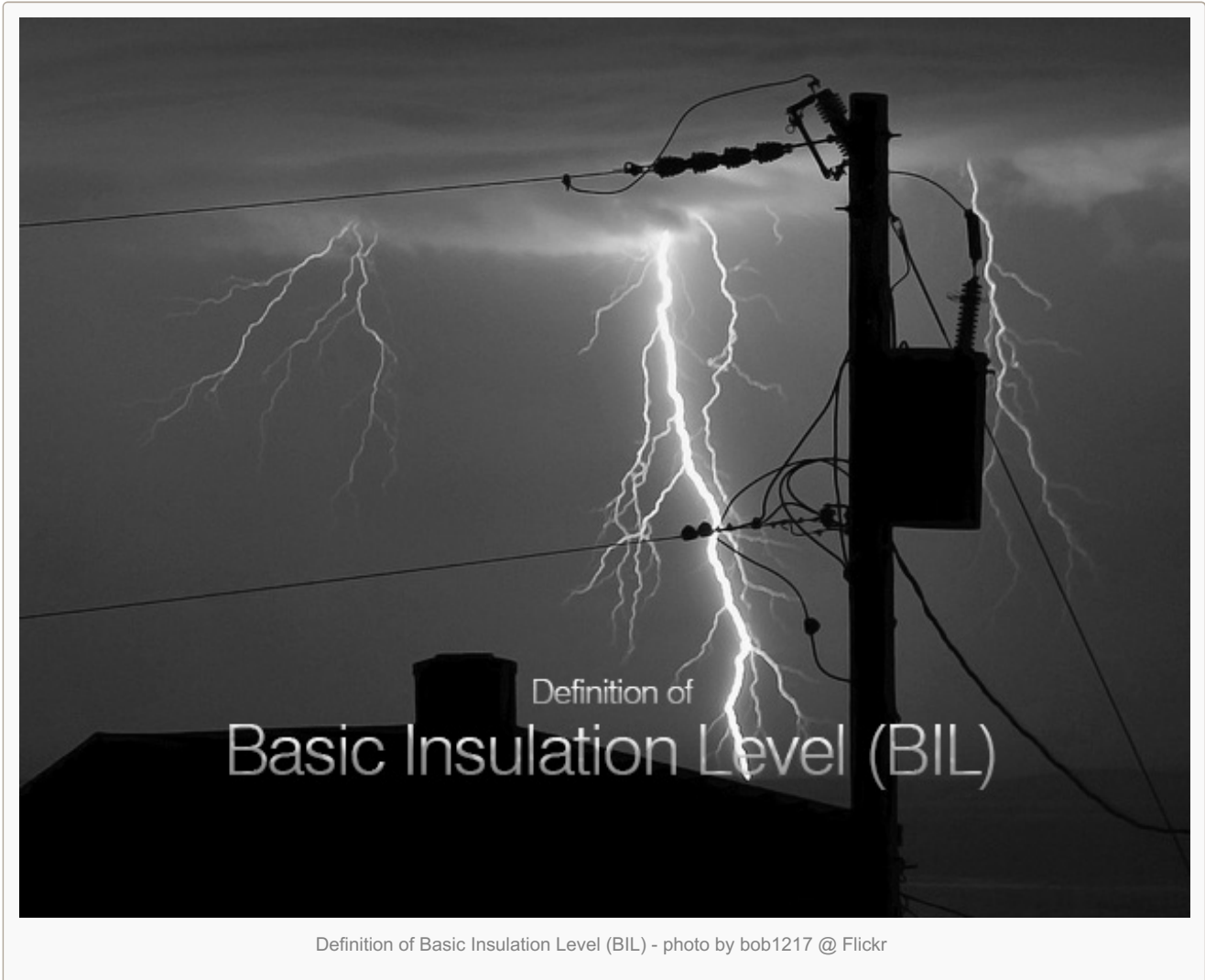


Definition of Basic Insulation Level (BIL)

Edvard



Introduction to BIL

Insulation levels are designed to [withstand surge voltages](#), rather than only normal operating voltages. Since the insulation lines and equipment is protected by surge arresters draining the surges rapidly before the insulation is damaged, the arrester must operate below the minimum insulation level that must withstand the surges.

