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| <b>Technical Requirements for Electrical Equipment</b><br><br><small>Title</small><br><b>Low and medium voltage switchgears and control gears</b> | Document<br>TBE 118 |
|   | Issue<br>9          |
|   | Date<br>2020-04-20  |
|   | Supersedes<br>8 (E) |

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# 1      **General**

These Technical Requirements specify requirements for factory-built, metal enclosed switchgear and control gear assemblies intended for use in nuclear power plants. The requirements concern design, construction and documentation. Some requirements are therefore applicable only for certain types of equipment.

The Manufacturer/Supplier shall fulfil the requirements in order to meet the safety and reliability objectives of the Swedish Nuclear Power Plant (NPP) Owners.

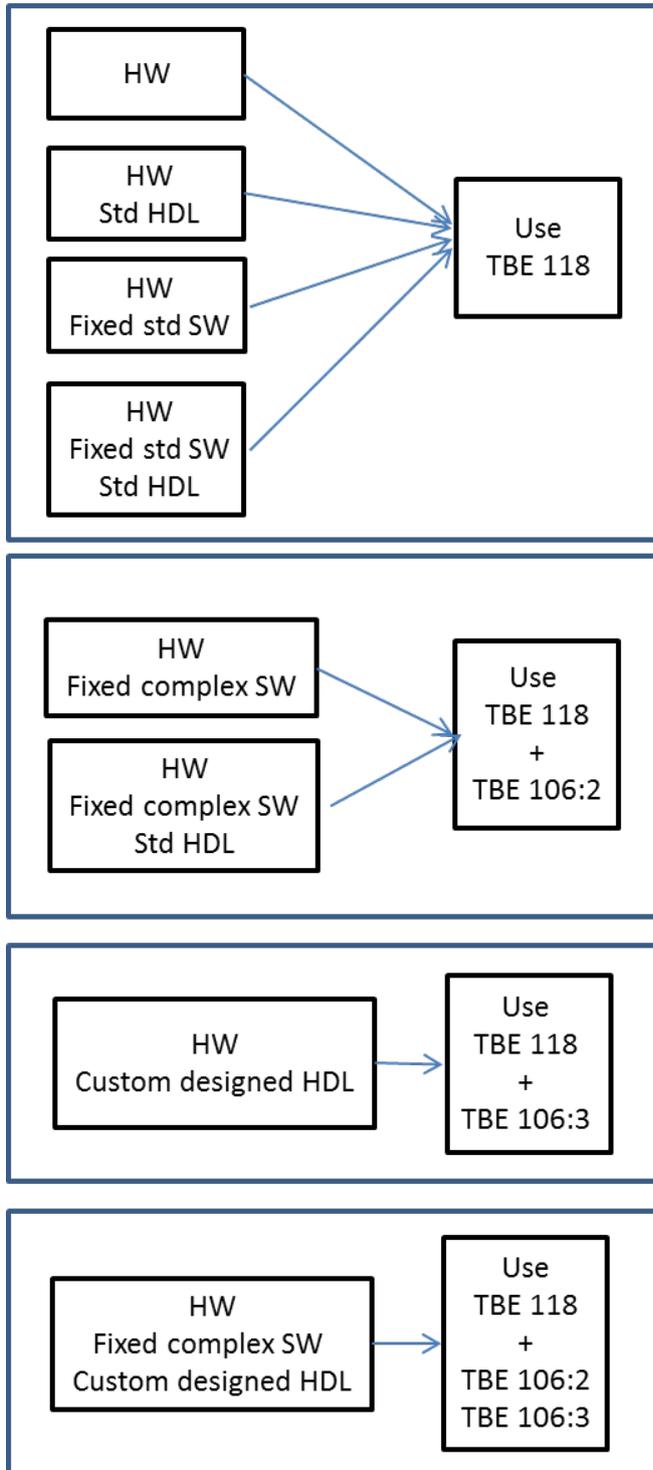
The purpose of this document is to provide Technical Requirements for factory-built, metal enclosed switchgear and control gear assemblies, up to and including 12 kV, intended for location indoor in electrical equipment rooms.

