Wake array losses were calculated using a model developed by RAM Associates. The basic principle of the model is conservation of energy. Briefly, the model concept is this:

1. Turbines extract power from the wind as a function of wind speed and the total amount of power extracted is a function of the thrust coefficient, which varies with wind speed. Some of the power is converted to electrical power and the rest of the extracted power dissipates into heat.
2. The extraction of power from the wind results in a turbulent wake with lower wind speed and the wind speed deficit is a function of the wind speed and thrust coefficient of the turbine.
3. Because the speed deficits are a function of the thrust coefficient, which varies with wind speed, the speed deficits also vary with wind speed, generally higher speeds have lower deficits than lower speeds. For this reason the overall wake losses are dependent upon the wind speed frequency distribution at a site. Sites with higher speeds have lower losses and vice versa.
4. The turbulent wake mixes with the free-stream flow, which is characterized by the local vertical wind shear α exponent, expanding in size as it mixes, and the speed deficit is gradually reduced following the flow downstream. The rate of wake dissipation is a function of the turbulence intensity. The area affected by the wake, or the size, is a function of the turbulence intensity and the distance downstream. The model assumes a constant angle of expansion which is a function of the local ambient turbulence intensity. The wake will expand in all directions uniformly, although it stops downward expansion when it encounters the surface but continues to grow vertically and laterally.
5. Maximum velocity deficits are found at the hub height of the turbine.
6. At any given point downstream the hub height wind speed is determined by calculating the vertical wind speed profiles within the wake (from the bottom of the wake up to hub height and from hub height up to the top of the expanded wake) that would be required to account for the decrease in total power in the layer affected by the wake at all wind speeds. The hub height wind speed thus calculated is used to calculate the power output from the turbine. The resulting power values across all wind speeds are integrated with the percent of time at those speeds from the frequency distribution, which produces the total energy. This value is compared to the energy that would be generated in the free stream and the difference is expressed as a percent energy deficit.
7. Hub height speed and resulting turbine power deficits are calculated for all speeds up to cut-out and the amount of energy lost depends on the wind speed frequency distribution.
8. Hub height wind speed and turbine power deficits are calculated for distances shorter than the closest spacing between turbines in a row to greater than the furthest distance between turbines on the entire project.
9. Characteristic wind speed distributions (with their attendant wake loss characteristics) are developed for the project site as a function of wind direction. These are used to develop characteristic wake losses as a function of distance in the same wind direction ranges.

10. The turbine energy losses as a function of distance are analyzed in a 5th order polynomial regression to arrive at a continuous function employing coefficients that can calculate the energy loss at any distance from one turbine to another.
11. After producing the wake loss coefficients the actual running of the loss model considers each turbine individually, with respect to the others in the entire array.
12. From a representative set of wind speed and direction data and the turbine power curve, the percentage of energy in 36-10° wind direction sectors is calculated.
13. For a subject turbine, the others in the array are considered one at a time. Their distance and azimuth with respect to the subject turbine are calculated. Depending on their azimuth, the appropriate loss coefficients for that direction are used with the distance to calculate the percentage loss that would occur, and this is applied to the percentage energy in the corresponding 10° wind direction sector in which the upwind turbine lies.
14. Losses due to each turbine in the array are accumulated by adding their effects in a straightforward manner.
15. There is a cap of 60% loss that can occur, which was intended to apply to conditions when the wind direction is parallel to a row of turbines with rather close spacing. This was based on the findings of Nierenberg [1].

[1] Nierenberg, R.; Wake Deficit Measurements on the Jess and Souza Ranches, Altamont Pass, SERI/TP-257-3455, 1990.