IEEE C37.04i-1991
(Supplement to IEEE C37-04-1979)

Supplement to IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis

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The following paragraph will replace the last paragraph of 5.11.4.2 in C37.04-1979:

In addition, there is a time delay of the line-side recovery voltage as a result of the capacitance of apparatus on the line side. This time delay is 0.5 μs for circuit breakers rated 242 kV and above and 0.2 μs for circuit breakers rated below 242 kV.

The following paragraph will be a new section:

5.11.4.3 Initial Transient Recovery Voltage

Circuit breakers rated 121 kV and above with rated short-circuit current of 31.5 kA and above shall have an initial transient recovery voltage capability for phase-to-ground faults as defined by the envelope shown in Fig X.

The initial transient recovery voltage envelope rises linearly from the origin to the first peak voltage E_i at time T_i. The first peak voltage and the time to the first peak voltage are determined by the fault current, bus surge impedance, bus wave velocity, and the distance from the circuit breaker to the first major discontinuity of bus surge impedance.

NOTE — As an example, the first major discontinuity of bus surge impedance may be limped capacitance of 1000 pF or more connected to the bus or a reduction of the bus surge impedance, i.e., the interconnection of two or more buses or lines. The apparent wave velocity is approximately 280 m/μs for outdoor substations.

The times to first peak voltage T_i for phase-to-ground faults are as follows:

Rated Maximum Voltage kV rms	Time to First Peak Voltage T_i μs
121	0.3
145	0.4
169	0.5
242	0.6
362	0.8
550	1.0
800	1.1

The first peak voltage E_i is

$$E_i = \omega\sqrt{2} I Z_b T_i 10^{-6} \text{ kV}$$

where the bus surge impedance, Z_b, is 260 Ω (outdoor substations, phase-to-ground faults only), T_i is in microseconds, I is in kiloamperes, and $\omega = 2\pi f$. (See 4.6.5.4 of IEEE C37.09-1979.) For breakers installed in gas-insulated substations, the initial transient recovery voltage can be neglected because of low bus surge impedance and small distances to the first major discontinuity.

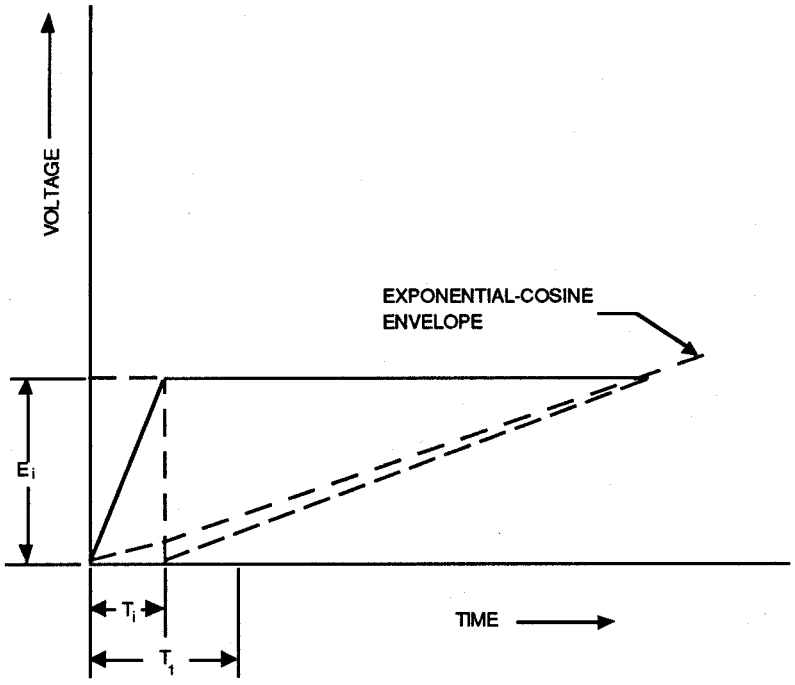

Figure X —Initial Transient Recovery Voltage Envelope