In addition to the requirements in this document, applicable parts of TBE 100:1 “General Technical Requirements and Explanations”, shall apply.

Detailed Technical Data, and in some cases other technical requirements to be followed, for the equipment is given in the Technical Specification. If the requirements in various documents differ, the Technical Specification shall have precedence.

Section 6 is a checklist that should be used when making an inquiry or an order.

## How to use combinations of TBE 118 and TBE 106:x



Definitions:

**Fixed std SW**

Application software for a single dedicated component and single use/few functions. Normally used/manufactured in large numbers.

**Fixed complex SW**

Application software for single dedicated component and single use with many functions. Normally used/manufactured in large numbers

**Std HDL**

HDL for single dedicated and single use/few functions. Normally used in large numbers.

**Custom designed HDL circuit**

Specific circuit, designed by use of a HDL tool and used in a custom designed application.

The above figure shows the relation between a specific equipment/component and its HW, SW and HDL elements and the related TBEs to be used. As an example, the interpretation of the upper block is as follow: TBE 118 is used as it is if the equipment consists of one of the following

alternatives HW only or HW and standard HDL or HW and fixed standard SW or HW, standard HDL and fixed standard SW.

## 2 Definitions

For general definitions see TBE 100:1 and KBE 100.

### **HDL-Programmed Device, HPD**

*Integrated circuit configured (for NPP I&C systems), with Hardware Description Languages and related software tools*

*NOTE 1 HDLs and related tools (e.g. simulator, synthesizer) are used to implement the requirements in a proper assembly of pre-developed micro-electronic resources.*

*NOTE 2 The development of HPDs can use Pre-Developed Blocks.*

*NOTE 3 HPDs are typically based on blank FPGAs, PLDs or similar micro-electronic technologies.*

(IEC 62566-1)

### **Printed Circuit Boards**

The general term for completely processed printed circuit or printed wiring configurations. It includes rigid and flexible, single, double and multilayer boards.

### **Printed Circuit Board Assembly**

A printed board with electrical or mechanical components, other printed boards, or a combination of these, attached to it with all manufacturing processes, soldering, coating, etc.

## 3 General product requirements

### 3.1 Standardisation

Switchgears and control gears shall comply with Swedish regulations and the standards listed below, except for items specified in section 3.1.1:

|               |  |
|---------------|--|
| IEC 60439     | Low-voltage switchgear and control gear assemblies   |
| IEC 62271-200 | High-voltage switchgear and control gear - Part 200: A.C. metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV |

Specific requirements on standards will be found in the Technical Specification.

In the tender, the Manufacturer/Supplier shall specify standards to which the product or delivery conforms. This also includes to which standards printed circuit boards and printed circuit board assemblies have been manufactured and mounted. If the standard referred to is divided into requirement levels for different classes, the Manufacturer/Supplier is also required to show which of these classes was applied.

The following documents are examples of applicable standards which can be the basis for the manufacturing of printed board assemblies:

|                    |   |
|--------------------|---|
| IPC-A-600          | Acceptability of printed boards                               |
| IPC-A-610(class 2) | Acceptability of electronic assemblies                        |
| J-STD-001          | Requirement for soldered electrical and electronic assemblies |
| IEC 61188-5-6      | Printed board and printed board assemblies                    |

The following documents are examples of applicable standards according to which components can be manufactured:

|             |  |
|-------------|--|
| IEC 60747   | Semi-conductor devices, discrete devices         |
| IEC 60748   | Semi-conductor devices, integrated devices       |
| IEC 60384   | Fixed capacitors for use in electronic equipment |
| IEC 60115   | Fixed resistors for use in electronic equipment  |
| IEC 60130   | Connectors for frequencies below 3 MHz           |
| IEC 60603-2 | Two part connectors                              |

#### 3.1.1 Deviations/Modifications from standards

Concerning EMC and immunity the equipment shall fulfil the requirements in TBE 101, table 5.

For emission the equipment shall fulfil the requirements in KBE EP-153.

## **3.2 Other technical requirements**

Since the greatest degree of uniformity in the plant is desirable, the Manufacturer/Supplier is to choose manufacturer including type of equipment and components in consultation with the Purchaser.

