UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C. 20460

OFFICE OF THE ADMINISTRATOR
SCIENCE ADVISORY BOARD

October 1, 2008

EPA-SAB-09-001

The Honorable Stephen L. Johnson
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Washington, D.C. 20460

Subject: Consultation on EPA's Proposed Aircraft Drinking Water Rule (ADWR)

Dear Administrator Johnson:

EPA is responsible for developing and implementing the National Primary Drinking Water Regulations (NPDWRs) for all public water systems. Existing NPDWRs were designed for traditional, stationary public water systems, not mobile aircraft water systems that are operationally different. EPA's Office of Ground Water and Drinking Water requested that the Science Advisory Board (SAB) Drinking Water Committee (hereafter, the Committee) provide consultative advice on EPA's Proposed Aircraft Drinking Water Rule (ADWR). EPA is proposing a rule that seeks to protect passengers against pathogens by requiring development and implementation of aircraft water system operation and maintenance. These requirements include routine sampling for total coliforms and *E. coli*. There remain technical issues regarding the sampling for total coliform bacteria/*E. coli*, and these comprise the charge questions for the Committee.

The proposed ADWR requires sampling each aircraft. EPA requested comments on whether: (1) statistical sampling could replace sampling water from every aircraft, and (2) hot water taps should be sampled in aircraft galleys, if the galleys have no cold water taps (and if the temperature of the hot water should be recorded).

On July 24, 2008, the Committee met via teleconference. With regard to the first charge question, a majority of the Committee members (listed in Enclosure 1) were not in favor of statistical sampling of aircraft for drinking water quality at this time. Currently available information on contamination was generally considered too sparse to interpret the results for the whole fleet. Several members thought that information gathered during implementation of this rule might allow such sampling in the future, by providing information on how to stratify the samples, e.g., by type of aircraft or by routes traveled by the aircraft especially internationally.

Suggestions as to what types of information could be collected to provide a basis for statistical sampling are in the members' individual comments (Enclosure 2).

The second charge question generated a discussion of the effects of water temperature and holding time, given that the current test is for total coliform/*E. coli* bacteria that are unlikely to survive at a temperature at which coffee can be brewed. It was noted that the sampling of hot water has not been accepted as a legitimate type of sample for coliform bacterial analysis. The members' preference was to sample cold water taps; they were concerned that the hot water taps in the galleys would produce false negative results. The members had several suggestions for the situation where only hot water taps are available in galleys; these are provided in the enclosed, individual comments. For example, since the water from the galleys and the lavatories has the same source, a second sample from the lavatory could be more scientifically justified. Another suggestion was that the hot water tap might be sampled after the heating element had been off for an extended period of time. Again, several members expressed the expectation that data from the initial years of sampling might be used to make a more informed decision on this issue in the future.

The Committee would like to thank the presenters from EPA's Office of Water for providing their expertise, perspectives, and insights. Their contributions greatly increased our understanding of the Agency's proposed rule and current information regarding safe drinking water on aircraft. Written, individual responses to the charge questions were provided by several Committee members, which are enclosed.

Sincerely,

/Signed/

Joan Rose, Chair
SAB Drinking Water Committee

Enclosures

Enclosure 1

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

CHAIR

Dr. Joan B. Rose, Professor and Homer Nowlin Chair for Water Research, Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI

OTHER SAB MEMBERS

Dr. Mark Borchardt, Director, Public Health Microbiology Laboratory, Marshfield Clinic Research Foundation, Marshfield, WI

Dr. John (Jack) Colford, Professor, Division of Public Health, Biology & Epidemiology, School of Public Health, University of California, Berkeley, CA

Dr. Penelope Fenner-Crisp, Independent Consultant, Independent Consultant, North Garden, VA

Dr. Stanley B. Grant, Professor, Department of Chemical Engineering, School of Engineering, University of California, Irvine, Irvine, CA

Dr. Jeffrey Griffiths, Associate Professor, Public Health and Family Medicine, School of Medicine, Tufts University, Boston, MA

Dr. Gary King, Professor of Microbial Biology, Department of Biological Sciences, Louisiana State University, Baton Rouge, LA, USA

Dr. Joseph R. Landolph, Jr., Associate Professor, Molecular Microbiology and Immunology and Pathology, Keck School of Medicine and Associate Professor of Molecular Pharmacology and Pharmaceutical Science, School of Pharmacy, University of Southern California, Los Angeles, CA