An example is shown in **Figure 1a** below.

The minimum level is known as the **Basic Insulation Level (BIL)** that must be that of [all of the components of a system](#).

Insulation values above this level for the lines and equipment in the system must be so coordinated that specific protective devices operate satisfactorily below that minimum level.

In the design of lines and equipment considering the minimum level of insulation required, it is necessary to define surge voltage in terms of its peak value and return to lower values in terms of time or duration. Although the peak voltage may be considerably higher than normal voltage, the stress in the insulation may exist for only a very short period of time.

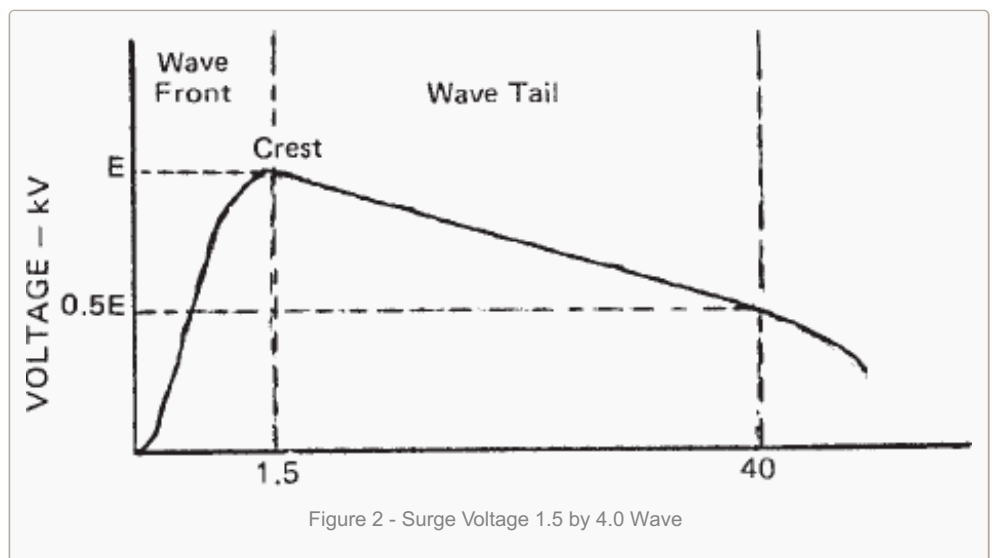
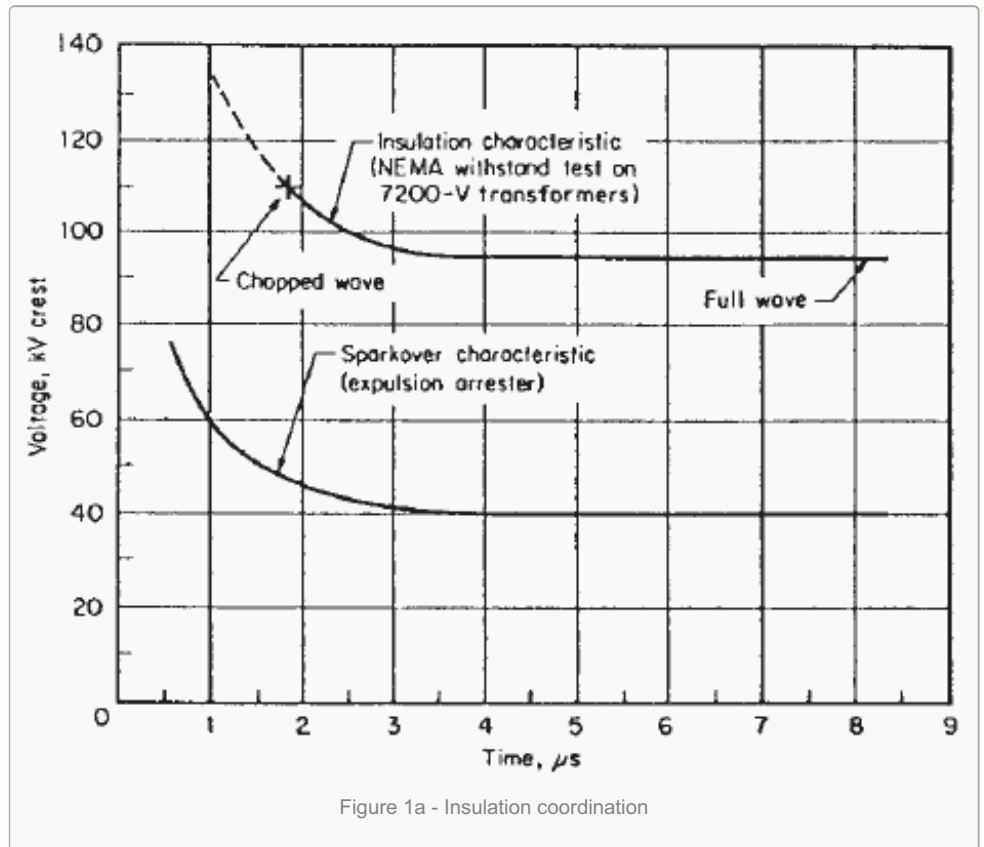
For purposes of design, the [voltage surge](#) is defined as one that peaks in 1.5 microseconds and falls to one-half