Crimping, soldering, wire-wrapping, shrinking and surface treatment are special processes and shall, therefore be performed according to qualified methods by specially trained personnel or by correctly set automatic processes.

### **3.2.1 Bus bar**

If not otherwise specified in Technical Specification the bus bar shall be of copper. Splices shall be avoided and shall, when necessary, be performed with a reliable and well-documented method.

### **3.2.2 Circuit breaker and disconnecter**

Circuit breakers shall be of reliable type and fulfil requirements according to standard specified in Technical Specification. The circuit breaker shall be able to cut out short-circuit current and voltage transients given in Technical Specification without need for maintenance. Purchaser shall agree type and Manufacturer/Supplier of circuit breaker. The circuit breaker shall be off truck or cassette type.

Maneuverer of disconnecter shall be able with closed door. The disconnecter shall have auxiliary contacts that in a safe way indicate the disconnecter position. Disconnectors shall be able to carry the short circuit current specified in the Technical Specification.

### **3.2.3 Current and voltage transformer**

Current and voltage transformer shall be of reliable type. Specifications according number of cores and accuracy class will be stated in Technical Specification.

### **3.2.4 Fuses**

Fuses for switchgear and control gears with rated voltage <1 000 V will normally be provided by the Purchaser if nothing else is agreed upon.

### **3.2.5 Lifting eyes**

To facilitate transport, the cubicles shall be provided with a sufficient number of lifting eyes or prepared to allow mounting of lifting eyes.

### **3.2.6 Protection of personnel**

Local manoeuvring shall be possible only if doors and hatches are closed and locked in the prescribed manner. Bypassing of door latches shall be made by tools and performed by qualified personnel.

When doors and hatches are closed and locked in the prescribed manner and if a fault occurs, no personal injury shall come to those who are in the immediate vicinity of the equipment. The Manufacturer/Supplier has to provide detailed description of the protecting devices.

### **3.2.7 Earthing requirements**

In order to enable future extension or exchange of equipment in operating plants the following requirements shall be subject to agreement between the Purchaser and the Manufacturer/Supplier.

#### General

Each low-voltage cubicle shall be provided with a busbar for protective earthing (PE) and if necessary a busbar for neutral connection. It shall be possible to connect a 120 mm<sup>2</sup> protective earth wire at each end of the PE busbar.

All exposed chassis, metal covers and other metallic parts shall be designed for connection to protective earth.

#### Earthing for maintenance work

It shall be possible to connect devices at maintenance work for earthing of the busbar and on the supply side of the incoming circuit breaker. Marking shall be provided on labels, approved by the Purchaser, indicating in text and location the connection points for earth at maintenance work.

#### Current and voltage transformers

The secondary side of current transformer shall be earthed close to the current transformer in such a manner that the earthing is made on the side facing the busbar.

The secondary sides of voltage transformers shall be earthed close to the voltage transformer.

### **3.2.8 Components**

Components used in the equipment shall be tested according to latest issue of applicable standards. This is the responsibility of the Manufacturer/Supplier.

Capacitors installed in power electronics shall comply with the standard EN 61071.

Electrolytic capacitors shall be of long-life types, e.g. IEC 60384-4 Long-life. Capacitors should not be older than two years at delivery to the Purchaser.

Potentiometers with carbon elements may not be used without the approval of the Purchaser.

### **3.2.9 Software**

Software used in the equipment shall fulfil requirements stated in TBE 106:x-y. Acceptable level is given in the Technical Specification.

Restriction in access to software and modification of parameters shall be specified in the Technical Specification.

If other than the above specified development process have been used it shall have followed the IEC 61508, SIL 2.

If higher requirements (e.g. SIL 3) is required, this can be achieved by use of SIL 2 classified components if it is configured according to the requirements in IEC 61508 to fulfil SIL 3.

If another documented and reviewable development process has been used that fulfils the requirement the Supplier/Manufacturer shall compare and specify to what extent the invoked standard or development process fulfils the above specified requirements.

Documented and traceable operating experiences may to a certain extent compensate deficiencies in the production methodology.

