Alternative Chemicals and Improved Disposal-End Management Practices for CCA-treated Wood

(FINAL DRAFT)

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LIST OF ABBREVIATIONS AND ACRONYMS

AAC	Alkyl Ammonium Compound
ACA	Ammoniacal Copper Arsenate
ACC	Acid Copper Chromate
ACQ	Alkaline Copper Quat
ACQ-B	Alkaline Copper Quat Type B
ACQ-D	Alkaline Copper Quat Type D
ACZA	Ammoniacal Copper Zinc Arsenate
AITC	American Institute of Timber Construction
As	Arsenic
Ave.	Average
AWPA	American Wood Preservers Association
AWPI	American Wood Preservers' Institute
BAE	Boric Acid Equivalent
CBA	Copper Boron Azole
CC	Copper Citrate
CCA	Chromated Copper Arsenate
CCB	Copper Chrome Boron
CDDC	Copper Dimethyldithiocarbamate
C&D	Construction and Demolition
Cr	Chromium
Cu	Copper
CSI	Chemical Specialties Incorporated
CuMEA	Copper ethanolamine
DF	Douglas Fir
FPL	Florida Power and Light
GWGC	Groundwater Guidance Concentrations
HF	Hem Fir
DDAC	Didecyl Dimethyl Ammonium Chloride
DEP	Department of Environmental Protection
DOT	Disodium Octaborate Tetrahydrate
EPA	Environmental Protection Agency
ICBO	International Conference of Building Officials
MOE	Modulus of Elasticity
MOR	Modulus of Rupture
MPY	Mils Per Year
MRF	Materials Recovery Facility
MSDS	Material Safety Data Sheet

LIST OF ABBREVIATIONS AND ACRONYMS (Con'd)

MSW	Municipal Solid Waste
NACE	National Association of Corrosion Engineers
NM	Not Measured
pcf	pounds per cubic foot
PCP	pentachlorophenol
PP	Ponderosa Pine
RCRA	Resource Conservation and Recovery Act
SDDC	Sodium Dimethyldithiocarbamate
SPLP	Synthetic Precipitation Leaching Procedure
Std. dev.	Standard Deviation
SYP	Southern Yellow Pine
TAG	Technical Advisory Group
TCLP	Toxicity Characteristic Leaching Procedure
TMB	Tri-Methyl Borate
UBC	Uniform Building Code
UF	University of Florida
UM	University of Miami
WTE	Waste to Energy
WML	Work to Maximum Load

UNITS OF MEASURE

%	parts per hundred
µg/L	micrograms per liter
ft^3	cubic feet
lb/ft^3	pounds per cubic foot
lbs.	pounds
MPY	mils per year, 1 mil = 1/1000 of a pound
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
pcf	pounds per cubic foot
psi	pounds per square inch

ABSTRACT

The purpose of this study was to develop strategies by which the impacts of arsenic associated with CCA-treated wood can be minimized within the disposal sector. Two broad approaches were utilized. The first was to evaluate waterborne wood preservatives that contained no arsenic. The use of non-arsenical preservatives translates into a significant reduction in the amount of arsenic imported and ultimately disposed within the State. The second approach was to develop new disposal management strategies for CCA-treated wood. This phase of study included: a) a field demonstration for sorting CCA-treated wood from other wood types using chemical stains, b) a literature review of pyrolysis technology for the ultimate disposal of CCA-treated wood, and c) the development of a resource book to identify existing disposal facilities for treated wood waste and for educating the general public about treated wood.

Seven chemical alternatives to CCA were evaluated through this study. Among these seven, four were identified as the most promising substitutes for existing uses of CCA-treated wood. These four included alkaline copper quat (ACQ), copper boron azole (CBA), copper citrate (CC), and copper dimethyldithiocarbamate (CDDC). Efficacy of the four alternatives were comparable to that of CCA in laboratory and/or field tests. Copper depletion (as indicated by % copper losses) were comparable between the alternatives and CCA, except for CC-treated wood which could not be compared to CCA-treated wood performance due to a lack of CCA control. ACQ and CDDC chemical concentrates appear to be more corrosive to treatment plant equipment, in particular to that made of brass and bronze. In general ACQ- and CC-treated wood are more corrosive to metal fasteners than CCA-treated wood. Corrosivity of CBA- and CDDC- treated wood is comparable to that of CCA-treated wood. The cost of ACQ- and CDDC-treated wood was 10 to 30% higher than CCA-treated wood as determined from inquiries made at retail establishments. No cost data was available for CBA- or CC-treated wood. Although the co-biocides for the alternative chemicals are used in other human contact applications and for agricultural uses, the environmental impacts of these co-biocides should be further evaluated before the use of these alternatives are promoted throughout Florida. Overall, it is concluded that viable non-arsenical waterborne alternatives are available for above ground and ground contact applications requiring 0.25 pcf and 0.40 pcf of CCA. These applications account for 60% of the treated wood volume and 20% of the CCA chemical. Alternative structural materials should be evaluated for applications requiring high CCA retention levels, if the standardization of the waterborne alternatives at these higher retention levels cannot be expedited. Alternative oilborne preservatives should also be considered for utility poles.

Evaluation of disposal-end management strategies indicates that the chemical stains, PAN indicator and chrome azurol, are useful for sorting small quantities of wood. Between 9 and 30% of the C&D wood piles analyzed using the stains was composed of CCA. Most of the CCA-treated wood was found in the form of cut-offs and dimensional lumber. Higher proportions of CCA-treated wood were found in construction piles (20%) than in demolition loads (5%). Pyrolysis of treated wood is considered to be a promising technology for volume reduction of CCA-treated wood once it is sorted from untreated wood. The impacts of incineration time and temperature on metals emissions have been experimentally determined by other researchers with varying results. Two full-scale pyrolysis operations have been implemented in Europe, one in France and another in Finland, both of which claim to retain nearly 100% of the metals. Information gathered for the resource book indicates that parks and recreation facilities prefer not to reuse treated wood products due to concerns about the structural integrity of the discarded material. Unless statutes regarding C&D landfills are revised, the most common method of disposal for treated wood waste will continue to be C&D debris facilities. This means that treated wood will continue to be buried in unlined landfills, burned as fuel in industrial boilers, and possibly sold as mulch.

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CHAPTER I

MOTIVATION, OBJECTIVES, AND BACKGROUND

I.1 MOTIVATION

The quantities of CCA-treated wood disposed in Florida are projected to increase significantly in the near future (Solo-Gabriele and Towsend, 1999). About 5 million cubic feet of the wood product or 350 tons of the chemical were discarded during 1996. We anticipate that by 2006 this figure will quadruple and by 2016 it will reach a value of 35 million cubic feet or 3000 tons of CCA chemical per year (figure I.1). Research has also shown that the primary disposal pathway for this waste in Florida is through the construction and demolition (C&D) waste stream where CCA-treated wood is either disposed in unlined C&D landfills, or recycled as mulch or wood fuel. As a result, a considerable amount of the CCA chemical, which includes arsenic, chromium, and copper, can be potentially released into the Florida environment.

Among the three metals found in CCA, arsenic is of special concern given the low natural background levels in Florida's soils (0.42 mg/kg geometric average) (Ma et al. 1997) and the low risk-based guidance concentrations that have been established by the Florida Department of Environmental Protection (FDEP) for residential (0.8 mg/kg) and industrial (3.7 mg/kg) land uses (Florida Administrative Code, Chapter 62-777). During the late 1980s and through the 1990s, the amount of elemental arsenic imported into the State of Florida associated with CCA-treated wood use was over 1,400 tons per year. The cumulative amount of elemental arsenic imported through the year 2000 (associated with CCA-treated wood usage) was 131,000 tons. If it is assumed that this quantity (131,000 tons) of elemental arsenic were to impact the upper 1 inch of Florida soil, the arsenic concentration of the soil would increase by 4 mg/kg (figure I.2 and Appendix A). This is significant compared to Florida's background arsenic concentrations and compared to the levels that would cause an elevated risk to humans.

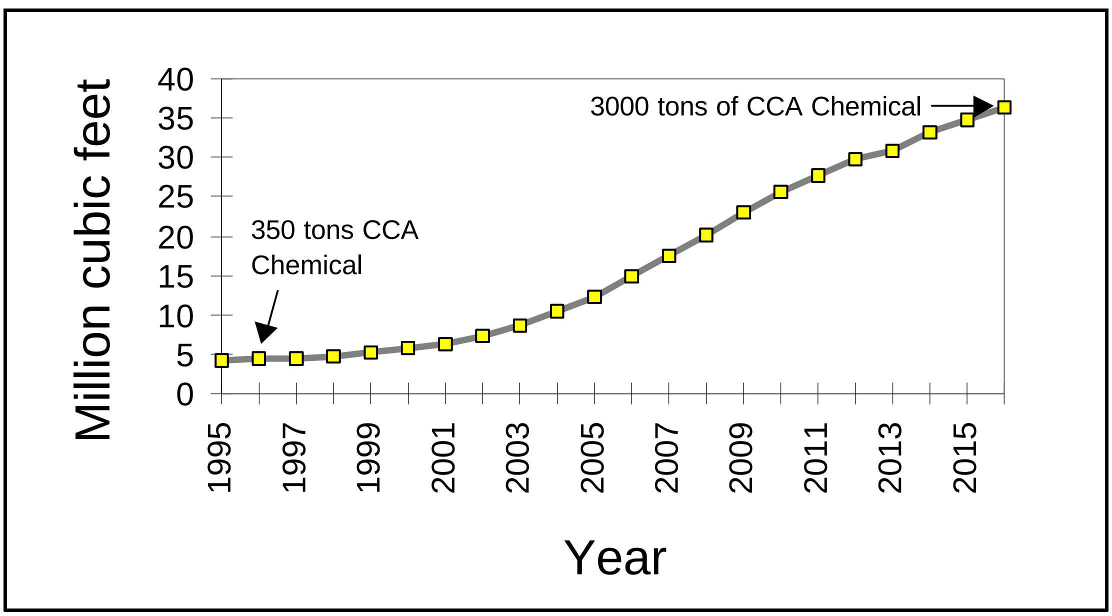


Figure I.1: Disposal Forecast for CCA-Treated Wood Waste in Florida

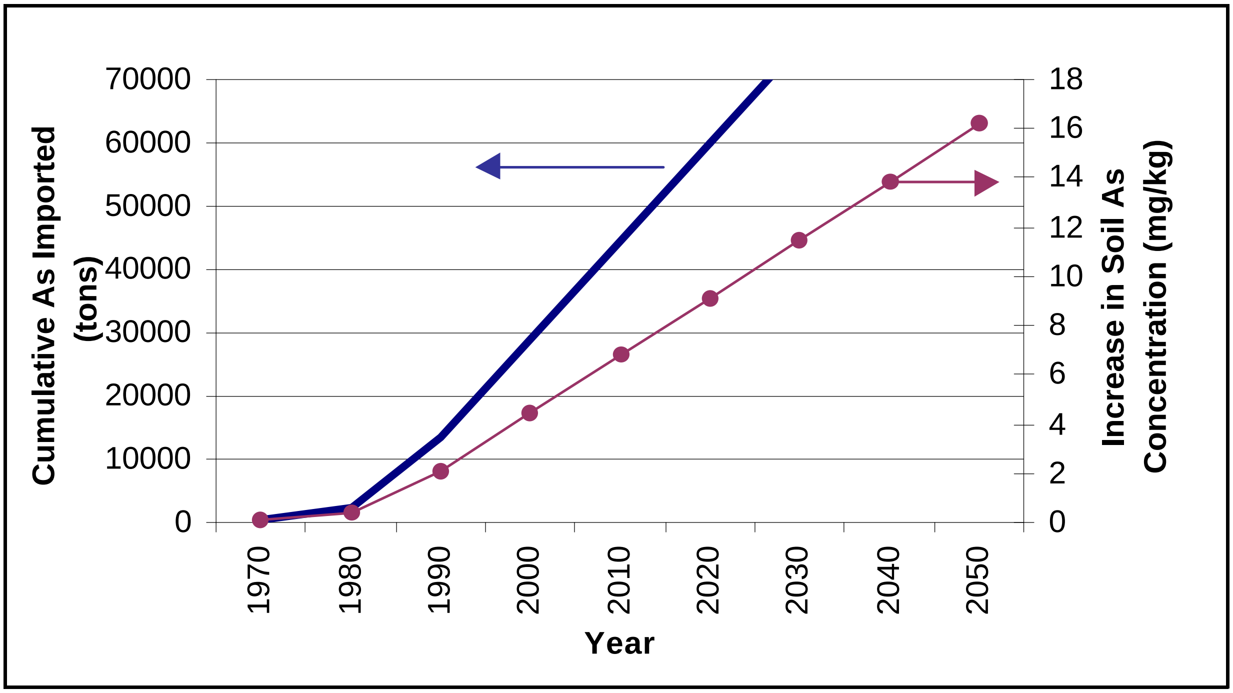


Figure I.2: Scaling Computation Illustrating Potential Impacts of Arsenic Importation into the State of Florida

I.2 OBJECTIVES

The overall goal of this research was to minimize the impacts of discarded CCA-treated wood, especially the arsenic from this product, on the Florida environment. In establishing the objectives for this study it was determined that this goal could be achieved through two broad approaches. The first was to evaluate alternative wood preservative chemicals that contained no arsenic. The use of non-arsenical preservatives would translate to a significant decrease in the quantities of arsenic imported into the State and eventually into a significant decrease in the amount of arsenic disposed associated with CCA. The use of alternative chemicals, however, would only make a significant impact on the composition of wood waste after the typical service life of CCA-treated wood, which is on the order of 25 to 40 years. To illustrate this point, a disposal forecast (Solo-Gabriele and Townsend 1999) was developed using historical treated wood production statistics for the State of Florida (figure I.3). One forecast is based upon the assumption that the future yearly production for CCA-treated wood is equal to the production during 1996 which was roughly 35 million cubic feet. For this assumption the amount disposed into the future would "level-off" to 35 million cubic feet per year of product. A second forecast was developed by assuming that in the 2002, wood treatment in Florida changes completely to a non-arsenical alternative chemical. The disposal forecast for this case looks very similar to the forecast for the first case for the 2002 to 2025 time period. Only after the year 2025 is a decrease observed for the quantity of CCA-treated wood disposed. The disposal sector will therefore experience a significant increase in the amount of CCA-treated wood disposed in years to come, regardless of policy concerning the use of the product today. Therefore, improved disposal-end management is very important for the State.

The second approach in meeting the project goal focused on evaluating improved disposal management strategies for CCA-treated wood waste. Three different tasks were established for the disposal-end management portion of this study. These tasks included: a) a field demonstration of sorting technologies using chemical stains to distinguish between CCA-treated wood and other wood types at C&D facilities, b) a literature review of pyrolysis technology and full-scale systems for ultimate disposal of CCA-treated wood, and c) development of a resource book for the wood disposal sector which compiles a list of facilities that are willing to dispose or recycle/reuse discarded CCA-treated wood. The resource book is intended to serve general educational purposes as well as provide an easy-to-read reference for those who must ultimately dispose of CCA-treated wood.

The organization of this report is consistent with the project objectives and is summarized as follows.

- Alternative Chemicals (Chapter II)
- Disposal End Management (Chapter III)
  - ✓ Field Demonstration of Sorting Technologies (Section III.1)
  - ✓ Pyrolysis Technology (Section III.2)
  - ✓ Resource Book for Wood Disposal Sector (Section III.3)

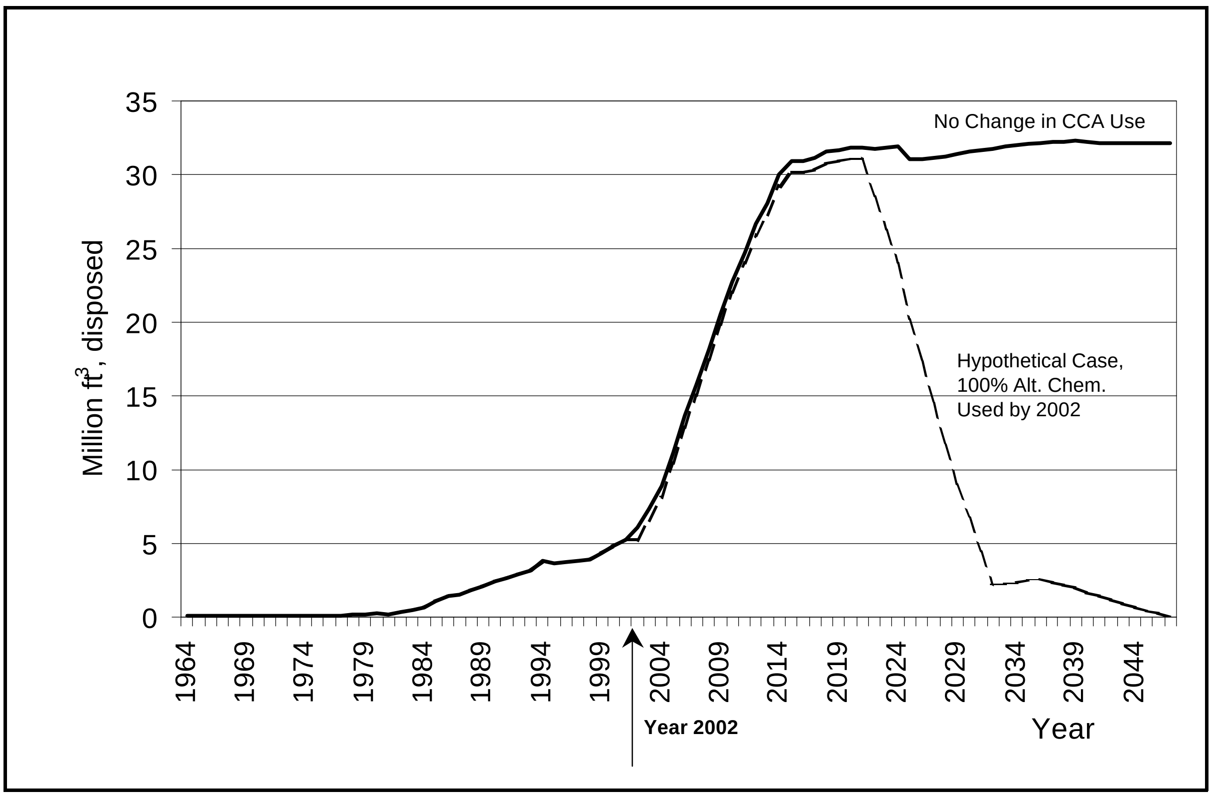


Figure I.3: Long-term Disposal Forecast for CCA-Treated Wood Waste in Florida

I.3 BACKGROUND

I.3.a General Information Concerning CCA-Treated Wood

The most common wood preservative used in the U.S. is chromated copper arsenate (CCA). CCA represents roughly 75% of the treated wood market by wood product volume; among waterborne preservatives, CCA represents over 97% of the market. During 1997 40% of all treated poles and pilings and over 90% of treated lumber, timbers, posts, and plywood were treated with CCA. Approximately 144 million pounds of the chemical were utilized in the U.S. during 1997 to produce 450 million cubic feet of treated wood product (AWPI, 1997). The State of Florida utilizes between 6 and 15% of the U.S. production of CCA-treated wood products in any given year (Solo-Gabriele *et al.* 1998).

CCA is composed of the oxides of chromium, copper, and arsenic. The copper in the wood serves as the fungicide whereas the arsenic protects the wood against insects. The chromium fixes the copper and arsenic to the wood. The most common formulation for CCA is Type "C" which is composed of the following proportions of chemicals: 47.5% as CrO_3, 18.5% as CuO, and 34.0% as As_2O_5 (AWPA, 1998). The amount of CCA utilized to treat the wood or retention level depends upon the particular application for the wood product. Typical retention levels utilized by the industry are 0.25 pcf, 0.40 pcf, 0.60 pcf, 0.8 pcf, and 2.50 pcf. (Note: pcf = pounds per cubic foot). Low retention values (0.25 pcf) are permissible for plywood, lumber, and timbers if the wood is used for above ground applications. Higher retention values are required for load bearing wood components such as pilings, structural poles, and columns. The highest retention levels (0.8 and 2.5 pcf) are required for wood components which are used for foundations or saltwater applications.

CCA is a member of a class of wood preservatives called “waterborne preservatives.” All waterborne preservatives utilize water to carry the treatment chemical into the wood fiber. After chemical addition, most of the water is evaporated through kiln drying or natural processes leaving the CCA chemical within the wood. Waterborne preservatives differ from oilborne preservatives and creosote by providing wood with a surface that is easy to paint and by producing no odor or vapor while in service. At low retention values waterborne preservatives do not change the general appearance of the wood, maintaining the aesthetic quality of natural wood. CCA-treated wood is suitable for use indoors and is generally used for interior parts of a wood structure in contact with the floor. Drawbacks of the wood are a strong green color at high retention values. It should not be used in applications where it is in contact with food or drinking water.

I.3.b CCA-Treated Wood Within Florida’s Waste Stream

A majority of wood waste in Florida is either disposed of in C&D landfills, which are generally unlined, or recycled as either wood fuel for cogeneration, or mulch. However, there are growing concerns about the impact of treated wood, particularly CCA-treated wood, on the quality of the wood waste stream. The primary drawback in the use of CCA-treated wood for recycling purposes is the high levels of metals within the wood product. The concentration of chromium, copper, and arsenic in CCA-treated wood exceed values in untreated wood by several thousand mg/kg for retention levels of 0.25 pcf and 0.60 pcf and by tens-of-thousands of mg/kg for a retention level 2.50 pcf (table I.1). After incineration, the concentration differences between untreated and treated wood are more pronounced. For untreated-wood ash, the sum of the chromium, copper, and arsenic concentration is less than a few hundred mg/kg. For treated wood with retention levels of 0.25 pcf and 0.60 pcf, metals represent about 4 % and 13% of the ash weight, respectively. In other words, for every 100 pounds of ash, many pounds (4 or 13 pounds respectively for 0.25 pcf and 0.60 pcf) would be in the form of metals. At a 2.50 pcf retention level, metals account for about 39% of the ash weight (Solo-Gabriele et al. 1999).

Currently the amounts of CCA-treated wood observed within the waste stream represent a problem. CCA-treated wood has been identified as the cause of elevated arsenic and chromium concentrations in the ash from wood cogeneration facilities located in Florida and it has been found in recycled wood waste at C&D facilities at an average concentration of 6% (Solo-Gabriele and

Townsend, 1999; Tolaymat et al. 1999). Furthermore, there has been a recent increase in the use of C&D wood waste within the mulch industry, primarily in the production of colored mulch. The 6% value is too high if wood waste is to be recycled properly. In order to use wood waste as fuel so that the resultant ash is not classified as hazardous, earlier research by Solo-Gabriele et al. 1999 indicates that wood fuel must contain less than 5% CCA treated wood whereas other studies (C.T. Donovan and Assoc. 1995) indicates that levels should be as low as 1 to 2%. In order to recycle wood waste as mulch it must contain less than 0.1% CCA if it is to meet Florida's industrial soil clean-up target level. Thus, the presence of CCA-treated wood within the wood waste stream strongly limits recycling opportunities for wood waste as a whole.

The concerns about CCA-treated wood in the waste stream are heightened by the forecasted increases in CCA-treated wood waste within the next 15 years and the lack of proper management strategies currently in place for handling the material in an environmentally responsible fashion. Implementation of improved disposal-end management strategies for the material must be expedited for the State of Florida.

Wood Type			Metals Concentration, mg metal per kg of wood or ash		
			Cr	Cu	As
Unburned Wood[a]	Untreated Wood		7.0	3.7	2.0
	CCA-Treated Wood at 0.25 pcf		2,060	1,230	1,850
	CCA-Treated Wood at 0.60 pcf		4,940	2,950	4,435
	CCA-Treated Wood at 2.50 pcf		20,600	12,300	18,500
Ash[b]	Non-CCA-Treated Wood		141	212	28
	CCA-Treated Wood at 0.25 pcf		20,600	11,200	11,400
	CCA-Treated Wood at 0.60 pcf		51,100	32,300	42,800
	CCA-Treated Wood at 2.50 pcf		174,000	104,000	113,500
Regulatory Limits	Federal[c]	Ceiling (mg/kg)	Not Applicable	4300	75
		Pollution (mg/kg)	Not Applicable	1500	41
	Florida[d]	Industrial (mg/kg)	430	12,000	3.7
		Residential (mg/kg)	290	105	0.8

[a] Computed values assuming that retention rating equals amount of chemical in wood.
[b] Measured values
[c] Federal Register 40 CFR Part 503.13, Standards for the Use or Disposal of Sewage Sludge, Subpart B, Land Application. These standards are used in many instances as guidance levels for regulating metals concentrations in other land applied wastes.
[d] Florida Department of Environmental Protection,Chapter 62-777, F.A.C. Contaminant Target Clean-up Levels

Table I.1: Chromium, Copper, and Arsenic Concentrations in Treated Wood and Treated Wood Ash Samples Used in This Study. Regulatory Levels Provided for Comparison.

CHAPTER II

ALTERNATIVE CHEMICALS

CHAPTER II, ALTERNATIVE CHEMICALS

This chapter on alternative chemicals begins by summarizing: the methods used to evaluate the alternatives (II.1) and the general characteristics of 7 alternative chemicals that meet the project criteria (II.2). After a general review of these 7 chemicals, four chemicals were chosen as the most promising alternatives to CCA. A more in-depth evaluation of these four alternatives is provided in the subsequent sections which focus on efficacy (II.3), depletion/leaching (II.4), corrosion (II.5), mechanical properties (II.6), and costs (II.7). Material safety data sheets (MSDS) for the alternative chemicals and alternative-chemical treated wood are provided in appendix A. The chapter ends by providing a summary of advantages and drawbacks of the alternative chemicals as perceived by wood treaters and large end users of CCA-treated wood (II.8).

II.1 METHODS

Chemical alternatives investigated during this phase of study were waterborne preservatives that contain no arsenic. The alternative chemicals considered included those which had been used commercially to some extent and standardized by the American Wood Preservers' Association. Waterborne preservatives were chosen because of their aesthetic characteristics (non-oily, no odor, etc...) which makes them especially attractive for residential home usage. The second set of criteria was based upon the desire to identify alternative preservatives that could be quickly brought into widespread commercial use. Therefore, chemicals that are still in the research phase were not considered in this project due to the large lag-time that would be necessary in specifying these alternatives within the marketplace. Futhermore, there are chemicals utilized in other countries (including copper chrome boron used in Germany) that have not been standardized in the U.S.A. and thus are not included within the list of chemicals considered. Chemicals that met the criteria for this research include the following (table II.1).

AAC: alkyl ammonium compound
ACC: acid copper chromate
ACQ: alkaline copper quaternary
Borates
CBA: copper boron azole
CC: copper citrate
CDDC: copper dimethyldithiocarbamate

Table II.1: Alternative Chemicals Evaluated

An initial evaluation of these 7 alternative chemicals was made by corresponding with the manufacturers of the alternative chemicals by telephone and email. Marketing information and samples of the alternative chemical treated wood products were gathered. Furthermore, each alternative chemical manufacturer is required to publish a proposal if they seek standardization through the American Wood Preservers' Association *Book of Standards*. It was found that these proposals, when available, were extremely useful in evaluating the technical characteristics of each alternative. After a preliminary evaluation of the information gathered it was determined that four of the seven alternative chemicals showed considerable promise as potential substitutes to CCA. These alternative chemicals included ACQ, CBA, CC, and CDDC. These four chemicals were then the subject of a more in-depth evaluation which focused on comparing efficacy, leaching/depletion, corrosion, mechanical properties, and costs. In order to facilitate the gathering of data, a field trip was taken during June to July 1999 to meet with representatives from each alternative chemical manufacturer. The technical centers located in Griffin and Conley, Georgia were visited for the chemicals produced by Osmose and Hickson, respectively. Meetings were arranged at the manufacturing facilities of Chemical Specialties Inc (CSI) located in Charlotte, NC and Kodiak Inc. located in Allendale, SC. A summary of the information gathered for each of the alternative chemicals is provided in table II.2. A summary of contact information for each alternative chemical manufacturer and distributor is provided in table II.3.

	AAC	ACC	ACQ	Borates	CBA	CC	CDDC
Telephone Inquiries	✔	✔	✔	✔	✔	✔	✔
Marketing Info			✔	✔	✔	✔	✔
AWPA Proposal			✔		✔	✔	✔
Add'l Literature			Some	Some	Some		Some
Sample		✔	✔	✔	✔	✔	✔
List of Retail Outlets			✔				✔
Company Visited		Osmose	CSI	Osmose	Hickson	Osmose	Kodiak

Table II.2: Information Gathered for Each Alternative Chemical

Furthermore, the perceived advantages and drawbacks associated with the use of alternative chemical treated wood products were evaluated among wood treaters and users of treated wood products by developing and mailing a questionnaire to these sectors. A copy of the questionnaire sent to the wood treaters and large-end users along with samples of the cover letters is provided in appendices B and C. These appendices also contain a list of the facilities sent questionnaires. The wood treater questionnaires were sent to all known treatment facilities located within Florida, southern Georgia, Mississippi, and Alabama. Inquiries were made about general company information, CCA usage, and alternative chemicals. Questions concerning alternative chemicals were designed to determine whether there were any alternative chemical treaters within the study area, and inquired about the treater's perceived advantages or drawbacks concerning wood treated with an alternative chemical. The first mailing of the questionnaire occurred during April 1999. This mailing was followed-up by numerous phone calls to non-responding plants and a second mailing during January 2000.

The large-end user questionnaire included questions concerning CCA usage. Specifically, the questionnaire inquired about factors that were important to the large-end users in choosing a particular product when CCA-treated wood was considered for purchase, the amount of CCA-treated wood purchased, and potential alternatives to CCA products. The first mailing occurred during June to July 2000. The questionnaire was mailed to electric utilities that serve more than 300,000 people, to Bell South, and to representatives of Home Depot and Lowe's Hardware. The first mailing of the large-end user questionnaire was followed by numerous phone calls to non-responding facilities and a second mailing during January 2000.

Chemical	Company Name	Company Address	Contact Person	Phone/Fax	Internet Contact
AAC	Mason Chemical Company	721 West Algonquin Road Arlington Heights, IL 60005	Robert DeWolf	Phone: (847)290-1621 1-800-362-1855 Fax: (847)830-1625	mason@maquat.com
AAC	Lonza		Bill Woods or Lee Walker	Phone: 1-800-777-1875	
AAC	AKZO		Dalton Thompson	Phone: (803)327-1249	
ACC	Osmose Wood Preserving Inc.	P.O. Drawer 0 Griffin, Georgia 30224-0249	August (Gus) Staats, Mngr. of Environ. Services	Phone: (770)228-8434 Fax: (770)229-5225	
ACQ	Chemical Specialties Inc. (Manufactures alkaline copper and supplies quat solution for ACQ.)	One Woodlawn Green Suite 250 200 E. Woodlawn Road Charlotte, NC 28217	Sales: Tom Fitzgerald Tech. Serv.: David Jones R&D: Alan Preston	Phone: (704)522-0825 or 1-800-421-8661 Fax: 1-704-527-8232	email:acqinfo@ chemspec.com http://www. treatedwood.com
Borates	Osmose Inc. (Distributors)	P.O. Drawer 0 Griffin, Georgia 30224-0249	August (Gus) Staats Manager of Environ. Serv.	Phone: (770)228-8434 Fax: (770)229-5225	
Borates	U.S. Borax, Manufacturer of Tim-Bor	U.S. Borax Inc. 26877 Tourney Road Valencia, CA 91355-1847	Mark Manning, Ph.D (661)287-6089 Frederick Ascherl (805)287-6013 Victor Lew (805)287-6086	Tarun Bhatia Phone: (661)287-6055 Fax: (661)287-5545 Jeff Lloyd Phone: (661)287-6075 Fax: (661)287-6014	jeff.lloyd@borax.com
Borates	Other Manufacturers Kerr-McGee Chemical Corp. AZ-Bor Corp.				
CBA	Hickson Corporation	1579 Koppers Road Conley, GA 30027 1955 Lake Park Dr., Suite 250 Smyrna, GA 30080	Kenneth E. Cogan Plant Manager Bob Gruber, Vice Pres. Regulatory Affairs	(404)363-6300 Fax: (404)363-8585 (770)801-6600 Fax: (770)801-8170	ken_cogan@hicksoncorp.com Bob_Gruber@HicksonCorp.COM
CC	Osmose Wood Preserving Inc.	P.O. Drawer 0 Griffin, Georgia 30224-0249	August (Gus) Staats Mngr of Environ. Serv	Phone: (770)228-8434 Fax: (770)229-5225	
CDDC	Kodiak Inc.[1]	Hwy. 278 East at Airport Road P.O. Box 99 Allendale, SC 29810	Don Dean, plant mngr (x132) or Jim Nix, head operator for trtmnt (x137)	Phone: (803)584-1923 1-800-K-KODIAK Fax: (803)584-2208	nixj@kodiakwood.com www.kodiakwood.com

[1]The Kodiak Inc. wood treatment facility went up for sale during January 2000.

Table II.3: Contact Information for Alternative Chemical Manufacturers

II.2 GENERAL BACKGROUND

General information is provided for the seven alternative chemicals identified in table II.1. Information provided in this section includes, where available, a description of the chemical formulation for each alternative, aesthetic characteristics, warranty information, and general environmental considerations. Additional information is provided for a particular alternative where appropriate. For example, efficacy information is provided in this section for borate-treated wood given that it is not included in section II.3, the section on efficacy. The background on ACQ-treated wood includes information concerning treatment plant conversions, given that such a treatment plant was visited as part of the information gathering effort. The unique treatment process and history of CDDC-treated wood is also discussed within this section.

II.2.a Alkyl Ammonium Compound (AAC), a.k.a. DDAC

Alkyl ammonium compound (AAC) is also known as didecyl dimethyl ammonium chloride (DDAC) and is sold through Mason Chemical under the tradename, Maquat 4450-E (EPA registration no. 10324-34). The chemical formula for DDAC is provided in figure II.1 which is located in the section describing ACQ.

Three chemical manufacturers (Mason Chemical, Lonza, and AKZO) were contacted concerning the use of AAC as a wood preservative. All three indicated that AAC is generally not sold as a stand alone wood preservative. Work by Dubois and Ruddick, 1998, showed that AAC as a stand alone preservative performed as well as CCA in laboratory tests against wood decay fungi; however, when wood treated with AAC was tested in the field, it did not perform well. Manufacturers recommend that AAC be mixed with other chemical preservatives if it is to be used to treat wood. Mason Chemical, for example, provides information concerning mixing AAC with ACQ-C2 (EPA registration no. 10465-36), ACQ-C (EPA registration no. 10465-33), Tim-Bor a borate containing preservative (EPA registration no. 1624-39), and with propiconazole an organic-based wood preservative (EPA registration no. 1409-65 or 43815-15). Other recommended uses of the chemical in wood preservation include as a brush-on preservative for freshly cut pieces, uses within wood stains, and for remedial treatment of treated wood products.

II.2.b Acid Copper Chromate (ACC)

Acid copper chromate (ACC) is a preservative used during the 1970s. Today, there is only one treatment plant that utilizes ACC in the U.S. This plant is located in Idaho. The primary market for ACC-treated wood from this plant is for the construction of cooling towers (Staats, Osmose Inc., personal communication). ACC is currently distributed through Osmose Inc. After several information requests through the American Wood Preservers' Association and Osmose Inc., it was determined that no technical information was available concerning this chemical and therefore this chemical was dropped from consideration during the evaluation as a suitable alternative for CCA-treated wood. It is important to note, however, that ACC has been standardized by the AWPA for lumber, timbers, plywood, and glue-laminated members in above ground uses and ground contact uses and for posts and columns used in general construction. ACC is the only alternative chemical on the initial list of preservatives (table II.1) that contains chromium.

II.2.c Alkaline Copper Quat (ACQ)

General information

Alkaline copper quat (ACQ) is a mixture of copper and quat. Copper serves as the primary biocide. The quat serves as a secondary biocide which interacts synergistically with the copper to improve the efficacy of the treatment chemical. The quat in ACQ is used in swimming pool chemicals, shampoos, hospital mop washes, and many other human contact applications. Two formulations have been marketed by Chemical Specialties Inc: ACQ Type B and ACQ Type D. Both contain the same ratio of active ingredients, copper and quat. The difference in the formulation lies in the carrier fluid. ACQ Type B is dissolved in a solution of ammonia (NH_3) in water whereas ACQ Type D is dissolved in ethanolamine. ACQ Type D provides for easier handling characteristics of the treated wood and lower treatment operational costs. Furthermore, wood treated with ACQ Type D provides for more uniformity of color (CSI 1995). This difference in carrier fluid results in different wood penetration characteristics. ACQ Type B tends to penetrate western wood species better. For Florida, which treats primarily with Southern Yellow Pine, ACQ Type D is the recommended formulation (Archer, CSI, personal communication).

Chemical Characteristics

ACQ contains 66.7% copper as CuO by weight and 33.3% quat as didecyl dimethyl ammonium chloride (DDAC). The ratio of copper to quat in ACQ is 2:1. Raw materials utilized for chemical production include recycled metallic copper which is then dissolved in ethanolamine, C_2H_7NO and water for the ACQ-D formulation. The pH of the solution is adjusted by adding carbon dioxide, CO_2. This ethanolamine solution along with DDAC is then mixed in appropriate ratios by the treatment plant to form the ACQ solution. The structural formula of DDAC is provided in figure II.1. Other additives to the ACQ solution include boric acid which is not claimed to serve as an active biocide. A mold inhibitor and an anti-foam agent may be added to the formulation by some ACQ treatment plants.

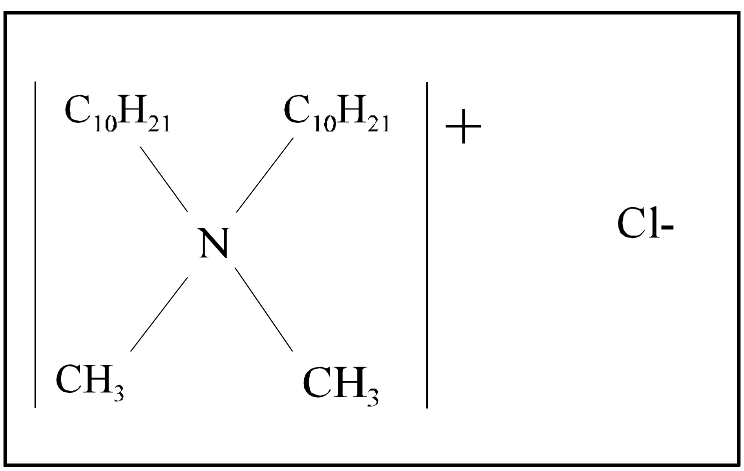


Figure II.1: Stuctural Formula of DDAC, the organic component of ACQ

Aesthetic Characteristics

The color of ACQ-treated wood is a light tan to an olive color. The color depends upon the species of wood, heartwood and sapwood content, chemical retentions and treatment cycle parameters. Within a species, treated heartwood is typically brownish, whereas the sapwood is green to brown in color. Typically southern yellow pine exhibits a greenish color. After weathering the wood is a gray to gray brown tone. There is no detectable odor or vapor associated with the treated wood product and it can be stained or painted. Both oil-based and latex paints can be used. Paint test adhesion analysis indicates that adhesion of coating materials tested onto boards treated with ACQ Type D was not significantly different than adhesion on the untreated control boards, and often performed better than that on CCA treated boards (CSI 1995).

Currently Chemical Specialties Inc. is seeking accreditation from AITC (American Institute of Timber Construction) for glue systems. The company is currently negotiating with glue resin manufacturers to develop special resins needed for laminators (Archer, CSI Inc., personal communication).

Environmental Considerations

The results from toxicological and ecotoxicological tests indicate that ACQ-treated wood has low mammalian toxicity. The chemical contains no EPA listed compounds and no known or suspected carcinogens (ACQ Type B & D product information).

Chemical Specialties Inc. 1995 recommends that ACQ-treated wood be disposed via landfill. Alternative disposal strategies may include incineration followed by chemical extraction of copper and recycling through acid extraction (CSI 1995). If ACQ Type D treated wood is incinerated, CSI Inc. claims that the gaseous products of combustion will be similar to those for untreated wood.

The ACQ Type D concentrate was found to be a skin irritant and like other copper containing wood preservatives ACQ Type D concentrate is toxic to aquatic organisms. A study conducted by Bennett and Farrell in 1998 indicates that larval forms of a particular fish species are very sensitive to DDAC, the organic component of ACQ.

Warranty

A lifetime limited warranty is available for certain residential and agricultural uses.

Treatment plants that utilize ACQ

As of 1999, nine treatment plants treated with ACQ in the U.S. These plants were located in California (2 plants), Illinois, North Carolina, Ohio, Oregon, Rhode Island, Washington State, and Wisconsin. Approximately 60 million board feet of the product were sold in 1998 collectively by these plants through 300 retail outlets around the country (Archer, CSI Inc., personal communication).

Treatment Plant Conversion to ACQ

A meeting and tour was taken at the largest ACQ treatment plant on the eastern seaboard. The information below is a summary of that meeting and tour.

