APPENDIX A

Uncertainty and Variability of Selected Risk Assessment Model Parameters

In risk assessment, uncertainty refers to a lack of knowledge in the underlying science, while variability considers that some individuals in a population have more or less risk than others because of differences in exposure, dose-response relationship, or both (NRC, 2001). In the following discussion, the CPSC staff briefly explores the ranges of values that several risk model parameters may take, due to uncertainty and variability, and the resulting effects on the risk estimates. Wherever possible, the ranges of values were taken from data relevant to the variable. Thus, for the most part this analysis only considers what has been measured in the various laboratory and human field studies, and does not consider the full range of possible unmeasured values for each variable.

Concentration of Arsenic on the Hands (C)

Values for the concentration of arsenic on a child's hand from contact with CCA-treated wood would best be obtained from directly measuring the amounts of arsenic on children's hands after playing on CCA-treated wood. Since studies involving children have many drawbacks, it is often more practical to use adults in place of children. Indirect measures, such as using an instrument or cloth to measure wood residues may also be used if the data can be reliably extrapolated to human hands.

For the current CPSC risk assessment, CPSC technical staff collected data from adult volunteers, using a protocol for rubbing the wood surface by hand (Cobb and Davis, 2003; Levenson, 2003a; Thomas, 2003). The amount of arsenic that would be transferred to a child's hands was extrapolated from the data for the adult volunteers' hands. The CPSC staff believes that the results provide a reasonable estimate of arsenic residues that may be transferred from wood to hands during use or play, despite the controlled, experimental nature of hand contact with the wood in the study. The staff acknowledges that this sampling does not represent the expected wide variety of decks or playground structures or of climatic conditions in the U.S. From the results of the CPSC staff testing, estimates for arsenic handloads from contact with eight CCA-treated wood structures ranged from 1.0 to 21 µg, with a mean of 7.7 µg and a median of 4.8 µg; of the eight structures, the highest estimate had a 95 percent upper confidence limit of about 41 µg.

For the reasons discussed in the body of this memorandum, the investigation of dislodgeable residue transfers to the hands of human volunteers was conducted on decks. The investigation involved a convenience sampling of residential decks made with CCA-treated wood, chosen to represent a variety of use patterns, surface treatments, ages, and weathering. Following the deck work, the staff conducted a limited sampling of CCA-treated wood playground structures using the "surrogate" cloth wiping methodology rather than human volunteers (Cobb and Davis, 2003). The results of this sampling (mean, 7.6 µg; median, 3.5 µg; range, 0.3-34 µg) are similar to the deck results (Levenson, 2003b; Thomas, 2003).

Results from this and other studies show that the amount of dislodgeable arsenic residue varies by more than one order of magnitude (*i.e.*, more than a factor of 10) among boards, among wood structures, or among volunteers (Cobb and Davis, 2003). A report of several studies conducted by the California Department of Health Services using adult volunteers indicates much higher hand values—1,200 µg in one case, and up to about 300 µg for others, although the experimental methods were not clearly described (CDHS, 1987). Few other studies provide data that would be applicable to this issue (see Thomas, 2003 for a review).

Overall, there is likely to be a large amount of uncertainty and variability in this variable, due, for example, to natural variations in wood, weathering and use patterns, and differences in human behavior. Based on the existing studies, a possible distribution of values for this variable would be one that is skewed from a normal distribution, such as a lognormal distribution. The staff believes that a reasonable range, including the possibility of quite high values is 1-300 μg.

<u>Hand-to-Mouth Transfer (HT)</u>

The value for this variable was estimated from studies on the amount of soil children collect on the hands, and the amount of soil children ingest daily during normal activities.

Analysis of soil skin adherence (Kissel *et al.*, 1996; Holmes *et al.*, 1999; Finley *et al.*, 1994) suggest a range of about 0.1 to 2.4 mg/cm^2 as reasonable for soil handloads under a variety of conditions. Data on soil ingestion in one- to four-year-old children indicated an estimated mean soil ingestion for the median child of 45 mg/day (Stanek and Calabrese, 1995). This study showed that the mean soil ingestion for the 75^{th} percentile was 88 mg/day, and for the 25^{th} percentile, the mean soil ingestion was 10 mg/day. The data showed a very large amount of variability in daily soil ingestion, with a long tail skewed towards high values. Despite the possibility of very large soil ingestions on occasion, such as intentional eating of soil, the CPSC staff believes that incidental ingestion of soil during play would best be represented by the more narrow range of mean soil ingestions for the 25^{th} to 75^{th} percentile children, since the likely range of behaviors of children in this range would better correspond with incidental transfer of wood residues from the hand to the mouth.

There is a great deal of uncertainty and variability in both of these inputs, but by combining the extremes of a reasonable range of adherence values with the extremes of a reasonable range of ingestion values, we can calculate a range of handload transfers to the mouth. Assuming 129 cm^2 as a representative surface area of the palm side (including fingers) of children's hands, the lower bound of the resulting range (0.03 handloads per day) would represent children that ingest very little soil from their hands even while their hands are quite "dirty." The upper bound of the range (7 handloads per day) would be for children who transfer large amounts of soil from their relatively clean hands. This behavior combination is less likely because it requires frequent "reloading" of soil onto the hands, in addition to frequent removal of the soil through hand-to-mouth contact. Further, children with soil ingestion in the upper tail of the distribution likely engage in behaviors that result in soil ingestion other than through simple, incidental hand-to-mouth contact. Thus, the CPSC staff has less confidence in the estimate based on the high value of soil ingestion.

Using central tendency values, the CPSC staff estimated handload transfers to the mouth of about 0.43 handloads per day.

<u>Exposure frequency (EF)</u>

The value for this variable could range from zero to 365 days per year, although a more reasonable upper end of this range might be 350 days year, assuming that for about two weeks a year, a child spends time away from their school, community playground, or residential playground due to illness, or other reasons.

The current CPSC technical staff risk assessment is for children with regular contact with these structures, and does not cover children who have access to all kinds of play structures, with only occasional (or none at all) contact with CCA-treated wood play structures. Regular play has been determined by the CPSC technical staff to account for about 156 days per year, but some children may have much more frequent contact with playground equipment (*e.g.*, children in daycare in mild weather regions). Children in more extreme climates (*e.g.*, very cold, very hot, or very rainy) may have much more limited access to playground structures, although this assessment does not account for children that have no access to treated wood playground structures. A reasonable range of values for this variable may be bounded at the low end by 50 days per year for children with an average of one contact per week for 50 weeks per year, and at the upper end by 350 days per year for children with daily contact for 50 weeks per year.

Relative Bioavailability (B)

The relative bioavailability of arsenic from dislodgeable wood residue could range from zero to 100 percent. In this case, a relative bioavailability of 100 percent means that the bioavailability is assumed to be the same as in the epidemiological studies of arsenic exposure in drinking water. Data from several studies of dust, soil, mine waste, and sawdust indicate great variability in arsenic bioavailability from these media, with means generally about 20-50 percent, although several studies showed much greater or much lower values (reviewed in Hatlelid, 2003). However, no data address bioavailability of arsenic from dislodgeable residues. The CPSC technical staff uses 100 percent as a default value for bioavailability of a substance in the absence of relevant data. Although the relative bioavailability of arsenic from dislodgeable residue has not been determined, the lower bound estimate for relative bioavailability is assumed to be 20 percent, based on studies of other exposure media.

Effect on risk estimate

The goal of this analysis was to explore the effect of uncertainty and variability on the estimated risk of lung or bladder cancer associated with exposure to arsenic in CCA-treated wood playground structures.

In its risk assessment and in this analysis, wherever possible, the CPSC technical staff chose to incorporate data related to the risk scenario under study. For example, data from adult volunteers rubbing samples of CCA-treated wood were used to estimate what a child might be exposed to during play on a CCA-treated wood playground structure. Likewise, data on children's activities and behaviors were used to estimate hand-to-mouth transfers of chemical residues and children's exposures to playgrounds. However, little direct data exists to measure the arsenic exposures children might experience. Rather, the staff chose reasonable values for each variable, based on the available information. Because of limited experimental or observational data, the range of values available for this analysis may not cover the full range of possible values for real children for each variable. Nevertheless, the CPSC staff believes that the most likely values have been considered.

Table A-I illustrates the effect of varying the values of several inputs into the risk assessment model. If these variables are changed, one at a time, the resulting risk estimate could be up to about one order of magnitude lower than the lower end of the base risk range estimated by CPSC staff, or more than one order of magnitude higher than the current staff estimate. Overall, this analysis resulted in a range of risk estimates from about two in 10 million ($2x10^{-7}$) to approximately five per 1,000 (5,000 per million, or $5x10^{-3}$). This risk range may also be expressed as 0.2-5,000 per million.

Clearly, varying more than one input into the model at a time might also alter the outcome depending on the parameter and choice of value. However, because the deterministic model is based on simple multiplication and division, even if several inputs were changed, it would be possible to arrive at the same estimate of risk, because statistically, independent effects tend to cancel each other.

For example, if we assume that the concentration of arsenic residues that children would collect on their hands during play is actually 38 µg per handload (5 times the current estimate), and we assume that it is more reasonable to choose a relative bioavailability of 0.2 (1/5 the current value), the result would be the same as the current estimate (5 x 1/5 equals 1).

Table A-I. Effect of parameter uncertainty and variability for selected parameters on the cancer risk estimate

Parameter	Base Staff Estimate*	Reasonable Lower Bound	Reasonable Upper Bound	Factor Between Lower And Upper Bounds	Alternative Risk Estimate (R)*	
					Lower Bound	Upper bound
Concentration of arsenic on the hands (C)	7.6 µg/handload	1	300	300	$3x10^{-7}$	$5x10^{-3}$
Hand-to-mouth transfer (HT)	0.43	0.03	7	230	$2x10^{-7}$	$2x10^{-3}$
Exposure frequency (EF)	156 days/year	50	350	7	$7x10^{-7}$	$3x10^{-4}$
Bioavailability (B)	1	0.2	1	5	$4x10^{-7}$	$1x10^{-4}$

*The staff estimate for excess cancer risk (R) is $2x10^{-6}$ to $1x10^{-4}$.

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APPENDIX B

Summary of Other Risk Assessments Conducted for Arsenic Exposure from CCA-Treated Playground Structures

Introduction

CPSC staff originally conducted a risk assessment for arsenic exposure from CCA-treated playground structures for its 1990 project on playground equipment (Lee, 1990a). That assessment concluded that the risk for skin cancer to people who played primarily on CCA-treated playground structures in early childhood would be about three-four per million ($3\text{-}4 \times 10^{-6}$), based on analysis of a few samples of new CCA-treated wood obtained from playground equipment manufacturers. In its current work on the health risks associated with contact with CCA-treated wood, the CPSC technical staff estimated a lifetime risk of lung or bladder cancer of two to 100 per million ($2\text{-}100 \times 10^{-6}$) for people who played primarily on CCA-treated playground structures in early childhood.

Recently, several other groups have released risk assessments for children and other consumers who have contact with CCA-treated wood structures. These assessments have been produced by Gradient Corporation, under contract with two producers of CCA wood treatments (Gradient, 2001); the Environmental Working Group (EWG) and Healthy Building Network (HBN) (EWG/HBN, 2001); and the University of Florida Center for Environmental & Human Toxicology (Roberts and Ochoa, 2001).

In general, cancer risk is determined from an estimate of exposure and a factor that relates the level of exposure to a specific level of risk.

$$CancerRisk = LADD\left(\frac{\mu g}{kg \cdot day}\right) \times Q\left(\frac{\mu g}{kg \cdot day}\right)^{-1}$$

where,

LADD is the lifetime average daily dose, and
Q is the unit cancer risk.

Although risk assessment models are dependent on a number of inputs, the differences among risk assessments stem mainly from differences in only a few variables. Other variables take values that cannot vary substantially. In this case, variables that may have a large effect on the risk assessment results include handload concentration and hand-to-mouth transfer. Variables, such as the average body weight of children ages two through six years, do not have a great effect on the analysis. For each of the other risk assessments, the variables with largest impact are discussed below and are compared to the current CPSC assessment.

