



**North Carolina Department of Health and Human Services
Division of Public Health · Epidemiology Section**

1931 Mail Service Center • Raleigh, North Carolina 27699-1931

Tel 919-733-3816 • Fax 919-715-3807

Michael F. Easley, Governor

Carmen Hooker Odom, Secretary

February 7, 2003

MEMORANDUM

TO: Keith Overcash, Division Director
Division of Air Quality

Marion Deerhake, EMC Air Quality Committee Chairman

THROUGH: Douglas Campbell, MD, MPH, Head
Occupational and Environmental Epidemiology Branch
North Carolina Division of Public Health

William J. Pate, PE, CIH, Supervisor
Medical Evaluation and Risk Assessment Unit
Occupational and Environmental Epidemiology Branch
North Carolina Division of Public Health

FROM: Luanne K. Williams, Pharm.D., Toxicologist
Medical Evaluation and Risk Assessment Branch
Occupational and Environmental Epidemiology Branch
North Carolina Division of Public Health

SUBJECT: Request Adoption of 1-hour average AAL of 56 ug/m³ (micrograms per cubic meter) and 24-hour average AAL of 33 ug/m³ for Hydrogen Sulfide to Reduce the Risk of Triggering Asthma Symptoms Among Asthmatics and Reduce the Risk of Eye Irritation Among the General Public

Request that Hydrogen Sulfide Emissions from Pulp and Paper Mill On-Site Waste Water Treatment Plant be Permitted and be Required to Comply with the Recommended AALs

Request Adoption of 1-hour average AAL of 56 ug/m³ and 24-hour average AAL of 33 ug/m³ to Reduce the Risk of Triggering Asthma Symptoms Among Asthmatics and Reduce the Risk of Eye Irritation Among the General Public

In October 2002, Dr. Leah Devlin, State Health Director, sent the attached memo to Bill Ross requesting that DENR adopt the Acceptable Ambient Levels (AALs) recommended by the Scientific Advisory Board of 56 ug/m³ (1-hour average) to protect asthmatics from triggering of asthma symptoms and 33 ug/m³ (24-hour average) to protect the general public from eye pain and visual disturbances. Adoption of these recommendations will provide improved health protection for North Carolina citizens. There are serious public health risks associated with the current Acceptable

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Ambient Level. Lower AALs for hydrogen sulfide are needed to protect public health from the risk of asthma and eye-related adverse health impacts.

In October 2002, the North Carolina Division of Public Health requested air modeling data from the North Carolina Division of Air Quality to determine the impact radius or extent and modeled average annual number of exceedances of these recommended levels around PCS Phosphate in Aurora, Weyerhaeuser pulp mill in Plymouth and Associated Asphalt distribution terminal in Salisbury. The October modeling results are attached. In January 2003, the Occupational and Environmental Epidemiology Branch discovered that the majority of the hydrogen sulfide emissions released from the pulp and paper mills originates from the on site waste water treatment plant (see enclosed pie chart) and many of these emissions were not included in the October modeling. Therefore, a request was made to determine the impact radius for Weyerhaeuser again by including operational emissions and emissions from the on site waste water treatment plant. The extent and modeled average annual exceedances for these facilities are provided in Table 1 which are based on the most current operational conditions.

Exceedances of the recommended 1-hour average level (or impact radius) of 56 ug/m^3 are estimated to occur between 0.25 to 25 miles beyond the property lines of these three facilities. Based on modeling, persons within these areas are estimated to be exposed to on average 30 to 46 exceedances per year. For these three facilities alone, an estimated 81,769 individuals may be exposed to hydrogen sulfide levels exceeding the SAB recommended 1-hour average level of 56 ug/m^3 . Of these 81,769 individuals, it is estimated that 8,259 asthmatics may be exposed to hydrogen sulfide levels exceeding the SAB recommended 1-hour average level of 56 ug/m^3 .