The existing ACQ plant that was toured was converted from a CCA-treating plant. The amount of ACQ-treated wood sold by this plant during 1998 was 12 million board feet. The absolute maximum capacity of the plant if run 24 hours per day 7 days per week is 40 million board feet per year. The conversion of the plant required that valves and the impellers of the chemical feed pumps be converted to stainless steel. The work tanks that hold the chemical must be made of soft roll metal, fiberglass, or special polymers. If the water-repellant formulation of ACQ (or CCA for that matter) is to be used, the mixing pumps should be air driven given that mechanical pumps tend to shear the emulsion associated with the water-repellant. It is important to note that some existing CCA treatment plants, especially the newer ones, already have work tanks of appropriate composition and stainless steel valves and propellers, so costs associated with these conversions would not be incurred at these plants. Chemical drip pads are not required at ACQ plants by the Resources Conservation and Recovery Act (RCRA); existing drip pads from a retrofitted CCA treatment plant can be used to collect runoff that can be re-incorporated into the ACQ treatment process. CSI recommends their use. The time to apply the ACQ chemical is slightly longer than the time for CCA application; however, this difference in time is more than offset by the much shorter fixation time associated with ACQ. The plant manager estimates that the cost for converting a CCA plant to an ACQ plant was recovered by the company within a period of a few months. Business has been going well for this particular ACQ treater and plans are in place for this facility to expand treatment operations with ACQ.

II.2.d Borates

General Background

The use of boron-based formulations for wood preservation has the advantages in that the chemical has low acute oral and dermal toxicity; it is colorless, odorless, non-corrosive (*Proceedings* 1997) and non-flammable when applied to wood,. Borates can be added to wood in liquid, solid, or vapor form for the primary treatment of the wood. It can also be added in the form of rods (e.g.Tim-bor Rods and Impel Rods) for remedial treatments (Manning and Arthur 1995).

Borate, as a liquid, is very diffusible in wood and treatment even under non-pressurized conditions will result in the distribution of borate throughout the wood matrix, including the heartwood. If the wood cracks or is cut during construction, the part that is exposed is still protected (Best 1988). The highly diffusible nature of borate represents a drawback for treated wood used in outdoor environments given that it can diffuse out from the wood when it comes in contact with water. Therefore, wood treated with diffusible borate has been standardized by the AWPA only for uses where the product does not come in contact with water.

Borate in a powder form, such as zinc borate, can be incorporated into composite materials including particleboard, flakeboard, oriented strand board, and parallam. Powdered borates used in composite materials are non-diffusible and remain within the treated wood, even when in contact with water.

Borates can also be applied to wood in a vapor phase. The method involves exposing untreated wood to a vapor of a volatile boron compound, trimethyl borate (TMB), which leads to the deposition of the active preservative ingredient boric acid in the wood (Manning et al. 1997). Methanol is a by-product of the reaction and can be recovered from the wood at the end of the treating process and can be recondensed for reprocessing into new TMB or it can have other uses. The wood remains dry during treatment. The process therefore has the advantages in providing shorter processing times and minimizing dimensional changes in the wood during treatment (Greaves 1990). Borate application in the vapor phase, however, has seen limited application in the industry and is still considered an experimental method.

Borate-treated wood is used extensively in New Zealand, Australia, and Europe, especially in Germany and the United Kingdom. It has also been used in southeast Asia to treat rubberwood used for furniture manufacturing (Lloyd 1997). The U.S. market for diffusible borates is estimated between 50 to 100 million board feet per year (Clif Jones, Osmose Wood Preserving, personal communication). Diffusible borates are available in the U.S. from the major wood preservative suppliers as well as directly from borate producers. The most well known diffusible borate is disodium octaborate tetrahydrate (DOT) and is sold under the tradename Tim-bor® by U.S. Borax and distributed by Osmose Inc. DOT is also available from North American Chemical as well as producers located in South America. A similar product is sold overseas by Hickson Corp. under the trade name Diffusol® (Gene Pasek, Hickson Corp, personal communication) for the treatment of timber by diffusion. Zinc borate powder for use in composite materials is sold under the trade name Boroguard® ZB, and Composibor™ by U.S. Borax but is also available from North American Chemical and other manufacturers.

Given the restrictions in the use of stand alone borates, however, the new preservative could tap into a very small fraction of the existing U.S. CCA market. For example borate-treated wood can be used for sill plates in areas not prone to flooding, pallets, and composite materials. The future large impact of borate-treated wood in the U.S. lies in a completely new market known as the "whole house" concept where all interior framing of a home is treated to decrease the potential for termite attack. In the U.S., wood within the interior of a home, not in contact with the external environment or the floor or foundation, is generally not treated. Examples of these products include joists, roof trusses, beams, studs, trim, rafters, framing, and sheathing. The primary exception to this practice is found within the State of Hawaii where all wood framing must be treated as per Hawaiian Building Standard No. 2317.5 and between 80 to 90% is currently treated with DOT, which replaced CCA in this use about 8 years ago (Lloyd, U.S. Borax, personal communication).

Adoption of a "whole house" treatment concept is a possibility in other U.S. States located in high termite hazard zones. The State of Louisiana, for example, has recently passed regulations that empowers the state's commissioner of agriculture and forestry to develop rules and regulations to help combat losses against termite damage (State Senate Bill No. 373). If Florida were to adopt a "whole house" treatment system, borate-treated wood should be considered among the preservative chemicals of choice given its benefits and cost effectiveness.

A further possible impact of borates on CCA use is indirect through its incorporation within multi-chemical formulations such as CBA and ACQ.

Chemical Formulations

Powdered Borate Preservatives, zinc borate: Powdered borate preservatives, which are known under the tradename Borogard® ZB, are also known by the chemical names of zinc borate hydrate (2335) and dodecaboron tetrazinc docosaoxide heptahydrate. The composition of the chemical is 48.0% as boric oxide (B_2O_3), 37.5% zinc oxide (ZnO), and 14.5% water of crystallization (H_2O). The overall chemical formula is 2 ZnO•3 B_2O_3•3.5 H_2O. The zinc in the formulation serves as a co-biocide. Zinc also tends to be leach resistant due to its lower solubility (Manning and Laks 1997)

Diffusible Borate, disodium octaborate tetrahydrate: Historically diffusible borates were applied as boric acid ($B(OH)_3$) or borax ($Na_2B_4O_7$•5H_2O or $Na_2B_4O_7$•10H_2O). However, the use of disodium octaborate tetrahydrate (DOT) has gained popularity due to its higher solubility, fast rate of dissolution, higher boron content, and higher pH which makes it a mores desirable preservative (Manning and Arthur 1995). The chemical formula for DOT is $Na_2B_8O_{13}$•4H_2O. The chemical consists of 67.1% boric oxide (B_2O_3), 14.7% sodium oxide (Na_2O), and 18.2% as water (H_2O). The pH of the treating solution ranges from 8.5 for a 1% solution to 7.6 for a 10% solution. DOT is the most water soluble of the commercially available borates; true solubilities range from 9.5% at 20 ^oC to over 30% at temperatures above 50 ^oC but higher concentrations at these temperatures are readily achieved through supersaturation. This high water solubility allows the chemical to be applied either by dip or pressure treatment process (Manning and Laks 1997). The dipping process involves dipping the wood into a concentrated borate solution for a period of time just sufficient to wet all surfaces. The timber is then held under non-drying conditions to allow the borate to diffuse throughout the cross-section. The time for the chemical to diffuse throughout the cross-section is approximately 6 weeks. Diffusion time can be reduced to 7 to 9 days by pre-steaming the wood prior to treatment, or pressure treatment, or followed by an increase in the wood storage temperature (Manning and Arthur 1995). In fact, borates are the only preservative which can be effectively applied to green lumber. DOT-treated wood is recommended for interior or protected use (not in ground contact) due to the high solubility of compound, even after application.

Efficacy

Borate-treated wood is effective against decay fungi, wood boring beetles, termites, and general household pests such as cockroaches and silverfish. Published data is available for performance against decay (Morrell et al. 1998) and subterranean termites (Tsunoda et al. 1998). The New

Zealand Timber Preservation Council specifies 0.1 % boric acid equivalent (BAE) w/w for softwoods and 0.2% BAE w/w for hardwood, although they do not have a subterranean termite problem which requires a higher borate loading. The AWPA standard suggests a loading of 0.17 pcf B_2O_3 in a 0.0 to 0.6 inch assay zone which is equivalent to 0.9% BAE w/w for Southern Yellow Pine (Manning and Arthur 1995). Although borate-treated wood is effective against decay fungi, it is important to note that in diffusion treatment of green lumber additional fungicides are normally added to the treatment solution to prevent mold discoloration. DDAC, the quarternary ammonium compound described in sections II.2.a and II.2.c, is typically used.

There are two general DOT retentions normally specified in the U.S. One provides protection against North American Subterranean Termites, decay, and insects at a minimum retention level of 0.25 pcf as DOT. The other provides protection against the same organisms and the Formosan Subterranean Termite (minimum retention level is 0.42 pcf as DOT).

Lloyd, 1995, and Manning et al., 1997, indicate that there is no danger of efficacy loss due to external exposure during construction. Loss of these preservatives can only take place to a serious degree when treated timber remains wet throughout its cross-section for long periods, while at the same time having an external sink for boron migration.

Aesthetic Characteristics

Treatment with diffusible borate does not impart color nor an odor to the wood. Borate-treated wood appears the same as untreated wood. However, this can confuse some builders who wish to easily see that wood is treated and so a colored dye can be added. Blue-green is currently used in Hawaii (Lloyd, U.S. Borax, personal communication). The borate in borate-treated wood will not affect ferrous metals, fasteners, or screws. The wood can be easily machined, glued, coated, and painted.

Environmental Considerations

Boron-treated wood is suitable for conventional methods of disposal (e.g. combustion), but is also amenable to more novel approaches (Manning et al. 1997). For example, because borates are compatible with a number of resins and glues, treated wood can be incorporated into composite wood products. Alternatively, wood dust from treated material can be potentially disposed through land application as a method of fertilizing agricultural fields with boron (Lloyd 1998). Wood chips from borate-treated timber can also be used as animal bedding. This reuse option has the added benefit of providing two commodities: sanitized bedding material and, subsequently fertilizer when bedding is spread on fields as is customary with animal waste. The latter use is particularly appropriate since animal manure tends to have a relatively low boron content and so the addition of borate-treated wood has the effect of elevating the final boron level of the fertilizer (Manning et al. 1997). It is perhaps of interest to note that the active ingredient in borate preservatives is the same as in agricultural fertilizers and vitamin supplements, and that the amount of borates applied to crop land is in excess of 60,000 tons per year (Lloyd, U.S. Borax, personal communication).

Warranty

A 20-year $10,000 transferable whole-house limited warranty is available for non-commercial residential construction.

Restrictions

Diffusible borates, including Tim-Bor® treated wood products, are not to be used in outdoor environments. Borates are very effective against mold such as sapstain and blue-stain. However, borates are compatible with many sapstain preventive chemicals that help combat blue-stain and are normal components in anti-stain wood treatments.

Costs

The cost of the borate chemical is generally less that the cost of the CCA chemical (Lloyd, U.S. Borax, personal communication). Therefore, for an equivalent “economy of scale” the cost of borate-treated wood should be less than the cost of CCA-treated wood. Actual chemical cost of borate-treated wood is very minor, with most of the additional cost resulting from additional handling and transportation due to the treatment process (Lloyd, U.S. Borax, personal communication).

II.2.e Copper Boron Azole (CBA)

General Background

Copper boron azole (CBA) is a mixture of three preservatives, copper, boron, and azole. The principle biocide is copper which is effective against termites and a wide variety of decay organisms. The azole and boron are co-biocides that provide additional protection against termites and other decay organisms.

The chemical is produced by Hickson Corporation and is marketed as Tanalith® E outside of the U.S. It is used extensively in Japan and Europe including Germany, France, Sweden, Italy, and Holland. It is also being used to construct structures for the 2000 Olympics in Syndey, Australia (DeVenzio, Hickson Corp., personal communication). Although the chemical has been field tested in North America, the chemical has not been marketed in the U.S as of April 2000. However, representatives from Hickson (Black, Hickson Corp., personal communication) indicate that U.S. marketing materials are currently under development. The tradename that will be utilized for CBA marketed in the U.S. will be Wolman® E.

Chemical Composition

CBA will be supplied as a one-pack concentrate. It is prepared by dissolving copper (as $CuCO_3$) and boric acid in ethanolamine (C_2H_7NO). The azole, tebuconazole, is emulsified with surfactants and added to the concentrate. Tebuconazole is the name given to alpha [2-(4-chorophenyl)ethyl]-alpha-(1,1-dimethylethyl)-1H-1,2,4-triazole (1)-ethanol]. The concentration of components within the concentrate is 9.25% copper, 9.25% boric acid, and 0.37% tebuconazole. The ratio of copper to boric acid to azole for CBA Type A preservative is 25:25:1 (Hickson 1998). The pH of the concentrate is 11 ± 0.5. The concentrate is diluted with water to make a working solution (Gruber, Hickson Corp., personal communication).

Aesthetic Characteristics

The color of CBA-treated wood is a green color similar to that of CCA. After weathering the wood turns a honey brown color. There is no detectable odor or vapor associated with the treated wood product. The wood can be painted.

Environmental Considerations

Results show that the CBA has low mammalian toxicity and is non-mutagenic (Hickson 1998). The concentrate was found to be an irritant to the skin and, like other copper containing wood preservatives, it has a high toxicity to the aquatic organisms. Based on these results, good personal hygiene and the use of suitable protective equipment is recommended. Treating plants should be designed to prevent loss of preservative to the environment.

The recommended method for the disposal of CBA-treated wood is by landfill or incineration. Hickson Corp., 1998, claims that if CBA is incinerated the gasous products of combustion are similar to those for untreated wood. Note that open burning of the treated wood is not recommended. It should not be used in domestic heaters nor should it be used as cooking fuel. Alternative disposal strategies have also been investigated. Copper present in the treated wood or ash is water insoluble but may be extracted with acid for recycling. CBA-treated sawdust and shavings are not recommended for composting, mulching or for use as animal litter (Hickson 1998).

II.2.f Copper Citrate (CC)

General Information

Copper citrate (CC) treated wood is used primarily in Northern California in the form of posts. The material is generally sold to agricultural cooperatives in the area, primarily for grape stakes. Only one wood treatment plant actively utilizes the preservative commercially.

Chemistry

Copper citrate is a formulation containing 4 moles of copper oxide (CuO) to 1 mole of citrate ($C_6H_4O_7$) (Anderson et. al 1992). The composition by weight is given as:

- 62.8% Copper Oxide and 37.2% Citrate

  OR
- 62.3% Copper Oxide and 37.7% Citric Acid

The above chemicals are dissolved in a solution of ammonia (NH_3) in water. To aid in solution, it is necessary that the treating solution contain carbonate (as CO_2) at least equal to 0.5 times the weight of copper as copper oxide.

Aesthetic Characteristics

The color of CC-treated wood is a green color similar to that of CCA-treated wood. The heartwood portion of CC-treated wood products is a brownish-green color. After weathering the wood appears a natural light brown color. There is a mild ammonia odor on the wood immediately after treating. This odor dissipates over time, however. There are no special restrictions on painting CC-treated wood (Inwards, Osmose, personal communication).

Environmental Considerations

Osmose Inc. through their marketing information recommend that CC be dispose by ordinary trash collection or burial. CC-treated wood should not be burned in open fires stoves, fireplaces, or residential boilers because toxic chemicals may be produced as part of the smoke and ash. Treated wood may be burned only in commercial or industrial incinerators or boilers in accordance with state and federal regulations.

Warranty

Osmose Wood Preserving warrants that CC meets AWPA Standard P5-95. Osmose Wood Preserving, Inc., makes no other warranties of fitness for a particular purpose otherwise.

Restrictions

CC is approved for lumber, timbers, plywood, and posts. Copper citrate is not recommended, at this time, for the treatment of critical structural wood commodities such as piling or poles, or for use in preserved wood foundations (Anderson et al. 1992).

II.2.g Copper Dimethyldithiocarbamate (CDDC)

Treatment Process

CDDC is a unique preservative in that the active ingredient is formed in-situ by two sequential treatments. Thus, the commercial plant incorporates two separate processing cylinders that distinguish it from a typical waterborne treating plant (McIntyre 1998). The existing treatment plant located in Allendale, South Carolina is fully computerized and rated at a capacity of 50 million board feet per year. As of 1999 yearly production was estimated at 1 million board feet per year. The plant is characterized by two primary chemical feed tanks each with a capacity of 15,000 gallons and two treatment cylinders each of 60 feet in length. The first treatment cylinder is designed to apply bivalent copper-ethanolamine (2-aminoethanol) (CuMEA) and the second applies sodium dimethyldithiocarbamate (SDDC). Copper is the active ingredient in the first step and the ethanolamine is the carrier fluid. Dithiocarbamate is the active ingredient in the second treatment cylinder. CDDC is formed within the wood in the second cylinder; the residual treatment chemical from the second cylinder is recycled through a filtration process to remove excess CDDC crystals. A sludge is produced in the process. This sludge is considered non-hazardous and can be disposed in a landfill (Nix, Kodiak Inc., personal communication).

Wood is introduced to each of the cylinders (which are both made of carbon steel) through an elaborate conveyor system that is in the form of a "table top" (See figure II.2). This particular conveyor configuration was chosen to fit the dimensions of the building that houses the plant. Limitations in the maximum length of product that can be treated is governed by the existing conveyor system which can carry a maximum length of 22 feet. Limitations in the maximum treatable length can be overcome by redesigning the conveyor and cylinder tank system. According to Jim Nix, head operator at the Kodiak plant, an ideal layout would include treatment cylinders with dual doors which can then be aligned lengthwise so that the product from one cylinder can be passed directly to the second cylinder (See figure II.3).

During 1999, the primary market for CDDC was the northeastern portion of the U.S. extending from northern Virginia to Maine and west to Ohio. There were also markets in Arizona, Florida, Illinois, and Texas. Roughly 90 Kodiak wood dealers are found within these states. In Florida, during October 1999, Dixie Plywood and Lumber Company began to stock CDDC-treated wood in their outlets located in Orlando, Tampa, West Palm Beach, and Miami (Nix, Kodiak Inc., personal communication). By January 2000, however, the Kodiak Inc. treatment facility along with its patent for producing CDDC were put-up for sale and was no longer producing CDDC-treated wood.

Chemistry

The first part of the treatment process is the application of copper to the wood. Historically two different copper solutions have been used for this purpose. The first is copper as copper sulfate, $CuSO_4$, which is needed for the production of CDDC Type S. More recently, copper has been applied as copper hydroxide in an ethanolamine solution. CDDC produced with the copper ethanolamine solution, CuMEA, is known as CDDC Type A. The chemical concentrate consists of 10% copper as Cu or 17.45% copper as $Cu(OH)_2$. Ethanolamine (2-aminoethanol), C_2H_7NO, the carrier fluid for the copper, is present in a 30% concentration in the concentrate and has a pH greater than 12. The working solutions are generally diluted by a factor of 10 with a CuMEA concentration of 1 to 2%.

The second treatment solution consists of sodium dimethyldithiocarbamate (SDDC).

Dithiocarbamates are known as excellent fungicides and are extensively used in agriculture (Petric et al. 1998). The SDDC concentrate (40%) has a pH of 11 to 13.2; the treating solution typically contains 4% SDDC (McIntyre et al. 1994). The copper dimethyldithiocarbamate chemical is produced within the wood fiber during the application of the second chemical. There are two complexes formed through this chemical application process, a 1:2 complex and a 1:1 complex (figure II.4). The relative proportion of each complex formed is dependent upon wood treatment conditions.

Unlike CCA-treated wood which requires days to fix by air drying, fixation time for CDDC-treated wood is on the order of hours (Cooper and Stokes 1993).

History of the Chemical

Work on CDDC first began in 1969 through the efforts of Bob Arsenault who was working for Koppers Inc. at the time. The process he developed involved a two step treatment process in which the first treatment chemical applied was copper sulfate and the second was sodium dimethyldithiocarbamate (SDDC). The performance data for this chemical was presented in 1991 (Arsenault et al. 1991). During the late 1980's and 90's, independent research through Mike West of Chapman Chemical Co. resulted in a patent for the process. During the early 90's ISK Biosciences, who then owned the patent, was able to successfully standardize CDDC in 1995 through the AWPA. ISK Biosciences implemented the full-scale production of CDDC-treated wood in 1996 under the trade name Kodiak® (McIntyre 1998).

Aesthetic Characteristics

CDDC-treated wood is a dark-honey brown color upon treatment. Knots in the wood tend to stain a very dark brown to black color. If the number of knots are to be minimized for aesthetic reasons, the treatment of grade 1 dimensional wood is recommended. After weathering CDDC-treated wood turns a silver-gray. Lightly sanding the outer layer of the wood will restore the treated wood's brown color. The chemical will not vaporize once in the wood. It is not susceptible to either thermal or photochemical degradation.

The treated wood product can be painted with oil-based and latex paints; however, oil-based in recommended. Stains are available to match the dark brown color. If wood is cut, heartwood portions generally do not stain resulting in a lighter color that does not match the exterior. An end cut solution is available to stain the cut heartwood portions of the wood. The treated wood can be readily glued and machined (Nix, Kodiak Inc., personal communication).

Environmental Considerations

The metal chelates as a concentrated solution can be slightly irritating to the skin and moderately toxic on oral ingestion. Marketing information for CDDC states that emissions from burning CDDC-treated wood are no worse than untreated wood; however, Arsenault 1991 speculates that the dimethyldithiocarbamate metal chelates will emit hightly toxic fumes of cyanide if heated to decomposition. Subsequent test burns have shown, however, that insignificant quantities of cyanides are formed during combustion (McIntyre, McIntyre and Assoc., personal communication).

Warranty

A lifetime residential limited warranty is provided by the manufacturer of CDDC-treated wood products.

Restrictions

Not recommended for areas that may come in contact with chlorine since chlorine removes the surface color and gives the wood a “greenish” cast. Therefore CDDC-treated wood should not be used for decks around pools and hot tubs.

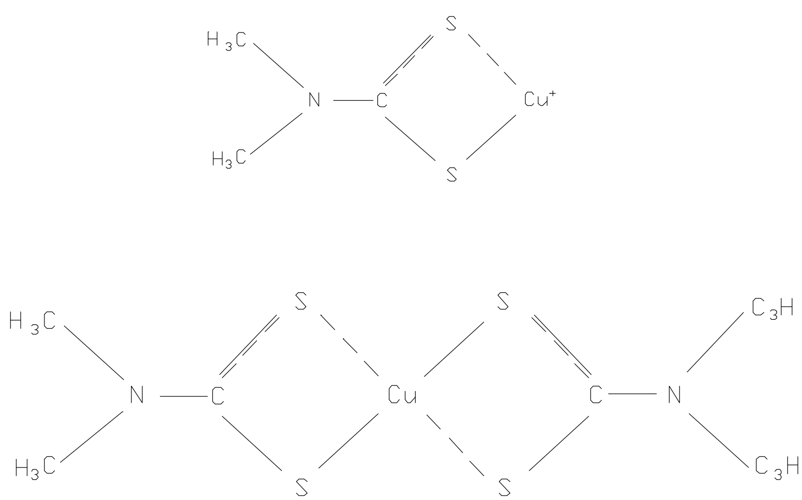


Figure II.4: Structural Formula of CDDC.
Above, 1:1 Complex. Below: 1:2 Complex
(From Arsenault et al. 1991)

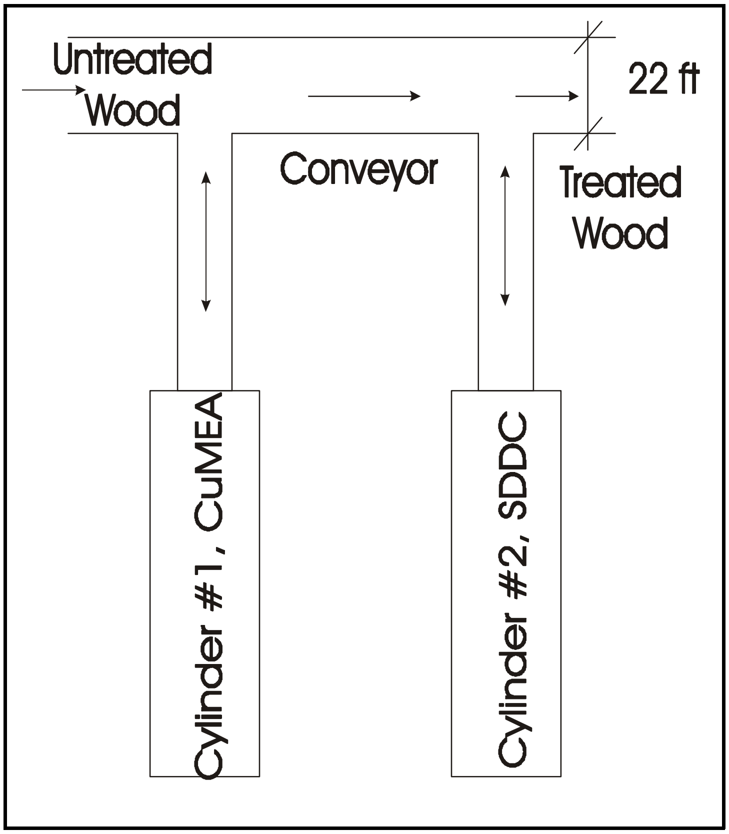


Figure II.2: “Table-top” Configuration of the Existing CDDC-Treatment Plant

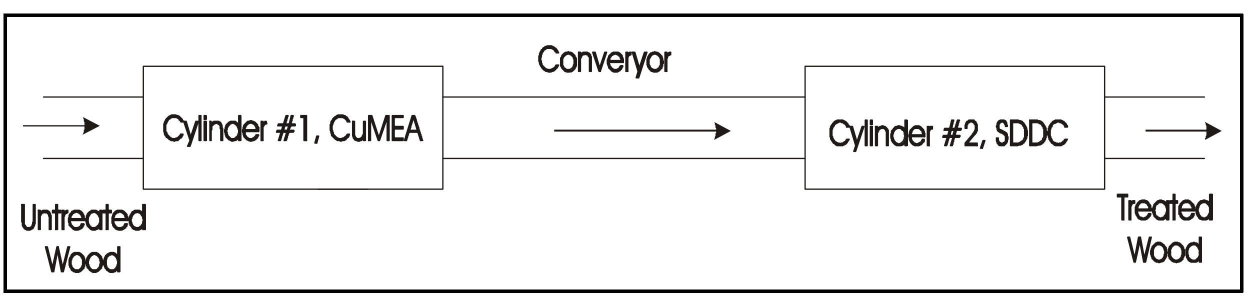


Figure II.3: Recommended Configuration for a CDDC-Treatment Plant.

II.2.h Summary

General chemical and aesthetic characteristics of each of alternative chemical discussed in this section are provided in table II.4. With the exception of AAC and borates, all of the alternative chemicals contain copper. The majority of the copper containing alternatives also contain an organic co-biocide. The treatment process that is utilized for each chemical is similar except that CDDC requires two treatment cylinders rather than 1, and borates can be applied in a variety of methods, in addition to traditional pressure treatment processes. Aesthetically, all the alternative treated wood products appear similar except for the dark honey brown color associated with CDDC-treated wood and the fact that borate-treated wood appears like untreated wood.

Abbreviation	Chemical Name	Chemical Composition	Aesthetic Characteristics
AAC	Alkyl Ammonium Compound	100% DDAC	
ACC	Acid Copper Chromate	31.8% CuO and 68.2% CrO_3	Light tan to olive
ACQ-D	Alkaline Copper Quaternary	66.7% CuO and 33.3% DDAC	Light tan to olive
Borates		Boron in various different forms including disodium octaborate tetrahydrate (DOT)	Appears like untreated wood (for diffusible borates)
CBA-A	Copper Boron Azole	49% Cu, 49% H_3BO_3, 2% tebuconazole	Green color similar to CCA
CC	Copper Citrate	62.3% CuO and 37.7% Citric Acid	Green color similar to CCA
CCA-C	Chromated Copper Aresenate	18.5% CuO, 34% As_2O_5, 47.5% CrO_3	Green hue which is more intense at high retention levels.
CDDC-A	Copper Dimethyldithio-carbamate	Cu and SDDC, The weight ratio of Cu to SDDC varies from 2.5 to 5.0	Honey brown

Table II.4: General Characteristics of Alternative Chemicals

II.3 EFFICACY

Efficacy is defined as the effectiveness of a treatment process to prolong the useful service life of wood. The longer the treated wood lasts, or resists fungal decay or termite attack, the more effective is the chemical treatment. Efficacy tests conducted on alternative-chemical treated wood products can be separated into two general categories: laboratory tests (II.3.a) and field tests (II.3.b). These tests can be further subdivided into tests that focus on resistance to termites or fungi. The term decay is used to describe the efficacy of treated wood against fungi. Given the large number of tests conducted by each company, the results provided below focus on those tests performed on treated Southern Yellow Pine and which included a CCA-treated control, when available. Furthermore, detailed results from tests are provided only for the field data, given that field based data is more readily accepted by the wood treatment industry as proof of performance than are the results from laboratory-based tests. The data obtained from laboratory and field efficacy tests are used to standardize the alternative preservatives for various uses. A summary of these standardizations are provided in section (II.3.c).

II.3.a Laboratory Tests

Laboratory tests include soil-block, agar-block, and fungus cellar tests. In a soil-block test (AWPA method E10-91), blocks of wood containing a pre-determined retention level of chemical are exposed to wood-destroying species of both brown-rot and white-rot fungi. The blocks along with the fungi inoculum are placed within a sealed jar containing soil. Efficacy is measured as a loss of block weight. An agar-block test is similar to a soil-block test except that it uses agar instead of soil medium. Agar-block tests are the recommended standard in Europe. The fungus cellar test is also known as an accelerated soil bed test (AWPA Standard E14-94). In the fungus cellar an unsterilized soil sample is maintained under conditions designed to accelerate decay. The method requires controls for temperature, humidity, and soil moisture content. The colonization of the wood sample relies on the natural soil microflora rather than upon an inoculum. The fungus cellar test is considered to be an intermediary test procedure between laboratory and field tests. Furthermore, some companies provided results from termite tests (AWPA method E1-97). The standard termite test method involves placing damp sand, termites, and a treated wood sample into a container; in some cases an additional block of untreated wood is also added to the container. A rating is provided to the treated wood sample which is based upon the amount of wood consumed by the termites. Tests are usually conducted with different termite species, with the Formosan termite considered to be the most difficult to protect against. Companies interested in standardizing their preservatives for marine applications will also include marine aquaria tests which involve placing treated wood within marine aquariums that have been inoculated with marine borers.

ACQ: Soil-block tests conducted using ACQ-D treated SYP with four different fungi, including a specie of copper tolerant fungi, showed that ACQ-D was effective against the fungi at a retention level of 0.25 pcf. A series of agar-block tests conducted with other wood species also support that ACQ-D was effective against fungi. Results from three separate fungal cellar tests conducted over 45 month, 50 month, and 22 month test periods indicate that performance of ACQ-D is equivalent to that of CCA up through 0.4 pcf retention levels (CSI 1995).

CBA: Results of agar-block tests using Scots Pine (rather than SYP) indicate that toxicity thresholds for coppr tolerant fungi for CBA-treated wood is similar to that of CCA-treated wood (Hickson 1998). Soil-block tests using CBA-treated SYP showed that CBA-treated wood performed as well as ACZA-treated wood. Unfortunately a comparison with CCA-treated wood was not available. Results from a fungal cellar test run for a 53 month exposure period indicates that CBA-treated wood performed better than CCA-treated wood at retention levels through 0.5 pcf (Hickson 1999). Hickson Corp. supplemented the fungal cellar test data with results from the AWPA standard termite test using a "common" termite and a Formosan termite. Results from these tests indicate that CBA is as effective as CCA against termites (Hickson 1999).

CC: A soil block test was conducted to determine the toxicity thresholds of fungi to CC-treated wood. The toxic threshold for two copper-tolerant brown-rot fungi was found to be greater than 0.6 pcf. The toxic threshold of one other brown-rot fungus tested was 0.2 pcf (Anderson et al. 1993).

CDDC: Results from soil block data indicate that CDDC performed as well as CCA for three of the four fungi tested at retention levels through 0.4 pcf. Poorer performance was noted among *P. placenta*, a copper tolerant fungi (Arsenault 1993). Results from the agar-block decay test indicate that results obtained from CDDC- and CCA-treated wood were comparable, especially when CDDC-treated wood was leached prior to experimentation. Results from a 12 month fungal cellar test indicates that CDDC-treated wood out-performed CCA-treated wood. Results from marine aquaria tests indicate that CDDC-treated wood out-performed CCA-treated wood against marine borer species (Cookson et al. 1998)

II.3.b Field Tests

The standard field test for determining efficacy of treated wood (AWPA Standard E7-93) is based upon installing a series of stakes placed partially above ground within wooded test plots. The stakes are inspected periodically for signs of biological attack. Two grades are usually assigned to each stake: one for fungal decay and one for termite attack. Grades vary from a value of 0 to 10; ten indicating that the stake is sound and zero indicating that the stake has failed. A minimum of five years worth of data is usually needed for such tests to be considered for preservative standardization by the AWPA (Nix, Kodiak Inc., personal communication). Within the industry, standard field tests are considered to be the most reliable indicator of efficacy prior to installation of the wood. Other field tests include marine evaluation tests which require the placement of treated wood panels within an ocean exposure site.

ACQ: Standard stake tests were conducted with ACQ-D within test plots located in Harrisburg, NC, Gainesville, FL, and Hilo, HI. Results from the Harrisburg test plot run over a 46 month test period indicate that the performance of ACQ-D and CCA was comparable at 0.25 pcf and 0.40 pcf retention levels. No significant difference was noted in performance between ACQ-D with and without a water repellent additive for this site. The results from the Hilo, HI test plot conducted over an 18 month exposure period and from the Gainesville, FL test plot conducted over a 24 month period confirmed the results from the Harrisburg test plot indicating that ACQ-D and CCA performed comparably at 0.25 pcf and 0.40 pcf retention levels. CSI Inc. also tested ACQ-D in the field using configurations other than stakes, including boards lying flat on concrete blocks, above ground simulated decking, and series of innovative field termite tests. Results from these additional field tests indicate that ACQ-D and CCA are comparable at the 0.25 pcf and 0.40 pcf retention levels.

CBA: Field stake tests were conducted in Conley, Georgia, and Gainesville, Florida. Two sets of field tests were conducted. One set was conducted using Fahlstrom stakes (1/8" x 1.5" x 10") and another set was conducted using 3/4" stakes. All tests were conducted over a 77 month exposure period except for the Fahlstrom stakes at the Gainesville site which were conducted over a 65 month exposure period. The Fahlstrom stakes showed considerable attack (for both CBA-A and CCA-C) after the exposure period. The 3/4 inch stakes showed evidence of attack after 65 months (for both CBA-A and CCA-C treated stakes) at the lower retention levels tested (<0.4 pcf). Results from these tests show that the performance of CBA-A is comparable to that of CCA-C (Hickson 1999).

CC: Two test plots were initiated in Gainesville, Florida for CC-treated wood. Seven years of data were available for the first test plot and five years of data were available for the second test plot. Results from the first test plot indicate that CC-treated wood performance was similar to that of CCA-treated wood. Results from the second test plot indicate that CC-treated wood is slightly inferior, however comparable, to CCA-treated wood at a similar retention level (Anderson et al. 1993, p. 5). Results were available for two marine exposure tests. The first test was conducted over a period of 74 months within Biscayne Bay located off the coast of Miami, FL. The second test was conducted in Yaquina Bay, OR over a period of 60 months. Results from these tests indicate that the performance of CC-treated wood is similar to that of CCA-treated wood submerged in marine environments at the 1.5 pcf and 2.5 pcf retention levels (Anderson et al. 1993).

CDDC: Field tests conducted on CDDC-treated wood differ from the other alternative chemicals in the longevity of their tests. Two stake installations were used. One set was monitored over a 20 year period within a test plot located in Charleston, SC. Another test plot was initiated in Orange Park, FL. After five years, the Orange Park plot was discontinued and the stakes containing the highest chemical retention were transferred to a test plot located in Bainbridge, GA for the duration of the 23 year test (Arsenault et al. 1993). Results show that CDDC-treated wood at 0.22 pcf as copper performs about the same as CCA-treated wood at a 0.4 pcf retention. Performance was comparable between 0.1 pcf as Cu CDDC and 0.25 pcf CCA (Arsenault et al. 1993; Arsenault et al. 1991).

Testing for CDDC-treated wood has been initiated for saltwater applications; however, standardization has not yet been sought for use in marine environments. Following the AWPA standard procedures (AWPA Method E5), SYP panels treated with CDDC were installed in Key West, FL, in July 1994. The average rating after 42 months exposure showed that CDDC at 0.5 pcf Cu is performing essentially the same as CCA at 2.5 pcf oxide. CDDC-treated wood at 0.25 pcf as Cu was still performing very well at the time that the report was written (McIntyre 1998).

II.3.c Summary, Comparison Among the 4 Alternatives

A comparison among the four alternative chemicals for efficacy against decay is provided in figure II.5. Please note that each symbol in this figure corresponds to a different alternative chemical. The data shown correspond to the results from stake tests. For each chemical the results of the untreated and CCA-treated controls are shown for comparison. When evaluating the data it is important to compare performance of an alternative against the performance of CCA-treated wood control within the same test which is indicated by those which have the same symbol. Results show that for all tests, the untreated controls performed relatively poorly exhibiting a considerable amount of decay within two years. Results for the treated wood indicates that the performance of the alternatives was comparable to that of CCA.

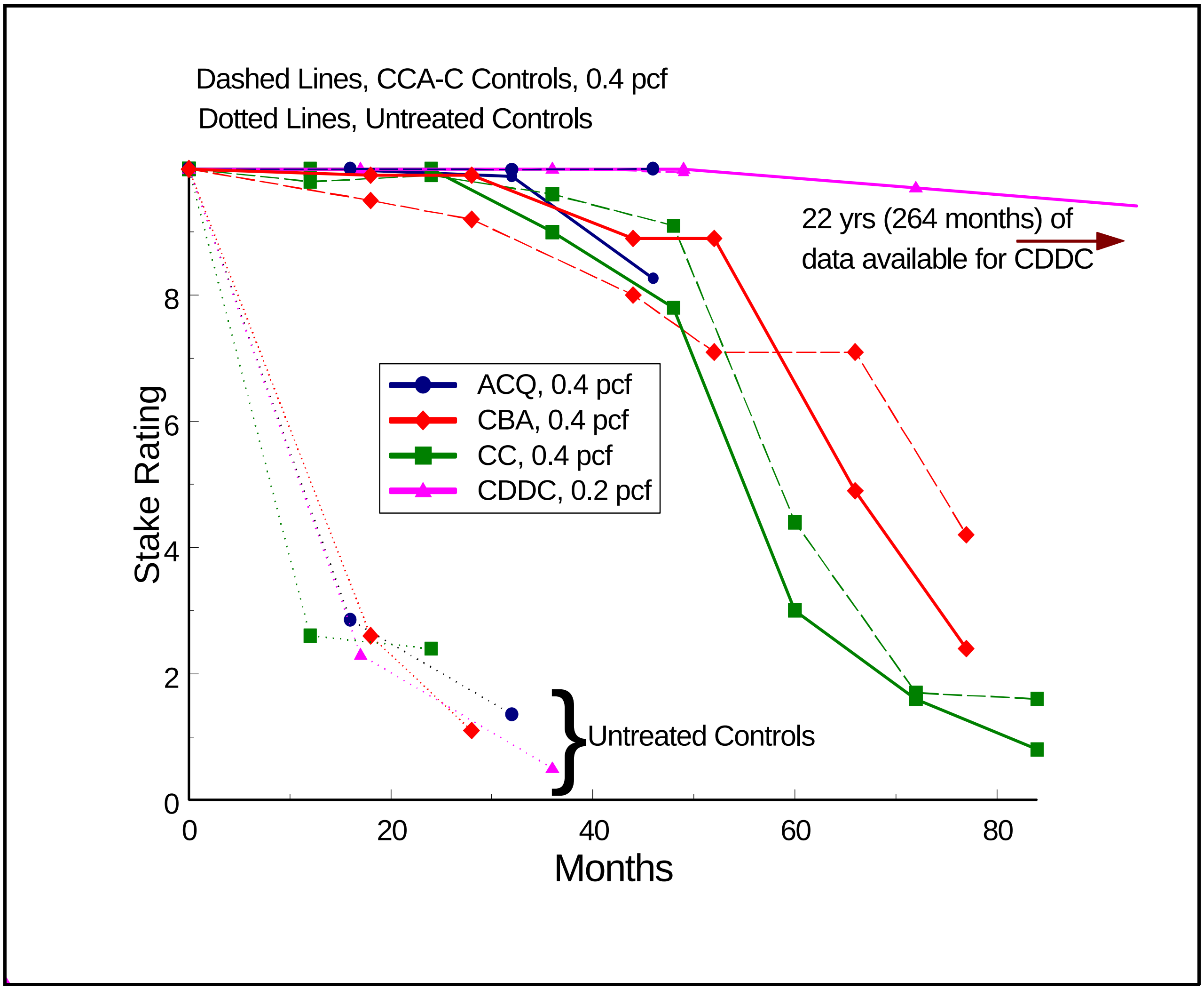


Figure II.5: Comparison of Efficacy Data for ACQ-, CBA-, CC-, and CDDC- Treated Wood.
Note, Dashed Line for CDDC & ACQ treated wood hidden by solid line for CDDC-treated wood.

II.3.c Standardization of Alternative Chemicals

Standardization of treated wood is necessary in order to commercialize the product for inclusion within building specifications. AWPA standards are recognized by most specifiers of marine, road, and building construction, as well as by local, state and federal governments (AWPA 1999). In the U.S., there are two standardization routes for treated wood. The first, which is the most common method, is through the AWPA. The second route is through the building codes. The most widely used building code in the U.S. is the Uniform Building Code and some alternative chemical manufacturers have sought standardization through this second route. However, this building code is not recognize throughout the State of Florida, such as in South Florida where construction is regulated through the South Florida Building Code.