Lee (1990a)

The original CPSC staff assessment (Lee, 1990a) calculated exposure based on the approach that some arsenic residue on the surface of the wood would be transferred to the child's hands and then a portion of that "handload" would be transferred to the child's mouth during the day. The "handload" concentration was estimated from wipe studies of playground wood samples conducted by CPSC staff.

$$LADD\left(\frac{\mu g}{kg \cdot day}\right) = \frac{C\left(\frac{\mu g}{handload}\right) \times HT\left(\frac{Handload}{day}\right) \times EF\left(\frac{days}{year}\right) \times ED(years)}{BW(kg) \times LT(days)}$$

Concentration of Arsenic on the Hands (C)

The "handload" concentration (the amount of arsenic residue transferred from the wood surface to one hand) was estimated from wipe studies of wood samples conducted by CPSC staff (Jain, 1990). Most of the samples were new wood obtained from manufacturers of playground equipment. A comparison sample of CCA-treated wood was purchased from a local retail outlet. In most cases, the surface of the playground equipment wood had been sanded and stained by the manufacturer; the wood from the retail outlet was new, but the surface was not finished in any way.

The CPSC staff report (Lee, 1990a) presented separate risk estimates for subsets of the experimental data; *i.e.*, samples of CCA-treated wood obtained from playground equipment manufacturers that had arsenic residues below the limit of detection, other playground equipment samples that had detectable levels of arsenic, and the sample of CCA-treated wood purchased from a local retail outlet. In the present interpretation of that work, the CPSC staff chose to combine the data for all the wood samples and present a single estimate of exposure and risk.

The experiments for the 1990 study were conducted by dragging a nylon cloth attached to a 1.1-kg wood block across a 400-cm^2 area of the wood. The cloths were digested in nitric acid and analyzed for arsenic by inductively coupled plasma spectroscopy, and the results were presented as micrograms arsenic per 100 cm^2 of wood sampled.

Of the 40 samples of wood tested (five subsamples from each of seven playground manufacturers and one local retail outlet), only 17 had detectable levels of dislodgeable arsenic. The limit of detection was 6.3 μg arsenic per 100 cm^2. Assuming a value of one-half the detection limit for each measurement below the limit of detection, the average dislodgeable arsenic value was 17.7 μg/100 cm^2. The palm side (including fingers) of a child's hand was assumed to be 66 cm^2, and transfer of arsenic from the wood was assumed to be proportional to hand size and dislodgeable arsenic. Therefore, the average handload concentration would be 11.7 μg (66 cm^2 x 17.7 μg/100 cm^2).

The CPSC staff believes the methodology for determining dislodgeable arsenic residues was reasonable at the time, although no attempt was made to relate the results to what would be obtained if children or adults touched the wood with their hands. In addition, the wiping results were normalized to 100 cm^2 of wood and then extrapolated to a child's hand size based on an assumed one-to-one transfer from the wood to the hands. A concern with this approach is whether a relationship would be expected to exist between the amount of residue that is removed from a given surface area of wood and the size of the hand or object conducting the removal. In addition, it is unclear whether any data support this type of wood-to-hand extrapolation.

These study weaknesses created limits on the ability of the CPSC staff to estimate exposure to people who might contact the wood. A better method would be to measure the amount of arsenic on the hands of people who touch or rub the wood, or to estimate the relationship between the transfer of arsenic residue to the hands and to cloths used in the experiment.

The current CPSC staff assessment is based on studies conducted by the CPSC chemistry laboratory staff of several residential decks and play structures (Cobb and Davis, 2003;

Levenson, 2003a; Levenson, 2003b; Thomas, 2003). The experiments using decks were conducted with adult volunteers, using a protocol for rubbing the wood surface by hand. The playground sampling used the "surrogate" wiping methodology and extrapolation to equivalent handloads, based on the results of the deck work. The CPSC staff believes that the results provide a reasonable estimate of arsenic residues that may be transferred from wood to hands during use or play, despite the controlled, experimental nature of hand rubbing or cloth wiping of the wood in the study. Based on the current exposure assessment, the estimated arsenic handload (both hands) for children is 7.6 μg.

<u>Hand-to-Mouth Transfer (HT)</u>

Exposure to dislodgeable arsenic was based on the approach that arsenic residue on the surface of the wood would be transferred to the child's hands during play and then a proportion of that "handload" would be transferred to the child's mouth during the day.

The analysis in 1990 was based on a study that measured lead on the hands of 11-year-old children engaged in normal daily activities (Roels *et al.,* 1980). Assuming that the lead originated in the soil, and given the soil lead concentrations, the amounts of soil adhering to the children's hands were calculated. It was assumed that the soil adhered to the palm side of the hands, and that the surface area of the palm side of the hand of an 11-year-old child is about 108 cm^2 (approximately 1/3 of the total surface area of one hand). Therefore, on average, about 1.47 mg/cm^2 of soil adhered to the hands for males, and about 0.82 mg/cm^2 of soil adhered to the hands for females.

If the soil adheres to the palm surface of the hands, and a 2-year-old boy has a palm surface area of about 48 cm^2, then the soil handload for a 2-year-old boy is 71 mg (1.47 mg/cm^2 x 48 cm^2).

From a study of 1- to 4-year-old children by Calabrese *et al.* (1989), the 2-year-old has an estimated median soil ingestion of 30 mg/day. Therefore, a 2-year-old boy ingests the equivalent of 0.42 "handloads" (30/71). Adjusting for children ages 2-6 years results in an estimated daily hand-to-mouth transfer rate of 0.374.

The current CPSC staff assessment uses the same approach as the original assessment (Lee, 1990b), but takes advantage of updated data on soil ingestion by children from Stanek and Calabrese (1995). Further, the current CPSC staff assessment uses several studies of soil skin adherence in combination with the study by Roels *et al.* (1980), and does not separate the analysis by sex. In the current study, the CPSC staff also chose to consider that residues collect on both hands and that hand-to-mouth transfers occur from both hands.

In the original assessment, the data for soil hand-loading for boys and girls from Roels *et al.* (1980) were considered separately, because it appeared that the boys had much greater amounts of soil on their hands than the girls in the study. However, it is unknown if the sex difference observed in the 11-year-old children in this study is generalizable to other children's age groups or activities. Other studies of soil adherence do not allow comparisons by sex, so the generalizability of this observation cannot be determined. Further, the soil ingestion data used in conjunction with this soil adherence data does not distinguish the children by sex.

If the data for boys and girls were considered separately, the result of these calculations would suggest that girls have much greater hand-to-mouth activity than boys. That is, from soil ingestion studies, boys and girls ingest soil at the same rate, but, from the hand-loading data, the girls' hands had much lower soil residues than the boys' hands (in the age range included in the

Roels *et al.* study, boys' and girls' hands are approximately the same size; Snyder *et al.*, 1977). If girls ingest as much as boys, it would follow that they transfer a larger portion of the residue from their hands to their mouths. However, there are few data to support that conclusion. Further, the girls in the Roels *et al.* study had lower blood lead levels, which is consistent with lower lead exposures through lower soil exposures (*i.e.*, lower soil hand-loading), and does not support that the girls had greater hand-to-mouth activity than the boys.

The value for hand-to-mouth transfer used in the current assessment, 0.43 handloads/day, is slightly higher than the value calculated in the original analysis (0.37 handloads/day), but because the current assessment considers transfers from both hands, the current transfer rate is more than double the previous estimate[1].

<u>Exposure Frequency (EF)</u>

Exposure frequency, measured in days per year, represents the frequency of children's contact with CCA-treated playground equipment. This variable was assumed to be 104 days per year (6 months, 4 days per week).

The current analysis by Midgett (2003) indicates that 156 days per year is a reasonable estimate of the number of days children in the 2- to 6-year-old age group play on playgrounds, based on analysis of several studies of children's outdoor behavior patterns.

<u>Unit Cancer Risk</u>

The original CPSC staff assessment used 0.00048 $(\mu g/kg/day)^{-1}$ as the unit risk (Lee, 1990c). The unit risk was derived from the skin cancer and arsenic in drinking water data in southwest Taiwan from Tseng and coworkers (Tseng *et al.*, 1968; Tseng, 1977).

The range of unit risks in the current assessment was estimated from the quantitative analyses performed by the National Research Council Subcommittee on Arsenic in Drinking Water (NRC, 2001) and the EPA Office of Water (2001) of the risks for lung and bladder cancer associated with arsenic in drinking water, using more recent studies from southwest Taiwan (Chen et al., 1985; Chen et al., 1992; Wu et al., 1989), extrapolated to the U.S. population. These data were not available at the time the original report was prepared. The lower unit risk estimate, from EPA (2001), at 0.00041 $(\mu g/kg/day)^{-1}$, is approximately the same as the unit risk derived in the original staff assessment, but the upper end of the range, 0.023 $(\mu g/kg/day)^{-1}$, is 48 times higher than the previous estimate. Therefore, the difference in the unit risk is responsible for much of the difference between the upper end of the current risk range and the original estimate.

Although there are weaknesses in the data that form the basis of these unit risk estimates, the CPSC technical staff believes bladder and lung cancer are more appropriate endpoints because of the much higher case fatality rates for these cancers compared to skin cancer, and because the more recent data on the internal cancers represent an improvement, both in terms of the choice of endpoint and in the quality of the data, over the skin cancer data used previously.

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[1] As discussed above, the original CPSC staff assessment (Lee, 1990b) calculated the hand-to-mouth transfer rate using estimates of daily soil ingestion and adherence of soil to a single hand. More likely, when children transfer soil from their hands to their mouths during the day, they do so from both hands. Therefore, the hand-to-mouth transfer rate determined in the previous CPSC staff report (Lee, 1990b) could be presented as 0.19 handloads of both hands, instead of 0.37 handloads of one hand. Compare 0.19 handloads/day to the 0.43 handloads/day estimated in the current CPSC assessment.

Lee (1990a) Model Inputs			
Parameter	Definition	Value	Units
C	concentration of arsenic on the hands	11.7	µg/handload
HT	handload transfers to the mouth	0.374	handloads/day
EF	exposure frequency	104	days/year
ED	exposure duration	5	years
BW	body weight	17.9	kg
LT	lifetime	25550	days
Q	unit cancer risk	0.00048	$(\mu g/kg/day)^{-1}$
Results			
LADD	lifetime average daily dose	0.005	µg/kg/day
Cancer risk	lifetime cancer risk	2 per million ($2x10^{-6}$)	

Conclusion

The original CPSC staff report presented separate risk estimates for subsets of the experimental data, ranging from less than one per million ($1x10^{-6}$) for some samples of CCA-treated wood obtained from playground equipment manufacturers, to three-four per million ($3\text{-}4x10^{-6}$) for other playground equipment samples, to nine per million ($9x10^{-6}$) for a sample of CCA-treated wood purchased from a local retail outlet. In the current re-analysis of the original CPSC staff report, the CPSC staff combined the data for all the wood samples and calculated a single estimate of risk. Thus, based on the model inputs given above, people who regularly played on CCA-treated wood playground structures in early childhood would have a lifetime risk of skin cancer of two per million ($2x10^{-6}$).

Although the current CPSC staff assessment includes updated wood sampling results, as well as updated inputs for several parameters in the risk assessment model, the difference in the unit risk is responsible for most of the difference between the previous CPSC staff assessment and the current analysis. Since the upper end of the range of unit risks in the current assessment is higher than the previous factor, the corresponding upper end of the updated risk range estimated for children who regularly play on CCA-treated wood playground structures is higher. Applying the unit risks from EPA (2001) and NRC (2001) to the original risk assessment model (Lee, 1990a) would yield a range of cancer risks of two per million ($2x10^{-6}$) to one per 10,000 ($1x10^{-4}$, or 100 per million), which, at the upper end of the range, is about 50 times greater than the risk estimated in the original analysis ($2x10^{-6}$). This updated estimate is similar to the risk range estimated in the current CPSC staff assessment.

Environmental Working Group/Healthy Building Network (2001)

The Environmental Working Group (EWG) and Healthy Building Network (HBN) released a report containing data from their study of CCA-treated wood residues.

