1 (100 pts) Determine the removal efficiencies required (if any) for a 650 MW cyclone furnace coal-fired electric utility steam generating power plant. The plant is 39% efficient, and uses bituminous coal with energy content of 10,700 BTU/lb of coal. The coal has an ash content of 9.7% of which 40% is bottom ash, and a sulfur content of 3.5%. NOx emission factors for this coal may be found in Table 2.5. Only consider the $SO_2$, PM and NOx annual average emissions and assume all sulfur is converted to $SO_2$.

2. (100 pts) A proposed emission source releases $SO_2$ at a rate of 500 g/sec. The average surface wind speed at standard height is 7 m/s, and the incoming solar radiation is strong. The stack has an effective height of 150 m and it is located in an urban area.

- Find the expected maximum ground level concentration ($\mu g/m^3$ 1-hour average) and downwind distance (km)
- Find the surface concentration 500 m to the side (perpendicular) of this point.
- If this source is expected to increase the 24-hour ambient air level of $SO_2$ by no more than the above calculated maximum amount, and the 24-hour average regional class II level is 230 $\mu g/m^3$ should the source be permitted to operate? Explain your reasoning ‘why?’ or ‘why not?’.

3. (100 pts) Determine the particle size which is removed at 50% efficiency in a cyclone. The cyclone has the following dimensions – inlet width is 25 cm, inlet height is 50 cm, collection cylinder is 2 m, bottom cone is 1 m. The inlet stream is air at 300 K containing particles with a density of 2.1 g/cm$^3$ and a flow of 0.2 m$^3$/s.