PR-NET-OSM-034

OPERATIONAL RATINGS OF SWITCHGEAR

OPERATIONAL SAFETY MANUAL - SECTION 4.10

Scottish & Southern Electricity Networks

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1 Introduction

1.1 The switchgear in use on the **SSEN-D High Voltage System** is comprised of a wide variety of different makes and types of **Switching** devices. It is essential that all Persons Authorised for **Switching** are aware of the capability of the **Switching** devices they may be required to operate.

1.2 This **Approved** procedure provides guidance on the operational ratings of switchgear.

2 Scope

2.1 The scope of this **Approved** procedure is to provide information relating to the operational ratings of **Switching** devices found on the **SSEN-D System**.

2.2 This **Approved** procedure applies to all staff and contractors working for or on behalf of **SSEN-D**.

3 References

The documents detailed in Table 3.1 - Scottish and Southern Electricity Networks Documents, and Table 3.2 - External Documents, should be used in conjunction with this document.

Table 3.1 - Scottish and Southern Electricity Networks Documents

Reference	Title
PR-NET-OSM-006	SSEN Distribution Operational Safety Rules – Operational Safety Manual – Section 1.1
PR-NET-OSM-028	Switching Terminology and Approved Abbreviations - Operational Safety Manual - Section 4.4
PR-NET-OSM-014	Response to System Faults - Operational Safety Manual – Section 2.4
PR-NET-OSM-037	Management of Operational Restrictions - Operational Safety Manual – Section 4.13
TG-NET-SST-021	After Fault Maintenance: Justification and Calculation Methodology
TG-NET-OHL-023	Rating Labels for Air Break Switch Disconnectors – Data Sheet
WI-NET-OSM-002	Personal Protective Equipment and Workwear for Live Environments
WI-PS-339	Appendix 7 Making and Breaking Live Connections
N/A	SSEN SHE Handbook (Held in Safety, Health and Wellbeing SharePoint Site)

Table 3.2 - External Documents

Reference	Title
BS EN IEC 62271-102	High-voltage switchgear and control gear
ENA TS 41-47	Pole Mounted, Non-Enclosed: Switch Disconnectors, Disconnectors, Earthing Switches, Fuse Switches (Expulsion fuses), Solid Links and Automatic Sectionalising Links (ASLs)
ENA ETR 137	Testing methodologies for power electronic devices
ENA ACE Report 75	Characteristics and performance of fuses for use on 11 kV overhead lines

4 Definitions

4.1 The words printed in bold text within this document are either headings or definitions. Definitions used within this **Approved** procedure are defined within the list presented immediately below, or within Section 2 of the **OSR**.

4.2 **Dependent Manual**

An operation executed solely by means of directly applied manual energy, such that the speed and force of the operation are dependent upon the action of the operator.

4.3 **Independent Manual**

A stored energy operation where the energy originates from manual effort, stored and released in one continuous operation, such that the speed and force of operation are independent of the action of the operator.

4.4 **Operational Safety Rules (OSR)**

The **SSEN-D** Distribution set of rules, as read with related documents and procedures, that provide generic safe systems of work on the **System** therefore ensuring the health and safety of all who are liable to be affected by any **Danger** that might arise from the **System**.

5 General Responsibilities

5.1 Persons who are required to operate and undertake work on the **System Shall** have a thorough understanding of the work and ensure on-site risks are suitably assessed and appropriate control measures put in place before, during and after all activities.

5.2 Persons must ensure that at all times during the work, (or associated testing), **General Safety** arrangements are maintained and that other work areas are not adversely affected by the activities for which they are responsible.

6 Authorisation

6.1 It **Shall** be the responsibility of the individual to ensure that any actions performed are within the bounds of their competency and authority level.

6.2 Competence and authorisation certificates **Shall** be retained personally and be made available upon request.

7 Personal Protective Equipment

7.1 Persons who are required to work or carry out **Switching** or testing on or near the **System Shall** wear suitably **Approved** Personal Protective Equipment (PPE). Furthermore, where warning labels or signs identify the existence of a particular hazard, additional and appropriate PPE **Shall** be worn.