Standardization through the AWPA was reviewed by compiling data from the commodities section of the *1998 AWPA Book of Standards*. It is important to note that the list of commodities is extensive. A summary of the standardization for CCA- and alternative-chemical treated wood products is provided in table II.5. Within this table, "Yes" indicates that the chemical has been standardized for the application. Retention levels, in pcf, for which they have been standardized are provided in parenthesis. Please note that the designation of the retention level for CDDC-treated wood is different than the designation used for other chemicals. CDDC-treated wood is specified in terms of pcf as copper whereas for the other chemicals it is specified as pcf in terms of all chemical components. The CCA components, for example, are added on an oxide basis.

As indicated in table II.5 CCA-treated wood has been standardized for a wide range of commodities. All of the four alternative chemicals which were identified as the strongest candidates have been standardized for the treatment of lumber and timbers in above ground and ground contact applications. CDDC-treated wood has been standardized through lumber and timbers used in structural composites. The reason that the manufacturers have not sought standardization for poles is due to logistical restrictions of their conveyors at the treatment plant rather than chemical performance issues (See section II.2.g). Furthermore, a considerable amount of data has been collected for the performance of CDDC-treated wood in marine environments. Although the marine data looks very promising, the manufacturers of CDDC-treated wood have not sought standardization for use in submerged water and marine environments. ACQ-treated wood has been standardized through poles. It is important to note that standardization for utility poles has been obtained for ACQ Type B, not for ACQ Type D which is the formulation recommended for Southern Yellow Pine. The reason that Type D has not been standardized for poles is because the chemical manufacturers have not perceived a demand for treating SYP poles with ACQ and have therefore chosen not to invest resources in further standardization (Archer, CSI Inc., personal communication). There currently is one installation of ACQ-B utility poles in Eugene, Oregon. A qualitative analysis of these poles indicates that they are performing well (Archer, CSI Inc., personal communication). CC-treated wood is the only preservative among the four alternatives that has been standardized for marine applications. Products for marine applications are limited to lumber, timber, and plywood. Also of interest is the fact that ACC-treated wood, which was not among the four considered to be the most promising, has been standardized for lumbers, timbers, plywood, posts, and columns used in above ground and ground contact applications.

ACQ- and CBA-treated wood have been accredited by the International Conference of Building Officials (ICBO) for inclusion within the Uniform Building Code (UBC). CBA-treated wood has been approved for above ground use at a 0.204 pcf retention level and for soil and fresh water contact at 0.408 pcf retention. The ICBO states that CBA-treated wood should not be used in areas subject to Formosan termite attack. Detailed information concerning the standardization process for ACQ is provided in table II.6.

Use	Product	ACC	ACQ Type B or D	CBA	CC	CCA	CDDC
Above ground	lumber, timbers, ties	Yes (0.25)	Yes (0.25)	Yes (0.204)[a]	Yes (0.25)	Yes (0.25)	Yes (0.10)[b]
Above Ground	Plywood	Yes (0.25)	Yes (0.25)	Yes (0.204)	Yes[c] (0.25)	Yes (0.25)	
Above Ground	Glue Laminated Members[d]	Yes (0.25)				Yes (0.25)	
Soil or Water Use	lumber, timbers, ties	Yes (0.50)[e]	Yes (0.40)	Yes (0.408)	Yes (0.40)	Yes (0.40)	Yes (0.2[f])
Soil or Water Use	Plywood	Yes (0.40)	Yes (0.40)	Yes (0.408)	Yes (0.40)	Yes (0.40)	
Ground Contact	Glue Laminated Members[d]	Yes (0.50)	Yes (0.40)[g]			Yes (0.40)	
General Construction	Posts and Columns	Yes (0.50)	Yes (0.40)	Yes (0.408)	Yes (0.40)	Yes (0.40)	Yes[h] (0.20)
General Construction	Crossarms					Yes (0.40)	Yes (0.20)
Structural Composites	Lumber & Timbers		Yes[g] (0.60)			Yes (0.60)	Yes[h] (0.20)
Used on Permanent Wood Foundations	Lumber & Plywood		Yes[i] (0.60)			Yes (0.60)	
Highway Construction	Poles		Yes[i] (0.60)			Yes (0.60)	
Land and Freshwater Foundations	Piles					Yes (0.80)	
Marine & Coastal Waters	Lumber, Timbers, Ties, & Plywood				Yes (2.50)	Yes (2.50)	
Marine & Coastal Waters	Piles					Yes (2.50)	

[a] Corresponds to 0.10 pcf as Cu
[b] 0.1 pcf as copper is approximately 0.48 pcf CDDC
[c] Not for roof decking or flooring,in residential construction
[d] Treated Prior to Gluing
[e] A 0.62 pcf retention level recommended for use on farms
[f] 0.2 pcf as copper is approximately 0.96 pcf CDDC
[g] Approved only for highway construction
[h] Approved only for residential and commercial construction
[i] ACQ-B only

Table II.5: Standardization of CCA- and Alternative-Chemical Treated Wood Products by the AWPA, 1998. Retention level in pcf provided in parenthesis.

Use	Product	Standards[a]	Species[b]	Preservative	
				ACQ-B	ACQ-D
Above Ground	Lumber	AWPA C2, ICBO	SYP, HF	Yes	Yes
		AWPA C2	PP	Yes	Yes
		AWPA C2	PP		Yes
Above Ground	Plywood	AWPA C9, ICBO	SYP, HF, PP	Yes	Yes
Ground Contact, Fresh Water	Lumber	**ACQ C2, ICBO**	SYP, HF, PP	Yes	Yes
Ground Contact, Fresh Water	Plywood	AWPA C9, ICBO	SYP, HF, PP	Yes	Yes
Foundations	Plywood	AWPA C22	All Species	Yes	
		ICBO	SYP, DF	Yes	Yes
	Lumber	AWPA C22	SYP, PP, DF, HF	Yes	
		ICBO	SYP, PP, DF, HF	Yes	Yes
Highway Construction	Utility Poles	AWPA C4	SYP, PP, DF	Yes	
	Lumber and Bridge Timbers	AWPA C14	SYP, DF, HF	Yes	
	Guard Rail Posts, Spacer Blocks	AWPA C14	SYP, DF, HF	Yes	
General Construction	Fence Posts	AWPA C5	SYP, DF	Yes	Yes
Commercial-Residential Construction	Sill Plates	AWPA C15, ICBO	SYP, DF, HF, PP	Yes	Yes
Playground Equipment	Sawn and Round Members	AWPA C17	SYP, PP, HF	Yes	

[a] The C after AWPA corresponds to the commodity number within the *AWPA Book of Standards*

[b] SYP - Southern Yellow Pine, HF - Hem Fir, DF - Douglas Fir, PP - Ponderosa Pine

Table II.6: Details Concerning the Standardization of ACQ-Treated Wood (Archer, CSI Inc., personal communication)

II.4 DEPLETION/LEACHING

Depletion and preservative permanence are terms utilized by the wood treatment industry to describe the leaching characteristics of treatment chemicals from treated wood products. Depletion is approached by the wood treatment industry as an indirect indicator of efficacy. If a preservative chemical is readily lost from the treated wood then it is no longer available to protect the wood from biological degredation. Information concerning depletion is therefore not provided for the carrier fluids and for other additives, such as antifoam agents, which do not provide protection against biological deterioration.

Depletion of chemicals from treated wood are evaluated through standard laboratory (II.4.a) and field-based (II.4.b) protocols. Depletion data is typically reported by the alternative chemical manufacturers as the percent of the chemical lost. Another useful measure for depletion is the total mass of chemical lost per cubic foot of wood, given that each alternative chemical has different proportions of biocides which include copper. Comparison of the mass lost per unit wood volume (pcf leached) is a more appropriate measure when evaluating the potential environmental impacts due to leaching of the preservatives from the wood. A summary of the results from these tests are provided below.

II.4.a Laboratory Tests

One laboratory leaching test method (AWPA Method E11-97) involves impregnating and immersing blocks of treated wood in de-ionized water. During the two week test period the water is change at periodic intervals. The percentage of the original preservative leached is determined through chemical analysis of the leachate and treated blocks. The soil-block test method (AWPA Method E10-91) described earlier in the efficacy section (section II.3.a) also has a provision for depletion determinations. Depletion is measured in the soil-block test by periodically analyzing the leachate generated over a two week period. In addition to bench top laboratory methods, some chemical manufacturers also tested depletion during fungal cellar tests. Fungal cellar tests are described in section II.3.a.

ACQ: Results from standard laboratory leaching tests (AWPA Method E11) indicate that the amount of copper lost from ACQ-B (15%) and ACQ-D (8%) formulations is higher than the copper loss from CCA (2%) at the same retention level (table II.7). Roughly 3 to 4% of the DDAC was lost whereas less than 1% of the chromium and almost 10% of the arsenic was lost under the same test conditions for CCA. For these tests, the mass of copper lost from ACQ-D (0.018 pcf as Cu) is larger than the corresponding loss from CCA (0.001 pcf). Two fungal cellar tests were conducted to evaluate the depletion of ACQ. The first test, which was run for a period of 9 months for ACQ-B, included a CCA-treated wood control. The second test was run for ACQ-B and ACQ-D for a period of 3 months but did not include a CCA-treated wood control. Results (table II.8) indicate that copper and DDAC loss from ACQ-B is roughly 20% and 30-40%, respectively. Slightly lower depletion rates were observed for the ACQ-B formulation with water repellant. At the 0.60 pcf retention level, the % copper leached from the ACQ-B formulation is comparable to that of the CCA control; however when comparing the copper leaching rates on a per mass basis, roughly 4 times more copper is leached from ACQ-B than CCA at 0.60 pcf. Slightly lower copper depletion rates were observed for the ACQ-D formulation than for the ACQ-B formulation. A significant reduction in DDAC depletion rates was also observed for ACQ-D as compared to ACQ-B.

Formulation	Retention (pcf)	% Leached				Mass Leached (pcf x 1000)			
		CuO	DDAC	CrO_3	As_2O_5	Cu	DDAC	Cr	As
ACQ-B	0.40	14.7	3.3			31.3	4.4		
ACQ-D	0.40	8.3	4.0			17.7	5.3		
CCA	0.40	2.4		0.4	9.5	1.4		0.4	8.4

Table II.7: Laboratory Depletion Data for ACQ-Treated Wood (from CSI 1995)

Formulation	Retention (pcf)	% Leached				Mass Leached (pcf x 1000)			
		CuO	DDAC	CrO_3	As_2O_5	Cu	DDAC	Cr	As
Test #1: Test Period 9 months (from Archer et al. 1992)									
ACQ-B	0.40 0.60	17.6 19.0	38.1 30.5			37.5 60.7	50.8 61.0		
ACQ-B with water repellant	0.40	15.1	21.4			32.2	28.5		
CCA	0.60	17.9		11.0	15.8	15.9		16.3	21.0
Test #2: Test Period 3 months (from CSI 1995)									
ACQ-B	0.25 0.40	21.1 17.4	42.6 32.7			28.1 37.1	35.5 43.6		
ACQ-D	0.25 0.40	18.5 15.4	20.3 12.9			24.6 32.8	16.9 17.2		

Table II.8: Fungal Cellar Depletion Data for ACQ-Treated Wood (from Archer et al. 1992)

CBA: Manufacturers of CBA-treated wood utilized test AWPA method E10-91 to estimate the depletion. ACZA was utilized as the treated wood control; CCA was not included within the test method. The retention levels of the samples tested were 0.306 and 0.445 pcf. Results indicate (table II.9) that between 8 and 13% of the copper was leached from CBA-treated wood, 6 to 10% of the tebuconazole was leached, and virtually all of the boron was lost from the sample (Hickson 1999).

Formulation	Retention (pcf)	% Leached			Mass Leached (pcf x 1000)		
		CuO	Boric Acid	Azole	Cu	Boric Acid	Azole
CBA-A	0.306	7.9	100	9.9	11.9	150	0.59
CBA-A	0.445	13.1	100	6.3	28.6	218	0.55

Table II.9: Laboratory Depletion Data for CBA-Treated Wood (from Hickson 1999)

CC: Laboratory tests were conducted with CC-treated wood; however, these tests did not include a CCA-treated wood control and did not reference a standard AWPA leaching protocol. The data showed that roughly 26% of the copper was lost from ground-up CC-treated wood (less than 2 mm size) over a four hour period when immersed in deionized water (Anderson et al. 1993). The original retention value of this wood was 1.45% weight by unit weight which is roughly 0.4 pcf. A 26% loss of CuO therefore corresponds to approximately 0.05 pcf of Cu leached.

CDDC: Two water leaching tests were conducted on CDDC-treated wood (AWPA Method E11). Results (table II.10) show that the fraction of copper leached during this 2-week test was between 0.5 and 1.2% which was significantly less than the 4.6% loss of copper observed for the CCA-treated control. The amount of SDDC leached from the treated wood was below the detection limit of the analytical method utilized (Cooper and Stokes 1993). According to AWPA standards, several wood products requiring a 0.4 pcf as oxides CCA retention level can also be treated at an equivalent CDDC retention level of 0.208 pcf as Cu. If one utilizes this ratio of CCA to CDDC (0.4 pcf as oxides/0.208 pcf as Cu), then 0.27 pcf as Cu for CDDC is roughly equivalent to 0.55 pcf as oxides for CCA. The laboratory results in table II.10 therefore indicate that the mass of copper lost from CDDC is roughly ½ the loss from CCA.

Results (table II.11) from an 18 month fungal cellar test indicates that CDDC-treated wood lost between 10 to 21% of copper at retention levels of 0.1 and 0.2 pcf as Cu. These % losses correspond to 0.01 pcf as Cu leached for the 0.11 pcf as Cu retention level and 0.04 pcf as Cu leached for the 0.20 as Cu retention level. The fraction of SDDC lost from the CDDC-treated wood was between 42 and 48%. The pcf leached for SDDC are reported as maximum values given that the weight ratio of Cu to SDDC can vary from 2.5 to 5.0 according to AWPA standards. The CCA controls used during this test lost between 11 and 48% of the copper and between 23 and 48% of the arsenic (McIntyre et al. 1994). This loss on a mass basis corresponds to 0.003 to 0.03 pcf loss as Cu and 0.01 to 0.02 pcf loss as As.

Formulation	Retention (pcf)	% Leached				Mass Leached (pcf x 1000)			
		CuO	SDDC	CrO_3	As_2O_5	Cu	SDDC	Cr	As
CDDC	0.065 as Cu	1.2	<1.74			0.78	<5.7		
	0.13 as Cu	0.90	<0.84			1.2	<5.46		
	0.27 as Cu	0.59	<0.44			1.6	<5.94		
CCA	0.55 as total oxides	4.59		0.58	6.13	3.7		0.8	7.5

Table II.10: Laboratory Depletion Data for CDDC Treated Wood (from Cooper and Stokes 1993)

Formulation	Retention (pcf)	% Leached				Mass Leached (pcf x 1000)			
		CuO	SDDC	CrO_3	As_2O_5	Cu	SDDC	Cr	As
CDDC	0.11 as Cu 0.20 as Cu	10.1 21.3	41.5 47.7			11.1 42.6	<228 <477		
CCA	0.10 as total oxides 0.20 as total oxides 0.43 as total oxides	47.8 10.5 49.3		N/A N/A N/A	48.4 42.7 22.6	7.1 3.1 31.3		N/A N/A N/A	10.7 18.9 21.5

N/A: Not Available

Table II.11: Fungal Cellar Depletion Data for CDDC-Treated Wood, 18 month test period (from McIntyre et al. 1994)

II.4.b Field Tests

During field tests of preservative permanence, treated wood samples were placed in the outdoor environment for a specified period of time during which the samples were periodically exposed to natural rainfall. The most common type of samples utilized were stakes. In many cases, stakes from the standard field tests for efficacy were "sacrificed" and analyzed for preservative permanence.

ACQ: Early field tests (Archer et al. 1992) utilizing ACQ-B indicated that the presence of water repellant in CCA resulted in a slight decrease in depletion with the water repellant formulation of ACQ-B for both the copper and DDAC. Subsequent field tests utilizing ACQ-D utilized the formulation without water repellant and therefore did not include a comparison between formulations with and without water repellants.

Field depletion tests conducted for ACQ-D included, ground proximity tests, above ground simulated decking tests, and field soil depletion tests. Ground proximity tests were conducted by placing samples of ACQ-D treated Southern Yellow Pine on top of concrete blocks for a period of 18 months. These samples were installed in Hilo, HI. Results showed that the % leached decreased with increasing retention level. For the 0.25 pcf retention level (table II.12), ACQ-D treated wood lost 8% or 0.01 pcf of the copper and 19% or 0.02 pcf of the DDAC. CCA-treated wood lost 10% of the copper (0.004 pcf as Cu), 8% of the chromium (0.005 pcf as Cr), and 20% of the arsenic (0.01 pcf as As).

Above ground simulated decking tests were conducted by exposing samples in a mini-deck configuration. Installations were placed in both Hilo, HI and in Gainesville, FL; however a CCA control was not included for the Gainesville installation. For brevity, only the results from the Hilo installation are reported in table II.13. The test period for the Hilo, HI installation was 18 months. Data were collected for depletion from both the center and ends of the deck. Results indicate that the percent of copper and DDAC leached from the ACQ-D treated deck was between 6 and 13% and 42 to 45%, respectively. On a mass basis, this corresponds to 0.008 - 0.02 pcf leached as Cu and 0.03 - 0.04 pcf leached as DDAC. The percent copper, chromium, and arsenic leached from the CCA deck was between 8 and 20%, 4 and 11% and 17 to 38%, respectively. This corresponds to 0.003 to 0.008 pcf leached as Cu, 0.002 to 0.006 pcf leached as Cr, and 0.01 to 0.02 pcf leached as As. The amount leached from the ends of the deck were higher than the amount leached from the center, presumably due to a larger surface area of wood exposed at the ends.

Two stake installations were utilized for the field soil depletion tests. One was located in

Hilo, HI and the other was located in Gainesville, FL. The sample utilized for depletion analysis was in soil contact throughout the 18 month exposure period. Results (table II.14) for ACQ-D were relatively uniform between installation sites and between retention levels with 20 to 32% of the copper leached and 28 to 45% of the DDAC leached. Results from the CCA controls were not as uniform. The fraction of copper leached varied from 10 to 13% at the Hilo installation to 32 to 35% at the Gainesville installation. The chromium data for CCA within the Gainesville test plot was also variable from below detection for the 0.25 pcf sample to 26% for the 0.40 pcf sample. The fraction of arsenic leached varied from 16% to 47%. Results on a per mass basis indicate that larger quantities of copper are lost from ACQ-D than from CCA. Copper losses from ACQ-D varied from 0.03 to 0.07 pcf whereas for CCA losses varied from 0.005 to 0.02 pcf. It is important to note, nevertheless, that arsenic losses from CCA varied between 0.01 to 0.04 pcf.

Formulation	Retention (pcf)	% Leached				Mass Leached (pcf x 1000)			
		CuO	DDAC	CrO_3	As_2O_5	Cu	DDAC	Cr	As
ACQ-D	0.25	7.9	19.2			10.5	16.0		
CCA	0.25	9.9		7.8	19.7	3.7		4.8	10.9

Table II.12: Depletion of ACQ and CCA for Above Ground Tests for an 18 Month Installation Located in Hilo, HI.

Formulation	Sample Location	Retention (pcf)	% Leached				Mass Leached (pcf x 1000)			
			CuO	DDAC	CrO_3	As_2O_5	Cu	DDAC	Cr	As
ACQ-B	Middle End	0.25 0.25	6.2 12.5	41.6 44.8			8.3 16.6	34.6 37.3		
CCA	Middle End	0.25 0.25	7.9 20.2		3.7 10.4	17.2 38.2	2.9 7.5		2.3 6.4	9.5 21.2

Table II.13: Depletion of ACQ-D and CCA for a Simulated Deck Test Installed in Hilo, HI, 18 Month Installation.

Formulation	Retention (pcf)	% Leached				Mass Leached (pcf x 1000)			
		CuO	DDAC	CrO_3	As_2O_5	Cu	DDAC	Cr	As
Gainesville, Florida Installation									
ACQ-D	0.25 0.40	20.3 31.6	32.4 28.3			27.0 67.3	27.0 37.7		
CCA	0.25 0.40	32.0 35.3		-1.3 25.7	28.3 46.7	11.8 20.9		-- 25.4	15.7 41.4
Hilo, Hawaii Installation									
ACQ-D	0.25 0.40	20.2 21.6	44.6 31.7			26.9 46.0	37.1 42.2		
CCA	0.25 0.40	13.0 9.7		10.9 13.9	24.9 15.6	4.8 5.7		6.7 13.7	13.8 13.8

* Note negative depletion rates are considered an anomaly as the stake did not gain preservative.

Table II.14: Depletion of ACQ-D and CCA for Field Soil Contact Tests, 18 Month Installation.

CBA: Five stake depletion tests were conducted for CBA-treated wood. These tests included: a) a 13 month test in Conley, GA, b) 13 month test in Gainesville, FL, c) 38 month test in Madison, GA, d) 38 month test in Gainesville, FL, and e) 42 month test in Gainesville, FL. Only the results from the Gainesville, FL test sites are provided in table II.15 for brevity. These data were similar to those obtained from the installations located in Georgia. Please note that the negative values in the table are considered to be an anomaly of the analysis. The stakes did not gain preservative (Gruber, Hickson Corp., personal communication). In general, the results show that lower quantities of chemicals are lost from treated wood in the above ground portion of the stake for both CBA- and CCA-treated wood. The fraction of copper lost in the above ground portion of the CBA-treated stakes ranged from 2 to 8%. Losses from the below ground portions were significantly higher between 12 and 32%. Most of the boric acid is lost from the portion of the stakes below ground whereas roughly ½ is retained in the above ground portions. Between 18 and 32% of the tebuconazole is lost from the stakes. On a mass basis, these losses correspond to 0.005 - 0.06 pcf loss of copper, 0.09 - 0.2 pcf loss of boric acid, and 0.001 to 0.003 pcf loss of tebuconazole. For CCA-treated wood the results were variable. Ignoring the negative values for the above ground stake test for the 13 month exposure, the data show that 0 to 2% of the copper is lost from the above ground portion of the stakes whereas 3 to 25% is lost from the below ground portion. Chromium losses were within the 2 to 5% range. No significant amount of arsenic was released from the above ground portion of the CCA-treated stakes. For the below ground portions arsenic losses were between 10 and 17%. On a mass basis, these losses correspond to 0.002 - 0.02 pcf loss of copper, 0.002 - 0.005 pcf loss of chromium, and 0.009 - 0.01 pcf loss of arsenic.

Formulation	Sample Location	Retention (pcf)	% Leached					Mass Leached (pcf x 1000)				
			CuO	Boric Acid	Azole	CrO_3	As_2O_5	Cu	Boric Acid	Azole	Cr	As
13 month installation												
CBA	Above Ground	0.48	2.1	41.2	30.5			4.9	96.9	2.9		
	Below Ground	0.48	12.2	99.9	31.6			28.7	235	3.0		
CCA	Above Ground	0.34	-11.3			-17.6	-15.7	–			–	–
	Below Ground	0.34	3.2			4.1	17.3	1.6			3.4	13.0
38 month installation												
CBA	Above Ground	0.37	8.1	64.9	25.7			14.7	118	1.9		
	Below Ground	0.37	31.0	100.0	17.6			56.2	181	1.3		
CCA	Above Ground	0.43	2.1			2.1	-0.7	1.3			2.2	–
	Below Ground	0.43	25.4			4.8	14.6	16.1			5.1	13.9
42 month installation												
CBA	Above Ground	0.39	5.4	48.5	27.3			10.3	92.7	2.1		
	Below Ground	0.39	32.4	95.7	29.1			61.9	183	2.2		
CCA	Above Ground	0.40	-0.4			-0.9	-2.0	–			–	–
	Below Ground	0.40	17.0			1.6	10.3	10.0			1.6	9.1

* Note negative depletion rates are considered an anomaly as the stake did not gain preservative.

Table II.15: Depletion of CBA-Treated Wood from Field Stake Tests Conducted in Gainesville, FL. (From Hickson 1999)

CC: Two field stake installations were used for the CC-treated wood depletion study (AWPA Method E7). One installation was located in Gainesville, FL and the other was located in Dorman Lakes, MS. The poles were treated with 2.2% weight per unit weight solutions of chemical which is roughly 0.7 pcf. The treated wood control utilized for these tests was ACA. CCA was not included as a control. Results (table II.16) indicate that after a 60 month exposure period between 28 and 60% of the copper was lost and between 49 and 100% of the citric acid was lost. The largest percent removals occurred from the portion of the stake that was either at or below ground line. On a mass basis, the data indicate that between 0.06 to 0.1 pcf of copper was lost, whereas between 0.07 to 0.15 pcf of citric acid was lost. A pole stub depletion study was also conducted by the manufacturers of CC-treated wood. As for the stake installations, no CCA-treated control was used; rather an ACA control was included within the tests. Results indicate that depletion varied throughout the depth of the pole. Fractions of copper lost varied from 8 to 50% (Anderson et al. 1993) which correspond to roughly 0.02 to 0.17 pcf Cu leached.

Formulation	Sample Location	Retention (pcf)	% Leached		Mass Leached (pcf x 1000)	
			CuO	Citric Acid	Cu	Citric Acid
Gainesville, Florida Installation						
CC	Above Ground Groundline Below Ground	0.40 0.40 0.40	39.9 56.4 49.7	87.9 100.0 100.0	79.4 112 98.9	133 151 151
Dorman Lakes, Mississippi Installation						
CC	Above Ground Groundline Below Ground	0.40 0.40 0.40	28.2 49.1 59.8	49.0 99.0 99.6	56.1 97.7 119	73.9 149 150

Table II.16: Depletion of CC-Treated Wood from Field Stake Tests, 60 Month Exposure Period. (From Anderson et al. 1993)

CDDC: Stakes placed in the field in the Bainbridge, GA test plot were analyzed for depletion after nearly 23 years of exposure (Table II.17). The below ground losses of copper from CDDC- and CCA-treated wood were comparable on a percent loss basis. Roughly 65% of the copper and 70% of the SDDC was lost from CDDC-treated wood. For the CCA-treated control essentially none of the chromium was lost and between 18 and 25% of the arsenic was lost. On a per mass basis, between 0.1 to 0.2 pcf of the copper was lost from CDDC, whereas copper losses for the below ground portion of the CCA stake was 0.06 pcf.

Formulation	Sample Location	Retention (pcf)	% Leached				Mass Leached (pcf x 1000)			
			CuO	SDDC	CrO_3	As_2O_5	Cu	SDDC	Cr	As
CDDC	Above Ground Below Ground	0.2 as Cu 0.2 as Cu	55.3 77.4	73.5 68.5			111 155	<735 <685		
CCA	Above Ground Below Ground	0.6 0.6	None 71.6		None None	17.7 25.3	– 63.5		– --	23.5 33.7

Table II.17: Depletion of CDDC-treated Wood from Field Stake Tests, 23 Year Exposure Period. (From McIntyre et al. 1994)

II.4.c Summary

When evaluating the % leached, the loss of copper is comparable between CCA and its alternatives. On a per mass basis, field data indicate that the alternative chemicals lose more copper than CCA. For ACQ-D, generally 2 to 3 times more copper is released from ACQ-D than from CCA. One notable exception was observed for the Hilo, HI installation which suggests that up to 6 to 8 times more copper can be released. For CBA, the results were more variable, presumably due to problems encountered with the CCA controls which indicated negative loss rates. Regardless of these problems, data suggest that between 3 and 11 times more copper can be released from CBA-treated wood than from CCA-treated wood. Field data for CDDC-treated wood indicated that copper losses, on a per mass basis, were 2 times larger than for CCA-treated wood. This is contrasted by laboratory data obtained for CCA-treated wood which indicates that less copper was lost from CDDC-treated wood than from CCA-treated wood. No CCA control was included in field depletion tests on CC-treated wood. Nevertheless, the copper mass loss of up to 0.1 pcf is considered high given that the field experiment corresponded to a 60 month exposure period.

II.5 CORROSION

Several standard tests have been established to determine the corrosivity of wood preservatives. These tests can be separated into two broad groups. One set of tests were conducted with the chemical concentrate (section II.5.a) to determine whether the chemical was compatible with materials that are typically utilized to construct treatment cylinders and chemical holding tanks. Most of the tests were conducted on metallic materials; however, on occasion, an alternative chemical manufacturer will test the concentrate on non-metallic materials used to seal tanks and valves. The second set of experiments were conducted with the treated wood (section II.5.b). This set of experiments was designed to determine what type of fasteners can be utilized in contact with treated wood. Results from these tests are also useful to infer the potential impact of the treated wood on metallic materials that come in permanent or occasional contact with the wood. Section II.5.b closes by summarizing the recommendations from manufacturers for fastener systems used in contact with alternative-chemical treated wood.

II.5.a Corrosion Tests Using the Chemical Concentrate

Corrosion tests of the chemical concentrate are usually conducted as a partial immersion test. The standard test typically performed is a modified version of the National Association of Corrosion Engineers (NACE) Standard Number TM-01-69. This test involves taking a metal coupon and immersing a portion of the coupon in the chemical concentrate for a period of 6 weeks. Following the exposure period the samples are re-weighed and the weight change is then expressed as mils per year immersed; one mil equals 1/1000 of a pound. The test number TM-01-69 was referenced in the CBA and ACQ literature on corrosion; a description of a similar test was referenced in the CC literature except that the test was run for a 28 day period rather than a 6 week period. The method used for testing CDDC was not referenced in the available literature.

Table II.18 provides a summary of the results from corrosion tests conducted on the chemical concentrates. Corrosion rates in this table are expressed as “relative corrosion” which is equal to the mils per year (MPY) corrosion rate of the metal coupon immersed in the alternative chemical minus the MPY of the metal coupon immersed in the CCA control for a particular experiment. A positive value of relative corrosion means that the alternative chemical is more corrosive than CCA. A negative value indicates that CCA is more corrosive. Results (table II.18) indicate that the CuMEA solution associated with CDDC treatment and ACQ-D is more corrosive to bronze and to brass fittings. The only exception is the brass result for the 15% solution of ACQ-D. These results support the need for replacing brass and bronze valves for the conversion of a CCA treatment plant to ACQ. CBA and SDDC tend to be less corrosive except that CBA tends to be corrosive when in contact with brass. It is important to note that Hickson Corporation addressed the potential brass corrosivity issue associated with CBA by converting a full scale CCA treating plant to CBA. Prior to the conversion to the CBA solution, the brass valves from the plant were cleaned and weighed. The plant was operated for four months and the brass valves were again cleaned and re-weighed. The weight change of the brass valves was found to be minimal (Hickson 1999). CC is less corrosive to carbon steel than CCA. No data was available for other metals in contact with CC.

Overall, it is interesting to note that bench scale testing for the 1.1% solution of ACQ-D, the CuMEA component of CDDC, and CBA indicate that the alternative chemical was more corrosive to brass and bronze than CCA. This corrosivity to brass and bronze may be associated with CuMEA found within the formulation of all three of these chemicals; however, it appears as though this corrosivity is “pacified” within the CBA and ACQ formulations.

Additional tests were conducted for CC and CDDC on non-metal sealing materials. Results show that Viton, Hypalon, EPDM, and Teflon are acceptable sealing materials for plants using CC (Anderson et al. 1992). For the chemicals needed to produce CDDC, 1% and 10% CuMEA solutions and 4% and 40% solutions of SDDC were tested on various materials including 2 joint compounds (polysulfide and urethane), various types of Garlock gaskets, teflon, 6 different types of rubber gaskets, and fiberglass. The control utilized in the experiment was water. Results show that only the 10% solution of CuMEA and the 40% solution of SDDC had a measurable impact on some of the Garlock gaskets and that the 40% SDDC solution also had a measurable impact on urethane. At the lower chemical concentrations no impact on the non-metals was noted. The overall conclusion from this study was that no special sealing materials are needed for plant conversion if it were to produce CDDC-treated wood (McIntyre et al. 1994).

Chemical	Relative Corrosion, MPY				
	Mild or Carbon Steel	Brass	Galvanized Steel	Bronze	Stainless Steel
ACQ-D, 1.1% solution	0.78	1.57		1.59	0
ACQ-D, 15% solution	-0.03	-17.76		0.76	0
CBA, 0.6% Cu	-0.063	0.827	-2.322		
CC	-0.0064 %[a]				
0.5% CuMEA (CDDC)	0.01	10.16		18.11	
3.5% SDDC (CDDC)	0.07	-0.3		-0.43	

[a]Value provided in terms of percent weight loss (CC-CCA)

Table II.18: Relative Corrosion of Alternative-Chemical Concentrates to Different Types of Metals

II.5.b Corrosion Tests Performed on the Treated Wood

Corrosion tests performed on treated wood are typically utilized to determine the compatibility of fastener systems. The compatibility of metals, other than fasteners, that come into permanent or occasional contact with the treated wood can also be inferred from these tests. Tests are usually conducted under controlled laboratory conditions and in the field.

Laboratory Tests

The traditional laboratory method for testing the susceptibility of different metal fasteners to treated wood involves "sandwiching" a metal coupon between Southern Yellow Pine blocks treated with the alternative chemical. Tests with untreated- and CCA-treated wood are included as controls. After the test period the metal coupons are re-weighed. Weight loss is typically expressed in units of mils per year (MPY). The test method reported within the literature for CBA and ACQ-D was AWPA Standard E12-92. Literature for CC indicates that a modified version of this test was used.

Literature for CDDC indicates that the test methods were based upon the methodology published in the 1991 AWPA Annual proceedings. The methodology was referred to as "Report of Subcommittee P-6, Methods of Evaluation of Wood Preservation, Appendix A."

Materials tested by most alternative-chemical manufacturers included aluminum, mild steel, galvanized steel, red brass, and stainless steel. Results (table II.19 and figure II.6) indicate that ACQ- and CC-treated wood are corrosive to fasteners made of mild steel. ACQ-treated wood is also corrosive to aluminum and may be mildly corrosive to brass and hot-dipped galvanized fasteners. Given the results of these experiments, CSI, 1995, states that aluminum, mild steel, and electro-plated galvanized fasteners are not recommended for use in contact with ACQ- treated wood. Results also show that CC-treated wood is corrosive to hot-dipped galvanized. Overall, CBA- and CDDC-treated wood have low corrosivity for all the metals listed in table II.19.

Chemical	Relative Corrosion, (MPY)					
	Mild Steel	Aluminum	Brass	Stainless Steel	Hot-Dipped Galvanized	Copper
ACQ-D	5.42	14.29	0.18	0	0.12	NM
CBA	0	0	0	0	0	NM
CC	26.3	0	NM	0	15.15	0
CDDC	0	-.02	-0.35	NM	0	NM

NM = Not Measured

Table II.19: Relative Corrosion of Metals in Contact With Alternative-Chemical Treated Wood

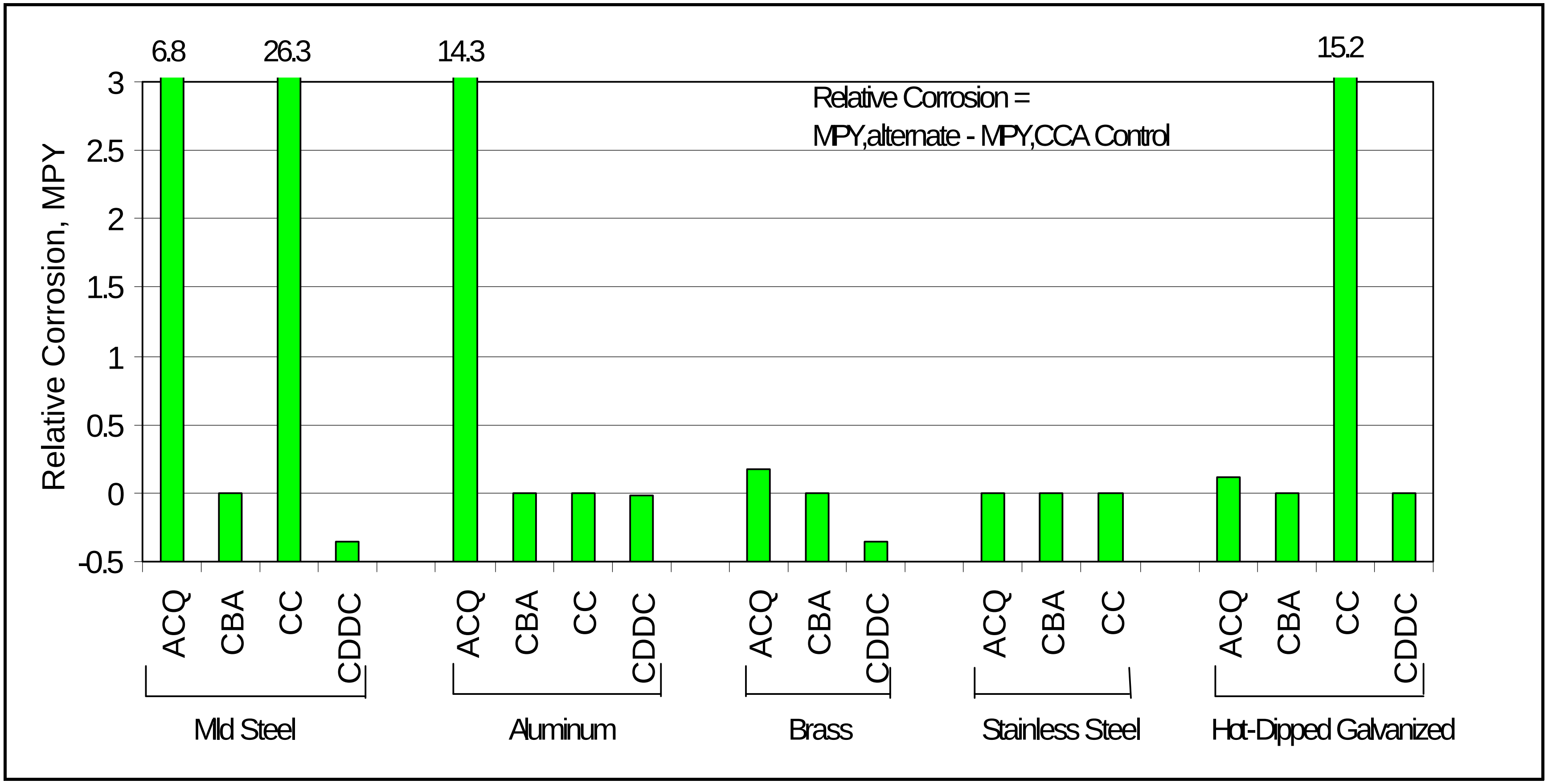


Figure II.6: Relative Corrosion of Metals in Contact With Alternative-Chemical Treated Wood

Field Tests

Manufacturers of CBA, ACQ-D, and CC report the results of field experiments designed to test the corrosivity of the treated wood to metal fasteners within their AWPA proposals for standardization. The manufacturers of CC also conducted experiments with galvanized steel truss plates. No results from field experiments to test the corrosion of metal fasteners in contact with CDDC-treated wood were reported within the literature obtained through Kodiak Inc. Methodology for each field test generally involved construction of test decks containing alternative-chemical treated wood along with CCA-treated and untreated controls. Metal nails and screws were used to fasten the decks. After a pre-determined exposure period, the nails/screws were inspected. A similar experiment was used to test truss plates. Manufacturers of ACQ-D and CC went a step further by weighing the fasteners before and after the exposure period to provide a quantitative measure for the relative corrosivity in terms of mils per year. Manufacturers of CC, however, included an untreated control but did not include a CCA-treated control in some of their field tests.

ACQ: Field data collected by the manufacturers of ACQ-treated wood are provided in table II.20. Results show that ACQ-D is more corrosive to mild steel, electro-plated galvanized, and aluminum. Evaluation of the hot-dipped galvanized fasteners indicate varying results. For the Hilo, HI test site data for ACQ was comparable to that of CCA. However, the same results for the Harrisburg, NC test area indicate that ACQ-treated wood may be slightly more corrosive to hot-dipped galvanized fasteners as compared to CCA-treated wood. Overall, CSI 1995 recommends that aluminum, mild steel, and electro-plated galvanized fasteners not be used in contact with ACQ-treated wood.

Nail Type	Average Weight Loss, %					
	Hilo, HI test area			Harrisburg, NC test area		
	ACQ-D	CCA-C	Untreated Wood	ACQ-D	CCA-C	Untreated Wood
Stainless Steel	0.232	0.117	0.000	-.152	0.117	0.078
Mild Steel	3.564	0.946	0.833	3.796	0.979	-0.259
Hot-dipped Galvanized	0.941	0.252	0.447	1.069	0.423	0.050
Electro-plated Galvanized	3.721	3.336	1.918	3.132	1.245	-0.234
Silicon Bronze	0.252	0.567	0.377	0.063	0.251	0.252
Aluminum	3.117	0.844	0.520	1.544	0.779	0.085
Hot-dipped Galvanized Screws	0.854	1.232	0.435	1.368	0.858	0.210
Brass Screw	0.047	0.497	0.435	0.685	0.161	0.184

Table II.20: Field Metal Fastener Tests in Contact with ACQ-Treated Wood (CSI 1995)

CBA: CBA-treated wood was tested using mild steel, galvanized, stainless steel, brass, copper, and aluminum fasteners. Results from tests on CBA-treated wood indicate only a minor difference between the condition of fasteners applied to CBA- and CCA-treated wood. Mild steel nails and screws showed comparable levels of corrosion among CBA-, CCA-, and untreated wood samples. Brass screws were observed to tarnish and galvanized fasteners showed slight superficial corrosion. Internally, there was no evidence of corrosion for brass and galvanized fasteners except for discoloration. No corrosion was observed for stainless steel and copper fasteners. Some evidence of corrosion was evident for aluminum fasteners at the wood/metal interface (Hickson 1998).

CC: CC-treated wood was found to be considerably more corrosive to galvanized steel truss plates than the CCA-treated control (Anderson et al. 1992, p. 43). An additional study which focused on galvanized fasteners including nails (hot-dipped), deck screws, roofing nails, and truss plates showed various levels of corrosion after a three year exposure ranging from small amounts of iron oxide corrosion at the wood/metal interface to iron oxide on the entire surface. Small amounts of corrosion were observed for the untreated controls. Table II.21 provides the results for a one year exposure study on suite of different fastener systems in contact with CC-treated wood. Results show that electroplated galvanized, common steel, and aluminum nails were subject to corrosion. Anderson et al. 1992 report that the hot-dipped galvanized nails and screws had their galvanized coating partially removed on the embedded shanks, but little corrosion was observed. An overall conclusion reported from this study was that the field tests "have yet to demonstrate that hot-dipped galvanized fasteners pose a serious problem when used with CC-treated wood. However, until such time that field tests are in place long enough to confidently recommend the use of galvanized hardware, stainless steel and silicon bronze fasteners are recommended for use with CC-treated wood."

Fastener	%Weight Loss	
	Treated	Untreated
Galvanized Deck Screws	10.1	2.7
Hot Dipped Galvanized Nails	16.7	9.3
Electroplated Galvanized Nails	23.6	6.9
Ceramic Coated Screws	10.4	5.3
Stainless Steel Nails	0	0
Silicon Bronze Nails	0	0
Commercial Bronze Nails	0	0
Copper Nails	0	0
Common Steel Nails	6.1	2.8
Aluminum Nails	3.2	0

Table II.21: Metal Fastener Tests in Contact with CC-Treated Wood (Anderson et al. 1992)

Alternative-Chemical Manufacturer Recommendations for Fasteners

Given the results of the corrosivity studies, manufacturers of alternative-chemicals provide recommendations for fastener systems in contact with treated wood (table II.22). The manufacturers of CC recommend that when structural integrity is important only stainless steel fasteners be used in contact with CC-treated wood. CC marketing information also states that, "Galvanized wire and galvanized staples are acceptable for use with CC-treated posts for use in vineyards; however, the anchor wires used with end posts must be protected from direct contact with the wood with the use of a flexible material that is ultraviolet resistant and that will provide a barrier between the wire and the wood around the post top or around the anchor cables." Marketing information developed for CBA-treated wood recommends that hot-dipped galvanized, nickel coated, or stainless steel fasteners be used. Non-ferrous metal alloys are also acceptable including for example, monel, brass, and silicon bronze. The CBA-manufacturer warns, however, that contact between CBA-treated timbers and zinc-aluminum roofing may cause pitting of the metal coating. The manufacturer of ACQ recommends that fastener systems in contact with ACQ-treated wood be made of hot-dipped galvanized or stainless steel. Hot-dipped is preferred over electroplating because it generally provides a thicker layer of protection. If stainless steel or hot-dipped galvanized products are not available, the life of electroplated products can be maximized by properly preparing the metal surface and painting with a rust preventive coating before installation. ACQ manufacturers go a step further and provide a list of fastener types for use with ACQ-treated wood (table II.23). According to Kevin Archer of CSI work is underway to expand the list of recommended fastener systems. Recommended fastener systems were not specified for CDDC-treated wood within their marketing literature. Jim Nix of Kodiak Inc. recommends that fasteners used for CCA-treated wood can be also used in contact with CDDC-treated wood. For CCA-treated wood, the AWPI, 1995, recommends that hot-dipped galvanized or stainless steel fasteners be used. The AWPI recommends these types of fasteners due to the long performance life of the treated wood product which requires that the fasteners withstand the effects of the general environment. Specifically, AWPI states that these types of fasteners "ensure permanence and head off corrosion." Other recommended fastener materials include silicon bronze, copper, and specifically for screws, electroplated galvanized with polymer coating.

Chemical	Metal Fastener Recommendation
ACQ	hot-dipped galvanized or stainless steel
CBA	hot-dipped galvanized, nickel coated, stainless steel fasteners, or non-ferrous metals
CC	stainless steel, galvanized staples and galvanized wire for use in vineyards
CCA	hot-dipped galvanized or stainless steel fasteners
CDDC	hot-dipped galvanized or stainless steel fasteners

Table II.22: Manufacturer Recommendations for Metal Fastener Systems

Brand	Coating Type
Swan Secure	Silicon Bronze
Swan Secure	Stainless Steel
Maze Stormguard	Hot Dip Galvanized
Maze	Stainless Steel
Duofast	Stainless Steel
Quickdrive	Stainless Steel
Grabber Guard	Zinc and Polymer
Stalgard Deck Screw (Red, Wood Grain Tan, Silver)	Proprietary
Duo Fast Hot Dip Galvanized	Hot Dip Zinc
ITW Buildex Dec-King Climacoat	Propietary
Prime Source Prime Guard Plus	Proprietary
Prudential S/S Screws	Stainless Steel
Mid-America Weatherwise Combo Screws	Proprietary

Table II.23: Recommendations for Screws and Nails in Contact with ACQ-Treated Wood (from ACQ Marketing Literature)

II.6 MECHANICAL PROPERTIES

This section summarizes the available data, as provided in the proposals for AWPA standardization, concerning the impacts of the treatment process on the strength of treated wood. Also given the interest that large end-users have expressed concerning the climability of utility poles, available information, although very limited, is discussed on this issue toward the end of this section.

II.6.a Strength

The strength properties most commonly measured are the modulus of elasticity (MOE), modulus of rupture (MOR), and work to maximum load (WML). The MOE is measured by applying an axial load (units of psi) to a wood sample and measuring the load and deformation simultaneously. The ratio of load to strain (strain having units of deformation length per unit length of wood sample) is generally constant or proportional for the lower loads. This proportional ratio of load to strain is the value of MOE. The larger the MOE the larger the deformation that occurs per unit load applied to a sample. The MOR is analogous to the ultimate bending strength of a material (Winandy, Forest Products Lab, personal communication). It is computed by assuming a fictitious linear distribution of stresses which approximates, but over-estimates, the actual ultimate stress of a material. The computation utilizes the dimensions of the wood sample and the maximum load (units of pounds) that causes rupture of the sample. The larger the MOR, the larger the load that a material can withstand without rupture. WML is a measure of the total energy required per unit volume required to cause a material to rupture. It is obtained by integrating the area beneath a stress strain plot. WML is a measure of the elasticity of a material as well as its ultimate strength, and the capacity of a structure to withstand an impact load (Beer and Johnston 1981).

ACQ: Tests (ASTM Method D-143) were run for two drying conditions: air-dried and kiln-dried. Results (table II.24) show that the MOR, MOE, and WML did not differ significantly between the water treated controls and the air-dried samples of ACQ-D and CCA. Kiln drying, however, appears to significantly decrease the strength properties of the ACQ-D- and CCA-treated samples. Especially apparent is the decrease in WML for ACQ-D. This decrease was attributed to the high kiln-drying temperatures used (180 ^{o}F) during experimentation and thus CSI 1995 recommends a maximum kiln-drying temperature of 165 ^{o}F which is consistent with AWPA guidelines. CSI 1995 also notes that "the slight reductions in WML observed for air-dried and kiln-dried (under 165 ^{o}F) ACQ-D treated wood should not influence the performance of this product."

Tests were also conducted with ACQ-D treated plywood. Results (CSI 1995) show that there were no statistically significant differences in the MOE, MOR, and WML between CCA, ACQ-D, or water treated controls. Glueline shear test data indicate poorer performance for all preservative treatments compared with water treatment. The performance of ACQ-D, nevertheless, was comparable to that of CCA.

CBA: Tests (ASTM Method D-143) were run for CBA-treated wood and water treated controls. No treated wood controls were included. No information was provided concerning the drying process; therefore it is presumed that the samples were air-dried. The MOE and MOR values for each sample were statistically equivalent. A 15% reduction in WML was observed. Hickson 1999 indicates that the "slight reduction in WML is consistent with strength values reported for other standard wood preservative systems."

CC: CC-treated and untreated wood was tested for bending properties in accordance to ASTM Method D-143. The treated wood control utilized was ACA. No information was provided concerning the drying process; therefore it is presumed that the samples were air-dried. The MOE values for CC-treated wood were not statistically different than that for the untreated control. The MOR and WML were lower for CC by 3% and 15%, respectively. For MOR and WML, CC-treated wood performed either equivalent or better than ACA-treated wood. Manufacturers of CC-treated wood also tested pole hardness before and after treatment. A brief summary of these results are provided in section II.6.b.

CDDC: Manufacturers of CDDC-treated wood sponsored two strength studies, one conducted at Michigan Tech following ASTM method D-143 and another at State University of New York (SUNY) which utilizes a comparable method. Results (table II.24) from the Michigan Tech study showed no adverse effect for the CDDC treatment, either air-dried or kiln-dried (190 °F), on the strength of the wood. Of interest is the significant increase in MOR for the kiln-dried sample. Results from SUNY indicate that kiln-drying resulted in an increase in MOR and MOE for CDDC-treated wood. The air-dried samples had comparable MOR's for CDDC- and CCA-treated wood. The MOE for CDDC-treated wood was slightly higher than that for CCA-treated wood. The WML values between untreated, CDDC-treated, and CCA-treated wood did not differ significantly except for a reduction observed for the kiln-dried CCA-treated sample (McIntyre et al. 1994).

Sample Description	Retention (pcf)	MOE (1000 psi)		MOR (1000 psi)		WML (in-lb/in^3)		Wood Moisture Content (%)
		Ave.	Std. Dev.	Ave.	Std. Dev.	Ave.	Std. Dev.	
ACQ Data (CSI 1995)								
Water Treatment	---	1670		13.56		11.6		12.7
ACQ-D Air-Dried	0.44	1612		13.19		11.1		14.3
ACQ-D Kiln-Dried	0.44	1559		12.17		8.3		13.6
CCA Air-Dried	0.41	1647		13.55		12.2		13.9
CCA Kiln-Dried	0.44	1528		12.34		11.0		14.3
CBA Data (Hickson 1999)								
Water Treatment	---	1540	210	12.5	1.4	12.4	4.6	12.6
CBA-Treated	0.51	1630	294	13.0	1.5	10.6	2.9	13.0
CC Data (Anderson et al. 1993)								
Untreated	---	2260	340	15.7	1.8	15.6	3.9	12.9
CC-Treated	0.63	2220	260	15.2	1.5	13.3	3.1	13.7
CDDC Data (McIntyre et al. 1994)								
Untreated, Air-Dried	---	1288	362	12.8	1.9	16.7	5.5	12.3
Untreated, Kiln-Dried	---	1649	211	13.1	1.7	8.9	3.2	9.5
CDDC, Air-Dried	0.1 as Cu	1513	193	12.0	1.1	12.3	4.6	12.7
CDDC, Kiln-Dried	0.1 as Cu	1649	299	15.2	1.2	13.3	5.0	8.6
CCA, Air-Dried	0.4 as oxides	1609	270	13.0	1.3	11.0	3.0	13.0

Table II.24: Strength Properties of Treated Wood.

II.6.b Summary

The mechanical properties of the alternative-chemical treated wood products are comparable to that of CCA-treated wood. The WML value for kiln-dried ACQ-D treated wood appears low as compared to kiln-dried CCA-treated wood; however, it is still within one standard deviation of the

CCA-treated wood value and therefore performance of wood treated with ACQ-D was considered comparable to that of wood treated with CCA.

II.6.c Climability

Climability of poles is associated with unintentional spur pull-out when linemen are at the top of a pole and set their spurs to lean out and work on the cross arm. It is here that gaff penetration may be insufficient and may result in the linesman to fall off the pole (Ruddick, University of British Columbia, personal communication). One test that can be used to determine if a pole should be climbed is a Pilodyn test. The Pilodyn test is based on the principle of driving a pin with a fixed energy into wood. The penetration of the pin provides a relative measurement of wood hardness. The threshold value for the Pilodyn test is generally accepted as 10 mm. If the Pilodyn reading is less than this then the pole should not be climbed (Ruddick, University of British Columbia, personal communication).

Information concerning pole hardness was only available from the manufacturers of CC (Anderson et al. 1993). The CC manufacturers tested pole hardness of several wood species both before and after treatment with CC. Wood species tested included Douglas fir, western red cedar, lodgepole pine, red pine, jack pine, and southern yellow pine. No CCA-treated control was included in experimentation. The poles were tested using a 6-joule Pilodyn at points 1/3 inch from each end and at the center of the pole. Results (table II.25) show no significant difference in pole hardness before versus after treatment. However, differences were observed between wood species with western red cedar and red pine characterized by the highest values of pin penetration and southern pine characterized by the lowest values.

Wood Species	Pilodyn Reading (mm)				Moisture Content (%)			
	Before Treatment		After Treatment		Before Treatment		After Treatment	
	Avg.	Std. dev.	Avg.	Std. dev.	Avg.	Std. dev.	Avg.	Std. dev.
Western Red Cedar	16.5	1.4	18.3	4.9	30.2	12.6	15.5	2.9
Red Pine	16.1	1.6	15.2	1.2	25.3	3.0	19.7	3.9
Jack Pine	15.0	1.5	15.8	1.2	17.7	1.8	15.8	11.3
Lodgepole Pine	13.4	1.5	13.1	1.5	29.1	5.2	17.2	3.6
Douglas Fir	12.5	1.4	12.8	1.0	28.7	5.2	15.5	3.9
Southern Pine	9.9	2.2	9.7	2.1	25.3	4.4	24.8	7.2

Table II.25: Pilodyn Readings of Various Wood Species Before and After Treatment with CC-Treated Wood (Anderson et al. 1993)

II.7 COSTS

Comparative costs to the consumer were sought for alternative-chemical- and CCA-treated wood (table II.26). Costs were available for ACQ-, CDDC-, and CCA-treated wood. No costs were available for CBA- and CC-treated wood. Prices for CBA-treated wood were not available because it was not sold within the U.S. A list of retail outlets that stock CC-treated wood was not disclosed. Only one treatment plant located in California produces CC-treated wood and costs were not available from this facility either.

Between August 5^{th} and August 13^{th}, 1999, retail outlets were contacted throughout the U.S. and asked for the price for a 12 foot deck board. A 12 foot deck board has the dimensions of 1 1/4 inch x 6 inches x 12 feet. It was found that retail outlets that were part of the same franchise tended to have the same prices. When the average price for a deck board was computed, such outlets were assumed to represent one facility. The price for CCA-treated wood came from facilities that stocked at least one of the alternative-chemical treated wood products. The list of retail outlets that supply ACQ-treated wood was obtained from the following web site: http://www.chemspec.com/aboutus/customers.html. A list of outlets that stock CDDC-treated wood was provided by Kodiak Inc., however, it was not published here given that as of January 2000, the Kodiak treating facility was put up for sale and was no longer treating wood.

Comparative costs between ACQ-, CDDC-, and CCA-treated wood is provided in table II.26. The average price for a CCA-treated deck board among 15 facilities contacted was $\$8^{.94}$. The average price for a CDDC-treated deck board among 16 facilities contacted was $\$10^{.29}$. Two different types of ACQ-treated wood were stocked by retail outlets. These types included ACQ-treated wood *without* a water repellant and ACQ-treated wood *with* a water repellant. Among the two outlets that were found to stock ACQ-treated wood without the repellant, the average cost was $\$9^{.90}$ for a 12 foot deck board. Among the ten outlets that stocked ACQ-treated wood with the water repellant, the average cost for a deck board was $\$11^{.47}$. On average the cost for CDDC-treated wood was roughly 15% more than the cost of CCA-treated wood. The cost of ACQ-treated wood (without water repellant) was 11% more than the cost of a CCA-treated deck board and the cost of ACQ-treated wood (with water repellant) was 28% more. None of the facilities called stocked CCA-treated wood with a water repellant.

Overall the costs between CCA-treated wood and alternative-chemical treated wood are competitive. In evaluating the differences in costs, it is important to note that the amount of CCA-treated wood produced annually in the U.S. is orders of magnitude greater that than the amount of alternative-chemical treated wood products. Furthermore, there are three major CCA manufacturers and hundreds of CCA wood treaters in the U.S. resulting in considerable competition. This situation is contrasted by only one manufacturer for each alternative chemical and only a few treaters. If the economies of scale were more balanced it is likely that the costs of the alternative-chemical treated wood products would be more competitive with that of CCA. Furthermore if the overall cost for a deck were considered, which would include both material and labor costs, the percent difference in the constructed costs of a CCA-deck versus alternative-chemical deck would be less than those for the material costs listed above. And finally, it is important to note that the costs provided by the retail establishments do not include disposal costs of the treated wood which are ultimately paid indirectly by the consumer. A more appropriate comparison would be based upon a life cycle analysis which would include costs and environmental impacts of the alternative chemical from production through disposal.

	CCA	CDDC	ACQ	ACQ with Water Repellant
Average	$8.94	$10.29	$9.90	$11.47
Range	($6.99-$11.69)	($9.28-$12.00)	($9.29 - $10.50)	($9.95-$14.25)
No. of Retail Outlets	n=15	n = 16	n = 2	n = 10

Table II.26: Costs for a 12 Foot Deck Board Treated with CCA, CDDC, and ACQ

II.8 FEEDBACK FROM WOOD TREATERS AND LARGE-END USERS CONCERNING ALTERNATIVE CHEMICALS

Feedback from wood treaters (section II.8.a) and from large end-users (section II.8.b) concerning alternative chemicals is provided in the sections below.

II.8.a Feedback from Wood Treaters

General Statistics

Of the 85 facilities sent questionnaires, 22 responded. Of the 22 that responded, 9 were from Florida, 8 were from Georgia, 2 were from Alabama, and 3 were from Mississippi. The responding plants located in Florida sold between 65 to 100% of their product within the State during 1998. For responding plants outside of Florida, Florida represented between 0 and 40% of their market during 1998. The amount of CCA chemical utilized by the responding plants located in Florida varied from 23 tons to 1,250 tons per year.

Alternative Chemical Usage

All of the responding plants located in Florida treated exclusively with CCA during 1998. Only one of these utilized other treatment chemicals, creosote and pentachlorophenol, prior to 1998. One of the Florida respondents indicated that they were considering converting treatment chemicals from CCA to a non-arsenical formulation.

For the 13 responding plants located in southern Georgia, Mississippi, and Alabama, 8 treated exclusively with CCA, 1 treated exclusively with creosote, and 1 treated exclusively with creosote and pentachlorophenol during 1998. The remaining three plants treated wood with CCA and one other chemical. These chemicals included pentachlorophenol, creosote, and Wolman FCAP.

Response to "What would prohibit your facility from changing from CCA to an alternative chemical."

Of the 22 responding facilities, 15 responded to the question above. Of these 15 facilities, 11 mentioned that cost effectiveness of the alternatives is a factor that would prohibit a change. Effectiveness or quality of CCA versus the alternatives was cited as a drawback for conversion by 6 of the responding plants. Six plants also cited customer preference and specifications for CCA-treated wood as a reason to continue use of CCA. Two plants mentioned that their primary market is for treating utility poles. One indicated that the alternatives have not been approved to treat utility poles made of southern yellow pine. Safety of the alternatives, warranty, liability of replacement chemicals, and the necessary process changes for conversion were also cited by individual plants as an impediment to conversion.

Additional Comments

Additional comments were provided by 11 of the 22 responding plants. Four of the 11 facilities indicated that CCA does not significantly impact the environment. Two of these four indicated that there is no strong evidence to indicate that the arsenic potentially released from CCA-treated wood could affect human health or the environment. Other comments focused on the cost and effectiveness of CCA versus the alternatives. Two of the respondents commented on the long service life of CCA-treated wood used for marine applications. One of these facilities emphasized that they sell CCA-treated wood for marine applications but there is currently no alternative approved for this application. One respondent emphasized the need to assure that the alternatives leave a pole climbable, machinable, and aesthetically acceptable.

Drawbacks of the alternatives identified among individual wood treaters included corrosivity, excessive mold growth, odor, heavier shipping weight, the presence of copper which may impact aquatic environments, fixation of the alternative chemicals, energy requirements to produce the alternative, and the disposal of copper. It was also mentioned that substitution will not solve the disposal problem because of the large amount of product already in service.

Four of the respondents provided details concerning their opinions concerning more than one of the alternatives. These details are summarized in table II.27.

Chemical	Responding Wood-Treatment Plant Number			
	1	2	3	4
AAC	more expensive, odor problems during manufacturing operations			Corrosive, expensive, requires retrofit of plant
ACC	more expensive	Positives: Close in cost to CCA. Can be used for above ground and ground contact Negatives: Cr does not fix well. Not in many end-user specifications		Corrosive, expensive, requires retrofit of plant
ACQ	more expensive, potential odor problems	Positives: No As no Cr. Above ground contact. AWPA approved. Treats refractory species Negatives: High depletion, high cost, Can't use utility pole defects for piling, not useable in marine environ., may require use of stainless steel fasteners, not in many end-user specfications, requires separate plant from CCA. DDAC toxicity?	More expensive than CCA. Still has Cu which is more detrimental to aquatic life than As or Cr.	Corrosive, expensive, requires retrofit of plant
Borates	wash out from wood in unprotected environment	Positives: Protects against Formosan Termites, Cost effective in indoor applications, can treat some refractory species Negatives: Only can be used in weather protected areas, requires separate plant from CCA, not dual treatable.	Unsuitable for exterior applications. Very Susceptible to leaching.	Leaches out when wet. Can be used in interior only.
CBA	more expensive, not AWPA approved for poles and piles			
CDDC	requires 2 cylinders to treat. High capital costs. Very attractive product.	Negatives: Requires 2 treatment steps and 2 cylinders, expensive, depletion rate.		
CC	odor problems, not approved for utility poles.			Corrosive, expensive, requires retrofit of plant

Table II.27: Detailed Feedback For Particular Chemicals for Facilities that Discussed More than One Alternative

II.8.b Feedback from Large End-Users

Utilities

Of the six utilities contacted, three responded fully to the questionnaire and two provided some information via telephone. One of the six facilities did not respond. Reported usage of CCA-treated wood varied among the five responding utilities. Four of the five responding utilities purchase CCA-treated wood regularly. Three of these four also purchase pentachlorophenol-treated wood; one of these four purchases creosote-treated poles in addition to CCA-treated poles. One of the five responding utilities does not use CCA-treated wood. All wood poles and cross-arms used by this facility are treated with pentachlorophenol. This same facility contracts pole purchasing and disposal to an outside vendor and owns the pentachlorophenol-treated poles only while they are in service. Alternative structural materials listed by the responding utilities included steel for crossarms or transmission lines, concrete, and fiberglass.

Two utilities provided considerable feedback concerning factors that are considered during purchase of treated wood. The responses by both utilities were very consistent with one another. The utilities reported that factors considered when purchasing treated wood include:

- longevity or service life which should be about 50 years
- cost
- useability including climability and corrosivity to hardware
- environmental issues including leachability into the soil, disposal issues, and safety to crew members
- conformance to industry standards

One respondent indicated that all of the above items were important and that a product not meeting one of the above criteria would cause the utility not to purchase the product.

The two utilities that responded to the question, "Would reducing the use of CCA-treated wood within the next few year cause hardship within the company" both answered yes. The reasons stated for this response were cost effectiveness and the longevity of CCA as compared to other wood treatments. One of the two respondents indicated that "CCA-treated wood has very little environmental impact because the chemicals are locked into the cells of the wood and do not leach into the ground as other treatments do."

Two of the responding facilities also report that they have no problem selling their used poles for reuse purposes. Scraps from used utility poles that are not sold are sent to a landfill.

Retail Establishments

Both retail establishments that were sent questionnaires responded. The factors considered important when choosing a particular product when treated wood is considered for purchase by the retail establishments included:

- grade marked wood
- quality and appearance of wood
- availability and distribution to stores
- warranty for a particular retention level
- third party inspection
- wood species
- price

One of the two facilities stocked treated wood at retention levels of 0.25 and 0.40 pcf. The other stocked 0.40 and 0.60 pcf treated wood. Potential alternatives to CCA listed by the retail outlets included fiberon decking, cedar, redwood, plastic decking, metals studs, and concrete.

Concerns that must be answered when the retail establishments evaluate alternative-chemical treated wood products are that they must be EPA approved and satisfy environmental concerns, the alternative must have a track record including laboratory and real-world testing, must be durable, must have a warranty, its retention level must be assured, it must have a pleasing appearance, and must be cost effective. One alternative-chemical treated wood product, ACQ-treated wood, is available through special order at one of the two retail establishments.

The responses varied among retail outlets when asked, “Would reducing the use of CCA-treated wood within the next few year cause hardship within the company?” One retail establishment answered yes indicating that there is not enough production of any viable alternative. Freight costs and lack of competitive products would be the primary hardships. The second retail establishment indicated that hardship would depend upon the alternative product available. If an alternative is available at the same cost then their answer to the hardship question would be no.

CHAPTER III

DISPOSAL END MANAGEMENT

CHAPTER III,
DISPOSAL END MANAGEMENT

The disposal-end management portion of this study was separated into three tasks. These tasks included a) a field demonstration of sorting technologies (section III.1), b) evaluation of pyrolysis systems through a literature review and contact with operators of full-scale systems (section III.2), and c) development of a disposal resource book that summarizes disposal options for discarded CCA-treated wood in Florida (section III.3).

III.1 FIELD DEMONSTRATION OF SORTING TECHNOLOGIES

During last year's study (Solo-Gabriele et al. 1999), three chemical stains were evaluated in the laboratory to determine whether they could be used to separate CCA-treated wood from other wood types in the wood waste stream. Stains evaluated included specially mixed solutions with chrome azurol, 1-(2-pyridylazo)-2-naphthol (PAN) and rubeanic acid chemicals. Laboratory scale experiments showed that these stains performed very well (Kormienko et al. 2000). The objective of this year' study was to determine whether the chemical stains could be implemented as tools for the sorting of CCA-treated wood from other wood types at construction and demolition recycling facilities. In order to identify C&D facilities for field studies, a letter, a brochure, and questionnaire were mailed to C&D recyclers in Florida. The letter informed C&D recyclers of the planned demonstration projects and requested participation from C&D recycling facilities. The brochure explained the importance of separating treated from untreated wood and included color photos illustrating stain performance (See appendix D). The questionnaire inquired about sorting practices at the C&D facilities.

Three facilities, located in the State of Florida, participated in the field study, and are referred to here as facilities A, B, and C. All chemical stains were to be studied, but rubeanic acid was eliminated during the first study conducted at facility A due to disadvantages associated with its use. The primary disadvantages to using this chemical was the need for two separate solutions requiring two different sprays, and dark green color produced for CCA-treated wood that could be mistaken for dark and dirty untreated wood typically found in C&D wood waste.

Facility A processed 225 U.S.tons/day, out of which 30 tons or 13 % was assumed wood waste (table III.1). Primarily man-power, i.e. hand picking, was utilized for sorting. Employees at this facility were trained to pick and remove CCA-treated wood from the remainder of wood waste using visual recognition without stains. The facility had covered areas where employees could sort C&D debris. Facility B processed 83 tons/day of C&D debris with about 11 tons of this quantity representing wood waste. Facility B did not train employees to pick CCA- treated wood from the waste piles, even though some obvious CCA-treated wood products, such as utility poles, were often removed. This facility did not possess covered areas for waste processing. Facility C processed 300 tons of C&D debris per day, out of which 40 tons was wood. This facility provided extensive training of their employees for picking painted and CCA-treated wood using visual recognition without use of stains. Removal of these wood types was done manually under covered areas. Data collected at the C&D recycling facilities was obtained by weight in pounds and by number of pieces of wood. A custom-made plywood box with dimensions of 5 x 4 x 3 ft was used to weigh the wood. Four mechanical weighing scales, were placed evenly on a flat surface in four corners of the box. The scales were re-zeroed after each experiment and re-calibrated using a known weight. Weights on each scale were added to yield a total weight.

There were three types of experiments conducted at the C&D recycling facilities: a) separation of CCA-treated wood from other wood by product type, b) visual separation of wood waste without chemical stains, and c) analysis of pre-sorted wood waste piles.

Facility	Amount of Waste Processed[a] (tons/day)	Type of Wood Sorting Performed	Date of Pilot Study
A	225	Hand-picking based on visual separation without use of stains	May 3, 1999
B	83	No specific wood sorting performed	July 16, 1999
C	300	Hand-picking based on visual separation without use of stains, separation of painted wood	June 28, 1999

[a] Amount of wood processed is estimated as 13 % of the total amount of waste. This estimate was made by averaging the % wood composition from loads summarized in table III.2

Table III.1: Description of Facilities that Participated in Pilot Studies

III.1.a Separation of CCA-Treated Wood from other Wood By Product Type

This experiment involved separation of wood waste loads into product types (dimensional lumber, plywood, cutoffs, pallets), followed by sorting CCA-treated from other wood types using chemical stains. Loads were initially weighed as they entered the plant and identified as construction or demolition. Once a suitable size load entered the plant, it was placed in a location away from general C&D operations for analysis by the UM/UF research team. The purpose of this study was to evaluate the fraction of products that were CCA-treated. It is important to note that on average only 13% of the waste in those piles consisted of wood (by weight). The rest was composed of C&D debris, such as concrete, cardboard, metal, and carpet.

A total of four waste loads were analyzed. These loads are called A, B1, B2, and C. Load A came from facility A; loads B1 and B2 came from facility B; load C came from facility C. Three waste loads consisted of construction debris (A, B1, and B2) and one consisted of demolition debris (C). The distinction between construction and demolition waste is important due to the different types and conditions of materials that are in construction and demolition debris. In general, construction wastes contain more CCA-treated wood, since currently CCA-treated wood is the primary type of treated wood used in construction. Demolition wastes have smaller amounts of CCA present, given that 20 to 30 years ago CCA-treated wood was not as widely used in construction. According to forecasted disposal statistics, however, amounts of CCA-treated wood in demolition loads will increase during the next 5 years. At that time disposal will follow the increasing production amounts of CCA-treated wood about 20 years ago. CCA-treated wood is much harder to distinguish in demolition waste piles, because most demolition materials are weathered and often contain a lot of dirt.

On average CCA-treated wood represented roughly 16% of the wood waste on a weight basis and 27% on a piece basis for all loads analyzed (table III.2 and figures III.1 to III.4). It is important to note that wood waste in the construction piles had a larger CCA fraction (20% on average by weight) than the demolition pile (5% by weight). Dimensional lumber represented the majority of the CCA-treated wood waste for three of the four loads. Cutoffs, classified by a length of dimensional member of 1 foot or less, represented the majority in the remaining pile analyzed. Plywood in the piles analyzed was generally untreated. All four loads had significant quantities of untreated plywood (> 25 % of the untreated portion by weight). Only one of the four loads (pile A) contained CCA-treated plywood (24 % of the treated portion by weight). Pallets represented a small fraction of the wood waste. None of the pallets were treated with CCA.

Fractions determined on a weight basis were different than fractions determined on a by piece basis, especially for the construction waste piles. The data show that cutoffs increase in significance when it came to the number of pieces; the percentage of the cutoffs for the construction loads was always higher when the number of pieces was used for analysis, rather than when weight was considered. Number of pieces translates directly into labor involved in sorting. It is easier and faster to sort one big piece than many smaller pieces having the same total weight. Waste load A illustrates the large role cutoffs can play in sorting CCA-treated wood from other wood types (figure III.1). In construction waste loads B1 and B2 (figures III.2 and III.3), cutoffs also increase in importance when analyzed by number of pieces as opposed to weight. Both of these construction waste piles contain less cutoffs than construction waste pile A, because they were both roofing construction piles and plywood was a major waste source. The demolition pile, C, did not contain any cutoffs. This pile consisted primarily of dimensional lumber and plywood. Only a relatively small fraction of the dimensional lumber (<7%) in the demolition pile was CCA treated.

<table>
<tr><th>Waste Pile</th><th colspan="2">By Weight</th><th colspan="2">By Number of Pieces</th></tr>
<tr><td rowspan="7">A

Total weight = 17 tons

Wood weight = 1 ton</td><td rowspan="3">28% CCA treated</td><td>54% Cutoffs</td><td rowspan="3">32% CCA treated</td><td>89% Cutoffs</td></tr>
<tr><td>24% Plywood</td><td>8% Plywood</td></tr>
<tr><td>18% Dimensional Lumber</td><td>3% Dimensional Lumber</td></tr>
<tr><td rowspan="4">72% Other wood types</td><td>49% Plywood</td><td rowspan="4">68% Other wood types</td><td>58% Cutoffs</td></tr>
<tr><td>26% Dimensional Lumber</td><td>20% Dimensional Lumber</td></tr>
<tr><td>14% Cutoffs</td><td>22% Plywood</td></tr>
<tr><td>11% Pallets</td><td>< 0.5% Pallets</td></tr>
<tr><td rowspan="6">B1

Total weight = 5 tons

Wood weight = 0.65 tons</td><td rowspan="2">14% CCA treated</td><td>90 % Dimensional Lumber</td><td rowspan="2">28% CCA treated</td><td>78% Dimensional Lumber</td></tr>
<tr><td>10% Cutoffs</td><td>22% Cutoffs</td></tr>
<tr><td rowspan="4">86% Other wood types</td><td>67% Plywood</td><td rowspan="4">72% Other wood types</td><td>35% Plywood</td></tr>
<tr><td>22% Dimensional Lumber</td><td>32% Dimensional Lumber</td></tr>
<tr><td>6% Pallets</td><td>1% Pallets</td></tr>
<tr><td>5% Cutoffs</td><td>32% Cutoffs</td></tr>
<tr><td rowspan="6">B2

Total weight = 4.2 tons

Wood weight = 0.92 tons</td><td rowspan="2">19% CCA treated</td><td>84% Dimensional Lumber</td><td rowspan="2">43% CCA treated</td><td>50% Dimensional Lumber</td></tr>
<tr><td>16% Cutoffs</td><td>50% Cutoffs</td></tr>
<tr><td rowspan="4">81% Other wood types</td><td>53% Plywood</td><td rowspan="4">57% Other wood types</td><td>35% Plywood</td></tr>
<tr><td>41% Dimensional Lumber</td><td>46% Dimensional Lumber</td></tr>
<tr><td>4% Cutoffs</td><td>19% Cutoffs</td></tr>
<tr><td>2% Pallets</td><td><0.5% Pallets</td></tr>
<tr><td rowspan="4">C

Total weight = 7.5 tons

Wood weight = 0.83 tons</td><td>5% CCA treated</td><td>100% Dimensional Lumber</td><td>7% CCA treated</td><td>100% Dimensional Lumber</td></tr>
<tr><td rowspan="3">95% Other wood types</td><td>73% Dimensional Lumber</td><td rowspan="3">93% Other wood types</td><td>66% Dimensional Lumber</td></tr>
<tr><td>25% Plywood</td><td>34% Plywood</td></tr>
<tr><td>2% Pallets</td><td>< 0.5% Pallets</td></tr>
</table>

Table III.2: CCA Treated and Untreated Wood Compositions in Construction and Demolition Waste Piles.

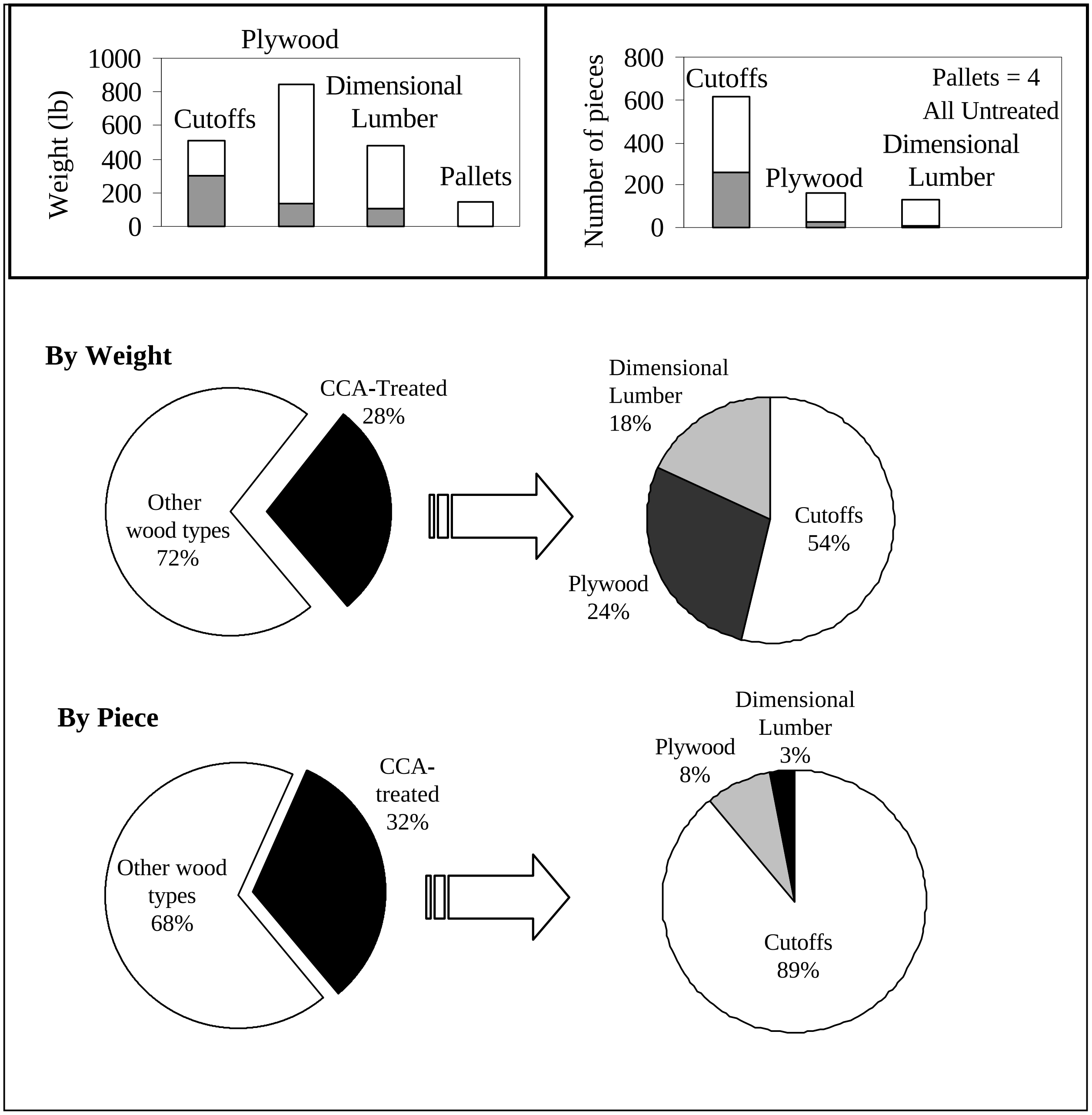


Figure III.1: Wood Contents of Construction Pile A by Weight and by Number of Pieces

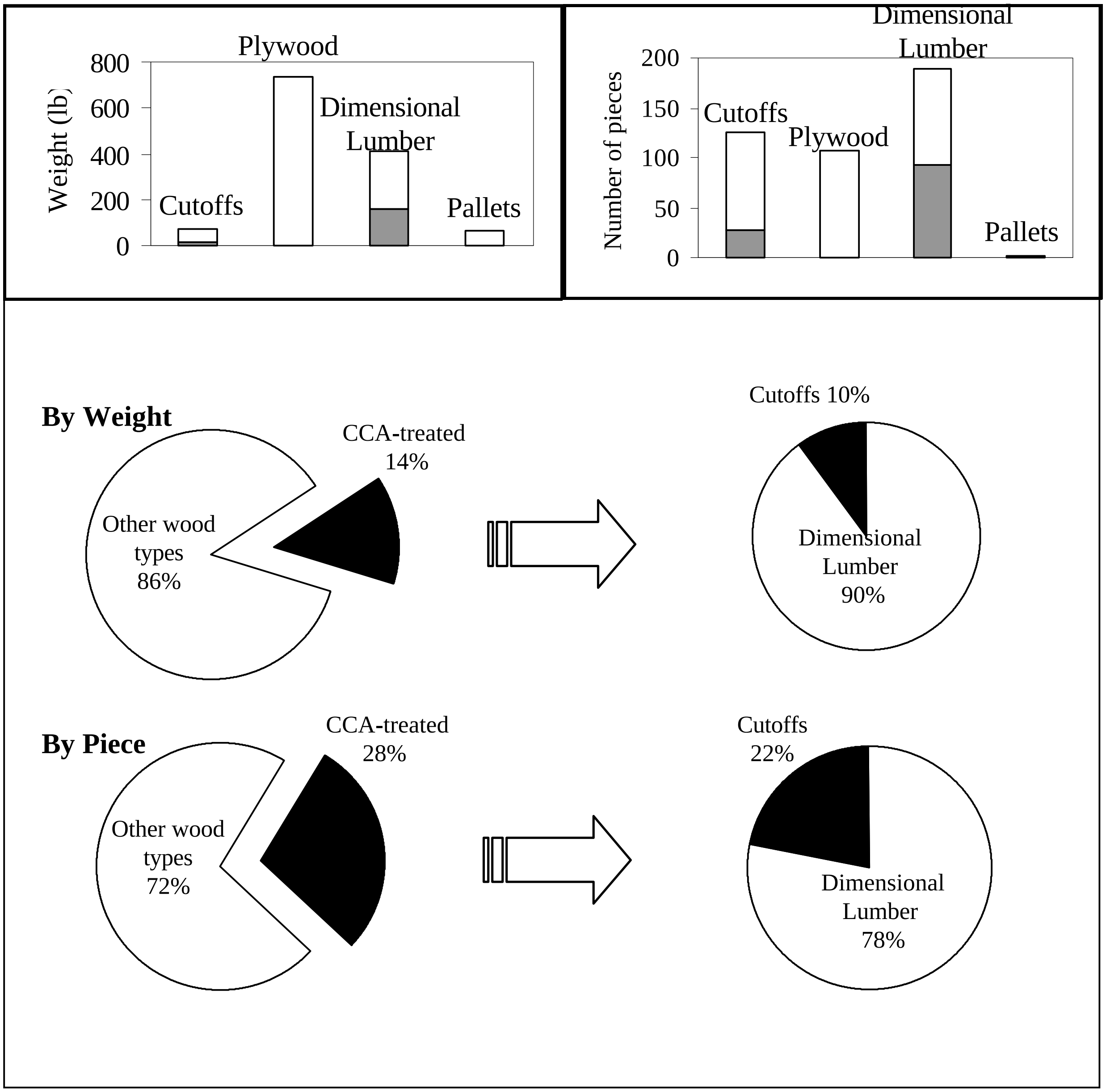


Figure III.2: Wood Contents of Construction Pile B1 by Weight and by Number of Pieces