The wood sampling was conducted by several EWG/HBN staff members in several locations in the U.S. immediately after purchasing new CCA-treated wood from retail outlets. The wiping was conducted by hand with polyester cloths moistened with distilled water on a measured 100-cm^2 section of wood. The sampling consisted of a series of three wipes, with the cloth folded on itself during wipes. The pressure applied was said to vary. The wipes were sent to a laboratory, where they were digested in nitric acid and hydrogen peroxide. Arsenic analysis was conducted using furnace atomic absorption. An average of 247 µg, with a range of 18 to 1020 µg was reported for the 100-cm^2 wipes, which was equated to the size of a handprint of a 4-year-old child.

The risk analysis procedure was not fully described. EWG/HBN reported that the dose to a child would be based on the length of playtime on the wood, how often children put their fingers in their mouths, and other factors, but they did not specify what variables or values they used in their analysis. They appear to have used the NRC (2001) quantitative risk assessment of lung or bladder cancer risk. They reported a lifetime risk of developing lung or bladder cancer of one per 500 for children who regularly play on swing sets and decks made from CCA-treated wood. This risk can also be expressed as two per 1,000 (2×10^{-3}) or 2,000 per million.

Based on experiments conducted by the CPSC chemistry laboratory staff, adult volunteers who rubbed their hands on CCA-treated wood with firm pressure (equivalent to about 1.1 kg) removed proportionally less residue from the wood compared to the sampling conducted with polyester cloth-covered 1.1 kg disks (Cobb and Davis, 2003). This suggests that a wiping procedure using polyester cloths will probably overestimate the amount of residue that would be transferred from the wood surface to children's hands during play.

Although EWG/HBN did not clearly describe their assumptions and model inputs, based on the CPSC staff discussion above, the range of possible values is rather narrow for most of the inputs, and differences in calculated risks are driven largely by a few key parameters. Therefore, if the exposure assessment by EWG/HBN is an overestimate of the amount of residue that can be transferred to hands, the EWG/HBN risk estimate would likely be greater than the CPSC staff estimate. In addition, EWG/HBN included in their assessment play on decks as well as swing sets. This would result in greater estimates of risk than for playground structures alone.

Gradient Corporation (2001)

The Gradient Corporation (Gradient) assessment calculated exposure using an approach essentially similar to the CPSC staff approach, which is based on arsenic residue on the surface of the wood that would be transferred to the child's hands and the proportion of that handload that would be transferred to the child's mouth during the day. Although Gradient also estimated exposure and risk for residential exposure and other exposure media, pathways, and ages, they presented risk estimates for incidental ingestion of arsenic from contact with CCA-treated wood at playgrounds separately. These estimates are discussed here.

$$LADD\left(\frac{\mu g}{kg\cdot day}\right)=\frac{C\left(\frac{\mu g}{cm^2}\right)\times SA\left(\frac{cm^2}{handload}\right)\times HT\left(\frac{Handload}{day-equiv.}\right)\times EF\left(\frac{day-equiv.}{year}\right)\times ED(years)\times B}{BW(kg)\times LT(days)}$$

Concentration of Arsenic on the Hands (C)

The handload concentration was estimated from wipe studies of wood samples conducted for a CCA chemical supplier (SCS, 1998). Five adult volunteers rubbed sections of nine samples of CCA-treated lumber. After rubbing, the hands were rinsed with water, and the rinsates were collected and analyzed for arsenic, chromium, and copper. The amount of arsenic transferred to the hands was reported as micrograms arsenic per square centimeter of the hand ($\mu g/cm^2$).

Extrapolated to the palm surface of both hands of children aged 2-6 years (132 cm^2), the estimated handload (both hands) of arsenic is 0.66-17 μg.

The methodology for the hand rubbing was not clearly described. For example, specific details, such as the area of wood rubbed or the pressure the volunteers applied as they rubbed, were not provided. A key deficiency in the methodology may be in the rinse procedure to collect dislodgeable residues from the hand after rubbing. Based on data generated by the CPSC staff (discussed in Thomas, 2003), simply rinsing the volunteers' hands with water is likely to be inadequate to collect all of the arsenic residue. Therefore, the amount of arsenic residue that may be transferred from the wood to the hand is likely underestimated in this assessment. Nonetheless, the range of arsenic handloads estimated by Gradient is comparable to the current CPSC staff estimates.

Hand-to-Mouth Transfer (HT)

The current CPSC staff and Gradient assessments used the same approach to calculate hand-to-mouth transfer. The difference between the values used by Gradient and CPSC staff is due to use of different datasets for soil skin adherence.

Relative Bioavailability

Gradient used a relative bioavailability term based on studies of reduced bioavailability of arsenic from soil or wood. It would be appropriate to adjust for relative bioavailability if data show that the bioavailability from ingestion of wood residue is different from the bioavailability from drinking water (the basis of the risk determination). However, there are limited data on relative bioavailability for CCA-treated wood sawdust or for soil impacted by CCA. Further, the CPSC staff does not know of any study that addressed the bioavailability of arsenic from the residue that may be transferred onto hands from wood. The staff does not believe that the available data are sufficient to show that the bioavailability of arsenic from CCA-treated wood residue is different from the bioavailability of arsenic from drinking water. Therefore, the staff assumed that the bioavailability of arsenic from the treated wood is the same as that from water in this case; *i.e.*, the relative bioavailability is one (100 percent). Nonetheless, this assessment, based on a relative bioavailability of less than one, results in lower exposure, and therefore, lower risk than if the assessment were to use a bioavailability of one.

Exposure Frequency

This assessment also uses a "day-equivalent" approach to estimating exposure frequency. This approach is based on the premise that play structure activities and related exposures account for only a fraction of a child's daily activities (*i.e.*, the median time spent on school grounds or a playground is 1 hour/day or 7 hours/week, and, assuming 12 hours of daylight/day, 7 hours/week is 0.6 day-equivalents/week or 31 day-equivalents/year). The CPSC staff approach used 156 days, and did not portion out the fraction of the day spent on the playground. The CPSC staff believes that the approach used by Gradient would be appropriate if children transfer residues picked up onto hands to their mouths only during the time they spend on the playground. However, the CPSC staff believes that once residues have been transferred to the children's hands, a portion of that residue could be transferred to their mouths throughout the day, such as during mealtimes or quiet play indoors. The approach used by Gradient results in lower risk estimates versus the CPSC staff assessment.

Unit Cancer Risk

The unit risk for this assessment was 0.0015 per µg/kg/day, calculated by EPA for the Integrated Risk Information System (IRIS) (EPA, 1998). This estimate is based on analysis of skin cancer data from a southwest Taiwan population exposed through drinking water. Gradient used this value to estimate the lifetime skin cancer risk for this scenario as four per 100 million (or 0.04 per million) to one per million ($4x10^{-8}$-$1x10^{-6}$).

The CPSC staff believes that the case and exposure data for internal cancers (bladder and lung) from southwest Taiwan represent an improvement, both in terms of the choice of endpoint and in the quality of the data, over the skin cancer data from the same population. The unit risk derived from the NRC (2001) analysis and the upper bound of the range derived by EPA (2001) analyses are higher than the IRIS value, so that risks calculated using the IRIS value are lower than if the NRC value or EPA range values are applied.

Gradient (2001) Model Inputs			
Parameter	Definition	Value	Units
C	concentration of arsenic on the hands	0.005 (low) 0.13 (high)	$\mu g/cm^2$
SA	surface area of palm side of hands	132	cm^2/handload
HT	handload transfers to the mouth	0.25	handloads/day-equivalent
EF	exposure frequency	31	day-equivalents/year
ED	exposure duration	5	years
B	relative bioavailability	0.47	unitless
BW	body weight	17.8	kg
LT	lifetime	25600	days
Q	unit risk	0.0015	$(\mu g/kg/day)^{-1}$
Results			
LADD	lifetime average daily dose	0.000026 (low) 0.00069 (high)	µg/kg/day
Cancer risk	lifetime cancer risk	4 per 100 million ($4x10^{-8}$) (low) 1 per million ($1x10^{-6}$) (high)	

Conclusions

The lower estimated risk that results from the Gradient analysis compared to the current CPSC staff analysis is due to differences in the exposure assessment, in which Gradient assumed a lower exposure frequency and relative bioavailability, and to the use of a unit risk that is lower than the values used by the CPSC staff.

If the higher unit risks used by the current CPSC staff assessment for bladder or lung are used here instead of the IRIS value for skin cancer, this assessment results in a lifetime risk for bladder or lung of up to two per 100,000 ($2x10^{-5}$, or 20 per million). While the resulting range represents risk estimates that are still lower than the CPSC staff estimates, at the upper end of the range, the risks exceed the one in a million level.

Roberts and Ochoa (2001)

This assessment critiqued several existing assessments and made recommendations for several inputs. Cancer risks were calculated for various exposure levels, but some of the inputs of the assessment were not clearly specified. Therefore, the CPSC staff assumed values that are consistent with their results.

$$LADD\left(\frac{\mu g}{kg \cdot day}\right) = \frac{C\left(\frac{\mu g}{cm^2}\right) \times SA\left(\frac{cm^2}{handload}\right) \times HT\left(\frac{Handload}{day}\right) \times EF\left(\frac{days}{year}\right) \times ED(years) \times B}{BW(kg) \times LT(days)}$$

Concentration of Arsenic on the Hands (C)

These authors did not choose a single exposure value that they thought would be representative of children's contact with CCA-treated playground wood. Rather, they chose a range of values from several sources of data (CDHS, 1987; Jain, 1990; SCS, 1998). They extrapolated from either hand-rubbing or other wipe data to the get the equivalent amount of arsenic per area of palm side surface of the hands. To extrapolate from the studies' adult volunteers, they assumed a hand size of 500 cm^2 for the palm side of both hands. To apply that to children, they assumed a hand size of 228 cm^2 for the palm side of both hands.

The CPSC staff believes that the estimates for hand sizes for both adults and children are too high. But, the CPSC staff believes that since the extrapolation from wood wiping experiments involves estimating arsenic handloads first for adults, and then for children, if the ratio between them (adult/child) is considered, the extrapolation by these authors is similar to the CPSC staff's assessment.

The handload values used to calculate cancer risk ranged from 2.28 μg/handload to more than 1,400 μg/handload. The CPSC staff acknowledges that the data from CDHS (1987) included one very high result from an adult volunteer rubbing CCA-treated wood, but cautions against relying on that high value since the methodology used in the experiment was not clearly described and the data reported by CPSC staff and others indicate considerably lower values.

Hand-to-Mouth Transfer (HT)

These authors followed the approach for estimating hand-to-mouth transfer used by the CPSC staff for the original assessment (Lee, 1990b), although they disagreed with some of the assumptions and calculations. They chose to focus on the data on girls, because, as discussed in above in this document, the apparent sex difference in the soil hand-loading data from Roels *et al.* (1980) lead to the conclusion that girls have greater hand-to-mouth transfers than boys. The value they estimated somewhat less than the current CPSC staff assessment, but it did not take advantage of the re-analysis of the soil ingestion data by Stanek and Calabrese (1995).

The CPSC staff does not believe that a sex difference in hand-to-mouth activity has been clearly established by the available data, but the CPSC staff does believe that the re-analysis of soil ingestion data is an improvement over the original analysis and should be used instead. The effect of using the re-analysis would be to increase by about 50 percent the estimate for hand-to-mouth transfer, to a value similar to the CPSC staff estimate.

Relative Bioavailability

Although bioavailability was not explicitly discussed, the authors apparently used a value of one (100 percent).

Exposure Frequency

These authors decided to use 365 days per year for the exposure frequency. Although they acknowledged that this would represent the extreme and is not a central tendency estimate, they believe that in a state with favorable year-round weather, such as Florida, daily play on CCA-treated wood structures is possible.

The CPSC staff agrees that daily exposure is an upper estimate of children's actual activities. Illness, among other factors, would probably serve to decrease the number of days per year that children would have access to the playground.

Unit Cancer Risk

Roberts and Ochoa used the unit risk value for skin cancer from IRIS (EPA, 1998), which is generally lower than the values calculated from NRC (2001) and EPA (2001) for bladder or lung cancer. As discussed above, the CPSC technical staff believes the NRC (2001) and EPA (2001) quantitative assessments are reasonable and appropriate.

