Problem Set 7 – Fall 2005 Due Monday, December 5, 2006

Question 1 (20 pts): Many city bus agencies are considering the purchase of hybrid diesel-electric buses to replace conventional buses to promote clean air. Hybrid buses have engines that run on two energy sources – diesel fuel and batteries. However, the hybrid engines and their battery packs are expensive and need to be replaced. The table below summarizes the costs and technical parameters of conventional and hybrid buses.

Helpful data and assumptions:

- Assume you **need to buy a battery pack even for a new hybrid** bus.
- Since bus agencies are public entities, they do not pay taxes.

	Bus Type	
	Conventional	**Hybrid**
Purchase Price	$280,000	$400,000
Bus Maintenance	$1.60 / mile	$1.60 / mile
Battery Pack Cost	N/A	$10,000
Battery Lifetime	N/A	3 years
Annual Bus Distance Driven (miles)	27,000	27,000
Diesel Fuel Cost (per gallon)	$1	$1
Net Fuel Economy (miles per gallon)	3.5	4.5

a) [7 pts] Considering only the costs above, which type of bus should be chosen over a 15-year lifetime by a bus agency? Assume a 5% discount rate.

b) [3 pts] Find the price of diesel fuel that makes the lifetime costs of the 2 buses equal. Given current diesel fuel costs, would you recommend hybrid buses if diesel prices were expected to remain at today's costs (find current costs if you do not know them)? Fuel prices are variable – give specifics on how to best model such a decision given the variance in prices.

Emissions Data (grams/mile)	**Conventional**	**Hybrid**
Particulate Matter (PM)	0.24	0.12
Nitrogen Oxides (NOx)	30.1	19.2
Volatile Organic Compounds (VOC)	0.14	0.08
Carbon Monoxide (CO)	3.0	0.1
Carbon Dioxide (CO2)	2,800	2,300

c) [5 pts] How cost-effective are hybrid buses compared to an alternative program that reduces emissions at a cost of $8 / kg of NOx?

d) [3 pts] Does your bus choice from part (a) change if society values emissions at $4 / kg for PM, $3 / kg for NOx, $2 / kg for VOC, $0.01 / kg for CO, and $0.10 / kg for CO2?

e) [2 pts] PAT recently bought 6 buses with a federal subsidy. Assuming that the federal money was trying to subsidize the environmental benefits, how much in subsidies should the government be willing to pay per bus? Would this subsidy make the decision change?

Source for data in this problem: Transit Cooperative Research Program (TCRP), TCRP Report 59, "Hybrid-Electric Transit Buses: Status, Issues, and Benefits", Transportation Research Board, 2000.

Question 2 (20 pts):

San Francisco International Airport (SFO) has some of the worst flight delays in the United States, made worse by local weather that is often foggy and rainy. In bad weather, arriving flights are disrupted because their runways are too close to each other to allow safe simultaneous landings. SFO is planning to build a new runway that would let them increase the rates of landings allowed in normal and poor weather conditions. (See figure at bottom).

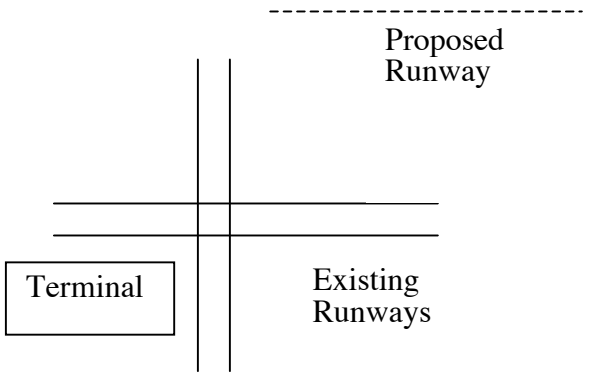
Assume that the following table summarizes U.S. Department of Transportation data (1997-1999) on sources of flight arrival delays at SFO. **Note** the flight delays column has data on both weather-related and total delays.

		Average Number of Flights Delayed Per Day	
Weather Conditions	Number Days per Year	Total	Due to Weather
Good All Day	188	149	0
Bad in Morning Only	116	210	61
Bad All Day	61	248	99

Helpful data:

- In the year 2000, roughly 20 million passengers arrived on flights at SFO.
- Roughly 50% of these passengers were flying for business, the remainder leisure.
- Business traveler income is $85,000 per year and leisure income is $40,000 per year.
- There were about 380 arrivals per day given the data above

a) [8 pts] Given the data above, estimate a range (low end, high end) of weather-related delay in passenger-hours at SFO in 2000.
b) [8 pts] Create a distribution function given your result in part (a). Assuming the life of a runway is 30 years and a 5% discount rate, and no changes in the number of passengers, estimate a range of willingness to pay for the runway by the SFO airport to eliminate the weather-related delays.
c) [4 pts] How does the willingness to pay change as the runway life and discount rate change?



Question 3 (10 pts):

The level of tire pressure (in pounds per square inch of air) is important in operating automobiles. If tires have too little pressure, then dangerous conditions can occur (e.g. vehicle rollover, spinning, etc). The following URL has a link to a policy document written by the US Department of Transportation that discusses several options related to mandating a tire pressure measurement system in automobiles.

http://www.nhtsa.dot.gov/cars/rules/rulings/TirePresFinal/FEA/TPMSCover.html

You will notice that the document discusses the tire pressure measurement devices in much more detail. I suggest reading the sections on Introduction, Target Population, Costs, and Cost-Effectiveness. This document is a good example of how to incorporate non-death injury rates into a cost-effectiveness study by a health status index (in this case, MAIS).

A – 4 pts) Create a new 'cost per life saved' value for alternatives 1a, 1b, 2, and 3 that ONLY includes fatalities (i.e. that excludes the MAIS equivalent fatality benefits). Consider both the non-discounted and discounted fatalities with the 2-10% range.

B – 4 pts) One minor problem with this study is that it does not calculate a 'cost per life years saved' value for each alternative. Assume that each avoided fatality saves 35 life years. Create 'cost per life years saved' values for each of the alternatives in part (a).

c – 2 pts) Compare your values from part (b) with those presented in the '500 Life-Saving Interventions' paper discussed in class. Should these tire pressure systems be required?