The Airborne Particles Expert Group was established to provide the Department of the Environment, Transport and the Regions, the Welsh Office, the Scottish Office and the Department of Environment (Northern Ireland) with a review of current knowledge on airborne particles in the UK and to advise on:

- *the levels and sources of particles in the UK;*
- *the physical and chemical characteristics of particles; and*
- *the long range transport capabilities of particles.*

The Expert Group published a draft report for comment in June 1998. Comments were received from organisations listed in Annex 2, and the final report was drafted having regard to the comments received.

The aim of this report is to estimate the contributions from various source categories to the concentrations of airborne particulate matter within the United Kingdom and to make projections of contributions into the early part of the next century. The quantitative source attribution estimates in the Third Report of Quality of Urban Air Review Group (QUARG) are based upon data which are now several years old and require refinement in the light of more recent measurements, since emissions of primary particulate matter and secondary particulate matter precursors have reduced in the intervening period. Additionally, knowledge of sources has been refined, modelling approaches have become more sophisticated and powerful and new methods for source apportionment have emerged. This report therefore seeks to synthesise, review and assess the currently available information on the source apportionment of airborne particulate matter in the UK. Additionally, projections of the future contributions from the various source types are attempted, to provide a firm basis for the review of the National Air Quality Strategy and to assist local authorities when undertaking review and assessment of particles under Part IV of the Environment Act, 1995.

Particulate matter in the UK is determined using a number of metrics. The most frequently measured is PM_{10}, describing the diameter of particles which pass a sampler entry with a 50% efficiency at 10 micrometres (μm): thus, to a good approximation, PM_{10} describes the mass of particles in the atmosphere with a size of less than 10 micrometres diameter. The less commonly measured determinand $PM_{2.5}$ is defined similarly, but for particles of less than 2.5 micrometres diameter. For many years particulate matter in the UK atmosphere has been measured in terms of its blackness, using a measure known as black smoke. These data are still of value and the report will also address particles measured in this way.

A diverse range of sources contribute to the airborne particulate matter observed in the urban atmosphere. Amongst the common air pollutants, particulate matter presents uniquely complex problems of source apportionment, i.e. the quantitative estimation of the contributions from different source categories to the concentrations measured in the atmosphere. This complexity arises for a number of reasons including the following:

(a) Many different source categories contribute particulate matter emissions to the atmosphere;
(b) Emissions from several of the potentially large source categories are not well established;
(c) Particulate matter can be emitted, and exist in the atmosphere, in a very wide range of particle sizes. The atmospheric lifetimes, and thereby ranges of travel of the different size fractions, vary considerably, and therefore the geographic range over which specific sources exert an influence is highly variable (from tens of metres for very coarse particles to thousands of kilometres for accumulation mode particles); and
(d) Airborne particles arise from both primary sources (emitted as such) and secondary sources (i.e. formed in the atmosphere from chemical reactions).

For the other common air pollutants (except ozone), emissions are in the main rather well

defined, and hence emission inventories can be constructed with a reasonable degree of confidence. In the case of particulate matter, some primary sources (such as quarrying and wind-blown suspension of surface dusts and soils) are highly variable in nature and therefore difficult to include reliably in source inventories. Thus, knowledge of emissions is far from complete. This weakness has additional implications in that numerical models, designed to predict the airborne concentrations of air pollutants, and which allow the testing of emission reduction strategies, depend upon the inclusion of high quality emissions data. Without such data the predictions of the models are bound to be uncertain.

A further complexity with airborne particulate matter noted above is that it has both primary (i.e. emitted from source) and secondary (i.e. formed in the atmosphere) components. The secondary components arise predominantly from oxidation of sulphur and nitrogen oxides in the atmosphere and require very detailed chemical models for their prediction. Additionally, there is a secondary component arising from the oxidation of volatile organic compounds and this secondary organic component is currently very difficult to measure or model.

The Third Report of QUARG addressed the issue of airborne particulate matter in the UK. It reported emission inventories for primary particulate matter and reviewed both measurements and model predictions for secondary particulate matter. It applied receptor modelling techniques (i.e. methods based upon the analysis of atmospheric measurements rather than predictions from a knowledge of emissions) to the source apportionment of particulate matter in the urban atmosphere. These approaches demonstrated three predominant contributors of particulate matter in the UK atmosphere, i.e. secondary sulphates and nitrates, vehicle exhaust emissions, and suspended soils and road dusts. It recognised that such a picture was an oversimplification, but provided valuable estimates of the contributions from the two main controllable source categories, i.e. road traffic and secondary inorganic particles, allowing a prediction of the impact of control strategies.