THE ORIGIN OF AMMONIA EMISSIONS TO THE ATMOSPHERE IN AN URBAN AREA

by

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An accurate description of ammonia emissions to the atmosphere of the South Coast Air Basin is needed to support air quality models for NH_4NO_3 formation. Such a study has been completed for the year 1974, and the principal results are summarized here. A grid system composed of 5 km x 5 km cells was superimposed on the South Coast Air Basin map shown in Figure 1. Ammonia emissions were estimated within each grid cell for the 53 classes of mobile and stationary source types listed in Table 1.

Source tests show that trace amounts of ammonia are present in the exhaust of both mobile and stationary combustion sources (Cadle and Mulawa, 1980; Gentel et al., 1973; Harkins and Nicksic, 1967; Henein, 1975; Hovey et al., 1966; Hunter, 1971; Muzio and Arand, 1976; Wohlers and Bell, 1956). Emission factors for ammonia release obtained from these and other references were combined with fuel use data reported by Cass (1978) to give total NH_3 emissions from autos, trucks, railroads, shipping, plus industrial, residential and commercial fuel use. Within each fuel use category, the NH_3 emissions shown in Table 1 were distributed spatially in the same manner as NO_x emissions. A number of industrial processes are known to emit ammonia (National Research Council, 1979; Miner, 1969), including refinery operations, ammonia-based fertilizer manufacturing, ammonia storage facilities, refrigeration plants, chemical plants and steel mill coke ovens. Estimates of NH_3 emissions from industrial facilities were derived from source test informaton and questionaires sent to individual companies.

Biological decay processes also produce ammonia and the release rates from a variety of soil surface types are avalable (Porter et al., 1975; Elliot et al., 1971; Denmead et al., 1978; Denmead et al., 1976; Miner, 1976). Using aerial photographs and maps available from the U.S. Geological Survey (1976) the land use within each grid square was summarized by type. Emissions from exposed land surfaces were estimated within each square by matching emission rate data to soil surface types.

Chemical fertilizers used in the air basin include ammonia, urea, ammonium nitrate and ammonium sulfate. Depending on fertilizer type and method of application, anywhere from a few percent to several tenths of the nitrogen content may be lost to the atmosphere as ammonia (Allison, 1966; Baker et al., 1959; Ernst and Massey, 1960; Gasser, 1964; McDowell and Smith, 1958; Stanley and Smith, 1955; Trickey and Smith, 1955; Wahhab et al., 1957; Walkup and Nevins, 1966). The ammonia loss characteristics of fertilizers were estimated by consultation with a local agricultural expert (Meyer, 1981). Fertilizer use statistics were obtained from the California Department of Food and Agriculture (1974) and from the U.S. Bureau of the Census (1977). Chemical fertilizer consumption, subdivided into cropland, orchard and non-farm use, was combined with the ammonia loss data to compute total NH_3 emissions.

Decomposition of livestock wastes is a major source of NH_3 emissions. Animal inventories by county were obtained from the U.S. Bureau of the Census (1977) and from state and county agricultural agents. Waste production rates, nitrogen content and ammonia volatilization rates were estimated for each major commercial animal type from previous studies (Adriano, et al., 1971; Adriano et al., 1974; Fogg, 1971; Giddens and Rao, 1975; Lauer et al., 1976; Luebs et al., 1973ab; Stewart, 1970; Taiganides and Hazen, 1966; Viets, 1971). Emissions from range animals were distributed spatially in proportion to pasture and herbaceous range land areas. U.S. Geological Survey (1976) maps were used to locate emissions from animals raised in confinement (e.g. dairy cattle, feedlot cattle). NH_3 losses from domestic animals (cats and dogs only) plus human respiration, perspiration and household cleaning chemicals were distributed in proportion to residential land use.

The overall spatial distribution of NH_3 emissions in the South Coast Air Basin is shown in Figure 2. The largest spike in the NH_3 diagram is centered over the town of Chino on the prevailing upwind side of the city of Riverside, and results from the intensity of livestock operations in that area. Details of the ammonia emission inventory calculations are presented in the Appendix to this report.