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Developing per smoker emission rates from Environmental Tobacco Smoke

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Environmental Tobacco Smoke (ETS) emissions are the complex mixture of gases and fine particles, with thousands of individual toxic air contaminants (Daisey et al, 1998) emitted by the burning of tobacco products (cigarettes, cigars, and pipes) and from smoke exhaled by the smokers. The composition of ETS emissions vary depending on the tobacco content, additives present and the type of paper and filter material used. In Australia, cigarettes are the principal source of ETS emissions (ABS, 2000). The environmental and health impacts of ETS emissions from cigarettes are of concern to regulatory agencies.

In recent years, there has been an increasing interest in developing emission inventories as a tool for regional air quality management. Development of emission inventories is, however, an expensive and time-consuming task due to diversity and large number of individual emission sources. Techniques for estimating emissions using readily available data and simplifications are therefore highly desirable. For example, locally-specific default emission rates can be used to estimate emissions for developing national emission inventories.

The purpose of this research was developing per smoker emission rates (PSER) from cigarette smoke for using them as a cost-effective means of estimating emissions over large geographic areas containing many pollution sources.

The PSER, in kilograms per year, were estimated from the total annual amounts of a pollutant emitted during smoking cigarettes, divided by the number of cigarette smokers in the inventory year. Total annual ETS emissions were estimated using smoking prevalence data from the Australian tobacco surveys and cigarette sales data from the manufacturers. The emissions factors (μg/cigarette) used for calculations (for the pollutants of interest) were specific to the Australian conditions; they were based on the most recent data available for cigarette brand variants manufactured and sold in Australia.

A selection of the default per smoker emission rates (kg/smoker/yr) derived from this research is presented in Table 1. These figures are the mean values (plus SD) for the last seven years, for which data were available (up to 2007).

Table 1. Selection of per smoker emission rates (PSER) from cigarette smoke

	PSER (κg/smoker/yr)	
Compound	Mean	SD
1,3 Butadiene	2.06E+00	8.67E-02
Acetaldehyde	9.60E+00	4.04E-01
Acetone	5.96E+00	2.51E-01
Acrolein	1.96E+00	8.24E-02
Acrylonitrile	5.57E-01	2.35E-02
Benzene	1.70E+00	7.16E-02
Benzo[a]pyrene	6.24E-04	2.63E-05
Cadmium	2.17E-03	9.12E-05
Carbon monoxide	3.28E+02	1.38E+01
Catechol	6.37E-01	2.68E-02
Chromium	1.05E-03	4.44E-05
Ethylbenzene	7.24E-01	3.05E-02
Formaldehyde	2.63E+00	1.11E-01
Hydrogen cyanide	7.00E-01	2.95E-02
Methyl ethyl ketone	1.03E+00	4.32E-02
Oxides of nitrogen	1.16E+01	4.90E-01
$PM_{2.5}$	7.60E+01	3.20E+00
Phenol	1.61E+00	6.79E-02
Styrene	5.92E-01	2.49E-02
Toluene	3.39E+00	1.43E-01
Volatile organic compounds	2.44E+01	1.03E+00
Xylenes	2.62E+00	1.11E-01

It has to be noted that the derived default PSER values (in Table 1) are based on the assumption that, following the results of the national population surveys, the average Australian adult (older than 15 years) smoker consumes approximately 5150 cigarettes annually, over the most recent years.

Daisey, J.M., K.R.R. Mahanama and A.T. Hodgson. (1998). *J. Exposure Analysis and Environmental Epidemiology*, 8, 313-334.

ABS (2000). Australian Social Trends, Australian Bureau of Statistics 2000, Cat. No. 4102, Canberra.