Roberts and Ochoa (2001) Model Inputs			
Parameter	Definition	Value	Units
C	concentration of arsenic on the hands	0.01 (low) 6.32 (high)	μg/cm^2
SA	surface area of palm side of hands	228	cm^2/handload
HT	handload transfers to the mouth	0.31	handloads/day
EF	exposure frequency	365	day/year
ED	exposure duration	5	years
B	relative bioavailability	1*	unitless
BW	body weight	18	kg
LT	lifetime	25600*	days
Q	unit cancer risk	0.0015	(μg/kg/day)$^{-1}$
Results			
LADD	lifetime average daily dose	0.0028 (low) 1.8 (high)	μg/kg/day
Cancer risk	lifetime cancer risk	4 per million (4x10^{-6}) (low) 3 per 1,000 (3x10^{-3}) (high)	

*Not specified, but fits the reported results.

Conclusions

Roberts and Ochoa relied on some inputs into the risk assessment model (*e.g.*, exposure frequency, handload concentration, and hand-to-mouth transfer) that would result in greater estimates of risk than the CPSC staff assessment. On the other hand, they used a unit risk that is at the lower end of the range used by the CPSC staff. The lower end of the range of cancer risk estimates is comparable to the low end of the CPSC staff risk estimate, but the upper range of the estimated cancer risk is more than 10 times higher than the CPSC estimate, largely due to the upper value used for the handload concentration.

Summary and Conclusions

These models estimate lifetime cancer risks for people who have contact with CCA-treated wood playground structures. The estimates range from three per 1,000 ($3x10^{-3}$) for skin cancer in the Roberts and Ochoa scenario to four per 100 million ($4x10^{-8}$) for skin cancer in the Gradient model. The original CPSC staff estimate was about two per million ($2x10^{-6}$) for skin cancer (Lee, 1990a). The current CPSC staff estimate is two per million to one per 10,000 ($2\text{-}100x10^{-6}$) for bladder or lung cancer.

One of the most significant differences among these assessments is in the estimates for the amount of arsenic that may be transferred from the wood surface to the hands. The current CPSC staff experiments are an improvement over other reported sampling efforts and may provide the most reliable estimates for transfer of residues from CCA-treated wood surfaces to hands; *e.g.*, the staff recognized that steps are required to ensure that all of the residues on the hands are collected and analyzed, and that even in a limited study, a wide variety of structures should be sampled.

Another major factor for the differences is the choice of unit risk used to relate the estimated exposure to cancer risk. The CPSC staff chose to use a range of unit risks for bladder or lung cancer, derived by the technical staff from the analysis of the National Research Council and the EPA Office of Water.

These risk assessments differ somewhat in the values chosen for other parameters (*e.g.*, years of exposure, bodyweight, lifetime), but because the possible range of values for each of these inputs is relatively small, these differences probably account for only a small portion of the differences among the estimated cancer risk results.

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TAB J

United States
Consumer Product Safety Commission
Washington, DC 20207

Memorandum

Date: February 3, 2003

TO : Patricia Bittner
Project Manager
CCA-Treated Wood in Playground Equipment

THROUGH: Warren Prunella, AED, Directorate for Economic Analysis

FROM : Robert Franklin
Economist
Directorate for Economic Analysis

SUBJECT : Petition HP 01-3: CCA-Treated Wood in Playground Equipment

Attached is an updated economic report on CCA-treated wood and its use in playground equipment. The material in the report is for use in consideration of Petition HP 01-3.

ECONOMIC INFORMATION CONCERNING THE USE OF CCA-TREATED WOOD IN PLAYGROUND EQUIPMENT

Robert Franklin
Directorate for Economic Analysis
3 February 2003

Economic Information Concerning the use of CCA-Treated Wood in Playground Equipment

Table of Contents

ECONOMIC INFORMATION CONCERNING THE USE OF CCA-TREATED WOOD IN PLAYGROUND EQUIPMENT

Background

The U.S. Consumer Product Safety Commission ("CPSC" or "Commission") received a petition (HP 01-3) requesting that the Commission ban the use of chromated copper arsenate (CCA) treated wood in playground equipment. CCA is a pesticide or preservative used to prevent insect and fungal damage to wood. It contains arsenic – a known human carcinogen. The petitioners asserted that a ban was necessary because they believe that children playing on playground equipment made with CCA-treated wood could ingest enough arsenic (e.g., by touching the wood with their hands and then putting their hands in their mouths) to result in serious adverse health effects, including cancer. The Commission docketed the petition under the provisions of the Federal Hazardous Substances Act (FHSA), 15 U.S.C. 1261-1278.

Pesticides, such as CCA, must, in most instances, be registered with the U.S. Environmental Protection Agency (EPA) before they can be used in the United States. The registration includes, among other things, the uses for which the pesticide is approved. On 12 February 2002, the EPA announced that the manufacturers of CCA had requested that registrations of CCA be either cancelled or amended to terminate certain uses of CCA, effective 31 December 2003. The EPA stated that it intended to grant these requests. These cancellations and terminations of certain registered uses will end the use of CCA-treated wood in most residential applications, including playground equipment, picnic tables, and decks. CCA may not be used to treat wood for these uses on and after 31 December 2003.[1] Wood treated prior to that date can still be used.

Although CCA will not be used to treat wood to be used in playground equipment after 2003, the CPSC staff is continuing to investigate the potential hazards that CCA-treated wood in playground equipment may pose to children and whether or not the Commission should grant the petition. This memorandum provides some market and other information about CCA-treated wood and its use in playground equipment.

The Use of CCA in Preserving Wood

If not treated with a preservative, most wood used in outdoor applications will be damaged by insects and fungi. Depending upon its use and the local environmental conditions, untreated wood will generally sustain damage within 3 to 5 years. This damage shortens the useful life of wood structures (e.g., playground equipment or decks). The damaged wood can pose physical safety hazards.

In almost all cases involving exterior residential applications, including playground equipment and decks, wood is preserved through a process called "pressure treating." Pressure-

[1] At the time of this writing, EPA has not yet taken its final action on granting the requests to cancel or amend the CCA registrations. This memorandum, however, assumes that EPA will grant the requests and the use of CCA to treat wood for most residential uses will cease.

treated wood is produced by placing the wood inside a cylinder and applying a vacuum. The vacuum removes air from the wood to make it easier for the preservative to infiltrate the cellular structure of the wood. Then the preservative is introduced into the cylinder and forced into the wood under high pressure. The wood is then removed from the cylinder and tested for penetration and retention of the preservative. According to industry sources, pressure-treated wood lasts 10 to 20 times longer than untreated wood in the same application.[2]

CCA, which was introduced in the 1930's, has been the chemical most commonly used in pressure treating wood. As recently as 2001, CCA was used in about 98 percent of the pressure-treated wood produced for residential use.[3] Until very recently the terms "CCA-treated wood" and "pressure-treated wood" almost could be used interchangeably. However, other chemicals also can be used. These other chemicals include other arsenicals (or "arsenic containing chemicals"), such as ammoniacal copper zinc arsenate, and several preservatives that do not contain arsenic, such as ammonium copper quaternary[4] (ACQ), copper boron azole (CBA), didecyldimethylammonium chloride, and copper citrate.

The American Wood Preservers Association (AWPA)[5] sets standards for pressure treating wood with CCA. The standards are set in terms of pounds per cubic foot (pcf) of the preservative retained in the wood at a specific depth. The retention standards are listed in Table 1.

Table 1: CCA Retention Standards by Application

Application	Standard Retention (pcf)
Above ground use (e.g., deck boards and beams)	0.25
Ground or fresh water contact (e.g., posts)	0.40
Salt water splash (e.g., decking for docks and marinas)	0.60
Wood foundations and heavy structural use (e.g., PWFs and utility poles)	0.60
Foundation piles (used in highrise foundation construction)	0.80
Salt water immersion (e.g., docks and marinas)	2.50

Although the AWPA standards call for retention levels of 0.25 pcf for wood used above ground, which would include most uses in decks and playground equipment (other than for posts that may be anchored in the ground), industry sources confirmed that very few retailers carry wood treated to the 0.25 retention level.[6] Because the price differential between wood treated to the 0.25 pcf retention level and the 0.40 pcf level is very small, most retailers find that the expense of maintaining inventories of lumber at both retention levels outweighs the advantages. Moreover, carrying only one retention level decreases the confusion on the part of the consumer

[2] American Wood Preservers Institute (AWPI) website, http://www.preservedwood.com/faqs/faqs44.html.
[3] Presentation by Scott Ramminger, President of American Wood Preservers Institute (AWPI), at CPSC on 6 August 2001.
[4] Sometimes called alkaline copper quaternary.
[5] The AWPA is a standards setting organization independent of the AWPI.
[6] Based on statements made at the public meeting between CPSC staff and the AWPI and Arsenicals Task Force of the American Chemistry Council (ACC) on 6 August 2001.

as to what retention level to buy, since wood treated to the 0.40 retention level can be used for both above ground and ground contact use.

Residential Uses of Pressure Treated Wood and CCA

About 7 billion board feet of pressure-treated wood are produced annually in the United States.[7] Table 2 summarizes the use of CCA pressure-treated wood by application. The largest application is for outdoor decks. Over 60 percent of new homes are built with decks and a significant number of households add decks to existing homes each year.[8] Other residential uses include such things as landscaping (including playground equipment), house framing, permanent wood foundations (an alternative to concrete or block foundations), and fencing. Just about one percent (or about 50 million board feet) of all CCA-treated wood is used for playground equipment.[9] CCA will still be approved for some of these uses, such as marine applications, pilings, and utility poles, on and after 31 December 2003.

Table 2: Estimated Use of CCA-Treated Lumber by Application

Application	Percent of Pressure-Treated Wood
Outdoor Decks	32
Marine Applications	16
Landscape (includes playground equipment)	12
Highway Materials	9
Fencing	8
House Framing	6
Utility Poles	5
Permanent Wood Foundations	1
Pilings	1
Other (e.g., bed liners for utility trailers, cooling towers, and shoring for excavations)	8
Export	2
Total	100

***Source:** Data provided by the ACC and AWPI in a public comment to CPSC (11 September 2001).*

Substitutes and Prices for CCA-Treated Wood

In those applications for which the use of CCA is being phased out, most wood treaters are expected to substitute a preservative that does not contain arsenic, such as ACQ or CBA. Each of the three leading manufacturers of CCA also manufacture one or more non-arsenical

[7] A Board-foot is a unit of measure one foot long, one foot wide, and one inch thick or its equivalent.
[8] Shook, Steven R. and Ivan L. Eastin, "A Characterization of the U.S. Residential Deck Material Market," Forest Products Journal, vol. 51, no. 4 (April 2001), p. 28-36.
[9] U.S. Environmental Protection Agency, transcript of *Scientific Advisory Panel (SAP) Open Meeting, October 23,2001, Volume I*, p. 39.

preservatives. The non-arsenical preservatives are expected to cost wood treaters 3 to 5 times more than CCA.[10] This increased cost is expected to increase the price of pressure-treated wood by 10 to 20 percent.[11] The retail prices of products manufactured from pressure-treated wood (e.g., playground equipment) will also increase due to this increased cost. However, because pressure-treated wood is only part of the cost of the final products, the percentage increase in the final products will be less than the percentage increase in the cost of the pressure-treated wood.

Some types of wood, notably redwood and cedar, are naturally resistant to termites and fungi and do not need to be treated with preservatives. However, redwood and cedar cost significantly more than pressure-treated southern yellow pine (SYP), the most common wood that is pressure-treated. Because this price differential will be narrowed as the use of CCA is eliminated, there may some increase in the use of redwood and cedar. However, because the price of wood preserved with non-arsenical preservatives is still expected to be lower than the price of redwood or cedar, any shift to redwood or cedar due to the phase out of CCA will probably be small.

Other substitutes for CCA-treated lumber include various types of plastic or composite lumber, which is a relatively new class of products. Plastic and composite lumber is often manufactured out of recycled plastic and wood scrap. Some attributes of plastic and composite lumber differ from those of lumber. For example, plastic and composite lumbers may have different colors and may weather or age differently than wood. Although these products are generally suitable for uses such as decking and railing, some are not suitable for use as primary load-bearing members, such as posts, beams, and joists.

Because of the variety of plastic and composite wood products available, and because it is a still evolving technology, it is difficult to obtain information on comparative prices between plastic or composite lumber and pressure-treated lumber. However, available information suggests that using some forms of composite lumber may increase the initial cost of a deck by 10 to 30 percent over the cost of using CCA-treated lumber.[12] Thus, since the phase-out of CCA is expected to reduce the price differential between plastic or composite wood products and pressure-treated lumber (due to the use of the more costly non-arsenical preservatives), the use of plastic or composite lumber is likely to increase in some applications. The competitiveness of plastic or composite lumber with pressure-treated wood may be enhanced if the cost to maintain structures made of plastic and composite lumber proves to be lower than the cost to maintain structures made of pressure-treated wood, as some manufacturers suggest.

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[10] Based on comments made by industry representatives at a public meeting at CPSC on 6 August 2001.

[11] Estimate contained in a "frequently asked questions" supplement to the statement issued by AWPI announcing the transition to preservatives that do not contain arsenic. The estimate is consistent with observed price differences in a report prepared for the Florida Center for Solid and Hazardous Waste Management (Helena Solo-Gabriele, Timothy Townsend, et al., *Alternative Chemicals and Improved Disposal-End Management Practices for CCA-treated Wood (Final Draft)*, State University System of Florida, Florida Center for Solid and Hazardous Waste Management, Gainesville, Florida (July 2000)).

[12] Based on an assertion made by a manufacturer in an article in a business magazine ["One Word: Plastics," Business Week, 30 August 1999, p. 235] and literature from manufacturers of plastic and composite lumber. However, the cost of plastic or composite lumber that can be used as primary load-bearing members may be substantially higher.

Use of CCA-Treated Wood in Playground Equipment

Wood has been used in playground equipment for at least 50 years. However, its use in playground equipment became more common in the 1970's and 1980's.[13] At least until recently, CCA-treated wood, usually pine or fir, has been the type of wood most often used in playground equipment. The use of redwood and cedar have generally been limited to the more expensive or high-end equipment since it is more expensive than CCA-treated wood.[14] Some playground equipment manufacturers use CCA-treated lumber for load-bearing or structural components, such as posts, beams, and joists, but use other materials, such as redwood, cedar, plastic, or composite lumber, for other components, such as decking, hand rails, and roofs.

Even before EPA announced its intention to grant the requests to terminate the use of CCA in residential applications, several playground equipment manufacturers had already switched to using wood treated with non-arsenical preservatives or had begun offering these as alternatives to CCA-treated wood. This was in response to an increase in consumer demand for alternatives to CCA-treated wood due to the negative news media coverage about CCA. Any manufacturers that are still using CCA-treated wood are expected to begin using alternatives to CCA-treated wood over the next couple of years as wood treaters convert from using CCA to the non-arsenical alternatives.

Types of Playground Equipment and Manufacturers

Playground equipment can be separated into two broad market segments: equipment intended for use by individual households in their home or yard and equipment intended for public, commercial, or institutional use, including day care centers, apartment complexes, and parks.[15] Public and home playground equipment are covered by different ASTM International (ASTM) standards. The ASTM standard for public playground equipment is F1487-01e1; the ASTM standard for home equipment is F1148-00.

There is a tendency for playground equipment manufacturers to specialize; some manufacture primarily for the home market and others specialize in public or institutional equipment. Even within these segments there may be further specialization. For example, some manufacturers specialize in the upper end residential equipment, often of a premium wood, such as redwood or cedar. These products may cost several thousand dollars. Other manufacturers specialize in less expensive equipment, usually using CCA-treated wood. Retail prices for the least expensive wood home playground equipment start at around $200. Public or institutional playground equipment manufacturers also may specialize along similar lines. Some specialize in providing equipment for larger playgrounds, such as may be found in some public parks and larger schools or community associations. Other companies may specialize in equipment for

[13] Based on a private communication from a representative of a playset manufacturer.

[14] For example, according to one playground equipment manufacturer, using even a low quality cedar may increase the price of the equipment by 25 percent relative to equipment constructed out of CCA-treated wood; a high quality cedar may double the price.

[15] Home playground equipment is classified under product code 3399205101 in the North American Industrial Classification System (NAICS); institutional and commercial equipment is classified under NAICS product code 3399205106.

smaller establishments, such as some day care centers or smaller apartment complexes. There are a few companies that specialize in designing and supervising the construction of playgrounds that are built with members of the community providing much of the labor.

Some manufacturers of the high-end equipment may assemble the equipment for the consumer on site. However, most home equipment is sold in ready-to-assemble kits that contain everything needed to build the playset. This includes the accessories, such as swings and slides, the hardware, fasteners, and the lumber. The lumber is usually pre-cut, drilled, and sanded. Many manufacturers also apply a coating to the lumber, such as water repellant, stain, or enamel paint. There are a few manufacturers that sell kits that contain the accessories and hardware required for the playset, but that do not contain the required lumber. These kits contain detailed instructions for purchasing the lumber. Kits that do not supply the wood are generally sold at retailers where the consumers can conveniently purchase the required wood at the same time they purchase the kit, such as retail building supply centers, lumber yards, and hardware stores that also sell lumber.[16] Finally, there are some firms that sell only the designs and instructions for building playground equipment, but not hardware or wood.

According to the 1997 Economic Census, there were 27 manufacturers of home playground equipment with shipments of $100,000 or more and 38 manufacturers of public, commercial or institutional equipment with shipments of $100,000 or more. This number includes manufacturers of metal and plastic equipment as well as wooden equipment. With some exceptions, most manufacturers of wooden equipment would be considered to be small businesses according to the size standards established by the Small Business Administration (13 CFR § 121.601). With the exception of some imports from Canada, most wood playground equipment sold in the United States is manufactured domestically.

Distribution

Home playground equipment is sold through a variety of retail channels, including toy stores, department stores, and retail building supply and lumber stores. Home playground equipment is also sold by some specialty stores such as those that sell pools, spas, patios, and hearth products or outdoor structures such as storage buildings and gazebos. Some landscape companies and designers sell home playground equipment and there are some retail outlets that specialize in home playground equipment.

Sales and Number in Use

The value of shipments, adjusted for inflation, of both home and public playground equipment is shown in Table 3. Although the number of children between the ages of 2 and 12 (approximately the ages during which children are most likely to use the equipment[17]) in 1997 was only slightly higher than the number in 1972, real spending for both public and private

[16] Based on statements in the 10-K forms, filed with the U.S. Securities and Exchanged Commission, for Hedstrom Holdings, Inc. (for the fiscal year ended 31 December 1998) and Playcore Inc. (for the fiscal year ended 31 December 1999).

[17] CPSC Memorandum, from Jonathan D. Midgett, Engineering Psychologist, Directorate for Engineering Sciences, Division of Human Factors, to Patricia Bittner, "Children's Contact with Playground Structures," (January 2003).

playground equipment has increased by more than a factor of 4. Nationwide, spending on all playground equipment, commercial and home equipment, has increased in total from about $3.90 to more than $16.84 per child ages 2 through 12. The increase in per capita spending for playground equipment can be explained by an increase in the quality of playground equipment as well as by an increase in the number of playgrounds or amount of equipment being purchased per child. In the case of home playground equipment, this could reflect an increase in the proportion of wooden sets to metal, since wooden sets are generally more expensive than metal sets. However, this generalization does not necessarily hold true for public, institutional, or commercial playground equipment. One industry source indicated that some of the increase in the value of shipments for public, institutional, and commercial playgrounds since the late 1980s was due to the establishment of standards for playground safety by the CPSC. Many local governments and other establishments upgraded their playgrounds to meet these standards.[18]

Table 3: Value of Shipments of Playground Equipment (1972-1997)

	Home Equipment			Public, Commercial, and Institutional Equipment				
Year	Nominal Dollars (millions)	1997 Dollars (millions)	Real Spending per Child Aged 2 - 12	Nominal Dollars (millions)	1997 Dollars (millions)	Real Spending per Child Aged 2 - 12	Children Ages 2 - 12	GDP Chain-Type Price Index
1997	344.8	344.8	8.06	375.6	375.6	8.78	42.8	1.000000
1992	226.7	251.6	6.15	158.1	175.5	4.29	40.9	0.900932
1987	123.2	161.9	4.26	68.3	89.8	2.36	38.0	0.760961
1982	85.3	131.2	3.55	58.7	90.3	2.44	37.0	0.649926
1977	56.8	128.6	3.34	35.2	79.7	2.07	38.5	0.441589
1972	25.6	82.0	1.96	25.4	81.4	1.94	41.9	0.312016

Source: U.S. Department of Commerce, Economics and Statistics Administration, Economic Census – Sporting and Athletic Goods Manufacturing (1972, 1977, 1982, 1987, 1992, 1997).[19]

Approximately 1 million home playsets were sold annually in the 1990's. Based on information obtained during a 1999 conformance monitoring study, the staff estimates that 30 to 40 percent of the home playground equipment market at that time was wood.[20] This estimate includes wood equipment made out of CCA-treated wood as well as cedar and redwood equipment. As stated earlier, the proportion of annual sales of home playsets made out of wood may have increased, based on the fact that the value of shipments of home equipment per child aged 2 through 12 has increased substantially since 1972. However, we do not have comprehensive historical shipment data to verify that this is the case.

The expected useful life of home wooden playground equipment is probably limited more by the ages of the children in a household than by the failure of the equipment. Although properly maintained playground equipment constructed with CCA-treated wood may last for 20

[18] Conversation with Bill Duffy of the International Play Equipment Manufacturers Association (12 December 2001).

[19] Population estimates from the U.S. Department of Commerce, Bureau of the Census. Estimates of the population by single year age were available from 1980 on. For 1972 and 1977 the data in the table above were estimated by taking one-third of the number of children between ages 0 and 2 and eight-ninths of the children between the ages of 5 and 13.

[20] CPSC Memorandum, from Mary F. Donaldson, Directorate for Economic Analysis, to Scott Heh, Project Manager, Backyard Playsets, "Backyard Playset Petition, HP 93-01" (23 August 2001).

or more years, children are likely to play on the equipment only between the ages of about 2 to 12. Households whose children have outgrown the playground equipment may not maintain the equipment and may even dismantle it. Consequently, a plausible estimate of the useful life of a piece of wooden home playground equipment probably ranges from about 10 years (approximately the number of years one child is likely to use it) to perhaps 15 years (to account for households with multiple children several years apart in age).[21]

The useful life of commercial wood playground equipment is likely to be longer than that of home equipment. Although children in individual households are expected to outgrow playground equipment, the population of children in the community that would be expected to play on the equipment is more stable. Therefore, public parks, schools, day care centers, apartment complexes, and other institutions that have commercial equipment have a greater incentive to maintain the equipment. One designer of wooden public playground equipment asserts that the equipment may last for 20 years or more, if properly maintained.[22]

The number of residential playsets in use that contain CCA-treated wood will be significantly reduced within 20 to 30 years of the phase-out of CCA. Based on projections from the CPSC's product population model, if the expected useful life of a playset is 10 years, less than 10 percent of those currently in use will still be in use 20 years from now; less than 2 percent will still be in use in 30 years. Even if the average useful life of a playset is 15 years, less than 25 percent of the playsets now in use will still be in use 20 years from now and less than 5 percent will still be in use 30 years from now.

Public or institutional playground equipment can be found in public and private parks, at schools, places of worship, day care centers, apartment complexes, and community associations. Many of these were constructed out of CCA-treated wood. However, the staff have not found any data on which reliable estimates of the number of public, commercial, or institutional playgrounds that contain CCA-treated wood could be based. Data provided by a representative of a trade association showed that in the last few years, wood playground equipment accounted for only around 5 percent of the sales, as measured in dollars, of the manufacturers reporting.[23] However, we do not know the market share of the manufacturers that reported, nor do we know their historical sales. Thus, although the number of places or institutions that may have public or institutional playground equipment may number in the hundreds of thousands the data are not available to reliably estimate the number of locations that actually have playground equipment, and of those, how many were constructed of CCA-treated wood.

As discussed above, the useful life of public or institutional playground equipment is probably longer than for home or backyard equipment. This is because while a household may stop maintaining or even disassemble the equipment once its children have outgrown it, public or institutional equipment may be maintained for a longer period of time. Therefore, the proportion

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[21] In the memorandum cited earlier by Mary Donaldson, the expected life of home playsets was estimated to be 5 to 7 years. However, that estimate concerned both wood and metal backyard playsets. However, because wood playsets are substantially more expensive than metal home playsets, the expected useful life of wood playsets is probably longer than that of metal home playsets.

[22] Statement contained on the manufacturer's internet site (http://www.leathersassociates.com/frame1.htm).

[23] Conversation with Bill Duffy of the International Play Equipment Manufacturers Association (12 December 2001).

of public or institutional playground equipment that contains CCA-treated wood in use today that is still in use 30 years or more years from now may be greater than the proportion of home or backyard equipment still in use. For example, if the average useful life of public playground equipment is closer to 30 years, 15 percent of the equipment may still be in use after 45 years.

Availability of CCA-Treated Wood On and After 31 December 2003

The agreement between EPA and the CCA registrants would prohibit the treatment of wood with CCA for the specified residential uses effective 31 December 2003, if finalized as proposed by EPA. Wood treated with CCA prior to that date can be sold for residential uses, including playground equipment. Therefore, CCA-treated lumber and playground equipment made with CCA-treated lumber will probably still be available for retail sale on and after 31 December 2003. However, most CCA-treated wood is expected to be sold and no longer available within 6 months of the effective date of the cancellation of the CCA registrations, or around the end of June, 2004.[24]

[24] Personal Communication from J. Housenger, Acting Associate Director, Microbials Division, Office of Pesticide Programs, U.S. Environmental Protection Agency.

TAB K

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

January 22, 2003

TO: Mary Ann Danello, Ph.D., Associate Executive Director, Directorate for Health Sciences

THROUGH: Lori E. Saltzman, M.S., Director, Division of Health Sciences LS

FROM: Patricia M. Bittner, M.S., Toxicologist, Division of Health Sciences PMB
Jacqueline Ferrante, Ph.D., Pharmacologist, Division of Health Sciences JF

SUBJECT: Response to Public Comments on Petition HP-01-3 to Ban the Use of Chromated Copper Arsenate (CCA) Treated Wood in Playgrounds

This memorandum provides the U. S. Consumer Product Safety Commission (CPSC) staff responses to public comments made to the Commission regarding petition HP-01-3. This petition requests a ban on the use of CCA-treated wood in playground equipment. The Commission docketed the petition in June 2001 and published a Federal Register notice on July 13, 2001 requesting public comments by September 11, 2001 (66 FR 36756). There were a total of 28 comments from various sources including the wood industry, environmental groups, trade associations, consumers, and state and local governments. A complete listing of commenters is in Appendix A.

I. CCA Wood--Overall Risk

Issue: Recommendations to grant or deny the petition based on toxicity and/or health risks.

The Commission received a number of comments from the public, state government agencies, and various public interest and environmental groups recommending that the Commission grant the petition to ban the use of CCA-treated wood in playground equipment because arsenic is carcinogenic and presents other health risks. The health risks to children were of particular concern.

Other commenters (e.g., consumers, the State of Wisconsin Department of Agriculture, Trade, and Consumer Products, the environmental organization "Beyond Pesticides", and the Seminole Tribe of Florida, Water Resource Management) went further and supported an immediate ban on the sale, manufacture, and/or use of CCA wood for playground structures. Other suggestions included initiating a review of the other uses of CCA-treated wood and removal of all CCA-treated wood playground equipment currently in use. Additionally, a consumer asked if the CPSC plans to perform an occupational study to determine whether workers or construction industry personnel are at increased risk.

Conversely, trade associations representing chemical manufacturers, wood preservative manufacturers, wood treaters, and a playground manufacturer recommended that the Commission deny the petition because there is no evidence that arsenic is more toxic than previously recognized and risk assessments have shown that there is no unreasonable risk to children from using this equipment.

Representatives from several industry groups recommended that the Commission refrain from banning CCA-treated wood playground equipment because it does not pose an unreasonable risk of harm to children or other consumers. The American Chemistry Council Biocide Panel's Arsenical Wood Preservatives Task Force (ACC) and the American Wood Preservers Institute (AWPI) argued that there is no need for further regulatory action because they have risk assessment data showing that CCA-treated wood does not pose an unreasonable risk.

The playground design firm, Leathers and Associates, recommended that no decision should be made on the ban of CCA without proof of a health risk and noted that scientific research has not demonstrated that children are harmed from playing on CCA-treated wood playgrounds. Moreover, the playground manufacturer, Playlofts, commented that CCA-treated wood is as risk-free as possible and suggested that the controversy over CCA was a result of overzealous news reporters and not the scientific community.

Response: Commission staff examined the possible health hazards or long-term human health risks from the use of CCA-treated wood in playground equipment.

The staff reviewed and evaluated information from the following sources:

1. Public meetings with the petitioners, chemical manufacturers, and wood preservers.
2. Available peer reviewed scientific literature.
3. Preliminary risk assessments performed by the EPA and several consulting firms for the chemical manufacturers.
4. Data submitted by the chemical and wood treatment industries, academics, public interest and environmental groups, and consumers.
5. Documents prepared by the National Academy of Sciences on Arsenic in Drinking Water.
6. Meeting minutes of the EPA Science Advisory Panel on CCA Wood.

Additionally, the staff performed an exposure and risk assessment to estimate the likely cancer risk to children from playing on equipment made with CCA-treated wood (Hatlelid, 2003b). This involved a review of toxicity data of the chemical constituents of CCA (Hatlelid, 2003a; Osterhout, 2003; Ferrante, 2003) and laboratory and field studies on both new and aged CCA-treated wood from decks and playsets to estimate the amount of CCA that a child might pick up on his or her hands by touching the wood (Cobb, 2003; Cobb and Davis, 2003; Levenson, 2003 a, b, c; Thomas, 2003). CPSC staff also evaluated the reasonably forseeable use of the product, the developmental characteristics of children that could result in exposures, the frequency and duration of exposure, accessibility, and extent of exposure (area contacted) (Midgett, 2003a, 2003b).

Although several commenters supported a ban simply based upon CCA toxicity data, it is important to emphasize that a toxic chemical will not present a hazard to consumers if there is no exposure to the chemical. Therefore, the staff assessed the potential exposure to CCA chemicals and used these data to estimate risk.

The staff determined that there were insufficient data available on the exposure to arsenic from CCA-treated wood on which to base a recommendation to the Commission on the potential risk to children. Previous studies that measured the amount of arsenic on the surface of the wood have not been adequate to assess risk because of small sample sizes and incomplete protocols. Staff attempted to address the inadequacies of existing data by designing and performing its own studies.

Commission staff will not initiate a study of worker exposure to CCA-treated wood because federal jurisdiction for occupational hazards and research is outside the authority of CPSC and resides with other federal agencies (e.g., the National Institute for Occupational Safety and Health and the Occupational Safety and Health Administration).

<u>Issue</u>: CCA-treated wood should not be considered hazardous under the FHSA.

The American Forest and Paper Association (AFPA) stated that there is no justification for the classification of CCA-treated playground equipment as a hazardous substance under the FHSA, as the Commission would have to conclude that the product causes, "...substantial personal injury or substantial illness during or as a proximate result of reasonably forseeable handling or use, including reasonably forseeable ingestion by children."

<u>Response</u>: The CPSC administers the FHSA, the relevant statute for this issue, and its implementing regulations (16 CFR part 1500). The FHSA defines a "hazardous substance" as a substance that satisfies both parts of a two-part definition. To meet the statutory definition of a "hazardous substance," a product must first present one or more of the hazards enumerated in the statute, that is, it must be toxic, corrosive, flammable, an irritant, or a strong sensitizer, or generate pressure through decomposition, heat, or other means. Second, the product must have the potential to cause substantial personal injury or substantial illness during or as a result of any reasonably forseeable handling or use, including reasonably forseeable ingestion by children. That is, whether a given substance presents a hazard depends not only on its toxicity, but also on the potential exposure to it.

The CPSC staff estimates an increased lifetime risk of lung or bladder cancer of 1.8×10^{-6} to 1.0×10^{-4}, that is approximately two per one million to 100 per one million for a person who plays on CCA-treated wood playground structures during early childhood (Hatlelid, 2003b). The estimated average risk exceeds one per million (1×10^{-6}), which is the risk level that is generally considered by federal agencies as relevant for regulatory considerations (CPSC, 1992). The CPSC staff believes that this risk assessment model results in a reasonable estimate of exposure for children who have regular, repeated contact with CCA-treated wood play structures, and who engage in behaviors typical of young children, such as frequent hand-to-mouth contact.

<u>II. Toxicity</u>

<u>Issue</u>: Arsenic and chromium can cause birth defects in animals and humans.

A consumer, Joseph Prager, expressed concern and cited studies that both arsenic and chromium can cause birth defects in humans. Therefore, he argues that the greatest risk may not be to children playing on the playgrounds, but to pre-pregnant, pregnant, or nursing women exposed to CCA-treated wood or sawdust.

<u>Response</u>: While data are limited in humans, the CPSC staff agrees that there is sufficient evidence in animals to indicate that arsenic is a probable developmental toxicant and chromium is a probable reproductive and developmental toxicant in humans (Hatlelid, 2003a; Ferrante, 2003). However, the issue of risk depends not only on toxicity, but on the level of exposure (See earlier response in Section I). Arsenic causes both cancer and noncancer health effects, but the CPSC staff considers arsenic carcinogenicity to be the most sensitive endpoint. To address this petition, the exposure assessment was based on CCA-treated wood in playground equipment. Other exposures to CCA-treated wood are outside the scope of this assessment.

<u>Issue</u>: Arsenic may/may not act as an endocrine disruptor.

A consumer, Joseph Prager, commented that new data are available about the potential for arsenic to act as an endocrine disruptor and submitted supporting data. The American Forest and Paper Association commented that endocrine disruption has been attributed to arsenic on the basis of a single *in vitro* study of the glucocorticoid receptor using hormone-responsive rat hepatoma cells. The ACC comments that there are no reliable data showing that CCA-treated wood is associated with endocrine disruption and argues that these studies should be assessed according to the Guidelines of the EPA Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC).

<u>Response</u>: Generally, the mechanism for endocrine disruption is poorly understood. CPSC staff believes that there are insufficient data at this time to show that arsenic is an endocrine disruptor. Arsenic causes both cancer and non-cancer health effects, but the CPSC staff considers arsenic carcinogenicity to be the most sensitive endpoint for human health effects.

<u>Issue</u>: Arsenic or chromium exposure cause adverse health effects in humans.

The environmental organization, Beyond Pesticides, cited supporting data showing that arsenic and chromium VI are known human carcinogens that also cause damage to the skin, nervous system, and internal organs.

<u>Response</u>: The CPSC staff acknowledges that arsenic and chromium VI can cause cancer and other health effects (Hatlelid, 2003a; Ferrante, 2003), but considers arsenic carcinogenicity to be the most sensitive endpoint and calculated the cancer risk associated only with the exposure to arsenic from CCA-treated wood used for playground equipment. Any potential health risks associated with the other compounds would be in addition to the risk calculated by CPSC staff.

<u>III. Exposure and Bioavailability</u>

<u>Issue</u>: Arsenic is readily absorbed after oral exposure.

Citing several studies, the environmental organization, Beyond Pesticides, noted that the oral route of exposure is a concern for children playing on CCA-treated wood because children frequently put their hands in their mouths and ingest soil. The State of Wisconsin Department of Agriculture, Trade, and Consumer Products comments that "children face a higher risk of exposure to CCA and inorganic arsenic because of inconsistent hygiene practices, hand-to-mouth habits, and the tendency to play in dirt." The State of Wisconsin also recognized the conclusions of the National Research

Council (1993) study on the susceptibility of children, with regard to diet, physiology, and behavior.

Response: The CPSC staff believes that the principal route of exposure to arsenic from CCA-treated wood playground equipment occurs through the transfer of residues on the wood surface to a child's hands and subsequently, through ingestion via hand-to-mouth transfer. Data exist to show that developmentally, young children mouth objects, including their hands.

Generally, soluble forms of inorganic arsenic are well absorbed orally (55 to 95%) while absorption of insoluble forms is lower (Hatlelid, 2003a). Some data show that dosing from soil results in variable bioavailability with values ranging from 0 to 98% absorption (Hatlelid, 2003a). Ultimately, absorption is due to many factors including the arsenic species, the matrix (e.g., soil), and dosing (Hatlelid, 2003a). (See discussion on relative bioavailability on p. 8).

Issue: Estimates of dislodgeable arsenic residues may be highly variable.

The Connecticut Department of Public Health and the Connecticut Agricultural Station estimated that there is approximately 20-200 ug of arsenic residue on the hands at any given point during a play activity. The ACC commented on the extensive inter- and intra-study variability in measurements of dislodgeable arsenic, which is primarily due to a lack of consistency in methodology, including the lack of a validated method of sample collection or dislodgeability measurement.

Response: CPSC staff acknowledges the considerable variation within and between data sets of dislodgeable arsenic. The CPSC staff performed preliminary studies designed to estimate the amount of arsenic that can be transferred to a child's hands during playground activity and to establish a standard protocol to quantify arsenic migration from CCA-treated wood (Thomas, 2003).

The staff: 1) evaluated various surrogate materials (e.g. polyester) to obviate the need for human subjects in future studies; 2) built a sampling device or template to minimize variability; and 3) determined the extraction efficiency of arsenic removal from hands exposed to CCA-treated wood (Thomas, 2003). There was considerable variability in the amount of arsenic removed by hands on new and aged wood.

Issue: Children's exposure to arsenic from CCA-treated wood.

The ACC commented that children's exposure to arsenic from CCA-treated wood is primarily oral or dermal. Inhalation exposure is not considered to be significant and children's exposures from CCA-treated wood is less than that from other environmental exposures and is unlikely to pose unreasonable risks. The ACC states that dislodgeable arsenic is not volatile and no mechanism exists for its release during normal playground use that would generate sufficient quantities of respirable wood particulates. The American Forest and Paper Association (AF&PA) also addressed exposure conditions.

Response: The risk assessment conducted by the CPSC staff is focused on arsenic exposure from CCA-treated wood through transfer of wood surface residues to a child's hands and subsequent hand-to-mouth transfer because hand-to-mouth transfer is considered to be the primary mechanism for exposure to playground equipment wood (CPSC 1990; Hatlelid 2003b). The amount of arsenic residue transferred from the wood surface to the hand or the "handload" concentration was estimated from wipe studies of playground wood and hand and wipe studies of deck wood that were conducted by CPSC staff (Cobb and Davis 2002; Levenson 2003a, b; Thomas, 2003). The CPSC staff estimates an increased lifetime risk of lung or bladder cancer of 1.8×10^{-6} to 1.0×10^{-4} or approximately two per one million to 100 per one million for a person who plays on CCA-treated wood playground structures during early childhood. The estimated average risk exceeds one per million (1×10^{-6}), which is the risk level that is generally considered by federal agencies as relevant for regulatory considerations (CPSC, 1992). The CPSC staff believes that this risk assessment model results in a reasonable estimate of exposure for children who have regular, repeated contact with CCA-treated wood play structures, and who engage in behaviors typical of young children, such as frequent hand-to-mouth contact.

The risk assessment does not address exposure through direct mouthing of the wood by very young children, direct dermal uptake, or exposure to arsenic-contaminated soil under playgrounds that can subsequently contaminate food, clothing, or other articles handled by the child or further contaminate their skin. Thus, the overall risk to children from playing on or near CCA-treated wood playground structures is likely to be higher than that estimated in this analysis because of potential arsenic exposures other than through dermal contact and subsequent hand-to-mouth transfer of arsenic-containing residues from CCA-treated wood playground equipment.

Also, there may be some arsenic-containing respirable particles in the dust from soil surrounding the structures where the children might play. Since this does not appear to be the most significant exposure pathway, the staff did not include inhalation exposure from soil particulates in the risk assessment.

Issue: Bioavailability must be considered before performing risk assessment.

The AF&PA commented that CPSC guidelines strongly emphasize the importance of bioavailability in exposure assessment noting that it is part of the analysis of whether a substance is "toxic" under the FHSA (57 FR 46648). Moreover, the AF&PA asserts that the physical or chemical form of the substance is relevant and cites an industry study showing that the predominant species of arsenic in CCA-treated wood is chromium arsenate (Gradient, 2001). AF&PG states that the implications for this compound and the valence state must be considered when assessing bioavailability and methylation because As^{+5} is less mobile and soluble than As^{+3}.

Response: Bioavailability is a term used to indicate the extent to which a substance is absorbed by the body. The bioavailable dose can be different from the dose available for exposure (such as the amount ingested, deposited on the skin, etc). In performing the risk assessment, the CPSC staff reviewed: 1) all available literature on the bioavailability of arsenic, chromium, and copper; 2) other risk assessments; 3) documents related to bioavailability; and 4) the report of the EPA's Scientific Advisory Panel (SAP, 2001).

The CPSC Chronic Hazard Guidelines indicate that in the absence of other data, bioavailability is assumed to be 100% (CPSC, 1992). Based on the available information, the CPSC staff concurred with the SAP and used a bioavailability of 100% because there are insufficient data on the bioavailability of arsenic from soils and data are lacking on the ingestion of arsenic-containing surface residue (Hatlelid, 2003b). There are no human studies measuring the bioavailability of arsenic in the surface residue from CCA-treated wood. There are a few studies measuring bioavailability in experimental animals dosed with CCA-treated wood sawdust or with soil contaminated with arsenic[2], but there are no studies on the bioavailability of CCA-treated wood residue. Since bioavailability data are not available on CCA-treated wood residue, the default assumption of one (100 %) is used.

Exposure estimates must also be adjusted for "relative bioavailability." Relative bioavailability is the bioavailability from the exposure of interest (in this case, from the surface residues of CCA-treated wood) in comparison to the bioavailability in the dose-response study, which in this case are the epidemiological studies of arsenic exposure from drinking water. The CPSC staff believes that the available data are not sufficient to assign a bioavailability of less than one (100 %) to the ingestion of arsenic-containing surface residue, relative to the bioavailability from water. Thus, the relative bioavailability of arsenic from CCA-treated wood residue is considered to be the same as the bioavailability of arsenic in the drinking water studies.

In the CPSC risk assessment, the staff also considered the oxidation state of arsenic (Hatlelid, 2003b). CCA contains arsenic pentoxide (oxidation state: As^{+5}), but the oxidation state of arsenic in wood treated with CCA is unknown. Consequently, the staff used the total amount of arsenic on the wood surface in the risk assessment because the toxicity of several inorganic forms of arsenic is similar (Hatlelid, 2003a).

Issue: The release of dislodgeable arsenic from play structures diminishes over time.

The ACC submitted supporting data showing that there is less dislodgeable arsenic on the surface of weathered wood than on fresh wood surfaces and there is less releasable arsenic within the wood over time. Therefore, they believe that exposure

[2] US EPA's Scientific Advisory Panel (SAP) on CCA-treated wood recommended that 100% bioavailability be used in risk assessment until appropriate research is conducted (SAP 2001).

assessments should take into account this decrease and should not consider dislodgeable levels to remain constant over the time period of the exposure scenario, or it will result in an overestimation of risk.

Response: CPSC exposure studies indicate that significant levels of dislodgeable arsenic may exist on aged wood (Thomas, 2003; Levenson, 2003a, b). The CPSC data show that dislodgeable arsenic residues were found on wood surfaces ranging in age from a few days to approximately 18 years.

Issue: Exposure to arsenic in the soil and groundcover near CCA-treated playgrounds.

The ACC commented that there are several factors that should be considered in assessing exposure from soil, one of which is the use of groundcovers under playgrounds. The use of groundcovers under playground structures reduces the amount of soil to which children are exposed during play, and this should be considered in the risk assessment.

Response: The CPSC staff risk assessment focused on hand-to-mouth transfer of wood surface residues (Hatlelid, 2003b). The risk assessment did not address exposure from arsenic-contaminated soil under playgrounds that can subsequently contaminate food, clothing, or other articles handled by the child or further contaminate their skin. Thus, average overall risk to children from playing on or near CCA-treated wood playground structures is likely to be higher than that estimated in CPSC staff's current analysis.

Issue: Deck brightener products for use on CCA-treated wood may cause more hexavalent chromium to be present on the surface of the wood.

Joseph Prager, a consumer, stated that deck brightener products used by consumers to enhance the appearance of their wood structures causes a chemical reaction that releases even more hexavalent chromium at the surface of the wood, thereby increasing the amount of potential exposure to hexavalent chromium.

Response: CCA is a mixture of arsenic, chromium, and copper compounds. The chemical forms of these compounds that exist in the wood after treatment are not known. Although copper and chromium constituents of these compounds may be toxic to humans, CPSC staff considers that arsenic is the most potent of the three and that the toxicological effects of potential exposure to arsenic are the most significant (Hatlelid 2003b). Arsenic causes cancer and non-cancer health effects, but the CPSC staff considers arsenic carcinogenicity to be the most sensitive endpoint. Thus, at this time, the staff has calculated the cancer risk associated only with the exposure to arsenic from CCA-treated wood used for playground equipment. Any potential health risks associated with the other chemicals would be in addition to the risk calculated by CPSC staff.

IV. Jurisdiction

Issue: CCA-treated wood playground equipment is regulated by EPA under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) instead of by CPSC under the FHSA.

The American Chemistry Council Biocides Panel Arsenical Wood Preservatives Task Force and the American Wood Preservers Institute assert that the Commission does not have jurisdiction under the FHSA over playground equipment made of wood treated with CCA.

Response: This comment is addressed in a separate, restricted memorandum from the Office of the General Counsel to the Commission.

Issue: A neutral party, not CPSC, must develop a standard testing method for CCA-treated wood before responsible decisions can be made.

The playground designer, Leathers and Associates, suggests that "a neutral party, such as the EPA," develop a standard method for testing dislodgeable arsenic on CCA-treated wood, because different treatment processes and qualities of wood result in different levels of dislodgeable arsenic on the surface.

Response: CPSC develops standard test methods as part of its mission to reduce unreasonable risks of injury and death from consumer products. To address the petition, CPSC staff developed a standard method for determining the amount of dislodgeable arsenic on the surface of CCA-treated wood under a variety of test conditions. Additionally, the staff used hand wipe data to develop a material surrogate for the hand for use in larger field studies. EPA is the federal agency responsible for regulating the use of CCA as a pesticide.

V. Manufacture, Sale, Transport, and Disposal of CCA-Treated Wood

Issue: Wood type and quality are factors in determining the amount of dislodgeable arsenic.

Leathers and Associates, a playground design firm, stated that the amount of arsenic in the soil depends on the type and quality of the wood. They recommend "using No. 1 dense select Southern yellow pine, kiln-dried after treatment" because it decreases the amount of excess CCA and allows better chemical fixation to the wood. (Note: On January 18, 2002, Leathers & Associates announced on its website, www.leathersassociates.com, that "ACQ or CBA will replace CCA-treated wood on future projects").

Response: The new wood the staff tested was Southern yellow pine purchased at two major home improvement stores. It is unknown whether this wood was kiln-dried, but it did have measurable levels of dislodgeable arsenic (Cobb, 2003). The studies performed by CPSC do not permit a statistical comparison of arsenic migration from different wood types (e.g., southern pine, hemlock fir, etc.) treated with CCA.

In February 2002, the CCA chemical manufacturers announced a voluntary agreement with EPA to cancel the registration of CCA for use in dimensional lumber of sizes that would be available for most consumer uses effective December 31, 2003. Consequently, no further work is planned by Commission staff to determine arsenic leaching from different wood types.

Issue: Potential health risks from CCA-treated wood are not disclosed to consumers.

A consumer, Jonathan Held, commented that CCA use in lumber should be disclosed. He notes that retail stores, including toy stores, are selling products that contain potential health risks. These products do not contain warnings that the lumber used was treated with CCA, and he has been told by playground manufacturers that no labeling of the wood in a playground equipment package is required by law. He believes that consumers need this information for proper maintenance and use.

Another consumer, Joseph Prager, commented that informed decisions cannot be made on the basis of the AWPI brochures available at the point-of-sale because they refer to the wood as "a very safe product" that has "no risk to human health (AWPI brochure, 2001)." His personal survey of lumber store retailers found that most stores did not have information on potential hazards of CCA-treated wood. He concluded that the voluntary efforts of the wood industry are not working and that there is not a sufficient safeguard for the public.