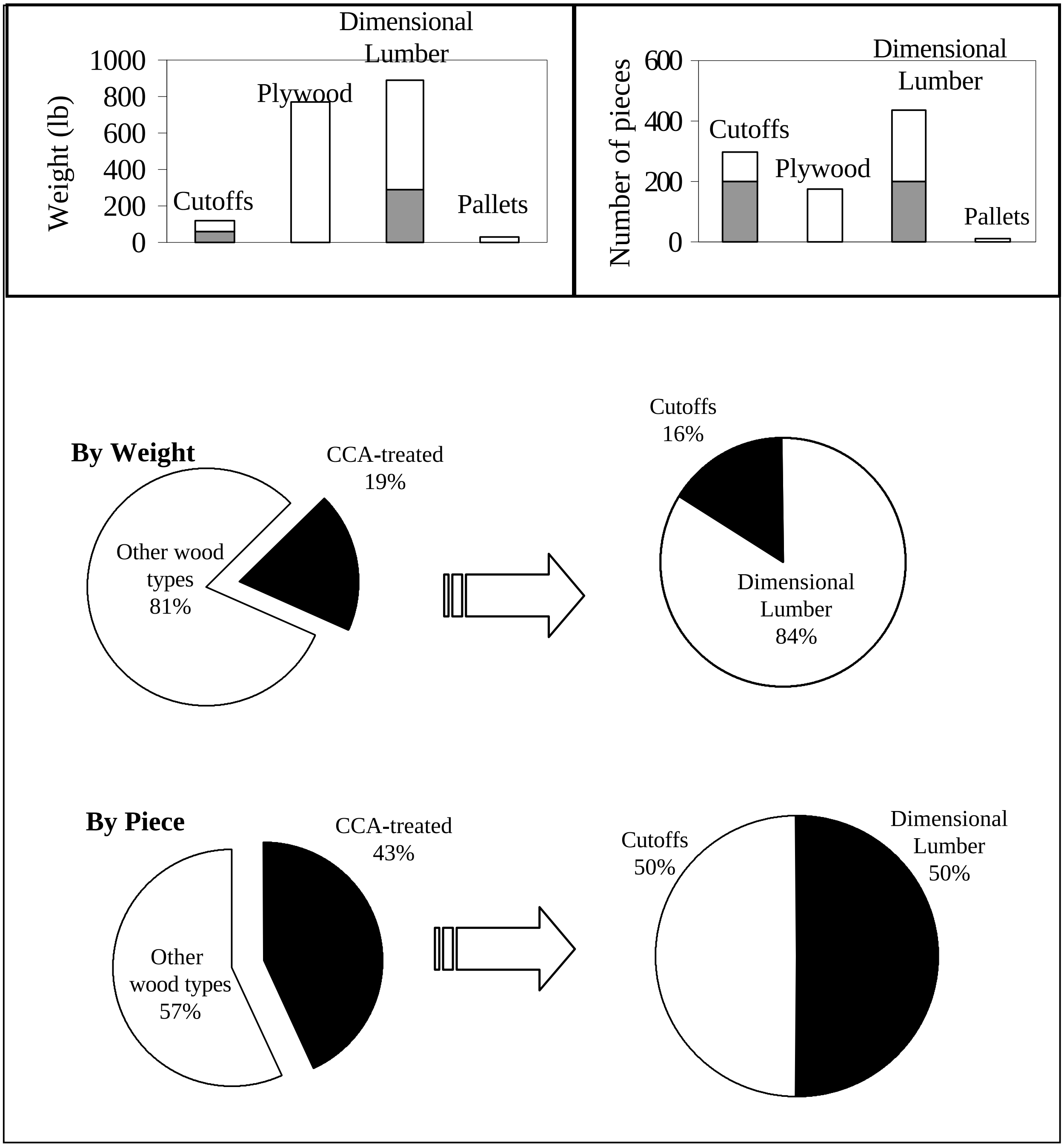


Figure III.3: Wood Contents of Construction Pile B2 by Weight and by Number of Pieces

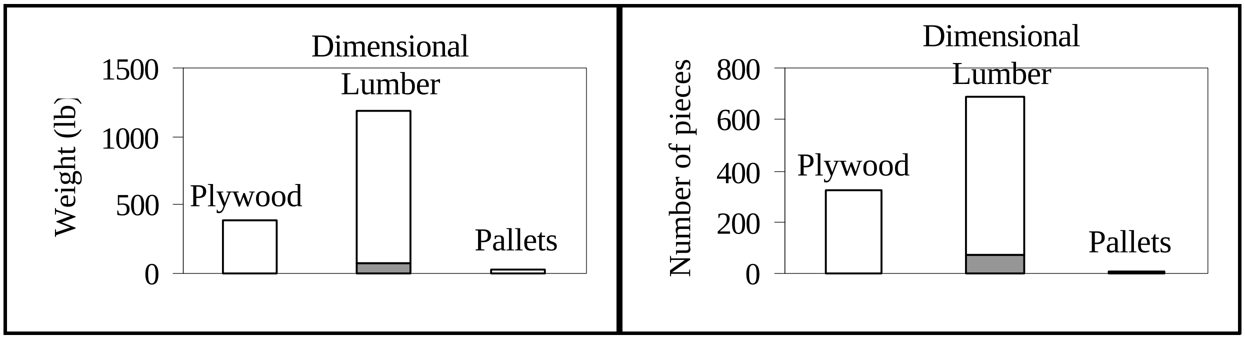


Figure III.4: Wood Content of Demolition Waste Pile C by Weight and by Number of Pieces

III.1.b Visual Separation of Wood Waste Without Chemical Stains

In a second set of experiments conducted at each facility visited (A, B, and C) a pre-weighed C&D waste load was identified by the C&D operator for the sort and placed in an area away from the normal C&D operations. These loads consisted of co-mingled C&D waste from which the wood was pulled-out by the UM/UF research team. Prior to sorting all the researchers involved in the experiment were shown samples of CCA-treated and untreated wood to facilitate their ability to distinguish CCA-treated wood from other wood types based upon the green hue associated with CCA-treated wood. Once the wood was removed, it was visually separated without the use of stains into CCA-treated and not CCA-treated wood. Once sorted into these categories, wood in each pile (the assumed CCA and not CCA-treated piles) was then checked with chemical stains to determine the quantities in each pile that were in fact true CCA-treated vs. true not CCA-treated. The three piles analyzed in this set of experiments were all demolition related.

This experiment showed the effectiveness of separating CCA-treated wood from other wood types based solely on visual discrimination. If any wood sorting is presently done at the C&D facilities on routine basis, it is done by visual means without chemical stains. The purpose of this set of experiments was to evaluate the efficiency of this sorting method.

The visual separation experiment included a visual sort of a wood waste debris pile into visually identified CCA-treated (assumed CCA-treated) and visually identified not CCA-treated piles (assumed not CCA-treated). Visually identified CCA-treated and assumed not CCA-treated piles were further separated, using chemical stains, into true CCA- treated and true not CCA-treated. The conceptual set-up of the visual sorting experiment is shown in figure III.5.

Visual separation at facility A was performed on a 546 pounds wood waste pile that contained 105 wood pieces. By weight, 46 % was visually identified CCA-treated, by number of pieces, 25 % was visually identified CCA-treated (table III.3, figure III.6). In the visually identified CCA-treated pile 84 % of the wood, by weight, was actually CCA-treated. In the visually identified untreated pile, 60 % of wood, by weight, was in fact not CCA-treated. Analysis by number of pieces showed that in the visually identified CCA-treated pile 92 % of the wood was CCA-treated. In a visually identified untreated pile 65 % of the wood was really not CCA-treated (table III.3).

The same experiment at facility B was accomplished on a 1810-lb waste pile, containing 373 wood pieces. 22 % of the waste pile by weight was visually identified CCA-treated, and by number of pieces, 14 % was visually identified CCA-treated (table III.3). In the visually identified treated pile, 64 % of wood, by weight, was true treated. In the visually identified untreated pile 97 % of wood by weight was actually not CCA-treated.

The visual separation experiment at facility C was performed on a kitchen-remodeling demolition waste. A total of 1446 pounds and 374 pieces of wood were analyzed. Results yielded from facility C were different, because of the nature of wood waste source (i.e. kitchen-remodeling) present in that pile. By weight 1 % of wood was visually identified CCA-treated, and by number of pieces 4 % of wood was visually identified CCA-treated. In the visually identified CCA-treated pile there was no CCA-treated wood present. In the visually identified not CCA-treated pile 99.5 % of all wood by weight was not CCA-treated, with only 0.5 % of CCA-treated wood. This waste load yielded only trace amounts of CCA-treated wood altogether.

Results indicate that visual sorting without stains is beneficial. In all cases better than 50% sorting efficiencies were noted. 84% (by weight) of the visually identified CCA-treated pile for facility A and 64 % (by weight) of the visually identified CCA-treated pile for facility B were correctly identified. For the not CCA-treated piles, 60 % (by weight) of the wood was correctly sorted for facility A, 97 % (by weight) was correctly sorted for facility B, and almost 100 % was correctly sorted at facility C.

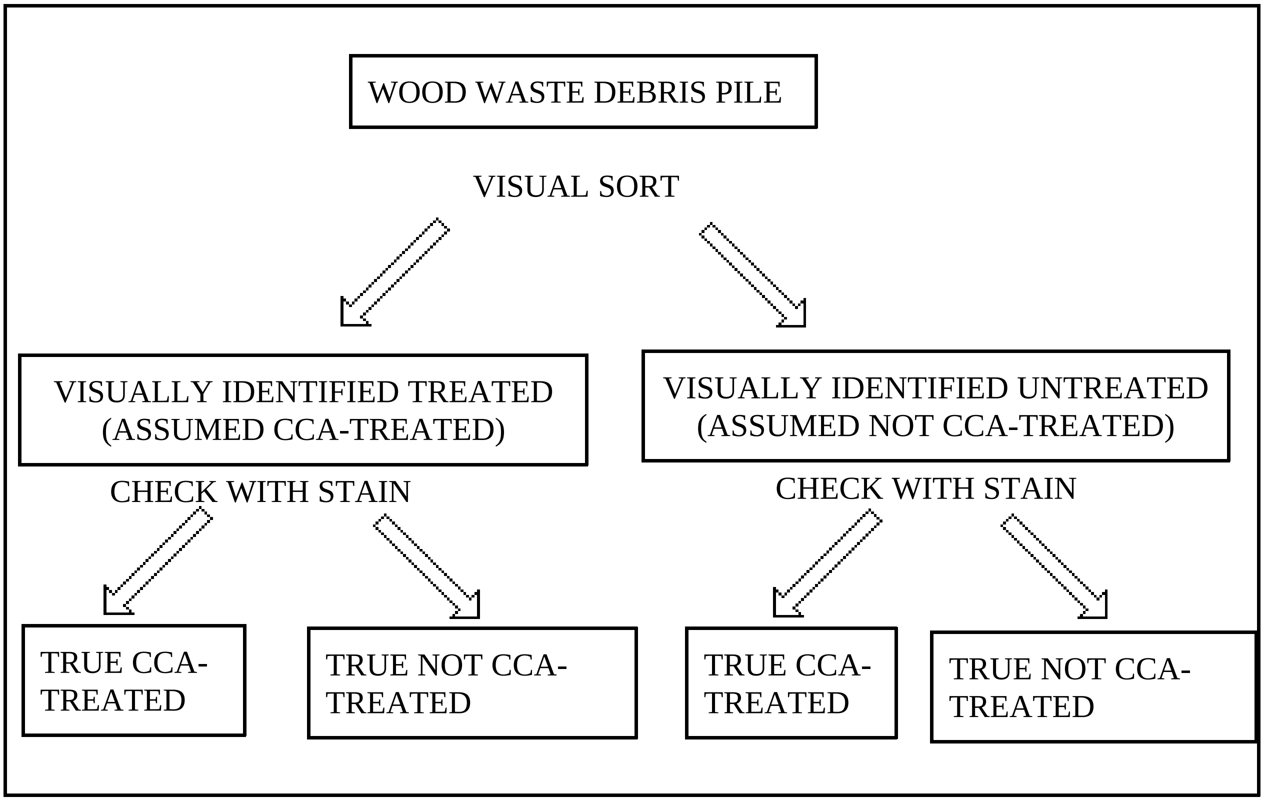


Figure III.5: Set-up of Visual Sorting Experiment

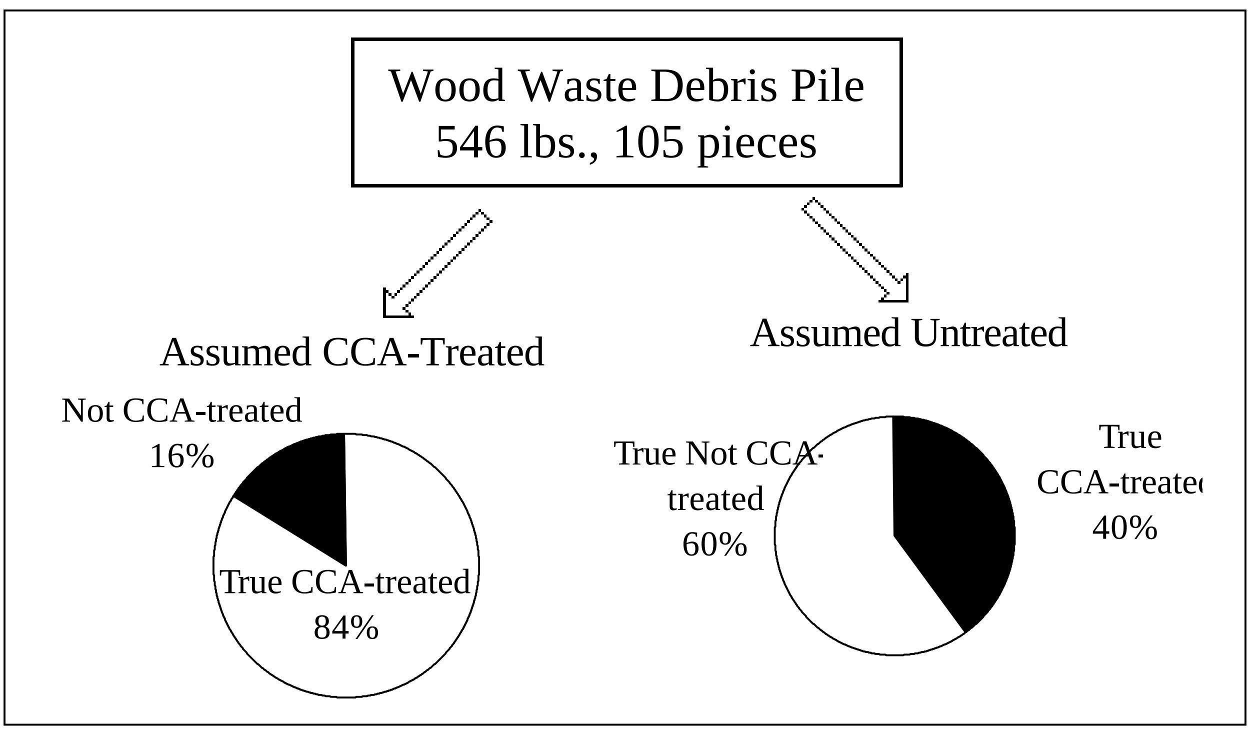


Figure III.6: Results of a Visual Separation of a Wood Debris Pile at C&D Facility A (shown by weight).

Facility	By weight				By Number of Pieces			
	Visually Identified CCA-Treated		Visually Identified Not CCA-treated		Visually Identified CCA-Treated		Visually Identified Not CCA-treated	
A	46%		54%		25%		75%	
	True CCA-treated	True Not CCA-treated	True CCA-treated	True Not CCA-treated	True CCA-treated	True Not CCA-treated	True CCA-treated	True Not CCA-treated
	84%	16%	40%	60%	92%	8%	35%	65%
B	22%		78%		14%		86%	
	True CCA-treated	True Not CCA-treated	True CCA-treated	True Not CCA-treated	True CCA-treated	True Not CCA-treated	True CCA-treated	True Not CCA-treated
	64%	36%	3%	97%	59%	41%	6%	94%
C	1%		99%		4%		96%	
	True CCA-treated	True Not CCA-treated	True CCA-treated	True Not CCA-treated	True CCA-treated	True Not CCA-treated	True CCA-treated	True Not CCA-treated
	0%	100%	<0.5%	~100%	0%	100%	0.5%	99.5%

Table III.3: Results of Visual Separation of Wood Debris at Facilities A, B, and C by Weight and by Number of Pieces.

III.1.c Analysis of Pre-Sorted Wood Waste Piles

A total of three pre-sorted wood waste piles were analyzed, one at each facility visited. These piles were pre-sorted by employees at the facilities and are considered not CCA-treated by those facilities. The piles consisted of wood only, and their sizes are on an order of 10 or more tons. Given their large size, the wood for this experiment was randomly picked from the perimeter of the pile, then stained, weighed, and counted. The intent was to show the amounts of CCA-treated wood that would eventually be recycled.

For facility A, 443 pounds were analyzed; for facility B, 1196 pounds were analyzed; for facility C, 868 pounds were analyzed. It was found that at facilities A and C the amount of CCA-treated wood in the pre-sorted piles was 10 % and 9 % respectively, whereas at facility B that amount was 30 % by weight (figure III.7). Similarly, for facility A, 65 pieces of wood were analyzed; for facility B, 172 pieces were analyzed; for facility C, 182 pieces were analyzed. Analysis by number of pieces showed that at facilities A, B, and C the amounts of CCA-treated wood by the number of pieces were 15 %, 28%, and 8 %, respectively. It is important to mention again that facilities A and C, where pilot studies were conducted, implemented a considerable amount of employee training on sorting CCA-treated wood from other wood types. Facility B, while encouraging workers to separate CCA-treated wood, did not have extensive training. The difference in training alone can be clearly noted in the figure III.7. This result suggests that training is an integral part of sorting CCA-treated wood from other wood types. Visual sorting (without the use of chemical stains) can potentially reduce the amount of CCA- treated wood entering waste stream by 15 to 20 percent.

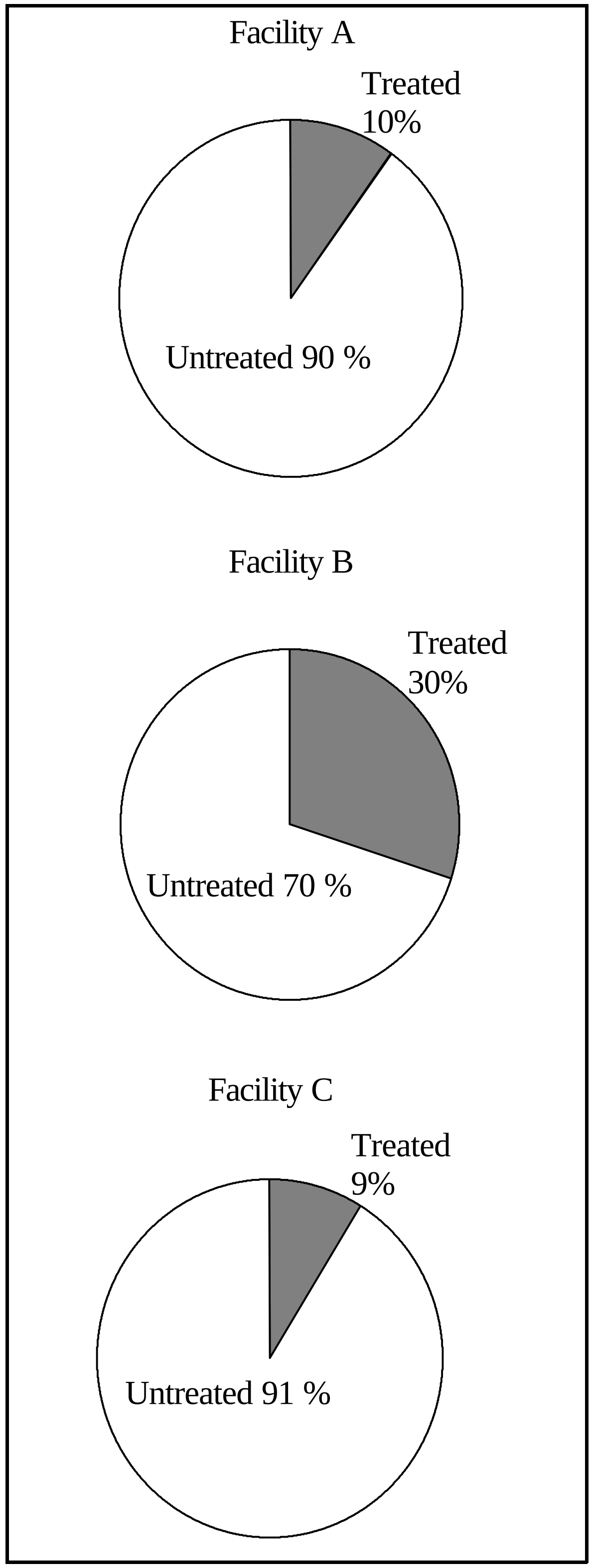


Figure III.7: Results on a C&D Pre-Sorted Pile that was Assumed Untreated by C&D Recyclers (by weight)

III.1.d Discussion

A summary of the CCA-treated wood fraction for all the loads evaluated in this study is provided in table III.4. The data show that CCA-treated wood represented between 0 and 60 % of the wood. It is interesting to note from the data that demolition loads where characterized by smaller CCA-treated wood fractions (< 5%); whereas the construction loads were characterized by fractions ranging from 14 to 28%. The composition of the mixed loads was variable.

During the pilot studies it also became evident that time and labor intensity would be a driving factor in using stains for sorting. Although in the laboratory setting absorbance time differences seemed minimal, it is very crucial in the field applications. Also weathered wood is much harder to work with than new wood because of dirt and other residues present on the wood. Often well weathered pieces of wood had to be cut with a knife to expose a clean surface for better visibility of color. Some wood pieces had to be wiped on surface to remove soil or excess moisture. All of these preparation activities took a toll on time effectiveness of sorting CCA-treated wood from other wood types using the chemical stains.

PAN indicator performed the best in the field, mainly due to its faster reaction time (12 seconds). PAN, however, was subject to interference reactions with paints, adhesives, nails and other metal fasteners. Is known that PAN might react with metals other than those found in CCA, therefore those reactions can form a color on contact. The color that was produced in those reactions was different from the magenta color found on CCA-treated wood. The color produced during interference reactions was bright pink or bright red, not magenta (a purple-red color). It was also found that some pieces of wood would stain slightly on the surface of the wood, even though it was untreated through its cross-section, because of surface treatments or sealants.

Chrome Azurol S, characterized by a much slower reaction time (63 seconds), made it impractical for quick sorting. It was useful however to differentiate between CCA-treated and other wood types when interference reactions with PAN took place. Chrome Azurol was subject to little or no interference reactions. For that reason it would be a preferred stain if the reaction time could be minimized. It could also be used as a back-up, when performance of PAN is questionable, i.e. the bright red color appearing.

Even though methods could be implemented that would allow C&D recycling facilities to deal with their substantial amounts of wood, it would be challenging to apply chemical stains for sorting large amounts of wood. Stains could be easily used, nevertheless, for regulatory purposes and as quality control checks of wood quality for both recycling and wood burning facilities. The stains can also be used to augment training activities at the C&D facilities that rely on visual sorting without stains. Such training will improve separation of treated from untreated wood.

Load I.D.	Experiment Type	Load Type	All Wood (pounds)	CCA treated wood (pounds)	% CCA treated
A	Separation of CCA treated wood from other wood by product type	Construction	2000	560	28
B1	Separation of CCA treated wood from other wood by product type	Construction	1300	182	14
B2	Separation of CCA treated wood from other wood by product type	Construction	1840	350	19
C	Separation of CCA treated wood from other wood by product type	Demolition	1660	83	5
A	Visual separation of wood waste without chemical stains	Mixed	546	328	60
B	Visual separation of wood waste without chemical stains	Mixed	1814	297	16
C	Visual separation of wood waste without chemical stains	Demolition	1446	~0	~0
A	Analysis of pre-sorted wood waste piles	Mixed	443	44	10
B	Analysis of pre-sorted wood waste piles	Mixed	1196	359	30
C	Analysis of pre-sorted wood waste piles	Mixed	868	78	9

Table III.4: Summary of CCA-treated Wood Fraction in Loads Evaluated

III.2 EVALUATION OF PYROLYSIS SYSTEMS

The following sections provide a summary of the available literature concerning the pyrolysis of CCA-treated wood. These sections include relevant background information (section III.2.a), information concerning emissions (section III.2.b), and a description of two full-scale operational systems (section III.2.c).

III.2.a Background

After adequate sorting of CCA-treated wood from other wood types at the C&D recycling facilities, CCA-treated wood needs to be disposed in an environmentally sound fashion. One promising technique for the ultimate disposal of CCA-treated wood is pyrolysis. In simple terms, pyrolysis breaks apart chemical bonds and convert a given substance into another substance or substances by only using heat (Wampler 1995). The major emphasis in designing pyrolysis processes is adjusting the pyrolysis conditions to yield a desired product as well as a reproducible system (Irwin 1982). The conditions that could be manipulated when designing a pyrolysis process include temperature control, air intake or oxygen levels, duration period (time-temperature relationship), and cooling rate (Irwin 1982). It is important to mention that pyrolysis is widely used in industry and in various areas of study. Pyrolysis is used in production of coal, oil shales, and cellulosic materials (Irwin 1982). Pyrolysis is also utilized to study fundamentals of thermal degradation, flammability, and flame retardation (Ellis 1993). Analytical pyrolysis allows researchers to study high molecular weight compounds, which are difficult to study by other means (Wampler 1995).

Given the many beneficial applications of pyrolysis, studies were initiated on the pyrolysis of CCA-treated wood in the mid-eighties. The main objective in pyrolysis of CCA-treated wood is to retain arsenic, as well as copper and chromium, in the ash, and to avoid air emissions. Arsenic is the most volatile of the three metals; up to 77 % of arsenic can potentially be volatilized, when CCA-treated wood is burned (McMahon et al. 1988). A successful pyrolysis system would eliminate air emission problems. The following section provides more details on the emission characteristics of CCA-treated wood, as well as a description of full-scale systems designed for the pyrolysis of CCA-treated wood that meet the above criteria. Two systems are currently in operation, a system in France, called Chartherm, and a system in Finland, which utilizes a copper smelter. Information has been obtained on those systems through personal communication with individuals who designed these systems.

III.2.b Emissions from Pyrolysis Systems

Arsenic

Arsenic present in the form of arsenic pentoxide (As_2O_5) can be reduced to arsenic trioxide (As_2O_3) under high temperatures. Arsenic trioxide, which contains arsenic (III), is more apt to volatilization at temperatures well below the combustion temperatures of wood (Pasek and McIntyre 1993). Air emissions of arsenic trioxide are of great concern. A dose as low as 1 to 2.5 milligrams per kilogram of body weight can be fatal to humans (Hirata et al. 1993).

Arsenic trioxide is formed from arsenic pentoxide and oxygen (Pasek and McIntyre 1993):

$$As_2O_5 \Leftrightarrow As_2O_3 + O_2$$

Arsenic trioxide, with a melting point of 313°C (595°F) and boiling point of 465°C (869°F), starts to sublime at 135°C (275°F), and is gasified according to this equilibrium (Hirata et al. 1993, McMahon et al. 1986):

$$2\ As_2O_3\ (\text{solid}) \Leftrightarrow\ As_4O_6\ (\text{gas})$$

The percentage of arsenic that volatilizes depends on the temperature of combustion as well as the exposure time.

Several studies have evaluated the relationship between temperature of incineration and emissions of arsenic. One of the earlier studies (McMahon et al. 1986) utilized a horizontal tube furnace which allows wood samples to be subjected to various time/temperature conditions under controlled air flow. The furnace utilized by McMahon et al., 1986, permitted for quantitative sampling of the combustion gases and fly ash through a series of filter traps. During each run 850 mg of sawdust were placed into a pre-heated furnace. The samples consisted of sawdust from southern yellow pine that was originally treated to 0.60 pcf with CCA type C. The time period of combustion was sufficient to completely incinerate the sawdust, and in some cases, permitted for heating well after the residual ash was produced. The air flow was maintained at 2.8 liters per minute throughout each test. Data from these tests showed that as much as 77 % of the arsenic can be volatilized when the wood is burned at 1,000°C (1832°F) at an exposure time of 6 hours. The study indicated that when the exposure time was lowered to 1 hour, the volatilization percentage decreased to 70 % at a temperature of 1000°C (figure III.8). At 400°C (752°F) arsenic emissions were 27 % for 10 and 30-minute exposure times, and 19 % for 20-minute a exposure time (figure III.8). At 800°C the emissions were 22 %, 42 %, 34 % ,and 44 % for exposure times of 10 minutes, 20 minutes, 30 minutes, and 60 minutes, respectively (figure III.8). Overall, the data indicate that higher arsenic emissions occur with higher temperatures and longer incineration times. Of the arsenic that was volatilized and recovered, essentially all was trapped with the fly ash for experiments that were conducted for exposure periods of 30 minutes or less. For experiments where heating exceeded 30 minutes, a significant but small amount of arsenic was trapped from the gasous phase (McMahon et al. 1986). Data were also collected concerning the speciation of the arsenic. Essentially all of the arsenic recovered from the residue (bottom ash) was in the pentavalent (arsenate) form. The ratio of arsenite to arsenate in the fly ash and in the gaseous arsenic phase was found to vary between 1 to 1 and 6 to 1. It is important to mention, however, that although the general trend of the results showed greater arsenic losses for longer exposure times, this increase is not always consistent throughout the data set. For example, the study showed that at a temperature of 400°C and exposure time of 10 minutes, the volatilization is 27 %, which decreases to 19 % for the time of 20 minutes.

During another study (Hirata et al.1993) Japanese cedar and red lauan wood species treated with CCA were incinerated to quantify metal emissions and estimate tha amount retained in the ash. Incineration was accomplished utilizing a thermal analyzer which was able to reach the target temperature within one minute. The air flow rate was maintained at 150 ml/min during experimentation and condensates from the thermal analyzer were captured through a series of liquid traps. Incineration time was continued until decomposition of the wood sample was complete. The results from these experiments showed that arsenic emissions increased with increasing temperatures (figure III.8). At 505°C, 42 percent of arsenic was volatilized, followed by 48 percent at 600°C, 60 percent at 700°C, 73 percent at 800°C, 85 percent at 900°C, and 95 percent at 1030°C (figure III.8).

Two other studies showed different trends between arsenic volatilization and temperature. In the first of these studies (Pasek and McIntyre 1993) an electric furnace was utilized to incinernate between 2 and 2.5 grams of sawdust produced from southern yellow pine treated to a retention level of 2.0 pcf CCA type C. The air flow rate through the furnace was maintained at 150 cubic centimeters per minute. At a temperature of 600°C and an exposure time between 15 and 20 minutes the volatilization of arsenic was between 18 % and 21 % (Pasek and McIntyre 1993). For an incineration time of 30 minutes, 18.5 % was volatilized at a temperature of 700°C, 15.8% at a temperature of 800°C, and 8 % at a temperature of 1000°C (figure III.8). In this study volatilization of arsenic was inversely proportional to temperature, except for one result, where volatilization of arsenic increased from 3.3 % at 900°C to 8 % at 1000°C. The amount volatilized also generally increased with incineration time, except for the results obtained at 900°C where emissions decreased from 4.2 % at 6 minutes to 3.3 % at 30 minutes.

The work of Pasek and McIntyre, 1993, was replicated by Clark and Maxwell, 1998. Both studies utilized similar equipment. The wood used was southern yellow pine treated at retention levels of 2.61 pcf and 2.60 pcf (Clark and Maxwell, Georgia Institute of Technology, personal communication, 1998). Approximately 2-gram samples of CCA-treated wood were maintained under the target incineration temperature for a period of 30 minutes. The air flow was maintained at 150 cubic centimeters per minute. The results show that the amount of arsenic volatilized decreases with temperature increase. For 600°C, 8 percent of the arsenic was volatilized. One percent was volatilized for temperatures in excess of 700°C, 0.5 percent for 800°C, 0.4 percent for 900°C, and 0.5 percent for 1000°C (figure III.8).

Summary of Studies

Some studies indicate that arsenic emissions increase with temperatures (McMahon et al. 1986, Hirata et al. 1993), and others suggest that emissions decrease with temperatures (Pasek and McIntyre 1993, Clark and Maxwell 1998). Several reasons could be posed for such discrepancy in results of pyrolysis research. Since pyrolysis is a sensitive operation, parameters such as time of exposure, species of wood incinerated, procedures followed, and apparatus used could affect the results greatly. Hirata et al., 1993, speculates that in order to retain arsenic in the ash, CCA treated wood should be incinerated at low temperatures with a limited air supply. It can be inferred from the graphs generated that no concluding data has yet been gathered and further research is needed to determine with certainty the relationship between arsenic volatilization, temperature, and incineration time.

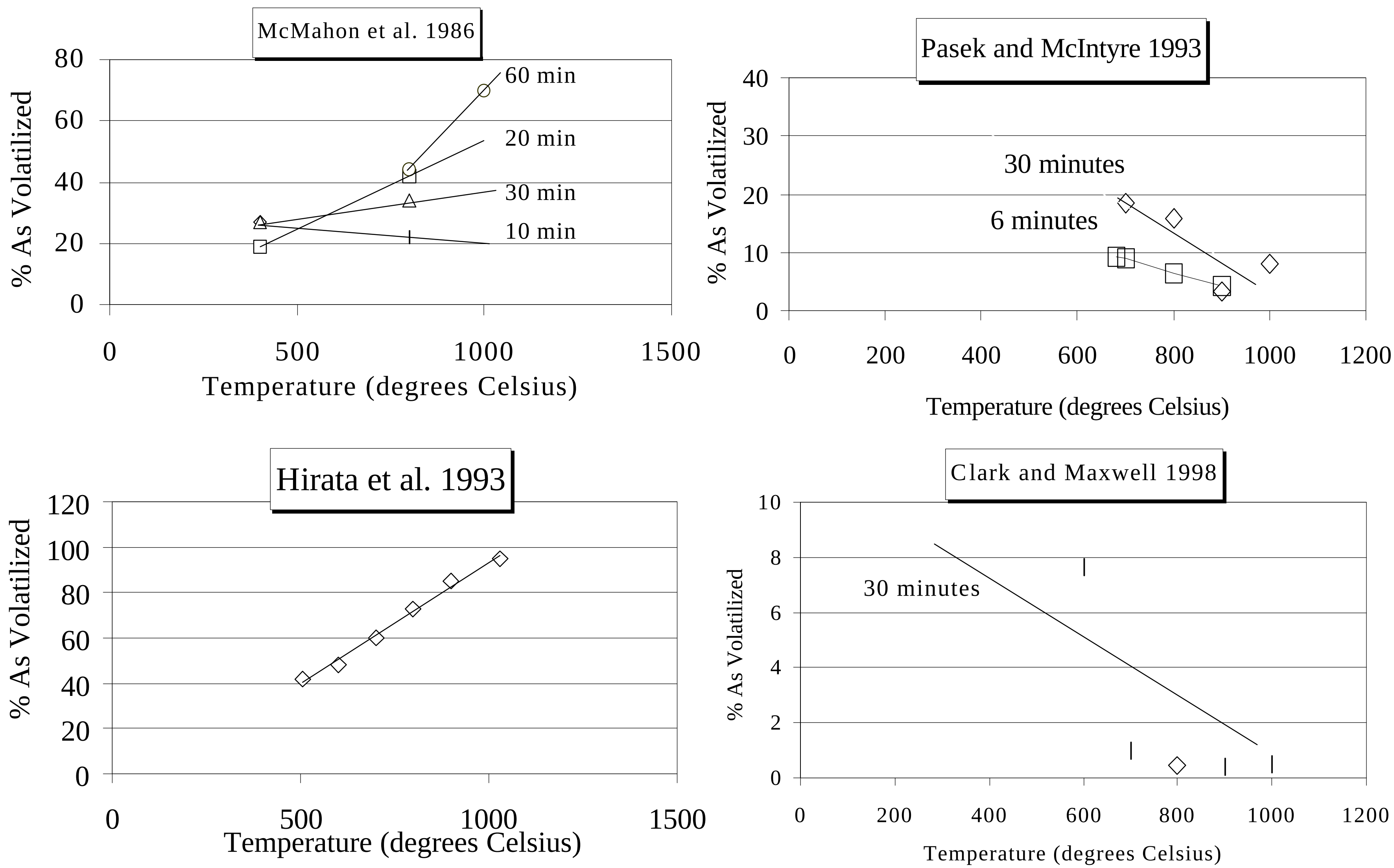


Figure III.8: Arsenic Loss versus Temperature for Different Studies

Copper and Chromium

Although copper and chromium do not volatilize as easily as arsenic, it is important to mention their emission characteristics. The emission of copper ranges from 5 % at 800°C and exposure time of 60 minutes to 20% for a temperature of 400°C and exposure time of 30 minutes (McMahon et al. 1986). Chromium emissions range from 6 % to 21 % at the same temperatures and exposure times as copper (McMahon et al. 1986). Some studies (Helsen et al. 1997), however, show that the emissions of copper can be undetectable in some cases, and chromium emissions can be as low as 2 %. In general lower emissions of copper and chromium are observed at higher temperatures.

III.2.c Full-Scale Systems for the Pyrolysis of CCA-Treated Wood

Currently there are two known full-scale systems that burn CCA-treated wood in such a manner that the emissions are minimal. One system is located in France and is called by its founders as the "Chartherm process," and a second system which operates as a copper smelter is located in Finland.

Chartherm Process

The following description of the Chartherm process was obtained by personal communication with one of the founders of the technology, Jean Hery, as well as the company website. Figure III.9 provides a diagram of the process described below.

The wood that is pyrolyzed is first crushed creating wood shreds. The wood is then ignited (ignition point established as 273 ºC [523 ºF]) and temperatures are kept below 500 ºC. The oxygen input to the chamber is kept at a minimum in order to better control air emissions. Following the combustion, fumes are abruptly cooled in order to capture the condensable elements. At the exhaust of the reactor, the gases are captured and burned at temperatures in excess of 850°C for more than 2 seconds in order to eliminate all the organics present in the gases. The remainder of the combustion products are referred to as "graphitic charcoal," rather than ash. According to the founders of Chartherm process, it is able to capture 99.7 % of arsenic. Following the combustion procedure, the charcoal residue goes through a process of grinding until all of its particles are reduced to a size of 40 microns or less. After grinding of the charcoal residue, the metals and other non-carbon elements are separated from the carbon by the use of centrifugation, which is pictured in figure III.10. The metals, characterized by a higher density, move toward the walls of the centrifuge and the carbon is drawn into the center (Hery, Chartherm, personal communication, 1999). It is important to mention that this part of the process in most controversial and certain evaluations of it are pending.

The size of the current Chartherm operation is 1.65 tons/hr. The initial cost for the plant is one million dollars plus land, building, civil works and services. It is claimed, however, that through this system the disposal costs can be substantially reduced to about $^{1}/_{3}$ price of incineration and ½ price of landfilling (Hery, Chartherm, personal communication, 1999). This is due to the 95 % mass reduction that Chartherm process claims to provide.

