M/DBP Stage 2 Federal Advisory Committee (FACA2)

MEETING SUMMARY

Treatment Technologies

Meeting #5

September 22-23, 1999
Washington, DC

Final

November 24, 1999

Table of Contents

Attachments:

I.a Participants List

I.b Meeting Agenda

II.a TWG Presentation to FACA Committee - ICR Data Summary, Michael McGuire, MEC

II.b Bromate in Commercial Bleach Products. *Chlorine Institute Inc*. *handout*

III.a Treatment Technologies for Microbial and DBP Control: A Primer, Michael McGuire, MEC

III.b Water Treatment Primer - Qualitative Summaries, Scott Summers and Gabriele Solarik, University of Colorado at Boulder

IV. UV Disinfection for Drinking Water - A BAT but not a Panacea,
James P. Malley, University of New Hampshire

Introduction

On September 22-23, 1999, EPA held the fifth meeting of the Stage 2 Disinfection Byproducts and Long-Term 2 Enhanced Surface Water Treatment Rules (MDBP) Federal Advisory Committee (FACA). This meeting included presentations by the Technical Work Group (TWG) on ICR data, a primer on treatment technologies, and substantial time spent in caucusing and conversation among FACA Committee members. [See Attachment I.a for a list of meeting participants.]

After introductions, mediator Abby Arnold, RESOLVE, reviewed the objectives of this meeting:

- Provide overview and elaboration on ICR Occurrence Data;
- Provide primer/overview of drinking water treatment technologies;
- Review and provide guidance on the Technical Work Group's priorities; and
- Provide time for FACA members to ask questions, talk, and get to know one another.

The Committee approved the agenda as proposed [See Attachment I.b.] The afternoon of September 22 consisted of caucus time in which FACA members met among themselves. This meeting report summarizes the discussions and next steps from this meeting.

II TWG Presentation to FACA Committee - ICR Data Summary

Michael McGuire, MEC, presented the TWG's report to the FACA committee [See Attachment II.a] McGuire reviewed the following points concerning his role as representative of the TWG and the progress of the TWG:

- McGuire is acting as a reporter from the TWG to the FACA. Dozens of people are involved in the work of the TWG.
- The TWG is covering a lot of information. Presentations from the TWG are intended to be summary information, not raw data.
- The TWG is still laying the groundwork for analysis of the first 12 months, and then the full 18 months of data. The TWG is on schedule for creating data analysis tools (auxiliary data bases and query tool).
- The TWG is preparing to present the 12 month pre-Stage 1 baseline at the October 27-28, 1999 FACA meeting. Previously, the TWG has been designing how to organize data and presentation. Beginning in October the TWG's focus will shift to data analysis, including identifying and following trends.

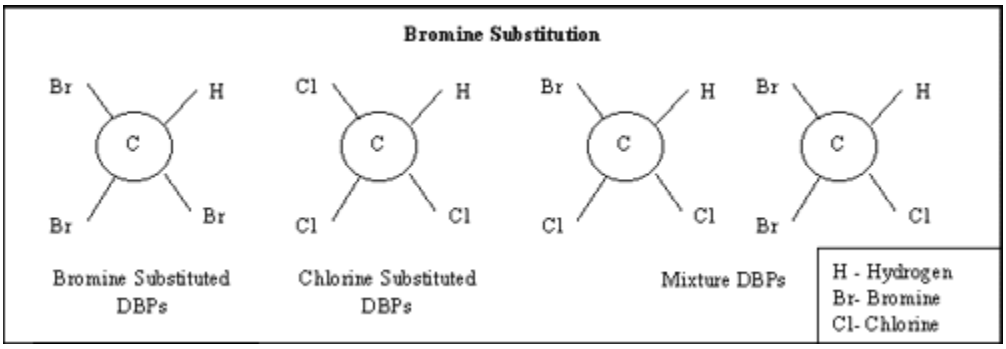
Only 9 months of data are included in the TWG presentation covering three quarters (summer, fall and winter). McGuire cautioned that the TWG is still learning about the data and there may still be some data quality problems. McGuire reviewed the use of boxplots for presenting the distribution of data. Data exceeding the 5 and 95 percentile are outliers that represent real data points, not problems with the data set.

McGuire provided an overview of bromine incorporations into DBPs and Total Trihalomethane (TTHM) speciation. A relatively small percent of bromide in source waters will be "incorporated" into DBPs forming in the finished water to yield brominated DBP species - brominated trihalomethane (THM-Br) and brominated haloacetic acid (HAA-Br). The chemistry of bromine incorporation into DPBs is not fully understood and only 40% of brominated species can currently be measured.

