table 4	Refer Table 4	-	-	Refer Table 4	-

Note:

a) This table provides the maximum distributor LV fuse rating for HV/LV discrimination other than mentioned below. The maximum permitted fuse size for the ground mounted LV system is 500A[12] less than the 630A LV fuse which would be permissible for grading with the HV. The maximum permitted fuse size on the pole mounted LV system is 400A as JPU fuse (PM LV fuse) are restricted to the 400A rated fixed contacts.

b) As there are different practices across the two business licenses for fusing pole mounted and inverted pole mounted transformer. Please refer to Table 2 and Table 3 of IMP/001/912 which outlines the protection requirements in the Northern Powergrid Northeast and Northern Powergrid Yorkshire.

c) Any new ground mounted transformer to be installed should be protected from ring main unit (if previously protected from expulsion fuses). This also applies to split phase ground mounted transformers.

d) Refer to drawing 1091471503 sheet 3 for details on modifying the universal fuse elements to fit into historical legacy fuse carriers.

Appendix 13: Fuse Rating for Overcurrent Protection on GM Network Transformer with TLF Fuse-Links (Legacy)[25]

Table 30: 1600kVA Transformer Time Fuse Overcurrent (Legacy)[25]

1600kVA TRANSFORMER

Voltage	Circuit Breaker with Time Fuses					
	Time Fuse to ENATS 12-6			Time Fuse Type Tin		
	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating
20kV	50/5	15A	800A	50/5	15A	800A
	80/5	7.5A	800A	80/5	12.5A	800A
11kV	100/5	12.5A	800A	100/5	15A	800A
	120/5	10A	800A	120/5	12.5A	800A
6.6 & 6.3kV	200/5	10A	800A	200/5	12.5A	800A
5.75kV	200/5	12.5A	80A	200/5	15A	800A
5.3 & 5.0kV	200/5	12.5A	800A	200/5	15A	800A

Note:

a) This table provides the maximum distributor LV fuse rating for HV/LV discrimination. The maximum allowed fuse size to utilise on the LV system is 500A[12] whereas 630A LV fuse mentioned on the table above is the maximum permissible LV fuse for grading with HV system.

b) The ratings shown for tin fuses do not apply to fuses compliant to ENATS 12-6.

c) Time fuse to ENATS 12-6 refers to the cartridge type time fuse, e.g. English Electric Type XF.

d) Time fuse type "Tin" refers to the time fuse of pure tin twisted wire construction, e.g. Reyrolle pattern.

e) For three phase transformers connected single phase use the CT ratio and fuse size recommended for the three phase transformer rating.

[25] Refer legacy document O.551: Protection of Network Transformers And Low Voltage Distributors.

Table 31: 1250kVA Transformer Time Fuse Overcurrent (Legacy)[25]

1250kVA TRANSFORMER

Voltage	Circuit Breaker with Time Fuses					
	Time Fuse to ENATS 12-6			Time Fuse Type Tin		
	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating
20kV	40/5	12.5A	600A	40/5	15A	800 A
	50/5	10A	600A	50/5	12.5A	800 A
11kV	80/5	12.5A	600A	80/5	15A	800 A
	100/5	10A	630A	100/5	12.5A	800 A
	120/5	7.5A	600A	120/5	10A	800 A
6.6 & 6.3kV	200/5	7.5A	600A	200/5	10A	800 A
5.75kV	200/5	10A	600A	200/5	12.5A	800 A
5.3 & 5.0kV	200/5	10A	600A	200/5	12.5A	800 A

Note:

a) This table provides the maximum distributor LV fuse rating for HV/LV discrimination. The maximum allowed fuse size to utilise on the LV system is 500A[12] whereas 630A LV fuse mentioned on the table above is the maximum permissible LV fuse for grading with HV system.

b) The ratings shown for tin fuses do not apply to fuses compliant to ENATS 12-6.

c) Time fuse to EA Technical Specification 12-6 refers to the cartridge type time fuse, e.g. English Electric Type XF.

d) Time fuse type "Tin" refers to the time fuse of pure tin twisted wire construction, e.g. Reyrolle pattern.

e) For three phase transformers connected single phase use the CT ratio and fuse size recommended for the three phase transformer rating.