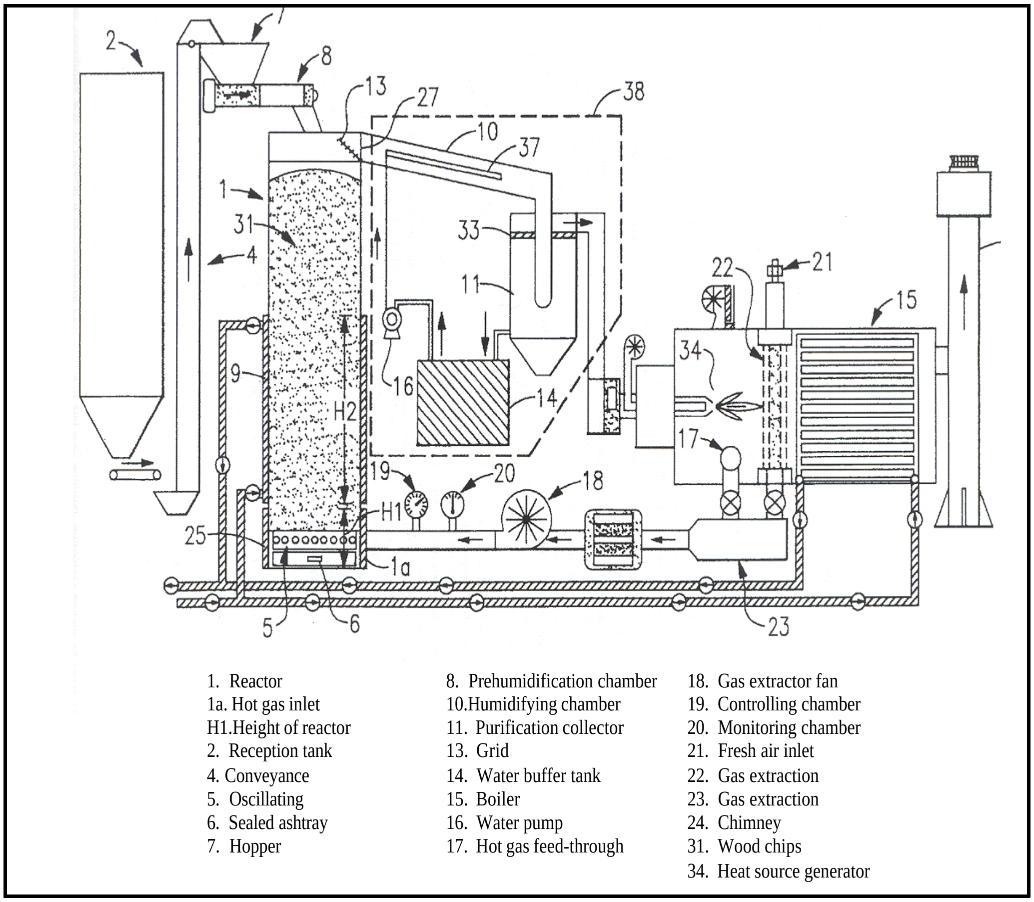


Figure III.9: Diagram of Chartherm Process
(From Chartherm U.S. Patent Application)

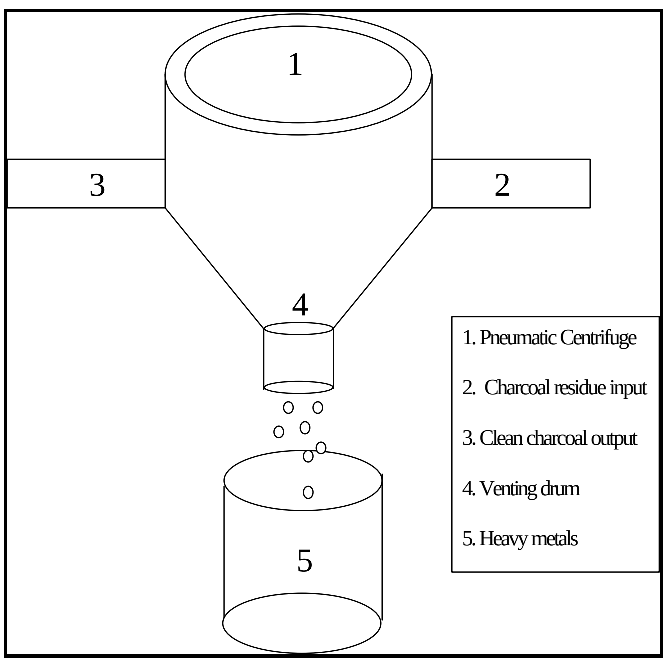
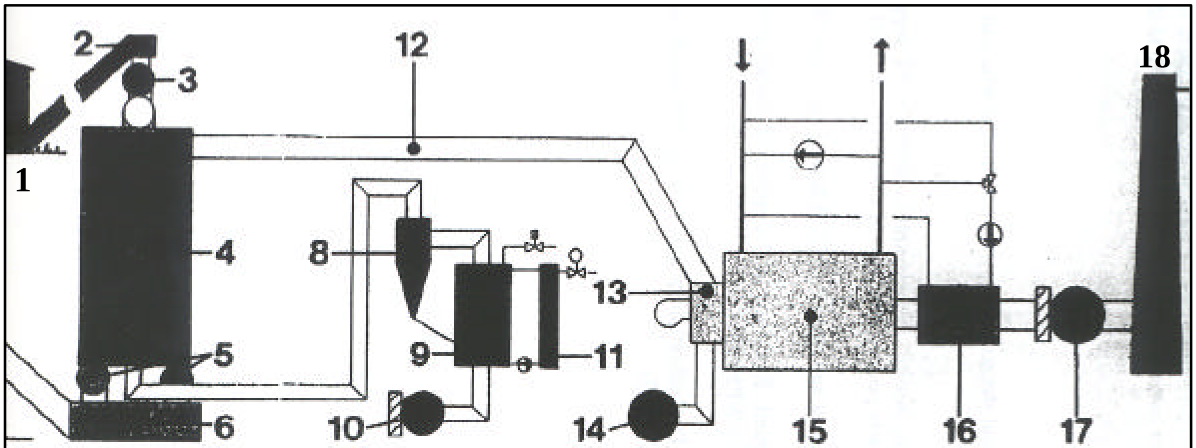


Figure III.10 Extraction of Heavy Metals by Centrifugation
in Chartherm process (From Chartherm Web Page 1999).

4.3.B Copper smelter

The copper smelter process aims at recycling the CCA chemical bound in the wood. It was developed by a Finnish company, Outokumpu Oy, and was applied to small scale trials during 1993 (Nurmii 1996). Copper smelting uses a flash smelting furnace, which provides an oxygen rich atmosphere and very high temperatures (Nurmii and Lindroos 1994). In the heating process solid fuel in the form of wood is gasified in its entirety and the combustion gas produced is burned in the boiler (Nurmii 1996). Figure III.11 shows the operating diagram of the plant.



1. Fuel bin	7. Ash pallette	13. Gas burner
2. Fuel feed conveyor	8. Drop separator	14. Combustion fan
3. Fuel feeder	9. Humidifier	15. Gas boiler
4. Gas generator	10. Gasification air fan	16. Economizer
5. Ash removers	11. Plate heat exchanger	17. Flue gas fan
6. Ash conveyor	12. Gas pipe	18. Flue gas

Figure III.11: Copper Smelter Facility Located in Finland (Nurmii 1996)

The first step of the process is to chip the wood to obtain a particle size of 0.4 inch (10 mm) or less. For the tests that were performed on the process, 51.3 tons of wood (6920 cubic feet) were chipped (Nurmii 1996). The chips were then sent by fuel feed conveyor to the gas generator. The process took 56 hours for completion.

The original analysis of the wood chips showed that by weight they contained 0.24 % of arsenic, 0.18 % of copper, and 0.30 % of chromium (Nurmii and Lindroos 1994). The next analysis was performed in the flue on the top of the pipe. It yielded arsenic emissions of about 1380 mg/h, copper emissions of about 16.9 mg/h, and chromium emissions of about 4.5 mg/h (Nurmii 1996). Total estimated emissions for the copper smelter process are given in table III.5.

Metal	Estimated total emission (g)	Percentage emission based on original amout of the metal present (%)
Arsenic	77	0.10
Copper	1.0	1×10^{-3}
Chromium	0.25	2.6×10^{-4}

Table III.5: Total Estimated Emissions of Arsenic, Copper, and Chromium (Nurmii 1996).

Data indicated that about 30 % of all the arsenic was found in the condensing water from the flue gas cooling system (31.2 lb) (Nurmii 1996). In comparison only trace amounts of copper and chromium were found. The same was true for drop separator, where 30 g of arsenic were collected. At the end of the study the remaining ash was tested for arsenic, copper, and chromium yielding 0.1 %, 0.38 %, and 0.45 % of each respectively (Nurmii 1996).

The plant costs were not evaluated because the copper smelter utilized for experimentation is run on an existing gasification type incineration plant that is also used for other applications. The overall capacity of the plant was 385,000 tons per year (Nurmii and Landroos 1994). This value corresponds to 44 ton/h, assuming constant operation throughout the year. It is therefore a much larger operation than the Chartherm process described above. Note that some important operational parameters were not disclosed for the copper smelter process, such as the temperature of burning, and the processing time for each unit.

III.3 RESOURCE BOOK FOR WOOD DISPOSAL SECTOR

Information concerning the development of the resource book is provided in the following sections. These sections describe the relevant background (III.3.a), the methods utilized (III.3.b), results (III.3.c), and conclusions (III.3.d). The draft of the resource book is included as attachment A of this report. Supplemental information concerning the development of the resource book including questionnaires sent to various disposal sectors is included within appendix E.

III.3.a Background

During the course of the research project, the investigators have received numerous inquiries about the management options and disposal costs of treated wood products. The primary source of these inquiries has been from homeowners with different treated wood products ready to be discarded. In addition similar questions have been raised throughout the project during meetings with various waste facility operators, government officials, and technical advisory group members. In response to this, the investigators set as an objective the development of a resource book that interested parties could use to determine their options for managing discarded treated wood. The treated wood products discussed as part of the resource book were to include products other than CCA-treated wood. Many of the questions directed toward the researchers regarded creosote- and pentachlorophenol-treated wood.

A second objective established for the resource book was to provide educational material on treated wood products and their safe management and disposal. One of the common observations made by both the investigators and some technical advisory group members was that many of the parties using treated wood products do not understand what these products are actually treated with and why the handling and disposal of such materials merit special attention. An additional common observation is that most retailers of treated wood products do not educate consumers about the proper handling and disposal of treated wood products.

A treated wood resource book was thus created to provide information for typical consumers of treated wood products. This information includes a basic description of treated wood and its properties, and options for safely managing discarded treated wood. The resource book was designed to be easily understood by a non-technical audience. The development of the resource book included developing the educational materials on treated wood basics as well as conducting a survey of disposal options available to consumers in Florida.

III.3.b Methods

The methods used in the development of the resource book included: 1) the development of the educational section, 2) the development and mail-out of surveys to the disposal sector, and 3) a compilation of survey results and other information on the disposal sector.

Development of Educational Section

Prior to writing the resource book, a number of basic questions that might be posed by the consumer of treated wood products were developed. These questions included the following:

1. What is treated wood?
2. Why does wood have to be treated?
3. What are the different types of treated wood chemicals and products?

4. How does one determine if wood is treated?
5. What health and safety precautions should be followed when using treated wood products?
6. Are discarded treated wood products a solid waste?
7. Are discarded treated wood products a hazardous waste?
8. What are the options for managing discarded treated wood products?
9. What safety and environmental concerns are associated with disposing of treated wood products?
10. Can treated wood be recycled?
11. Where can the consumer find additional information?

The objective of the resource book was to provide clear, concise answers to these questions. Answers were obtained by reviewing existing literature and industry information collected during the previous work on the project and from a review of current federal and Florida regulations regarding the requirements for disposing of treated wood.

Survey of Disposal Options

Parties who discard treated wood in Florida have a number of disposal options. Solid waste in Florida is typically managed by disposal in landfills, combustion in waste-to-energy (WTE) facilities, or recycling. Vegetative material is often managed by composting and mulching. If a homeowner generates only a small amount of treated wood, then it can be disposed as part of normal household waste collection. In this case it will end up in a lined landfill or at a WTE facility. When large amounts of treated wood are generated (for example when a fence or deck is demolished) then the material must be directly hauled to a disposal facility.

Questionnaires were sent to facilities that might accept treated wood in Florida. Questionnaires were sent to all Florida Class I landfills, Class III landfills, C&D debris facilities, WTE facilities, and industrial facilities that combust wood as fuel. Further definition and explanation of these facilities is presented in table III.6.

Disposal Option	Type of Disposal
Class I Landfill	Class I landfills are equipped with liners and leachate collection systems. Landfilled municipal solid waste must be disposed in a class I landfill.
Class III Landfill	Class III landfills accept solid wastes that are considered to be non-water soluble and non-hazardous in nature. They do not require liners although a number of Class III landfills in Florida are lined. Class III landfills do require groundwater monitoring. Typical class III waste includes discarded furniture, wood products, vegetative material, and C&D debris.
C&D Facilities	Construction and demolition debris facilities accept solid waste produced during construction and demolition activities. There are two types of facilities: 1) C&D landfills and 2) C&D materials recovery facilities. If treated wood is generated during a C&D activity, it is permitted for disposal in C&D landfills. C&D landfills are not lined but do require groundwater monitoring. C&D materials recovery facilities usually sort wood for recycling. Most reuse options require the treated wood to be removed.
WTE Facilities	Waste-to-energy facilities combust solid waste as fuel. The primary solid waste combusted is municipal solid waste, although one facility combusts waste wood and tires. WTE facilities do not typically receive C&D debris. Tipping fees for WTE facilities are usually greater than landfills. WTE facilities in Florida are required to maintain sophisticated air pollution control equipment and to manage ash in lined landfills.
Wood Burning Boilers and Furnaces	A number of industries in Florida utilize wood as a fuel source. Examples include pulp and paper mills and cogeneration facilities. These facilities were identified by Solo-Gabriele et al., 1998.

Table III.6: Common Disposal Options for Treated Wood in Florida

The questionnaires sent to disposal facilities inquired about the types of treated wood products that are accepted and the associated costs. The questionnaires differed somewhat depending on the recipient. Table III.7 presents examples of the types of questions that were asked. In addition to acceptance of treated wood and associated costs, the recipients were also asked whether they were interested in obtaining survey results and additional information on treated wood. A copy of all of the questionnaires and the cover letters are included in appendix E. The names and addresses of the questionnaire recipients were obtained using Florida DEP records for disposal facilities and a previous project list (Solo-Gabriele et al. 1998) for the wood burning boilers and furnaces. A complete list of all parties that were sent surveys is included in appendix E.

Survey Recipient	Questions
C&D Facilities	Type of Facility
	Is treated wood accepted as part of the mixed waste stream?
	What types of treated wood are accepted?
	What is the tipping fee?
	Is treated wood sorted from untreated wood?
Waste-to-Energy Facilities	Type of Facility
	Is treated wood accepted as part of the mixed waste stream?
	What types of treated wood are accepted?
	What is the tipping fee?
MSW Landfills	Type of Facility
	Is treated wood accepted as part of the mixed waste stream?
	What types of treated wood are accepted?
	What is the tipping fee?
Wood Burning Facilities	Is treated wood accepted at the facility

Table III.7: Summary of Survey Questions Developed for the Resource Book

Survey of Large End Users

No large-scale recycling operations are currently available to accept discarded treated wood products in Florida. One option that may be possible for future development is reuse. For example, some utility companies in Florida sell or give away poles taken out of service for reuse. To further explore the idea of reuse, a separate survey was sent to one of the larger consumers of treated wood products in the state, the county and municipal parks and recreation departments. A copy of this survey is also located in appendix E. This survey requested information regarding how departments used treated wood products (and what types) as well as what those products were used for. The survey also included questions regarding the specification of treated wood in construction projects and if the departments were interested in reuse options for treated wood. They were also asked whether they would be interested in additional information. The names and addresses of survey recipients were obtained from a DEP website (www.dep.state.fl.us/parks/agencies/agencies.htm).

Compilation of Results

Survey results were compiled after they arrived and organized into tables. Additional information beyond that collected in the survey was obtained from available Florida Department of Environmental Protection files on tipping fees for landfills in Florida.

III.3.c Results

A total of 509 surveys were sent out. The number of surveys sent out to each group are presented in table III.8, along with the number of responses received. A total of 106 completed surveys were returned to the investigators (a return rate of 21 percent). Seventy percent of those who returned the surveys indicated that they were interested in obtaining more information regarding the reuse options of treated wood, although only a few of the parks departments were interested in accepting treated wood for reuse purposes. Most of the parks and recreation services departments indicated that they were more interested in the disposal options for treated wood. Details of the responses from the different survey recipients are presented in the following sections.

Facility Type	Number of Surveys		
	Sent	Responded	More Information Requested
C&D	122	11	9
MSW Incinerator	15	6	4
MSW Landfill (Class I & II)	119	12	8
Power Plants	44	9	2
Parks and Recreation	209	68	52
Totals	509	106	75

Table III.8: Response Rate of Survey by Facility Type

Construction and Demolition Facilities Survey Results

Eleven of the C&D facilities responded to the survey. Some of the facilities indicated that they accept treated wood in the mixed waste stream, others advised that they accept treated wood both in the mixed waste stream as well as separate loads, while one facility indicated that they accept no treated wood. The tip fees were approximately the same for loads of treated wood versus mixed loads. The results are summarized in table III.9. Of the eleven facilities, eight were strictly C&D landfills, while three were both landfills and materials recovery facilities (MRF).

A number of C&D facilities in the state operate solely as MRFs, and none of these facilities responded to the survey. The low survey response rate from the C&D facilities, especially the MRFs, may be due to concerns about possible liability for disposing of treated wood in landfills or various recycling options. It should be noted that FDEP currently considers treated wood generated from C&D activities to be part of C&D debris, and thus can be disposed in C&D landfills. C&D MRFs are required to remove CCA-treated wood prior to most wood recycling options, but because this issue has only recently been raised, many operators are likely sensitive to the subject.

Of the three C&D facilities that operate as both MRFs and landfills, all of them sort wood from the mixed waste stream, but only two of the facilities sort treated from untreated wood. The facility that did not sort treated from untreated wood indicated that they do not sell wood for reuse or recycling, and they landfill all of the wood waste. The other two facilities advised that they receive so little wood that they either give it away, or place it in the landfill. The facility that gives its treated wood waste away indicated that they did not feel comfortable placing the treated wood into a C&D landfill or recycling into mulch. They said that the best scenario for the facility was to reuse the wood or send it to the county Class III facility.

None of the C&D landfills reported sorting treated from untreated wood. Only four of the eight C&D landfills that responded sort wood from the mixed waste stream and only one of the facilities indicated that they send the sorted wood to a recycling facility.

Site Name	City	Tip Fees $/cubic yard
All Dade Recycling	Miami	7.50
C&C Recycling	Miami	6.00
Continental Waste. Ind.	Winter Garden	4.00
Hernando County	Brooksville	20.00 ($/ton)
Holmes Dirt Services	Tavares	4.50
Melbourne C&D	Melbourne	22.50 ($/ton)
Southeast C&D	Winter Haven	20.00 ($/ton)
Waste Recyclers of N. Fla.	Niceville	2.25

Table III.9: Tip Fees for C&D Facilities (From Surveys)

Municipal Solid Waste Facility Survey Results

Twelve MSW landfills operators responded to the survey. The tip fees for mixed waste and separated treated wood waste are summarized in table III.10. If NA is marked in the treated wood column, the facility does not accept separate loads of treated wood. The tip fees reported through the survey were consistent with those reported by the FDEP (*Solid Waste Annual Report* 1999).

Two of the facilities that responded to the survey were Class III landfills. One of the facilities accepts treated wood only in mixed loads, while the other facility will accept loads composed primarily of treated wood. There were four Class I landfills that responded to the survey. Two of the facilities accept treated wood in mixed loads, but not in loads composed primarily of treated wood. One of the facilities accepts both mixed and separated loads. The other Class I landfill accepts no treated wood. The last facility that responded to the survey does not accept treated wood. They did not indicate what type of landfill they operate. Of the facilities that responded, approximately 33 percent of the facilities accept separated loads of treated wood.

The tip fees for MSW incinerators are provided in table III.11. The MSW incinerators receive treated wood mainly via mixed commercial and municipal solid waste disposal. Only one of the facilities that responded to the survey accepts separated loads of treated wood and they only accept creosote and pressure treated laminates. The facility also stipulated that they have a maximum length and diameter for the wood waste to be accepted. The other facilities, with one exception, accept treated wood in the mixed waste stream. All of the facilities indicated that the fraction of wood received is incidental compared to the volume of waste received. The highest percentage of wood reported in the MSW stream at any facility was 10 to 12 percent of the total volume of waste received. These percentages included both treated and untreated wood. The costs for disposal range from approximately $28/ton to $92/ton. It should be noted that none of the facilities with industrial furnaces that burned wood indicated that they would accept treated wood

Site Name	City	Tip Fees ($/ton)	
		Mixed Waste	Treated Wood
Brevard County Central	Cocoa	$29.50	$23.66
City of St. Cloud	St. Cloud	$32-38	NA
Five Points Landfill	Port St. Joe	$30.00	NA
Hamilton County	Jasper	$45.00	$40.00
Hardee County Regional	Wauchula	$32	NA
Putnam County Central	Palatka	$57.00	$57.00
Rosemary Hill	Green Cove Springs	$57	$47
Southwest Alachua	Archer	$32.00	NA
Springhill Regional	Cambelton	$38	$38
Suwannee County Central	Live Oak	$50.00	NA
Tomoka Farms Road	Daytona Beach	$30.00	$30.00
Trail Ridge	Baldwin	$30-40	$40.00

NA: Does not accept separate loads of unmixed treated wood

Table III.10: Tip Fees for MSW Landfills (from Surveys)

Site Name	City	Tip Fees ($/ton)	
		Mixed Waste	Treated Wood
Dade County Resource Recovery	Miami	$45-59	NA
Hillsborough County SW ER	Tampa	$55.21	$55.21
Lake County Resource Recovery	Tavares	$91.37	NA
McKay Bay Reg Resource Rec	Tampa	$28.00	NA
North County Regional Resource	West Palm Beach	$28-75	NA
Pasco County Solid Waste	Springhill	$49.30	NA

NA: Does not accept separate loads of unmixed treated wood

Table III.11: Tip Fees for MSW Incinerators (from Surveys)

Tipping Fee Data from FDEP

FDEP's *Solid Waste Annual Report* for 1999 does have a listing of tip fees by county. The tip fees for facilities receiving Class I waste ranged from $23/ton in Manatee and Palm Beach Counties to $92/ton in Monroe County, with and average tip fee of $42.47/ton. The class I tip fees included both Class I landfills and waste to energy facilities. The tip fees for C&D waste range from $5.00/ton to $92.00/ton with and average of $32.06/ton. A listing of Class I tip fees, C&D tip fees as well as averages and high and low rates are listed in table III.12.

County	Dollars per Ton		County	Dollars per Ton	
	Class I	C&D		Class I	C&D
Alachua	34.00	-	Lake	84.15	35.00
Baker	25.00	25.00	Lee	51.10	36.00
Bay	25.00	25.00	Leon	29.00	29.00
Bradford	46.12	46.12	Levy	45.00	25.00
Brevard	29.50	23.66	Liberty	25.00	30.00
Broward	50.00	10.00	Madison	40.17	31.20
Calhoun	-	-	Manatee	23.00	23.00
Charlotte	30.78	30.78	Marion	44.50	44.50
Citrus	30.00	0.00	Martin	38.60	38.60
Clay	57.00	47.00	Monroe	92.00	92.00
Collier	26.64	21.31	Nassau	40.00	40.00
Columbia	70.00	28.00	Okaloosa	58.00	0.00
Dade	52.00	52.00	Okeechobee	24.81	14.50
De Soto	38.00	38.00	Orange	30.65	17.20
Dixie	40.17	31.20	Osceola	38.00	18.50
Duval	35.00	35.00	Palm Beach	23.00	37.00
Escambia	35.50	35.50	Pasco	47.49	47.49
Flagler	46.00	20.00	Pinellas	37.50	37.50
Franklin	41.00	45.00	Polk	44.00	25.00
Gadsden	52.00	52.00	Putnam	57.00	57.00
Gilchrist	44.00	45.00	St. Johns	47.00	32.00
Glades	43.00	5.00	St. Lucie	32.00	30.00
Gulf	-	30.00	Santa Rosa	32.00	18.00
Hamilton	45.00	40.00	Sarasota	63.77	41.00
Hardee	32.00	32.00	Seminole	36.00	36.00
Hendry	0.00	10.80	Sumter	49.50	17.00
Hernando	56.00	20.00	Suwannee	50.00	12.00
Highlands	35.00	0.00	Taylor	52.17	43.20
Hillsborough	34.06	34.06	Union	32.00	32.00
Holmes	32.00	20.00	Volusia	30.00	30.00
Indian River	49.32	30.00	Wakulla	85.00	50.00
Jackson	29.02	20.00	Walton	50.00	21.00
Jefferson	40.17	31.20	Washington	0.00	0.00
Lafayette	40.17	31.20			
Average			42.47	32.06	
Highest Rate			92.00	92.00	
Lowest Rate (>0)			23.00	5.00	

(-) Data not available or the county does not accept the material. $0.00 may indicate the material is not accepted or is funded through a tax assessment.

Table III.12: County Solid Waste Disposal Fees in Florida as of June 1998

Parks and Recreational Services Survey Results

Of the 68 parks services that responded, eight indicated that they use no treated wood. Two of them advised that they are utilizing plastic timbers in place of wood treated with preservatives. Although neither of these departments use treated wood, they did indicate that they were interested in disposal options for treated wood.

Tables III.13 and III.14 list the county and municipal treated wood use, respectively. As shown in table III.13, the predominant form of treated wood used by the county parks departments is CCA, followed by creosote and then pentachlorophenol. Table III.14 shows the municipal parks department's usage. As with the county departments, CCA is the most prevalent, whereas pentachlorophenol is utilized more frequently than creosote in the municipalities.

The county and municipal parks and recreational services questionnaire also requested information on how the facilities use treated wood. This information was gathered to determine how these facilities may reuse discarded treated wood that still has a useful service life.

Both the county and municipal parks and recreation services use treated wood predominately to build decks, shelters and as landscaping timbers. Fences and picnic tables are also used extensively by the facilities that responded to the survey. Figure 1 summarizes how the treated wood is used by the cities, and figure III.12 breaks down how treated wood is used by the counties. Both the county and municipal services used treated wood in comparable ways.

Additional Surveys Sent to FDEP District Offices

Because of lack of response from C&D facilities, an additional survey was sent to the FDEP District Offices (Central, Northeast, Northwest, South, Southeast, and Southwest) to supply a more complete listing of facilities for the resource book. These supplemental surveys requested information on the types of facilities, whether or not the facilities accepted waste from the public, and if they recycle. Copies of the surveys and letters are located in Appendix C. Due to time constraints, the letters and questionnaires were faxed to the offices to facilitate a rapid response. Five of the six offices replied to the survey and the resource book was updated to reflect the additional information. The results reflected that very few facilities were missing from the original listing, but several had been duplicated, because they were listed with different names and/or addresses. There were only three facilities added to the earlier listing.

III.3.d Conclusions

These surveys were conducted to determine the feasibility of reusing treated wood products. Previous years studies have addressed different sorting techniques as well as other alternative management practices. They did not address the issue of recycling treated wood waste.

The survey results revealed that reusing treated wood products in place of disposal is not an option that is acceptable to many of the respondents. Most of the parks and recreation services indicated that they would be interested in the disposal options of treated wood, but would not reuse treated wood products. Service life appears to be the biggest obstacle when reuse of treated wood is considered. Because the wood has already been used, the facilities would be unable to determine the structural integrity, and therefore, they would not build decks or picnic tables with discarded treated wood. Some of the respondents advised that they would need to see the condition of the treated wood prior to making a decision about accepting wood for reuse.

The resource book was to include a listing of facilities (i.e. parks and recreation services) that would accept discarded treated wood for reuse, but the surveys indicated that these facilities were unable to accept this wood waste. Therefore, this listing was not included in the resource book.

Unless the regulations regarding C&D landfills are revised, the most common method of disposal for treated wood waste will continue to be at C&D debris facilities. This means that treated wood will continue to be buried in unlined landfills and incidentally recycled with untreated wood and combusted as fuel or mulched.

County	Treated Wood Use	CCA	Creosote	Pentachlorophenol
Alachua	X	X		X
Charlotte	X	X		
Citrus	X	X		
Hamilton	X	X	X	X
Lake	X	X		
Okeechobee	X	X	X	
Sarasota	X	X		
Seminole	X	X		
Suwannee	X	X		
Washington	X		X	X

Table III.13. County Parks and Recreation Services Treated Wood Usage by County

City	CCA	PCP	Creosote	City	CCA	PCP	Creosote
Altamonte Spgs	X			Miami Shores		X	
Apopka	X		X	Ocala		X	X
Arcadia	X			Oviedo		X	
Auburndale		X		Palm Bay	X	X	
Bartow			X	Palmetto	X		
Boca Raton	X		X	Panama City			X
Cape Canaveral	X		X	Panama City Bch		X	
Chattahoochee		X		Pensacola		X	
Crestview		X	X	Pinellas Park	X		
Crystal River	X	X		Plantation	X	X	X
DeFuniak Spgs	X	X	X	Port St. Lucie	X		
Fernandina Bch.	X	X	X	Quincy	X		
Fort Meade		X	X	Tallahassee	X		
Gulf Breeze	X	X	X	Tampa	X	X	
Gulfport	X	X		Tampa		X	
Holly Hill		X	X	Tavares	X	X	X
Jacksonville		X		Treasure Island	X		
LaBelle	X	X		Wellington	X	X	
Lakeland		X		West Melbourne			X
Lantana		X		West Miami		X	
Largo	X			Winter Spgs	X	X	X
Leesburg	X	X					

Table III.14. Municipal Parks and Recreation Services Treated Wood Usage by City

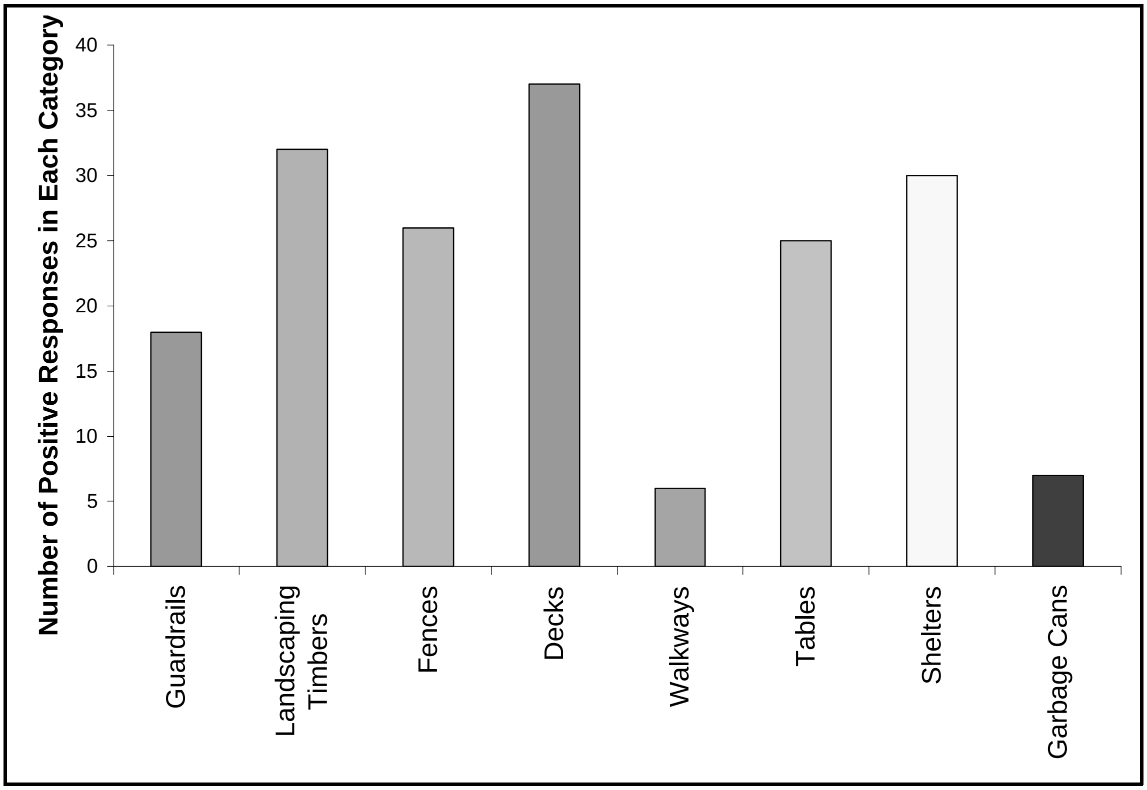


Figure III.12: Municipal Parks and Recreation Services Wood Product Use

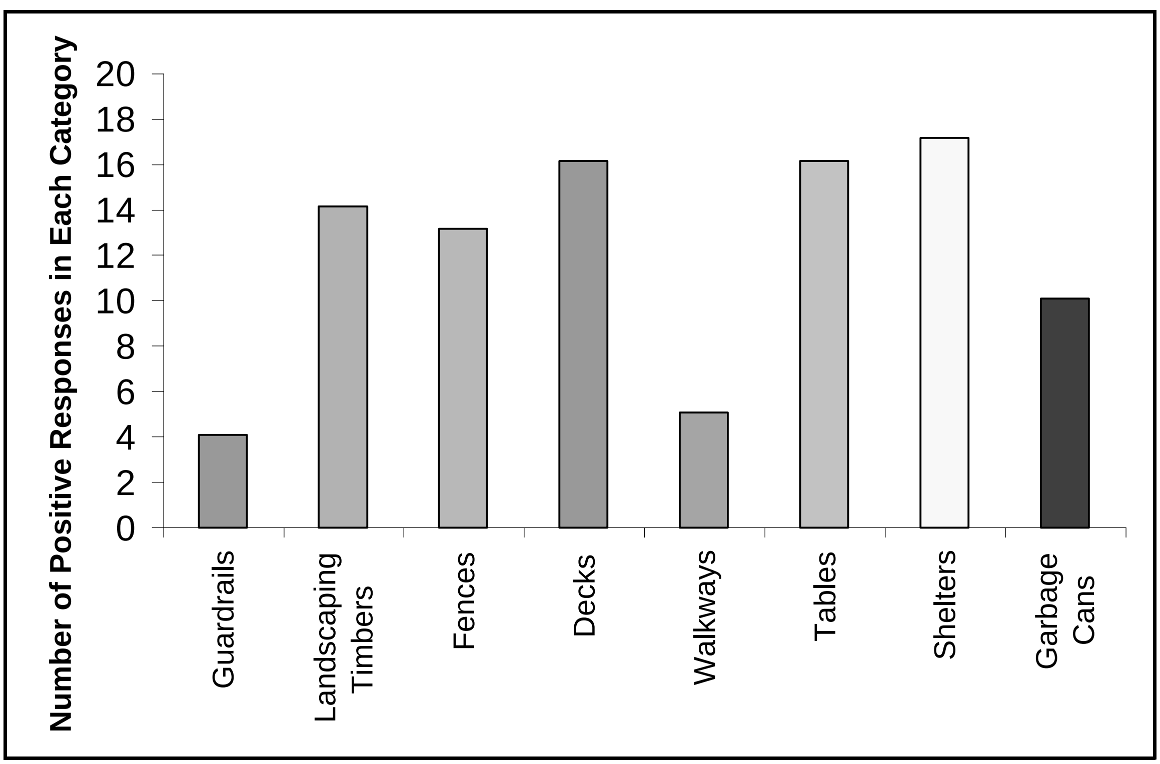


Figure III.13: County Parks and Recreation Services Wood Product Use

CHAPTER IV

CONCLUSIONS, RECOMMENDATIONS, AND ACKNOWLEDGEMENTS

IV. 1 CONCLUSIONS AND RECOMMENDATIONS

IV.1.a Alternative Chemicals

Data Summary

In order to summarize the results of the data, a subjective ranking process was developed where the performance of the alternative chemicals were compared to that of CCA (table IV.1). Performance categories ranked include: efficacy as evaluated through laboratory and field studies, depletion as evaluated through laboratory and field experiments, potential corrosivity of the alternative chemicals to treatment plant equipment, corrosivity of the alternative-chemical treated wood to metal fasteners, mechanical properties of wood, and costs. The ranking process included a "✔" if the alternative chemical performance was comparable to that of CCA, a "✔+" if the performance of the alternative was better, and a "✔-" if the performance of the alternative was worse. Please keep in mind that the ranking is subjective and is open to interpretation. The ranking is provided here to facilitate discussion concerning the relative advantages and drawbacks associated with each alternative chemical. Furthermore when reviewing this ranking it is important to note that not all alternatives were evaluated in the same manner. For example, corrosivity studies were conducted using different materials by each alternative-chemical manufacturer.

Efficacy: The efficacy of all the alternative chemicals was comparable to that of CCA as indicated by laboratory and/or field data. Efficacy tests conducted under laboratory conditions suggest that CC-treated wood may not be as effective as CCA-treated wood. Field data indicate that ACQ-, CBA-, CC-, and CDDC-treated wood performance was comparable to that of CCA for the retention levels evaluated. Overall, from an efficacy perspective, suitable substitutes for CCA-treated wood are available for applications requiring 0.25 pcf and 0.40 pcf CCA. These applications account for 60% of the treated wood volume and 20% of the CCA chemical in Florida.

Depletion: From the perspective of arsenic leaching rates, all the alternatives performed better than CCA given that none of the alternatives contain significant quantities of arsenic. This is especially relevant given that the CCA controls used during field depletion tests showed that between 10 and 47% or between 0.01 and 0.04 pcf of the arsenic (for the 0.25 and 0.40 pcf CCA-treated wood tested) was lost from CCA-treated wood during testing. Further analysis of the potential impact of this arsenic and other chemical components are provided on the next page. The ranking for depletion data focuses primarily upon % copper losses between the alternative chemical and CCA. Depletion data indicate that % copper releases for ACQ, CBA, and CDDC were comparable or better (less than) than that for CCA. In evaluating the laboratory data priority was given to the results from fungal cellar tests when available. Comparable data was not available for CC-treated wood given the lack of CCA-treated control in the depletion experiments. It is also interesting to note that CDDC-treated wood performed significantly better than CCA-treated wood under laboratory controlled conditions resulting in relatively low leaching rates for both copper and SDDC. The field data for CDDC-treated wood indicates that copper depletion was similar or slightly greater than that of CCA after a 23 year exposure period; it would have been useful to have field depletion data corresponding to a shorter time period for CDDC-treated wood so that a better comparison can be made against the performance of the other alternatives.

Corrosion: The copper ethanolamine solution used to manufacture CDDC is corrosive to brass and bronze. The ACQ-D concentrate appears to be mildly corrosive to these metals. Limited metal corrosivity data was available for the CC concentrate; nevertheless data indicate that the concentrate is not corrosive to mild/carbon steel. The CBA concentrate does not appear to be corrosive to metals used in treatment plant equipment. ACQ- and CC-treated wood tend to be more corrosive to metal fastener systems than CCA. Specifically, ACQ-treated wood is more corrosive to mild steel and aluminum fasteners. CC-treated wood is more corrosive to mild steel and hot-dipped galvanized fasteners. Metal fasteners in contact with CBA- and CDDC-treated wood appear to perform comparably to metal fasteners in contact with CCA-treated wood.

Mechanical Properties: The mechanical properties of the alternative-chemical treated wood products are comparable to that of CCA-treated wood. The WML value for kiln-dried ACQ-D treated wood appears low as compared to kiln-dried CCA-treated wood; however, it is still within one standard deviation of the CCA-treated wood value and therefore performance of wood treated with ACQ-D was considered comparable to that of wood treated with CCA.

Costs: The costs of ACQ- and CDDC-treated wood as determined for a 12 foot deck board at retail establishments were roughly 10 to 30% higher than that of CCA-treated wood. No cost data were available for CBA- or CC-treated wood. It is important to note that the costs provided by the retail establishments do not include disposal costs of treated wood which are ultimately paid indirectly by the consumer. A more appropriate comparison would be based upon a life cycle analysis which would include disposal costs and environmental impacts of CCA and the alternative chemicals from production through disposal.

Other: It is notable to mention that treatment of wood with CDDC will require two treatment cylinders rather than the conventional one. This will make the conversion of existing CCA plants to CDDC plants more difficult.

Composition of Alternative Chemical Treated Wood (% and pcf basis)

Table IV.2 summarizes the chemical composition of alternative-chemical treated wood products. Values in parentheses correspond to the percent composition of each chemical component. The pcf value corresponds to above ground retention level which is the lowest retention standardized within AWPA's *Book of Standards*. "pcf" values for other applications would be proportionately higher. As readily observed from the table, the alternative chemicals do not contain arsenic or chromium. These components are substituted within the alternatives by an organic co-biocide and additional copper. Copper (as Cu) accounts for 15% of the chemical weight in CCA-treated wood. Copper represents a significantly larger fraction for the alternatives. For ACQ-, CBA-, and CC-treated wood copper represents between 49% and 53% of the chemical weight. CDDC-treated contains between 2 to 3 times more copper than CCA-treated wood.

Evaluation of Depletion Data

In order to put the depletion data into perspective, an exercise was performed to determine the increase in soil concentrations if 25% of the treatment chemicals were to leach into the environment over the service life of a treated wood product. The computation was made by assuming that losses correspond to a 12 foot deck board (1 1/4" x 6" x 12') treated at 0.25 pcf. In order to assess the potential impacts on soil, it is assumed that the upper 1 inch of soil immediately below the deck board (6 " x 12 ') is impacted. Consistent with appendix A, the porosity and the specific gravity of the soil were assumed to equal 0.37 and 75 kg/ft3, respectively. The results of these computations (table IV.3) show that the use of an alternative chemical essentially results in the substitution of arsenic and chromium with roughly equal quantities of other chemicals including additional copper and the co-biocides associated with the alternatives. In order to better assess the potential benefits of using alternative-chemical treated wood products, the toxicity of the additional copper and co-biocides should be further evaluated and compared against that of chromium and arsenic. Only after it is shown that the added copper and co-biocides are indeed less toxic than the chromium and arsenic, would there be a clear advantage, from a depletion perspective, of using chemical alternatives. Please note that the numbers computed would change if different assumptions were made, such as assumptions of higher retention levels, different size of wood, and different assumptions concerning soil impacts. For example, if wood treated with higher retention levels were utilized in the computations, the soil concentrations computed would increase. Furthermore, another important assumption implied within the computations is that all the components from all the treated wood products leach at the same rates. In reality, the % leached can vary between different chemical components within a particular type of treated wood (e.g. Cu, Cr, and As within CCA-treated wood generally leach at different percentages) and between different types of treated wood products (the percent copper leached can vary between the alternatives). As such, changes in the assumptions will result in changes in the computed values below.

