The short-circuit current force is given by:

$$F_v = (n-1)\,\frac{\mu_0}{2\pi}\left(\frac{I''_{k3}}{n}\right)^2 \frac{l_s}{a_s}\,\frac{\nu_2}{\nu_3} \tag{45}$$

NOTE - In the case of two-line single-phase systems, replace I''_{k3} in equation (45), (46), (52) and (55) by I''_{k2}.

The factor ν_2 is given by figure 8, as a function of

$$\nu_1 = f\,\frac{1}{\sin\dfrac{180°}{n}}\cdot\sqrt{\frac{(a_s-d_s)\,m'_s}{\dfrac{\mu_0}{2\pi}\left(\dfrac{I''_{k3}}{n}\right)^2\cdot\dfrac{n-1}{a_s}}} \tag{46}$$

where f is the system frequency, and the factor ν_3 is given by figure 9.

If the line-to-earth initial short-circuit current I''_{k1} is greater than the three-phase initial symmetrical short-circuit current I''_{k3}, the latter shall be replaced by I''_{k1} in equations (45), (46), (52) and (55).

The strain factors characterizing the contraction of the bundle shall be calculated from

$$\varepsilon_{st} = 1{,}5\,\frac{F_{st}\,l_s^2\,N}{(a_s-d_s)^2}\left(\sin\frac{180°}{n}\right)^2 \tag{47}$$

$$\varepsilon_{pi} = 0{,}375\,n\,\frac{F_v\,l_s^3\,N}{(a_s-d_s)^3}\left(\sin\frac{180°}{n}\right)^3 \tag{48}$$

The parameter

$$j = \sqrt{\frac{\varepsilon_{pi}}{1+\varepsilon_{st}}} \tag{49}$$

determines the bundle configuration during short-circuit current flow as follows:

- $j \geq 1$ The sub-conductors clash. The tensile force F_{pi} is calculated in 2.3.3.2;
- $j < 1$ The sub-conductors reduce their distance but do not clash. The tensile force F_{pi} is calculated in 2.3.3.3.

