PROTECTING VISIBILITY

AN EPA REPORT TO CONGRESS

CHAPTER 8

8 RECOMMENDATIONS FOR VISIBILITY RESEARCH

The preceding chapters have identified a number of important information gaps and uncertainties in our current understanding of atmospheric visibility impairment. The extension and refinement of visibility protection programs will depend on improvement in available knowledge and techniques in several fundamental areas. These areas include monitoring, source identification, predictive modeling, atmospheric chemistry and transport, human perception, control techniques, implementation strategies, and value judgments. Increased communication among the various regulatory, scientific and technical disciplines represented by each of these areas is vital to the development of comprehensive research approaches to improve methods for making progress toward the national visibility goal.

EPA is currently developing an expanded visibility research program to be carried out over the next several years. In developing and implementing this program, EPA will continue coordination with major visibility studies conducted by the Federal Land Managers, Department of Energy, other governmental agencies, and industry groups. Important areas that should be addressed by these programs are summarized below.

8.1 CHARACTERIZATION OF EXISTING REGIONAL VISIBILITY CONDITIONS

Assessment of existing visibility in class I areas is an important need. Class I areas can be grouped into regions of similar climatology, scenery, prevailing visibility, and sources of impairment (such as those illustrated in Figure 7-1). Long-term comprehensive characterization of visibility-related parameters should be conducted in at least one class I area in each of these representative regions. Minimum requirements for such a program would include operation of a 10-to-20-station monitoring network for a period of 5 years. Priority should be given to pristine areas with significant emissions growth (or reduction) potential and areas with existing impairment problems. Approximately 3 to 5 Eastern sites (Northeast, mid-Atlantic, South Coast, Great Lakes) and 7 to 15 Western sites ("Golden Circle", Colorado, Pacific Northwest, California, Northern Plains, Southern Arizona, New Mexico-Texas) would give sufficient coverage. Each location should provide for comprehensive monitoring of optical, meteorological, and pollutant parameters. In addition to the human observation and instrumentation recommended in Chapter 3, instrumentation for monitoring light absorption by particles should be included. All identifiable major components of fine particulate mass should be monitored, and the contribution of coarse-mode particles to extinction estimated. The sampling strategy should be designed with data reduction and analysis methods in mind. Attempts should be made to separate natural and anthropogenic contributions and to characterize various air-mass influences. Supplemental regional aircraft sampling and auxiliary site "intensive " monitoring would be a useful adjunct to the base network.

The results of this comprehensive monitoring would include an improved understanding of natural and anthropogenic base-line contributions to visibility impairment, an indication of which parameters are necessary or most useful in

characterizing visibility, better monitoring instruments and operating procedures, and more precise approaches to assessment of visibility impairment. The network would also serve as a focal point for other visibility-related studies.

8.2 IMPROVED VISIBIDY MONITORING APPROACHES

Additional work is needed to develop simplified and improved visibility measurement approaches. An initial priority is development of a standardized guideline for "context pertinent" human observations by trained personnel. A consistent index should be developed for the three classes of impairment (plume blight, haze layers and general haze) and a generalized daily observation form should be made available. Development on standardized human observer methods should be coordinated with studies of human perception (Section 8.5) and visibility values (Section 8.6).

Improvements are needed in optical instruments. If possible, a single instrument, useful in a variety of applications, should be developed and tested. A portable, low-power consumption device for use in remote wilderness areas is particularly needed. Instruments for routine measurements of scattering *and* absorption by particles would be most useful. More sophisticated monitoring techniques for research applications are also needed. Instruments for measuring aerosol mass and chemical composition over shorter time intervals (1 to 2 hours) in clean areas would be a useful adjunct to current optical instrumentation. More accurate sampling and analysis approaches are needed for particulate organics and nitrates.

8.3 FIELD STUDIES OF POINT AND AREA SOURCE IMPACTS

Plume flights conducted in the VISTTA, MISTT, MAP3S, SURE and other research programs have provided significant information on the visibility impacts of major point source and large urban plumes. Such programs should be continued. Additional field studies are needed to examine the visibility impacts of source/environment combinations not yet studied. Briefly, these combinations include:

1. Plumes from power plants equipped with wet and dry ~ SO_χ scrubbers.

2. Secondary sulfate, NO2, and nitrate formation rates in plumes from Western power plants.

3. Emissions from new energy technologies.

4. Impacts of Los Angeles, Phoenix, and Tucson urban plumes on Southwest regional visibility.

5. Impacts of medium to small urban areas on nearby (50 to 100 km) Class I areas in the Southwest.

6. Fugitive dust emissions from mining, agriculture, and unpaved roads.

7. Impact of prescribed burning in the Pacific Northwest.

8.4 IMPROVEMENT IN PREDICTIVE VISIBILITY MODELS

8.4.1 Single Point Source Models

Validation and improvement of existing visibility models are extremely important. It is particularly necessary to determine whether the predicted significant NO_2 impacts at distances of 20 to 80 kilometers from well-controlled plants are observable. Analysis of validation studies (plume flights and ground measurements of relevant optical, dispersion, and chemical parameters), conducted by the VISTTA program for 1978-1979, should be accelerated to the extent possible, and plans for additional studies made. Current models should be improved to deal more effectively with complex terrain, channeling effects, and variable meteorological conditions over the course of a day and through seasonal cycles. Models should be extended to permit impact analyses of area sources, mining operations, and new energy technologies. The results of empirical studies of atmospheric visual perception (Section 8.5) should be incorporated into improved models. The LASL color display technique should be further developed and adapted for routine use on less sophisticated computers.

8.4.2 Regional Scale Models

As a starting point in developing regional-scale visibility models, the available airport visibility/pollutant satellite database in the Western states should be examined to determine if any evidence of hazy air mass episodes exists. Planned field studies in the East (PEPE and SURE) to evaluate chemistry, transport, and removal processes in a variety of conditions will be of significant value. Additional studies of Western hazy air masses should be initiated.

Studies of regional dispersion in the complex terrain of the West are needed. Basic Western meteorological data, such as transport winds through the mixing layer (up to 3 km), should be gathered as input for regional models. Regional models should be capable of dealing with spatial/temporal variations in plume trajectories, diurnal patterns in mixing heights, turbulence, stagnation, recirculation, channeling by terrain, and moderate to large scale meteorological patterns.

8.5 STUDIES OF ATMOSPHERIC HUMAN VISUAL PERCEPTION IN CLEAN AREAS

Both visibility modeling and monitoring require improved specification of the response of the eye/brain to atmospheric visual stimuli. Tests of the relationship between visual range of large dark objects and extinction (Koschmeider) are needed in "clean" areas. Validation of the applicability of the MTF approach for predicting the visual range of contrast detail and perceptibility of small pollution increments in scenic vistas is also needed. Most importantly, a study of thresholds of perception for discoloration caused by NO_2 and haze layers in the atmosphere should be conducted. Such studies should be linked and compared to the predicted outputs of visibility models. Many of these

perception studies could be conducted by use of panels of observers at or near comprehensive monitoring sites, discussed in Section 8.1. Initial studies by the American Petroleum Institute and the National Park Service will provide important insights for further work.

8.6 STUDIES OF THE VALUE OF VISIBILITY

Improved specification of the value of visibility, whether in economic, psychological, or social terms can assist in specific control/permitting decisions and in establishing interim objectives for making progress toward the national goal. A coordinated visibility values research program, tied to decision-making needs of the Land Managers and States, should be developed. The 1979 Visibility Values workshop represented a first step in this process (Fox et al., 1979). Values studies might be connected with studies of human perception and monitoring programs. Photography or field studies using observer panels could be conducted to define "significant" or "adverse " impairment better. Economic and psychological studies of activity, options, and existence values of class I area visibility might also prove useful. An analysis should be conducted of the benefits and desirability of improving visibility in Eastern class I areas, and hence, improving general visibility throughout the East. Such analyses may form the basis for deciding on long-term strategies for remedying existing impairment, as well as protecting general public welfare.

REFERENCES FOR CHAPTER 8

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