

Technical Requirements for Electrical Equipment <small>Title</small> Rack and Panel Mounted Process Instrumentation	Document TBE 104:1
	Issue 6
	Date 2020-04-20
	Supersedes 5 (E)

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Document	Issue	Date	Supersedes
TBE 104:1	6	2020-04-20	5 (E)

1 **General**

These Technical Requirements state the general requirements on Control Equipment and Process Instrumentation mounted in racks, panels, cabinets and boxes. The requirements concern design, performance and documentation. Some requirements are therefore applicable only for certain types of equipment.

Additional requirements for Equipment containing software are given in chapter 4.

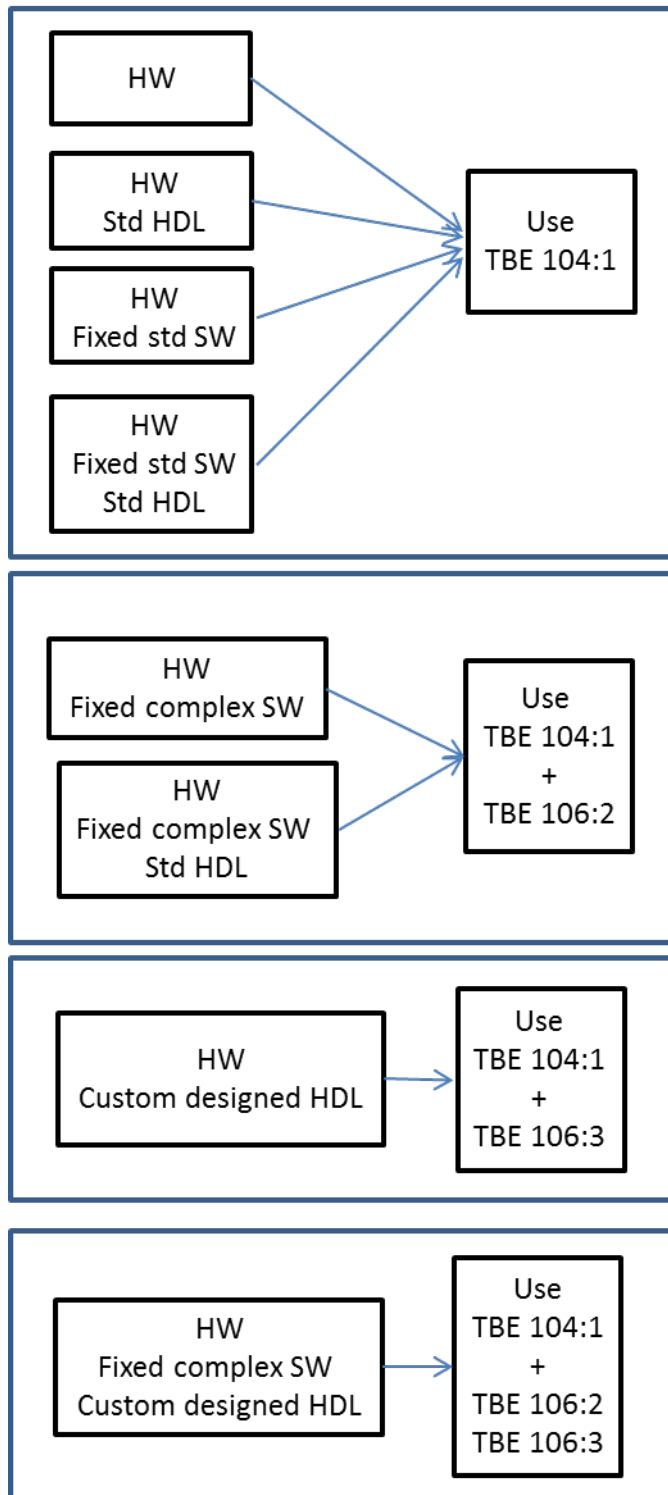
The equipment shall meet requirements in applicable EU-directives.

The purposes of these Technical Requirements shall state the general requirements on equipment for measurement, indication, signalling and protection as well as operating and regulating equipment.

In addition to this document applicable parts of TBE 100:1 “General Technical Requirements and explanation” apply.

Detailed technical data for the equipment are given in the Technical Specification (TS). If the requirements of various documents differ, the Technical Specification shall have precedence.

How to use combinations of TBE 104:1 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 104:1 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.

Some of the combinations above might not be relevant in practice.

2 Definitions

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

Hardware

Physical equipment used in data processing, as opposed to computer programs, procedures, rules, and associated documentation (IEEE, ISO)

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)

MTBF

Mean Time Between Failure

MTTR

Mean Time To Repair

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.