7.2 As a minimum, PPE **Shall** meet the requirements of WI-NET-OSM-002.

8 General Requirements

8.1 Specific ratings for Switchgear and **Apparatus** connected to the **SSEN-D System** can be obtained from the Asset Standards Team.

8.2 Switchgear and **Apparatus Shall** be operated within its load current rating and in accordance with its fault current make and break capabilities.

8.3 Any specifications / ratings provided within this document may be restricted by the application of operational restrictions or a Suspension of Operating Practice (SOP).

8.4 **Dependant Manual** ground-mounted switchgear **Shall** not be operated **Live**. Operational restriction notices **Shall** be clearly affixed to **Plant** of this type. **Dependant Manual** ground-mounted switchgear forming part of a Neutral **Earth System** (e.g. Primary Substations) may be operated **Live**.

9 Circuit-Breakers

9.1 Circuit-Breakers are devices which, when operated within their capability, may be used to make and break fault current. Circuit-breakers have different fault break ratings.

9.2 Circuit-breakers **Shall** be **Approved** through the **SSEN-D** procurement process, to ensure they are suitably rated for their intended operation.

9.3 Should a circuit-breaker not be suitably rated to carry out its duty, the fault level reduction process in PR-NET-OSM-014 Response to System Faults - Operational Safety Manual – Section 2.4 **Shall** be followed.

9.4 Operational restrictions can reduce the stated rating of a circuit-breaker, all operational restrictions **Shall** be identified in line with the requirements of PR-NET-OSM-037 Management of Operational Restrictions - Operational Safety Manual – Section 4.13

9.5 Where an operator doubts the capacity of a particular circuit-breaker to perform the duty required, they **Shall** have the right to decline to operate it. The matter **Shall** be investigated and, if necessary referred to a higher authority for a decision before proceeding.

9.6 To safeguard the continued acceptable fault performance of a circuit-breaker, it is essential that the number of recommended fault interruptions is not exceeded before appropriate After-Fault Maintenance is carried out.

9.7 The number of fault interruptions for each device will depend on the fault level at the point of fault and the design of the circuit-breaker.

9.8 The method used to calculate After-Fault Maintenance requirements is detailed in TG-NET-SST-021.

9.9 If the permitted number of fault interruptions has been reached and one further reclose is required to restore consumer's supplies, this is permissible provided the circuit-breaker is first inspected externally for signs of distress. If the circuit-breaker condition is satisfactory, the switchroom **Shall** be vacated of all personnel and the reclose attempted by telecontrol or from a remote-control panel.

9.10 In addition to the requirements of Clause 9.9, the circuit-breaker should be left in an automatic mode in case of a subsequent fault. Access to the switchroom **Shall** be restricted to essential operational purposes only and for the minimum time necessary.

9.11 For circuit-breakers where the fault count has been extended, or where the shot count has been exceeded and the circuit-breaker has been reclosed to restore supplies, then after-fault maintenance **Shall** be carried out as soon as network conditions allow and without undue delay.

10 Overhead Line Apparatus

10.1 Air Break Switch Disconnectors (ABSDs)

10.1.1 The categories of air break isolating switches are those assigned by ENA Engineering Recommendation G18.

10.1.2 The fault levels used to determine the **Live** fault close capability is based on normal running conditions of the **System**. The opening of the feeding bus-section circuit-breaker (where transformers feed in parallel) or the opening of one transformer circuit-breaker by the **Control Engineer** might therefore lower the fault level sufficiently to within the rating of the device.

10.1.3 The ABSD Category and Fault Rating **Shall** be marked on the structure supporting the using the signs in Appendix C and shown on the Network Management System.

NOTE: Category 3 ABSDs are not marked as such on the structure, if an ABSD does not have a label, it **Shall** be assumed to be Category 3.

10.1.4 ABSD categories are shown in Table 10.1.

Table 10.1 - ABSD Rating Categories

Category	Type	Description
0[1]	ABSDs: Independent Operation – Interrupter Heads	ABSDs equipped with an independent operation mechanism, fitted with a self-contained arc extinguishing device ('interrupter heads') and ganged for simultaneous operation of all phases.
1	ABSDs: Dependent Operation – Interrupter Heads	ABSDs equipped with a dependent operation mechanism, fitted with self-contained arc extinguishing devices ('interrupter heads') and ganged for simultaneous operation of all phases.
2	ABSDs: Dependent Operation – Arcing Horns or Plain-Break Contacts	ABSDs equipped with a dependent operation mechanism, fitted with any type of load-break arcing contacts (e.g. arcing 'horns') or plain-break contacts and ganged for simultaneous operation of all phases.
3	ABSDs: All Other Types	ABSDs of all other types, irrespective of operating mechanism type, with no assigned rating.