that value in 40 microseconds (thousandths of a second).

It is referred to as a **1.5/40 wave**, the steep rising portion is called the wave front and the receding portion the wave tail, **Figure 2**.

Insulation levels recommended for a number of voltage classes are listed in **Table 1**. As the operating voltages become higher, the effect of a surge voltage becomes less; hence, the ratio of the BIL to the voltage class decreases as the latter increases.

Table 1 – Typical Basic Insulation Levels



Voltage class, kV	Basic insulation level, kV (standard 1.5- × 40-μs wave)	
	Distribution class	Power class (station, transmission lines)
1.2	30	45
2.5	45	60

5.0	60	75
8.7	75	95
15	95	110
23	110	150
34.5	150	200
46	200	250
69	250	350

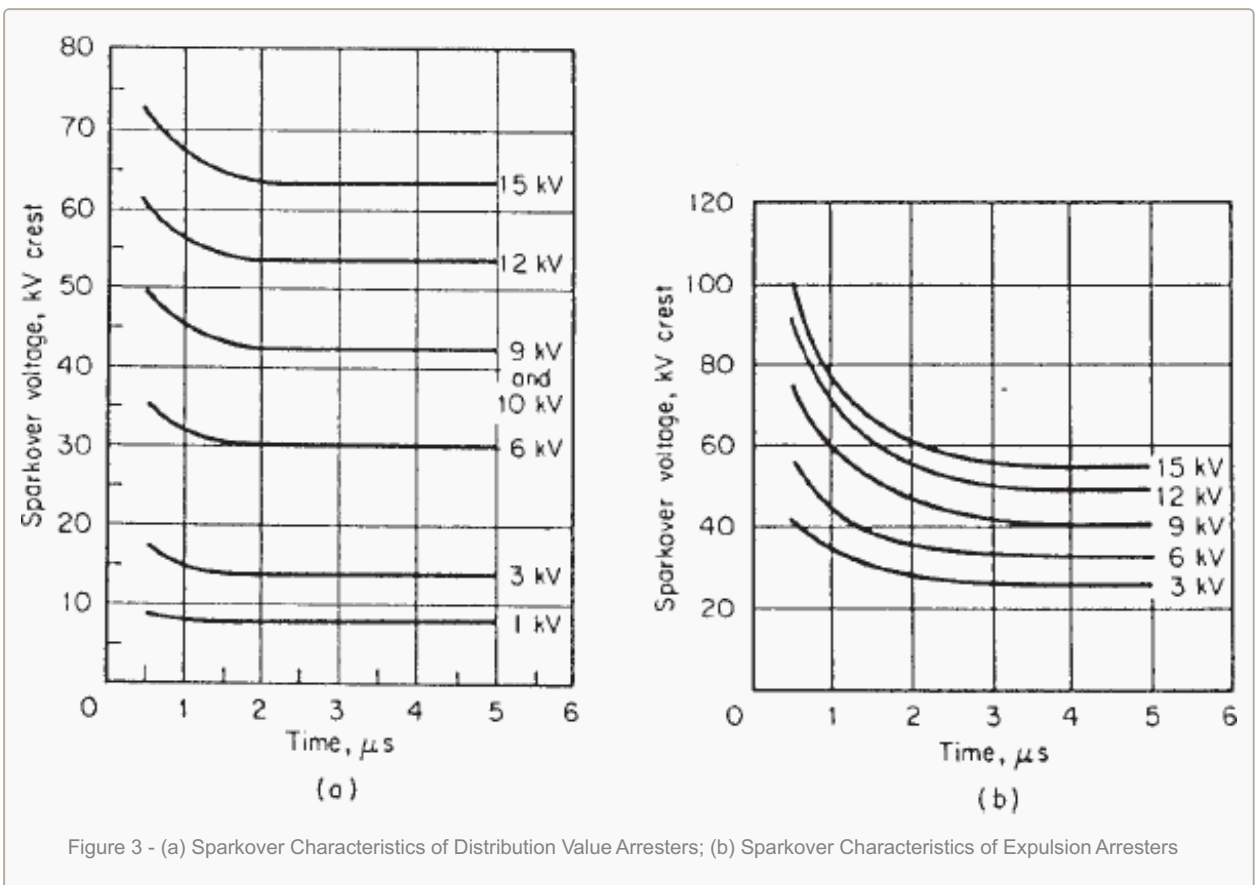
*For current industry recommended values, refer to the latest revision of the National Electric Safety Code.

Distribution class BIL is less than that for power class substation and transmission lines as well as consumers' equipment, so that should a surge result in failure, it will be on the utility's distribution system where interruptions to consumers are limited and the utility better equipped to handle such failures.

The line and equipment insulation characteristics must be at a higher voltage level than that at which the protecting arrester begins to spark over to ground, and a sufficient voltage difference between the two must exist.

The characteristics of the several type arresters are shown in the curves of **Figure 3**.

The impulse level of lines and



equipment must be **high enough for the arresters** to provide protection but low enough to be **economically practical**.

Surges, on occasion, **may damage the insulation of the protective device**; hence, insulation coordination should include that of the protective devices.