Programmable electronics (PE)

Based on computer technology which may be comprised of hardware, software and of input and/or output units

NOTE – This term covers microelectronic devices based on one or more central processing units (CPUs) together with associated memories, etc.

Example: The following are all programmable electronic devices

- microprocessors*
- micro-controllers*

- *programmable controllers*
- *application specific integrated circuits (ASICs)*
- *programmable logic controllers (PLCs)*
- *other computer-based devices (for example smart sensors, transmitters, actuators)*

(IEC 61508-4)

Software

A set of ordered instructions and data that specify operations in a form suitable for execution by a digital computer (IEC 60880)

Safety Integrity Level (SIL)

Discrete level (one out of a possible four) for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/PE safety-related systems, where safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest

NOTE – The target failure measures (see 3.5.13) for the four safety integrity levels are specified in tables 2 and 3 of IEC 61508-1.

E/E/PE

electrical/electronic/programmable electronic

3 Product Requirements

3.1 Standardisation

The standards referred in the document are:

IEC 60947-5-1	Low-voltage switchgear and control gear-Part 5-1: Control circuit devices and switching elements – electromechanical control circuit devices
IEC 60297-3	Dimensions of mechanical structures of the 19 inch series
IEC 60447	Basic and safety principles for Man-machine interface, Marking and identification - Actuating principles
IEC 61812-1	Specified time relays for industrial use – Part 1: Requirements and tests
IEC 61508	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1-4

Other requirements of standards are specified in the Technical Specification.

The Manufacturer/Supplier shall in the quotation present degree of compliance with the regulations and applicable product standards. 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 General Technical Requirements

As a high degree of uniformity in the plant is desirable, the Manufacturer/Supplier shall choose type of equipment in consultation with the Purchaser.

General requirements on process instrumentation such as measurement range, resolution, settings and maximum acceptable errors including hysteresis, repeatability, accuracy etc. are specified in the Technical Specification.

Manufacturer/Supplier shall state the present response times for various functions. Response times shall be verified by test.

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 Reliability

The equipment reliability shall be stated by the Manufacturer/Supplier. Information of MTBF and MTTR values shall be given. The Manufacturer/Supplier shall specify how these data has been developed e.g. by calculation or by using operating experience.

3.2.2 Components

The Manufacturer/Supplier shall verify that components such as relays, circuit boards, indicators, controllers, limit switches etc. included in the equipment are tested and inspected according to applicable standards.

A list containing the parts of the component including technical information such as type, part number, manufacturer, value and tolerance shall be available upon request of the Purchaser. Original texts on parts may not be removed.

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.

3.2.3 Contact rating

The breaking capacity for contacts shall be according to IEC 60947-5-1. For contacts with maximum 110 VDC, Category DC 13 is applicable and for contacts with maximum 220/230 VAC, Category AC 15 is applicable. Other well-known standard may be accepted after the Purchasers approval.

3.2.4 Input and output circuitry

Input and output circuits should not be damaged by short-circuits or open circuits in connected equipment.

3.2.5 Cooling

The equipment shall be designed so that forced cooling is not needed. If forced cooling with fans is necessary a possible loss of individual fans in cooling or ventilation systems should not affect availability of the equipment. As an alternative, replacement of fans shall be possible during equipment operation.

Faults in cooling or ventilation systems that cause an increase in temperature that may damage the equipment shall give an alarm.

3.2.6 Marking

The component side of each printed board shall be marked, in screen-printing or other durable method, with information of board type, serial number and revision. All markings shall, where possible, be legible even after the printed board has been equipped with components.

3.2.7 Packaging and Handling

Printed board assemblies shall be packed, stored and otherwise handled so they are satisfactory protected from electrostatic discharges (ESD). Circuit boards shall always be packed in ESD-protective packages during transport and storage. Personnel handling sensitive components shall have necessary training and equipped with protective devices to reduce the exposure to ESD.

3.3 Testability

The Manufacturer/Supplier shall state how the equipment shall be verified after replacement of component, repair, modifications/upgrade of software or in connection with recurring testing.

It shall be possible to verify (simulate) important functions which are specified in the Technical Specification

3.4 Other Technical Requirements

3.4.1 Cabinets, racks and chassis

Cabinets, racks and chassis, if not otherwise specified, shall be of the 19-inch type in accordance with IEC 60297-3. Cabinet types are specified in the Technical Specification.

3.4.2 Panel instrument, recorders and data loggers

Glass surfaces should have an anti-reflection coating. Instruments and recorders should be made of materials, which do not contribute to static electricity. Panel indicators should have a zero adjustment screw on the front.