[1]Note: **SSEN-D** do not currently use Category 0 devices on the **System**.

Ratings for ABSDs are shown in Appendix A.

10.2 Live Line Taps

10.2.1 **Live** line taps **Shall** not be used for making or breaking **System** parallels.

10.2.2 Information relating to connection and disconnections through **Live** line taps can be found in WI-PS-339.

10.3 Live Jumper Cutting

10.3.1 Jumper cutting **Shall** not be used for:

- Making and breaking **System** parallels, or
- Making and breaking load currents.

10.3.2 Information relating to connection and disconnections through Live jumper cutting can be found in WI-PS-339.

10.4 Expulsion Fuses

10.4.1 Expulsion fuses are often installed without a corresponding switch disconnector in the near vicinity. As such, expulsion fuses are often required to be operated **Live** in order to avoid disconnecting a larger section of network with the subsequent disruption to other customers.

10.4.2 Three duties need to be considered:

- Re-energising unproven sections of network (fault-making)
- Re-energising proven section of the network (load-making)
- Disconnection of a healthy section of network (load-breaking)

10.4.3 Consideration **Shall** be given prior to operating expulsion fuses as to the state of the **System** they control, i.e. is there a possibility of a fault.

10.4.4 Expulsion fuses, in good condition and correctly installed, **Shall** be assigned a fault-making duty of 7.5 kA. Expulsion fuses installed in a position where the fault level is greater than 7.5 kA **Shall** not be operated **Live**.

10.4.5 Expulsion fuses, in good condition and correctly installed, can be assigned a load-breaking rating of no more than 0.5 A magnetising current, and a predominantly resistive load current of the equivalent of no more than 500 kVA installed capacity. There is no requirement to off-load the **Low Voltage** side of a transformer prior to disconnection via **High Voltage** expulsion fuses.

10.4.6 Expulsion fuses, in good condition and correctly installed, can be assigned a load-making rating of 20 A at 11 kV and 10 A at 33 kV

NOTE: At 33 kV this can be increased to 1500 kVA installed capacity.

10.4.7 Due to the number of these devices installed on the Distribution **System**, it is considered inappropriate to prescribe any one particular identification and marking system to expulsion fuses.

10.4.8 Expulsion fuse ratings are shown in Appendix B.

11 Revision History

No	Overview of Amendments	Previous Document	Revision	Authorisation
01	New document created	TBC	1.00	Richard Gough
02				

Appendix A ABSD Ratings

A.1 Category 0 – ABSDs: Independent Operation – Interrupter Heads

Rated Voltage U_r kV rms	System Voltage kV rms	Rated Normal Current I_r A	Rated Short-circuit Withstand Current I_k kA	Rated Short-circuit Making Current I_{ma} kA Peak	Breaking Duty			
					Rated Mainly Active Load-Breaking Current I_{load} A	Rated Closed-Loop Breaking Current I_{loop} A	Rated Line-charging Breaking Current I_{lc} A (MVA Equivalent Connected)	Rated Cable-charging Breaking Current I_{cc} A (Equivalent Length in km)
7.25	6.6	400 630 800	- 20 25	25 40 50	400 630 800	400 630 800	1 (5)	7 (50 Solid cable)
12	11	400 630 800	10 16 20	25 40 50	400 630 800	400 630 800	1 (7.5)	10 (30 Solid cable)
24	20-22	400 630 800	10 16 20	25 40 50	400 630 800	400 630 800	1.5 (15)	16 (12 Solid cable)
36	33	400 630 800	10 16 20	25 40 50	400 630 800	400 630 800	2 (24)	20 (8 Solid cable) (5.5 Fluid filled cable)