Exceedances of the recommended 24-hour average level (or impact radius) of 33 ug/m^3 are estimated to occur between 0.031 to 18.6 miles beyond the property lines of these three facilities. Based on modeling, persons within these areas are estimated to be exposed to on average 10 to 12 exceedances per year. For these three facilities alone, an estimated 50,142 individuals may be exposed to hydrogen sulfide levels exceeding the SAB recommended 24-hour average level to protect the general public from eye irritation of 33 ug/m^3 .

Supportive Published Scientific Literature for 1-hour average AAL of 56 ug/m^3 and 24-hour average AAL of 33 ug/m^3

Published scientific literature support lowering of the current AAL of $2,100 \text{ ug/m}^3$ to better protect public health (see Table 2). Acceptable ambient levels for hydrogen sulfide established for other states range from 1.42 ug/m^3 to 280 ug/m^3 (1-hour average) and 0.973 to 42 ug/m^3 (24-hour average). The U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry recommended level for 15 to 365 days of exposure (24 hours a day, 7 days a week) is 42 ug/m^3 (based on respiratory effects in mice) (ATSDR 1999, Agency for Toxic Substances and Disease Registry Toxicological Profile for Hydrogen Sulfide). The U.S. Environmental Protection Agency has proposed a reference concentration (recommended chronic daily lifetime level) of 2 ug/m^3 (based on nasal lesions in rats) (USEPA February 2002, DRAFT Toxicological Review of Hydrogen Sulfide), and the current reference concentration for hydrogen sulfide is 1 ug/m^3 (based on nasal mucosa inflammation in mice). The recommended levels of 56 ug/m^3 (1-hour average) and 33 ug/m^3 (24-hour average) are within the range of levels established by other states federal agencies.

To determine if the current AAL ($2,100 \text{ ug/m}^3$) was adequate to protect public health, in 2001, the DENR Scientific Advisory Board (SAB) reviewed the scientific literature, including a study by Jappinen et al., 1990 (Jappinen P, Vilkkka V, Marttila O, et al. 1990. Exposure to hydrogen sulphide and respiratory function. *Br J Ind Med* 47:824-828) and Vanhoorne et al. 1991 (Van Hoorne et al., 1991. Survey of Chemical Exposures in a Viscose Rayon Plant. *Ann Occup Hyg* 35 (6):619-631). The SAB

derived the recommended AAL of 56 ug/m³ for a 1-hour average and 33 ug/m³ for a 24-hour average. The recommended one-hour AAL is based on triggering of asthma symptoms among asthmatics and the 24-hour AAL is based on eye irritation. Since the recommendation was made for the 1-hour average level of 56 ug/m³, other study results have become available that further validates the use of 56 ug/m³ 1-hour average. For instance, at the 2001 American Thoracic Society International Conference, the U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry presented an abstract summarizing a study of adults and children exposed to hydrogen sulfide levels greater than or equal to 42 ug/m³ compared to adults and children exposed to levels less than 42 ug/m³ (30 minute average exposure time) (Campagna D, Kathman S, Inserra S, et al. 2001. Impact of Ambient Hydrogen Sulfide and Total Reduced Sulfur Levels on Hospital Visits for Respiratory Diseases Among Children and Adults in Dakota City and South Sioux City, Nebraska. *American Journal of Respiratory and Critical Care Medicine* 163(5), abstract presented by U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry at the 2001 American Thoracic Society International Conference, study submitted for publishing in November 2002; and January 30, 2003 letter from Michelle Lackey with ATSDR). This study demonstrates a positive association between asthma-related hospital visits for adults and children (total 455 asthma hospital visits) and child respiratory disease-related hospital visits (total of 5009 respiratory including asthma hospital visits) for those persons exposed to levels greater than or equal to 42 ug/m³ compared to those exposed to levels less than 42 ug/m³. In addition, this study shows that exposure to hydrogen sulfide levels above 42 ug/m³ is associated with increased risk of exacerbation of asthma which supports the recommended 1-hour average of 56 ug/m³.