Response: In February 2002, the EPA announced that the manufacturers of CCA requested that registrations of CCA be either cancelled or amended to terminate essentially all residential uses of CCA, including use in playground equipment, effective December 31, 2003. As described in EPA's Federal Register notice (67 FR 8244), it will be illegal to use CCA to treat wood intended for most consumer uses on and after December 31, 2003. Wood treated prior to that date could still be sold and used, but according to EPA, most wood treated for cancelled uses would be sold within 6 months (i.e., June 2004). EPA is responsible for monitoring the voluntary labeling agreement with the wood preservers industry that calls for voluntary labeling of CCA-treated wood. CPSC staff believes that CCA-treated wood for consumers that remains in the market on and after December 31, 2003 must be labeled according to EPA's voluntary agreement with industry.

Issue: Transporting the chemical CCA to wood treatment facilities is hazardous.

A consumer, Joseph Prager, noted that transporting the chemical CCA to various wood treatment facilities through the U.S. is hazardous because CCA contains 22% arsenic. An accident could cause a spill, resulting in environmental effects that threaten the community's health and water supply.

Response: The federal government has provisions for the safe transport of many toxic substances, including CCA, throughout the U.S. The regulations that govern this transport are administered by the U.S. Department of Transportation and the EPA.

Issue: There are significant costs and problems associated with safe disposal of CCA-treated wood.

Joseph Prager, a consumer, noted that some landfills are now banning disposal of CCA-treated wood at their facilities, and the owners of private and municipal landfills may carry the added cost burden of proper disposal of these products. Since an estimated 50% of disposed wood products in the waste stream contain CCA, it will rapidly become a disposal nightmare for counties, municipalities, and businesses in the U.S.

Response: CPSC does not have jurisdiction over the disposal of CCA-treated wood or other products. Jurisdiction over the disposal of CCA-treated wood and wood products resides with the EPA and the states. The EPA is currently not recommending that playgrounds be removed (EPA, 2002). Both the CPSC and the EPA are reviewing possible mitigation measures to reduce exposure to dislodgeable arsenic residues from existing structures.

Issue: Sawdust from CCA-treated wood should be regulated as a hazardous waste.

Joseph Prager, a consumer, commented that sawdust from CCA-treated wood should be considered as a hazardous waste because in standard leaching tests, the toxicity of chromium and arsenic increased as particle size decreased.

Response: As stated above, CPSC does not have jurisdiction over the disposal of CCA-treated wood or other products. Jurisdiction over the disposal of CCA-treated wood and wood products resides with the EPA and the states.

Issue: There is a lack of nationally recognized production standards to minimize the leaching of arsenic from CCA-treated wood.

The State of Wisconsin, Department of Agriculture, Trade, and Consumer Protection commented that although the AWPI has considered the development of "leaching minimalization" standards for CCA, it is unaware of any nationally recognized standards. The commenter is concerned because fixation of CCA to the wood is dependent upon storage time and temperature. Production monitoring is sometimes performed by the American Lumber Standard Committee (ALSC) and some state regulatory agencies, but the treated wood products used in playground equipment do not require ALSC oversight.

Response: The ASTM and the American Wood-Preserver's Association (AWPA) developed voluntary standards for playgrounds and the wood preserving industry, respectively (Whitfield, 2003). While the ASTM playground standards set safety and performance requirements to minimize injuries, the AWPA standards describe the types of preservatives, lumber categories, conditioning requirements, and treatment processes for preserving wood (Whitfield, 2003). However, since CPSC staff believes that CCA-treated wood will no longer be available for use for playgrounds relatively soon after December 31, 2003, production monitoring becomes moot. Moreover, playground manufacturers have already moved away from the use of CCA-treated wood to other alternatives, such as ammoniacal copper quat (ACQ), redwood, and cedar, according to a chemical manufacturer representative and some playground equipment manufacturers.

VI. Mitigation, Alternatives, and Education

Issue: Alternatives to CCA are available and should/should not be used.

Joseph Prager, a consumer, remarked that alternatives are available that are safer than CCA and should be used in its place. Leathers and Associates, a playground design firm, states that they have no objection to communities using copper-based alternative treated wood products, but have no reason to change their recommendation to use CCA, because in their experience it is economical, effective, and safe.

Response: The CPSC staff is aware of alternative non-arsenic-containing wood preservatives that are available for use (Franklin, 2003). There are several possible substitutes for CCA-treated wood: wood treated with other chemicals; naturally resistant wood; and plastic or composite lumber. A number of potential chemical substitutes for CCA are currently in use and expected to replace CCA as common wood preservatives.

In those applications for which the use of CCA is being phased out, the two most likely replacements for CCA are ammoniacal copper quat (ACQ) or copper boron azole (CBA). ACQ is similar to CCA in durability, range of use, and mechanical properties. While these alternatives do not contain arsenic, there are insufficient data available on the toxicity and exposure of these alternative chemicals to make a reasonable assessment, under the FHSA, of their potential for risk. The staff has not assessed claims that these chemical alternatives present a decreased health risk to consumers compared to that of CCA.

Note: In a press release on January 18, 2002, Leathers and Associates (commenter) announced "that ACQ or CBA-treated wood will replace CCA-treated wood on our future products. We still firmly believe that CCA is safe; however, ACQ and CBA are now better alternatives." (www.leathersassociates.com).

<u>Issue</u>: Type, quality, and maintenance of the wood is a factor in determining the amount of dislodgeable arsenic.

The playground design firm, Leathers and Associates, emphasized the importance of wood quality and wood type (they use No. 1 dense Southern Yellow Pine). Wood quality affects the fixation of chemicals to the wood, while kiln-drying wood after treatment reduces the amount of excess CCA and allows the wood to be stained or sealed immediately after treatment. Leathers also recommends using a composite material on handrails to reduce splinters and that their products be sanded and sealed annually.

The State of Wisconsin, Department of Agriculture, Trade, and Consumer Protection, comments that while applying an appropriate sealant may minimize leaching in some instances, CCA wood manufacturers do not recommend it during the first year, since chemical fixation continues to occur during this time period. The Connecticut Department of Public Health and the Connecticut Agricultural Experiment Station advises CPSC that arsenic exposure to children on playgrounds can be largely mitigated by the use of sealants on the wood at regular intervals (e.g., every 2 years as legislated in California in 1987).

<u>Response</u>: As stated above, the AWPA developed standards describing the types of preservatives, lumber categories, conditioning requirements, and treatment processes for preserving wood (Whitfield, 2003).

CPSC staff is aware that various trade and consumer groups, some state governments, and a Scientific Advisory Panel (SAP) recently convened by the U.S. Environmental Protection Agency's Office of Pesticide Programs, have made suggestions concerning surface coating of CCA-treated wood to reduce potential exposure to chemicals found in this wood.

Based on limited available data, these groups have suggested that applying certain penetrating coatings (for example, oil-based semi-transparent stains) on a regular basis (for example, once a year or every other year depending upon wear and weathering) may reduce the migration of chemicals from CCA-treated wood. However, "film-forming" or non-penetrating stains (e.g., latex semi-transparent, latex opaque, and oil-based opaque stains) are not recommended on outdoor wood surfaces such as decks (Williams, 1995) as subsequent peeling and flaking may ultimately have an impact on durability as well as exposure to the preservatives in the wood.

CPSC staff in collaboration with EPA staff will conduct studies to evaluate the efficacy of various stains/sealants against arsenic leaching. Therefore, CPSC staff cannot recommend specific types of penetrating surface coatings that effectively prevent leaching of arsenic at this time.

<u>Issue</u>: A public education program to inform the public about effective mitigation measures is needed to prevent the need for a ban.

The Connecticut Department of Public Health and the Connecticut Agricultural Experiment Station state that a large public education campaign will be needed to ensure that consumers will regularly seal their wood playground equipment in order to protect children. Otherwise, the use of mitigation measures are unlikely to be effective in preventing exposure.

<u>Response:</u> CPSC staff, in collaboration with EPA, is currently reviewing data and wil conduct studies on the effectiveness of mitigation measures. The staff will provide recommendations to consumers upon completion of these studies.

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Appendix A

ExHR

United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

MEMORANDUM

DATE: 9/19/01

TO : Patricia Bittner, HS

Through: Todd A. Stevenson, Acting Secretary, OS

FROM : Martha A. Kosh, OS

SUBJECT: Petition HP 01-3: Petition for Ban on Use of CCA Treated Wood in Playground Equipment

ATTACHED ARE COMMENTS ON THE CH01-4

COMMENT	DATE	SIGNED BY	AFFILIATION
CH01-4-1	7/24/01	Consumers **(approximately) 3,000**	Generation Green P.O. Box 7027 Evanston, IL 60201
CH01-4-2	7/27/01	R. Gilstein	gils4@mediaone.net
CH01-4-3	7/29/01	D. Marcelius	13881 Green Valley Rd Forestville, CA 95436
CH01-4-4	7/30/01	Brian Fink Consumer	390 2nd St., #13 Brooklyn, NY 11215
CH01-4-5	7/31/01	Edward Hoy	1031 Claire Ave Huntingdon Valley, PA 19006
CH01-4-6	7/31/01	Eloise Gumpert	6188 Bellaire Dr. New Orleans, LA 70124
CH01-4-7	7/31/01	Julia Holladay	JuliaLee60@aol.com
CH01-4-8	0/02/01	Emily Sims	forest elf@hotmail.com
CH01-4-9	8/05/01	Marge Folino	keith@glassinc.com
CH01-4-10	8/06/01	C. Stombler	3620 Forest Garden Ave. Baltimore, MD 21207
CH01-4-11	8/09/01	Mark Dobson President	PlayLofts 5200 N. US 1 Melbourne, FL 32940

Petition HP 01-3: Petition for Ban on Use of CCA Treated Wood in Playground Equipment

CH01-4-12	8/09/01	V. Christie	sibleyhouse@hotmail.com
CH01-4-13	8/10/01	Ruthann Spence	ru66@bellsouth.net
CH01-4-14	8/10/01	Thomas French	HC 68 Box 139 Taos, NM 87571
CH01-4-15	8/13/01	Karen Pushinsky	diamond1@fyi.net
CH01-4-16	8/12/01	Robert Davis	40 Puritan Road Tonawanda, NY 14150
CH01-4-17	8/20/01	Jonathan Held	jsheld@hotmail.com
CH01-4-18	8/20/01	Joseph Prager	9409 SW 81st Way Gainesville, FL 32608
CH01-4-19	8/21/01	Terri Becker	507 Lowell #4 Cincinnati, OH 45220
CH01-4-20	8/24/01	Rhonda ~~Ruff~~ Roff	Seminole Tribe of Florida Water Resource Mgmt. 6300 Stirling Road Hollywood, FL 33024
CH01-4-21	9/05/01	Gregory Kidd Science & Legal Policy Director	Beyond Pesticides National Coalition Against the Imsuse of Pesticides 701 E St, SE, Suite 200 Washington, DC 20003
CH01-4-22	9/05/01	Marc Leathers President	Leathers & Associates 99 Eastlake Road Ithaca, NY 14850
CH01-4-23	9/05/01	Nina Derda	2070 19th St Wyandotte, MI 48192
CH01-4-24	9/09/01	W. Oemichen Administrator	Depart. Of Agriculture Trade and Consumer Protection 2811 Agriculture Dr. P.O. Box 911 Madison, WI 53708
CH01-4-25	9/11/01	Gary Ginsberg Ph.D., Toxicologist &	Connecticut Department of Public Health PO Box 340398, MS 11CHA Hartford, CT 06134

Con't		David Stilwell Ph.D.	Connecticut Agriculture Experiment Station PO Box 1106 New Haven, CT 06504
CH01-4-26 (**attachments in OS**)	9/11/01	Sarah Watson **on behalf of The American Chemistry Council and the American Wood Preservers Institute**	Steptoe & Johnson 1330 Connecticut Ave, NW Washington, DC 20036
CH01-4-27	9/11/01	M. Feenster Coordinator - Regulatory Affairs	American Forest & Paper Association 1111 19th St, NW Washington, DC 20020
CH01-4-28	9/11/01	Jeff Hobson	2220-D Sacramento St. Berkeley, CA 94702