In general, scales shall be linear. For certain applications, e.g. conductivity and radioactivity measurement, nonlinear scales may be approved.

Equipment used for recording/logging of measured data should have easily read scales with legends corresponding to recorded quantities.

If multiple measured data are shown at the same view they shall have a separate scale for each recorded variable and coloured with the corresponding recording trace. Selection of colours in agreement with the Purchaser

3.4.3 Relays

Auxiliary relays should be manufactured and tested according to IEC 60947-5-1 or other standards accepted by the Purchaser.

Time relays should be manufactured and tested according to IEC 60812-1 or other standards accepted by the Purchaser.

3.4.4 Switches

Switches shall be mounted in a rigid way and have distinct switching positions. Switches in circuits with voltages of less than 40 V and currents of less than 30 mA should have dust-proof casings and self-cleaning contacts. The materials in contact elements shall be chosen according to requirements of TBE 100:1.

The positions of rotary switches shall comply with IEC 60447. A locking device should be provided to ensure that the knob could only be mounted in the correct position.

Toggle switches with an On/Off function shall be mounted so that the positions are in accordance with IEC 60447.

3.4.5 Indicating devices

Light sources for indicating devices should preferably be of the Light Emitting Diode type.

Breaks or short-circuits in an indicating device should not affect the performance of connected devices. Lamp replacements in switches or indicating devices shall be performed without risk of unintentional operation or short-circuiting.

3.4.6 Arrangement of equipment and components

Equipment should be placed well protected from vibrations, large variations in temperature, contamination and splash of water. Cables and conductors shall be protected from heat-emitting equipment.

Instruments shall be arranged in groups to facilitate readings. Adjustment and calibration devices should be easily accessible and access should not involve a risk of danger to maintenance personnel.

Space in cabinets and boxes should be sufficiently generous and the arrangement of equipment should be done so, that maintenance and replacement of devices and components do not affect adjacent equipment.

Fuses shall be placed in easily accessible positions and in such a manner that they can be replaced without danger.

Components, terminals and other equipment parts should be so arranged in a way that connections, operating controls and measurement devices shall be easily accessible during operation without the use of special tools.

3.4.7 Operation, adjustment, calibration and troubleshooting

Everything of importance for operation, testing, calibration, adjustment or troubleshooting shall be marked, be easily accessible and have test terminals or be connected to indicating instruments.

The terminals on the component shall be provided with a robust protection or locking device to prevent changes of settings due to unintentional manipulations. A closed door or cap can be used as such a protection device. Shocks and vibrations that may take place in environments specified for the equipment should not affect operation and trimming devices.

Test points with a peak voltage exceeding 250 V shall be provided with voltage dividers.

Adjustment ranges for operation and trimming devices shall be chosen so that the setting of values can be performed within the whole working range and with the requisite accuracy.

Equipment circuit design shall be such that stability of set values is achieved.

3.4.8 Interchangeability

Identical equipment parts are normally to be freely interchangeable, both with each other and with corresponding spare parts, without any impairment to measurement accuracy or performance. Re-adjustment of the equipment in connection with replacement is acceptable.

Replacement intervals for components with limited life, e.g. electrolytic capacitors, shall be specified.

4 Additional Requirements for Equipment containing Software

These additional requirements shall be applicable on all components and equipment using software for collecting, converting data, controlling other equipment or network components.

- This type of equipment is configured by setting different parameters by using buttons, switches on the front panel or by using a specific tool.
- Examples of such kind of equipment are converters and relays.
- Equipment using software may only use fixed application.
- The equipment may only use one or a limited number of inputs signals and convert them into defined output signals as mA, V or a logical level.
- If two-way communication is possible this shall be blocked. Wireless communication is not allowed if not approved by the Purchaser.
- The Manufacturer/Supplier shall specify the communication protocols with reference to applied standard.
- USB communication is only permitted for communication with peripheral units.
- It shall be possible to identify the current version of the software in the equipment by use of a superior system or other tools.

If any of the above requirements cannot be fulfilled TBE 106:2 shall be used.

Abnormal conditions, preposterous signals or cyber security attacks shall give an alarm and result in a safe state or be excluded if it can be handled by the equipment or the system.

The Manufacturer/Supplier shall specify all initial values of the output signals during the complete start-up sequence of the equipment.

Security aspects (data communication)

Requirement on Cyber Security is specified in TBE 100:2.

The following shall also be presented to the Purchaser.

- The Manufacturer/Supplier shall present all the equipment's implemented barriers concerning Cyber Security.
- The Supplier/Manufacturer shall state the possibility for encryption/alternative method/solution if reinforced security is required.
- The Supplier/Manufacturer shall be able to show that data are not distorted/number of retransmissions of telegrams is kept to a minimum.