Table 32: 1000kVA Transformer Time Fuse Overcurrent (Legacy)[25]

1000kVA TRANSFORMER

Voltage	Circuit Breaker with Time Fuses					
	Time Fuse to ENATS 12-6			Time Fuse Type Tin		
	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating
20kV	40/5	10A	600A	40/5	12.5A	800 A
	50/5	7.5A	600A	50/5	10A	800 A
11kV	80/5	10A	600A	80/5	12.5A	800 A
	100/5	7.5A	630A	100/5	10A	800 A
	120/5	5A	600A	120/5	7.5A	800 A
6.6 & 6.3kV	100/5	15A	600A	100/5	15A	800 A
	120/5	12.5A	600A	120/5	12.5A	800 A
5.75kV	100/5	15A	600A	100/5	15A	800 A
	120/5	12.5A	600A	120/5	12.5A	800 A
5.3 & 5.0kV	100/5	15A	600A	100/5	15A	800 A
	120/5	15A	600A	120/5	15A	800 A

Note:

a) This table provides the maximum distributor LV fuse rating for HV/LV discrimination. The maximum allowed fuse size to utilise on the LV system is 500A[12] whereas 630A LV fuse mentioned on the table above is the maximum permissible LV fuse for grading with HV system.

b) The ratings shown for tin fuses do not apply to fuses compliant to ENATS 12-6.

c) Time fuse to EA Technical Specification 12-6 refers to the cartridge type time fuse, e.g. English Electric Type XF.

d) Time fuse type "Tin" refers to the time fuse of pure tin twisted wire construction, e.g. Reyrolle pattern.

e) For three phase transformers connected single phase use the CT ratio and fuse size recommended for the three phase transformer rating.

Table 33: 800kVA Transformer Time Fuse Overcurrent (Legacy)[25]

800kVA TRANSFORMER

Voltage	Circuit Breaker with Time Fuses					
	Time Fuse to ENATS 12-6			Time Fuse Type Tin		
	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating
20kV	30/5	12.5A	500A	30/5	15A	800 A
	40/5	10A	600A	40/5	12.5A	800 A
	50/5	7.5A	600A	50/5	10A	800 A
11kV	80/5	7.5A	500A	80/5	10A	800 A
	100/5	7.5A	630A	100/5	7.5A	800 A
	120/5	5A	600A	120/5	7.5A	800 A

Note:

a) This table provides the maximum distributor LV fuse rating for HV/LV discrimination. The maximum allowed fuse size to utilise on the LV system is 500A[12] whereas 630A LV fuse mentioned on the table above is the maximum permissible LV fuse for grading with HV system.

b) The ratings shown for tin fuses do not apply to fuses compliant to ENATS 12-6.

c) Time fuse to EA Technical Specification 12-6 refers to the cartridge type time fuse, e.g. English Electric Type XF.

d) Time fuse type "Tin" refers to the time fuse of pure tin twisted wire construction, e.g. Reyrolle pattern.

e) For three phase transformers connected single phase use the CT ratio and fuse size recommended for the three phase transformer rating.

Table 34: 750kVA Transformer Time Fuse Overcurrent (Legacy)[25]

750kVA TRANSFORMER

Voltage	Circuit Breaker with Time Fuses					
	Time Fuse to ENATS 12-6			Time Fuse Type Tin		
	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating
20kV	30/5	12.5A	500A	30/5	15A	800 A
	40/5	10A	600A	40/5	12.5A	800 A
	50/5	7.5A	600A	50/5	7.5A	600 A
11kV	50/5	12.5A	500A	50/5	15A	800 A
	60/5	12.5A	630A	60/5	12.5A	600A
	80/5	7.5A	500A	80/5	10A	800 A
6.6 & 6.3kV	80/5	12.5A	500A	80/5	15A	600A
	100/5	12.5A	600A	100/5	12.5A	600A
	120/5	10A	500A	120/5	12.5A	800 A
5.75kV	80/5	15A	600A	80/5	15A	600 A
	100/5	12.5A	500A	100/5	15A	800 A
	120/5	10A	500A	120/5	12.5	800 A
5.3 & 5.0kV	100/5	12.5A	500A	100/5	15A	600A
	120/5	12.5A	500A	120/5	15A	800 A