2.3.3.2 *Tensile force F_{pi} in the case of clashing sub-conductors*

If $j \geq 1$, the tensile force F_{pi} is obtained from

$$F_{pi} = F_{st}\left(1 + \frac{\nu_e}{\varepsilon_{st}}\,\xi\right) \tag{50}$$

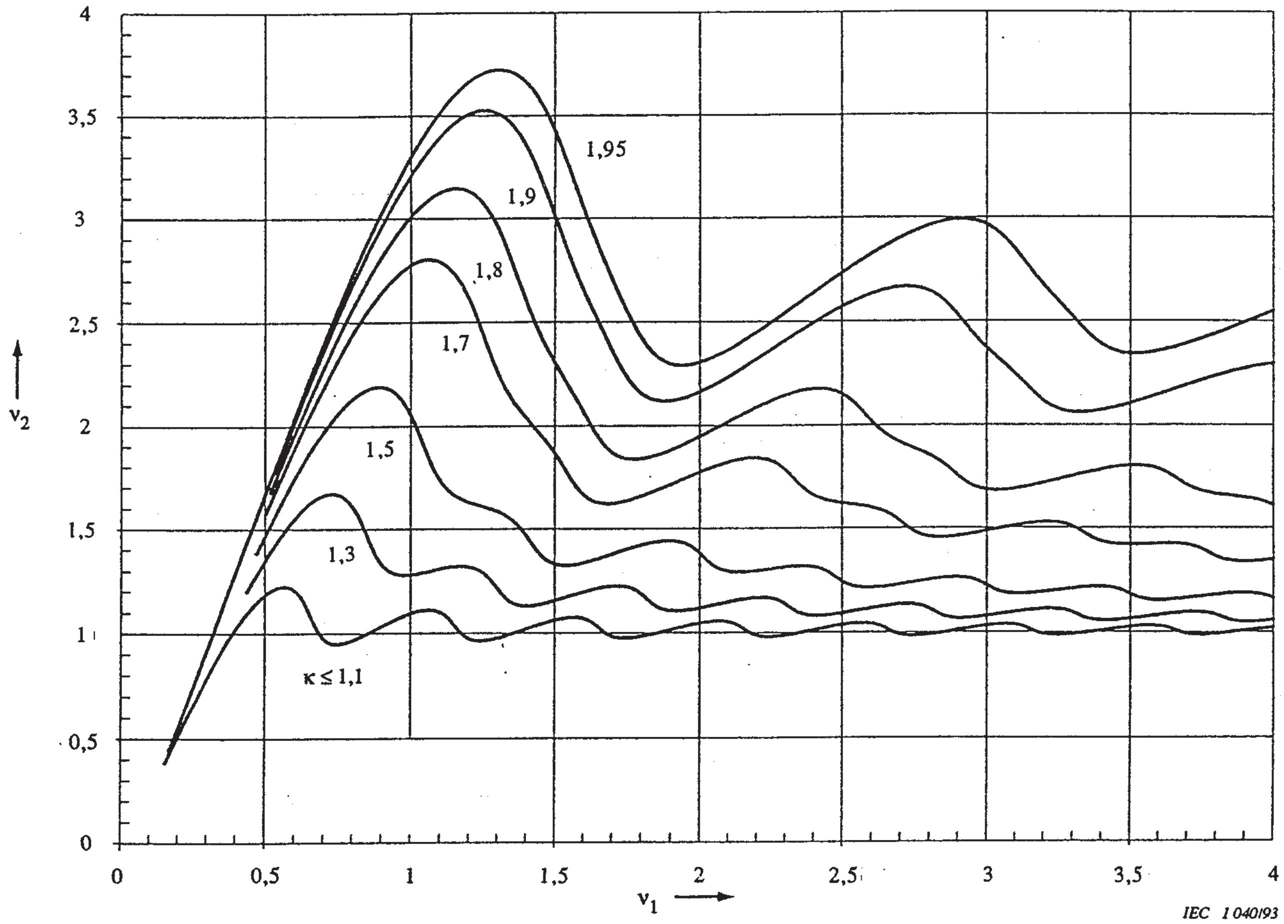

Figure 8 – v_2 as a function of v_1

For programming, the equations are given in annex A.

The factor V_σ is given by:

f_c/f	Factor V_σ
<0,04	$0,0929 + 4,49\ e^{-1,68\kappa} + 0,0664\ \lg\ (f_c/f)$*
0,04 ... 0,8	minimum value of $V_{\sigma 1}$ or $V_{\sigma 2}$ $V_{\sigma 1} = 0,756 + 4,49\ e^{-1,68\kappa} + 0,54\ \lg\ (f_c/f)$* $V_{\sigma 2} = 1,0$
>0,8	1
* If κ > 1,6 then κ = 1,6 shall be used.	

In the case of $V_{\sigma s}$, the same equations shall be used as for V_σ, but f_c/f shall be replaced by f_{cs}/f.

A.5 Figure 5

The factor V_r is given by:

$$V_r = \begin{cases} 1,8 & \text{for } f_c/f \leq 0,05 \\ 1,0 - 0,615\ \lg\ (f_c/f) & \text{for } 0,05 < f_c/f < 1,0 \\ 1,0 & \text{for } f_c/f \geq 1,0 \end{cases}$$

$$V_{rs} = \begin{cases} 1,8 & \text{for } f_{cs}/f \leq 0,05 \\ 1,0 - 0,615\ \lg\ (f_{cs}/f) & \text{for } 0,05 < f_{cs}/f < 1,0 \\ 1,0 & \text{for } f_{cs}/f \geq 1,0 \end{cases}$$

A.6 Figure 8

The factor ν_2 is given by:

$$\nu_2 = 1 - \frac{\sin\ (4\pi f T_{pi} - 2\gamma) + \sin 2\gamma}{4\pi f T_{pi}} + \frac{f\tau}{f T_{pi}} \left(1 - e^{-\frac{2fT_{pi}}{f\tau}}\right) \sin^2 \gamma - \frac{8\pi f\tau \sin\gamma}{1 + (2\pi f\tau)^2} \left\{ \left(2\pi f\tau \frac{\cos\ (2\pi f T_{pi} - \gamma)}{2\pi f T_{pi}} + \frac{\sin\ (2\pi f T_{pi} - \gamma)}{2\pi f T_{pi}} \right) e^{-\frac{fT_{pi}}{f\tau}} + \frac{\sin\gamma - 2\pi f\tau \cos\gamma}{2\pi f T_{pi}} \right\}$$

where τ is the time constant of the network and can be calculated according to IEC 909:

$$\frac{1}{\tau} = -\frac{2\pi f}{3} \ln \frac{\kappa - 1,02}{0,98} \quad \text{with } \kappa \geq 1,1 \text{ and } \gamma = \arctan\ (2\pi f\tau)$$

If κ < 1,1 then κ = 1,1 shall be used.

$f\,T_{pi}$ is the solution of the equation $\nu_1 = f\,T_{pi} \sqrt{\nu_2}$