SURGE IMPEDANCE LOADING (SIL)

$$\text{Surge impedance of a line, } Z_o = \sqrt{\frac{L}{C}}.$$

$$SIL = \frac{(kV_{LL})^2}{Z_o}, \quad (MW)$$

A transmission line loaded to its surge impedance loading:

(i) has no net reactive power flow into or out of the line, and
(ii) will have approximately a flat voltage profile along its length.

For (i) to hold:

$$I^2 X_L = \frac{V^2}{X_c}, \quad \text{or,} \quad \frac{V^2}{I^2} = X_L X_c = \frac{\omega L}{\omega C}, \quad \text{or,} \quad \frac{V}{I} = \sqrt{\frac{L}{C}} = Z_o = \text{Load impedance}$$

This means that there will be no net reactive power flow at surge-impedance loading.

For (ii) to hold:

$$V_s = AV_r + BI_r \;;\; I_s = CV_r + DI_r,$$

where, $A = D = \cosh\sqrt{ZY}$; $B = Z_o \sinh\sqrt{ZY}$; $C = \dfrac{\sinh\sqrt{ZY}}{Z_o}$; $Z = j\omega L\ell$; $Y = j\omega C\ell$

$$\sqrt{ZY} = j\omega\ell\sqrt{LC} = \frac{j\omega\ell}{\nu_c} = j\frac{2\pi f\ell}{f\lambda} = j\frac{2\pi\ell}{\lambda}$$

$$\text{Then,}\quad A = D = \cos\frac{2\pi\ell}{\lambda} \;;\; B = jZ_o\sin\frac{2\pi\ell}{\lambda} \;;\; C = j\frac{\sin\frac{2\pi\ell}{\lambda}}{Z_o}$$

$$\text{At surge-impedance loading,}\ \frac{V_r}{I_r} = Z_o.$$

$$\text{And,}\ V_s = \left(A + \frac{B}{Z_o}\right)V_r = \left(\cos\frac{2\pi\ell}{\lambda} + j\sin\frac{2\pi\ell}{\lambda}\right)V_r = V_r\angle\tan^{-1}\frac{2\pi\ell}{\lambda},$$

$$I_s = (CZ_o + D)I_r = \left(j\sin\frac{2\pi\ell}{\lambda} + \cos\frac{2\pi\ell}{\lambda}\right)I_r = I_r\angle\tan^{-1}\frac{2\pi\ell}{\lambda}$$

This means that the line will have a flat voltage profile, i.e., no voltage drop.

LOADABILITY CURVES

Loadability of a line is limited by :

(i) thermal limitation (I^2R losses)
(ii) voltage regulation
(iii) stability limitation

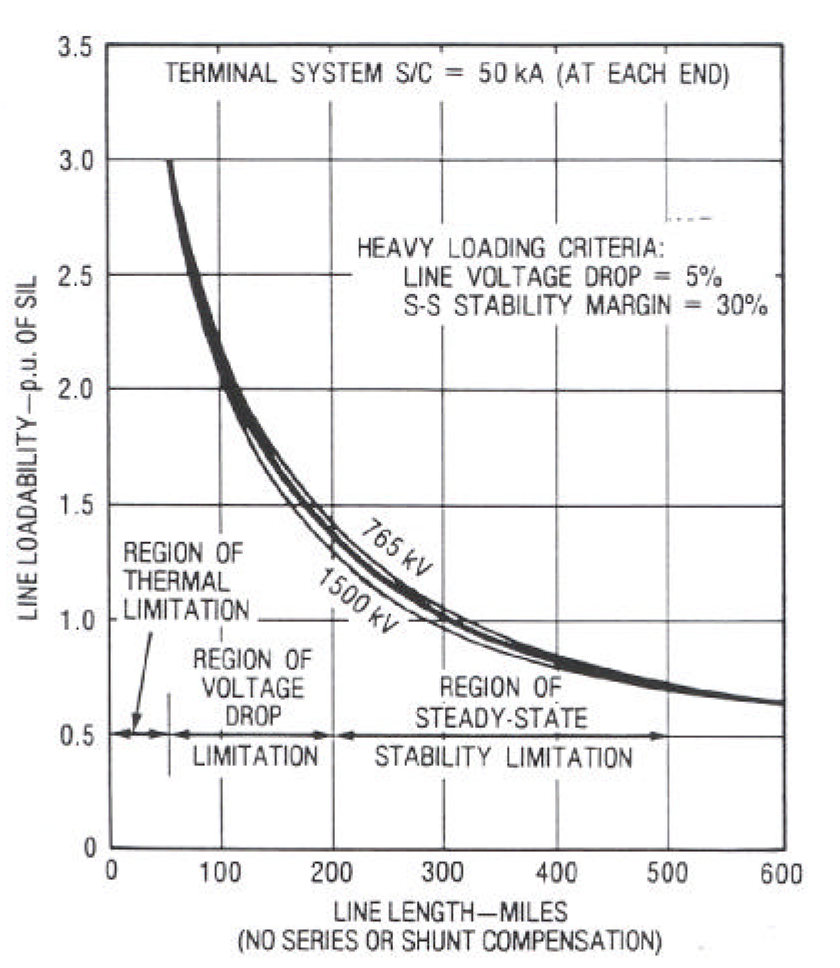

Figure 2.4.4. EHV-UHV line loadability curves.

(EPRI Publication EL-2500)