Note:

a) This table provides the maximum distributor LV fuse rating for HV/LV discrimination. The maximum allowed fuse size to utilise on the LV system is 500A[12] whereas 630A LV fuse mentioned on the table above is the maximum permissible LV fuse for grading with HV system.

b) The ratings shown for tin fuses do not apply to fuses compliant to ENATS 12-6.

c) Time fuse to EA Technical Specification 12-6 refers to the cartridge type time fuse, e.g. English Electric Type XF.

d) Time fuse type "Tin" refers to the time fuse of pure tin twisted wire construction, e.g. Reyrolle pattern.

e) For three phase transformers connected single phase use the CT ratio and fuse size recommended for the three phase transformer rating.

Table 35: 500kVA Transformer Time Fuse Overcurrent (Legacy)[25]

500kVA TRANSFORMER

Voltage	Circuit Breaker with Time Fuses					
	Time Fuse to ENATS 12-6			Time Fuse Type Tin		
	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating
20kV	30/5	7.5A	400A	30/5	10A	600A
	40/5	5A	400A	40/5	7.5A	600A
11kV	40/5	12.5A	500A	40/5	15A	600A
	50/5	10A	500A	50/5	12.5A	600A
	60/5	7.5A	500A	60/5	10A	600A
6.6 & 6.3kV	60/5	12.5A	400A	60/5	15A	600A
	80/5	10A	400A	80/5	12.5A	500A
	100/5	7.5A	400A	100/5	10A	600A
5.75kV	80/5	12.5A	500A	80/5	15A	600A
	100/5	10A	500A	100/5	12.5A	600A
	120/5	7.5A	500A	120/5	10A	600A
5.3 & 5.0kV	80/5	12.5A	400A	80/5	15A	600A
	100/5	10A	400A	100/5	12.5A	500A
	120/5	7.5A	400A	120/5	10A	600A

Note:

a) This table provides the maximum distributor LV fuse rating for HV/LV discrimination. The maximum allowed fuse size to utilise on the LV system is 500A[12] whereas 630A LV fuse mentioned on the table above is the maximum permissible LV fuse for grading with HV system.

b) The ratings shown for tin fuses do not apply to fuses compliant to ENATS 12-6.

c) Time fuse to EA Technical Specification 12-6 refers to the cartridge type time fuse, e.g. English Electric Type XF.

d) Time fuse type "Tin" refers to the time fuse of pure tin twisted wire construction, e.g. Reyrolle pattern.

e) For three phase transformers connected single phase use the CT ratio and fuse size recommended for the three phase transformer rating.

Table 36: 315kVA Transformer Time Fuse Overcurrent (Legacy)[25]

315kVA TRANSFORMER

Voltage	Circuit Breaker with Time Fuses					
	Time Fuse to ENATS 12-6			Time Fuse Type Tin		
	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating
20kV	30/5	5A	315A	30/5	7.5A	400A
	40/5	3A	315A	40/5	5A	400A
11kV	40/5	7.5A	315A	40/5	10A	400A
	50/5	5A	315A	50/5	7.5A	400A
	60/5	3A	200A	60/5	5A	400A

Note:

a) The ratings shown for tin fuses are not applicable to fuses to ENATS 12-6.

b) Time fuse to EA Technical Specification 12-6 refers to the cartridge type time fuse, e.g. English Electric Type XF.

c) Time fuse type "Tin" refers to the time fuse of pure tin twisted wire construction, e.g. Reyrolle pattern.

d) For three phase transformers connected single phase use the CT ratio and fuse size recommended for the three phase transformer rating.