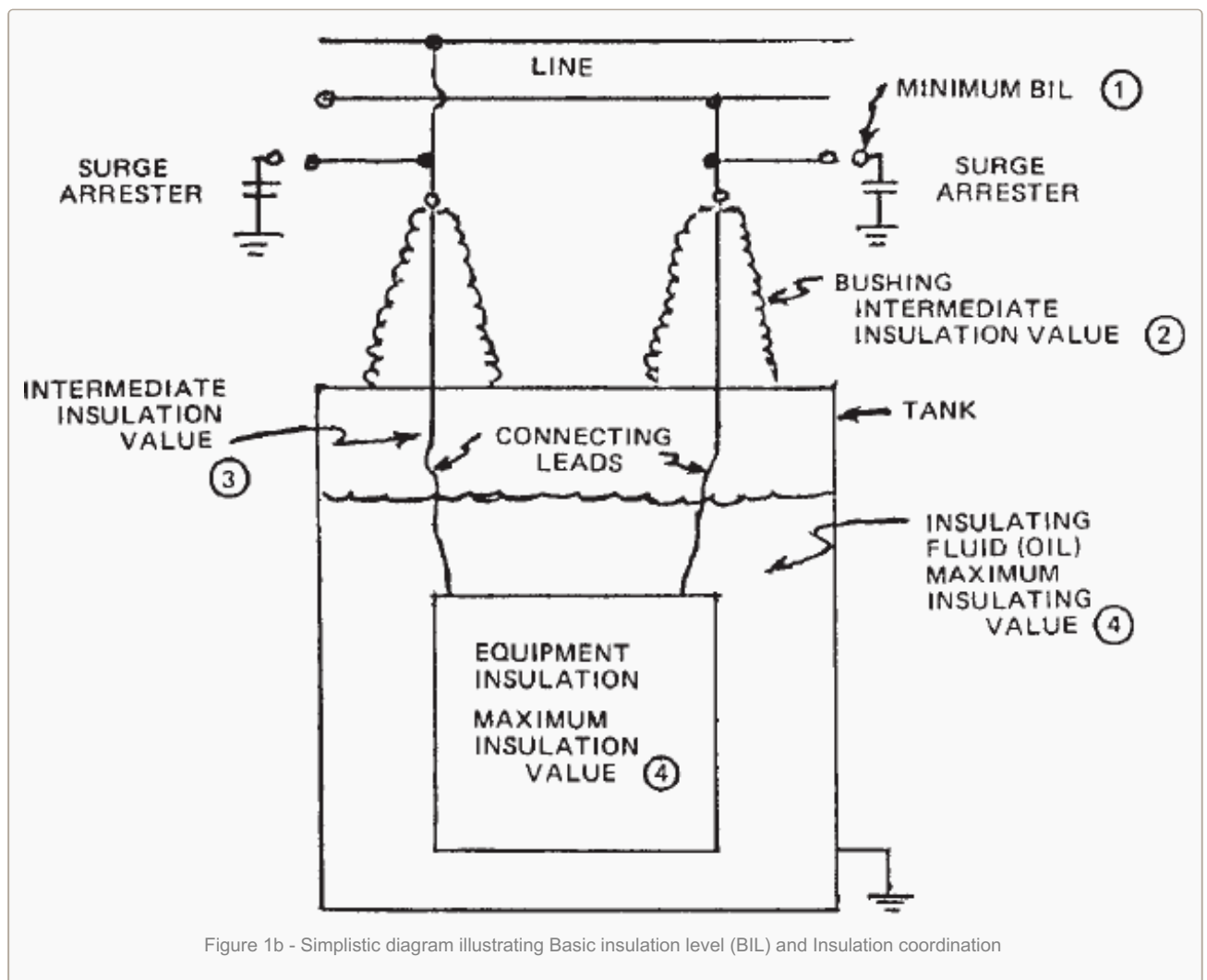
As there are a number of protective devices, mentioned earlier, each having characteristics of its own, the characteristics of all of these must be coordinated for proper operation and protection.

Before leaving the subject of insulation coordination, such coordination also applies within a piece of equipment itself. The insulation associated with the several parts of the equipment must not only withstand the normal operating voltage, but also the higher surge voltage that may find its way into the equipment.

So, while the insulation of the several parts is kept nearly equal, that of certain parts is deliberately made lower than others; usually this means the bushing. Since the bushing is usually protected by an air gap or arrester whose insulation under surge is lower than its own, flashover will occur across the bushing and the grounded tank.

The **weakest insulation** should be weaker by a sufficient margin than that of the principal equipment it is protecting; such coordinated arrangement restricts damage not only to the main parts of the equipment, but less so to parts more easily accessible for repair or replacement.

The insulation of all parts of the equipment should exceed the basic insulation level (BIL). **Figure 1b.**



Resource: *Power Transmission and Distribution – Anthony J. Pansini* ([Get this book from Amazon](#))

Source:

<http://electrical-engineering-portal.com/definition-basic-insulation-level-bil>