Under the ICR, utilities had the option of measuring for HAA class sums of HAA5, HAA6, or HAA9 in the distribution system. Fewer plants measured for HAA9 because of problems with the analytical method. McGuire presented 9 months of data on:

- HAAs by class sum;
- speciation of brominated HAAs;

- HAAs by TOC ranges based on distribution system averages;
- TTHM versus HAAs (for all class sums); and
- distribution system "delta" calculation for TTHMs and HAAs.



The sources of bromate in finished water include:

- **Sodium hypochlorite** - bromate is a naturally occurring contaminant in the chlorine and caustic soda used in the manufacture of sodium hypochlorite (an alternative method of adding chlorine to water for secondary treatment).[(1)]
- **Plants using chlorine dioxide -** Levels are determined by chlorine dioxide residual, contact time with water containing bromide, and level of bromide.
- **Ozone plants** - Levels are determined by ozone residual, contact time with water containing bromide, and level of bromide. ICR data are based on 19 ozone plants in ICR data base.

The TWG presentation concluded with a review of chlorite levels in distribution systems including a comparison of chlorite levels in finished water and distribution sampling points, and differences in chlorite levels based on the distribution system disinfectant.

The following points were raised during the TWG presentation:

- A member requested that when technical presentations are made the FACA be told the reason why the presentation and data presented is relevant to the FACA's charge to develop recommendations to EPA for Stage 2.
- From the TWG's perspective, it is not understood what happens when DPBs come in contact with high acidity in the human stomach, though some DBPs may be unstable. A meeting participant noted that formation of DBPs in the stomach has not been observed in laboratory studies.
- Though they are a small percentage of the DBP mixture in finished water, brominated DBPs are a focus of the TWG because of concerns surrounding the health effects of these compounds.
- In response to a question, McGuire noted that the entire mixture, or soup, of DBP species is not known and may take years or decades to fully understand. TOX is used to measure the total halogen-substituted organic compounds in the water. THMs and HAA are viewed as surrogates of the entire soup of DBPs.
- Biological and chemical degradation of DBPs is not well understood. Filters may act like biological reactors breaking down some DBPs. The distribution system also contains biological activity that will affect DBP occurrence and degradation. Fate of DBPs in the distribution system is not fully characterized.
- In response to a question on the present level of comfort using THMs/HAAs as DBP surrogates, and possible changes in comfort levels based on anticipated research, McGuire noted that the TWG is continuing to work on this question. There is not evidence yet that they are not good indicators. However, with time data will increase on what DBPs are not being measured, and thereby the effectiveness of using THMs or HAAs as surrogates.

- In response to a question McGuire noted that iodine and floride in water are not significant sources of DBPs.
- HAA class sums are cumulative, i.e. HAA9 includes HAA5 and HAA6. HAA9 is not currently used as an indicator because of analytical method problems for detecting HAA9.
- There may be formation of DBPs (HAAs) in distribution systems in chloramine plants with long detention times.
- A Committee member noted that, though it was not discussed in the TWG presentation, some systems have large DBP formation in their distribution system.
- EPA cautioned that the TWG is presenting data that has not been fully analyzed and that FACA members should wait before drawing conclusions on incomplete data. The FACA's desire to see information quickly must be balanced with the time need to learn about the data and grasp what the data are saying. A FACA member requested that in future presentation the TWG:
    1. identify likely misinterpretations of data;
    2. clarify how other approaches to data analysis will change interpretations of data; and
    3. include questions that the data does not address or answer.
- A FACA member noted that many utilities shifted technologies to sodium hypochlorite from free chlorine because of air release and other regulatory initiatives.

[1.] The Chorine Institute, which first identified this problem, has prepared a working paper analyzing the problem: Bromate in Commercial Bleach Products, September 1999 [Attachment II.b].

III Treatment Technologies for Microbial and DBP Control: A Primer

At the request of the FACA, R. Scott Summers, University of Colorado at Boulder, and Michael McGuire, MEC, presented a qualitative overview of treatment technologies from a regulatory compliance perspective [see Attachment III.a].

Summers began by introducing the topic and explaining that the mix of technologies used at plants is broadening as plants react to their specific source water characteristics. Summers added that the FACA should embrace flexibility in treatment design scenarios used by plants.

Microbial treatment involves a multiple barrier approach consisting of physical removal, primary disinfection and secondary disinfection - coupled with source water protection. Summers added the following comments in his discussion of the presentation materials.

