

observed in studies of lung function and symptoms upon repeated exposures).<sup>42</sup>

(ii) *Excess respiratory-related hospital admissions.* A separate risk assessment was done for increased respiratory-related hospital admissions as reported in several epidemiologic studies.<sup>43</sup> The assessment looked only at one urban area, New York City, for which adequate air quality information also was available to assess population risk. Increased respiratory-related hospital admissions for individuals with asthma were modeled using a probabilistic concentration-response function based on the results of an epidemiologic study in New York City (Thurston *et al.*, 1992) and estimated distributions of daily maximum 1-hour average O<sub>3</sub> concentrations upon attainment of alternative standards at various monitors in New York City (developed as part of the exposure analysis discussed above).<sup>44</sup> The resulting risk estimates are for excess respiratory-related hospital admissions (*i.e.*, those attributable to O<sub>3</sub> concentrations above an estimated background O<sub>3</sub> level of 0.04 ppm) for asthmatic individuals over an O<sub>3</sub> season.

Similar to the risk assessment discussed above for lung function and respiratory symptom effects, reductions in hospital admissions for respiratory causes for asthmatic individuals and the general population are estimated to occur with each change in the level of alternative 8-hour standards from 0.09 ppm to 0.07 ppm. In looking more specifically at a comparison between 8-hour standards at 0.09 ppm and 0.08 ppm levels, a standard set at 0.09 ppm is estimated to allow approximately 40 more excess hospital admissions of asthmatics within an O<sub>3</sub> season in New York City for respiratory causes as compared to a 0.08 ppm standard, which represents approximately a 40 percent increase in excess O<sub>3</sub>-related admissions, but only approximately a 0.3 percent increase in total admissions of asthmatics. The EPA believes that while these numbers of hospital admissions are relatively small from a public health perspective, they are indicative of a pyramid of much larger

numbers of related O<sub>3</sub>-induced effects, including respiratory-related hospital admissions among the general population, emergency and outpatient department visits, doctors visits, and asthma attacks and related increased use of medication that are important public health considerations.

In taking these observations into account, the Administrator recognizes the uncertainties and limitations associated with this assessment. These include: (1) The inability at this time to quantitatively extrapolate the risk estimates for New York City to other urban areas; (2) uncertainty associated with the underlying epidemiologic study from which the concentration-response relationship used in the analysis was drawn; and (3) uncertainties associated with the air quality adjustment procedure used to simulate attainment of alternative standards for the New York City area.<sup>45</sup>

#### *B. Potential Indirect Beneficial Health Effects Associated with Ground-level O<sub>3</sub>*

This section is drawn from information in the record of the 1997 review with regard to the effect of ground-level O<sub>3</sub> on the attenuation of UV-B radiation and potential associated health benefits. All relevant record information was reviewed, including EPA documents, published articles, oral testimony at public meetings, and written comments submitted during the rulemaking and on the proposed response. This section summarizes information on the health effects associated with UV-B radiation exposure (section B.1) and the relationship between ground-level O<sub>3</sub> and UV-B radiation (section B.2), and evaluates estimates of UV-B radiation risks that have been attributed to reductions in ground-level O<sub>3</sub> projected to result from attainment of the 1997 O<sub>3</sub> NAAQS (section B.3). This section also responds to a number of technical comments on the proposed response relating to (i) the distinctions that EPA has drawn between assessing the public health impacts of changes in stratospheric versus ground-level O<sub>3</sub>, (ii) the distinctions between assessing the public health impacts of changes in inhalation-related exposures to ground-level O<sub>3</sub> versus the impacts of changes in dermal-related exposures to UV-B radiation as mediated by changes in ground-level O<sub>3</sub>, and (iii) the appropriate weight to give to analyses in the record that provide quantitative

estimates of the public health impacts of changes in dermal-related exposures to UV-B radiation as mediated by changes in ground-level O<sub>3</sub>.

#### *1. Health Effects Associated with UV-B Radiation Exposure*

The following short summary of information<sup>46</sup> on the adverse human health effects associated with exposure to UV-B radiation focuses on the three major organ systems whose tissues are commonly exposed to solar radiation: the skin, eyes, and immune system.<sup>47</sup> It is these three systems that are potentially subject to damage from increased UV-B radiation as a result of the absorption of solar energy by molecules present in the cells and tissues of these organs. The biologically effective dose of radiation that actually reaches target molecules generally depends on the duration of exposure at particular locations, time of day, time of year, behavior (*i.e.*, "sun avoidance" and "sun seeking" behavior<sup>48</sup>), and, for the skin, characteristics that include pigmentation and temporal variations (*e.g.*, changes in the pigmentation due to tanning).

##### *a. Effects on the Skin*

The most common form of solar damage to the skin is sunburn. Susceptibility to sunburn and the ability to tan are the basis for a classification system of six skin phenotypes. The most sensitive individuals (skin type I) are very light-skinned, with red or blonde hair and blue or green eyes (U.S. EPA, 1987, ES-33). The most resistant individuals (skin type VI) are darkly pigmented even without exposure to solar radiation. Susceptibility to sunburn may be a risk factor for skin cancer.

Among light-skinned populations, skin cancer is among the most common kinds of cancer. The three types of skin cancer that have been associated with exposure to solar radiation include two common types of nonmelanoma skin cancers (NMSC), squamous cell carcinoma (SCC) and basal cell carcinoma (BCC), and melanoma, a far less common form of cancer.

<sup>42</sup> A more complete discussion of assumptions and uncertainties is presented in the Staff Paper and the technical support documents (Whitfield *et al.*, 1996; Richmond, 1997).

<sup>43</sup> Several studies, mainly conducted in the northeastern U.S. and southeastern Canada have reported excess daily respiratory-related hospital admissions associated with elevated O<sub>3</sub> levels within the general population and, more specifically, for individuals with asthma.

<sup>44</sup> The model is described in more detail in Whitfield *et al.* (1996) and results from the supplemental analysis are presented in Richmond (1997).

<sup>45</sup> A more complete discussion of these uncertainties and limitations is presented in the Staff Paper and technical support documents (Whitfield *et al.*, 1996; Richmond, 1997).

<sup>46</sup> More detailed information about the health effects associated with UV-B radiation exposure may be found in the proposed response to the remand (66 FR 57278-57280).

<sup>47</sup> The reference document available in the record for the information in this section is the EPA document "Assessing the Risk of Trace Gases that Can Modify the Stratosphere" (U.S. EPA, 1987).

<sup>48</sup> Sun avoidance is an intentional decrease in exposure, for example, by using clothing, sunscreens, and sunglasses to shield the body from solar radiation. Sun seeking behavior is an intentional increase in exposure to solar radiation, for example, by sunbathing.