Calculation of short-circuit force

Example:

P_k = short-circuit power (MW) — $P_k = 400\ MW$

U = voltage between 2 phases (kV) — $U = 10\ kV$

I_k = thermal short-circuit current (kA)

$$I_k = \frac{P_k}{U \cdot \sqrt{3}}$$

$$I_k = \frac{400MW}{10kV \cdot \sqrt{3}}$$

$I_k = 23{,}1\ kA$

short-circuit current :

$$I_s = \sqrt{2} \cdot \chi \cdot I_k$$

$$I_s = \sqrt{2} \cdot 1{,}8 \cdot 23{,}1kA$$

χ = impulse factor (usually 1,8)

$Is = 58{,}8\ kA$

The dynamic short-circuit force is calculated on a maximum short-circuit current and the geometric arrangement of the cables.

$$F = \alpha \cdot \frac{\mu_0}{2\pi} \cdot l \cdot \frac{I_s^2}{a}$$

F = dynamic short-circuit force (N)

l = distance between 2 cable clamps (centre distance in m)

a = centre distance between the cables (m)

I_s = maximum asymmetric short-circuit current (A)

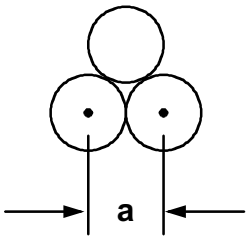
μ_0 = permeabiliy constant = $4 \cdot \pi \cdot 10^{-7} \frac{Vs}{Am}$

α = factor for the radial forces at the 3-pole short-circuit = $\frac{\sqrt{3}}{2}$

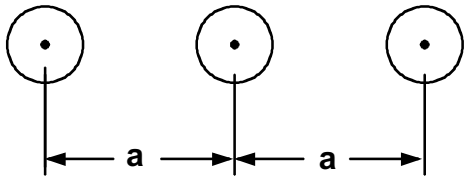
$$\alpha \cdot \frac{\mu_0}{2 \cdot \pi} = 1{,}73 \cdot 10^{-7} \frac{Vs}{Am}$$

Example:

a) joint fastening of trefoils of single-core cables



b) fastening of single-core cables



a = axial spacing
a = outer diameter of cable
cable diameter = 30 mm = a = 0,030 m

a = 0,12 m

To receive the short-circuit force per meter of cable, you put $l = 1$

$$F_k = 1{,}73 \cdot 10^{-7} \frac{Vs}{Am} \cdot 1 \cdot \frac{(58.800A)^2}{0{,}030m}$$

$$F_k = 19.940 \frac{N}{m}$$

$$F_k = 1{,}73 \cdot 10^{-7} \frac{Vs}{Am} \cdot 1 \cdot \frac{(58.800A)^2}{0{,}12m}$$

$$F_k = 4.985 \frac{N}{m}$$

The permissible distance between the cable clamps is calculated on the short-circuit force per m (F_k) and the permissible strain (F_{perm}) on the cable clamp:

$$l_{max} = \frac{F_{perm}}{F_k}$$

l_{max} = maximum permissible distance between cable clamps
F_{perm}= permissible strain on the cable clamp
F_k = short-circuit force per m

a) Triple 27-38

$$F_{perm} = 25.000N$$

$$l_{max} = \frac{25.000N}{19.940N/m}$$

$$l_{max} = 1{,}25m$$

b) SE 26-38

$$F_{perm} = 12.000N$$

$$l_{max} = \frac{12.000N}{4.985N/m}$$

$$l_{max} = 2{,}40m$$

Recommendation:

Distance between the cable clamps 60 cm because bending of the cable in case of short-circuit. amount of cable clamps is required.