NOTE 1: The values in this table reflect those for new equipment which is specified in ENA TS 41-47 Table 2.
NOTE 2: For special applications e.g. for switching networks involving long lengths of cable to supply embedded generation e.g. wind turbines, use the following ratings for cable-charging breaking current. Refer to Clause 7 of ENA ETR 137 for further information.
a) 12 kV, 25 A.
b) 24 kV, 40 A.
c) 36 kV, 50 A.
NOTE 3: The no-load transformer breaking current is based on the total installed MVA (Nameplate rating – natural cooling).
NOTE 4: The cable-charging breaking current is based on a copper conductor cable size of 185 mm^2 at 6.6 kV and 11 kV, and on 300 mm^2 at 20-22 kV and 33 kV.
NOTE 5: There is no practical limit on the length of overhead line charging current that may be interrupted.

A.2 Category 1 – ABSDs: Dependent Operation – Interrupter Heads

Rated Voltage U_r kV rms	System Voltage kV rms	Rated Short-circuit Making Current[1]) I_{ma} kA Peak	Breaking Duty			
			Rated Mainly Active Load-Breaking Current I_{load} A	Rated Closed-loop Breaking Current I_{loop} A	Rated Line-charging Breaking Current (No-load Transformer Breaking Capacity) I_{lc} A (MVA Equivalent Connected)	Rated Cable-charging Breaking Current I_{cc} A (Equivalent Length in km)
7.25	6.6	7.5	400	400	1 (5)	7 (50 Solid cable)
12	11	7.5	400	400	1 (7.5)	10 (30 Solid cable)
24	20-22	7.5	400	400	1.5 (15)	16 (12 Solid cable)
36	33	7.5	400	400	2 (24)	20 (8 Solid cable) (5.5 Fluid filled cable)

NOTE 1: The making and breaking ratings quoted above are confirmed by good operational and safety experience. Refer to ENA ETR 137.
NOTE 2: New equipment requirements for make and break duty are specified in ENA TS 41-47 Table 2.
NOTE 3: The breaking ratings the range of breaking capacities should be amended pro-rata, e.g. for a unit rated at 600 A the breaking capacities may be increased by 50%. The short-circuit making current is unaffected.
NOTE 4: The making and breaking ratings quoted above are independent of mounting arrangements.
NOTE 5: The no-load transformer breaking current is based on the total installed MVA (Nameplate rating – natural cooling).
NOTE 6: The cable-charging breaking current is based on a copper conductor cable size of 185 mm^2 at 6.6 kV and 11 kV, and on 300 mm^2 at 20-22 kV and 33 kV.
NOTE 7: There is no practical limit on the length of overhead line charging current that may be interrupted.

A.3 Category 2 – ABSDs: Dependent Operation – Arcing Horns or Plain-Break Contacts

Rated Voltage U_r kV rms	System Voltage kV rms	Rated Short-circuit Making Current I_{ma} kA Peak	Breaking Duty			
			Rated Mainly Active Load-Breaking Current I_{load} A	Rated Closed-loop Breaking Current I_{loop} A	Rated Line-charging Breaking Current (No-load Transformer Breaking Capacity) I_{lc} A	Rated Cable-Charging Breaking Current I_{cc} A (Equivalent Length in km)
7.25	6.6	7.5	33	Full load rating or 300 A whichever is less	1.4	5 (2.0 Solid cable)
12	11	7.5	20		1.4	5 (1.3 Solid cable)
24	20-22	7.5	17		1.8	5 (0.7 Solid cable)
36	33	7.5	10		2.0	5 (0.4 Solid cable) (0.3 Fluid filled cable)

NOTE 1: The making and breaking ratings quoted above are confirmed by long service experience. Refer to ENA ETR 137.
NOTE 2: New equipment requirements for make and break duty are specified in ENA TS 41-47 Table 2.
NOTE 3: The above breaking capacities are for units that are mounted horizontally above or below the line. For vertically mounted units the breaking capacity should be reduced by 50%.
NOTE 4: The no-load transformer breaking current is based on the total installed MVA (Nameplate rating – natural cooling).
NOTE 5: The cable-charging breaking current is based on a copper conductor cable size of 185 mm^2 at 6.6 kV and 11 kV, and on 300 mm^2 at 20-22 kV and 33kV.
NOTE 6: There is no practical limit on the length of overhead line charging current that may be interrupted.

