7.9

$$RO\bullet + O_2 \rightarrow HO_2\bullet + R'CHO \qquad (7.19)$$

for R'CHO to be HCHO, R' must be H so that

$$RO\bullet + O_2 \rightarrow HO_2\bullet + HCHO$$

for the reaction to balance, $R = CH_3$

which says RH in (7.16) must be CH_4 (methane)

7.10 RH = propene = $CH_2{=}CH\text{-}CH_3 = C_3H_6$ so, $R = C_3H_5$

so the sequence of reactions (7.16) to (7.19) are:

$$C_3H_6 + OH\bullet \rightarrow C_3H_5\bullet + H_2O$$
$$C_3H_5\bullet + O_2 \rightarrow C_3H_5O_2\bullet$$
$$C_3H_5O_2\bullet + NO \rightarrow C_3H_5O\bullet + NO_2$$
$$C_3H_5O\bullet + O_2 \rightarrow HO_2\bullet + C_2H_3CHO$$

The end product is acrolein, CH_2CHCHO.

7.11 U. S. Power plants:

$$\text{heat input} = 685\text{x}10^6\text{tons x } 2000\frac{\text{lb}}{\text{ton}} \text{ x } 10{,}000\frac{\text{Btu}}{\text{lb}} = 1.37\text{x}10^{16}\text{Btu}$$

$$\text{efficiency} = \frac{\text{output}}{\text{input}} = \frac{1400\text{x}10^9\text{kWh x }3412\text{Btu/kWh}}{1.37\text{x}10^{16}\text{Btu}} = 0.349 \approx 35\%$$

At NSPS of 0.03 lb particulates per 10^6 Btu input, emissions would have been:

$$\text{emissions} = \frac{0.03\text{ lb}}{10^6\text{Btu heat input}} \text{ x } 1.37\text{x}10^{16}\text{Btu in x } \frac{1000\text{g}}{2.2\text{ lb}} = 1.87\text{x}10^{11}\text{g}$$

$$\text{For comparison, } \frac{\text{emissions at NSPS}}{\text{actual emissions}} = \frac{1.87\text{x}10^{11}\text{g}}{0.39\text{x}10^{12}} = 0.48 = 48\%$$

7.12 Derivation for the dry adiabatic lapse rate:

$$dQ = dU + dW \qquad \text{where } dU = C_v dt \text{ and } dW = PdV$$

$$dQ = C_v dt + PdV \qquad (1)$$

ideal gas law says $PV = nRT$

so, $d(PV) = PdV + VdP = nRT$

or, $PdV = nRT - VdP$

plugged into (1) gives: