# RESEARCH PRIORITIES WORKSHOP

## Environmental Impacts of Preservative-Treated Wood
## February 8-11, 2004, FL, USA

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## Abstract

This manuscript documents the feedback received from conference participants concerning research needs for evaluating the environmental impacts of preservative treated wood. The purpose of this effort was to develop a list of research priorities, which can be potentially used by funding agencies as they develop their research agenda and identify key areas for future funding. The documents included in this manuscript were developed through a conference sponsored by the Florida Center for Environmental Solutions (FCES), located in Gainesville, Florida. The conference was held in Orlando, Florida, February 8 – 11, 2004 and the title of the conference was, "Environmental Impacts of Preservative-Treated Wood." Approximately 150 people from 12 countries attended the conference. Research priorities were solicited from conference participants in three phases including: 1) an email solicitation prior to the conference, 2) a two hour workshop held at the conclusion of the conference, and 3) an email solicitation, including a ballot, sent to participants after the conference. The draft ballot was developed from information received during the first two phases. The ballot was separated into 3 sections, each section corresponding to a different topic area. Five or six research priorities were to be ranked within each topic area. A total of 28 conference participants returned the ballot. The following research priorities received the highest ranking among those who voted: 1) evaluate the exposure and risk to people from preservative chemical releases, 2) develop new more environmentally friendly alternative chemicals, and 3) evaluate the impact of treated wood during disposal within landfills. Additional results from the vote along with more details are provided within the following pages of this document.

## Organization of Manuscript

The research priorities were established in three phases. Phase I included an email solicitation prior to the conference. The responses from this email solicitation were compiled and provided to conference participants during the conference (Section I). The conference concluded with a two hour workshop which consisted of a set of three panel sessions during which panelists and conference participants provided their opinions concerning research needs (Section II). The information documented in Sections I and II was used to develop a voting ballot which was distributed via email after the conference. Those who returned the ballot also had the opportunity to provide additional feedback at this time. The post-conference feedback is summarized within Section III. The voting ballot is provided in Section IV and the results from the vote are provided in Section V.

## SECTION I: SUMMARY OF RESEARCH NEEDS RECEIVED PRIOR TO THE FCES CONFERENCE

The suggestions for research needs received prior to the conference were placed within one of three groupings: "release of preservatives to the environment (sub-section I.1)," "exposure/risk assessment (sub-section I.2)," and "disposal, reuse, and recycling of treated wood (sub-section I.3)." These groupings were chosen in an effort to organize and consolidate the suggestions into related topic areas. The last name of the person submitting that suggestion is provided in parentheses within the following sections.

### I.1 Release of Preservatives to the Environment

***Mechanisms of Releases***

- Some of the areas of research that we consider to be priorities are: **Fate/attenuation** of leached preservative components in soil, nature of chemical preservative reactions in wood and **effects on leaching and dislodging**, methods of promoting optimum fixation or stabilization to **minimize leaching**, and **long term prediction** of leaching and application of leaching models to **risk assessment** (Cooper).

- Standardizing **methodology for quantifying the emission** of wood preservative components from full-dimension timber in service. Having such methodology could facilitate the **development of low-emission wood preservative formulations** and impregnation processes, or supplementary emission-reduction treatments (Kennedy).

***Soil Transformations***

- Arsenic, Cu and Cr **transformations in soil** systems (biotic processes of interest to Florida ecosystems). I feel there is a dearth of knowledge in this area. It could be used to paint a complete picture of As, Cr and Cu dynamics in Florida soils (Chirenje).

- **Pedogenic processes** governing As, Cu and Cr kinetics in solid and aqueous media. Will these three chemicals end up in groundwater or will they be sequestered in soils for good (we have characterized sorption and desorption, but do we know the processes that will lead to future releases? (Chirenje).

- **Arsenic movement in soil-** Data developed by researchers in Florida shows some movement of arsenic downward in the vadose (unsaturated) zone. Does arsenic move downward thru the **vadose zone**? How much do natural soils act to bind up and **attenuate** arsenic that is leaching downward thru the vadose zone? If arsenic reaches the **groundwater**, is it attenuated or does it move with the groundwater? (Schert)

- **Bioremediation and extraction methods** – How to remediate soils contaminated with As. (Stilwell)

***Aquatic Impacts***

- **Effects of decks on the intercoastal waterways**; subdivisions in Ft Lauderdale? (Chirenje).

- More research is needed to evaluate **freshwater impacts** of preservative treated wood (Weis).

***Release of Arsenic in Gaseous Form***

- **As outgassing in houses**. Is there any way that outgassing of CCA could occur at toxic levels in the home? Microorganisms are known that convert **As to volatile forms**, but are they on **wood in**

**houses**? Has anyone done air sampling in houses with CCA wood in the interior and with significant water/mold damage? (Stilwell)

- **Arsenic in landfill gas.** Is As reduced to **arsine gas** in landfills? Are the reducing conditions present in a landfill powerful enough to force the conversion of arsenic to arsine gas? (Stilwell)

- Can gaseous As be released from a landfill in **volatile forms other than arsine gas**? (Solo-Gabriele)

## I.2 Exposure/Risk Assessment

***Exposure***

- I believe there is legitimate concern about the extent to which arsenic may be **tracked into households from CCA deck** surfaces and nearby soils. This tracked-in As may pose a significant **exposure** threat especially to young children playing on indoor floors and carpets. A couple of good well-designed **track-in exposure studies** would serve an important unmet need by enabling us to assess this potential route of exposure compared to the outdoor exposure routes where we have focused our efforts up until now (Maas).

- There are many studies that estimate the **risk of developing cancer** after long-term exposure to CCA in preserved wood. However, the critical question is whether the known exposures to CCA over the last 30 years have resulted in an increased incidence of arsenic related cancer. The critical next step is to **conduct a study that directly measures past exposure to CCA** treated wood and then determines whether that exposure is associated with an increased rate of arsenic-related cancer. Other important questions include determining the **bioavailability of ingested CCA** and the **efficiency of transfer from hands** and fingers to the mouth. Development of an **animal model** for arsenic induced cancer would also be extremely helpful in determining whether a cancer threshold level exists for arsenic ingestion (West).

- At a recent EPA SAP meeting (Dec 3-5, 2003) some gaps in our understanding of arsenic in wood as it pertains to human risk assessment were identified. Among them were: A) the **nature of the dislodgeable residue on wood** (1. Cr/As ratio in residues is greater than in leachate. To explain this discrepancy there may be chemical reactions on the wood surface which result in preferential release of As and 2. Sequential extraction techniques would be one way to determine the various forms of arsenic on the surface, particularly the soluble and insoluble fractions.) B) **As leaching and dislodgeable residues** – (How are they tied in to each other with rainfall? After a significant leach event is the surface depleted in As. What are the major effects which cause surface increases in As (the observed rejuvenation). C) **Bioavailability of As in wood in soil from CCA wood leachate** (Development of sequential extraction methods might be a way to predict bioavailability), and D) **Skin Absorption**. (Any suggestions in this area?) (Stilwell)

- There also seems to be a dearth of information when it comes to specific **risk assessment** and characterization for As, Cu and Cr (not just from the **toxicological** point of view; but **environmental** risk assessment [especially risk charactyerization]!!). (Chirenje)

***Methods for Exposure and Risk Assessment***

- **Testing Methods** – How would the available methods need to be revised to carry out these studies? For example the **sequential extraction** methods were developed for soil not for wood residues. Can **leaching protocols be used in coating studies**. What improvements can be made in using **animal models for** bioavailability and skin absorption studies?

- **Developing methodology for evaluating the environmental effects** of wood preservative emissions. While it may be relatively simple to develop appropriate **bioassays** for primary **aquatic organisms**, practicable bioassays for **soil-dwelling organisms**, and other organisms up the food chain from both types, will require a lot of work to perfect. Until we have such bioassays, any work done to reduce emissions from preservative-treated wood will lack a **valid frame of reference** (Kennedy).

***Remediation***

- Research is needed on the short term and **long term effects of coatings, stains and water repellents on preservative leaching**. (Cooper)

- **Coatings and encapsulates**- According to the EPA's risk assessment model, application of coatings significantly reduces risk, to the **extent that they reduce dislodgeable As** on the wood surface. Coatings also **reduce leaching** and could even have application for use in **aquatic environments**. Work needs to be done on the following: A) **Survey of coatings**, B) **Methods** – field and simulated, C) **Formulations** – what material forms As barrier, D) **Iron** – what would be the effects of adding iron oxides (or hydroxides) in the formulation, and E) **Surface preparation**. (Stilwell)

- However, the fact remains that it would be best if we could instead focus our research efforts on finding or developing an effective and economically-viable **treatment system to seal in this arsenic for a period at least equal to the usual expected service life of the lumber**. If, as the leading scientists in this field, we could accomplish this, it would be an achievement we could truly be proud of, and would transend disagreements about the exact dynamics and extent of public risk. (Maas)

***Plant Uptake***

- **Rice** - A significant amount of As was reported in rice. How much As is in different varieties of rice? Is the amount geographically dependent? How much uptake of **As in plants grown near CCA** wood is there compared to rice. (Stilwell)

- **Phytoremediation** – How to remediate soils contaminated with As? (Stilwell)

- Are there **plant indicators of As, Cu or Cr** problems? **IS Cu a problem** in Florida? While it is not as harmful as the other two components of CCA, little has been done on its distribution and effects on other **environmental compartments**. (Chirenje)

- Do these chemicals (As, Cu and Cr) have any **impact on other components** of the Florida ecosystem (e.g. **wildlife** associated with stormwater retention **wetlands**?). How about **plant uptake in wetland** systems? (Chirenje)

- **Arsenic in Vegetables**- Is CCA leaching out of **wood timbers (used in gardens** to make raised beds) being taken up by vegetables grown by home gardeners? Data developed by Stillwell and others indicates that **certain vegetables** (turnip greens, salad greens, carrots, etc) can accumulate arsenic in the **edible portion** of the plant if the vegetables are grown in soils that contain arsenic from CCA. Data developed in Texas several years ago indicates that this did not occur in those experiments. Is it advisable to grow vegetables in gardens **framed with CCA wood**? Which vegetables are accumlators of arsenic? Under what conditions does this occur? (Schert)

## I.3 Disposal, Reuse, and Recycling of Treated Wood

***Sorting***

- Prior **sorting** needed? Additional **cost**! (Helsen)

- **Disposal** – Identification of CCA. How do we **identify and remove** CCA from the recovered wood stream?, Is it wise to try to **extract** the CCA from the wood prior to disposal? (Stilwell)

***Thermochemical Processes***

- Research is needed in the identification of the best available **thermochemical technology** including possibly **pyrolysis, gasification, incineration**, and co-incineration. (Helsen)

- Is **combustion or pyrolysis** of CCA a viable method of disposing/treating CCA? (Stilwell)

***Landfills***

- **Final Resting Place for Arsenic-** What should the final resting place be for the arsenic in CCA wood? Background- The treating industry has used about 30,000 tons of arsenic to treat the wood that has been sold in Florida since 1970. Most of the arsenic that has been used is still in the wood that is in service. Leachate data from **Class I landfills** indicates that some Florida landfills have **elevated concentrations of arsenic** that are above the pre-treatment standards for some waste water treatment plants (also called Publicly Owned Treatment Works, POTW). Groundwater data that has been collected at **groundwater monitoring wells** near Constrution and Demolition Debris Landfills suggests that some of these wells have elevated concentrations of arsenic. Research is underway to determine how much arsenic will leach out of CCA treated wood after it has been placed in a Class 1 Landfill. Similar research is underway to determine how CCA behaves when it is placed in a **Construction and Demolition Debris Landfill**. The DEP has proposed that all CCA taken out of service be placed in lined landfills. (Schert)

***Mulch***

- **Arsenic Contamination of Mulch-** Does arsenic contamination in commercial mulch present a hazard to **homeowners and workers** who operate chippers and bagging equipment? Data developed by Solo-Gabriele and Townsend shows that some of the CCA that has been taken out of service in Florida has made its way into the **commercial chipped wood market**. Wood recovered by the Construction and Demolition Debris recycling industry is chipped and sold as **fuel or as mulch**. In a case reported in the press, a homeowner who handled relatively high amounts of bagged chipped wood had highly elevated levels of arsenic in his urine. Does CCA contamination in commercially sold mulch present a **threat to human health**? If so, what are the pathways for exposure? (Schert)

***Bioremediation***

- What is the **Cost/effect ratio** of such processes? Issues to be addressed include two-step process of bioremediation, use of **fungi**, **scale up**, **sorting** of various treated wood, use of **remediated wood**, **phytoremediation**, and what to do afterwards with **organic material**. (Humar)

- Influence of Cu, Cr and Ac from CCA wood leachate on **soil micro flora**, soil organisms and **plant uptake**. It is known, that **fungal colonization** of CCA treated wood influence fixation of the biocides in wood. These elements can be afterwards leached out of wood, this is used already in bioremediation techniques. But, what happens if **colonization of CCA treated wood appears in the nature**. How this influence leaching, and particularly how toxic is this leachate. What is

the pattern of decay succession afterwards? **Spread of copper tolerant fungal strains**. Local micro-conditions, micro-clima, soil type, where these organisms are more frequent. (Humar)

***Hydrolysis***

- Development of **new ideas** what to do with waste impregnated wood. Hydrolysis (**Liquefied wood**), production of resins from wood, and removal of toxic biocides from using **electrolysis**. **Extraction of biocides within pulp and paper processes**. (Humar)

***Wood Cement Composites***

- Potential to recycle treated wood in wood cement composites (how to overcome oxidation of chromium). (Cooper)

***Other Important Comments***

- Can the same technology be used for **preservatives of the future**? (Helsen)

- I think more emphasis should be diverted towards finding a method for **removing these CCA from waste wood before disposal**. In my view CCA is like money, spread around in small quantities has its benefits and is useful but, too much of it **piled up in one place is dangerous** and can cause problems. CCA while in use does not create major problems (except in direct contact situations) but when it is piles up on an unprotected soil or put in an **unlined landfill in huge quantities**, can create major problems. (Oskoui)

- How is CCA-treated wood handled upon **disposal within countries** around the world? (Solo-Gabriele)

## SECTION II: ORGANIZATION AND TRANSCRIPTS FROM CONSENSUS WORKSHOP

The overall organization of the 2-hour conference workshop is described in sub-section II.1 and the transcripts from the workshop are provided in sub-section II.2.

### II.1 Organization of the Consensus Workshop

The consensus workshop was held Wednesday, February 11, 2004 from 8 to 10 am. The purpose of the workshop was to identify research needs for possible future funding opportunities. Three 40-minute panel sessions were held that focused on the topics outlined in table 1. The themes for each of the three panels were: 1) disposal, reuse, and recycling of treated wood, 2) release of preservatives to the environment, and 3) exposure/risk assessment. During each panel session, panelists and participants were asked for their input concerning research gaps and needs. Each panelist was given about 2 minutes to speak. After the panelists provided their feedback, input was requested from the audience at large. The last 5 minutes of the panel session were devoted to summarizing the information that was presented during the panel. The moderator of the workshop was Helena Solo-Gabriele.

| | | **Panelist and Affiliation** |
|---|---|---|
| **Panel 1** | Disposal, Reuse and Recycling of Treated Wood | Lieve Helsen, Catholic University in Leuven, Belgium<br>Bill Hinkley, Florida Dept. Of Environ. Protection, Tallahassee, FL, USA<br>Joran Jermer, SP Swedish National Testing and Research Inst, Sweden<br>Pascal Kamdem, Michigan State University, USA<br>Jeff Morrell, Oregon State University, USA<br>Lisbeth Ottosen, Technical University, Denmark |
| **Panel 2** | Release of Preservatives to the Environment | Tait Chirenje, Richard Stockton College of New Jersey, USA<br>Paul Cooper, University of Toronto, Canada<br>Michael Kennedy, Queensland Agency for Food & Fibre Science, Australia<br>Daniel Mourant, Laval University, Canada<br>Tim Townsend, University of Florida, Gainesville, FL, USA |
| **Panel 3** | Exposure / Risk Assessment | Rolf Dieter-Peek Federal Research Centre for Forestry & Forest P., Germany<br>Curtis Englot, Environment Canada, Canada<br>Tim Leighton, U.S. Environmental Protection Agency, Washington D.C., USA<br>John Schert, Florida Center for Environmental Solutions, Gainesville, FL, USA<br>David Stilwell, Connecticut Agricultural Experiment Station, CT, USA |

Table 1: Topics and Panelists who Participated in the Research Needs Consensus Workshop

### II.2 Transcript from the Consensus Workshop

The transcripts were written from a tape recording of the conference. These transripts are provided below.

#### *Introduction*

*Helena Solo-Gabriele*: It's a few minutes after 8 oclock and we've got a tight agenda. The purpose of this morning's meeting is to develop a research agenda. Assuming that we have research funding available where should those funds be spent. We would like to get feed back from the panelists and participants at the conference. The way we have organized this is into three panel sessions. Panel one focuses on disposal, reuse, and recycling of treated wood. Panelists are : Lieve Helson, Joran Jermer, Pascal Kamdem, Jeff Morrell, Lisbeth Ottosen, Bill

Hinkley. This panel will be held for 40 minutes. Each panelist will be asked to provide a 2 minute informal summary of where they believe research should go in the future. Then we will open it up for public comments and input from the rest of the audience. The last 15 minutes of the session will focus on summarizing what we have heard and to come up with consensus on what we have heard. Following panel one we will have another 40 minute session. I am switching the order of the sessions because flight schedules of our panelists and participants. Panel three will be second; it focuses on exposure and risk assessment, followed by panel two which will focuses on leachating preservatives in the environment. I also want to mention that we will be taping this, this way we can keep track of everything that is said. I will be keeping notes, but it may be a little bit too fast for me to catch everything so to get all the information the session will be taped. At this point I would like to begin with our panel session, also before I get started we have green inserts within your conference packets. These green inserts are feedback obtained concerning research needs obtained prior to conference. We have complied these into the same categories corresponding to our various panels. The comments that we received before the conference is on the third to the last page on disposal, reuse and recycling. At this point in time I would like to begin with our panelist and Lieve if you have a two minute summary.

***Panel #1: Disposal, Reuse, and Recycling of Treated Wood***

Panelists: Lieve Helsen, Bill Hinkley, Joran Jermer, Pascal Kamdem, Jeff Morrell, Lisbeth Ottosen

*Lieve Helsen*: Well I remember from yesterday that there is a great difference between the United States and Europe. In the States there are a lot of landfill waste. There is a big point about lining or not lining the landfills. I think it is very important from what we have heard yesterday that we remember that there is leaching from these kinds of wood waste so lining is very important so I think there should more studies on that: leaching. And regarding Europe it is totally different because we don't have space for landfills so we have to look for alternative methods. Therefore we have seen a lot of different opportunities. We have seen biological methods, thermal method, electrochemical methods, chemical extraction. I think the solution will become a mission of this so maybe we have to start with a thermal process but then we still have to separate the metals out of residue. This can be done in several ways. I think more research is needed to determine which alternative method is the best technology taking into account all economic considerations. I think we have to focus on lining the landfills, and focus on looking for the best thermal/alternative technology and there I think it is important to know if research is needed or not because there is a big additional cost and I think if a solution can be found research is not needed. Also this is the age that disposal peaked now and in the near future of revising. When this peak is going down again we don't have much to do with CCA treated wood waste anymore. If these technologies exist, then it would be good because they could be used for other waste streams. So I think we have to look a little more boarder beyond not only CCA treated wood waste. That is all I have to say.

*Joran Jermer*: I will talk about the Swedish experience. We have been using waste as a fuel for couple of years, large amounts in some plants. The problems that we are most concerned with are the operational problems including: slagging, fowling, and corrosion in the boilers. The reason for these problems is that the fuel is contaminated. The most important contaminant is painted wood, lead, and chlorine to some extent. In order to reduce these problems measures need to be taken and one of course is to improve the fuel quality, we have discussed yesterday that sorting is a realistic thing. Personally I don't believe that we can spend time and money on sorting the

waste wood because that would be costly. However it should be considered. Also we have carried out trials with sieving the material, if you analyze the different fractions of waste wood, you will find that a lot of the metals are found in the finer fractions. If you sieve the materials however you will have a problem with a sieve fraction, what to do with that. We need to however discuss the fuel quality still and also there are possibilities. If you incinerate waste wood without any sorting you will have to modify the combustion process to avoid reducing conditions at the heat exchange surfaces and that will help to minimize slagging, fowling, corrosion in the boilers. We don't know everything about this yet so I think more research is needed on this. There is also a possibility to add certain additives like sulfur to avoid troublesome metals like metal chlorides in the process. I think all these measures that are necessary. I agree with Lieve about the ash, if you don't have any sorting you will get all the stuff in the ash and more research is needed to know what to do with this. Another thing we have discussed in Sweden is whether regulations imposed by the European Commission and the national authorities if they would make it more difficult to handle waste wood that could influence the market for this because in the end everything is about money and you have to have a market that is working. If there are too many restrictions, for example on the transportation of the wood, it could be a problem to take care of all the waste. That should also be considered when we talk about waste wood in the future. That is all.

*Jeff Morrell*: I think one of the first things that you want to do when you have a problem is figure out how big it is. I think Florida did a good job of that . I think you guys have figured out how big the issue is within recycling facilities. One of the big gaps is that we think that Florida represents the rest of the U.S. So one of the first things that we want to do is figure out what the impacts is on C & D and landfills around the country so that you can get a grasp of the magnitude. My suspicion is that that it might be a localized affect. You might be able to target those facilites to then separate materials. One of the first things would be a national assessment. At the same time I think there is some room for looking at a practical approach. Florida has the lowest remediation levels of any State in the nation and if we let the level drive our decision making we will be making a mistake because in many parts of the country the arsenic background levels are much higher and the impacts are much lower due from this issue. And so I think it is important to look at that and look across the country and see what the risk is because there is no sense in cleaning up to a level that is essentially below background or to trying to meet a level that is below background. Once we do that then we can start looking at the sorting and the education, etc on a more national scale. I totally understand the level of the problem across the country. You are really wasting a lot time and money.

*Pascal Kamdem*: I think one of the main problems is how to collect and handle all the wood preservatives or how to handle all the wood contaminated with lead, mercury and other contaminants, how to store them if you want to collect them. And another problem is to characterize, to get a picture of what is in the wood. If you don't know what is in the wood, it will be difficult to address the issue because we won't know the amplitude of the problem. So to characterize the wood itself, and then I would say the final solution would be incineration. But if we know the level of contamination we may be able to come up with some intermediate solution like some wood composites or some other medium solution to delay incineration to take advantage of the wood fiber that we still have there. But we need to know what is in the wood first. And if we go with incineration a lot of studies need to be carried out to understand exactly how we can incinerate to have a very low level of toxic gas release. How do we control the air emission during incineration or combustion? Also I would like to address the problem of ashes. How do we remove all the heavy metals that are concentrated in ashes. I believe those are the major issues that we need to address.

*Lisbeth Ottosen*: My starting point is that I am from a very small country with only 5 million inhabitants and it not very big so all the problems that a huge country experiences are the same but Denmark has fewer inhabitants. But in Denmark we already must collect all the treated wood from demolition and private households and it will be just pilled up and landfilled. We can not incinerate it because it is not allowed so we must landfill it until a new method is developed where we can recover the energy from the wood and remove the residue from the incineration or combustion process. And since I don't think that landfilling, even though we have lined all of our landfills, is the best solution to this and we can definitely use the energy in Denmark so that is why I think it is very urgent that we find a message that will meet the requirements from the EPA so that we can get off landfilling of this wood. Because right now we are just landfilling all these we can not burn, so that is not really a good solution. I agree with the others here that we need to find other methods, I think it is important to sort it and treat the residues and we have to find to do this and also avoid arsenic emissions from the thermal processes and to treat the ashes afterwards. And I think in a small country like ours it should actually be possible. We should not have more than 100 tons a year.

*Bill Hinkley*: Thank you. First I just can't resist the opportunity to respond to Jeff's point on the soil numbers that I have been batting around here. I think they are wrong on a couple of points. First of all Florida is not the lowest in the country, secondly it will be in the range of half a dozen other states when it is raised, thirdly this is most important, if you look at the average soil concentration in the data that Helena and Tim collected under decks that were treated with CCA, the average concentration if I recall is 27 mg/kg. That is way above almost all other states clean up numbers. I actually went to the association for environmental health of soils website and got all the numbers for arsenic cleanup and plotted them. And found maybe 2 states. So lets not get too carried away with all these arsenic numbers. CCA leaches virtually well above all states numbers so I don't think we should spend too much time worrying about whether it 0.8 , 2.1 or 5 or whatever. But on that point I would like to add that the national arsenic natural background standard is only 5 mg/kg. So again this is a bigger problem than just a risk based number that is quite theoretically derived. Here are my items that I think are the priorities and this is based on my role as a garbage guy. I work in solid and hazardous waste like Tim that is where I focus my energy and my interest. First off we are in rule making in Florida to require all this CCA treated wood to go lined landfills, though it sounds like a good idea, and it is a good idea but once you do that your problems have just began. Arsenic is here to forever, its on the periodic chart, it is not treated it is not going anywhere. What happens, the wood goes into the landfill it leaches arsenic, arsenic goes into leachate collection system, where does it go? Well it is commonly tanked or hard piped to a waste water treatment plant where they knock down the BOD and so forth but they do not do nothing to the arsenic. Well where does the arsenic go, it ends up in sludge and sludge is land applied. That is the standard practice nation wide. So we need to think about that, what I think we will have to is manage these leachates at these sites. What does that mean. You can't use activated carbon, which is the cheap way. You will have to go the hard way which is reverse osmosis which is expensive. Management will have to re-circulate the leachate to keep the arsenic in the fill, we have to figure out a way to do that without poisoning the biological process because you get build up of ammonia for example. There is a lot we need to learn I think about recirculation of leachate, not for the purpose of not having to haul the water out which it is currently used for to cut costs, but to sequester and ultimately put the arsenic in some kind of geological state. I don't know if that means it will combine with the sulfides in the landfill, I don't understand the chemistry well enough, though I think it is fascinating. For number two, for C&D landfills in Florida, why don't you just line your C& D landfills and be done with it, that will solve your problem right there. And then your problems have just begun.

When you look at the C&D waste trend its not that bad: its wood, rocks, concrete, dry wall, wood, most of it is innocuous inert waste, its largely an aesthetic problem getting rid of C& D waste, its not an pollution problem like putrescible and solid waste with a few notable exception most prominately CCA. I was talking with Lena Ma about this yesterday, to me the ideal solution is go ahead and keep in the C&D stream and put it in unlined C&D landfills if you don't want to line landfills if you can help it. We launched strategy of waste management in this county decades ago when we decided to build all these closed dry tombs to manage waste, but we are not really managing it we are just storing in big piles and putting something on the bottom and on top and walking and we are doing that all over the country; its called subtitle D- RCRA. This is how waste is managed. It is stupid. We would be better served in my opinion to have leaky C&D landfills. We don't want to collect leachate, it is expensive it is needless in most case, could we in the lifts that we put in the cover of the landfills bring in certain types of soil , Lena mentioned iron filings I though that was interesting. I was at a fluidized bed coal plant the other day in Jacksonville, where they had huge mountains of their treatment sludge which is all virtually all calcium oxides. Could that could be used, in other words the C & D sites would be a treatment facility where the arsenic is binding up while letting everything else go through. That would be slick. The third area is the waste energy plant emissions. That looks like a great opportunity for us but I am leaving this conference completely confused about this issue. I don't understand it. I don't understand if it is good or bad and that is because I am stupid I am sure. I don't know enough about air. That would be a slick solution to burn. I am in favor of waste energy. It is good technology under the new max standards these plants all have scrubbers, bag houses, activated carbon injection, continuous emission monitoring. They are very sophisticated. They are a great way to get rid of it. We have actually had some preliminary discussions with Wheelabrator and Covana (?) Energy on this topic but we have to set up a test burn. This would be a real applied area where we could greatly us the help of the Center. Quickly , I have learned from this process that the arsenic free alternatives that we have been talking about, ACQ, copper azole, aren't quite arsenic free. They will have arsenic as a trapped contaminant in the copper that was used to make those materials. We have been involved with discussion with the treaters on closure of old CCA treatment sites and we have been talking about how clean is clean. How clean do I have to make it? Well you have to wash the system out, shot glass the drip pad, whatever. But how clean do we have to have it. We said we wanted them to get parts per billion. The correct MCL and they said we can't get there from here and I said why? All you have to do is just keep washing, take the rinse water and use it in your CCA line, most of these guys are keeping CCA as an option, they can't get there because there is enough arsenic in the copper that is in the ACQ that you will still get a 150 parts per billion in the wash water. Why do we care? What is happening in the mulch market is, the big corporate guys the big box stores are testing their own mulch now because they have been burned, they have law suits against them. This issue is being regulated by the market in a really nice way I would have to say. Home Depot is canceling contracts with mulch makers when they detect arsenic. The problem is though that they are going to be detecting arsenic even if that wood is made from ACQ. This is an issue we need to think about as we move forward because if we don't we are going to end up killing us the recycled wood mulch market. If these big box guys say if we detect arsenic then we are not going to buy mulch from you, so what are these guys (mulch makers) going to say, they are going to use all virgin chips. Anyway that's me as a side issue. Lastly I was intrigued, this might take away from the whole thing from the air people, is slow pyrolysis gasification or something like that is probably the optimum way to deal with this if I understood everything correctly. I like that, but I have seen every pyrolysis scheme in the book in my 15 years in this business: tires, medical waste you name it. There has never been a commercially successful pyrolysis unit in the United States and I dare say that we have seen 20 facilities globally there are a few in Italy that are burning waste and making a go of it. But in this country because of low disposal costs its

very tough. I think that that could work. But I think that the disposal cost is going to have to be keep in the 100-150 dollar per ton range that Kazem talked about yesterday. There are wastes out there right now that we charge 100 bucks a ton to get rid of them: waste tires, asbestos, medical waste, so that is not out of range. If you go above 150 it is spent in the water.

***Comments from Audience:***

*Comment*: Hi, Bill's idea with removing arsenic selectively with ferric hydroxide or maybe some of those schemes that they use in India to remove arsenic from water.

*Gerard Deroubaix*: I think the recollection issue is also very important and I would like to give you some direction to look for, we have certain kind of waste in France where it is the responsibility of the marketer. We are exploring the idea that the people putting on the market the treated timber can be involved in managing the system for recollection and recycling of this timber because as it been said yestereday it is wide spread across the country and there are difference kinds of sources for this waste and it would be, I agree with you and your merits that it would be very difficult to collect this thing specifically if there is a special way of recycling these materials.

*Mary Stewart*: I am just concerned about doing too much research in isolation, especially looking at the waste to energy processes. You can't look at those without looking at what happens to your ash when investigating the combustion processes. Combustion determines what your ash will be and you can't just say that that is a problem you can solve by another technology later. You need to start intergrating work and need to start understanding how those two things interact. Just to say also, that the minerals industry has a lot of expertise in looking at the environmental stability of these materials and we heard yesterday from the coal people about the combustion of coal and what metals do in combustion and the same way the minerals industry has a lot to say about the stability of metals and to start looking at their research. I don't know if this comment belongs in this session or, but relative to the release of preservatives in the environment to recognize that a geologically stable form of arsenic has not yet been found. The longest time it has been possible to deposit arsenic stably is 30 years. After that it will move. Further chromium also ages you get a move from chromium 3 to chromium 6 switch and depending on what other metals are present in that waste the chromium will start leaching over time. So we need to integrate the research, you need to integrate technology and waste management and you need to start looking at other regions of interest especially around the metals.

*Paul Cooper*: One of the thermal methods that really hasn't been mentioned, and there is some interest in Canada for CCA that's as fuel start for cement kilns. Cement kilns have, the clinker has quite a bit of capacity to hold arsenic and quite high allowance for arsenic and copper. The indication is chromium because of the conversion to hexavalent chrome in the high pH environment. We calculate in Canada that roughly 20% of the total CCA wood being produced could be accommodated in the cement counts in Canada. The big problem is the collection and grinding of the material. But I think that's one were you would not have to sort wood to put it into use.

*Curtis Englot*: I would just like to speak on Dr. Cooper's point there. In Canada we have done test burns to look at incineration. And one of the big one's I am quite disappointed that we haven't been able to move along is the burning of creosote treated wood. That is easy to accomplish yet we don't do it done in Canada, instead we send our creosote treated ties down to

the US. And the big issue there is gaining acceptability by the general public that this can be done safely. That is why I think that sessions like this are important. There is a lot of experience in other areas in the world where they have been doing this for a long time. And we really need to pull the science together to show that different processes can be done effectively and gain acceptance by the public and that is one of the biggest problems we face in Canada and that sharing of the knowledge is very important here.

*Comment*: Just a comment about thermal treament, ball park numbers on the resource and what that means in terms of energy. Some ballpark numbers, if you took the entire CCA resource that is expected to be available you can fuel about 200 one MegaWatt power plants and that is about 1 MW of electricity. So the point is that this is a widely distributed resource that would have to go into some kind of distributed heat and power facility. I think cement kilns is an interesting idea, I know that cement kilns are using alternative fuels. They are burning tires and other things like that. Just so everyone understands, getting this resource into a large heat source or power generating facilities is more difficult than pushing a market of smaller distributed opportunities. But then the challenge with the smaller distributed opportunities is that pollution control is less on the back end. What I am trying to say is that from a market stand point, you have to fit the resource where it can be used. Research on all thermal treatment methods and how you create that process to handle those materials, and then recycling of copper and chromium back into the market place maybe the best final fate for those materials.

*Bill Hinkley*: A quick comment on that and to Mary's comment, I do not favor the recycling of CCA or arsenic. I think it is time for arsenic to be retired from the biosphere. We are doing the same with mercury, mercury is been withdrawn from all products, conditions have dropped dramatically, the amount of mercury in the waste stream is going down down down, thermometers are being dutifully replaced , etc, etc. Now the problem is what do we do with all this mercury? There is honest research is to turn it all into cinanabar and put it back into the ground. And I think we need to start thinking that way with arsenic. It has served it purpose, it's a a powerful chemical, but we have got to move on. We need to figure out a way to sequester it permanently either in landfills or in ash or in old salt mines. We have 31 thousand metric tons of arsenic to manage in this state according to Tim and Helena's data. That is a lot of metal. For something that has a standard for 10 parts per billion. Talk about scaling.

*Rolf Dieter-Peek*: I am working for a resource center which belongs to the ministries of consumer protection for agriculture. Sometimes I have to sit on their side, on the ministry side. The decisions there are so far away from what we are as scientists are thinking. We make our experiments about ashes and we make our experiments and thinking about thermal processes, landfilling and all these things but politicians decide on a different basis, much more pragmatic than we are sometimes. So we have discussions about landfills in Germany and I am making a strong point that they are forbidden. We can not bring any timber in the landfills in Germany. The reason why is that there is potential hazard at risk that this wood would break down and that we would have to cope with the leachates. That was one reason to say. We don't want to have this any more. On the other hand we have so much more other demolition materials other than wood which go into landfills and don't do any harm to the landfills so why not take all the wood out of landfills except this little part which has been burned and the ashes which are not contaminated go to public landfills. This is the only option we have at the moment. If there are ashes as I said from incinerators they have to go to special dumps and salt mines and wait there for a second generation of recovery which has not been developed as somebody said at the moment. So our way was to incinerator plants very special, only for wood nothing else, not municipal waste incinerators, but only for wood. The technology, I have been in a number of

sessions where people from the burning industry were sitting together, where people who have knowledge of filters and all these things, this kind of technology is so sophisticated today that the emission rates really which I showed in my paper can be met even when they are under these limits values. So the only way, the political decision in Germany is to get rid of the treated material by incineration in special incinerators. I think what we have to do is like Bill said go around the world, or John would come to Germany, and have a look at these incinerators and see what technology is used there and start to think again. We are in many cases not enough informed and not enough skilled to know all the details which are available all over the world, we do research in many fields without knowing that the results, the solutions are already on the table.

*Helena Solo-Gabriele, Summary*: At this point I would like to close this particular session, the plan is to put everything on paper. I am going to re-listen to the tapes and I will try to assimulate all the information that has been provided here and then send to all the participants via email at this workshop for one final set of input. What I have heard in this particular panel, I have heard some general themes, there are some issues of US versus Europe, with respect to the US there is characteristizing of what is happening in the US as a whole vs the state of Florida. Also there is a theme of issues of regulation both throughout the Europe, as mentioned in Sweden and also in the US. And most importantly the issue of landfill vs. thermal chemical processing. These are the two processes that have appeared to be the most economical at this time. There may be some opportunities for some wood cement composites or other recycling options, perhaps if recycling should be encouraged. As far as the landfill, I thought it was interesting with respect to Europe it seems that thermal chemical processing are encouraged there except with the exception of Denmark and in the US it appears of the low landfills cost, landfills may be preferred. But it seems that there maybe some issue or areas where thermal-chemical processes would be highly desirable. With respect to the landfills there is an issue of liners vs no liners that need to be evaluated also issues of clean up of the landfill leachate. With respect to the thermo chemical processes a lot of the discussions focused on issues of fuel quality and whether or not sorting is necessary. It seems as though if we could get around not having to sort it would be better by lowering cost. But that might have an impact with respect to ultimate disposal of the metals within the ash and also quality of the emissions. Also with respect to sorting the issues brought up as far as the responsibilities of the marketer and the people who produce the waste. The importance of integrating thermo-chemcial studies with ash quality. We need to learn from other industries such as the mining industry as far as what they are doing. I thought it was interesting as far as going out and visiting other incineration facilities, pyrolysis facilities to gather information to see what is being done world wide in some coherent fashion to come up with the best possible solution. Issue of slow pyrolysis, cement kilns were a possibility, large versus small facilities, and air pollution control facilities on the small facilities versus large facilities. Also the issue of creosote, and encouraging the burning creosote within thermo-chemical plants. That is what I have taken away from this. There are certain themes that are consistent throughout many of the discussions. What I will try to do is put a summary of these themes together and provide a summary statement of what was said here and sent it out via email. At this point in time, given the lack of time, I would like to proceed with our next panel.

The next panel which will be rearranging due to airport schedules. We will be discussing exposure risk assessment in the next session. Our panelists include Rolf Dieter-Peek, John Schert, Tim Leighton, Curtis Englot, and David Stillwell. At this point I would like to turn over the floor.

***Panel #3: Exposure/Risk Assessment***

Panelists: Rolf Dieter-Peek, Curtis Englot, Tim Leighton, John Schert, David Stilwell

*Rolf Dieter-Peek*: I am coming from a small country like Florida, but with more inhabitants, 70 - 80 million people. So we have different opportunities, different challenges, and different chances. Some of you might be informed about that wood preservatives will be approved according to the European Biosolid Product Directive. This Biosolid Product Directive was taken into place last year, and all the new wood preservative have to be approved according to this regulation. That means that they have to go through an efficacy test as we had in the past and we have to be careful about our environment and environmental risks from the wood preservatives and people look for it and we have a new panel on board that is their place exposure. There we are on the risk side of exposure, risk assessment. Risk assessment and exposure are two different topics in my opinion. One is of course the exposure to the environment, so what is coming out of the timber and how can we measure the possible risk to the environment and of course workplace exposure and the exposure to the consumer, secondary exposure or indirect exposure. The first work place exposure is direct exposure to the wood preservative and to the treated wood as such. The indirect exposure is to the consumer. And to my knowledge there are great programs going on especially in the UK, HSE is looking for the exposure to work place and to people on the work place. And in Germany we will do the same. So at the end of the day every new wood preservative will have to go through four different functions: is it efficient, is it harmful to the environment, what is the risk to consumer, and what is the work place situation. All the new formulations and actives will go this way. So what I would propose is having more risk assessment especially concerning the workplace exposure. If we don't have figures there we at least in Europe run into the possibility that special wood preservatives will not get approval anymore. And since we are a little bit advanced in Europe this might also come to the US and other countries. So be careful about exposure, and measurements, and invest some money in this field.

*John Schert*: I am from the Florida Center for Environmental Solutions. It is really great to see the exchange of ideas, and to see other folks from other countries coming to share their ideas. Over the years that we have been working with this, I have really been struck by how little is known about the exposure issue and what sort of a murky area that is. A lot of people have called me over the years finding us on the web believing that they might have had some exposure. My answer is usually well I am a garbage guy I am not a toxicologist and I am not a health and safety person. So I have always been really uncomfortable with that issue. But I think we need to get a better handle on how people are going to maintain structures and work with existing structures. Are they getting exposure problems from that, from sanding or sawing or those kind of things from the existing stalk that is out there. My big task is what to do with all of this C& D wood. To sort or not to sort, how do we use it as an energy source. Joran mentioned the metals in the fines when we start handling this stuff and chipping it up what kind of exposure problems are we creating for the people who are doing that, the people handling it. We have had some cases of people who looked like they had been pretty heavily contaminated by handling mulch here in Florida because of the arsenic in the mulch. There have been some legitimate concerns raised about that. I personally noticed a lot of burning of waste wood by people who aren't clear at all that they are burning treated wood. We have so much wood in Florida that is heavily weathered, I am just not sure, that whoever is in charge of doing this, is not doing a good job of letting people know that they shouldn't be burning this stuff especially with construction workers. I routinely see it happening. A lot of little burn sites I have pulled out pieces of CCA 2 by 4's and things. So anyway I think we need to look at are we doing a good job at managing this as a waste. I think we need to find easy ways of distinguishing CCA from non CCA wood. We

don't have any easy means of doing that. I mean you can go and buy a 40 thousand dollar X-ray device. The stains that we have been working with here in Florida do not distinguish CCA from non CCA. They just detect metals. I think the ideas that Rick Maas and Dr. West have on the green sheet are some really good ideas too.

*Tim Leighton*: Thank you John, I am here from the US EPA. I work for the Office of Pesticides where we register and reregister the wood preservatives. Generally when I come to a conference and I get an opportunity to speak with researchers I go more along the line of we need some basic research and some more information on the efficiency on the sampling methods. But today I am going to be a little bit more focused and the research needs that I am going to push for are more towards the reregistration and registration of wood preservatives, especially because this group is more tending toward that. We look at both worker exposure and non-worker exposure for the non-occupational, specifically we are looking at children on treated decks, children on treated play sets or whatever areas that are there. I think the best way to start looking at where our research needs are is to looking at exactly what kind of data that we have now. For the exposure portion of the data right now we do have residue data that we have been using for registration, really the registration of CCA, creosote and pentachlorophenol. The residue data that we are looking are hand versus cloth wipes from actual wood on decks. We are also looking at soil residue concentrations. One of the things we are looking at for CCA is the incidental ingestion of soil and for the chromium portion we were looking at assumptions on how to get from total chromium to hexavalent chromium. And right there, there is some needs because nobody has speciated that in the soil as far as I can see. There's other exposure type information that we need and that includes, mostly assumptions, such as hand to mouth assumptions. When I saw one of the slides earlier yesterday that children are not miniature adults there are other exposure activities that are involved. We need to get to areas of replenishment for hand-to-mouth. We also need to look at saliva extraction efficiency. We do have some data there. And you could probably go to some of our website at EPA and find out the values that we are using. For the toxicity side, this is where I usually capture the bioavailability issues and that was also brought up. The exposure that people are getting or children getting from decks are not necessarily liquid forms of arsenic. The arsenic is bound with the wood and the chromium. So we have some data and you can see this from our science advisory panel on the data that we have used and our CCA probabilistic assessment. And from that information you can look to see the ranges and assumptions or if we have used specific data. And from there you can go on to see what further needs to be done for those issues. For more concrete steps, if you really want to get down to what the further research needs are the SAP is going to release its comments on our probabilistic assessment and I believe that release might even be as early as this week. There will be some specific comments in there on the data that we have used and from the data where we should start looking for additional information. So as far as a concrete step that is one spot that I suggest everybody go to. Now for some specific data needs we always talk about residue data and exposure data, but there is also survey data that we need. There are measurements, but besides the measurements we need to know how long children are out there and contacting, and what kind of frequency are people are on treated structures. One of my pet peeves that I usually have in exposure data, I want to make sure that everybody gets this across, this goes to my (preference) of being able to use data, is that environmental concentrations that are collected are not necessarily equal to human exposure. So when you do look at collecting residue type data do look at it as what is existing. If you are going to look at carpet residue for instance, I think that was brought up in the green paper here, if you are going to look at carpet residues we want to look up residues that are transferable and not necessarily deep into the plush where it is not going to be available for exposure. There has been …. (end of Tape 1, Side 1)……So when you are thinking of designing look at some of our guidelines like series 875 and look and see what kind

of transfer coefficients exist and use similar sampling methodologies so that we can link those data directly to human exposures. And then the final thing that I would like to say, if you are going start large scale type exposure monitoring due come to us in the antimicrobial division and we will review protocols to help you decide if we have the information where we can link environmental concentrations to human exposure.

*Curtis Englot*: I am going to take a little bit of a different angle on this one and I hope no one throws me out of the room. I deal with risk management not assessment and so I have a little bit different take on this issue. I think if we look at the information that we have learned here throughout this workshop but also in the past. We know that leaching occurs of the chromium and the arsenic. It is getting into a variety of different forms into the aquatic environment and into the soil. There is a lot of debate about what are the numbers, are they high numbers, and are they low numbers. We have talked about under decks and all the different potential areas where we could be exposed to the leachate and contaminants. But the bottom line is the exposure to that. Even if you do have a high number, I know that most decks that I see that I don't crawl under them. And they are usually the place where things get dropped and never get recovered until the deck's torn out. You really have to examine that situation and I think part of that comes down to information. My boss when he brought me into this whole wood preservative issue, his bottom line was look you have a piece of wood with a pesticide in it and I think that is what has happened here is that the general public doesn't know that and once they become aware of that and they know that, then they can address it more effectively. There was a comment made yesterday about the workers and getting the workers to separate the waste stream out at the source. So that you would have a treated wood waste source and untreated. And there was a comment that well trying to educate these people about what they were using and the need to separate them was difficult because of the turn over and that sort of thing. I have worked with the big boxes as well to trying to inform their staff so that they could properly answer questions and pass this information along to the public and they gave the same compliant or the same excuse is that there is a high turn over. Well the bottom line is that we need to up the education level of everyone so that they really understand what they are using. And I think if we look at certain issues as the public becomes more aware of them they can deal with the exposures more appropriately and we can manage the risk. They know that they are dealing with a piece of wood with pesticide in it and they treat it a little more different respect than just a piece of wood when it comes to issues like burning it and that sort of thing. And they understand that they can't do that sort of thing. So I think that is a really important point here and my concern number one is the education and not necessarily the research aspect of it. If we do look at the research perspective, I think we need to bring in a lot of other disciplines here. I am actually quite glad to see quite a few engineers in the room here. A lot of the wood preservation meetings that I have gone to are full of all of forestry guys. We had one doctor come here and present yesterday. I think we need to bring in a lot more of these other disciplines. Statisticians, I mean the variability that you can find in treated wood: how much will be leaching, the different treating rates. There is huge variabilities here; the exposures to the public. Two years ago I spent 3 weeks in Virginia where I basically looked after my daughter. We went around from playground to playground in June/July and there was very seldom children at the playground. We were virtually the only ones playing on these structures a lot of times. So when you are doing the calculations and trying to figure the exposures look at what is a reasonable number and what is the variability in those numbers. It can be huge. We have been working on a study in Edmonton right now and we went out and we did some sampling in the summer as well and it was surprising when you figure out how many kids are geographically served by one structure and how many kids are there. It is a really low percentage. So trying to figure out the variability in the exposure to kids. You can have some kids who would play a lot and some that never go

there. So you need to bring in these other disciplines to provide more science and better answers to these questions. Looking at the waste we were talking about how to deal with that yesterday. One of the things that came to mind was essentially we are trying to mine a resource was what about looking at some of the mining processes that they use for removing the copper and the arsenic from the ores and that sort of thing. And maybe they would have some sort of take on how to get that stuff out easier because they deal with that in a different scenario. But again they are trying to do the same thing, they are trying to pull something out and I think the comment that was made about bringing the metallurgists and sort of thing it supports that kind of approach. One of the other things that we need to do is to decide when we have enough information. I don't think I have ever read a paper where were there wasn't an end section that said we need to do more research on this, this and this and a lot of times, we keep trying to look for the ultimate answer and we can't do that we need to move forward. I think my conclusion to this is that perhaps we don't need a lot more effort on this when it comes to the exposure and risk assessment. If we look at the future I am speaking specifically for CCA here, it is out of the residential market. I think that is the primary exposure and it is not going to be happening much longer. And as such we should probably move the bulk of the work away from the assessment and the exposure there. Aside from the fact that there is still exposure associated with the product that is still installed. So you know if there is going to be research on the exposure and the assessment, lets concentrate it on minimizing the risk, the risk management so things like the coating and those sort of thing. But other than that educate the public so that when they are tearing their decks out as they need replacement that they know how to do it properly and things should be probably covered. Thank you.

*Dave Stilwell*: After a deck gets removed though now you have the arsenic polluted soil now exposed and other people might not know that there was a deck there. Tim covered a lot of the stuff so I think a specific experiment would be sequential extraction to determine the forms of arsenic on the surface. Also the coatings, survey of coating, methods, formulations, iron and those sorts of things would be a way to reduce the exposure. Somebody mentioned yesterday smoke, for the firemen, and the EPA report that's really going to cover a lot of topics: biomonitoring, skin absorption, bioavailability, arsenic leaching and dislodgeable residues and how they relate to each other and the nature of the residue. There was proposed that there was a chromium dimer associated with one arsenic atom. However the leaching data show quite the opposite and to explain this discrepancy there may be chemical reactions on the wood surface which result in preferential release of arsenic. This would be another reason to design a sequential extraction experiment. That would be one way to determine the various forms of arsenic on the surface, particularly the soluble and insoluble fraction. That would also be tied in to the bioavailability, biomonitoring is also a lot more complicated than I would ever imagine. I wouldn't suggest that anybody take that up just by themselves. There is also plant uptake around the raised bed gardens. Most people would agree that the tomatoes plant will not pick up arsenic but there are plenty of leafy green vegetables, lettuce, mustard greens, arugula, Swiss chard and to a lesser degree those sorts of things like herbs basil, chives, some may take them up, to a variety of degrees. Actually, when I monitored playgrounds, I did a little study, and I had to wait for a cold rainy day because there were like tons of kids on the playground in Connecticut. Thank you.

*Helena Solo-Gabriele*: Thank you panel. We would like to open it up for comments from participants.

***Comments from Audience:***

*Comment*: Well I am pleased to see the emphasis by the panel on the workers who will be handling CCA waste and handling CCA solutions. That is a very important factor compared to the public. We would like to suggest there be a definition of proper medical tests and procedures to indicate exposure to arsenic. It is very important to the sector who is working with the arsenic products. I will give you my example, in Canada wood preservation plants are to have health monitoring programs on a yearly basis. The question is what do we monitor for and how? We have had a number of plants that have monitored yearly for arsenic concentrations. One plant I know the office staff had the highest arsenic concentrations compared to people who were actually handling the solutions. So was it that the test wasn't conducted properly or were we are looking for the wrong parameters, maybe we shouldn't have been looking for arsenic in urine we should be looking for some other test. The other aspect deals with annual physicals that people are required, particularly those who are exposed to arsenic. In Canada workers who were exposed to arsenic are to have such annual tests. They go to their physician and say ok I work in a wood preservation plant. I am suppose to have this test. The physician says I don't know what I am supposed to be looking for. We might have some general idea, but there has to be some kind of reference point for indication that there is exposure to arsenic that may be of potential concern. The other point that I would like to make has to do with exposure limits for the new chemicals. Right now we have ACQ, if you have a monitoring program in a facility that is using ACQ what are the proper parameters to be monitoring and secondly what would be the limit for those parameters.

*Raj Sharma*: One of the things that also needs another look is the NRC analysis of our arsenic potency in the first place. Recent studies have shown that arsenic isn't quite as potent as we thought from the NRC analysis. There has been further analysis of the Taiwan data set which really falls into two populations: a very high exposure in the hundreds of micrograms per liter of arsenic where the cancer developed and the second population where really there was a very low exposure and no cancer development. There have also been recent studies in the US published very recently by Bates and also by Smith. One of which was up on Dr. West's slide the yesterday, which again does not show any association at lower doses for arsenic and cancer. Another study just came out last week, which is in the Argentinean population, which again says the same thing. There are also recent ecological studies by Lam and Frost, which is saying the same thing in the US. There is a Takoma Smelter study, which has just come out by Frost, which had very high levels of arsenic in the environment, which really looked at the exposure to people through a lifetime and didn't show an increase. And really there are now new studies which really require that the NRC analysis be looked at again and these have been all submitted to EPA and I know that they will be looked at. And it really is very important for us to realize that we are targeting arsenic as a culprit and there is no doubt that arsenic is a carcinogen but the dose makes the poison, we shouldn't forget that.

*Helena Solo-Gabriele, Summary*: As far as the over arching themes that I can summarize from what has been said so far is that there are various areas of risk assessment, these include evaluating the risk of associated with the efficacy making sure that the wood holds up structurally and also the risk to the general environment. Most of the discussions focused on exposure to workers at the treatment plant and exposure to individuals within the solid waste sector, and in particular those who handle mulch and process mulch and also issue of secondary exposures through fire fighters and possibly smoke. A lot of the comments focused on exposure to consumers, specifically evaluating the exposure to people who may be sanding and working with the wood. Secondary exposure through children playing on play sets and also secondary exposure through uptake through plants to people who consume plants that may have been impacted by CCA. As far as the children and playgrounds there was a long list of areas or data

that would be useful these included information on the soil residue concentration, chromium 6 in soils, hand-to-mouth, saliva extraction, also the need for surveys, I heard from a couple of the panelists with respect with how often a child plays on a playground, transfer coefficients, skin absorption and also the issue of bioavailability was discussed amongst a couple of the panelists, the need for sequential extraction studies to determine the soluble versus insoluble fractions of residues from the wood. Also there is the issue of low versus high doses and the impacts and health affects associated with low versus high does of chemicals from the treated wood products. And also there was a need to minimize or remediate the exposures through the use of sealants on existing structures. As far as follow up concerns or follow up issues that include issues of risk management and the need to educate consumers also the need to recognize possible exposure by improving our medical tests, developing new ways to recognize exposure among the general population. Another over arching theme that I heard in the last panel and also in this panel is the need to bring individuals from all different disciplines to address this problem including the forestry groups, engineering, medical doctors, statisticians, and individuals from the mining industry. Also there is a need to evaluate exposure to other chemicals. So, I would like to thank everyone and if you have comments we will be emailing everyone a summary statement. I would like to thank the panelist.

At this point I would like to invite the panelist for panel two who will provide feedback on the release of preservatives to environment. Our panelist includes Tait Chirenje, Paul Cooper, John Ruddick, Michael Kennedy, Daniel Mourant and Tim Townsend.

***Panel #2: Release of Preservatives to the Environment***

Panelists: Tait Chirenje, Paul Cooper, Michael Kennedy, Daniel Mourant, John Ruddick, Tim Townsend

*Tait Chirenje*: A lot of what I wanted to say has already been covered especially by members in panel two. But from doing research over several years here in Florida especially soil characterization and sorption there are a few things that we feel that we don't quite understand about the dynamics of arsenic especially arsenic in soils. A lot of research by Dr. Solo-Gabriele and Townsend shows that arsenic is leaching from these structures and yet we have gone to a lot of sites, especially there is a site outside Gainesville where they have had test plots for over 60 years and when you look for arsenic in those soils it is gone. We know the concentration in existing decks is probably 20 to 30 ppm. So something is releasing this arsenic from soils after certain period of time. And one of the things that we feel we should do is to understand what are the conditions that lead to the release of these chemicals from soil. Especially soil properties, pedogenic processes that are involved in these. Another issue that I feel needs to be looked at is the environmental impact apart of from human health assessment. I consider myself an environmentalist and when I look at the environment I don't just look at the impact on people but also on plants, and other parts of the environment flora and fauna. Especially here in Florida where there are a lot of wetlands, if you look at it from a point of view from a watershed approach you want to see if any of the arsenic which is leaching is going in anyway to affect parts of the same ecosystem. So that is one of the things that I would like to see done.

*Paul Cooper*: I would like to focus on some of the issues that were identified in Canada during a process called the Strategic Options Process which was a multi-stake holder group that mandated by Environment Canada to look at ways that of minimizing the impact of the toxic components of all the wood preservatives. One of the issues of course is release at the treatment plants and this was addressed through mandating that the industry would accept the technical

recommendation documents that recommended that practices at the wood treatment plants. And so for example there was a requirement that complete hexavalent chromium be reduced in CCA treated wood before material was moved off and this is a requirement of the industry. These TRDs have now been extended to the new preservatives ACQ, copper azole, and borates. There are either available now or will be available soon. They are living documents, we really don't have the data that we need yet on the new preservatives and John Ruddick mentioned yesterday that there are a lot things that could be done to reduce the releases of copper from ACQ. But we haven't pin pointed those completely yet and so more work needs to be done to understand the mechanism of stabilization or fixation of these preservatives and what can be done at the process level to reduce the amounts released. Two other things that were identified as being data gaps were when we tried to do the inventory of how much preservative was in product that would go to disposal and how much of that had already entered the environment in some way. It was really hard to come up with the numbers and we identified that there was not enough information on the fate and emissions and fate of creosote from railway ties and CCA from treated products and we have now extended that of course to, say we obviously don't have the information we need on the new preservatives. So we need to generate that information and I believe find a way that we can predict the performance of new preservatives as part of the evaluation process so that we know how a new preservative is going to do not just in terms of efficacy but in terms of impacts on the environment. So those are sort of broad things and there a few specific things like the coatings that I am hoping that the EPA study will give a fairly definitive indication of how effective coatings are short term and long term on leaching and dislodgeability. But otherwise we more work on that as well.

*John Ruddick*: Thank you, yes a couple of things, first of all phasing out of arsenic or retire arsenic as I think I heard someone say earlier reminded me of Alice in Wonderland and the walls and the carpenter sweeping the ocean. To me there is a large amount of arsenic so that this really is not a realistic target. A more realistic target is to try and manage the material that we have and I think that should be our goal rather than trying to think that we are going to get rid the world of arsenic. So really our focus should really be management and management of these risks in a reasonable and responsible way. I am going to deal with the topic in a general way but I will focus on CCA to some extent. Modeling I think is a really critical aspect of what we do and there we can learn again from Europe with the Biocide Directive and the OECD and various groups that have looked at the modeling impact of the use of treated wood and the various situations and the modeling of releases and the modeling of things like impact of fixation and the size of product and density load of wood in the particular environmental exposure. These are things that have been looked at in Europe and I think we can learn a lot from Europe in understanding the environmental impacts, differences say between a deck and a dock structure and an isolated pole. These are different environmental considerations and I think we can learn a lot by sharing information. There are data caps like Paul mentioned and these need to be recognized and filled. What is the long-term impact for instance, if you have already impacted and released arsenic from decks well you're a bit late, because most of them are in. And we need to understand what is the situation now. The situation is most of the decks have already lost most of the arsenic that they are going to lose anyway. That means arsenic is not in the decks anymore, it mobile, and it's mostly in the soil, underneath. So what are you managing, are you managing the soil that is underneath or are you managing the deck that is still there. So you need to consider what exactly what is the target that you are aiming for. Looking at some of the other topics Paul mentioned and really is an expert in this area which is modeling loses of chemical from wooden structures and as we both know things like species, things like coatings, things like retention, things like type of treatment and things like fixation, all these things impact on what is going to be lost from that wood in service and we need to conduct and to continue to conduct research to better

understand how these systems work when they are put into wood. And that is an on going area. That will be driven not by government though, that will be driven by industry and by others who are interested, curiosity driven to understand how these things work. But I don't think it is going to be driven by government, it hasn't been in the past. I already mentioned modeling and Paul Cooper done tremendous work in that area. I would make sure that kind of work continues to be done, it is really critical. This is also a moving target, so speaking to the new preservatives, you know you've already got ACQ type B,C, D, copper azole types A,B and I mean it goes on so you have to understand that this is a moving target. The industry itself is improving and enhancing these preservatives sometimes it is driven by environmental considerations, sometimes it is corrosion, sometimes its color, sometimes it is wood quality. But the target itself will move, the CCA wasn't always all CCA. It was CCA and sometime it was with water repellant. So the target itself is not always the same and you need to understand that, that the quality of the preservative and the type of the preservative and the formulation of the preservative, even here now, this week you actually went to a plant last night and you may not realized it but that actually is a latest version of ACQ. It actually is not just the quat, but it actually contains a quart carbonate as opposed to a quart chloride which has most widely been used and that is actually just been introduced. You may understand or appreciate the impact of carbonate on the leachability of copper. So there are many variations going on and those are being driven by industry not by government. That's why I don't think that research will be driven by the government. I think that research is going to be driven by the industry. But those involved and interested in environmental impact and releases need to understand the formulations themselves change. The other thing we need to look at is the impact of losses in real time, not just in little beakers or in big basins. You need to look at real time. And many of these preservatives have been used for a significant periods of time. Particularly in Europe, ACQ for example has been around in Europe for a decade or longer, not necessarily in the amine form. So we need to take a look at material that is already has been out in service for several years to see what the impact of that product in that particular environment has been; what are the losses in real time? I think there is information out there. Finally I would like to say also in context, it is very easy to take a look at a small industry that has a relatively small impact and small use of chemical, we are in an area in the southeast states where we talk about arsenic but I mean there are huge usages of arsenic in the southeast states that has nothing to do with wood preservatives all. So if you want to take a look at the removal of a particular element from industrial use it is a very interesting and useful thing to do in terms of human health and environmental impact. But I think it should be industry wide and not just wood preservation wide. It should be across the board of interest in getting rid of copper for example, you better talk to the computing industry who have a very great reliance upon this element and what are you going to do with the waste materials that that industry produces. So I think it is an important idea, how you are going to deal with and manage materials that should be on an industrial wide basis and not just on a specific industry basis. That is enough.

*Michael Kennedy*: I am Michael Kennedy. I would like to address a few more remarks to the specific subject of release of wood preservatives components to the environment from wood in service. I would like to point out two real requirements before the process of wood preservative improvement and development can proceed. I would like to take an urge, a proactive approach in this. John has already mentioned that industry is really driving the improvement and the development of wood preservative formulations. But they do that in response to a whole range of different factors, just one of which is the environmental performance. Now when CCA was developed all of the thoughts of leaching and fixation were driven towards efficacy rather than towards environmental performance and the industry obviously recognized the learning problems with chromium and arsenic many years ago and they have been developing chromium and

arsenic free alternatives. These alternatives take a long time to develop, maybe 10 or 15 years to go through the whole product development cycle. So if we are going to take a whole proactive approach, we need to be looking forward and setting ourselves some targets for environmental release for the new actives. So it might be, it is already easy and simple now to say well the arsenic release we have been measuring is not acceptable. But are we yet in the position of being able say what level of copper release is acceptable. Because until we do that it is very difficult for wood preservative developer to adjust his formulation and develop his product to meet that target if that target hasn't been set. So I think that we need to be looking into the future and working out in which environments copper release is important and trying to set some figures for that so that can be factored into the development cycle. And not just with copper but with the new biocides that are coming along, perhaps some metal free wood preservatives. Well once we have a target, then we need to have a methodology in order to assess that in a rapid way. It is all very well to go back to a deck that has been in service for 15 years and measure what has come out. It is all very well to take some decking boards and put them into some kind of a test deck and measure them over a year. But neither of them is rapid enough to provide the feedback necessary for wood preservative development program by a commercial wood preservative developer. And we really do not have accelerated emission measurement systems that, for which the correlation between them and losses in service is well understood. So I think we need to do some work on defining targets which the future formulations and the improvements of the current formulations need to meet and we need to do some work on the methodology that can be used in the development cycle to assess whether or not the preservatives are meeting those targets.

*Daniel Mourant*: Maybe to continue a little on that vain of coatings, to be able to better assess what will be the needs in the future. I think the life cycle of the product should be elaborated first using timber then possibly using wood panels or other engineered materials, then ending up in possibly concrete or other thermal conversion systems. We optimize our resource because the release of preservatives is one thing but there is also the management of the resource to take into account. Another thing that I would like to say is we need the metals also. For now most preservatives have been copper based or arsenic based. There is a lot of research that has been done especially in Asia and in Europe concerning wood extractives and tannins. Those products have limited applications but could they be increased or incorporated more into formulations lowering the need for such metals. Also resins could be a possibility even though it is not naturally economically viable. We need to look into these things. We need to look at renewable resources or organics to include into those compounds, these resins that could be used to lower the demand on petroleum industry based phenol. So we must aim at renewable energy or renewable resources into that area as well. That is my input for now.

*Tim Townsend*: With regard to the release of preservatives a couple of immediate research needs that jump to me based on some of our experiences here. One relates to the copper in the newer preservatives. I heard different folks in the meeting the last couple of days express different opinions about copper. Of course there were some folks who said copper is a biocide. It's very toxic. It just shouldn't be used at all and then based on some of the literature and some other things you get the impression that copper is something that is relatively bound up in these aquatic environments and gets in the sediment and is not readily available. And copper is known to complex with humic and tannic substances in the water and is not necessarily bioavailable to these organisms so right now as some folks discussed in Florida a lot of these people who are going to be building these structures in aquatic systems are not going to have the option of using CCA any more because the only thing available to them is going to be ACQ or copper azole. So I think a real question that needs to be addressed is whether or not the copper and its release,

whether that is a real aquatic impact or not. And then are there tools that you could use in assessing what type of water bodies is it ok for. Ken Brooks who some of the people industry know who has done a lot of modeling to determine worst case releases in estuarine systems and things like that and using fairly complex assumptions finds that in most cases you shouldn't see a build up in water quality standards or sediment quality standards. But at the same time again you see others who say well no, because of the aquatic toxicity associated with that is something that shouldn't be there at all. So I think that is something that is a realistic need in the relatively near future that folks are going to want to see. Another release research need, we talked about the mulch and of course the direct exposure of the mulch, which was, folks touching and working with it have certainly been addressed. One of the things that we do in Florida is that we will do a leaching test for example on the mulch and find that it leaches and therefore can conclude it is not something that should be land applied but the question about what the ultimate fate of a preservative is going to be. Is that really something that is ever going to have an impact on ground water quality if you put down an inch or two of mulch in a landscape bed or if you do that year after year, is that something in terms of release, because it were to just use the direct exposure standards or even the leaching standards on these mulch tests it basically means that you can't use recycled construction demolition debris wood for mulch in Florida right now and so you would think that there is some deminimus amount that should be acceptable that would encourage that other positive environmental aspect of recycling that wood, so that is something. The thing that is a little concerning that I think needs a little bit more thought is the whole organic side everybody is talking about arsenic and copper and chromium but at the same time I am hearing in the future what we will be seeing is organic preservatives and that the writing is on the wall and that is what is going to be there. As an engineer one of the things that I rely on are tables of data and standards that toxicologists and risk assessors have put together and I can go and I can find what values of toxicity limit are for things like copper, chromium and arsenic, but when it comes to some of these newer organic chemicals that are out there, the question is are they going to be introduced and the data that was collected to prove that it was safe for use is that the same data that someone in a regulatory agency is going to need to evaluate what its impact on soil is going to be or its impact on disposal. And I think a good research area is going to be for experts like in this room to get together and say here are all the data that is needed when you are developing a new wood preservative that are going to need to be addressed to evaluate all these issues in the life cycle not necessarily just the ones that are normally used in terms of efficacy and then direct use in the environment, like the long term impacts on disposal. And another kind of release issue which goes back to disposal a little bit which is a big picture question which I don't know, I am just wrestling with it in my mind right now, but what is the better idea, is the better idea to concentrate all the arsenic as an example or to dilute it all. It goes into that lined vs. non-lined landfill. If you have a non lined landfill you are concentrating whatever arsenic is to leach down there at the one particular spot so a few areas around in Florida, or anywhere, or if you are talking about lining the landfills what are you doing? Well its going to a waste water treatment plant, and Bill mentioned before some of it is going to get into the biosolids but a lot of it is not. And those biosolids might be spread out everywhere and so while there is a goal to concentrate it and keep it. On the other hand there are some folks, ecologists, who have suggested that best ways is to just distribute that all back to the lower levels in the environment that are below any kind of risk threshold. I don't necessarily come down one side or the other, but I think that is a good interesting debate that should occur. Thanks.

***Comments from Audience:***

*Lisbeth Ottosen*: I just wanted to follow up on your comments on the new organic preservatives because I think it is really scary that they can be moved from A to B and it is not nice when they

go to B most often. But when we move to the organics so we don't know what they will be transformed into so we so not know what we are looking for. So I think there must be a huge work to be done there to see if it is getting worse actually when it leaves wood or what are we looking for there. I think there must be so much work to be done there.

*Rolf Dieter-Peek*: If I may, I would like to support John in what he said on the OECD work that is going on and about losses in real time to the environment. There is really an option, at the moment OECD goes the way that they test a given wood preservative in a block in a laboratory and try to model flux rates out of it to see how much comes out during a life time. That is one way, and I would say that it is a wrong and a right way. The other way that I would propose, what John is obviously thinking of is the large experiment we have out in the field. We know that there are poles outside for more than 20, 25, 30 years. In Europe we made an experiment, we made a survey, on these old poles many years ago, really many years ago before we started all these discussions and we found out that the CCB poles when it fails that has about half of it still remaining so we know about the releases during the service time. We know about the releases of CCA during the service time of 25 years. If we start with a retention of 6 kilogram in the ground lines after 25 years or 30 years we can calculate we have a daily of release below surface line of about 3 to 5 ppm per day. That is the release rate. If we don't take into consideration that we have losses at the beginning that are much higher and which fades out so that is one. The other approach is what we did in Sweden with a project on creosote. We know that there are fields outside, test fields for more than 40 years and even longer and we know the releases to the environment of creosote during this time. A creosote pole will fail about when you test 40 kg so we calculate the amount of loses by real time, by looking at these poles in real time and this would be an experiment now for all the old wood preservatives which are out in the field to look for the real remaining (metals) in the timber and calculate back how much the release was. And for the new preservatives we have to bring the samples out into a field tests for 5 years, look for the samples, how much is remaining in the samples, we have some studies on that at the moment, but not enough. Look at that and then we see how large the releases are. That would be a good way to do it and the last point I would like to make is fate and behavior studies, which have not been done sufficiently. We should start to do that. What is the bioavailability of the new wood preservatives in the soil.

*Comment*: Good morning. Let me start off thanking the officials in Florida for their effort here. I think they are certainly leading the states in environmental concerns in certainly the issues of arsenic control, chromium and copper. Let me first address this to one of the panel's comments that a lot of this research is driven by industry. I think the question is why? It maybe for self-defense and it may be for a genuine effort to improve the product. There are a lot of legal issues at play, a lot of the decisions being made are based on legal advice from lawyers and it may not be in the publics' interest. A lot of this research may be done by the public, paid by the taxpayers, used as self defense mechanisms and some of the research, which should be done, may be avoided by support from the industry. No one has addressed other options that have been freely discussed with the industry and that is high penetrating polymers that will seal arsenic and will lock in copper and will lock in chromium. There is absolutely no mention about them after discussion for over a year about the availability of this process, its been proven a lot of the testing has been anecdotal some of it being done by a few of the people that have given programs and it is a little bit in the early stage to meet the scientific criteria. But the possibilities of this working is highly beneficial and highly objective and it will meet all the basic needs that I have heard here about the concerns about economic issues, about the control of copper, chromium, and arsenic for existing decks as well as for new lumber. The product is available, it reduces the cost, it has superior characteristics in that if provides a totally hydrophobic condition; it's

cathodic, the weight is much less, there is no leaching and I would support or ask you to support whatever research you think is necessary to make this a viable option in the quest to provide health and safety for….(end of Tape 1 Side 2)

*Paul Cooper*: … and back to the hexavalant state but as part of our study we did a pressure (test) with water and compared to the others and you will get slightly elevated levels in pressure washing if you are going to remove material. But I think this is material that would normally come off eventually through the rainfall and so it is not having a large additive effect. But the chemicals that you might use in conjunction with this are more of a concern.

*Kazem Oskoui*: I would like to make a comment on actually the true cost of different disposal systems. For example I hear a lot about the cost of landfills being very cheap and very economical and that's what is driving the whole thing, but especially on unlined landfill. I think there is a need for doing some research to find out what is the cost of cleaning up an aquifer which that land fill may actually contaminate and we have cleaned some aquifers and I can tell you it is not very cheap and if any of these C&D landfills found that the arsenic level in those aquifers around that area are above a certain level, the cost will be astronomical and it is not going to be very cheap to do. So when we are actually considering the cost of a particular treatment, Bill mentioned about 100-150 dollars a ton, it may sound like a lot of money but when you are actually looking at the implications of not doing that in the future, especially, now we all know how much it costs to go and take out asbestos from a house and take it into proper treatment. We do that all the time and we charge a lot of money for that. And what worries me is that we may end up coming into a landfill and being forced to empty that landfill completely take away everything, I mean go into the garbage there and you know identify arsenic contamination and remove that because we are contaminating the aquifer. Another aspect of it is the leaching collection, now some of the publicly owned treatment plants are refusing to accept this leachate because there are in mid-western areas where the arsenic levels are already high. There are already struggling with that and to add to that their compost, not their compost, their sludge, is not going to meet the requirements for disposal so they have to go and dispose it in a hazardous waste place and it is going to add a cost so there are actually refusing that. The other area is that in the state of Minnesota in most of the landfills who volunteer, they are refusing to accept CCA wood. And that is automatically limiting the number of options for people who dispose it to one or two landfills and that will gradually raise the cost. So it might be, if you are looking at the alternatives, a few dollars more cost now for an alternative, we shouldn't put it away and say it is really not a good solution because it is costing so much. Lets look at the overall cost and the true cost of this and I think there is need to do some research on this area to do the real economics of different disposal methods, not just how much it costs us today. Thank you.

*Comment*: I would like to make a comment. Dr. Tim had made earlier about dilution being the solution to the pollution. 28 years ago when I began my career as an environmental engineer I was told that was absolutely not the truth at all. Looking back over the last 28 years I realize that much of the pollution today results from the concentration naturally occurring elements in the environment. So I think we need to take another look at the practical side of waste management. There is a lot of CCA treated wood out there that is going to come to our waste disposal facilities and I think we need to take a much better look at what percentage of this material is in the total waste stream. What practical affects do we get from dilution. Do we really have the environmental impact from our waste disposal facilities that at least hypothetically we are concerned about. There is a lot of research being done in Florida right now to address that. One of the important research activities on going right now is the leaching test at the University of Florida that we heard about yesterday. We need to know is this stuff really going to come out of

C & D landfills. Is it going to come out in MSW landfills to the point where we have moved the arsenic problem from one place to another but we have not solved it. The second thing is that the Florida DEP has a technical advisory group that is looking at existing C & D landfills to see what impacts these landfills have had on the environment with regard to arsenic and other metal releases. We may not have a real problem here that we need to solve that it is already being taken care of for us or there may be some modification to a C& D landfill that we can make with a particular metals filter or something like for a liner or mixing the CCA treated wood with other materials to bind that arsenic up in the landfill. I am more concerned now about source separating or separating at a processing facility of CCA treated wood. When I hear about risk and exposure to the very workers that will be now concentrating this material yet again. And can we mitigate that exposure. We can have guys in respirators and white suits out there handling this material. There is a lot of good research going on and I encourage you all to continue to support it and get that information to us. That is the science. The engineers are the applied scientists and right now I don't know which part of this science to apply so I applaud all the research that is being done and encourage you to continue.

*Comment*: I would like to come back to the releases and the needs that we have, that has already been stressed a few times, a need to predict the emissions from treated timber in service. We have a draft OECD guideline on the topic to measure that in the lab for the new preservatives. It has to be updated and it has to be refined. It also has to be linked to the real life situations and I support very strongly the idea that there is a lot of data out there in the field tests and probably we can make good used of the data. We also may have probably have to do such large scale experiments also to monitor the new preservatives in use in treated wood. Thank you.

*Helena Solo-Gabriele, Summary*: I would like to go ahead and provide some sort of summary statement. What I have heard towards the beginning is the identification of our targets. We need to determine what it is we are going to evaluate releases from; what type wood, CCA vs other formulations and what kind of environment these releases are going to be impacting. With respect to the other formulations there were a lot comments on the other formulations, in particular the need for the concept of going to non metallic formulations, resins where mentioned, purely organic formulations, polymers were mentioned. There was concern about the release of the organics and the lack of guidelines concerning the release of the organics and that these organics may be causing other problems. Another topic that was discussed was the need, what is our goal as far as going back to our target: are we trying to dilute the waste or concentrate it back. As far as releases are concerned there was interest in the mechanisms of releases. These include releases from the wood, from the soil, and also the impact of the releases on the water. As far as the soil: what are the losses from soil, what is the bioavailability of the metal releases into the soil. Once in the soil what are the impacts to the ecosystem. Once in the water, what are the dynamics of the metals in the water? Are they bound up or are they complexed in some fashion that makes them less bioavailable with lower toxicity to the environment. As far as the wood itself, there is a need to understand the mechanism of fixation not only for CCA, a lot of work has been done on CCA, but especially the new alternatives. We need to model the releases from the wood itself. This would help in assessing the long term impacts. Also in assessing the long term impacts we need new measurements systems by which we can evaluate the accelerated or rather we need accelerated measurement systems by which we can better assess the long term impacts. To assses the long term impacts we should use available information. There was a mention of the OECD method of block testing that may not be good enough. We should look at available large scale field test such as the results that we get from poles, test plots, and information that we can get from real life uses of treated wood products. We also need to evaluate the mechanism of the releases upon disposal and during their in service use.

There was a mention of during in service of the affects of the brighteners and pressure washing and also during disposal to evaluate releases from mulches. There was a discussion on C&D landfills and binding within C&D landfills. And also the issue was brought back as far as concentrating once we start disposing the material and trying to concentrate it back; is that a good idea? There needs to be an overall assessment of the products. These products need to be evaluated on a life cycle analysis. We need to look at it from the point of view that treated wood is a renewable resource. Should we recycle the wood or the metals in the wood. Also when the wood is first proposed we need to develop guidelines that include not only guidelines in the production but also guidelines in the disposal of the material. We also need to integrate information from other possible industries: arsenic, copper, is not only from pressure treated wood but maybe coming from other sources as well and we need to look at these other possible sources. The issue of funding also came up. The industry vs the tax payer, economical solutions were discussed. The need to evaluate or balance off the need for clean up vs that for proper disposal. In summary that is where I have gone. I will summarize it and put it in written form and send it out. At this point I would again like to thank our panelist and again I would like to thank everyone who participated in the conference

## SECTION III: POST CONFERENCE FEEDBACK

As part of the voting ballot, feedback was solicited from respondents. Specifically, respondents were asked to provide research suggestions or comments that were not included within the ballot. A summary of the post-conference feedback is provided below. The post-conference feedback was split into 4 sub-sections: the three topic areas utilized earlier plus a section on general comments.

### III.1 General Comments

- The results from the ballot will be a dependent upon those who attended. Many at the conference were engineers and therefore engineering issues will likely be prioritized. **Representation by biologists/ecologists/ecotoxicologists** was very low. The lack of ecologists at the meeting indicates that the needs for research in this area are the most pressing, because the amount of research is so small. (Weis)

- Research should focus on the **investigation of alternative material types** to replace chemically treated wood. A lot of time, effort and expense is devoted to identifying additional chemical coatings for wood, but not for seeking an alternative material for use in certain applications. (Thomason)

### III.2 Disposal, Reuse and Recycling of Treated Wood

- Research should focus on **alternative disposal strategies** including chemical, biological, electrochemical. Research should focus on determining the appropriate concentrations of **metals in the wood after extraction** in order for the wood to be used in other applications. (Helsen)

- There is a need for a **hands-on (non-academic) review** of whether some of the research is going in a practical and useful direction, e.g., a good review of research related to thermo-chemical processes and its potential for real world applications is required. Research should be put in the context of real world logistics. (Konasewich)

### III.3 Exposure/Risk Assessment

***Exposure***

- Research is needed to evaluate the **potential exposure of workers** at wood preservation sites since the exposure of these individuals is significantly greater than exposure that users may experience. A concern arises in that little is known about the toxicity and environmental impacts of A and the Q in **ACQ**. (Konasewich)

- Reasearch should focus on evaluating **exposure and risks to the environment and people during the disposal** of CCA-treated wood. Risks should also be evaluated when CCA-treated wood is **inadvertently burned**, by people who are unfamiliar with the composition of the wood, and during house fires. The risks to firemen should be evaluated when they work to extinguish fires on structures containing CCA-treated wood. (Godson)

*Managing Risks*

- Research is needed to development of **coatings** to minimize releases. (Konasewich)

- Efforts should focus on **educating and informing those who recommend the use** of wood preservatives and preservative treated wood (retailers, wood treaters, Architects, Engineers, Builders etc.). (Venkatasamy)

- Options that specifically address production issues including "**best management practices**" should be evaluated. (Robinson)

**III.4 Release of Preservatives to the Environment**

- **Less hazardous alternatives** should be evaluated. (Robinson)

- Not only the amount (or concentration) of metals released is important, but also the oxidation state of the released metals, since both mobility and toxicity highly depend on the oxidation state (As(III) versus As(V) and Cr(III) versus Cr(VI)). Therefore, **speciation studies** are also important. (Helsen)

- An extensive amount of laboratory research has already been conducted. The focus should be on **real world applications**. Evaluation of soil/water releases must be site-specific. There is a need to utilize real-world data in evaluating releases (e.g. from EPRI). Compilation and interpretation of such real world data might be of more value than continued studies on a micro-level. (Konasewich)

*Gaseous Releases*

- **Emissions from the combustion** of treated wood be evaluated further. Specifically there is concern about the "increased PCDD/F (polychlorinated dibenzo-p-dioxins and dibenzofurans formation) in the bottom ash from fires of CCA-treated wood " which was the title of the study conducted by Tame et al., 2003 (*Chemosphere* Volume 50, Issue 9 March 2003, Pages 1261-1263). (Godson)

- Research should focus on evaluating the **effects of large "brush fires"** on the outdoor environment containing large quantities of CCA treated timber (e.g. such as the bushfires which devastated Canberra Australia January 2003, *Waste Management & Environment* Vl14#10 November 2003, "Need an Environmental Solution?", pages 52- 53). (Godson)

## SECTION IV: VOTING BALLOT FOR RESEARCH PRIORITIES

Below is the voting ballot that was distributed to conference participants after the conference. This voting ballot was developed from the information presented in Sections I and II and from comments received from the Technical Advisory Committee (TAC) established for the FCES conference. Please note that the ballot was separated into three different topic areas, with separate rankings within each topic area.

******** beginning of voting ballot**********

# "Environmental Impacts of Preservative Treated Wood" Conference Research Priorities

**VOTING BALLOT**
**(Distributed via email April 14, 2004)**

**Name: _____**

**Affiliation: _____**

**Purpose:** The conference organizers intend to use this voting ballot to develop a ranking of the research priorities. This ranking will be provided to the National Science Foundation, the agency that funded the conference, and to other funding agencies. This ranking will be useful to such funding agencies as they prioritize their research funding programs. The ranking will be based upon a majority vote among those who **return this ballot by April 26, 2004**. Only ballots from those individuals who registered for the "Environmental Impacts of Preservative Treated Wood" conference will be included within the vote.

**Instructions:** Below are three tables of research priorities that were summarized from: a) the research suggestions submitted via email prior to the conference, and b) from the discussions held during the conference workshop held February 11, 2004. The first table corresponds to research topics associated with the disposal of treated wood products. Please rank these topics from 1 to 6 where 1 corresponds to the item that should receive the highest priority and 6 the lowest. Similarly please rank the research topics in the "exposure/risk assessment" table from 1 to 5 and the research topics in the "leaching of preservatives to the environment" table from 1 to 6. If you have additional research suggestions or comments that have not been included within these tables, please list these at the end of this ballot. These comments will be added to a POST conference list of research topics that were suggested by the conference participants. The results of this ranking, along with the PRE-CONFERENCE, WORKSHOP, and POST-CONFERENCE list of research agenda items will be included within the POST conference proceedings.

**Over-arching theme that will contribute to the success of a research project:** During the workshop clear statements were made concerning the need to include experts from different disciplines to address the areas of research needs. Some of these experts include statisticians, forestry professionals including experts in wood preservation, engineers, experts in medicine and public health, biologists/ecologists/ecotoxicologists, and experts from the mining and metallurgical industries. It is understood that a successful research project will require an interdisciplinary approach which draws upon experts from different fields.

# Disposal, Reuse, and Recycling of Treated Wood

*Please Rank from 1 to 6 with 1 receiving the highest priority*

| Rank | Research Item |
|---|---|
| | Research should focus on the **role of regulations** (national and European Commission) in influencing disposal markets. Acceptable remediation levels (e.g. acceptable soil concentrations) should be evaluated. Re-evaluate role of U.S. regulations (RCRA subtitle D) which encourage particular disposal methods. Research also needs to be included on the effects of public perception in accepting available disposal strategies. Research should also evaluate the impacts of making those that distribute the material responsible for its collection and management upon disposal (e.g. currently under evaluation in France). |
| | The **economics** of all available disposal options should be evaluated. An economic evaluation should include costs plus a term that accounts for environmental protection in terms of long-term future releases that may occur as a result of the disposal option evaluated. If the disposal alternative is to compete with landfill disposal which is currently allowed in the U.S., the costs should not exceed 150 U.S. dollars per ton. Costs can be higher in countries that do not allow landfill disposal. |
| | **Alternative disposal strategies** should be evaluated. These alternative strategies should include wood composites, recycling of wood fiber, liquefaction, chemical extraction, electrodialytic processes, bioremediation and cement kilns. In Canada, it has been estimated that cement kilns have the capacity to dispose of up to 20% of the CCA-treated wood produced. The conversion of Cr from Cr(III) to Cr(VI) within the alkaline environment within cement kilns should be evaluated further. A considerable amount of work has been conducted on bioremediation technologies at the laboratory and bench scale. Future work should focus on scale-up of these processes. Electrodialytic and chemical extraction processes are also very promising and should be evaluated further. |
| | Research is needed on **thermo-chemical processes** (pyrolysis, gasification, and incineration) that are capable of disposing CCA treated wood, mixtures of CCA-treated wood with other wood types, and mixtures of wood with other waste materials. Work in this area should include evaluation of optimum temperature, air, and possibly pressure conditions. The ability to recover energy from this process should be also included. Research should also focus on practical issues such as slagging, fowling, and corrosion within boilers. Research in this area should focus on the separation of the metals from the residue for possible reuse or ultimate disposal and on controlling air emissions. Additives, such as sulfur, should be evaluated to determine their possible role in controlling air emissions and minimizing leaching from the ash. Efforts should focus on cataloguing thermo-chemical conversion processes implemented throughout the world that process treated wood. Efforts should focus on drawing information from different disciplines (e.g. including the minerals and metals industries) when evaluating thermo-chemical processes and stabilization of the metals from treated wood. |
| | Research should focus on **controlling the quality of the incoming waste stream** used for fuel or incineration processes. Sorting processes may be useful for this purpose. The incoming waste stream should be characterized, including the amount of metals within various size fractions of waste. Efforts should focus on quantifying the amount of CCA to be disposed (e.g. Florida versus other States, amounts in various countries). Logistical issues associated with collecting, transporting, grinding, and disposing contaminated wood waste should be evaluated. The practicality of identifying and removing CCA from the waste stream should be evaluated. Quick methods of identifying CCA-treated are needed. |
| | Research is needed to evaluate the impacts of disposing **treated wood within landfills** including municipal solid waste landfills and construction and demolition landfills. Studies should focus on leaching rates and on possible additives (such as iron filings, iron hydroxide, or calcium oxides) which may minimize leaching. Once leached, the metals are found in the landfill leachate. The ultimate fate of the metals within these leachates need to be evaluated, which may include disposal at wastewater treatment plants and ultimately within the sludge at these plants . New strategies need to be implemented to manage these metals at wastewater treatment plants. Possible management schemes to be evaluated include reverse osmosis or recirculation of the landfill leachate to keep the metals within the landfill. Technologies for remediating arsenic should be evaluated from throughout the world (e.g India/Bangladesh). Methods are needed to sequester the metals that are leached. The possibility of intentionally constructing “leaky” landfills which promote the biodegradation of waste materials should be evaluated. The impacts of these “leaky” landfills on CCA leaching rates should be evaluated. |

# Exposure/Risk Assessment

*Please Rank from 1 to 5 with 1 receiving the highest priority*

| Rank | Research Item |
|---|---|
| | Evaluate **exposure and risks to workers at wood treatment plants**. Research should focus on standardizing medical tests used to evaluate exposures in workers. Exposure limits should be identified for those industry workers who will be exposed to the new chemicals. |
| | Evaluate **risks to the environment during in-service use** of the wood. Methodologies or assays should be developed to evaluate the environmental impacts of wood preservative chemicals among aquatic and terrestrial organisms. Toxicity assays should be developed for both aquatic and terrestrial organisms. Work should focus on identifying plant indicators of possible As, Cu, and Cr problems. Does the As, Cu, and Cr impact other components of the ecosystem? Work should also focus on the copper releases from CCA-treated wood and the copper based alternatives to CCA-treated wood within freshwater environments, since the copper in these wood preservatives is more toxic to aquatic organisms than the arsenic. |
| | Evaluate **exposure and risks to people during in-service use**. This includes consumers who use the wood as a building material and their exposures to sawdust through sanding and sawing the wood. Risks and exposures should be evaluated for children who play on CCA-treated structures. Specific data needs for children's exposure assessments include better estimates of hand-to-mouth behavior, speciation of chromium in CCA contaminated soil, saliva extraction efficiencies, transfer coefficients, survey data for time children play on CCA-treated structures, skin absorption rates, amount of dislodgeable metals and leachable metals from CCA, and bioavailability. Bioavailability studies should include a series of sequential extractions to determine the soluble and insoluble fractions of the metals in the residues on the treated wood surfaces. The dose-response data set evaluated by the National Research Council should be re-evaluated along with data available from more recent studies to determine cancer risks associated with arsenic exposures. An animal model for arsenic induced cancer is needed. Animal models are needed for bioavailability and skin absorption studies. A study is needed that directly measures past exposure to CCA-treated wood and then determines whether that exposure resulted in an increased risk for cancer. Research should also focus on secondary human exposures. These secondary exposures include uptake of metals by plants from CCA contaminated soils. Plant types evaluated should include rice, green leafy vegetables and herbs. Also "track-in" exposures should be evaluated from arsenic that may be tracked into households from CCA deck surfaces and nearby soils. |
| | Evaluate **exposure and risks to the environment and people during the disposal of CCA-treated wood**. Risks to people who work within the disposal sector should be evaluated. This includes workers at construction and demolition processing facilities. Exposures should be evaluated among mulch workers and homeowners who spread the mulch on their yards. Risks should also be evaluated when CCA-treated wood is inadvertently burned, by people who are unfamiliar with the composition of the wood, and during house fires. The risks to firemen should be evaluated when they work to extinguish fires on structures containing CCA-treated wood. |
| | Research and funds are needed to **develop and implement risk management strategies** that are based upon best management practices. Stronger efforts are needed in educating retail store staff and consumers concerning the proper handling and disposal of the wood. Methods are needed to remediate soil after CCA treated structures are removed. Research is needed on coatings as a means to minimize exposures and leaching during in-service use. Coating work should also focus on the effects of iron oxides within the coating formulation and the impacts of surface preparations prior to addition of the coatings. |

# Release of Preservatives to the Environment

*Please Rank from 1 to 6 with 1 receiving the highest priority*

| Rank | Research Item |
|---|---|
| | Research should focus on identifying **critical targets and goals** for wood preservative chemical releases and disposal. The allowable concentration or mass of the release from treated wood products needs to be defined. Research should be very specific concerning the particular type of preservative treated wood and research should clearly identify the system to be impacted (freshwater, soil, etc…). For disposal, research is needed to determine if the appropriate disposal technology should focus on concentrating the wood preservative metals and removing them from the environment or diluting the metal to below a threshold level. Research should be initiated to determine the appropriate threshold level for various disposal scenarios. Releases from preservative treated wood should be evaluated in the context of other industries. Is the arsenic, chromium, and copper released from CCA large or small in terms of releases from other products? |
| | Research is needed to identify **new more environmentally-friendly alternative chemicals** including purely organic chemical wood preservatives (e.g. resins, polymers, wood extractives, and others). These alternatives should be evaluated through a life-cycle analysis to estimate the true costs and environmental benefits associated with these non-metallic alternatives as opposed to the copper-based preservatives. Toxicological studies should be conducted for the new organic-based wood preservatives. The impacts of the primary chemical plus its breakdown products should be evaluated for the purely organic chemical wood preservatives of the future. |
| | The mechanisms of chemical **releases from preservative treated wood** should be evaluated further. Fixation of CCA versus that of the arsenic-free alternatives should be investigated. For the existing arsenic-free alternatives, research should focus on the copper and on the organic co-biocides and possible break-down products of the organic co-biocides. Guidelines are needed to assess impacts from the organic co-biocides. Standardized methods should be developed that minimize the releases from the arsenic-free alternatives. Coatings should be evaluated further as a means of minimizing leachability and dislodgeability. Chemical releases from the wood should be modeled in an effort to assess long term impacts. Research should include an evaluation of OECD criteria (Organization for Economic Co-operation and Development). Accelerated testing methodologies should be developed to evaluate releases over the long term. Existing structures and test plots, which have already been in the environment for long periods of time, should be evaluated to estimate leaching rates. Work is needed to evaluate the impacts of pressure washing and the addition of brighteners on the release of chemicals. Speciation of the metals should be examined given that metal toxicity is largely a function of species. Research should also focus on the release of chemicals from preservative treated wood after the wood has been disposed, including the releases during landfill disposal (C&D and MSW) and when incorporated inadvertently into mulch. Efforts should focus on quantifying the acceptable levels of releases of the new organic co-biocides associated with the alternatives to CCA. |
| | The **mechanisms of chemical releases from soils** impacted by preservative treated wood should be evaluated further. Research should focus on evaluating the fate and behavior of the chemicals in soil including, loss rates, bioavailability, and transformation of As, Cr, and Cu. Releases as a function of different soil properties should be evaluated. Research should focus on the movement of the chemicals through the vadose zone to determine whether or not these chemicals can impacts groundwater. The impacts of soil contamination on the flora and fauna of ecosystems should be evaluated further. Soil remediation technologies including phytoremediation should be also evaluated. |
| | The **dynamics of metals releases in water** should be evaluated, in particular with respect to the copper releases. What is the aquatic impact of copper releases? Are these impacts significant within waterways lined with docks? Under what conditions will the copper be complexed and bound to sediments thereby reducing the bioavailability of this metal? An emphasis of this research should be placed on evaluating freshwater impacts since this is where the impacts of the new copper based alternatives would be greatest. |
| | Research should focus on possible **gaseous releases**. Microbes are known to convert arsenic to volatile forms. Can such microbes transform the arsenic from the wood preservative to the gaseous form? Can arsenic be converted to arsine gas in landfill environments? Can gaseous arsenic be released from a landfill in volatile forms other than arsine gas? |

**********end of ballot**********

## SECTION V: RESULTS FROM THE VOTE

The ballot was sent to conference participants via email on April 14, 2004. The due date for return of the ballot was April 26, 2004. A total of 28 ballots were returned, which corresponds to a 19% response rate. The results from the vote are provided below. Please refer to the voting ballot (Section IV) for details concerning the specific verbage used to describe each research priority. Research priorities with lower numbers (closer to 1) are considered to represent a higher priority by those who voted.

Results of the ballot indicate that evaluating the behavior of treated wood within landfills is the highest research priority within the "disposal, reuse, and recycling" topic area. This research priority was closely followed by evaluating alternative disposal strategies. Within the "exposure and risk assessment" topic area evaluating the exposures to people during in-service use represented the highest priority, followed by evaluating risks to the the environment during in-service use. The highest priority within the "release of preservatives to the environment" topic area was identification of new more environmentally friendly alternative chemicals. This was closely followed by evaluating the releases from the wood.

| | Average score | |
|---|---|---|
| *Topic Area*: Disposal, Reuse and Recycling of Treated Wood | | |
| Treated wood within landfills | 2.54 | ↑ Higher Priority |
| Alternative disposal strategies | 2.79 | |
| Thermo chemical processes | 3.46 | |
| Controlling the quality of the incoming waste stream | 3.61 | |
| Economics | 3.75 | ↓ Lower Priority |
| Role of regulation | 3.93 | |
| *Topic Area*: Exposure & Risk Assessment | | |
| People during in service use | 1.82 | ↑ Higher Priority |
| Environment during in service use | 2.68 | |
| Environment and people during disposal | 3.21 | |
| Develop and implement risk management strategies | 3.29 | ↓ Lower Priority |
| Exposure and risks to workers at awood treatment plants | 3.61 | |
| *Topic Area*: Release of Preservatives to the Environment | | |
| New more environmentally friendly alternative chemicals | 2.46 | ↑ Higher Priority |
| Releases from preservative treated wood | 2.50 | |
| Mechanisms of chemical releases from soil | 3.11 | |
| Dynamics of metals releases in water | 3.61 | |
| Critical targets and goals | 3.68 | ↓ Lower Priority |
| Gaseous releases | 4.79 | |

Table 2: Results from the "Research Priorities" Vote held as part of the "Environmental Impacts of Preservative Treated Wood" Conference