

## 6. Important extracts of standards related to control or safety circuits

**Electrical cut out:** (IEC 60335-1)

**§3.8.1 All-pole cut out:** Cutting in two conductors in a single operation, or for three phase units, the cut of the three conductors in a single step ... Note: for three-phase, the neutral lead is not considered as a power conductor.

**§22.2: Phase cut out:** single pole protection systems cutting heating elements in single pole circuits of Class 01 devices and continuously connected Class 01 devices, must be connected to the phase conductor.

**Electrical conductors colors:** (IEC 60446)

**§3.1 ...** For the identification of leads the following colors are allowed: black, brown, red, orange, yellow, green, blue, purple, gray, white, pink, turquoise.

**§3.2.2** Neutral conductor or center conductor : when a circuit includes a neutral conductor or neutral conductor identified by color, the color used for this purpose should be blue ...

Note 2 – In the United States of America, Canada and Japan, identifying with white or natural gray colors for the neutral conductor or center conductor is used as a replacement for the identification by the light blue color.

**§3.2.3** AC phase conductors: black and brown colors are the favorite colors for the phase conductors of AC systems.

**§3.3.2** Conductor protection: The two-tone green-and-yellow combination must be used for identification of the protective conductor to the exclusion of any other use. The green-and-yellow is the only recognized color scheme for the identification of the protective conductor

Note 2 – In the United States of America, Canada and Japan, identifying with green color for the protection conductor is used as a replacement for the identification by the two-tone green-and-yellow combination.

**Fail safe, functional safety, safety levels:**

It is required by the European Directive 97/23 dealing with heat generators, pressure equipment and boilers as follow: «the procedures for conformity assessment and the essential safety requirements of the Directive apply to the complete safety chain. The requirements for the sensor itself can be different according to the safety design principles, for instance: redundancy or fail-safe ». Many “product” standards of the IEC (EN) 60335-xxx series require this type of safety.

**Definitions related to the functional safety:** this concept was introduced by the CEI 61508:1998 Standard. « Functional Safety for electrical /electronic and programmable electronic (E/E/PES) systems». This standard defines the requirements and provisions for the design of electronic and programmable complex systems and subsystems. This is a general standard that can be used in all industrial sectors. The categories of protection of industrial heating equipment have been classified into three levels by the old EN 954-1 Standard.

**Level 1** includes mainly the process control instrumentation: temperature sensors, thermostats, controllers, programmers. This level provides a control either permanently or in a sequence by programmed commands initiated by the operator (for example: control disc, bimetal, bulb and capillary thermostats, electronic temperature controls).

**Level 2** consists essentially of an instrumentation composition close to that of level one, but functionally completely independent of this level.

This level 2 protects the process by a discontinuous unsystematic function, that is to say not initialized by the operator, from threshold violation information on critical parameters of the process.

(For example, disc thermostat + disk limiter, bulb and capillary temperature limiters + bulb and capillary thermostat, double electronic controllers)

**Level 3** is the ultimate protection of the process. It does not include identical instrumentation to those of Level 1 and 2, but devices working without auxiliary energy (for example: fixed temperature limiters with manual or automatic reset on circuits controlled by electronic controllers, thermal fuses for systems controlled by disc or bulb and capillary thermostats, or by electronic controllers).