NOISE AND EMISSIONS MODELING – BASIC CALCUATIONS

A. Key Formulas

Noise (DNL) DNL at specified location due to specified aircraft = 10 log (N/T) Σ [10^(Si/10)]

where the summation is over all segments in the aircraft movement, and
Si = SEL value on segment i
T = number of seconds in a day (86400)
N = [number of daytime events + (10 * number of nighttime events)] for the specified aircraft

Emissions Total mass = Neng Σ (Ti * Fi * Ei)

where the summation is over all segments in the aircraft movement, and
Neng = number of engines on the aircraft
Ti = time that aircraft spends on segment i
Fi = fuel-consumption rate per engine during segment i
Ei = pollutant production per unit of fuel consumed

B. Population Data

		Location of Population		
		x (feet)	y (feet)	z (feet)
ID	Population			
A1	100	25000	0	0

C. Aircraft State Data

		Location of End of Each Segment				
Aircraft State	Segment	x (feet)	y (feet)	z (feet)	Thrust (lbs)	Time (min)
	Taxi Out	0	0	0	8000	16
	Takeoff	6300	0	1000	46000	0.7
	Climb	25000	0	3000	40000	2.2
	Approach (part 1)	25000	0	3000	16000	2

Approach (part 2)	6300	0	0	16000	2
Taxi In	-10000	0	0	8000	10
Initial and final positions:	-10000	0	0		

D. Noise Data (SEL values as function of distance and thrust setting)

					Distance from Aircraft (ft)									
					200	400	630	1000	2000	4000	6300	10000	16000	25000
Aircraft	Engine	Profile Type	Mode	Thrust (lbs)										
747-400	PW4056	Std	App (or Taxi)	8000	103.6	99.1	95.8	92.3	86.6	80.1	75.3	70.5	65.6	60.9
	PW4056	Std	App	16000	105.5	100.7	97.1	93.3	87.2	80.6	76	71.2	66.4	61.8
	PW4056	Std	Dep	26000	106.3	102	98.6	95	89	82.8	78.5	73.8	69.1	64.7
	PW4056	Std	Dep	32000	107.4	103.3	100.1	96.7	91	84.9	80.7	76.1	71.5	67.1
	PW4056	Std	Dep	40000	109	105.2	102.3	99.2	94	88.2	84.1	79.7	75.1	70.8
	PW4056	Std	Dep	46000	111.1	107.4	104.6	101.7	96.7	91.2	87.3	82.9	78.5	74.2

E. Emissions Data

				----------Fuel Flow----------				**----------EI NOx----------**			
Aircraft	Engine	ID	No. Engines	**Takeoff**	**Climb**	**App**	**Taxi**	**Takeoff**	**Climb**	**App**	**Taxi**
				----------kg/sec----------				**----------g/kg----------**			
747-400	PW4056	1PW042	4	2.34	1.93	0.66	0.21	28.1	22.9	11.6	4.8

F. Simplifying Assumptions

1. Assume the aircraft produces the same noise field in all directions. This means that the SEL level depends only on distance.
2. Assume that the distance to the population location is measured at the end of each segment.
3. Assume that linear interpolation between SEL values as a function of distance is appropriate.

G. Questions

1. What is the DNL at location A1 due to one 747-400 daytime departure?

2. What is the DNL at location A1 due to one 747-400 daytime arrival?

3. What is the total NOx emission due to one 747-400 departure?

4. What is the total NOx emission due to one 747-400 arrival?

FUEL AND CO2 MODELING – BASIC CALCULATIONS

A. Background Information

	kgCO2/kg_fuel	3.16

B. Total Fuel (kg) Used by the Aircraft as Function of Great-circle Trip Distance (nmi)

	125	250	500	750	1000	1500	2000
AT7	352	567	999	1430	1861	2722	3581
CR7	929	1324	2022	2737	3483	5063	6682
CR9	1023	1444	2206	3008	3824	5486	7201

C. Nominal Seat Capacity

AT7	70
CR7	70
CR9	90

D. Number of Engines, Fuel Consumption Rates (kg/sec), and NOx Emission Indices (g/kg_fuel)

	Number of Engines	Fuel (kg/s) 100% thrust	Fuel (kg/s) 85% thrust	Fuel (kg/s) 30% thrust	Fuel (kg/s) 7% thrust	EI NOx 100% thrust	EI NOx 85% thrust	EI NOx 30% thrust	EI NOx 7% thrust
AT7	2	0.15	0.14	0.08	0.05	16.8	15	9.4	6.6
CR7	2	0.6080	0.4790	0.17	0.07	13.82	12.00	9.85	4.03
CR9	2	0.648	0.530	0.179	0.064	14.69	12.60	10.75	4.60

E. Questions

1. If fuel efficiency is defined as fuel expended per unit distance, how do these three aircraft compare, as a function of trip distance?

2. If fuel efficiency is defined as fuel expended per unit seat distance, how do these three aircraft compare, as a function of trip distance?

3. What is the total CO2 and the CO2 emitted per passenger for these aircraft, as a function of trip distance?

4. What is the total NOx and the NOx emitted per passenger for these aircraft, as a function of trip distance?

Assume that the aircraft spends 16 minutes in taxi-out mode (7% thrust), 0.7 minutes in takeoff mode (100% thrust), 2.2 minutes in climbing to 3000 feet (85% thrust), 4 minutes in descending from 3000 feet, and 10 minutes in taxi-in mode (7% thrust). For simplicity, assume the remainder of the flight has an average thrust of 30%.