Formulation	Increase in Soil Concentration, mg/kg							
	Cu	Cr	As	DDAC	H_3BO_3	Azole	Citric Acid	SDDC
CCA-C	111	185	167					
ACQ-D	400			250				
CBA-A	300				300	12		
CC	374						283	
CDDC	300							750 - 1500

Table IV.3: Increase in Soil Concentrations, mg/kg, if it is assumed that 25% of a treatment preservative were to impact the upper 1 inch of soil below a 12 foot deck board

Recommendations

The alternatives evaluated through this study contain no arsenic and therefore provide a considerable advantage over CCA-treated wood with respect to arsenic leaching. As noted from the depletion data as much as 50% of the arsenic can leach from CCA-treated wood during standard efficacy tests. This is very significant and is cause of concern. Studies should be initiated that evaluate the environmental impacts of CCA-treated wood during its service life. If such studies indicate a considerable impact, the conversion of treated wood products to alternative chemicals should be accelerated.

Prior to promoting particular alternative chemicals, however, the environmental impacts of co-biocides and other chemical additives including carrier fluids, mold inhibitors, and anti-foam agents should be evaluated, given that significant quantities of these components can be also leached during the service life of treated wood. Furthermore, the potential impacts of copper, especially in aquatic environments, should be further evaluated given that on a mass basis the alternatives typically release between 2 and 3 times more copper than CCA-treated wood; data indicate that in some cases releases can be greater than 3 times that for CCA-treated wood. Copper losses on a mass basis from the alternatives generally ranged between 0.01 to 0.1 pcf.

Overall, it is concluded that viable non-arsenical alternatives are available for applications requiring 0.25 pcf and 0.40 pcf of CCA. These applications account for 60% of the treated wood volume and 20% of the CCA chemical. Wood treated with oilborne preservatives or alternative structural materials should be evaluated for uses requiring high CCA retention levels, if the standardization of the alternative waterborne wood treatment chemicals at these higher retention levels can not be expedited.

Although costs of alternative-chemical treated wood products were higher at retail establishments, these costs do not include environmental impacts and costs associated with the disposal of treated wood. A life cycle analysis, which includes measures (from production through disposal) of energy usage, air, water, and raw material usage along with costs, would provide a more appropriate measure of the overall cost and impacts of CCA-treated wood versus alternative-chemical treated wood products. Such a life cycle analysis should be a topic of future research.

Chemical	Efficacy[a]		Depletion		Corrosion[g]		Mechanical Properties	Costs	General
	Lab	Field	Lab	Field	Plant Equipment	Metal Fasteners			
ACQ	✔	✔	✔	✔[c]	✔-	✔-	✔	✔-	Environmental impacts of DDAC component should be further evaluated
CBA	✔	No data published	N/A[b]	✔[d]	✔	✔	✔	N/A[h]	Environmental impacts of tebuconazole component should be further evaluated.
CC	✔-	✔	N/A[b]	N/A[b,e]	Only mild steel tested	✔-	✔	N/A[h]	Significant depletion of copper and citric acid in field tests.
CDDC	✔	✔	✔+	✔[f]	✔-	✔	✔	✔-	Two treatment cylinders needed. Environmental impacts of carbamate component should be further evaluated

[a]For retention levels standardized. Note that most of the alternative chemicals have not been standardized for uses requiring high retention levels of CCA.
[b]Not available due to lack of CCA control
[c]Large % losses of DDAC are noted
[d]Large % losses of boric acid and tebuconazole are noted
[e]Large % losses of copper and citric acid
[f]Large % losses of SDDC. May have been due to the 23 exposure period
[g]For the metals tested. Not all metals were tested by all companies.
[h]No cost data available

Table IV.1: Subjective Evaluation of Chemical Alternatives Relative to CCA

Formulation	Retention Level		pcf of each component for **above ground** applications										
	Ground Contact	Above Ground	Cu	CuO	As	As_2O_5	Cr	CrO_3	DDAC	H_3BO_3	Azole	Citric Acid	SDDC
CCA	0.40, total oxides	0.25, total oxides	0.0369 (14.8%)	0.04625 (18.5%)	0.0554 (22.2%)	0.085 (34%)	0.0618 (24.7%)	0.11875 (47.5%)					
ACQ-D	0.40, total	0.25, total	0.1332 (53.3%)	0.1667 (66.7%)					0.0833 (33.3%)				
CBA	0.408	0.204	0.1 (49%)							0.1 (49%)	0.004 (2%)		
CC	0.40, total	0.25, total	0.1244 (49.8%)	0.1558 (62.3%)								0.0943 (37.7%)	
CDDC	0.2 as Cu	0.1 as Cu	0.1										0.25 to 0.5 pcf

Table IV.2: Composition of Alternative Chemical Treated Wood

IV.1.b Disposal-End Management

Field Demonstration of Sorting Technologies

Sorting of CCA-treated wood from other wood types without the use of chemical stains, by detecting the green hue of treated wood, was found to be beneficial. For the one facility that did not practice active sorting of CCA-treated from other wood types, 30% of their wood pile was CCA treated. The two other facilities, both of which actively practiced sorting CCA-treated from other wood types, had between 9 to 10% of their wood waste piles treated with CCA. Although sorting without stains improves wood quality, it is still not accurate enough to maintain CCA-treated wood levels within acceptable values for most recycling purposes. For example, a 5% mixture of CCA-treated wood with 95% untreated wood will result in the ash from wood fuel to be classified as hazardous. In order to utilize recycled wood as mulch, it must contain less than 0.1% CCA if it is to meet Florida's industrial soil clean-up target level. Assuming that current disposal practices continue, recycling of C&D wood can be maintained only if technologies that can sort CCA-treated wood from other wood types are developed and implemented.

The stains, PAN indicator and chrome azurol, were found to be useful for sorting small quantities of CCA-treated from other wood types. Sorting large quantities (several tons) of CCA-treated wood with the stains is considered to be impractical due to the excessive labor that would be involved in such a sort. The stains can be used, nevertheless: to train employees who sort CCA-treated using the green hue, for internal wood quality control checks by the C&D recycling facilities, and by those who purchase the recycled wood to spot check its quality. Sorting of large quantities of treated wood will require an on-line system that includes a conveyor and CCA detector, such as an x-ray fluorescence device or laser, that can quickly detect the presence of metals in the wood. Field demonstration projects should be initiated for on-line sorting.

Pyrolysis

Pyrolysis was found to be a promising technology for the ultimate disposal of CCA-treated wood once it is sorted from untreated wood. Data show that temperature and incineration time affect the amount of arsenic volatilized from CCA-treated wood. Given the inconsistent data in the literature it is difficult to determine the trends between arsenic emissions and incineration parameters. Two full-scale pyrolysis operations have been in operation in Europe. It is recommended that a representative from the Florida Center for Solid and Hazardous Waste Management visit the founders of these pyrolysis systems in Europe for the purpose of technology transfer. As an alternative, the founders of these pyrolysis systems can be invited to Florida to describe their operations. A cost analysis for implementing a pyrolysis system should be developed for the State of Florida.

Resource Book

The resource book should be distributed to treated wood consumers and to those within the disposal sector. Such a distribution will increase public awareness concerning the proper handling and disposal of treated wood.

During information gathering for the resource book it was found that parks and recreation facilities are not very interested in the reuse of treated wood products due to uncertainty about the quality of discarded CCA-treated wood. Unless regulations regarding C&D landfills are revised, the most common method of disposal for treated wood waste will continue to be C&D debris facilities. This means that treated wood will continue to be buried in unlined landfills, sold as mulch, or burned in industrial boilers. Efforts should focus on developing other markets for reuse, recycling, and ultimate disposal.

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Appendix A:
Computations Illustrating Potential Impacts of Arsenic Importation Associated with CCA-Treated Wood Use

Below are a set of sample computations which convert the tons of arsenic imported to Florida associated with CCA-treated wood use to increases in arsenic background concentrations assuming that the arsenic impacts the upper 1 inch of Florida soil. The purpose of these computations is provide a scale by which to compare the mass of arsenic associated with CCA-treated wood use. The computations are separated into two sections: a) the amount of arsenic imported to Florida associated with CCA-treated wood use, and b) increase in soil arsenic background concentrations assuming that the arsenic were applied to the upper 1 inch of Florida soils. Sample computations focus on statistics for the year 2000.

Arsenic Imported To Florida Associated With CCA-Treated Wood Use

Cumulative Amount of CCA-Treated Wood Used in FL Through 2000 = 581 x 10^6 ft^3

Year	Cumulative Amount of CCA-Treated Wood[1] (Million ft^3)
1970	8.8
1980	45.5
1990	272
2000	581

[1]See Solo-Gabriele 1998 for details concerning yearly CCA-treated wood production rates.

Average Retention Level for CCA-Treated Wood in Florida. Value Used = 0.45 pcf

The 0.45 pcf value is the best estimate given two different sources of information. The first source of information was from our extrapolation of industry statistics for the southeast region. Our extrapolation included both treated wood volume (cubic feet) and amount of chemical (pounds). These values are included in Solo-Gabriele et al. 1998, in the "year 1" report. We then took the ratio of the two to determine the average retention value for Florida in pounds per cubic feet (pcf). The value varied from 0.09 pcf to 0.93 pcf. The more recent industry-based data (from the mid-80's to the present) indicates that yearly values are between 0.2 to 0.34 pcf. The second source of information came from the questionnaires that were sent to wood treaters throughout Florida, as part of the "year 1" study. Among those facilities that responded to our questionnaires (>60% response rate which is about 2 times the response rate that is obtained by the industry), we found that 48% of the wood volume was treated at 0.25 pcf, 9% was treated at 0.4 pcf, 17% was treated at 0.6 pcf, 9 % was treated at 0.8 pcf, and 17% was treated at 2.5 pcf. The overall average from our questionnaires was 0.76 pcf. The 0.76 pcf value appeared high in comparison to our first estimate method so an average was taken towards the low end and therefore an average retention level of 0.45 pcf for CCA-treated products was estimated for Florida. This is likely a conservative estimate given the large amount of CCA-treated wood used for marine applications in Florida and the fact that some retail establishments are moving towards stocking CCA-treated wood with a 0.4 or 0.6 pcf retention level rather than the minimum of 0.25 pcf.

Cumulative Amount of CCA Chemical Imported Into Florida =
(Cumulative Amount of CCA-Treated Wood Produced in FL) x (Average Retention Level for CCA-Treated Wood in Florida)

e.g. Cumulative amount of CCA chemical imported into Florida in year 2000
= $(581 \times 10^6 \text{ ft}^3)(0.45 \text{ pcf})$
= 261×10^6 pounds of CCA chemical
= 131,000 tons
= 118×10^6 kilograms

Amount of Elemental Arsenic Associated with CCA-Treated Wood Use in Florida

Amount of arsenic associated with a given weight of CCA chemical –>
34% of CCA Type C is in the form of As_2O_5. The atomic weight of arsenic is 75 and that of oxygen is 16. The fraction of elemental arsenic in As_2O_5 is 65.2% (2x75)/(2x75 + 5x16). The fraction of elemental arsenic in CCA Type C is therefore 22% (0.34x0.652).

e.g. for the Year 2000, the Amount of Elemental Arsenic Associated with
CCA-Treated Wood Use = $(261 \times 10^6)(0.22)$
= 57×10^6 pounds of elemental As
= 29,800 tons
= 26×10^6 kilograms

Increase in Soil Arsenic Background Concentrations, if it is assumed that the arsenic were applied to the upper 1 inch of Florida soils

Land Area of Florida = 54,157 square miles (from standard Florida map)
Assumed Soil Porosity of Florida Soil = 0.37
(corresponds to a medium sand, Davis and Cornwell 1998)
Volume of Soil in Upper 1" = (1 - soil porosity)(1 inch)(Surface Area of Florida)
= $(1 - 0.37)\ (1/12 \text{ ft})\ (54{,}157 \times (5280)^2) = 7.93 \times 10^{10} \text{ ft}^3$

Weight of Soil in Upper 1" = Volume of Soil x density of soil
(assume that the density of soil = $2.65 \text{ g/cm}^3 = 75 \text{ kg/ft}^3$)
= $(7.93 \times 10^{10} \text{ ft}^3)\ (75 \text{ kg/ft}^3)$
= 5.95×10^{12} kg of soil

Increase in Arsenic Background Concentration = mass of elemental arsenic/mass of soil
e.g. for the year 2000 arsenic quantities

= 26×10^6 kilograms (x 10^6 mg/kg)/ 5.95×10^{12} kg of soil

= 4.4 mg As/kg soil

= 4.4 ppm

APPENDIX B:
MSDS SHEETS FOR ALTERNATIVE CHEMICALS
(First Page Only)

1. CCA Type C Pressure Treated Wood
2. ACQ Pressure Treated Wood
3. ACQ-C2 Pressure Treated Wood
4. Q50, Quarternary Ammonium Compound Solution
5. Timbor® Industrial, Disodium Octaborate tetrahydrate
6. Hickson CBA Type A Wood Preservative Concentrate
7. Kodiak® Preserved Wood
8. Kodiak® System 2, Alkylamine and SDDC
9. Kodiak® System 1, Monoethanolamine and Copper Hydrate

APPENDIX C:
WOOD TREATER QUESTIONNAIRE

1. **Sample Cover Letters**
2. **Copy of Questionnaire**
3. **List of Facilities Sent Questionnaire**

SAMPLE COVER LETTER FOR WOOD TREATER QUESTIONNAIRE ON ALTERNATIVE CHEMICALS - First Letter

DATE

Contact Person
Treating Company Name
Address

Dear XXXXXXX,

The University of Miami in collaboration with the University of Florida is conducting research on the disposal of CCA-treated wood waste in Florida. CCA is a wood preservative composed of the metals, chromium, copper, and arsenic. Earlier research has shown that the majority of CCA-treated wood waste is disposed through construction and demolition (C&D) activities. A significant amount of wood from the C&D waste stream is recycled as fuel for industrial applications. In the recycling process CCA-treated wood is inadvertently burned resulting in an accumulation of the metals in the ash residual. The quality of the ash is degraded by the presence of metals from CCA thereby limiting recycling opportunities for the ash residual and increasing costs for its disposal.

One focus of the current study is to identify a suitable alternative to CCA for wood preservation. The research team is especially interested in waterborne preservatives (non-oily texture) that contain no arsenic, since arsenic is the most problematic metal within CCA from a disposal point-of-view. Project tasks include identifying potential advantages and drawbacks to these alternatives as perceived by the operators of wood treatment plants located in Florida and within southern Georgia, Alabama, and Mississippi. Plants in southern Georgia, Alabama, and Mississippi were included within the inquiry due to their potential likelihood for selling treated wood products that can be ultimately disposed in Florida.

We request your assistance in conducting this research by completing the enclosed questionnaire and mailing it in the attached self-addressed envelope. The purpose of the questionnaire is to obtain feedback from wood treatment plant operators concerning the feasibility of utilizing alternative chemicals. Questionnaires will be kept confidential. Individual company names will not be disclosed when discussing the results of the questionnaires.

The results of our research will be available to your organization if desired. Please mark the appropriate box on the questionnaire if you would like a copy of our final report summarizing the research on alternative chemicals. If you would like to receive copies of our earlier reports addressing the disposal of CCA-treated wood in Florida please contact Maria Hall of the Florida Center for Solid and Hazardous Waste Management. Ms. Hall's telephone number is (352)392-6264 and her email address is mariatmc@ufl.edu. Please contact me if you have any questions about the enclosed questionnaire or any technical questions about our study. My telephone number, fax, and mailing address are included on this stationary. I can also be contacted by email at hmsolo@miami.edu.

Again we would greatly appreciate your organization's cooperation and I thank you in advance for any information that you can provide.

Sincerely,

Helena Solo-Gabriele, Ph.D.,P.E.
Assistant Professor

cc: Dr. Timothy Townsend, Univ. of Florida

SAMPLE COVER LETTER FOR WOOD TREATER QUESTIONNAIRE ON ALTERNATIVE CHEMICALS - Second Letter Sent to Non-Respondents

January 21, 2000

Dear XXXXX,

The University of Miami in collaboration with the University of Florida is conducting research on the disposal of CCA-treated wood waste and possible alternatives to its use in Florida. This past spring we distributed questionnaires to all of the known wood treating facilities in Florida and in Mississippi, Alabama and Georgia within 150 miles of Florida, in an effort to attain data and include the views of the wood treating facilities on this matter in our research. Our records show that we have not received the survey from your facility

This is just a friendly reminder concerning the questionnaire. We would greatly appreciate your response. For your convenience, we have enclosed a copy of the questionnaire and a return envelope. Please keep in mind that the purpose of this questionnaire is to obtain feedback from wood treatment plant operators concerning the feasibility of utilizing alternative chemicals. Questionnaires will be kept conditional.

The results of our research will be available to your organization if desired. Please mark the appropriate box on the questionnaire if you would like a copy of our final report summarizing the research on alternative chemicals. If you would like tolearn more about this project, please visit our web site at http://www.ccaresearch.org/. Please contact me if you have any questions about the enclosed questionnaire or any technical questions about our study. I can be contacted by telephone at (305)-284-3391 or via email at hmsolo@miami.edu

Again we would greatly appreciate you organization's cooperation and I thank you in advance for any information that you can provide.

Sincerely

Helena Solo-Gabriele, Ph.D., P.E.
Assistant Professor

c.c. Dr. Timothy Townsend, Univ. of Florida

CCA Treated Wood
Possible Chemical Alternatives for Florida

Questionnaire Distributed by the University of Miami in Collaboration with the University of Florida

Completing this questionnaire is a voluntary service. Individual treating companies have no obligations to complete the enclosed form. However, we would appreciate your organizations' participation by completing as much of the survey as possible and mailing it in the self-addressed envelope provided.

Purpose: This questionnaire addresses the wood preservative chemical CCA and possible alternatives to its use such as AAC, ACC, ACQ, borates, CBA, CDDC, and CC. If your organization does not treat wood with waterborne preservatives, check here ☐ then fill out the company information and return in the enclosed envelope.

Part A - Company Information

1. Company Headquarters Name: ____

2. Plant Information

   Name of Treating Plant:____

   Name and Title of Person Filling-out Questionnaire: ____________________________

   Plant Contact, Person's Name:____

   Address:____

   City:_____________________________ State:_____________ Zip Code:___________

   Phone Number with area code: ____

   Fax Number with area code: ____

3. Is the company headquarters address the same as this plant address? ☐ Yes ☐ No

4. During what years has this plant operated? _______________________________________

5. Did this plant treat wood in 1998? ☐ Yes ☐ No
   If the plant was idle in 1998, is the intention to resume operations? ☐ Yes ☐ No
   If yes, when? ____

6. Are any of the waterborne wood products produced by your company sold within Florida?
   ☐ Yes ☐ No If yes, what fraction? ________

I.7 Would you like to receive a copy of the final project report which documents compiled information on alternative treatment chemicals? ☐ Yes ☐ No The report should be available by the summer of 2000.

Part B - CCA Usage and Alternative Chemicals

Please answer questions to the best of your knowledge and check appropriate boxes.

8. Is chromated copper aresenate (CCA) used at your facility in treating wood? ☐ Yes ☐ No

   If yes, how much chemical did your facility use in 1998? ___________________________
   (pounds, oxide basis, dry)

   If no, which wood treatment chemical(s) does your facility use?

   ____

   ____

   ____

9. Has your facility ever utilized a chemical other than CCA? ☐ Yes ☐ No If no, go to next question.

   If yes,

   How many (pounds) did your facility use during 1998?

   AAC, Alkyl Ammonium Compound: ______________lbs.
   ACC, Acid Copper Chromate: ______________lbs.
   ACQ, Alkaline Copper Quaternary: ______________lbs.
   Borates: ______________lbs.
   CBA, Copper Boron Azole:______________lbs.
   CDDC, Copper Dimethydithiocarbamate:______________lbs.
   CC, Ammoniacal Copper Citrate:______________lbs.
   Other, ______________________ : _________________lbs.
   (chemical name)

   Which alternative chemicals were used prior to 1998?

   ____

   ____

   ____

10. What would prohibit your facility from changing from CCA to one of the alternative chemicals listed in question #9?

____

____

____

11. Below, briefly list any positive and/or negative points, that you or your plant manager or company president consider concerning the listed alternative chemicals. (Please attach additional pages if more room is needed).

AAC, Alkyl Ammonium Compound: ____

ACC, Acid Copper Chromate: ____

ACQ, Alkaline Copper Quaternary: ____

Borates: ____

CBA, Copper Boron Azole: ____

CDDC, Copper Dimethydithiocarbamate: ____

CC, Ammoniacal Copper Citrate: ____

12. Are there any other alternative chemicals that you, your plant manager, or company president recommend that the research team consider? If so please provide the name of the chemical and contact information for the manufacturer.

____

____

____

13. Please use the space below to provide additional comments and suggestions.

Thank you for completing the survey.
Please mail survey in the self addressed envelope provided.

First Name	Last Name	Company	Address	City	St.	Postal Code
Juan	Moran	Aljoma Lumber Inc.	10300 N.W. 121 Way	Medley	FL	33152
Jorge	DeFema	Anchor Wood Treating	P.O. Box 3537	Miami	FL	33147
David	Powell	Apalachee Pole Company	P.O. Box 610	Bristol	FL	32321
Chris	Jernigan	Arnold Lumber Company	Rt. 1 Box 260	Bonifay	FL	32425
		Atlantic Lumber Company	P.O Box 1299	Pompano Beach	FL	33061
Jay	Segot	Coastal Lumber Company	P.O. Box 1128	Havana	FL	32333
Fred	Poston	Cook Lumber & Treating, Inc.	4965 Lantana Road	Lake Worth	FL	33463
Joel	Miller	Cook Lumber Company	1905 N. 66th St	Tampa	FL	33619
Chuck	Galloway	Dantzler Lumber & Export Co.	P.O. Box 6340	Jacksonville	FL	32236
This plant is currently under construction		Dantzler Lumber & Export Co.	1500 SW 1st. Ct	Pompano Beach	FL	33061
Harry	Arlon	E.D. Cook Lumber Company, Inc	5901 Beggs Rd	Orlando	FL	32810--2609
Linda	Kiella	Florida Fence Post Company	P.O. Box 645	Ona	FL	33865
Stephen	Rose	Florida Perma-Wood Treaters	4500 E. 11TH Ave.	Hialeah	FL	33013
Marion	House	Georgia-Pacific Corp	Route 6, Box 960	Palakta	FL	32177
Gary	Sherman	Great Southern Wood of Florida Inc.	194 County Rd. 527-A	Lake Panasoffekee	FL	33538
Jimmy	Harris	Great Southern Wood Preservers	P.O. Box 759	Bushnell	FL	33513
		Greenwood Timber Products, Inc	P.O. Box 547	Greenville	FL	32331
Plant	Mangaer	Koppers Industries Plant Manager	P.O. Box 1067 200 N.W. 23rd Ave.	Gainesville	FL	32602 32609
Robert	Wheeler	Longleaf Forest Products, Inc.	1325 Yorktown St.	Deland	FL	32724
		Louisiana –Pacific Corp.	P.O. Box 460	La Belle	FL	33935
Jim	Brown	Lykes Bros. Inc. Forests Prods. Div.	154440 North Island Road	La Belle	FL	33935
		Mark – Ked, Inc	3686 Woodville Hwy	Tallahassee	FL	32301
		Bert Morsch Lumber	2331 Edison Ave.	Jacksonville	FL	32204

Table C.1: Wood Treatment Plants Located in Florida

First Name	Last Name	Company	Address	City	St.	Postal Code
Henry	Moxon	Ocala Lumber SaLes Co	P.O. Box 1389	Ocala	FL	34478--1389
Neil	McMillan	Pensacola Wood Treating	1813 East Gadster	Pensacola	FL	32501
Lawaine	Crawford	Pride of Florida/Union Forestry	Rt. 2 Box 308	Raiford	FL	32083
Pat	Smith	Ridge Lumber & Treating Co	P.O. Box 1651	Lakeland	FL	33802--1651
Mike	Provenza	Robbins Manufacturing Company	13001N.Nebraska Ave.	Tampa	FL	33612
		Robbins Manufacturing Company	3250 Metro Parkway	Ft Myers	FL	33916
		Robbins Manufacturing Company	7205 Rose Avenue	Orlando	FL	32810
Jerry	Lindsey	Southeast Wood Treating, Inc	P.O. Box 561227	Rockledge	FL	32956
Spencer	Willams	Southern Wood Piedmont Co.	900 N Center St.	Baldwin	FL	32234
Robert	Stovall	Southern Lumber & Treating Co	P.O. Box 7450	Jacksonville	FL	32238
Ken	Delle Donne	Sunbelt Forest Products	P.O. Box 1218	Bartow	FL	33830
Lee	Childers	Suwannee Lumber Mfg. Company	P.O. Drawer 5090	Cross City	FL	32628--5090
Jon	Scharfen-berg	Universal Forest Products, Inc	P.O. Box 217	Auburndale	FL	33823--0217
Stan	Hill	Wood Treaters, Inc.	P.O. Box 41604	Jacksonville	FL	32203--1604

Table C.1 (con’d): Wood Treatment Plants Located in Florida

Company	Address	City	State	PostalCode	Attention
Alabama-Georgia Preserving	P.O. Drawer 9	Lafayette	AL	36862	**W.C. Brinson III**
Baldwin Pole & Piling Company	P.O Box Drawer 758	Bay Minette	AL	36507 - 0758	**Tom Mcmillian**
Centreville Lumber Co.	P.O. Box 94	Vance	AL	35042	**Russ Griffin**
Everwood Treating Co., Inc.	P.O Box 7500	Spanish Fort	AL	36577	**Jar Hudson**
Great Southern Wood Preserving, Inc.	P.O. Box 610	Abbeville	AL	36310	**Mitchell Weaver**
Great Southern Wood Preserving, Inc.	P.O. Box 987	Theodore	AL	36590	
Gulf Treating Co., Inc.	P.O. Box 1663	Mobile	AL	36633	**Romean Upshaw**
Kopper Industries	P.O. Box 510	Montgomery	AL	36101	**Bill Hasley**
Lee Lumber Co.	P.O. Box 416	Centreville	AL	35042	**Don Lee**
Louisiana - Pacific Corporation	P.O. Box 388	Lockhart	AL	36455	**Roy Ezell**
Louisiana - Pacific Corporation	P.O. Box 726	Evergreen	AL	36401	
Olon Belcher Lumber Co., Inc.	P.O. Box 160	Brent	AL	35034	**Brent Belcher**
Stallworth Timber Co., Inc.	P.O. Box 38	Beatrice	AL	36425	**Bill Black**
Southeast Wood Treating, Inc.	P.O. Box 25	Louisville	AL	36048	
Swift Lumber, Inc.	P.O. Box Drawer 1298	Atmore	AL	36504	**Dwight Grant**
T.R. Miller Mill C., Inc.	P.O. Box 708	Brewton	AL	36427	**James McGougin**
Walker - Williams Lumber Co., Inc.	P.O. Box 170	Hatchechubbee	AL	36858	**Bobby Walker**
Great Southern Wood Preserving, Inc.	P.O. Box 610	Abbeville	AL	36310	**Bryan Newman**
Kopper Industries	P.O. Box 510	Montgomery	AL	36101	**Ed Davidson**

Table C.2: Wood Treatment Plants Located in Southern Alabama

JobTitle	First Name	Last Name	Company	Address	City	State	Postal Code
Plant Manager:	**C.M.**	**Eunice**	Ace Pole Company	6352 Timberlane	Blackshear	GA	31516
Plant Manger:	**J. Frank**	**Cliett**	Atlantic Wood Industries, Inc.	P.O. Box 1608	Savannah	GA	31402 - 1608
Plant Manager:	**Guy**	**Haltom**	Atlantic Wood Industries, Inc.	P.O. Box 384	Vidalia	GA	30474-0384
Plant Manager:	**Jim**	**Stovall**	B & M Wood Products Inc.	P.O Box 176 Rt. 1	Manor	GA	31550
Plant Manager:	**Lowton**	**Morris**	Baxley Creosoting Company	P.O. Box 459	Baxley	GA	31513
Plant Manager:	**David**	**Sorrell**	Cook County Wood Preserving	P.O Box 637	Adel	GA	31620
Plant Manager:	**Russel**	**Davis**	D & D Wood Preserving, Inc.	P.O. Box 1802	Albany	GA	31702
Plant Manager:	**Carter**	**Ramsey**	Georgia - Pacific Corp.	P.O. Box 668	Brunswick	GA	31521
Plant Supt:	**Stanley**	**Wall**	Georgia - Pacific Corp.	P.O. Box 799	Pearson	GA	31642
Plant Manager	**Jim**	**Langdale**	Langdale Forest Products Co.	P.O. Box 1088	Valdosta	GA	31603
Plant Manager:	**Bobby**	**Whittington**	Louisana - Pacific Corp.	P.O. Box 130	Statesboro	GA	30459
Plant Manager:	**William F.**	**Peagler**	Manor Timber Co., Inc.	RTE #1 Box 60	Manor	GA	31550 - 9601
Plant Manager:	**Matt**	**Corwart**	Mellco, Inc.	P.O. Drawer C	Perry	GA	31069
Manager:	**Neal**	**Holbrook**	Pidemont Building Products	441 Dunbar Rd	Warner Robins	GA	31093
Plant Manager:	**Herb**	**Gurry**	Savannah Wood Preserving Co., Inc.	501 Stiles Ave	Savannah	GA	31401 - 32141
Plant Manger:	**Jack**	**Shearouse**	Shearouse Lumber Company	P.O. Drawer C	Pooler	GA	31322
General Manager:	**Joe**	**Kusar**	Tolleson Lumber Co., Inc.	P.O. Drawer E	Perry	GA	31069
Sr. Vice Pres.:	**Jim**	**Ward**	Universal Forest Products, Inc.	P.O. Box 2487	Moultrie	GA	31776
General Mngr:	**Thomas**	**Shave**	Varn Wood Products, Co.	P.O. Box 128	Hoboken	GA	31542-0128
Ast. Plant Manager:	**Harold**	**Flyod**	Ace Pole Company	6352 Timberlane	Blackshear	GA	31516
Plant Manager:	**Mr.**	**Varn**	Varn Wood Products, Co.	P.O. Box 128	Hoboken	GA	31542-0128

Table C.3: Wood Treatment Plants Located in Southern Georgia

Company	**Address**	**City**	**State**	**Postal Code**	Attention
American Wood	P.O. Box 1532 Hwy. 15 N	Richton,	MS	39476	**General Mgr: Larry Polk**
Desoto Treated Material, Inc.	P.O. Box 460	Wiggins,	MS	39577	**Plant Mgr: Steve Owen**
Desoto Treated Material, Inc.	P.O. Box 460	Wiggins,	MS	39577	**Plant Mgr: Steve Owen**
Laurel Lumber Co., Inc.	P.O. Box 4178	Laurel,	MS	39441-4178	**President: Wayne Parker**
Southern Pine Wood Preserving	P.O. Box 818	Picayune,	MS	39466	**Vice Pres: Gina Maddalozzo**
Southern Wood Preserving of Hattiesburg, Inc.	P.O. Box 630	Hattiesburg,	MS	39403	**Plant Mgr: Joe Hartfield**
Treated Materials Co., Inc.	P.O. Box 2848 13334 Seaway Rd.	Gulfport,	MS	39503	**Owner: Bill Randal**
Tri State Pole & Piling	P.O. Box 166	Lucedale,	MS	39452	**Vice President: Bill Harlod**

Table C.4: Wood Treatment Plants Located in Southern Mississippi

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APPENDIX D:
LARGE END-USER QUESTIONNAIRE

1. **Sample Cover Letters**
2. **Copy of Questionnaire**
3. **List of Facilities Sent Questionnaire**

SAMPLE COVER LETTER FOR CCA-TREATED WOOD END USER QUESTIONNAIRE - First Mailing

DATE

Contact Person
Company Name
Address

Dear XXXXXXX,

It was a pleasure speaking with you earlier today. As mentioned during our telephone conversation, the University of Miami in collaboration with the University of Florida is conducting research on the disposal of CCA-treated wood waste in Florida. CCA is a wood preservative composed of the metals, chromium, copper, and arsenic. In Florida, a large amount of wood waste is recycled as fuel. As part of the recycling process, CCA-treated wood is inadvertently mixed with this fuel stream and, as a consequence, CCA-treated wood waste is ultimately burned. Metals from the CCA chemical tend to accumulate to high levels in the ash during the burning process causing the ash to be contaminated with chromium and arsenic. The presence of chromium and copper in this ash greatly escalates the cost for ash disposal.

The primary goal of our study is to minimize the amount of CCA-treated wood burned in cogeneration facilities in Florida. One of our project objectives is to identify potential alternatives to CCA for wood preservation. Use of alternative chemicals will help to reduce the quantity of CCA-treated wood that is ultimately disposed. Project tasks include identifying: a) costs b) potential drawbacks in the use of alternative chemicals as perceived by the wood treaters, and c) potential advantages and drawbacks as perceived by the users of treated wood products. As part of our inquiry, we have contacted several utilities throughout the state in an effort to obtain their feedback on the use of CCA and alternative chemical treated wood for their applications.

You would greatly assist our research efforts by completing the enclosed questionnaire and mailing it in the attached self-addressed envelope. The purpose of the questionnaire is to obtain feedback from large end-users of CCA-treated wood products. Questionnaires will be kept confidential. Individual company names will not be disclosed when discussing the results of the questionnaires.

The results of our research will be available to your organization if desired. Please mark the appropriate box on the questionnaire if you would like a copy of our final report summarizing research on alternative chemicals. If you would like to receive copies of our earlier reports addressing the disposal of CCA-treated wood in Florida please contact Ms. Rhonda Rogers of the Florida Center for Solid and Hazardous Waste Management. Ms. Rogers's telephone number is (352)392-6264 and her email address is fcshwm@eng.ufl.edu. Please contact me if you have any questions about the enclosed questionnaire or any technical questions about our study. My telephone number, fax, and mailing address are included on this stationary. I can also be contacted by email at hmsolo@miami.edu.

Again we would greatly appreciate your organization's cooperation and I thank you in advance for any information that you can provide.

Sincerely,

Helena Solo-Gabriele, Ph.D.,P.E.
Assistant Professor

cc: Dr. Timothy Townsend, Univ. of Florida

SAMPLE COVER LETTER FOR CCA-TREATED WOOD END USER QUESTIONNAIRE -Second Mailing to Facilities That Did Not Respond

DATE

Contact Person
Company Name
Address

Dear Mr. Conaway,

This is just a friendly reminder about the attached questionnaire. We have sent this questionnaire to eight large end-users of CCA-treated wood in Florida and we are only missing three responses including yours. If you could be so kind as to complete the questionnaire, we would really appreciate it. As an alternative, you can complete the questionnaire over the telephone if you would like. One of the five respondents responded in this fashion.

If you would like to learn more about our project please visit our new web site located at http://www.ccaresearch.org. Please contact me if you have any questions about the enclosed questionnaire or any technical questions about our study. My telephone number, fax, and mailing address are included on this stationary. I can also be contacted by email at hmsolo@miami.edu.
I plan to have a first draft of this year's study on alternative wood treatment chemicals, which will include the results of these questionnaires, by the end of February. The document will likely be finalized for distribution by this summer.

Again we would greatly appreciate your organization's cooperation and I thank you in advance for any information that you can provide.

Sincerely,

Helena Solo-Gabriele, Ph.D., P.E.
Assistant Professor

Large End-Users of CCA-treated Wood Products and Potential Chemical Alternatives

Questionnaire Distributed by the University of Miami in Collaboration with the University of Florida

Completing this questionnaire is a voluntary service. Individual companies have no obligations to complete the enclosed form. However, we would appreciate your organizations' participation by completing as much of the survey as possible and mailing it in the self-addressed envelope provided.

Attach Additional Sheets if Space Provided is not Sufficient

Purpose: This questionnaire addresses the wood preservative chemical CCA, primary reasons for its purchase, and requests information concerning the potential use of alternative chemicals.

Part A - End User Information

1. Company/Organization Name: ____

   Name and Title of Person Responding to Questionnaire: ________________________

   Organization Contact Person's Name:____

   Address:____

   City:____________________________ State:_____________ Zip Code:___________

   Phone Number with area code: ____

   Fax Number with area code: ____

2. During what years has this organization been in operation? ______________________________

3. Would you like to receive a copy of the final project report which includes compiled information on alternative treatment chemicals? ☐ Yes ☐ No The report should be available by the summer of 2000.

Part B - CCA Usage

Please answer questions to the best of your knowledge and check appropriate boxes.

4. What factors are the most important in choosing a particular product when treated wood is considered for purchase? List in order of importance. (1 most important)

   1. ______________________________________
   2. ______________________________________
   3. ______________________________________
   4. ______________________________________
   5. ______________________________________

5. What types of treated wood products are purchased by your company (e.g. lumbers, timbers, poles, etc..)? Please indicate the treatment chemical, the amount purchased (ft^3), and retention level (pounds per cubic foot, pcf) if known.

Product	Treatment Chemical	Amount (ft^3)	Retention Level (pcf)
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________
______________	______________	______________	______________

6. What products are considered to be the second and third best alternatives to the CCA-treated products purchased by your company? For example, alternatives may include products composed of materials such as concrete, steel, etc.. or wood products treated with other chemicals.

CCA-Treated Product ____________________

1st Alternative ______________________

2nd Alternative______________________

CCA-Treated Product ____________________

1st Alternative ______________________

2nd Alternative______________________

CCA-Treated Product ____________________

1st Alternative ______________________

2nd Alternative______________________

7. Are there applications where CCA-treated wood is the only quality product available on the market? ☐ Yes ☐ No. If yes, what are these applications, how much treated wood product is purchased for these applications (ft^3), and what is the corresponding retention level (pounds per cubic foot, pcf), if known?

Application	Amount Purchased (ft^3)	Retention Level (pcf)
____________________	____________________	____________________
____________________	____________________	____________________
____________________	____________________	____________________
____________________	____________________	____________________

8. What concerns or questions would be raised by representatives from your company when evaluating wood treated with alternative chemicals? ______________________________

9. What "assurances" are necessary to remove skepticism concerning the use of alternative chemicals? ______________________________

10. Would reducing the use of CCA-treated wood within the next few years cause hardship within your company? ☐ Yes ☐ No. If yes, explain____________________________

____
____
____
____
____
____
____
____

11. Please use the space below to add any additional comments or suggestions?

Thank you for completing the survey.
Please mail survey in the self addressed envelope provided.

Facility	Contact Person	Address	Phone and Fax
BellSouth	Scott Mulcahy, V.P.	600 N.W. 79 Avenue, Suite 664 Miami, Fl 33126	(954)492-2800 Fax: (954)491-9912
Florida Power and Light Co.	Jerry McMullan	2455 Port West Blvd. West Palm Beach, Fl 33407	(561)845-4837 Fax: (561)845-4844
Florida Power Corp.	Don Terebayza, Materials Contract Agent	MAC-BB2A P.O. Box 14042 St. Petersburg, FL 33733-4042	(727)826-4178 Fax: (727)826-4098
Home Depot	Glenn Roberts, Lumber Merchant	5463 West Waters Avenue Tampa, FL 33634	(813)243-2001 Fax: (813)243-2121
Jacksonville Electric Authority	Kris Rosenhauer	21 West Church Street, T-5 Jacksonville, FL 32202	(904)665-6011 Fax: (904)665-4276
Lowe's Hardware	Steve Eller, Vice President of Lumber Merchandising	P.O. Box 1111 Wilkesboro, North Carolina 28656-0001	(336)658-4744 Fax: (336)658-3279
Seminole Electric	Jeff Conaway Substation Transmiss. .Services Coordinator	16313 North Balemabry Highway Tampa, FL 33688-2000	(813)963-0994
Tampa Electric Company	Betty Karup	P.O. Box 111 Purchasing Plaza 3 Tampa, FL 33601-0111	(813)228-4913 (813)228-4935

Table D.1: Facilities Sent Large End-User Questionnairres

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APPENDIX E:
MATERIALS SENT TO C&D RECYCLERS

1. **Sample Cover Letter**
2. **Brochure**
3. **Copy of Questionnaire**
4. **List of Facilities Sent Questionnaire**

SAMPLE COVER LETTER FOR BROCHURE AND QUESTIONNAIRE SENT TO C&D FACILITIES

Date

Construction and Demolition Recycling Facilities
Miami, Florida

To Whom It May Concern:

The purpose of this letter is to inform your recycling facility of forecasted increases in the quantity of **CCA treated wood** disposed through the construction and demolition waste stream. A large portion of wood disposed this way is recycled and burned for energy recovery. **CCA** is a wood preservative that contains three metals: chromium, copper and arsenic. These metals are of major importance for the environment, because when the wood is burned, metals not only escape in the air, but also get concentrated in the ash potentially classifying it as hazardous. In the 1970's about 16 % of treated wood products were treated with **CCA** but by 1996 **CCA** was used to treat almost 80 % of al treated wood products. Given that the service life for **CCA** treated wood is about 25 years, the quantities of **CCA** treated wood being disposed are growing at an alarming rate.

To address this problem, University of Miami and University of Florida are currently working on a project sponsored by Florida Center for Solid and Hazardous Waste and Florida Power and Light. The project focuses on finding new ways to sort **CCA** treated wood from untreated wood before the wood is recycled as boiler fuel. Currently there are two methods evaluated: 1) use of a chemical solution, or 2) use of X-ray characteristics. There are three chemical solutions, which when sprayed on treated wood cause it to stain either blue, magenta/red or green in color. The other method involves using X-rays emitted by metals in the wood to determine their presence (this method is referred to as X-ray fluorescence). The second method has a potential of being incorporated in an automated system at the construction and demolition recycling facilities.

University of Miami and University of Florida would like to invite you to participate in a pilot study, scheduled at your convenience, where the chemical solution method would be tested for a possibility of implementation in such facilities as yours. The pilot study would be conducted in three facilities in Florida. Your participation would be a great help in improving our research and would surely be a great learning experience for us. Attached is a flyer explaining the points mentioned in greater detail and can be distributed amongst your colleagues. We also included a questionnaire, which would help us understand the sorting work performed at your facility.