A.4 Category 3 – ABSDs: All Other Types

Rated Voltage U_r kV rms	System Voltage kV rms	Rated Short-circuit Making Current I_{ma} kA Peak	Breaking Duty			
			Rated Mainly active Load-breaking Current I_{load} A	Rated Closed-loop Breaking Current I_{loop} A	Rated Line-charging Breaking Current I_{lc} A	Rated Cable-charging Breaking Current I_{cc} A
All voltages	All voltages	"Negligible current"	"Negligible current"	"Where no significant change in voltage across the terminals of each pole will result from the operation"	"Negligible current"	"Negligible current"
NOTE 1: Equipment in this Category has no making or breaking rating beyond the duties specified in BS EN IEC 62271-102. Such equipment will include: a) Units that are not ganged. b) Units that individual Distribution Network Operator Companies decide should be included in this Category because of deficiencies in design or installation, or environmental factors or operational history is abnormal. NOTE 2: "Negligible current" is given in 3.4.101 Note 1 of BS EN IEC 62271-102 - 'implies currents such as the capacitive currents of bushings, busbars, connections, very short lengths of cable. A current not exceeding 0.5 A is a negligible current for the purpose of this definition'. NOTE 3: Users may assign a limited rating to equipment in this category based on previous good experience.						

Appendix B Expulsion Fuses: Making and Breaking Duty

Rated Voltage U_r kV rms	System Voltage kV rms	Rated Short-circuit Making Current[1] I_{ma} kA Peak	Breaking Duty			
			Rated Mainly Active Load-Breaking Current[1] I_{load} A	Rated Closed-loop Breaking Current[2] I_{loop} A	Rated Line-charging Breaking Current[3] (No-load Transformer Breaking Capacity[3&4]) Ilc A	Rated Cable-charging Breaking Current Icc A
7.25	6.6	7.5	33	None	≤0.5 (500)	"Negligible current"
12	11	7.5	20		≤0.5 (500)	"Negligible current"
24	20-22	7.5	10		≤0.5 (500)	"Negligible current"
36	33	7.5	6		≤0.5 (500)	"Negligible current"

NOTE 1: The making and breaking ratings quoted above are confirmed by long service experience. Refer to ENA ACE Report 75 [1].

NOTE 2: The no-load transformer breaking current is based on the total installed kVA (Nameplate rating – natural cooling). For the purposes of this table, it has been assumed that all transformers are loaded to an arbitrary 75 % of nameplate rating.

NOTE 3: There is no practical limit on the length of overhead line charging current that may be interrupted.

NOTE 4: Although an expulsion fuse is deemed capable of interrupting magnetising current of an installed capacity of 2 000 kVA, it can only interrupt the full load current of 500 kVA. By restricting the installed capacity controlled by the device to 500 kVA, it avoids the necessity to off-load individual transformers prior to disconnecting the HV using an expulsion fuse. This restriction gives a conservative rating.

Appendix C Rating Labels for ABSDs

1. The labels replicated in this Section are found in TG-NET-OHL-023.
2. Fault levels less than or equal to the making capacity of the ABSD:

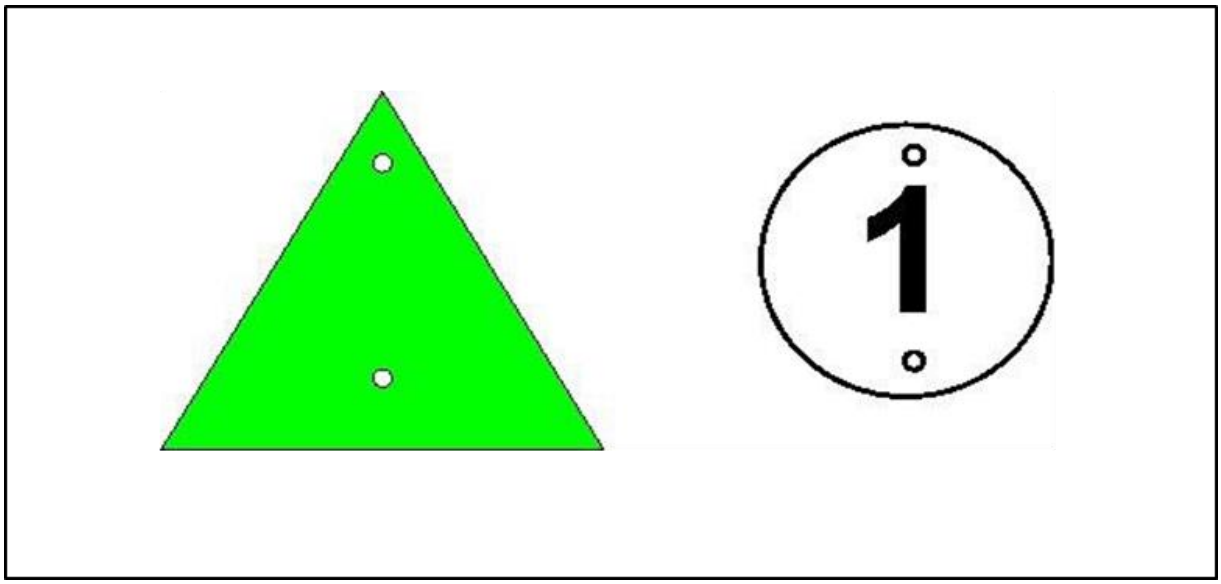

Figure C.1 - Category 1

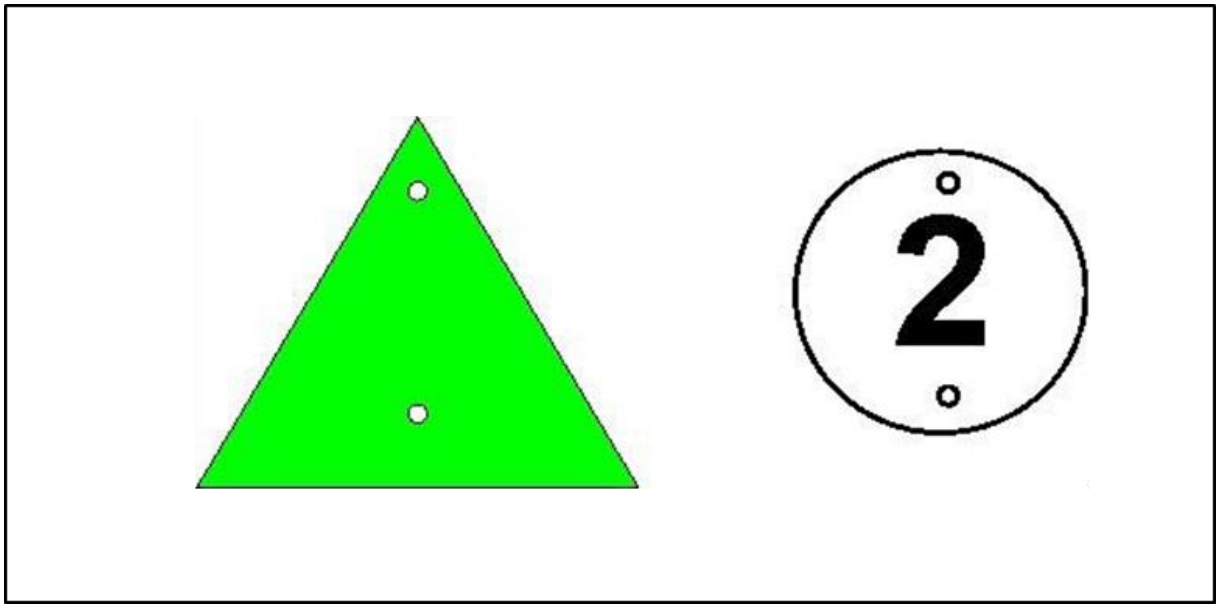

Figure C.2 - Category 2

3. Fault levels greater than the making capacity of the ABSD:

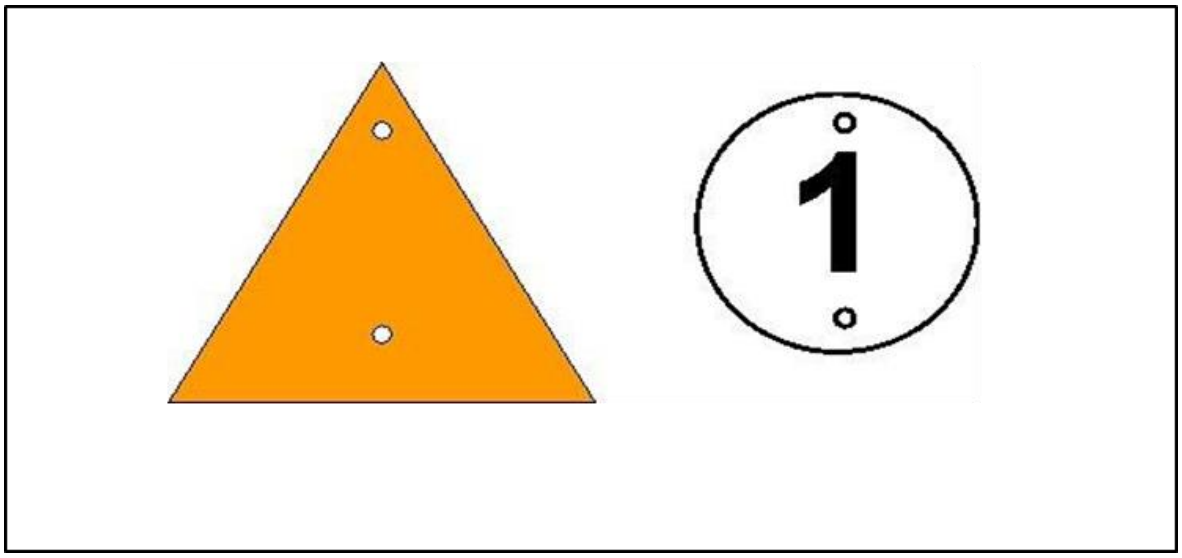

Figure C.3 - Category 1

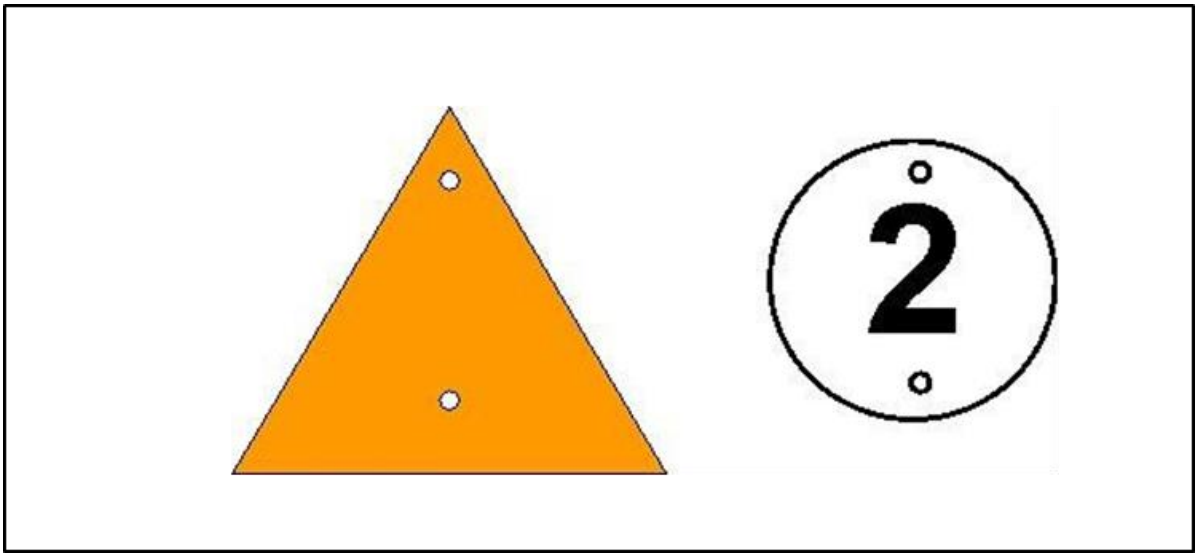

Figure C.4 - Category 2

4. Stock numbers for labels:

Table C.1 – Label Stock Numbers

Stock Number	Identification	Application
067047	1	Category 1 ABSD
067050	2	Category 2 ABSD
115291	Green Triangle	ABSDs which can be closed onto a fault
115333	Orange Triangle	ABSDs which cannot be closed onto a fault