It is especially important that the Supplier/Manufacturer can produce a configuration management plan which provides a basis for defining, controlling and tracing requirements at different stages of completion during the design process as well as documentation and versions of software.

Tools used for testing, documentation, etc., shall be evaluated and approved by the Supplier/Manufacturer.

The Manufacturer/Supplier shall present all the equipment's implemented barriers concerning Cyber Security.

## **4 Nuclear specific requirements**

### **4.1 Isolation of faulty part**

Defect in material or malfunction by a feeding out devices shall not cause that the bus bar or other feeding out devices will be de-energized. Defect in material or malfunction by a feeding in devices shall be able to isolate so the bus bar can be supplied from other feeding in devices if such exist.

### **4.2 Isolation by external fault**

Fault in a feeding cable or in the supplied device shall not cause that other devices in the switchgear will be de-energized.

### **4.3 Components including HDL**

The Manufacturer/Supplier shall state if custom designed HDL-programmed integrated circuits are used.

Requirements are specified in Technical Specification as per TBE 106:3.

## 5 Documentation

Documentation requirements are given in TBE 100:1.

## 6 Agreement between Manufacturer/Supplier and Purchaser

This checklist should be used as a base between Manufacturer/Supplier and Purchaser when discussing tenders or orders.

|    |   |  |
|----|---|--|
| 1  | Review and completing Technical Specification   |  |
| 2  | Review of actual Inspection Plan and Examination Procedures   |  |
| 3  | Verification of seismic requirements  |  |
| 4  | Personal safety if fault occurs in switchgear, verification   |  |
| 5  | Blocking of e.g. hinges, disconnecter and circuit breaker   |  |
| 6  | Availability at operation for people with special permission  |  |
| 7  | Availability at maintenance and service   |  |
| 8  | Choice of preventive measures against direct contact  |  |
| 9  | Choice of preventive measures against indirect contact  |  |
| 10 | Protection class after dismantling of removable part  |  |
| 11 | Portable equipment for earthing or earthing and short-circuiting  |  |
| 12 | Equipment for earthing or earthing and short-circuiting of bus bar  |  |
| 13 | Arc testing time  |  |
| 14 | Arc protecting devices, localisation, functionality   |  |
| 15 | Pressure relief at short circuit, design  |  |
| 16 | Current in neutral phase at short circuit test  |  |
| 17 | Marking of bus bar horizontal and vertical  |  |
| 18 | Connections of external cables  |  |
| 19 | Connection of earth wire  |  |
| 20 | Current-carrying capacity of neutral phase  |  |
| 21 | Splitting into switchgear modules   |  |
| 22 | Selection of equipment e.g. change-over switches, signal system, pilot lamps etc.   |  |
| 23 | Replace ability between components with the same function, both mutually and to spare parts, without influence upon equipment performance |  |
| 24 | Cable and wiring  |  |
| 25 | Area for cables in main circuits and auxiliary circuits (including current and voltage transformer) that will be connected                |  |
| 26 | Coordination of short circuit protection (selective protection)   |  |
| 27 | Value of prospective current when more feeding-in or feeding-out devices with rotating machines with great power                          |  |
| 28 | Availability for expansion with electric voltage  |  |
| 29 | Environmental temperature at temperature rise test  |  |
| 30 | Marking plates outside cabinets, performance and location   |  |
| 31 | Marking plates upon devices, performance and location   |  |
|    | <b>Components including HDL</b>   |  |
| 32 | Documentation   |  |
| 33 | Mounting, orientation and earthing of current and voltage transformers  |  |
| 34 | Plant designation and marking   |  |
| 35 | The component side of each printed board shall be marked, in screen-printing or other durable method                                      |  |
| 36 | Information on solvents and cleaning procedures for printed board assemblies  |  |
| 37 | Packed, stored and handled to protect from electrostatic discharges (ESD)   |  |
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|----|-------------------------|--|
|    |                         |  |
|    | <b>Software</b>         |  |
| 38 | SW Development process  |  |
| 39 | SW Operating experience |  |
| 40 | Cyber Security          |  |