Dr. Desmond F. Lawler, Bob R. Dorsey Professor of Engineering, Department of Civil, Architectural and Environmental Engineering, University of Texas, Austin, TX

Dr. Christine Owen, Water Quality Assurance Officer, Tampa Bay Water, Clearwater, FL

Dr. Richard Sakaji, Manager, Planning and Analysis for Water Quality, East Bay Municipal Utility District, Oakland, CA, USA

Dr. Gary Sayler, Beaman Distinguished Professor, Joint Institute for Biological Sciences, Oak Ridge National Laboratory, University of Tennessee, Knoxville, TN

Dr. David Sedlak, Professor, Department of Civil and Environmental Engineering, University of California-Berkeley, Berkeley, CA

Dr. Gina Solomon, Senior Scientist, Health and Environment Program, Natural Resources Defense Council, San Francisco, CA

Dr. Laura Steinberg, Professor, Department of Environmental and Civil Engineering, Southern Methodist University, Dallas, TX

Ms. Susan Teefy, Principal Engineer, Water Quality and Treatment Solutions, Inc., Castro Valley, CA

SCIENCE ADVISORY BOARD STAFF

Dr. Resha M. Putzrath, Designated Federal Officer, 1200 Pennsylvania Avenue, Washington, DC, Phone: 202-343-9978, Fax: 202-233-0643, (putzrath.resha@epa.gov)

Enclosure 2

Comments from Individual Committee Members

Comments from: Dr. Joseph R. Landolph, Jr.

Response to the EPA's Charge Questions Regarding the Proposed Aircraft Drinking Water Rule and Statistical Sampling

1. Statistical Sampling: EPA asks for SAB's recommendation on (1) the use of statistical sampling methodologies, specifically on what type of monitoring scheme would allow a statistical sample to be representative of the whole fleet, and whether such methodologies, if allowed, should only be used in conjunction with onboard or other supplemental treatment such as adding a disinfectant or ultraviolet light?

Ideally, the best thing to do would be to sample each and every airplane. I understand from the public meeting teleconference that there are over 7,000 aircraft public water systems (Mr. Richard Naylor, EPA). Sampling all of these systems would be a huge job, almost certainly prohibitively expensive and time-consuming. Therefore, in my opinion, statistical sampling is a necessary first step to obtain a picture of the frequency of the contamination, in a rapid, cost-effective, and efficient manner. At the same time, statistical sampling can be tricky, because microbial contamination is distributed with Poisson statistics. Hence, sampling only certain aircraft can the microbiologist to miss bacterial contamination, particularly low levels of contamination, in certain airplanes. Therefore, such sampling represents a lower bound to the true frequency of the contamination, but it does give a rapid estimate of the magnitude of the problem of microbial contamination of aircraft drinking water systems. I have personal experience testing newly filtered cell culture media for bacterial contamination. At low levels of contamination, if you sample only every tenth bottle, you can easily miss low levels of microbial contamination.

Therefore, to begin with, I recommend testing every tenth or even every twentieth airplane to obtain data on microbial contamination, to determine how serious the problem of contamination of aircraft water is among the airlines. Once EPA obtains this data, then they would have a better idea of what to do. Their preliminary data indicates that this frequency is somewhere around 2%. If there is reproducible frequent contamination of the water systems of many airlines, then I would recommend utilizing in conjunction with statistical sampling, other supplemental treatment, such as adding a disinfectant or ultraviolet light, to cleanse the water of those aircraft that were found by testing to have microbial contamination in their water systems. In this case, draining the water systems of the aircraft, flushing and decontaminating these systems with chlorine solutions, then draining this water and rinsing the system with clean U. S. drinking water would be recommended. Then, I could recommend finally adding back U. S. drinking water with a 1 ppm or 2 ppm chlorine residual, to maintain sterility of the water in the airplane. Hence, I recommend that statistical sampling be used, but in conjunctions with adding disinfectant or ultraviolet light treatment to the drinking water on those aircraft that have contaminated drinking water

I project that EPA would not have too many serious problems with water on aircraft from the NATO European countries. However, water from some Asian countries, from some African countries, and even from some Eastern European countries, would likely not be as pure as that from the U. S., and would likely need to be treated or better, purged, the system decontaminated with chlorine and rinsed, and fresh U. S. chlorinated water added. We know a large amount about

chlorination as a disinfectant. Chlorination is inexpensive, effective and relatively safe, except for DBPs in the treated water. Where microbial contamination of drinking water is detected on aircraft, the water on these aircraft should be flushed out, and the water systems should be decontaminated with chlorine solutions. The water system should be flushed again with drinking water from the U. S. with a chlorine residual, and then the airlines should add back U. S. water in these aircraft with chlorine, leaving a chlorine residual (1 or 2 ppm). This would probably be the best way to maintain quality of the aircraft water in terms of minimization of microbial contamination.

