UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

October 14, 1988

EPA-SAB-EHC-89-007

OFFICE OF
THE ADMINISTRATOR

Honorable Lee M. Thomas
Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Subject: Science Advisory Board's review of the Treatment Technology relating to the regulation of drinking water contaminants involved in Phase II draft regulations.

Dear Mr. Thomas:

The Drinking Water Subcommittee of the Science Advisory Board's Environmental Health Committee has completed its review of the issues pertaining to the treatment technology of drinking water contaminants involved in Phase II proposed regulations from the Office of Drinking Water at its Cincinnati, Ohio meeting, June 2-3, 1988.

Among its recommendations, the Subcommittee urged the Agency to speak in terms of field testing new types of treatment techniques, rather than classes of compounds or contaminants. Priority in field testing should go to those technologies which are likely to be most widely used. Once a technology is well understood, the field testing can be specified as Best Availability technology (BAT) for a new contaminant through the use of process models, physical and chemical data, and appropriate bench and/or pilot testing. MCLs supported by long-term or chronic effects should be evaluated by the long-term central tendency of the data. MCLs supported by short-term or acute effects should be evaluated by the likelihood of unacceptable short-term levels at the consumer's tap. Sampling requirements and compliance determination should be tied to the populations at risk. EPA should develop an effective research program to investigate treatment alternatives for minimizing soluble lead in consumer plumbing.

We appreciate the opportunity to conduct this particular scientific review. We request that the Agency formally respond to the scientific advice provided herein.

Sincerely,

Norton Nelson
Chairman, Executive Committee

D Warner North for
Richard A. Griesemer
Chairman
Environmental Health Committee

Gary P. Carlson
Chairman
Drinking Water Subcommittee

SUBJECT: SCIENCE ADVISORY BOARD'S REVIEW OF ISSUES RELATING TO THE TREATMENT TECHNOLOGY METHODS FOR PHASE II DRINKING WATER

SCIENCE ADVISORY BOARD COMMITTEE: DRINKING WATER SUBCOMMITTEE OF THE ENVIRONMENTAL HEALTH COMMITTEE

DATE OF REVIEW: JUNE 2-3, 1988

PLACE OF REVIEW: EPA LABORATORY, CINCINNATI, OHIO

Issue No. 1: How much field-scale demonstration of a Best Available Treatment Technique ("BAT") is required for maximum contaminant level ("MCL") determination?

Background

- Section 1415 of the SDWA requires that EPA identify BAT for each contaminant at the same time it publishes its MCL.

- Section 1415 of the Safe Drinking Water Act (SDWA) states that:

  1. The MCL must be set as close to the MCL goal (MCLG) as is feasible using BAT.

  2. Also, in making judgments about feasibility, the Administrator is to:

     i. Examine best available treatments, "...for efficacy under field conditions and not solely under laboratory conditions..."

     ii. Take costs into consideration.

     iii. Specify treatments as effective as granular activated carbon (GAC) for any synthetic organics.

- EPA observes that an obvious response to this requirement is to conduct separate field testing for each contaminant, but makes the following comments:

  1. Such testing would be very costly.

2. Such testing could not be done within the time constraints specified in the SDWA for MCL promulgations.

3. No field sites are available for many of the contaminants (that is, they haven't been found in drinking water.)

- EPA proposes to conduct field tests for "classes of contaminants:"

1. Use bench/pilot scale data on individual contaminants

2. Estimate cost of construction, operation and maintenance.

3. Weigh all this and make a judgment re. the MCL.

DISCUSSION

It is the opinion of the SAB that ODW's proposal makes good sense but requires clarification and modification. Along the lines of clarification, it might be preferable to speak in terms of types of treatment technologies rather than classes of compounds or contaminants.

Although analytical models, bench tests and pilot tests of a treatment process can do a lot to characterize performance, some problems are never uncovered until the process is continuously operated at field scale for an extended period. As a consequence, extensive field scale studies should be conducted with any new treatment technique. The scale at which the studies are conducted should be on the same order as the scale at which implementation is expected to occur.

Among the issues to be addressed in such tests are: 1) the importance of the raw water matrix, 2) process operating conditions and operating requirements, 3) side effects of the treatment technique, 4) pretreatment requirements, 5) the characteristics of the contaminant that affect performance, 6) overall integration of the treatment technique in a process train and 7) economics.

Field test should evaluate a reasonable number of contaminants, a reasonable number of raw water qualities, a variety of climates, and should be conducted over an adequate period of time (for example, 12 to 18 months at each site).

When a technology is well understood, and extensively tested in the field, it might be specified as BAT for additional contaminants through the use of process models, physical and chemical data on the compound and bench and/or pilot-scale testing.

Field testing of new technologies is necessary for two fundamental reasons: 1) demonstrating scale-up and 2) refinement of details of design and operation. Each of these considerations is important in determining the scale at which field testing must be conducted.

Requirements for scale-up are much different from one process to the next. Air stripping processes have been extensively demonstrated. As a result, only information on the Henry's constant is necessary in order to apply the technology to a new compound. The use of a new coagulant can usually be evaluated through the use of bench and pilot-scale evaluation. Generally, processes which are widely used elsewhere in the world or in other industries will not require as much testing as those which are not. Also, processes which are easily modeled can often be tested at a smaller scale.

Refinement of details of design and operation is something that can only come from keeping the process on line at a field scale for a prolonged period of time. Many such considerations only become evident after a full-scale unit is operated in its intended use under different weather conditions and with varying raw water qualities for a significant period of time.

The amount of money spent on studying a treatment technology should be a function of the number and size of the water treatment facilities that might be built using it, i.e., the regulation's cost impact. Many of the contaminants being regulated under the SDWA are rarely found in drinking water. For these contaminants, the cost impact of a proposed MCL does not justify extensive field-testing. EPA's scarce resources should be directed toward field testing of treatment technologies that affect a large number of communities and where significant investments will be required by the water industry.

Recommendations

The following are the Subcommittee's specific recommendations:

1. Conduct extensive field testing with any new treatment technique.

    a. Conduct testing at a scale similar to expected implementation.

b. Conduct testing for a minimum of 12 months continuous operation.

c. Conduct testing on a reasonable number of raw water qualities, with a reasonable number of contaminants and under a variety of climates.

2. Providing a technology is well understood, once it is field tested, the technology can be specified as BAT for a new contaminant through the use of process models, physical and chemical data and appropriate bench and/or pilot testing.

3. In deciding the amount of money to be spent on studying treatment technology for a particular contaminant, the EPA should carefully consider the number and size [i.e., the cost] of treatment facilities that will be built using it. The most resources should be directed toward treatment technologies in which the water industry will make the greatest investment.

Issue No. 2: Impacts of State and Local Regulations and Industry Practice

Background

Discussion of certain issues with ODW caused the Committee to conclude the EPA sometimes does not effectively cope with the impact of industry practice on regulatory policy.

Discussion

As the EPA works to develop regulations and to evaluate the costs which will result from their implementation, it is important that these efforts are based on an accurate portrayal of the industry's likely response. The Committee's perception is that ODW sometimes takes these issues too lightly, not adequately considering state requirements or industry practices when, in fact, they will have an important impact. Three examples serve to illustrate the problem.

In discussing the BAT for the removal of VOCs, EPA indicates that air stripping alone is sufficient and dismisses the need for treatment of the effluent air. When challenged with statements that an increasing number of states and local constituencies do not allow this practice, EPA cites a risk analysis which

demonstrates that negligible health risk results from the discharge of the VOCs to the atmosphere, implying that ODW cannot be expected to consider the entire range of local regulation in its cost analysis.

In discussing application of GAC to water treatment problems, the problems of disposal and regeneration of spent GAC were raised by the Subcommittee. EPA responded that these problems have been addressed and are judged not to be significant.

In discussing the use of GAC in conventional plants, the Subcommittee asked about the impact of prechlorination on GAC and the formation of potential by-products. ODW's response was that this wasn't good practice. Members of the Subcommittee are under the impression that this practice, whether good or not, is common and likely to continue to be common unless EPA directly addresses its implications in regulations.

Recommendation

The committee recommends that EPA explore every significant aspect of potential regulations and their impacts. Assumptions of industry practice likely to result from a regulation should consider EPA's best assessment of industry's likely response as well as EPA's judgment as to what the best response would be. When it becomes evident that local regulations or industry practice will result in practices different than those EPA has assumed, these practices should be considered in the development of the regulations and assessing their cost impact.

Issue No. 3: Determining Compliance from Monitoring Data

Background

- EPA considers both short-term acute and long-term chronic health risks in developing maximum contaminant limits.
- The majority of the MCLs promulgated and proposed to date are based on long-term chronic health risks.
- Compliance with the VOC and THM regulations is based on a running average of quarterly samples.
- Compliance with the draft Pesticide/Herbicide and lead regulations could be based on single exceedence in worst-case samples.

- Compliance with the lead regulation is based on calculating the average level by counting samples below the PQL as equal to one-half the PQL.

Discussion

EPA's procedures for determining compliance from sampling data are not consistent with the logic of the health risk analysis used in developing the MCLs. The logic of these procedures is also inconsistent from one regulation to the next. Finally, some of the methods used for determining compliance are just bad science.

1. Public Health Risk: If EPA's MCL is established on the basis of long term exposure then compliance with the MCL should also be based on long-term exposure. If the concentration of a contaminant is expected to vary with time, then a sampling program and compliance determination procedure should be established that captures the variation and accurately portrays the long-term exposure which is implicated.

If the concentration of the contaminant is expected to vary in space then a more complicated set of decisions ensue. One alternative is to determine compliance so that the average user receives an exposure less than or equal to the MCL (as in the THM regulation where the level of THMs throughout the distribution system are averaged to determine compliance). Another way is to limit the portion of the population that may be exposed to high levels (as in one draft of the lead regulation where the portion of the standing water sample above 20 ug/L is limited to 5% or less). Another approach is to set the maximum level of exposure and work to assure that portions of the system above that level are dealt with (as would be the case if EPA utilities to resample sites above 20 ug/L and to do something about the high levels at these sites). In the case of lead, the SAB finds that latter approach to be the most sensible.

2. Consistency Among Regulations: As much as possible, the EPA should establish standardized procedures for determining compliance. These procedures should be developed in a manner consistent with the health risk analysis used in determining the MCL's, they should be well thought out, and they should be consistent from one regulation to the next.

3. Good Science: In using sampling data to determine compliance with an MCL the EPA must consider variations in concentration with both time and space. The simplest way to accomplish this is to specify a maximum value that can never be exceeded by any one measurement. This approach does not require any assumptions about which probability density function (PDF) is most appropriate for characterizing the data, but it requires

that provision be made for analytical error and it also requires that the utility maintain the central tendency of the concentration of the contaminant so low that the probability of a measurement exceeding the MCL is negligible.

How low this must be depends on the variance of the data, but it often requires that the central tendency be brought a decade or more below the MCL. For example, to avoid exceeding a 20 ug/L maximum for lead, the average lead level would probably have to be reduced to something on the order of 2 ug/L.

Another approach is to specify a percentile value. Again using lead as an example, the EPA might specify that a value of 20 ug/L may be exceeded no more than 5% of the time, or that 10 ug/L may be exceeded no more than 50% of the time and 20 ug/L may be exceeded no more than 5% of the time. This type of approach has three strengths: 1) it does not require any assumption regarding which PDF best characterizes the data, 2) it can be used to characterize the central tendency of the long-term exposure (50% value) as well as the variance allowed (95% value), and 3) it does <u>not</u> require that all the samples measured be above the MDL or the PQL for the method. Statistically speaking, a disadvantage of this approach is that the central tendency cannot be determined if more that 50% of the samples are below the MDL nor can the 95% value be determined if fewer than 5% of the samples are above the MDL. These limitations are not a problem in determining compliance as the MCL will surely be set higher than the MDL. No method is available for calculating the central tendency of a data set if more than 1/2 the measurements are below the MDL.

Most other approaches to analyzing sampling data to determine compliance require the assumption that the data can be characterized by some PDF. For example, the arithmetic mean characterizes the central tendency of the Gaussian Distribution and the log mean characterizes the central tendency of the Geometric Distribution, (the arithmetic mean is also used as the central tendency of several other PDFs). Neither of these parameters can be rigorously calculated if any of the data are below the MDL, however, they can be estimated using the principle of maximum likelihood or, more crudely, by plotting a best fit line of the data on suitable probability paper and extrapolating to the median value.

Techniques like averaging only the measurements above the MDL, treating those values below the MDL as "zero", or as equal to the MDL or 1/2 the MDL do a disservice to the community by misrepresenting the actual exposure. The EPA should strive to use statistically sound techniques for determining if data are in compliance with regulations.

Recommendations

The following are the Subcommittee's specific recommendations:

1. EPA should develop a formal structure for determining compliance from sampling data depending on the nature of the health effect supporting the MCL. MCLs supported by long-term or chronic effects should be evaluated by the long-term central tendency of the data. MCLs supported by short-term or acute effects should be evaluated by the likelihood of unacceptable short term levels at the consumer's tap.

2. Details of sampling requirements and compliance determination should be specifically tied to the population to be protected. For example, if the objective is to lower the overall exposure of the community to lead through the drinking water, then a long-term measure of central tendency is appropriate. If the objective is to find those consumers with high levels of exposure and protect them, then sampling should be directed toward finding those homes and taking action to reduce the exposure of those consumers. The committee recommends that both courses of action be taken.

3. EPA should use good science in specifying methods for determining compliance from sampling data. For example, for lead, for specifying the central tendency as, "50% of the samples must be less than the specified limit" and specifying the limits of variance by specifying that, "95% of the samples must be less than a specified limit of variance" is not good science. Arithmetic averages are an unacceptable means for representing the central tendency of data with some values not detected.

Issue No 4: Research on Controlling Lead in Consumer Plumbing

Research on treatment technology for controlling lead in consumer plumbing is needed, both to support the development of regulations and to make effective compliance possible.

Background

Although it is generally recognized that increasing the pH will reduce the release of lead from consumer plumbing, beyond that, limited information is available. Orthophosphate is reported to be effective under certain conditions and other corrosion inhibitors have been proposed. On the other hand, available information is not sufficient to predict the best treatment program for a particular water quality, or even to outline a reasonable test program to find the optimum. The presentation on treatment technology for controlling lead focused on the lead contribution from faucets and water coolers rather

than lead in distribution systems. Presumably, this was because EPA's research to date has been limited to these subjects where lead is concerned.

Recommendation

Better information is needed on treatment alternatives for minimizing soluble lead in consumer plumbing - both for purposes of the regulation itself and in order that the industry might know what to do about the problem. EPA urgently needs to develop an effective research program to satisfy this need.

Information Currently Available: Its rapid pace makes SAB review especially important. The program should evaluate the effectiveness of conventional corrosion treatment remedies such as pH adjustment, adjustment of $CaCO_3$ saturation, use of orthophosphates, zinc orthophosphates, polyphosphates, and silicates. The design of affordable strategies for optimizing corrosion treatment for controlling lead by-products should be an objective of the effort.

U.S. Environmental Protection Agency
Science Advisory Board
Drinking Water Subcommittee

CHAIRMAN AND VICE CHAIRMAN

Dr. Gary Carlson [CHAIR], Department of Pharmacology and Toxicology, School of Pharmacy, Purdue University, West Lafayette, Indiana 47907 (317) 494-1412

Dr. Robert Tardiff, [VICE-CHAIR], Principal, Environ Corporation, 1000 Potomac St., N.W., Terrace Level, Washington, DC 20007 (202) 337-7444

MEMBERS AND CONSULTANTS

Dr. Julian B. Andelman, Graduate School of Public Health, 130 Desoto Street, Parran Hall - Room A-711, University of Pittsburgh, Pittsburgh, PA 15261

Dr. Rose Dagirmanjian, Professor, Department of Pharmacology and Toxicology, University of Louisville, Louisville, Kentucky 40292 (502) 588-5160

Dr. William Glaze, Director, School of Public Health, University of California, Los Angeles, 650 Circle Drive South, Los Angeles, CA 90024 (213) 206-1278

Dr. J. Donald Johnson, Professor, School of Public Health, University of North Carolina, Chapel Hill, NC 27514 (919) 966-3856

Dr. David Kaufman, Department of Pathology, University of North Carolina, Rm. 515 Brinkhous-Bullitt, Chapel Hill, North Carolina 27514 (919) 966-1396

Dr. Nancy Kim, Director, New York Department of Health, Bureau of Toxic Substance Assessment, Room 359, Tower Building, Empire State Plaza, Albany, New York 12037 (518) 474-2084

Dr. Verne Ray, Medical Research Laboratory, Pfizer, Inc. Groton, Connecticut, 06340 (203) 441-3564

Dr. Harold Schechter, Professor, Chemistry Department, Ohio State University, 140 West 18th Avenue, Columbus, Ohio 43201 (614) 292-6300

Dr. Thomas Tephly, Professor, Department of Pharmacology, The Bowen Science Bldg., University of Iowa, Iowa City, Iowa 52242 (319) 335-7979

EXECUTIVE SECRETARY

Dr. C. Richard Cothern, Executive Secretary, Science Advisory Board [A-101F] U.S. Environmental Protection Agency, Washington, D.C. 20460 (202) 382-2552