

**Report to the Legislature**

Evaluation of Hazards Posed by the Use of Wood Preservatives on Playground  
Equipment

Office of Environmental Health Hazard Assessment  
Department of Health Services  
Health and Welfare Agency  
State of California

February 1987

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## Addendum to the Second Printing

In February 1987, the California Department of Health Services (DHS), under mandate from Section 25930 of the California Health and Safety Code, completed and published the "Report to the Legislature: Evaluation of Hazards Posed by the Use of Wood Preservatives on Playground Equipment." As a result of the findings and recommendations of the report, Chapter 10.7 (commencing with Section 25930) was added to Division 20 of the Health and Safety Code, and signed into law by the Governor on September 24, 1987.

The law, "Wood Preservatives: Wooden Playground and Recreation Equipment," is summarized as follows:

(a) State funds cannot be used to purchase wooden playground or recreational equipment where there is a likelihood of contact by children when the equipment has been treated with pentachlorophenol or creosote. This also applies to wood treated with arsenical wood preservatives, unless the wood is treated in accordance with the American Wood Preservers' commodity standard C-17 and is treated with a nontoxic and nonslippery sealer.

(b) The state or any city, county, city and county, district, superintendent of schools, school district, community college district, or onsite employee child care center for state employees which receives education or parks and recreation funds from the state may not use state funds for maintenance of structures prohibited from purchase in subdivision (a), unless the structures are treated with nontoxic and nonslippery sealers and resealed in accordance with subdivision (c).

(c) The installer of any wooden playground or recreational equipment which has been treated with arsenical wood preservatives as listed in section (a), must seal the structures with a nontoxic and nonslippery sealer prior to or at the time of installation. The owner of the treated equipment must then reseal it every two years thereafter with a nontoxic and nonslippery sealer.

Subsequent to the publication of this report and addendum to the Health and Safety Code, additional toxicological data on wood preservatives may appear in the literature. The consumer should be aware of possible changes in preservatives' toxicological status as new data become available.

**August 1988**

## SUMMARY

The California Department of Health Services (DHS) investigated the health hazard posed to children by chemical wood preservatives such as arsenic, pentachlorophenol (penta), and creosote, which are sometimes used on playground and recreational equipment. Section 25930 of the California Health and Safety Code directed DHS to survey the use of wood preservatives on playground equipment, determine the degree of hazard they pose, and recommend a safe standard for these preservatives, if appropriate. In the interim, the law restricts the use of State funds for the purchase of new wooden playground equipment created with penta, creosote, or arsenic unless it is free of visible surface residues. The law also prohibits the use of State funds for maintenance of existing wood equipment created with these preservatives unless a sealant is applied to prevent children from contacting the chemicals. This special report to the Legislature summarizes the salient findings of DHS' studies and presents DHS' recommendations.

### Survey of Playground Structures in Elementary Schools and Municipal Parks

DHS surveyed play structures in elementary schools and municipal parks in California and estimated that there are about 5,300 wood structures and about 22,000 metal structures. About 60 percent of the 429 survey respondents did not know whether their wood was treated with preservatives. From information given by those who did know, it was estimated that about 20% of all wood structures were treated with a chemical preservative. Of the treated structures, about 20% were treated with arsenicals, 24% with penta, 24% with Niedox-10, 5% with creosote, and 12% with other preservatives. For the remaining 15%, the respondents knew that their structures were treated, but did not know the exact preservative used.

Approximately 1,500 structural failures of wooden components of playground equipment occur each year in California. There is no evidence of an increase in structural failures with an increase in age, or of a difference in the number of structural failures between treated and nontreated structures. However, due to the small sample size, these findings are tentative. It is reasonable to assume that treatment of wood with preservatives will increase the longevity of the structure, since treatment is known to increase the usable life of other wooden

structures, such as fencing, landscape ties, poles, mine ties and timbers, and pilings.

Data from the survey and information from the U.S. Consumer Product Safety Commission (CPSC) indicate that about 56,000 injuries occur statewide on playground equipment per year, and about 21,000 of these require a hospital visit. Of the 56,000 estimated injuries, 1.4 percent (about 800 per year, or about 114 per school-grade cohort of 400,000) are thought to be due to structural failure of wooden components.