4.1 Product Requirements

The method used to develop and manufacture the product shall conform to IEC 61508 SIL2 in combination with documented and traceable operating experience. If another development model has been used corresponding to the same quality level that is documented and reviewable the Manufacturer/Supplier shall describe the development model used for the equipment.

Documented and traceable operating experiences may to some extent compensate the shortcomings of the method used to produce the software.

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

4.2 Tools

Tools used for configuration, parameterisation, testing, fault tracing, etc., shall be evaluated and approved by the Manufacturer/Supplier.

4.3 Nuclear Specific Requirements

4.3.1 Components including custom designed 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

In addition to the documentation requirements according to TBE 100:1, the following requirements apply:

5.1 Product Documentation

The product documentation shall include data sheets, technical description and a description of the software function.

For PE-equipment the SW function shall be described and the version/revision number of the software shall be stated.

The Manufacturer/Supplier shall present identified potential cyber security risks when using tools or other possible terminals or possibilities for communication connections.

5.2 Design Documentation

The design documentation describes how equipment and components are connected together electrically. Normally it includes:

- Internal and external connections
- Circuit diagram
- Terminal connections
- Component list
- Measurement specification
- Installation guidance
- Block diagram

It shall be possible to follow signals by means of unambiguous references in the function diagram and to the circuit diagram, within the system and to other connected systems.

5.2.1 For equipment containing PE the following also applies:

The parameter list provides a list of timer circuits, counters and so on. There should be a list of the variables used. Inputs and outputs are shown on the circuit diagram and need not be included in the parameter list unless they have particular properties. Information about bit- and time resolution shall also be included.

The logic diagram and the control block diagram give an overall description of the system function. Generally it cannot be replaced by the function diagram, since this has such a high level of detail and information density that it becomes unsuitable for describing the system function for normal operation.

5.3 Maintenance Documentation

The maintenance guide describes:

- Fault localisation, troubleshooting
- Fault correction
- Preventive maintenance (checks, calibrations, cleaning, replacement of components with limited life in relation to the life of the system/component)
- Adjustment of parameters
- Equipment to perform the above function

5.3.1 For equipment containing PE the following also applies:

Linking between version/revision numbers for:

- * hardware
- * software
- * tools

Start and restart of the component.

Instructions for how to make back-up and restoring the software.

5.4 Operating Documentation

Documentation that is used for daily operation shall be written in Swedish.

5.5 Inspection Documentation

The Manufacturer/Supplier shall provide documentation from the performed Type Tests and Routine Tests according to the agreed inspection plan.

See also KBE 100.

5.5.1 For equipment containing PE the following applies:

The Manufacturer/Supplier shall show in writing that the development model/procedures invoked for the method used to produce the software is fulfilled. The Purchaser shall be given the opportunity to review the Manufacturer/Supplier method of production.

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 upgrading of Technical Specification.	
2	Review and upgrading of Inspection Plan	
3	Seismic verification	
4	Requirements on separation - isolation	
5	Applicable standard for used products	
6	Applicable standard for test of used products	
7	Material specification	
8	Protection class	
9	Input and output signals	
10	Type of ventilation or cooling system	
11	Connection to process parameter	
12	Access ability for maintenance	
13	Type of cable	
14	Cable and wire laying	
15	Selection of components e.g. switches, lamps	
16	The component side of each printed board shall be marked, in screen-printing or other durable method	
17	Information on solvents and cleaning procedures for printed board assemblies	
18	Packed, stored and handled to protect from electrostatic discharges (ESD)	
19	Plates on cabinets	
20	Plates on components	
21	Description of development model (PE)	
22	Tools assessed and approved (PE)	
23	Relevant software version and configuration management plan (PE)	
24	The equipment reliability. Figures and used references	
25	Performance <ul style="list-style-type: none"> • Response time and verification by test • Measuring range, accuracy, bit resolution • time resolution (PE) 	
26	Components including HDL	
27	Documentation, language	
28	Statement of document structure and where the information according to the description can be found.	
29	Product documentation	
30	Design documentation	
31	Maintenance documentation	
32	Operating documentation	
33	Inspection documentation	
34	Operating experiences	
35	Cyber security	
36	Show in writing that the development process invoked for the method used to produce the software is fulfilled	

37	Interfaces to the other systems in the plant	
38	Logging function registering all attempts to penetrate the firewall	
39	Verification of that transmitted data information is equal to the received data information	
40	Need of multicast traffic	
41	Need for separation or forced cooling in cabinets due to heat emission	