- Membrane filtration is a relatively new technology compared with the others mentioned.
- Cl2, O3, and ClO2 are the most commonly used primary disinfectants in the US.
- Chloramine is normally used as a secondary disinfectant.
- UV is not used in large surface water systems in the US, though it is used in Europe. A FACA member commented that UV would require some contact time (CT) requirement.

Summers reviewed the DBP precursor control technologies, and factors affecting DBP formation and DBP speciation shift, and made the following points:

- Stage 1 requires enhanced coagulation/softening - which lowers pH and increases removal of TOC. 50% of utilities already meet Stage 1 requirements.
- Ozone is effective for inactivating microbes and reducing organic DBP formation potential.
- Biofiltration consists of a sand, coal, or GAC filter without disinfectant residual in which biomass consumes TOC and organic contaminants.
- Processes that remove TOC but not bromide may be lowering the overall DBP concentration in water. However, there will be a shift towards increased fraction of brominated DBPs.

This treatment technology primer, as developed by the TWG, includes qualitative comparisons of different technologies in removing/inactivating microbe (viruses, *Giardia*, and *Crypto*) and reducing DBP formation (THM/HAA and bromate). Summers presented relative comparisons between technologies for physical removal and primary disinfection. This portion of the presentation did not address cost or commercial viability:

- Chloramines may be less effective than chlorine in inactivating microbes, however, they form fewer DBPs.
- The amount of chlorine dioxide added to water is limited because of the formation of chlorite which is limited by the MCL.
- Coliforms are in between *Crypto* and viruses in size.
- UV may be highly effective for inactivation of microbes, does not form THMs or HAAs. It is unknown if UV forms other DBPs.
- A FACA member noted that the possible use of *Crypto* as the indicator of microbial inactivation will drive the discussion to the use of UV.

Summers made the following additional points in his review of treatment technologies:

Conventional or softening treatment: Coagulant coats particles and allows them to clump together for easier removal. Though it does disinfect, high pH is not considered a reliable disinfectant alone.

Chlorine/chlorine: Used in many plants. Amount of chlorination added depends on the size of the clearwell (CT), need for algae control in plant, and oxidation of taste and odor problems. Most utilities add disinfectant at multiple points within plant.

Chlorine/chloramines: Use of chloramines (ammonia + chlorine) as secondary disinfectant reduces the formation of THMs in distribution system.

Chlorine dioxide/chloramines: Most plants still add chlorine as the pre-plant disinfectant. Because ClO2 leads to chlorite production, ClM or, in fewer cases Cl2, is used to ensure a disinfectant residual. A FACA member added that there is currently research into adding ClO2 earlier in the treatment process and removing chlorite before distribution.

Enhanced Coagulation/Softening: Coagulant and, if necessary, are added to water to lower TOC. Stage 1 will affect only the 50% of plants that did not already meet this requirement. Enhanced Coagulation requirements required a change in the chemistry of some plants. However, little new capital will be required.

Enhanced Coagulation/Softening and UV: UV does not affect TOC and does not add residual.

Conventional Treatment and Granular Activated Carbon: GAC may require the addition of a filter gallery. Carbon may be reactivated every 6 weeks to 2 months. 10-100 GAC units are required in ICR sized plants. GAC averages an additional 50% TOC removal and likely reduced (though possibly increased) brominated DBPs.

Conventional Treatment and Nanofilter/Reverse Osmosis: Filter membranes can break. Reject stream can be very difficult to dispose of and up to 80% of the inlet water can be lost in the waste stream.

Microfiltration/Ultrafiltration Membrane System: Has application for only clean source waters or requires pretreatment.

Summers concluded by presenting the additional costs associated with these technologies, as determined in the US EPA Cost and Technologies Manual. Small system costs may be double the costs for large systems because of economies of scale.

The additional points made during Summer's presentation:

- Reliability of these technologies may be a big issue, especially for processes that we do not have much experience with (*e.g*. UV).
- In response to a question, Summers explained that the only method of removing bromide from source waters is nano/RO filtration, which is expensive and remove all other materials in water as well.
- 70% of plants still practice prechlorination. However, compared with 20-30 years ago when production or occurrence of DBPs was not measured, THM and HAA concentrations are much lower due to more careful use of disinfectants. The first regulation of THMs occurred in 1979. 20% of plants went to chloramines at that time. More emphasis has been placed on removing precursors.
- New plants are designed to allow addition of disinfectants in many different spots within the treatment plant.

