TECHNICAL NOTE 1

DATE:	24 June 2020	**CONFIDENTIALITY:**	Public
SUBJECT:	Cable Loss Calculations		
PROJECT:	Baddesley EfW	**AUTHOR:**	Simon Peacock
CHECKED:		**APPROVED:**	

SUMMARY

Active power (kW) loss = 2333W (at 194A / 11.1MVA)

Reactive power (kVAr) loss = 1990W (at 194 / 11.1MVA)

Dielectric loss = 11.55W

Sheath loss = 24W

Therefore, no load losses are negligible.

NB Eddy current will by zero (or extremely low) as circuit is triplex and bonded/earthed at both ends.

CABLE DATA

150mm Cu XLPE, V_l 33kV, V_{ph} 19kV

Installed in tight triplex; bonded and earthed both ends

Length 130m

Z = 0.209 ohm/km

C = 0.196 microF/km

R = 0.159 ohm/km @90deg C (ac)

$X^2 = Z^2 – R^2$, $0.209^2 – 0.159^2$,

X = 0.13564 ohm/km

Loss angle = 0.004

D_m = 0.04m (cable diameter)

S = 0.041m (approx. dist between cable centres)

For 130m:

R = 0.159 * 130/1000 = 0.02067ohm

X = 0.13564 * 130/1000 = 0.0176332ohm

C = 0.196 * 130/1000 = 0.02548 microF

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Generator output 11.1MVA

I = P / sqr3 *33000 = 194A (NB Balanced load)

LOSS CALCULATIONS

Load loss at 11.1MVA

P_{tot} = 3 * (I^2 * R) = 3 * (194^2 * 0.02067) = 2333W

Q_{tot} = 3 * (I^2 * X) = 3 * 194^2 * 0.0176332) = 1990W

No Load Loss

Dielectric Loss (P_d) = 2 * pi * F * C * V_{ph}^2 * loss angle

= 314 * 0.196*10^{-6} * 19000^2 * 0.004,

= 88W/km

P_d = 88 * 130/1000 = 11.55W

Sheath Loss

Sheath loss are eddy current and sheath circuit losses. Eddy currents are negligible as cable is triplex and earthed/bonded at both ends.

Sheath loss current induced emf from ac current in the main conductor.

$P_{loss\text{-}sheath}$ = I^2 * R_s (X_m^2 / X_m^2 * R_s^2) (BICC cable handbook eq 2.16; X_m = mutual reactance)

X_m = 2 * pi * F * 0.2$\log_e$ (2S/d_m) * 10^{-3} ohm/km

= 314 * 0.2 $\log_e$(2 * 0.041 / 0.04) * 10^{-3}

= 0.045 ohm/km

$P_{loss\text{-}sheath}$ = 194^2 * 0.4 (0.045^2 / 0.045^2 + 0.4^2) *130/1000

= 24W