Table 37: 300kVA Transformer Time Fuse Overcurrent (Legacy)[25]

300kVA TRANSFORMER

Voltage	Circuit Breaker with Time Fuses					
	Time Fuse to ENATS 12-6			Time Fuse Type Tin		
	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating	CT Ratio	Time Fuse Rating	Max 415V Fuse Rating
20kV	30/5	5A	315A	30/5	7.5A	400A
	40/5	3A	315A	40/5	5A	400A
11kV	40/5	7.5A	315A	40/5	10A	400A
	50/5	5A	315A	50/5	7.5A	400A
	60/5	3A	200A	60/5	5A	400A
6.6 &	40/5	12.5A	315A	40/5	15A	400A
6.3kV	50/5	10A	315A	50/5	12.5A	400A
	60/5	7.5A	315A	60/5	10A	400A
5.75kV	40/5	15A	315A	40/5	15A	400A
	50/5	10A	200A	50/5	12.5A	400A
	60/5	10A	315A	60/5	12.5A	400A
5.3 &	40/5	15A	315A	40/5	15A	400A
5.0kV	50/5	12.5A	315A	50/5	15A	400A
	60/5	10A	200A	60/5	12.5A	400A

Note:

a) The ratings shown for tin fuses are not applicable to fuses to ENATS 12-6.

b) Time fuse to EA Technical Specification 12-6 refers to the cartridge type time fuse, e.g. English Electric Type XF.

c) Time fuse type "Tin" refers to the time fuse of pure tin twisted wire construction, e.g. Reyrolle pattern.

d) For three phase transformers connected single phase use the CT ratio and fuse size recommended for the three phase transformer rating.

Appendix 14: Network Transformers Controlled By Switch Fuses (Legacy)[25]

14.1. The range of legacy distribution transformers to be protected is from 100kVA to 1600kVA.

14.2. There are legacy substations which are still protected by HV switch fuses (cartridge type) both fuses in oil and air apart from the new substation which is protected by HV TLF fuses in conjunction with circuit breaker.

14.3. ENATS 12-8 Issue 3 "The application of fuse-links to 11kV/415V and 6.6kV/415V distribution networks" relates to co-ordination between 11kV and 415V fuse-links and specifies for both types of standard envelopes within which time current curves must lie. 11kV fuse-links complying with ENATS 12-8 were previously marked by the manufacturer with a reference indicating the rated voltage (in kV), whether for use in air (AIR) or oil (OIL) and the size of transformer for which it is suitable (e.g. 3 for 300kVA). Thus a fuse bearing the reference 11OIL5 is an 11kV fuse for use in oil and suitable for the control of a 500kVA transformer.

14.4. The present referencing convention is A for air fuses, O for oil fuses followed by number 1, 2, 3, 4 or 5 representing transformer ratings of 200, 315, 500, 800 and 1000kVA respectively. Current ratings only are given on fuses for transformers above 1000kVA as these fall outside the scope of ENATS 12-8.

14.5. NPg uses HV fuses complying with ENATS 12-8 for 6kV, 11kV and 20kV transformers, as indicated in Table 39 which additionally shows the maximum rating of 415V fuse which will discriminate with HV fuses.

14.6. The same fuses will also be used to protect 5kV - 6.6kV transformers whenever possible. Table 40 specifies suitable fuse ratings for transformers up to 800kVA. As no ENATS 12-8 fuse is suitable for use with a 300/315kVA transformer, fuses of appropriate current rating are specified.

14.7. Table 38 gives suitable current ratings of 20kV fuse-links selected from the range offered by NPg three principal suppliers. As the physical dimensions of 20kV and some 11kV fuse-links are identical, links for use on the 20kV system are marked 24kV in red on the barrel of the fuse, in addition to the normal type and rating particulars which are stamped on the metal end cap. The packaging of these fuses is also clearly marked "24kV fuse". Fuses without these markings should not be used in 20kV ring main units.

14.8. The fuse ratings specified in Table 38, Table 30 and Table 40 will operate for faults in the transformer LV terminal zone. The use of HV fuse ratings in excess of those given in the tables is not permitted as this may result in the LV terminal zone being inadequately protected.

14.9. NPg protection staff should be consulted regarding the rating of fuses to be used for transformers with ratings or voltages not included in the tables. Appendix 2 notes on "Selection of HV Fuse-Links with HV/LV discrimination" outlines the principles to be employed.