### Exposure Assessment

From many field and laboratory tests, DHS developed a range of exposure levels to wood preservatives that children could possibly encounter while playing on treated structures. These exposure estimates assumed that children would pick up the chemicals on their hands and ingest the preservatives by putting their hands in their mouths or by handling and contaminating food. In addition, it was assumed that penta could be dermally absorbed. For the high arsenic exposure, it was estimated that a child could receive a dose of 630 micrograms ( $\mu\text{g}$ )\* per playground visit, at moderate exposure 60  $\mu\text{g}$  per visit, and at low exposure 24  $\mu\text{g}$  per visit. For the high penta exposure, a child could receive a dose of 98  $\mu\text{g}$  per visit, at moderate exposure 34  $\mu\text{g}$  per visit, and at low exposure 17  $\mu\text{g}$  per visit. Studies conducted by DHS demonstrated that surface arsenic and penta levels decrease dramatically after application of sealants.

### Risk Assessment

With the possible exception of creosote, none of the wood preservatives pose an acute or chronic (noncarcinogenic) toxic hazard to children playing on treated wood. The health hazard of concern from wood preservatives used on playground structures is the possibility of an increase in the risk of cancer over a lifetime. Based on estimated exposures to arsenic and frequency of park visits averaged over a lifetime, the theoretical increase in lifetime cancer risk from arsenic exposure from playgrounds is at most between 100 and 6,000 additional cases of skin cancer in 1 million people exposed. Based on the total number of elementary school children in each grade in California (400,000) and the estimated number of arsenic-treated wood playground structures currently in use

\* 28.4 million  $\mu\text{g}$  - 1 ounce

in the state (20% of all structures are wood and 20% of these are arsenically treated), about 16,000 children in each grade could be exposed to the arsenicals. Over a 70-year period, no more than 2 to 96 additional nonmelanoma skin cancer cases would occur. Over the 70-year period, no more than one additional skin cancer death in this group would be expected to result from arsenic exposure from treated playground wood.

The theoretical additional lifetime cancer risk from exposure to the penta contaminants on play structures is at most from 5 to 67 cases per million people exposed. About 19,200 children in each grade of school are at risk of exposure. Over a 70-year period, no more than 1 additional case of invasive cancer would occur in each grade cohort. However, the pending results of the new cancer bioassay for penta may substantially increase the calculated risk.

### Recommendations

Several techniques were tested for measuring wood surface residues of arsenic and penta. These techniques can determine gross levels of residues of arsenic or penta in the 10s, 100s, or 1000s of micrograms per 100 square centimeters (cm<sup>2</sup>), but none are precise enough to be used for standard-setting. Thus, instead of a numerical regulatory standard for wood preservatives that could not be properly implemented because of the lack of a dependable sampling method, DHS recommends other means to reduce the risk to children. These include better equipment design, and prohibition of creosote and penta on playground equipment. In addition, playground or recreational wood treated with arsenic should meet the American Wood Preservers' Association commodity standard. All chemically preserved wood (except for Niedox-10) intended for use in playgrounds should be treated with a nontoxic and nonslippery sealant before the equipment is installed. Sealants should not be required for non-treated wood or wood treated with Niedox-10. The manufacturers of two other preservatives, copper naphthenate and copper-8, should conduct carcinogenic and other toxicological testing on their products.

For existing equipment DHS recommends that nontoxic and nonslippery sealants be applied every two years to playground or recreational

equipment, unless the wood has not been chemically treated or has been treated with Niedox-10. Existing structures should also be inspected at least yearly for signs of wood decay or structural inadequacy.

# EVALUATION OF HAZARDS POSED BY THE USE OF WOOD PRESERVATIVES ON PLAYGROUND EQUIPMENT

## I. INTRODUCTION

In 1978 several construction workers who were building a public fishing pier for the city of Monterey developed symptoms consistent with acute arsenic poisoning. It was discovered that the workers had been over-exposed to arsenic while cutting arsenic-treated wood and painting the cut ends with an arsenic wood preservative. The Monterey County Health Department became concerned that people who frequent the fishing pier might also become exposed to arsenic residues on the surface of the wood and requested that the city apply a polyurethane coating to areas of the pier where direct contact by the public was likely.

Following this incident, the California Department of Health Services (DHS) began to investigate whether the public was exposed to arsenicals and other wood preservatives. The study focused on wooden playground and recreational equipment where preliminary tests indicated that children could potentially be exposed to doses measurable in units of milligrams of arsenic from contact with treated wood. About this same time, a child died because of the collapse of a rotting timber on a play structure, demonstrating that the failure to properly construct, preserve, and maintain wooden playground equipment could lead to structural failure and injury or even death.

