Calculation for deriving new under and over voltage protection settings

The formula supplied to us from Hitachi:

$$V_{LV}[V] = V_{HV}[V] \cdot M - V_{R\_LV}[V] \cdot \frac{\%X[\%]}{100[\%]} \cdot \frac{Q_{SVC}[kVA]}{Q_{R\_SVC}[kVA]}$$

Where

$$M = \frac{V_{R\_LV}[V]}{V_{R\_HV}[V]}$$

And

V_{LV} = Voltage of LV
V_{HV} = Voltage of HV
$V_{R\text{-}LV}$ = Rated Voltage of LV
$V_{R\text{-}HV}$ = Rated Voltage of HV
%X = Impedance of Transformer
M = Transformation Ratio
$Q_{R\text{-}SVC}$ = Rated Reactive Power of D-SVC
Q_{SVC} = Reactive Power of D-SVC (- : Capacitive, + : Inductive)

The HV voltage lower limit is -6% of 11kV or 10,340V

To calculate the new undervoltage setting assuming maximum kVAr out put from the D-SVC:

$$V_{LV} = 10340 \cdot \frac{422.4}{11000} - \frac{422.4}{\sqrt{3}} \cdot \frac{4.97}{100} \cdot \frac{400}{400}$$

$$V_{LV} = 384.98$$

Phase to earth voltage:

$$V_{LV} \frac{384.98}{\sqrt{3}} = 222.2V$$

And taking account of the VT:

$$V_{LV} = \frac{222.2}{2} = 111V$$

The HV voltage upper limit is +6% of 11kV or 11,660V

To calculate the new undervoltage setting assuming maximum kVAr out put from the D-SVC:

$$V_{LV} = 11660 \cdot \frac{422.4}{11000} - \frac{422.4}{\sqrt{3}} \cdot \frac{4.97}{100} \cdot \frac{400}{400}$$

$$V_{LV} = 435.62V$$

Phase to earth voltage:

$$V_{LV} \frac{435.62}{\sqrt{3}} = 251.5V$$

And taking account of the VT:

$$V_{LV} = \frac{251.5}{2} = 125.8V$$