In addition to the ATSDR study, a community symptom survey study in Hawaii of 97 adults living near geothermal wells revealed a 41% shortness of breath and 26% wheezing response rate when persons were exposed to one-hour hydrogen sulfide concentrations of 1.39 to 65 ug/m³, compared to a 4% response rate for the control group that did not have hydrogen sulfide exposure (Legator M et al., 2001 Health Effects from Chronic Low-level Exposure to Hydrogen Sulfide. *Archives of Environmental Health* 56 (2):123-131; personal communication with Legator M January 2003).

Currently, there is no 24-hour average AAL established in North Carolina. A community symptom survey study of adults exposed to hydrogen sulfide emissions from a pulp and paper mill revealed that eye symptoms, nasal symptoms, shortness of breath, and wheezing were higher on days when the 24-hour average hydrogen sulfide concentrations were greater than 20 ug/m³ compared to symptoms when hydrogen sulfide concentration were less than 20 ug/m³ (Jaakkola J, Marttila O, Vikka V et al. 1990. South-Karelia Air Pollution Study: The Quantitative Effect of Malodorous Sulfur Compounds on Daily Symptoms. A longitudinal Study. Abstract presented at the 1990 World Conference on Lung Health *American Review of Respiratory Disease* 141(4):A75). Another community symptom survey study of adults and children exposed to hydrogen sulfide emissions from a pulp and paper mill revealed a 20% eye symptoms and 33% breathlessness response rate when persons were exposed to 3-135 ug/m³ over 2 days or 35 and 43 ug/m³ 24-hour average, compared to a 2% response rate for the same households 4 months later. (Haahtela T, Marttila O, Vikka V et al. 1992. The South Karelia Air Pollution Study: Acute health Effects of Malodorous Sulfur Air Pollutants Released by a Pulp Mill. *American Journal of Public Health* 82(4):603-605). Based on these study findings, 24-hour average hydrogen sulfide levels greater than 33 ug/m³ may be associated with increased risk of eye irritation and shortness of breath and wheezing symptoms.

Based on results of these studies, there is adequate information to support the recommended one-hour (56 ug/m³) and 24-hour (33 ug/m³) AALs for hydrogen sulfide.

Conclusions

- The current North Carolina 1-hour AAL of 2,100 ug/m³ for hydrogen sulfide is not adequate to protect public health. Division of Public Health staff has reviewed the proposed AALs for hydrogen sulfide and feels that the proposed levels accurately reflect current scientific literature on the health risks posed by hydrogen sulfide and provide an adequate and appropriate margin of safety. Adoption of the proposed AALs for hydrogen sulfide by the Environmental Management
- Commission and compliance with these levels by industry will reduce the risk of triggering asthma symptoms among asthmatics and eye irritation among the general public.
- Based on the SAB recommendations, the ATSDR study, other studies in the literature, and the current risks to asthmatics and the general public as evidenced by the latest air modeling and population exposure estimates, the Division of Public Health recommends that the Environmental Management Commission adopt a one-hour AAL of 56 ug/m³ and a 24-hour AAL of 33 ug/m³ for hydrogen sulfide.
- Because of the large volume of hydrogen sulfide emissions being released from the waste water treatment plant of Weyerhaeuser and possibly other pulp and paper mills, it is requested that the hydrogen sulfide emissions from the waste water treatment plant of pulp and paper mills be permitted and be required to comply with the recommended hydrogen sulfide AALs of 56 ug/m³ 1-hour average and 33 ug/m³ 24-hour average.

Please do not hesitate to contact me if you have any questions at 919-715-6429 or Mr. Bill Pate at 919-715-6432.

Cc: Mr. Tom Anderson, NC Division of Air Quality
Mr. Jeff Brown, NC Center for Geographic Information Analysis
Ms. Lori Cherry, NC Division of Air Quality
Dr. Douglas Campbell, NC Occupational and Environmental Epidemiology Branch
Dr. Steve Cline, Epidemiology Section
Dr. Leah Devlin, State Health Director
Mr. Bryan Lange, NC Division of Air Quality
Mr. Bill Pate, NC Occupational and Environmental Epidemiology Branch
Mr. Jim Roller, NC Division of Air Quality
Mr. Steve Schliesser, NC Division of Air Quality