14.10. Fuses now in use on the HV system should not be changed solely in order to bring ratings into conformity with this Instruction. However, after operation of one or more fuses of a set, irrespective of whether in accordance with this instruction, the complete set of fuses should be replaced by fuses complying with the instruction.

Appendix 15: HV Fuse-Links for Network Transformers with Maximum LV Distributor Fuse Rating (Legacy)[25]

Table 38: HV Fuse-Links for 20kV Transformers (Legacy)[25]

TRANSFORMER RATING		1600kVA	1250kVA	1000kVA	750/800kVA	500kVA	300/315kVA	200kVA
Fuse Type		Fuse in Oil	Fuse in Oil	Fuse in Oil	Fuse in Oil	Fuse in Oil	Fuse in Oil	Fuse in Oil
Stock Catalogue No		287843	287843	287843	287843	287839	287824	280011
Brush (Hawker)	Type	OEGMA	OEGMA	OEGMA	OEGMA	OEGMA	OEGMA	OEGMA
HV Fusegear	Rating	50A	50A	50A	50A	31.5A	20A	10A
Max 433 V Fuse for Discrimination		600A	600A	600A	500A	500A	315A	200A
B & S	Type	OQGRN	OQGRN	OQGRN	OQGRN	OQGRN	OQGRN	OQGRN
HV Fuses	Rating	50A	50A	50A	50A	31.5A	20A	16A
Max 433 V Fuse for Discrimination		600A	600A	600A	600A	500A	250A	200A
GEC	Type	KTMXO	KTMXO	KTMXO	KTMXO	KTMXO	KTMXO	KTMXO
HV Fusegear	Rating	50A	50A	50A	40A	32A	20A	10A
Max 433 V Fuse for Discrimination		600A	600A	600A	600A	500A	315A	200A

Note:

a) The maximum LV fuse size mentioned on the table above is for discrimination purpose only. The maximum allowed LV fuse is limited to 500A due to current carrying of rating of 300mm^2 WNE cable.

b) For three phase transformers connected single phase use the fuse recommended for the three phase transformer rating.

Table 39: HV Fuse-Links for 11kV Transformers (Legacy)[25] [26]

TRANSFORMER RATING		1600kVA		1250kVA		1000kVA		750/800kVA		500kVA		300/315kVA		200kVA		100kVA	
Fuse Type		Fuse in Oil	Fuse in Air	Fuse in Oil	Fuse in Air	Fuse in Oil	Fuse in Air	Fuse in Oil	Fuse in Air	Fuse in Oil	Fuse in Air	Fuse in Oil	Fuse in Air	Fuse in Oil	Fuse in Air	Fuse in Oil	Fuse in Air
Stock Catalogue No		361524	361717	361789	361721	287805	287665	287788	287627	287716	287631	287699	287608	288009	287595	287970	361793
ENATS 12-8 Ref						05	A5	04	A4	03	A3	02	A2	01	A1		
Pre 1986 ENATS Ref						11 OIL 10	11 AIR 10	11 OIL 8	11 AIR 8	11 OIL 5	11 AIR 5	11 OIL 3	11 AIR 3	11 OIL 2	11 AIR 2		
Brush (Hawker)	Type	OLGMA	AKGHD	OHGHD	AKGHD	OHGMA	BFGHD	OHGMA	BFGHD	OEFMA	BDGHC	OEFMA	BDGHC	OEFMA	BDGHC		
HV Fusegear	Rating	125A	125A	100A	112 A	90A	100A	80A	71A	50A	45A	31.5A	31.5A	20A	20A		
Max 433 V Fuse for Discrimination		600A	600A	600A	600A	600A	600A	600A	600A	400A	500A	315A	315A	200A	200A		
B & S HV Fuses	Type	OSGRN		OSGRN	SRGRN	OQGRN	SRGRN	OQGRN	SRGSC	OQFRN	SOGSC	OQFRN	SOGSC	OQFRN	SOGSC	OQFRN	SOGSC
	Rating	125A		100A	100A	90A	90A	80A	71A	56 A	45A	40A	31.5A	20A	20A	10A	10A
Max 433 V Fuse for Discrimination		600A		600A	600A	600A	600A	600A	600A	500A	500A	400A	315A	200A	200A	60A	60A
GEC HV	Type	KEMXO		KEMXO	K16EAX	KEMXO	K16EAX	KEMXO	K16EAX	KEBXO	K16EAX	KEBXO	K16EAX	KEBXO	K16EAX	KEBXO	
Fusegear	Rating	120A		100A	100A	90A	85A	80A	70A	50A	45A	40A	30A	25A	25A	16A	
Max 433 V Fuse for Discrimination		600A		600A	600A	600A	600A	600A	600A	500A	500A	400A	315A	200A	200A	100A	