Michael McGuire continued the primer on treatment technologies [Attachment III.b]. Based on a review of the regulatory context for treatment, the TWG concludes that:

1. Influent water quality, treated water objectives (regulations), and costs govern the choice of water treatment processes.
2. Treatment process choices and their implementation are integrated in a complex arrangement.
3. There is no panacea for micro and DBP control; no singe process can be dropped into a plant without considering consequences.

McGuire presented the pros and cons of treatment technologies, as developed by the entire TWG through consensus, although some differences of opinion remain. In conclusion McGuire made the following summary points:

1. Treatment processes exist to control all known pathogens and all known DBPs;
2. Cost of technologies is proportional to effectiveness -- the higher cost processes generally provide the broadest and most complete micro/DBP control; and
3. Switching treatment technologies to control DBPs raises distribution water quality issues that must be reconciled.

IV UV Disinfection for Drinking Water - A BAT but not a Panacea

James P. Malley, Jr., University of New Hampshire, presented an overview of UV treatment technology [Attachment IV]. Malley presented FACA members with four main points for consideration on UV: (1) UV has far too many advantages to be ignored, (2) UV is not a panacea, (3) there is consensus in the UV community that UV can be used to control bacteria, viruses, Giardia and Crypto, and 4) remaining concerns with UV are that we do not have design and performance experience for larger (>80 MGD) drinking water systems and that we do not have consensus on how UV performance will be monitored on a daily basis.

System size and the organism targeted will determine the UV dosage and the technology that is employed. UV light emitted in the wavelengths of 200 to 300 nm are considered the important germicidal wavelengths because lower wavelengths do not adequately penetrate water and higher wavelenghts are not as effective in damaging vital biomolecules such as the DNA. UV inactivates organisms by damaging DNA, RNA and possibly other biomolecules so they cannot replicate. Malley reviewed the use of UV for inactivating *Giardia*, viruses, and *Crypto.* Malley also presented existing research on effects of UV on

DBPs and regrowth. Malley was asked about organism's ability to repair the damage done by UV and remain viable. Malley indicated that for virus and bacteria this has been historically handled by providing a high enough dose to insure too much molecular damage to be repaired. Malley indicated that repair by Giardia cysts or Cryptosporidium oocysts is hypothesized to be unlikely but that good fundamental research could be conducted to confirm this hypothesis.

Malley also presented:

- US and European experience using UV, including use in wastewater plants;
- installation of UV into existing plants;
- use of UV in unfiltered systems;
- cost of UV technology;
- monitoring and reliability issues; and
- concerns about mercury releases.

V Next Steps:

The following points were discussed by the FACA during the meeting that may require follow up activities by FACA members, TWG, EPA or other participants:

- Half page summaries of each of the TWG sub-group objective and progress. *RESOLVE will work with TWG subgroup chairs to prepare and compile these summaries*.
- FACA members asked the TWG to look into treatment technology reliability issues.
- Arrange a tour of a drinking water plant for FACA members.
- More attention is needed on small systems in presentations and discussion.

The following are agenda topics or suggestions that FACA members suggested for future meetings:

Meeting:	Topics:
October	• What are interests, problem areas, or issues the FACA members care about? (discuss AM day 1 or PM day 2) • Too much time on cross-connections • Caucus time earlier in meeting • 12 month ICR data (discuss on day 1) • Health Risk Assessment Update
December	• Watershed characteristics - microbial occurrence, DBP precursors and watershed protection. • Bromate health effects • Options for reducing distribution system risks • Reliability of treatment technologies/operational issues • Stage 1 baseline • In-depth discussion of membranes/ozone/GAC • Small systems - state of technology • Health Risk Assessment

VI Chlorine Chemistry Council Announcement

FACA member Peggy Geimer and Keith Christman, Chlorine Chemistry Council, made the following announcement:

After discussions with the EPA, the Chlorine Chemistry Council (CCC) is launching a series of studies to directly address the need for better long term, low dose Reproductive and Developmental Studies on disinfection byproducts. There will be multigenerational research studies (including toxicokinetics) on BDCM and Dibromoacetic acid. The CCC will also do individual developmental studies for BDCM. The studies will start in October, finishing in time for the planned August 2001 Notice of Data Availability. The CCC is forming a Science Advisory Group and would appreciate nominations from FACA members of experts with strong scientific backgrounds in Reproductive and Developmental Toxicology to be considered for the panel.

VII Public Comment

There were no parties that requested public comment.

Adjourn