

500kV Double Circuit Line versus 765kV Single Circuit Line

For a fully developed 500kV system, a 765kV point to point line on top of the 500kV system is not the next logical step. Building 500kV double circuit (D/C) provides similar benefits at lower long term cost and no more right-of-way (R/W) than 765kV. The H-frame steel pole D/C design from Alburto to Wescosville uses 200ft R/W, same width as existing single circuit 500kV lines.

A 500kV D/C line has greater than 6000MVA thermal capability of two circuits with half the 500kV single circuit impedance. Very short 500kV D/C lines can take advantage of the high thermal capability.

As shown on the attached table of calculations, a very long 500kV D/C line (250 miles) has similar transfer capability to a single circuit 765kV line. A 250 mile 500kV D/C line transfer impedance is essentially the same as that for a single circuit 765kV line plus 765/500kV step down bank impedance.

Assuming adequate shunt compensation is installed, even at a maximum steady state power transfer at 90 degrees, both options can only transfer about 3900MW over 250 miles. As shown on the attached example, a 765kV point to point alternative does not provide a significant increase in transfer capability compared to a 500kV D/C line. The difference is far less than 10% --- 3% in this 250 mile example.

In practical terms, the phase angle must be significantly less than 90 degrees, and the transfer capability for such a long line will be in the 2000-3000MW range. As shown on the attached example, a 40 degree angle would result in an approximate 2500MW transfer for either the 765 kV line or 500kV D/C line. If 50% series compensation is used on 500kV D/C or a 765kV line, the transfer impedance would be cut in half, and maximum steady state power transfer capability would double for both alternatives.

A comparison of single circuit 765kV line versus 500kV D/C line Surge Impedance Loading (SIL) is a good academic exercise but means very little in actual practice. Above SIL loading 500kV shunt capacitor compensation is practical and proven to provide significant transfer capability. At high MW transfer levels a 765/500kV bank will consume MVARs and require shunt capacitor compensation. For a 500 kV line, the charging capacitance of the line will also compensate for a significant portion of the line losses. Both 765kV and 500kV alternatives require shunt capacitor compensation. The 500 kV line MVAR losses are higher for 500kV than 765 kV. The additional cost for 500kV shunt compensation is about \$20million dollars as shown in the attached example. Even with this additional expense, the 250 mile 500 kV D/C alternative is less costly than the 765kV alternative. In reality, most transmission lines between substations in the eastern US will be less than 250 miles.

A comparison of the cost of a 765 kV line & substation versus a 500 kV D/C line shows a 500kV cost savings of \$107M (13%) or more. When considering the cost to interconnect additional 500 kV substations to a very long 765 kV line, where no 765 kV substations exist, the 500 kV cost

savings will be far greater than \$107M. New long or short 500kV lines can be easily integrated with existing 500kV substations. 765kV line integration requires expensive 765/500kV substations (>\$125M) at every point of integration with the 500kV system.

In summary, relative to 765kV construction, 500 kV double circuit construction provides comparable

- increased transfer capability with resultant reduction in transmission congestion and lower customer costs,
- reduction of overall system losses due to increased transfer capability,
- access to lower cost generation,
- and enhances daily operation and maintenance with two circuits instead of one circuit on each transmission structure.

In addition to the above, the 500 kV D/C alternative is less costly to install.

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