Note:

a) The maximum LV fuse size mentioned on the table above is for discrimination purpose only. The maximum allowed LV fuse is limited to 500A due to current carrying of rating of 300mm^2 WNE cable.

b) For three phase transformers connected single phase use the fuse recommended for the three phase transformer rating.

[26] Refer ENATS 12-8: The Application of Fuse links to 11kV/400V and 6.6kV/400V Underground Distribution Networks.

Table 40: HV Fuse-Links for 5kV - 6.6kV Transformers (Legacy)[25 26]

TRANSFORMER RATING		750/800kVA		500kVA		300/315kVA		200kVA	
Fuse Type		Fuse in Oil	Fuse in Air	Fuse in Oil	Fuse in Air	Fuse in Oil	Fuse in Air	Fuse in Oil	Fuse in Air
Stock Catalogue Number		287805	287665	287805	287665	288013	287612	287699	287608
ENATS 12-8 Ref		05	A5	05	A5	-	-	02	A2
Pre 1986 ENATS Ref		11OIL10	11AIR10	11OIL10	11AIR10	-	-	11OIL3	11AIR3
Brush (Hawker)	Type	OHGMA	BFGHD	OHGMA	BFGHD	OHGMA	BGDHC	OEFMA	BDGHC
HV Fusegear	Rating	90A	100A	90A	100A	71A	50A	31.5A	31.5A
Max 433 V fuse rating for discrimination		400A	500A	400A	500A	315A	315A	200A	200A
B & S HV Fuses	Type	OQGRN	SRGSC	OQGRN	SRGSC	OQGRN	SOGSC	OQFRN	SOGSC
	Rating	90A	90A	90A	90A	63A	50A	40A	31.5A
Max 433 V fuse rating for discrimination		400A	500A	400A	500A	315A	400A	200A	200A
GEC HV Fusegear	Type	KEMXO	K16EAX	KEMXO	K16EAX	KEMXO	K16EAX	KEMXO	K16EAX
	Rating	90A	70A	90A	50A	63A	30A	40A	30A
Max 433 V fuse rating for discrimination		400A	400A	400A	400A	315A	200A	200A	200A

Note:

a) For three phase transformers connected single phase use the fuse recommended for the three phase transformer rating.

Appendix 16: Time Limit Fuses (Legacy)[25]

Pure Tin Time Fusewire for elements of twisted wire construction

Table 41: Tin Overcurrent Time Fuses (Legacy)[25]

Rating in A	1.0	2.5	3.0	5.0	7.5	10	12.5	15	20
S.W.G.	36	31	27	24	22	20	19	18	17

Note:

a) Re-wireable time fuses supplied by this manufacturer consist of a barrel with a colour coded replacement element. The following table gives details of the elements which are equivalent to the standard pure tin type of fuse as supplied by Reyrolle and Yorkshire Switchgear and referred to in Table 30, Table 31, Table 32, Table 33, Table 34, Table 35, Table 36 and Table 37.

Table 42: Switchgear and Cowan Overcurrent Time Fuses (Legacy)[25]

Reyrolle or YSE	Switchgear and Cowans Ltd		
Rating	**Rating**	**Colour**	**Colour Number**
3A	2.5A	Natural	D99.00.5009
5A	5A	Black	D99.00.582
7.5A	7.5A	White	D99.00.583
10A	7.5A	White	D99.00.583
12.5A	12.5A	Brown	D99.00.584

Note:

a) When Switchgear and Cowan time limit fuses are not available it is possible to utilise the equivalent YSE fuses by adjustment of the fuse clips.