It should be made mandatory that each aircraft have a chlorine residual in the drinking water system it contains. This would help to minimize problems with microbial contamination.

Secondly, perhaps it might be wise to pick say three large airlines that fly frequently to the U. S., one from say China, one from an African country, and one from an Eastern European country, do some detailed statistical testing on their water systems, and see what is needed to bring these airline into compliance. This could be done on a voluntary basis with the cooperation of these airlines. Then, this procedure could be replicated on all the other airlines once it was established. This would be a microbiology research project.

I understand from our public teleconference meeting on this topic that inspection of airline water systems occurs once every five years. This is not frequently enough. I recommend the rules on this topic be changed so that the airlines are required to inspect their water systems once per year, and that this inspection include testing for microbial contamination.

(2) If allowed, what should be the statistical sample occurrence triggers for total coliform and /or E. coli/fecal coliforms that would require follow-up action in the entire fleet and what should the follow-up action entail?

If one in twenty aircraft (5%) had drinking water that was contaminated with total coliforms and/or E. coli/fecal coliforms, this certainly should be a trigger that would require follow-up action in the entire fleet. Follow-up action should entail draining the water systems, decontaminating the aircraft water supply system with high concentrations of chlorine, flushing out the high levels of chlorine, and adding back U. S. drinking water with a 1 ppm or 2 ppm residual of chlorine to the system. This should happen with all aircraft in the fleet. Once EPA established a baseline on the statistics of contamination, sampling one in twenty aircraft, then EPA could take more stringent action to reduce this frequency of contamination.

2. Temperature of Sample Taps: **EPA asks for SAB's recommendations on (1) whether sampling should only be limited to cold taps when they are available; and (2) if a cold tap is not available in the galley, should the air carrier measure and provide sample temperature to EPA to provide some indication of whether the temperature achieved is high enough to alter the microbiology results.**

Response: (1) In my opinion, sampling should always be limited to cold taps when they are available, to enhance the sensitivity of detecting micro-organisms. This would be the best way to sample the water to detect micro-organisms. If possible, the temperature of the water in the tap should also be measured and recorded along with the sample taken.

(2) If a cold tap is not available in the galley, then my opinion would be that yes, the air carrier should still measure and provide the temperature of the sample to the EPA to provide some indication of whether the temperature achieved is high enough to alter the microbiology results. This would help out, but of course, the best way to do things to maximize the sensitivity of detection of micro-organisms in the sample would be to take a sample from a cold tap when this is available. I am uncomfortable in sampling hot taps, because obviously, the high temperature will kill many of the organisms. In this case, when only a hot tap is available, EPA should work with the carrier to see if EPA can tap into the water system ahead of the heating elements and take a sample, if this is possible. The next best thing would be to have the air carrier sample only when the water has been turned off for some time, and the temperature has reached room temperature, and then to sample this water. This would help to maximize the sensitivity of detecting micro-organisms.

However, given the time, effort, and expense of this microbial contaminant testing program, I would recommend first sampling all the aircraft that have cold taps, and compiling the statistics from these. Once the cold water sampling and testing has been done, and acted upon, then hot taps can be sampled, but as a second priority.

Comments from: Dr. Desmond F. Lawler

Response to the EPA's Charge Questions Regarding the Proposed Aircraft Drinking Water Rule and Statistical Sampling

1. Statistical Sampling: EPA asks for SAB's recommendation on (1) the use of statistical sampling methodologies, specifically on what type of monitoring scheme would allow a statistical sample to be representative of the whole fleet, and whether such methodologies, if allowed, should only be used in conjunction with onboard or other supplemental treatment such as adding as disinfectant or ultraviolet light?

This question, taken from p. 19330 of the Federal Register Notice (73, 69, April 9, 2008) is in the context of sampling requirements to exhibit compliance the proposed rules, not to determine the extent of drinking water contamination under the existing (or non-existent) rules. In that context, the question is whether sampling a representative sample of aircraft of a given fleet could be used to show that the entire fleet is in compliance. As pointed out in the FR notice, the inverse of this condition would also be true—that is, if the results of a statistical sampling method were negative, it would have to be taken that the entire fleet was out of compliance, and all planes in the fleet would have to undergo corrective action.

I should note at the outset that I am not an expert on statistical methods and am willing to accept the judgment of others that are more expert in this area than I am. While I have had graduate courses in statistics and use statistical analysis in evaluating research data, I am not in a position to comment knowledgeably on the potential for the statistical methods to ensure the public health. With that *caveat*, I offer the following ideas.

In the absence of supplemental treatment, I do not believe that a statistically-based method of sampling some portion of the fleet would be satisfactory. Each plane has its own system and its own history at any given moment, and the potential for contamination on one plane is independent of that potential on another. Even though the proposed rule requires only occasional sampling of every plane, it does require it of every plane, and that requirement would appear to provide both a better protection of the public health and a more defensible position for both the EPA and the industry itself in showing that they are making every reasonable effort to protect the public health by the provision of safe drinking water on every plane.

My concern has two bases. First, the data provided in the FR notice from the sampling that has been done suggests a far higher incidence of coliform-positive results than is typically found in public drinking water supplies. In municipal distribution systems, a coliform-positive result is rare, certainly far less than the 2.6 to 15.1% found in the various studies shown. The exact causes of this are unknown, but the extensive handling of the water between the public water supply and the aircraft taps includes many points where contamination and loss of disinfectant residual are possible.

Second, since the water in an aircraft can often be a blend of waters from different public water supplies, the water chemistry of the blend with respect to the carrying of a disinfectant residual

might be very different than any of the blended sources. Specifically, I am concerned about the real possibility that one source might have a free chlorine residual and another might have a chloramine residual. Any water with a chloramine residual also has a free ammonia concentration, and that ammonia will react with the free chlorine from the other source; depending on the relative volumes of water from the two sources and the concentration of free chlorine in one and free ammonia in the other, it is quite possible that the residual will be destroyed by the well-known "breakpoint" reaction. Such a blended water would have no disinfectant to ward off coliform or other biological contamination. A biofilm created under these conditions might be able to withstand subsequent periods of a chlorine or chloramine residual.

I can believe that a statistically-based sampling program to show the provision of safe drinking water could be developed to account for the first of my concerns, since the handling steps are similar everywhere. But the specific history of a particular plane with respect to its taking on water from different sources would greatly influence the second possibility, and that this individuality makes a statistically-based program unlikely to succeed in all cases.

On the other hand, I do believe that if UV systems were installed on every plane, that a statistically-based system could be reasonable. Although I still believe that sampling of every plane on a regulated schedule (as currently proposed) would be better, the uniformity of on-board treatment would reduce the independence of each aircraft in terms of the likelihood of contamination on the drinking water.

Other notes:

1. I believe that UV should be required on every commercial aircraft holding more than some number (perhaps 50) people.
2. I do not think that it is reasonable to require a residual disinfectant; the chemistry is too complex to think that this could be done well by relatively untrained people. In the end, it would appear cheaper to insist on UV treatment for additional protection than that provided by the water suppliers.

2. Temperature of Sample Taps: **EPA asks for SAB's recommendations on (1) whether sampling should only be limited to cold taps when they are available; and (2) if a cold tap is not available in the galley, should the air carrier measure and provide sample temperature to EPA to provide some indication of whether the temperature achieved is high enough to alter the microbiology results.**

I believe the answer should be yes to both of these questions. My understanding is that coliforms are inactivated at a temperature well below the range that is used for making coffee or tea, and in that case, the issue is only whether a reasonable temperature range is achieved prior to any use of the water (at least with respect to coliform bacteria).

It should be noted, however, that relying on a self-report by the airline holds some risk. Whereas the coliform testing would be done by an independent laboratory, these temperature readings would necessarily be done by the airline personnel. The greatest protection comes from the fact that it is in the best interest of the airlines to have good customer service, and in this case that means sufficiently high temperatures to make hot coffee. In turn, that would intrinsically mean sufficiently high temperatures to inactivate coliforms. Nevertheless, I believe requiring temperature measurement on the same schedule as the sampling should be done.

Comments from: Dr. Stanley B. Grant

Final Response to the EPA's Charge Questions Regarding the Proposed Aircraft Drinking Water Rule and Statistical Sampling

1. Statistical Sampling: EPA asks for SAB's recommendation on:

(1) the use of statistical sampling methodologies, specifically on what type of monitoring scheme would allow a statistical sample to be representative of the whole fleet, and whether such methodologies, if allowed, should only be used in conjunction with onboard or other supplemental treatment such as adding as disinfectant or ultraviolet light?

If the current draft of the ADWR is implemented, a large database will be quickly obtained on the water quality aircraft drinking water supplies. These data should be analyzed to determine if positive coliform samples are associated with particular airplane drinking water systems, flight routes, water blending practices, etc. These data may also shed light on the degree to which aircraft water systems can be treated as a statistically homogeneous population, for which representative statistical sampling designs can be formulated. However, given the unique history of each aircraft's drinking water system (source water used, topping off procedures, frequency of disinfection) it would be prudent to test all aircraft drinking water systems several times per year until the question of statistical homogeneity can be addressed.

(2) If allowed, what should be the statistical sample occurrence triggers for total coliform and /or E. coli/fecal coliforms that would require follow-up action in the entire fleet and what should the follow-up action entail?

It is hard for me to conceive of a situation where, for example, the log-mean total coliform concentration of the entire fleet would suddenly shift up, thus triggering a follow-up action for the entire fleet. As noted above, I believe that the current draft ADWR makes sense: all aircraft drinking water systems should be tested several times per year so that bad actors can be identified and remedied.

2. Temperature of Sample Taps: **EPA asks for SAB's recommendations on (1) whether sampling should only be limited to cold taps when they are available; and (2) if a cold tap is not available in the galley, should the air carrier measure and provide sample temperature to EPA to provide some indication of whether the temperature achieved is high enough to alter the microbiology results.**

Heat treatment of water kills most enteric bacteria and viruses provided that the water temperatures exceed 65 degrees C. However, a study[1] of bacterial survival in drinking water found that "at 13 of the 14 tourist-oriented hotels in four countries, water from the hot water tap did not reach

[1] Bandres, J.C., Mathewson, J.J., DuPont, J.L. 1988 Heat susceptibility of bacterial enteropathogens. Implications for the prevention of travelers' diarrhea" *Arch Intern. Med*. **148**:2261-2263.

temperatures of 65 degrees". The authors of this study concluded that "food and water that are too hot to touch may still be contaminated with bacterial enteropathogens."

Based on the aforementioned study and other similar studies, one can envision a scenario in which a human health risk might be posed by drinking water from the hot water tap, provided that the water distribution system on the plane was contaminated, and the water in the hot water tap did not achieve and sustain a temperature of at least 65 degrees C. It is important to note that in such a scenario, contamination of the aircraft drinking water distribution system would be evident by sampling the coldwater tap.

Based on the above discussion, I recommend that the coldwater tap be sampled preferentially, as currently recommended in the EPA technical guidance document for the ADWR. If only hot water taps are available on a particular airplane, or in the forward galley, water samples from the hot water tap should be collected and analyzed for total coliform. Ideally, this sampling would take place after the heating element for the hot water tap was turned off for some time, and the water flowing out of the tap was at room temperature. In all cases, EPA should require measurement and reporting of water temperature and chlorine residual at the time of sampling, together with the location of the sampling point within the water distribution system (e.g., rear lavatory, front galley, cold tap, hot tap…). Such information will be extremely useful for identifying risk factors for contamination of drinking water aboard aircraft, and the associated human health risk.

Comments from: Dr. Richard Sakaji

EPA asks for SAB's recommendation on: (l) the use of statistical sampling methodologies, specifically on what type of monitoring scheme would allow a statistical sample to be representative of the whole fleet, and whether such methodologies, if allowed should only be used in conjunction with on board or other supplemental treatment such as adding a disinfectant or ultraviolet light; and (2) if allowed, what should be the statistical sample occurrence triggers for total coliform and/or E. coli/fecal coliform that would require follow-up action in the entire fleet, and what should the follow-up action entail.

The idea of relating the frequency of monitoring to the frequency with which the water system is flushed and cleaned makes sense from a relative risk standpoint. As the introduction to the rule states, the aircraft water systems are storage reservoirs or distribution systems, but are unlike any typical noncommunity water system (NCWS). Unlike their "fixed" counterparts, which receive water from a single source, the source water for aircraft can vary markedly over the course of a day, week, month, or even year. An aircraft may take water from several different, surface or ground water sources within a given day, as aircraft move from airport to airport (some regulated; some not), depending on their flight schedules. Since no two aircraft fly the identical route and board water from the same locations, it would not be appropriate to assume that the microbiological water quality on any two aircraft would be identical. Therefore, the population is not homogenous and no single aircraft's water system should be considered representative of the overall population. Randomly selecting aircraft as being representative of the whole fleet would hardly be considered adequate, unless the number sampled was determined *apriori* considering, at a minimum, the variability in the population, the variability in the analytical method, and the level of confidence desired in the final result. Generally, the greater the variability and the higher the confidence level, the greater the number of samples that will be required to have confidence the program is meeting its objectives.

Under a random sampling program, if the objective remains to have each aircraft sampled annually, then the level of monitoring would be consistent with the minimum sampling allowed in noncommunity water systems under the current TCR. However, there are specific terms and conditions that must be met in order to allow this minimum sampling and there are indications that these conditions will become more restrictive under the revised TCR currently being negotiated. If the purpose of the monitoring program is to ensure compliance with the TCR objectives, then one should consider some of the discussions taking place in the current FACA negotiations for revising the current TCR. The draft AIP has TC+ (initial sample and followup) being used as a treatment technique which triggers an "assessment." TC is no longer being used as an MCL, but a treatment technique, triggering an assessment and remedial action (e.g., flushing boosting disinfection; similar to what is proposed in the ADWR). Public notification is required only if the followup monitoring and assessments are not carried out. The more serious and recognized acute problem is with E. coli or fecal coliforms, which triggers almost immediate public notice.

The agreement in principle (AIP) for the TCR has annual sampling as a minimum, but only under specific conditions. Otherwise minimum sampling for each noncommunity water system is quarterly. Also, the monitoring frequency is increased following certain TC and EC "hit"

combinations and not allowed to return to reduced monitoring until several criteria are met. Following a coliform "hit" a noncommunity could be forced into monthly monitoring, which, for airlines could present a problem for individual aircraft. If the monitoring and assessments are not identical, then, from a risk management standpoint, there will be a difference in the risk management level between the TNCWS and the aircraft.

A random sampling program for a fleet of aircraft would probably not be likely to detect water systems with a TC+. Based on an annual sampling, the odds of selecting the aircraft to sample that would be TC+ would be very small. While the frequency of the TC+ was a sizeable percentage in the preliminary work conducted under the AOC, as the frequency of TC+ decreases, the odds of selecting or finding the aircraft that is TC+ becomes slimmer and the number of samples collected to be fairly confident the samples are representative would increase exponentially. Adding the confounding factor of aircraft water system maintenance only decreases the likelihood of finding a TC+. This does not preclude the possibility that aircraft water systems may not be safe, but that the sampling program, due to frequency is masking the problem.

I would recommend against developing a monitoring program based on a random statistical sampling of the whole fleet. This would be the same as using a random statistical sampling of all noncommunity water systems to determine that each water system in the population was in compliance with the TCR. Like each noncommunity water system, each aircraft should be considered an independent entity and not representative of the population.

The intent of the ADWR seems to have each aircraft's water system sampled at least once a year, but does not specify when the system is to be sampled. Specific time of sampling appears to be designated in the sampling plan. Once a year is probably a minimum sampling frequency, but one should consider what the objective of the monitoring program might be. For a variety of reasons sampling should be conducted on aircraft closest to their next cleaning, in fact, those aircraft that are closest to their next water system cleaning and disinfection are those that should be sampled. If the objective of the monitoring program is to ensure the safety of the aircraft water system, by monitoring the microbiological water quality, then the monitoring program should focus on the efficacy of the maintenance practices, i.e., the samples should not be random, but should be collected just prior to maintenance (systematic). This will ensure the cleaning and maintenance intervals are sufficient to prevent a TC positive. It is my opinion that a systematic sampling approach would provide much more protection of aircraft water supplies than a random sampling program and could easily be tied to aircraft maintenance schedules.

Aircraft undergoing a level B, C, or D maintenance may not fly for 24 hours or more; collecting a TC sample before the system is emptied and cleaned would provide an indication whether the maintenance practices are adequate to maintain the microbiological quality of the water system. If the sample comes back positive, the plane will not be taking on passengers or crew and will be easily accessible for a repeat sample (unlike trying to track an aircraft that is in service and has had a TC or EC positive). Once that sample comes back clean the plane can be released. If the water system sample is still positive the aircraft water system can be recleaned and sampled (from a risk management stand point the USEPA can consider releasing the aircraft after the resample [only on a TC+]), since the resample will occur after water system has been cleaned and disinfected. This will provide strong economic incentive for airlines to pay attention to the maintenance of the aircraft

water systems, as they cannot afford to have aircraft "down" any longer than necessary. If the sample is EC positive (first sample), then a risk management choice must be made as to whether the aircraft should be released. If the second sample comes up TC+ a similar risk management decision will have to be made.

If the water system showed signs of E. coli or fecal contamination while undergoing maintenance, there would still be time to reclean and disinfect the system (and resample) before returning the aircraft to flight status. Overall, a systematic sampling program tied to the maintenance schedule would not only provide quantitative information on the efficacy of the water system maintenance schedule, but would minimize down time on the aircraft reducing the economic impact on the airlines, reduce public notification, and public exposure (and adverse public reaction). Given the airlines have minimal or no "spare" aircraft, this will encourage them to develop a flushing and disinfection program that will minimize maintenance downtime and reduce public exposure and probably push them toward on board treatment systems.

Another recommendation that could help is to have airlines check to make sure there is a chlorine residual in the water being boarded. The airlines should probably consider only boarding water that contains a chlorine residual. If the chlorine residual is below detection, the airline has a choice of boarding the water or not. Lack of a chlorine residual increases the potential for microbiological issues. A plane that boards water without a chlorine residual should be allowed to continue in service, like a distribution system reservoir, but the airline should consider itself at risk. However, as was discussed in the telecom, one SAB member made a point about mixing chloraminated and chlorinated drinking water. I support his statements regarding the mixing of a free and combined chlorine residual without regard to the different chemistries.

EPA asks for SAB's recommendation on: (1) whether sampling should only be limited to cold taps when they are available; and (2) if a cold tap is not available in the galley, should the air carrier measure and provide the sample temperature to EPA to provide some indication of whether the temperature achieved is high enough to alter the microbiological results.

What is the purpose of sampling? If it is to characterize the water in the system (tanks and lines), then sampling from the cooler tap would be more appropriate, since coliforms are inactivated at warmer temperatures, leading to false negatives.
If there are two separate water systems (fore and aft), these systems should be sampled separately and considered to be independent systems. This should not be an issue if the tanks are interconnected, as discussed during the teleconference. Some provision in the rule should make sure that, if water systems are not interconnected that they are each sampled during routine monitoring.

When collecting samples from the galley with in-line filters, the lines should be well flushed before the sample is collected. The POU device study done a number of years back indicated a flush of bacteria from carbon filters after sitting for overnight. Granted these in-line filters probably will not adsorb organics, as the carbon filters will, and will therefore not provide a growth medium for bacteria (not necessarily pathogenic). Nevertheless, bacteria can collect and concentrate on the

filters and potentially migrate through them, since the filters are not absolute filters. To minimize the impact it might be advisable to "flush" the system out by running the tap to waste for 10-15 minutes while preparing an aircraft for flight status after a layover.

Another issue is the collection point for the sample. While the SAB was asked about sampling the hot or cold tap, there is the issue of location with respect to the lavatory collection point. A lavatory sample may represent a very different risk management paradigm than a sample collected from a traditional NCWS, in which a sample is not usually collected from a lavatory. Collection of the sample from the lavatory might increase the odds of a false positive. If the risk management paradigm is to ensure the quality of water delivered from the storage tank through the distribution system to the faucet, then the sample should be free from potential contamination from an external source. While the sampling technique in the guidance manual calls for the use of an alcohol or disinfectant swab, I wonder how effective this is relative to flaming a tap? Is it possible for airborne bacteria to cross contaminate the sample? The TCR sampling protocols recognize the need to remove aerators before collecting a sample, something that is not noted in the ADWR guidance (this will increase the complexity of sample collection in an operational aircraft). External contamination would not be representative of the storage tank and distribution system, and could lead to public notification or aircraft shutdowns. This would argue for or support the collection of samples tied to the aircraft maintenance cycle which would allow the sample to be collected from the underdrain, reducing potential cross contamination from the lavatory, where the likelihood of fecal contamination is higher.

One point that was not discussed in the teleconference was whether most of the positive TC, FC, or EC samples from the mandated sampling program were from the lavatory or galley. I recommend the EPA attempt to harvest this information from their AOC monitoring.

Comments from: Dr. Gary Sayler

SAB consultation on ADWR, Fed. Reg. 73 (69):19321-19348. April 9, 2008

General comments

The Fed Reg proposed rule is well presented, generally clear, and technically appears well though out given that there have been no reported significant scale, disease outbreaks for passengers consuming potable water made available by the aircraft industry during flight. There will always be concern out the safety of water supplies made available to the air traveling public and in particular for equipment traveling to foreign destination. The proposed rule is a step in the right direct to reduce risk to the air passenger of exposure to potential pathogens in the on board potable water supply and distribution system.

The proposed rule continues the use of conventional and some archaic measurement protocols of the presence of total coliform (TC) bacteria to trigger further monitoring for fecal coliforms and E. coli, along with flushing and disinfection of the potable water system, to reduce exposure risk to the air traveling public by either eliminating the apparent contamination or consumption of the affected water.

> Consideration of continued and future development of more modern measurement protocols that could be multiplexed to provide quantitative information of the presence of both indicator organisms and specific pathogens should be considered. Such tools may also provide microbial source and dissemination tracking capability should and invent occur.
>
> Greater thought to requirements for on board point source disinfection using for example UV disinfection or filtration technology is encouraged.

The proposed monitoring and sampling plan is inversely related to the frequency of routine flushing and disinfection maintenance schedule for the aircraft. Sampling from the water system for TC analysis following this maintenance is not permitted before 72 hr. This appears to be an acceptable approach to provide the minimal level of protection for the air traveling public. However, important information not reported of the volume range of the of water supple in individual aircraft model as well as on board residence time and time domain for replacement, refill or topoff would be useful in fully assessing the sampling and monitoring plans.

Background data provided to support the rule development and drive the AOC is quite useful and provides a range from 2.8% to 15% of the potential plane that may be out of compliance at anyone time. This is a rather broad range and 15% reported TC positive (based on 2004 data) certainly appears higher than anticipated. This is also more than double that for the next highest reported estimate. More recent EPA and ATA analysis of less than 3% TC positive would appear to be more consistent with general DW findings.

Useful information not reported relates to variation. For routine sampling and monitoring were replicated sampling measurements made (not just repeat samples after a positive outcome) and, if so, what were the results even if not done for all flights examined? Were the individual test

replicated to determine internal variation of the methods (or what is the historical variability of the TC test)? Further statistical sampling designs are dependent on such data along with any new dating from continuous AOC driven monitoring. Have any TC, FC, or EC data been obtained that indicates source water in the major contributor to positive results rather than the equipment or contract services?

Charge question responses.

Charge 1 Statistical Sampling of fleet rather than all individual aircraft.

At the present time there does not appear to be a scientific rationale for use of statistical sub-sampling of the fleet for a representative lot (sub-population) of aircraft rather than sampling the whole at least once a year.

This conclusion is drawn largely from the complex heterogeneity of the aircraft and flight routes (water sources) involved. While statistical sub-sampling for microbiological quality control is widely used in industry (food, pharmaceutical, cosmetics, etc.), it appears that such product lots are much more representative of a more homogenous product as a whole. For example, it is much clearer that sub-sampling from a lot of ground beef is sufficiently representative that each individual ground beef patty or consumer sized retail product is not required. Contamination of the lot forces a total recall of all product of that lot. In the case of the ATA, what constitutes a lot, the whole industry fleet or the fleet of a given airline? Response to the event would be to either demand prohibition of potable water consumption and/or forced flushing and disinfection maintenance for all; resulting in the majority of conforming airplanes (perhaps as many as 97% based on current data) suffering the same fate as the guilty. Sub-sampling for microbiological quality control is not like sub-sampling for airframe stress fractures or missing engine mounting pins.

There are excellent reviews and designs of statistically based microbiological sampling plans and discussions of statistical analysis of the data for foods water and consumer products. A particularly good HACCP example (albeit foods) is:

> Susanne Dahms (2004). *Microbiological sampling plans-Statistical aspects.* Mitt. Lebensm. Hyg. 95, 32-44.
>
> (See also http://www.fao.org/docrep/w6419e/w6419e04.htm and US EPA final report contract 668-D4-0091, Data Quality Objectives and Statistical Design Support for Development of Monitoring Protocol for Recreational Waters. 8/24/99)

Charge 2 Should sampling be limited to cold taps and if not available in the galley should the temperature of the tap be reported to EPA?

Sampling should be limited to cold taps without requirement of hot tap sampling or temperature reporting to the EPA

There appears no justification for hot tap sampling as it appears that that heating by and large occurs at point of use. Heating itself if, even insufficient to pasteurize the sample, will induce a severe time dependent thermal stress that will seriously effect the cultivation and enumeration protocol resulting in false negative qualitative responses. Basically, the stressed organisms will not reproducibly grow or perform within the current test time frame of response for accurate TC or FC tests.

In lieu of hot tap sampling a second cold tap sampling should be included for more accurate evaluation (reproducibility) of the monitoring protocol.