For decades wooden playground structures, picnic tables, and park benches have been treated with various kinds of wood preservatives to prevent microbial and insect attack. Because treated wood generally has a useful life at least five times that of untreated wood, particularly if the wood comes in contact with soil (stated in the 1984 EPA Wood Preservative Pesticides Position Document No. 4), the preservatives have considerable economic and safety value. The most common preservatives used to treat wooden playground equipment are arsenic-containing compounds, including chromated copper arsenate (CCA) and ammoniacal copper arsenate (ACA), pentachlorophenol (penta), and Niedox-10, a boric acid and paraffin wax compound. Copper naphthenate and copper quinolinolate (copper-8) are occasionally used for this purpose. Although chemical preservatives increase the longevity of wood, they have toxic properties that may pose potential health hazards, including cancer.

Because of public concern about the potential hazard to children, the state adopted Health and Safety Code Section 25930, which prohibits the use of state



funds to purchase wooden playground or recreational equipment when there is a likelihood of children contacting wood treated with pentachlorophenol or creosote. The law applies the same restrictions for arsenic-treated equipment, unless the seller certifies that the wood is free from visible arsenical surface deposits.

For existing playground and recreational equipment treated with any of these three preservatives, the law prohibits the use of state funds to maintain the equipment, unless the wood is treated with a nontoxic and nonslippery sealer to prevent direct skin contact with the preservatives. If arsenically treated wood is free of visible deposits, a sealant is not required.

Finally, the law directed DHS to conduct a study and report to the Legislature on (1) the hazards of wood preservatives used on children's playground structures and (2) a recommended safety standard for the use of wood treatment products on playground structures, if appropriate. This is the summary of DHS' findings and recommendations.

## II. SURVEY OF PLAYGROUND STRUCTURES, WOOD TREATMENTS AND INJURIES IN CALIFORNIA PARKS AND SCHOOLS

The Department conducted a stratified random sample survey of playground structures in California public park districts and a simple random sample in elementary schools to:

- Estimate the total number of wood and nonwood playground structures in the state;
- Estimate the type and frequency of use of wood preservatives and sealants;
- Estimate the frequency of structural failure of wooden components of playground equipment and the number of injuries resulting from these failures;
- Estimate the number of health complaints related to exposure to wood preservatives;
- Detect any significant differences in injury rates between treated and nontreated structures.

### A. Park District Survey

Estimates of the number of park areas and playground structures are given in Table 1. There are approximately 8,700 metal structures and about 4,300 wood structures in California parks. In the sample, only 117 park areas were found to have at least one structure made entirely of plastic. The average age of wood structures was 6.8 years, with a range of 6 months to 17 years.

Table 1

## Park Area and Playground Structure Estimates

	Statewide Estimates	95% Confidence Limits
Total number of park/rec areas in California:	5800	5000 - 6500
Total number of park/rec areas with at least one play structure:	3700	3200 - 4300
Total number of areas with at least One wooden structure:	2300	1700 - 2900
Number of wooden structures:	4300	3200 - 5400
Total number of parks with at least one metal structure:	2700	2300 - 3200
Number of metal structures:	8700	2800 -10,000

1. Wood Preservatives and Sealant Use:

Approximately 60% of the park administrators who responded to the survey on wooden structures in their parks did not enter any information relating to wood preservatives. From information given by the remaining 40%, it was estimated that about 20% of all wooden structures were treated with chemical preservatives. The distribution of treatments used on wooden structures in park and recreation areas is shown in Table 2. Approximately 25% of the responders who had wooden structures in their parks answered affirmatively when asked if any of the wooden playground sets were sealed with an oil sealant, shellac, or paint. The majority of the responders (66%) stated that their wooden structures were not sealed. Nine percent did not know if their structures were sealed.

Table 2

## Distribution of Wood Treatments Among Park Areas

TREATMENT	NUMBER OF PARKS USING TREATMENT	PERCENTAGE
ARSENICALS	31	20
PENTA	37	24
NIEDOX-10	37	24
CREOSOTE	8	5
OTHERS	19	12
UNKNOWN	25	15
TOTAL	157	100

2. Structural failures:

In the sample, 119 structural failures of wooden components were reported for the two-year period, August 1, 1983, to August 1, 1985. An estimated 360 failures, or 180 failures annually, would be expected to occur statewide.

Eleven of 81 treated wooden structures enumerated were reported to have had structural failures since installation. Age was not a factor in structural failure, nor was there a statistically significant difference in failure rate between treated and untreated wood.

3. Injuries:

For the same two-year period, 11 injuries were reported from structural failures of wooden components. Ninety-two percent of respondents with parks having wood playground structures reported no injuries. Only one "chemical-type" illness (a noninjury-related illness) was reported, but no specific information was available.

**B. School Survey**

The estimates of the total school enrollment, injuries, and structural failures are given in Table 3. There are about 2.8 million children enrolled in California elementary schools, or about 400,000 children per grade. Over 80% of the structures enumerated in the sample were made of metal, whereas only 6.4% were made entirely of wood. The latter percentage represents an estimated 1,028 all-wood structures statewide in public schools, although that number could vary between 600 and 2,100. Of the types of

wood reported in structures in the sample, fir was the most common, comprising 44.3% of the sample.

Table 3  
Results of Elementary School Survey

	Statewide Estimates	95% Confidence Limits
Total elementary school enrollment:	2,800,000	2,582,000 - 3,088,000
Annual number of injuries on playground equipment:	56,000	44,000 - 68,000
Annual rate of injuries per 1000 children:	19.8	17.1 - 22.0
Annual number of injuries due to structural failure of wooden components:	800	330 - 1300
Annual rate of injuries due to wood structural failures per 1000 children:	0.28	0.13 - 0.14
Annual number of wood structural failures:	1340	1200 - 1900
Number of wooden structures:	1028	600 - 2100

The age of the wooden structures in the sample averaged 8.1 years, with a range of 1-30 years. For metal structures the average age was 16.2 years, with a range of 1 to 40 years. The difference in mean ages between the two types of structures may reflect either the recent popularity of wooden playground structures or the superior longevity of the metal components.

1. Wood Preservative and Sealant Use:

About 58% of the respondents who had wood structures at their schools did not know whether they had been treated with preservatives; 27% were reported as untreated, and 15% treated. Information on types of preservatives used was known for only seven structures.

More wooden structures (40%) were reported sealed with paint or an oil-based sealant than were treated with preservatives (15%). This may reflect the reporters' lack of knowledge of wood treatment status or an actually higher rate of sealing than preserving. Twenty-six percent were reported as unsealed, and 34% were unknown as to their sealant status. One-third of the structures reported as sealed had information as to the type of sealant used, with paint as the material of choice.

2. Structural Failures:

Factors such as age of structure, treatment status with wood preservatives, and sealant versus no sealant were not significantly related to the occurrence of structural failures of wooden components. These results could be due to the small sample size, the length of time that wood has been used in playground equipment, or some other factor. In schools there are an estimated 1,340 structural failures of wooden components annually. It is not known how many of these failures are minor and how many are major.

3. Injuries:

The total injuries occurring on school playground equipment statewide were estimated to be 56,000 annually, or 19.8 injuries per 1,000 children. Using Consumer Product Safety Commission data, it is estimated that there are about 21,000 injuries severe enough to require emergency room visits each year in California. Of the total school playground injuries in our survey, only a small proportion, 1.4% (~800), were estimated to be injuries due to structural failures of wooden components.

A higher mean number of injuries were reported as occurring on metal structures than on wood structures; however, because of the poor response on this portion of the survey this finding needs further clarification. For wooden structures, there did not appear to be an increase of injuries with increasing age of the structure.

No health complaints related to chemical exposures from playground equipment were reported in the elementary school sample.

C. Survey Summary

Combining both the park and school surveys indicates that there are an estimated 5,300 wooden structures in the state, with 1,500 structural failures of wooden components annually. Although the severity of

these failures is unknown, half of these failures (800) result in injuries, or about 114 for each grade cohort of 400,000.

In general, respondents to both surveys knew little about the presence of treatment or type of wood preservative used on their playground equipment. Since treatment is usually done before installation, this information may not have been readily available to the park and school administrator who generally completed the questionnaire. Occasionally, respondents stated that their structures had not been treated with wood preservatives, but on telephone follow-up respondents admitted to answering without knowing whether the manufacturer had treated the structure. Conclusions regarding wood preservative treatment from the data collected in the survey are therefore tentative.

More data were available regarding sealants, suggesting that sealing was more often done locally than preservative treatment. However, wood treatment and wood sealing were often confused, leading occasionally to erroneous answers in the survey. These answers were corrected before analysis upon clarification by the respondent.

Since only one complaint of chemical exposure-related illness was reported, it appears that acute illness from exposure to wood preservatives during play is extremely rare.

### III. EXPOSURE ASSESSMENT

#### A. Exposure Estimations

To determine the amount of dislodgable preservative residue on the surface of treated wood, the Department conducted field and laboratory tests and reviewed the literature. Despite the large number of tests that DHS and American Wood Preservers' Association conducted, and without doing actual experimentation on children, it is impossible to determine precisely how much arsenic, chromium, copper, or pentachlorophenol children get on their hands while playing on the playground equipment. Moreover, there is no way to determine the amount of preservative that children actually ingest from hand-to-mouth contact. Therefore, to estimate children's exposure to preservatives from playing on treated equipment, assumptions must be made. Because of uncertainties in this process, a range of exposure assumptions was made. The assumptions used and the range of one-time dose estimates and eight-year cumulative dose estimates are summarized in Tables 4 and 5.

Table 4

Assumptions and Estimated Dose Per Visit from Playground Structure  
Treated with CCA or Pentachlorophenol

Preservative Exposure	Amount Child Gets on Hands (µg)	Percent Ingested	Percent Absorbed	Est. Dose per Visit (µg)
<u>High</u>				
Arsenic	1,260 <sup>a</sup>	50	100	630
Chromium	575 <sup>a</sup>	50	100	288
Copper	362 <sup>a</sup>	50	100	181
Penta	98 <sup>b</sup>	100	100	98
<u>Moderate</u>				
Arsenic	236 <sup>c</sup>	50	50	60
Chromium	351 <sup>c</sup>	50	50	90
Copper	171 <sup>c</sup>	50	50	40
Penta	3 <sup>d</sup>	100	100	34
<u>Low</u>				
Arsenic	236 <sup>c</sup>	50	20	24
Chromium	351 <sup>c</sup>	50	20	35
Copper	171 <sup>c</sup>	50	20	17
Penta	3 <sup>d</sup>	50	100	17



- a** Based on the highest amount collected from the hands of 5 volunteers rubbing 5 minutes.
- b** Based on the highest amount collected on a gauze wipe over a 100 cm<sup>2</sup> area of penta-treated test pole.
- c** Based on the average amount collected on the hands of 5 volunteers rubbing 5 minutes.
- d** Based on the average amount collected on gauze wipe samples over 100 cm<sup>2</sup> area of penta-treated test pole.

Table 5

Estimated Eight Year Cumulative Dose from Playground Structure Treated with CCA or Pentachlorophenol

	High Estimate <sup>a</sup> 8-Yr Cumulative Dose (µg)	Moderate Estimate <sup>b</sup> 8-Yr Cumulative Dose (µg)	Low Estimate <sup>c</sup> 8-Yr Cumulative Dose (µg)
Arsenic	655,200*	370,000	
Chromium	299,000	55,000	14,600
Copper	188,300	25,000	7,000
Penta	101,000	21,000	7,100

- a** Based on one-time exposure dose and assumes a child visits a treated playground 5 times per week, 26 weeks per year. for 8 years.
- b** Based on one-time exposure dose and assumes that a child visits a treated playground 3 times per week, 26 weeks per year. for 8 years.
- c** Based on one-time exposure dose and assumes that a child visits a treated playground 2 times per week, 26 weeks per year, for 8 years.

**B. Sealants and Surface Wood Preservative Residues**

Studies conducted by DHS demonstrated that surface levels of arsenic and penta decrease dramatically after application of different kinds of sealants, such as shellac, paint, or oil-based stains. Monterey pier samples showed a mean surface arsenic residue level of 1.131 µg/100cm<sup>2</sup> before sealing with polyurethane, and a mean level of less than 10 µg/100cm<sup>2</sup> immediately after sealing. Two years after sealing, the levels were slightly higher (12-65 µg/100cm<sup>2</sup>). At Cedar Rose Park in Berkeley, surface arsenic residues collected on gauze-wipe samples were reduced from a range of 31-314 µg/100cm<sup>2</sup> before sealing to 1-13 µg/100cm<sup>2</sup> after sealing with an oil-base stain. Dislodgable surface-wipe penta levels were reduced in test poles from a mean of 34 µg/100cm<sup>2</sup> before sealing to an average of 3.9 µg/100cm<sup>2</sup> after sealing.

**C. Alternate Wood Types and Wood Preservatives**

As an alternative to using chemically-treated wood for playground equipment, several manufacturers have utilized wood that naturally resists microbial and insect attack, such as redwood and western red cedar. DHS was unable

to evaluate the efficacy or structural life of these materials, but within the limits of the survey of parks, no correlation materials, but within the limits of the survey of parks, no correlation between structural failure of chemically-treated wood versus nontreated wood was found.

There are also alternative wood preservatives to the arsenicals and penta compounds, such as Niedox-10, copper-8, and copper naphthenate. These preservatives appear to be efficacious, but they are not approved for soil contact by the American Wood Preservers' Association. Our survey did not show any difference in failure rate between the alternative chemical-treated structures and the arsenic- or penta-treated structures. Unfortunately, no extensive toxicological investigation of these compounds has been made.

**\* Roughly 1/40 of an ounce**