If you would like a copy of last year's report, which summarizes the results of our laboratory sorting experiments, please contact Maria Hall of the Florida Center for Solid and Hazardous Waste Management. Ms. Hall can be contacted by telephone at (352)
392- 6264 or by e-mail at mariatmc@ufl.edu. If you have any technical question about the report or about the field pilot study please contact Dr. Helena Solo-Gabriele by telephone at (305) 284-3489, by e-mail at hmsolo@miami.edu, or by regular mail at the address included at the bottom of this stationary.

We thank you for your consideration and time spent filling out the attached questionnaire. We are looking forward to hearing from you soon.

Sincerely,

Monika Kormienko

Helena Solo-Gabriele, Ph.D., P.E.

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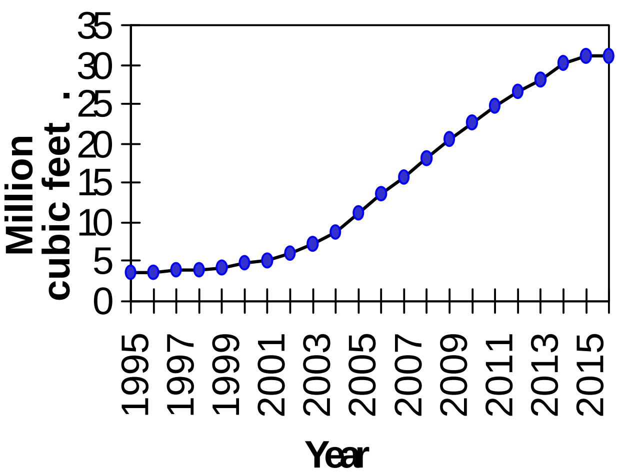
CCA is a waterborne wood preservative. Major reason for its use is the fact that wood treated with **CCA** produces no odors or vapors and its surface can be easily painted. It often does not change the appearance of wood. **CCA** treated wood is usually used for parts of a structure in contact with the floor or outside. Types of wood treated with **CCA** include limber, timber, post and plywood.

Did you know that…

- When CCA-treated wood is burned 5 to 40 % of the ash is metals?
- When wood waste contains as little as 5% CCA-treated wood, the ash will be classified as a hazardous waste, thereby escalating disposal costs?
- The projected amount of CCA-treated wood disposed in year 2010 is 5 times more than what it is today?



The disposal of CCA-treated wood through the construction and demolition waste stream will grow rapidly in the years to come. The wood recycling industry is not ready for such an increase. That is why it is important to test and explore sorting options for CCA-treated wood.

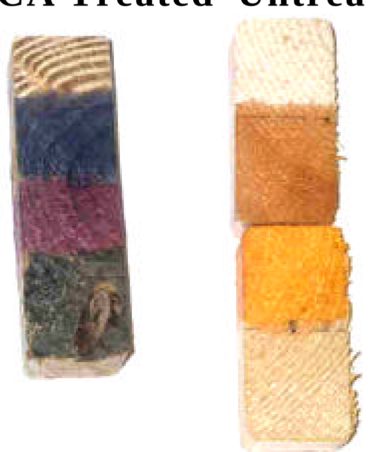
CCA Treated Untreated

No stain

Blue Stain

Magenta Stain

Green Stain



The performance of the stains used in this research are pictured on the left. The blue, magenta or green color appears only if the wood has been treated with **CCA**.

Colors shown appear on the surface of the wood as soon as it is sprayed with a special solution.

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Sorting Practices at Construction and Demolition Recycling Facilities in Florida

Questionnaire distributed by the University of Miami
in collaboration with the University of Florida.

Completing this questionnaire is a voluntary service. Individual facilities have no obligations to complete the enclosed form. However, we would appreciate your participation by completing as much of the survey as possible and mailing it in the self-addressed envelope provided.

Purpose: This questionnaire addresses the sorting practices at the construction and demolition facilities in the state of Florida.

Company Name:____

Address:____

City:_____________________________________ State:________ Zip Code:__________

Contact Person:____

Telephone Number: (   )________________

Fax Number: (   )_____________________

Would you like to receive a copy of the results from this survey? ☐ Yes ☐ No

Would you like to participate in the sponsored pilot study conducted by the University of Miami and University of Florida? ☐ Yes ☐ No

Please, fill in the amount of the waste processed at your facility ____________________

Out of that amount what approximate percentage is wood waste?__________________%

Is the waste sorted in any way at your facility? ☐ Yes ☐ No

If yes, how? ____
____

Is there any hand sorting of wood waste at your facility? ☐ Yes ☐ No

Is treated wood separated from untreated wood in any way? ☐ Yes ☐ No

If yes, how is the distinction between treated and untreated wood made?______________

____

Is most of the wood processed whole or shredded? ☐ Whole ☐ Shredded

Where is the majority of wood sent after being processed at your construction and demolition facility?____

Thank you for completing the survey.
Please mail the survey in the self addressed envelope provided.

	Facility Name	Mailing Address	Telephone	County
1	Enviro Cycle Director: Mari Burgess	849 S.W. 21st Terrace Fort Lauderdale, FL	954-792-8177	Broward
2	J & A Transfer Director: Frank Rousso	2214 N.W. 15th Court Pompano Beach, FL	954-968-6268	Broward
3	Waste Magic	Lox Achatchee Road Pompano Beach, FL 33076	561-451-0909	Broward
4	Naples Recycling Resources, Inc. Director: Don Summers	5801 Wahl Naples, FL 34117	941-597-8727	Collier
5	AB Martin Director: A.B. Martin	3680 N.W. 135 St. Miami, FL 34109	305-836-2851	Dade
6	Dade Recycling Director: Alex Gomez	15490 N.W. 97th Ave. Miami, FL 33016	305-826-0707	Dade
7	Jones Road Landfill Recycling Director: Don Kindig	Jones Road Jacksonville, FL 32226	904-781-2407	Duval
8	Kimmons Recycling Corporation	4017 Dignan Street Jacksonville, FL 32204	904-350-9336	Duval
9	Realco Recycling Company Director: Jim Senessac	8707 Somers Road Jacksonville, FL 32226	904-751-7556	Duval
10	Kimmons Recycling Corporation Director: Rick Chancey	1501 East 2nd Avenue Tampa, FL 33605	813-248-3802	Hillsborough
11	Reclaimed Resources Director: John Cauthen	4353 Michigan Link Fort Meyers, FL 33906	941-334-7272	Lee
12	All-Rite Recycling, Inc.	3401 Overland Road Apopka, FL 32703	407-290-8611	Orange
13	Kimmons Recycling Corporation Director: Wes Wiebe	9572 Sidney Heyes Road Orlando, FL 32824	407-855-3400	Orange
14	Atlas Waste Magic	15400 Lox Road Boca Raton, FL 33431	561-451-0909	Palm Beach
15	CAT Recycling	829 Benoist Farms Rd West Palm Beach, FL 33411	561-753-3571	Palm Beach
16	Kimmons Recycling Corporation Director: Don Glover	651 Industrial Way Boyton Beach, FL 33462	561-547-4000	Palm Beach
17	Meyer & Gabbert Director: Iris Meyer	8250 Bee Ridge Road Sarasota, FL 34241	941-377-5370	Sarasota
18	Florida Resource Management	101 Congress Avenue Riviera Beach, FL 33404	561-840-1846	Palm Beach
19	CAT Recycling	2201 N.W. 16th Street Pompano Beach, FL 33069	561-595-9333	St. Lucie
20	Kimmons Recycling Corporation	12950 40th Street Clearwater, FL 34622		Pinellas

Table E.1: C&D Facilities Sent Brochure and Questionnaire

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APPENDIX F:
QUESTIONNAIRES DEVELOPED FOR RESOURCE BOOK

1. **Sample Cover Letters**
2. **Copy of Questionnaire**
3. **List of Facilities Sent Questionnaire**

SAMPLE COVER LETTER FOR C&D FACILITIES

UNIVERSITY OF FLORIDA

Department of Environmental Engineering Sciences
Solid and Hazardous Waste Engineering Program

P.O. Box 116450
333 NEB
Gainesville, FL 32611-6450
Phone: (352) 392-0846
Fax: (352) 392-3076

September 30,1999

Name C&D facility
Street Address
FL

Dear Sir or Madam:

The University of Miami and the University of Florida are working to create a source book of organizations that accept discarded treated wood for reuse or disposal. We have been researching appropriate management options of chromated copper arsenate (CCA) treated wood for the last three years. During the course of the study, we have frequently been contacted by individuals inquiring about how and where they can dispose of treated wood. The objective of the resource book is to provide information on the disposal of CCA treated wood, as well as pentachlorophenol and creosote treated wood.

Currently, the largest portion of the treated wood waste stream is being disposed of at C&D recycling facilities and landfills. Treated wood generated during C&D activities may be disposed in C&D landfills under current Florida Regulations. Some treated wood products may also be recovered and reused.

We request your assistance in completing the source book by filling out the attached questionnaire and sending it back to us in the enclosed envelope. This survey has been distributed to all C&D debris facilities in the state, as well as to other facilities that may accept discarded treated wood for reuse or disposal. The ultimate goal of the source book is to provide disposal options and cost estimates for the generators of treated wood waste.

If you have any questions, please feel free to contact me by telephone at (352) 846-3035 or by email at kstook@ufl.edu.

Sincerely,

Kristin Stook
Graduate Student

QUESTIONNAIRE SENT TO C&D FACILITIES

Part A- Company Information

Company Name:

Address:

City: State: Zip Code:

Telephone Number:

Name and Title of person completing survey:

Fax Number:

Dates of operation during 1998:

Would you like to receive a copy of the survey results? Yes No

Part B- Wood Use

Type of facility:

LANDFILL MATERIALS RECOVERY FACILITY BOTH

Does your facility accept treated wood as part of the mixed waste stream?

Does your facility accept loads of primarily treated wood?

What types of treated wood are accepted?

CREOSOTE PENTACHLOROPHENOL CCA

What is the tipping fee for treated wood? ($/ton)

Does the facility separate wood from the rest of the C&D debris stream?

Does the facility sort treated wood from untreated wood? Yes No

How is the treated wood managed after separation? (ie. Landfill, incinerator)

Is treated wood ever recovered, reused, or sold at your facility? (ie. Utility poles to parks departments for landscaping timbers)

Please provide more information on possible reuse and recycling options for treated wood.

SAMPLE COVER LETTER FOR MSW LANDFILLS

UNIVERSITY OF FLORIDA

Department of Environmental Engineering Sciences
Solid and Hazardous Waste Engineering Program

P.O. Box 116450
333 NEB
Gainesville, FL 32611-6450
Phone: (352) 392-0846
Fax: (352) 392-3076

September 30, 1999

Name MSW
Street Address
FL

Dear Sir or Madam:

The University of Miami and the University of Florida are working to create a source book of organizations that accept discarded treated wood for reuse or disposal. We have been researching appropriate management options of chromated copper arsenate (CCA) treated wood for the last three years. During the course of the study, we have frequently been contacted by individuals inquiring about how and where they can dispose of treated wood. The objective of the resource book is to provide information on the disposal of CCA treated wood, as well as pentachlorophenol and creosote treated wood.

Although, the largest portion of the treated wood waste is being disposed of at construction and demolition (C&D) debris facilities, an alternative management option is disposal in municipal solid waste (MSW) landfills. We request your assistance in completing the resource book by filling out the attached questionnaire and sending it back to us in the enclosed envelope. This survey has been distributed to all MSW landfills in the state, as well as to other facilities that may accept discarded treated wood for reuse or disposal. The ultimate goal of the source book is to provide disposal options and cost estimates for the generators of treated wood waste.

If you have any questions, please feel free to contact me by telephone at (352) 846-3035 or by email at kstook@ufl.edu.

Sincerely,

Kristin Stook
Graduate Student

QUESTIONNAIRE SENT TO MSW LANDFILLS

Part A- Company Information

Company Name:

Address:

City: State: Zip Code:

Name and title of the person completing the questionnaire:

Telephone Number:

Fax Number:

Dates of operation during 1998:

Would you like to receive a copy of the survey results? Yes No

Part B

Type of landfill facility:

CLASS I CLASS III BOTH

What is your approximate annual tonnage of waste received?

What is your current tip fee for municipal solid waste? ($/ton)

Does your facility accept treated wood mixed in the waste stream?

Does your facility accept loads of only treated wood?

What types of treated wood are accepted?

CREOSOTE PENTACHLOROPHENOL CCA

What is the tipping fee for treated wood? ($/ton)

Would you be interested in more information regarding the disposal of treated wood?

SAMPLE COVER LETTER FOR MSW INCINERATORS

UNIVERSITY OF FLORIDA

Department of Environmental Engineering Sciences
Solid and Hazardous Waste Engineering Program

P.O. Box 116450
Gainesville, FL 32611-6450
Phone: (352) 846-3035
Fax: (352) 392-7735

September 15, 2000

MSWI\
Address
zip

Dear Sir or Madam:

The University of Miami and the University of Florida are working to create a source book of organizations that accept discarded treated wood for reuse or disposal. We have been researching appropriate management options for discarded chromated copper arsenate (CCA) treated wood for the last three years. During the course of the study, we have frequently been contacted by individuals inquiring about how and where they can dispose of treated wood. The objective of the resource book is to provide information on the disposal of CCA treated wood, as well as pentachlorophenol and creosote treated wood.

Although the majority of treated wood is being disposed of at construction and demolition (C&D) debris facilities, an alternative management option is disposal via municipal solid waste incinerators (MSWI). In fact, the American Wood Preservation Institute (AWPI) has proposed that the best place for managing discarded treated wood is through co-combustion with municipal solid waste (MSW).

We request your assistance in completing the source book by filling out the attached questionnaire. This survey has been distributed to all MSWI facilities in the state, as well as to other facilities that may accept discarded treated wood for reuse or disposal. The ultimate goal of the source book is to provide disposal options and cost estimates for the generators of discarded treated wood.

Sincerely,

Kristin Stook
Graduate Student

QUESTIONNAIRE SENT TO MSW INCINERATORS

Part A- Company Information

Company Name:

Address:

City: State: Zip Code:

Name and title of person filling out questionnaire:

Telephone Number:

Fax Number:

Dates of operation during 1998:

Would you like to receive a copy of the survey results? Yes No

Part B- Disposal Information

What is your annual tonnage of MSW combusted?

What fraction of the combusted MSW is wood?

What is the tip fee for MSW? ($/ton)

Does your facility accept treated wood mixed with the municipal waste?

Does your facility accept loads of only treated wood?

What is the tip fee for loads of treated wood? ($/ton)

What types of treated wood are accepted?

CREOSOTE PENTACHLOROPHENOL CCA OTHER ___________

SAMPLE COVER LETTER FOR PARKS AND RECREATIONAL FACILITIES

UNIVERSITY OF FLORIDA

Department of Environmental Engineering Sciences
Solid and Hazardous Waste Engineering Program

P.O. Box 116450
Gainesville, FL 32611-6450
Phone: (352) 846-3035
Fax: (352) 392-7735

September 15, 2000

NAME
ADDRESS
CITY, STATE

Dear OPERATOR:

The University of Miami and the University of Florida are working to create a source book of organizations that accept discarded treated wood for reuse or disposal. The current method of disposal of the treated wood is to put it into either a lined or unlined landfill. We have been researching appropriate management options for discarded treated wood for the past three years. This study is being conducted to determine the management options and costs associated with the disposal and/or reuse of this waste wood.

Chromated copper arsenate (CCA), pentachlorophenol and creosote are being used in the state of Florida as wood preservatives. Currently, the largest portion of the treated wood waste is being disposed of at construction and demolition (C&D) recycling facilities and landfills. An alternative management option is the reuse of pressure treated wood for poles, fence posts, retaining walls and landscaping timbers. Thus, parks and recreation departments in Florida are being contacted to determine whether these facilities represent a market for reuse of recovered treated wood materials.

We are requesting your assistance in conducting this research by completing the enclosed questionnaire and mailing it back to us in the enclosed envelope. This survey has been distributed to all of the municipal and state park departments in Florida. The ultimate goal of the source book is to provide alternative disposal methods or recycling options to the generators of discarded, treated wood.

If you have any questions, please feel free to contact me by telephone at (352) 846-3035 or by email at kstook@ufl.edu.

Sincerely,

Kristin Stook
Graduate Student

QUESTIONNAIRE SENT TO PARKS AND RECREATIONAL FACILITIES

Part A- Company Information

Company Name:

Address:

City: State: Zip Code:

Name and title of person completing the survey:

Telephone Number:

Fax Number:

Would you like to receive a copy of the survey results? Yes No

Part B- Wood Use

Does your department use treated wood?

What types of treated wood are used? (Circle all that apply)

CREOSOTE PENTACHLOROPHENOL CCA

How does the park service use treated wood? (Circle all that apply)

GUARDRAILS LANDSCAPING TIMBERS FENCES

DECKS COVERED WALKWAYS PICNIC TABLES

SHELTERS GARBAGE CANS OTHER

Does your department specify the type of treated wood to be used in any of its contracts? Yes No

Would your department be willing to accept and use discarded treated wood products that still have a useful service life? Yes No

If so, what types? CREOSOTE PENTACHLOROPHENOL CCA OTHER

Are you interested in learning more about opportunities for recycling or reusing treated wood materials?

SAMPLE COVER LETTER FOR POWER PLANTS

UNIVERSITY OF FLORIDA

Department of Environmental Engineering Sciences
Solid and Hazardous Waste Engineering Program

P.O. Box 116450
Gainesville, FL 32611-6450
Phone: (352) 846-3035
Fax: (352) 392-7735

September 15, 2000

Power plant

Address

zip

Dear Sir or Madam:

The University of Miami and the University of Florida are working to create a source book of organizations that accept discarded treated wood for reuse or disposal. We have been researching appropriate management options of chromated copper arsenate (CCA) treated wood for the last three years. During the course of the study, we have frequently been contacted by individuals inquiring about how and where they can dispose of treated wood. The objective of the resource book is to provide information on the disposal of CCA treated wood, as well as pentachlorophenol and creosote treated wood.

CCA, pentachlorophenol and creosote are being used in the state of Florida as wood preservatives. Although the majority of treated wood is being disposed of at construction and demolition (C&D) debris facilities, an alternative management option is disposal via industrial boilers and furnaces. While the environmental impacts of treated wood combustion need to be considered, some types of treated wood provide a good source of fuel.

We request your assistance in completing the source book by filling out the attached questionnaire and returning it to us in the enclosed envelope. This survey has been distributed to all power plants in the state, as well as to other facilities that may accept discarded treated wood for reuse or disposal. The ultimate goal of the source book is to provide disposal options and cost estimates for the generators of treated wood waste.

Sincerely,

Kristin Stook
Graduate Student

QUESTIONNAIRE SENT TO POWER PLANTS

Part A- Company Information

Company Name:

Address:

City: State: Zip Code:

Telephone Number:

Fax Number:

Dates of operation during 1998:

Would you like to receive a copy of the survey results? Yes No

Part B

What is your annual tonnage of wood combusted?

What is the tip fee for treated wood?($/ton)

What percentage of the wood used is purchased from construction and demolition facilities?

Does your facility accept treated wood mixed with the fuel?

Would your facility accept loads of only treated wood?

What types of treated wood are accepted?

CREOSOTE PENTACHLOROPHENOL CCA

Are you interested in more information?

SAMPLE COVER LETTER SENT TO FDEP DISTRICT OFFICES

UNIVERSITY OF FLORIDA

Department of Environmental Engineering Sciences
Solid and Hazardous Waste Engineering Program

P.O. Box 116450
333 NEB
Gainesville, FL 32611-6450
Phone: (352) 846-3035
Fax: (352) 392-3076

May 2, 2000

Name
Address
City, FL Zip

Name

As part of our ongoing research efforts regarding CCA-treated wood, our research team (University of Florida, University of Miami) has created a resource book for generators of treated wood waste (discarded treated wood, not waste from wood treaters). One of the items we want to include in the resource book is a listing of solid waste management facilities that a generator can contact for disposal. We think we have a pretty good grasp on the MSW facilities from the DEP facility database, but C&D facilities are another story. We know that a number of facilities on the current database may not be currently active. We would also like to get a better idea regarding which facilities would accept waste from the general public (i.e. not private facilities that only accept their own waste). And finally, we want to make sure we know which ones are landfills, recycling facilities, or both.

As you are very busy, we have tried to come up with a format to make this as easy as possible for you. Please see the attached sheet that lists C&D facilities we believe are in your district. We have provided a few simple questions that only require that the appropriate answers be circled. Your input would be of great service to the project. You can either fax your response to our office [(352) 392-7735] or email (kstook@ufl.edu) it to us. If you have any questions or if I can help gather this information in another way, please feel free to contact me via email or by telephone at (352) 846-3035.

Sincerely,

Kristin Stook
Graduate Student

SAMPLE QUESTIONNAIRE (CENTRAL DISTRICT) SENT TO FDEP DISTRICT OFFICES

Please Circle Appropriate Answers

Site Name by County	This location is permitted and currently operates as a:	This facility accepts waste from the general public?	This C&D facility is permitted to operate as a:
BREVARD			
CAPE CANAVERAL AFS CENTRAL CONTROL ROAD CAPE CANAVERAL	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
ROYAL OAK RANCH C&D FACILITY 3600 FOX LAKE ROAD TITUSVILLE	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
FLORIDA RECYCLERS OF BREVARD SARNO ROAD MELBOURNE	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
INDIAN RIVER			
INDIAN RIVER COUNTY LANDFILL RANGE LINE ROAD VERO BEACH	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
ORANGE			
MID-FLORIDA MATERIALS C&D LANDFILL GOLDEN GEM ROAD PLYMOUTH	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
PINE RIDGE 5400 DANBURY ROAD WINTER GARDEN	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
SOUTH ALAFAYA TRAIL RECYCLING 6000 SOUTH ALAFAYA TRAIL ORLANDO	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
CWI (SCHOFIELD) SR 545, S OF SCHOFIELD ROAD WINTER GARDEN	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
ACME RECYCLING INC 1056 BAILEY HILL ROAD PLYMOUTH	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
LAKE			
DANIS ENVIRONMENTAL HWY 27 & LITTLE GRASSY LAKE ROAD MINNEOLA	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
GRANTHAM PIT C&D FACILITY 39414 COUNTY ROAD 439 UMATILLA	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both

Please Circle Appropriate Answers

Site Name by County	This location is permitted and currently operates as a:	This facility accepts waste from the general public?	This C&D facility is permitted to operate as a:
LAKE			
LAKE COUNTY SOLID WASTE MANAGEMENT WEST OF SR 561 ASTATULA	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
RODGERS LANDCLEARING SITE 31806 TOLLGATE TRAIL SORRENTO	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
PROFESSIONAL DIRT SERVICE INC C44-A, 1/4MI W SR-439 EUSTIS	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
MARION			
AMODEO TRUCKING & EXCAVATION 5300 NE JACKSONVILLE RD OCALA	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
BIG D ROOFING INC 4480 NE 35TH ST OCALA	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
H & B EXCAVATING 7007 SW 38TH ST OCALA	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
HOLMES DIRT SERVICES HWY 42 WEST ALTOONA	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
H&I SAND & CLAY ENTERPRISES .5 MI S EMERALD RD, W OF RT 4 CANDLER	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
SUPERIOR CYPRESS ACRES (SANDMAN) NE 36TH AVE & SR326 OCALA	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
ORANGE			
MID-FLORIDA MATERIALS C&D LANDFILL GOLDEN GEM ROAD PLYMOUTH	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
PINE RIDGE 5400 DANBURY ROAD WINTER GARDEN	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both

Please Circle Appropriate Answers

Site Name by County	This location is permitted and currently operates as a:	This facility accepts waste from the general	This C&D facility is permitted to operate as a:
SOUTH ALAFAYA TRAIL RECYCLING 6000 SOUTH ALAFAYA TRAIL ORLANDO	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
CWI (SCHOFIELD) SR 545, S OF SCHOFIELD ROAD WINTER GARDEN	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
ACME RECYCLING INC 1056 BAILEY HILL ROAD PLYMOUTH	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
OSCEOLA			
BASS ROAD LF BASS ROAD KISSIMMEE	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
SEMINOLE			
OVIEDO MATERIALS EVANS ROAD, 1 MILE E OF OVIEDO OVIEDO	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
VOLUSIA			
CLYDE MORRIS BLVD C&D DISPOSAL SITE CLYDE MORRIS BLVD DAYTONA BEACH	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
FOUR JAY'S LANDCLEARING/EMUND JUNG S OF HWY 44 SAMSULA	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
GEL CORPORATION 1200 SOUTH LEAVITT AVENUE ORANGE CITY	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
SAMSULA (YANCEY) LAND CLEARING S SR-44, 1.25MI ON SR-415 E NEW SMYRNA BEACH	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
CONTINENTAL WASTE INDUSTRIES 1988 W PLYMOUTH AVE DELAND	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
HTS LANDFILL INC RHODE ISLAND AVE & JUANITA LN ORANGE CITY	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both

Please Circle Appropriate Answers

Site Name by County	This location is permitted and currently operates as a:	This facility accepts waste from the general	This C&D facility is permitted to operate as a:
VOLUSIA			
KIRTON LANDFILL - EAST 1630 TOMOKA FARMS RD, W OF SR415 DAYTONA BEACH	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
KIRTON C & D (WEST) 1630 TOMOKA FARMS RD, W OF SR415 DAYTONA BEACH	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
KLENK, ROBERT C&D 409 BAYWOOD CIRCLE PORT ORANGE	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
JADE (OSTEEN) C & D DISPOSAL FACILITY 255 DIXON LAKE ROAD OSTEEN	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
TOMOKA FARMS RD LANDFILL TOMOKA FARMS ROAD DAYTONA	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both
LINKOVICH LANDFILL W JCT GRAND AVE & MINNESOTA AVE DELAND	C&D Facility Land-Clearing Debris Facility Facility is closed	Yes No	Landfill Materials Recovery Facility Both

County	Facility Name	Address	City	Telephone Number
Alachua	**Johnston Landfill**	**SR 24- 1 Mi W of Archer**	**Archer**	**305-892-1442**
	Osteen Brothers	20125 SW Archer Rd.	Archer	
	Florence Landfill	0.5 E SW 122, SR 24	Gainesville	
	Watson Construction Co.	2.5 Mi W of Archer, SR 24	Archer	
	W G Buck Johnson & Son	7804 NE 69th Ave	Gainesville	
	VE Whitehurst & Sons	1.5 Mi W of Archer, SR 24	Archer	
Bay	Aggregate Transportation	HWY 390 @ Pipeline Rd	Lynn Haven	
	Beaches Barrow Pit	Back Beach Rd	Panama City	
	Calvin's C&D Disposal Fac.	Skunk Valley & Prosper Rds.	Panama City	
	City Environmental Services	4217 Cato Rd.	Panama City	
	Disposal Depot	¼ M W SR 77	Panama City	
	Florida Asphalt Paving Co.	1 MI E SR 77 on SR 20	Panama City	
	Gulf Asphalt Corporation	HWY 388	Panama City	
	Hall's C&D Landfill	½ Mi W HWY 77 Crooked Ln	Panama City	
	Leon's C&D Landfill	6410 E HWY 388	Youngstown	
	Lynn Haven C&D Landfill	1M W SR 77 3 M S SR20	Lynn Haven	
Broward	Central Recycling Center	3000 NW 48th St.	Pompano Bch	
Brevard	Cape Canaveral AFS	Central Control Rd.	Cape Canaveral	
	Royal Oak Ranch C&D Fac.	3600 Fox Lake Rd.	Titusville	
	Florida Recyclers of Brevard	Sarno Rd.	Melbourne	
Charlotte	Zemel Rd. SW Land Devel.	30001 Zemel Rd.	Punta Gorda	
Citrus	Citrus Sand & Debris II	3890 W Grover Cleveland	Homosassa	
	Citrus Sand & Debris	1590 N Quarterback Terrace	Crystal River	
	Material Exchange Corp.	Monier Resources Ash LF	Homosassa Spg	
	Sandland Pit C&D Debris	US 41 S of Holder	Holder	
Dade	All Dade Recycling	15490 NW 97th Ave	Miami	
	American Environ Recycling	2075A N Powerline Rd	Pompano Bch	
	C&C Recycling	8160 NW 183rd St.	Miami	
	Lofra Recycling	2601 SW 69th Ct.	Miami	
	Security Estates Landfill	PO Box 4944	Hialeah	
Dixie	Dixie County C&D Recycling	PO Box 1206	Cross City	352-498-5806
Duval	Jones Road LF and Recycling	3400 Jones Rd.	Jacksonville	
	Old Kings Rd. Recycling	219 Newman St. 1st Floor	Jacksonville	904-353-3181
Escambia	Amerson Roofing, Inc	4231 W HWY 4	Century	327-6320
	Beulah Excavating Co.	6640 Frank Reeder Rd	Pensacola	944-1517
	Cantonment Industrial Commercial Roofing	450 Neal Rd.	Cantonment	968-5561
	Clark North	395 N Ehrmann St.	Pensacola	455-0550
	Curtis & Doyle Lee	5015 Randy Kay Lane	Milton	626-1773
	English Brothers	825 Hope Drive	Pensacola	479-7845
	G.F.D. Construction Co. Inc.	8777 Ashland Ave	Pensacola	477-3554
	Gulf Coast Paving			

Table F.1: Listing of C&D Debris Facilities by County

County	Facility Name	Address	City	Telephone Number
Escambia	Guy Brothers Roofing	PO Box 17839	Pensacola	434-1785
	Kingry Trucking Co.	10350 Cove Ave.	Cantonment	968-3170
	Kingry Trucking Co.	10351 Cove Ave	Cantonment	968-3170
	Langford & Mills	7500 Pine forest Rd.	Pensacola	944-0460
	Morton, C.A. (Saufley Rd)	4512 Trice St.	Milton	479-7845
	NAS Penscola Site 8	NASP, Environmental Dept, Code 00500	Pensacola	452-3900
	W Pensacola Baptist Church	5213 W. Jackson St.	Pensacola	455-6077
	Baker C&D	1759 S Ferdon Blvd.	Crestview	689-5727
	Bowman (Rasberry Rd)	P.O. Box 1313	Crestview	689-3633
	Eglin AFB C&D	AFDTC/EMC 501 DeLeon St. Suite 100	Eglin AFB	882-6282
	J & B Sand Co.	595-B Bob Sikes Blvd	Ft. Walton Bch	862-0990
	Lingenfelter, Charles	P.O. Box 667	Ft. Walton Bch	863-2585
	Point Center Inc.	P.O. Box 456	Crestview	682-6611
	Waste Recyclers of N. Fla.	P.O. Box 5038	Destin	837-5728
	Whitrock	99-B Fetting Ave	Ft. Walton Bch	862-7900
	Dream Builders	P.O. Box 5397	Navarre	939-6738
	Frech Const.	Hwy 87, No. 2069	Navarre	939-9635
	Holley Dirt Co.	3224 River Road,	Navarre	939-4949
	Joiner Fill Dirt	7790 S. Airport Rd	Milton	623-5062
	K & K Construction	4962 Joiner Circle	Milton	850-936-9827
	Mills, Geo.	8200 Nuthatch Rd	Milton	939-0652
	Wells Land Clearing	1851 Black Rd	Milton	623-4404
	Coyote Land Co.	421 N. Palafox St.	Pensacola	433-0577
	Diamond Sand Co.	P.O. Box 1280	Mossy Head	892-3941
	Hackney	Rt. 3 Box 400	Freeport	835-2009
	L & S Sand Co.	326 Ruckle Dr.	Niceville	678-5541
	S R Beach Excavating	Route 2, Box 8085	Santa Rosa Bch	267-1559
	Waste Recyclers of N. Fla.	2256 Hwy 20	Freeport	800-847-6422
	Aggregate Transportation	P.O. Box 67	Lynn Haven	769-9136
	Calvin's C&D	1741 N. Sherman Ave.,	Panama City	785-1503
	City Env. Services, Inc	3910 E Avon Rd.	Panama City	785-4299
	Disposal Depot	1613 St. Andrews Blvd.	Panama City	763-4300
	Florida Asphalt Paving	P.O. Box 1310	Panama City	785-6139
	Leon's C&D	6410 E. Hwy 388	Youngstown	722-4325
	Lynn Haven	825 Ohio Ave.	Lynn Haven	265-2121
	New Creation Builders, Inc	6800 Gulf Drive	Panama City	234-6706
	Wetappo C & D	P.O. Box 278	Port St. Joe	229-8248
	Springhill (Waste Mgmt)	4945 Hwy. 273	Graceville	263-7100
	Granger Asphalt	P.O. Box 3358	Panama City	769-6640
	Crowder	Rt. 4 Box 446	Tallahassee	576-7176
	Crowder (Tram Rd)	Rt. 4 Box 446	Tallahassee	576-7178
	Ferrell	1369 E. Tenn. St.	Tallahassee	877-6535
	McNeill Co., Inc.	P.O. Box 5618	Tallahassee	942-6878
	Michaels of Tall.	350 Crossway Rd.	Tallahassee	545-7006
	Mitchell Brother, Tram Road	800 Aenon Church Rd.	Tallahassee	574-6000
	Morrison Pit	4871 Woodlane Circle	Tallahassee	562-3239
	Rankin Avenue Pit	1512 Groveland Hills	Tallahassee	545-6660
	SandCo	4727 North Monroe St.	Tallahassee	850-936-9827

Table F.1 (con’d): Listing of C&D Debris Facilities by County

County	Facility Name	Address	City	Telephone Number
Flagler	**Solomon Const.**	**P.O. Box 1449**	**Quincy**	**627-2348**
	Williams Conc.	**209 Tram Rd.**	**Tallahassee**	**850-514-2222**
	Stoutamire, James C&D	**2712 Spring Creek Rd.**	**Crawfordville**	**926-7954**
	Flagler C&D	**Rout1 Box 22c**	**Bunnell**	**904-437-0960**
	Old Kings Road Landfill	**1200 E. Moody Blvd., #1**	**Bunnell**	**904-437-7480**
Hernando	Sunshine Grove Rd. C&D	5025 Baseball Pond Rd.	Brooksville	352-796-6930
	Wildlife Lane C&D Landfill	7294 Sunshine Grove Rd.,	Brooksville	352-597-1885
Highlands	Sebring Landfill, Inc.	P.O. Box 1536	Sebring	
Hillsborough	Cone Rd. C&D	5005 Cone Rd.	Tampa	813-622-8299
	Coniglio C&D	11981 N. Williams Rd.	Thonotosassa	813-988-8284
Lafayette	Lafayette County C&D	Route 3, Box 418	Mayo	904-294-1500
Lake	Danis Environmental Mgmt.	P.O. Box 0446	Killarney	407 920-1353
	Grantham Pit C&D Facility	39414 CR 439	Umatilla	352 669-4479
	Lake County SWM C&D	13130 Astatula Landfill Rd	Tavares	352 343-3776
	Professional Dirt services	P.O. Box 147	Eustis	352 589-7000
Marion	Amodeo C&D Facility	10815 SE 145th PL	Summerfield	352-288-5621
	Big D Roofing C&D Facility	4480 N.E. 35th Street	Ocala	352 622-9076
	Holmes Dirt Service C&D	P.O. Box 321	Tavares	352 669-4555
	Superior Cypress Acres C&D	1319 No Business Creek Rd	Ragland, AL	352 624-0277
Nassau	Nassau Sanitation C&D Facility	254 W. Kenne Rd.	Apopka	407-880-2100
Orange	Continental Waste Industries	8050 Avalon Road	Winter Garden	407 654-0124
	Mid-Florida Materials	P.O. Box 547186	Orlando	407 740-5779
	Pine Ridge Landfill	3510 Rio Vista Ave.	Orlando	407 788-2838
Osceola	Bass Rd. Landfill- C&D	4400 Hunt Road	Kissimmee	407 847-4481
Pasco	Ash-Len C&D	6704 Congress St.	New Port Richey	813-849-7279
	Coastal LF Disposal C&D	11416 Houston Ave		813-868-0142
	Pasco Lakes C&D	9344 Old Pasco Rd.	Wesley Chapel	352-588-4958
Polk	Southeast C&D	10 Environmental Loop	Winter Haven	941-284-4319
	Northeast C&D	10 Environmental Loop	Winter Haven	941-284-4319
	Pembroke C&D	P.O. Box 229	Crystal Springs	813-788-2187
	DC Disposal C&D	P.O. Box 38	Oxford	352-568-0999
Putnam	Z to A, Inc.	P.O. Box 156	Palatka	904-325-4373
Seminole	Oviedo Materials C&D	P.O. Box 156	Palatka	904-325-4373
St. Johns	Southland Environ. Services	P.O. Box 39797	St. Augustine	
Volusia	Clyde Morris Blvd. Debris	P.O. Box 2451, Daytona Beach, FL 32115	Daytona Bch	904 258-3174
	Continental Waste Ind.	1988 W. Plymouth Ave.	Deland	407 240-6895
	Four Jays Land clearing	P.O. Box 59	Osteen	407 322-2020
	G.E.L. Corp.	1200 Leavitt Ave.	Orange City	904 775-5385
	Jade C&D (aka Osteen)	P.O. Box 163	Osteen	407 323-4243
	Kirton-Self C&D	1630 Tomoka Farms Rd	Daytona Bch	904 253-7864
	Klenk Disposal Site	Baywood Circle	Port Orange	904 767-7810
	Samsula Landfill	363 SR 415	New Smyrna Bch	904 767-5764
	Tomoka Farms Rd. LF	1990 Tomoka Farms Rd	Daytona Bch	904 736-5927

Table F.1 (con’d): Listing of C&D Debris Facilities by County

Facility Name	Address	City	Telephone
Bay County Resource Mgmt. Center	6501 Bay Line Dr.	Panama City	850-786-7933
North Broward County Resource Recovery	2600 NW 48th St.	Pompano Bch	305-971-8701
South Broward County Resource Recovery	4400 S State Rd. 7	Ft. Lauderdale	305-581-6606
Dade County Resource Recovery	6990 NW 97th Ave	Miami	305-593-7000
Hillsborough County SW Energy Recovery Facility	350 N. Faulkenburg Rd.	Tampa	813-684-5688
Southernmost Waste-To-Energy Facility	5701 W. College R.	Key West	305-293-6409
Lake County Resource Recovery Facility	3830 Rogers Industrial Park Rd.	Okahumpka	904-3685-1611
McKay Bay Refuse to Energy Project	107 N 34th St.	Tampa	813-248-1457
North County Regional Resource Recovery	6501 N Jog Rd.	West Palm Bch	407-478-3800
Pasco County Solid Waste Resource Recovery	14320 Hays Rd.	Springhill	813-856-0119
Pinellas County Resource Recovery Facility	34th St. N & 110th Ave	Clearwater	813-572-9163
Lee County Solid Waste Resource Recovery	10500 Buckingham Rd.	Ft. Myers	813-337-2200
Ridge Generating Station	PO Box 2397	Winter Park	407-628-8900
McIntosh Power Plant	3030 E. Lake Parker Dr.	Lakeland	813-499-6600
Miami International Airport Incinerator	NW 57th Ave & 25th St.	Miami	305-876-7380

Table F.2: Listing of Municipal Solid Waste Incinerator Survey Recipients

County	Facility Name	Address	City	Telephone
Alachua	SOUTHWEST ALACHUA LANDFILL	SR24, 2MI W ARCHER	ARCHER	
Bay	STEELFIELD ROAD LANDFILL	STEELFIELD RD,3 MI W OF HWY 79	WEST BAY	
	BREVARD COUNTY CENTRAL LANDFILL W OF ADAMSON RD, 2MI N SR524 COCOA	W OF ADAMSON RD, 2MI N SR524	COCOA	
Brevard	CAPE CANAVERAL ASBESTOS MONOFILL	CENTRAL CONTROL RD	CAPE CANAVERAL AFS	
	SARNO ROAD LANDFILL	.5MI S SARNO RD, 1.5MI E I95	MELBOURNE	
	SCHWARTZ ROAD LANDFILL	SCHWARTZ RD	KENNEDY SPACE CENTER	
Broward	BROWARD CO INTERIM CONTINGENCY LF	US 27 & SHERIDAN STREET	PEMBROKE PINES	
	BROWARD CO SOUTH RRF ASH MONOFILL	4400 S SR 7	FT. LAUDERDALE	
	CENTRAL SANITARY LF & RECYCLING CENTER	3000 NW 48TH ST (HILTON RD)	POMPANO BEACH	
Charlotte	CHARLOTTE COUNTY SLF	ZEMEL RD, W US41	TROPICAL GULF ACRES	
Citrus	CITRUS CENTRAL FL	3MI E LECANTO, SR44	LECANTO	
Clay	ROSEMARY HILL LANDFILL	ROSEMARY HILL RD, W OF C-315	GREEN COVE SPRINGS	
Collier	IMMOKALEE LANDFILL (NO 2 - STOCKADE)	STOCKADE RD @ CR846	IMMOKALEE	
	NAPLES LANDFILL CELL NO 6 (COLLIER COUNTY)	1.5MI E JCT SR951 & SR84	NAPLES	
Columbia	WINFIELD SW FACILITY	OOSTERCHOUDT RD, W. OF US41	LAKE CITY	
Dade	MEDLEY LANDFILL & RECYCLING CENTER	9350 NW 89 AVENUE	MEDLEY	
	SOUTH DADE LANDFILL	SW 248TH ST & 97TH AVE	GOULDS	
	DADE CO RES. RECOVERY ASH MONOFILL	6990 NW 97TH AVE & NW 69TH STREET	MIAMI	
	NORTH DADE LANDFILL	NE 215TH ST & 47TH AVE	CAROL CITY	
Desoto	SECTION 16 LANDFILL EXPANSION	2MI NW JCT US17 & SR760	NOCATEE	
Duval	TRAIL RIDGE LANDFILL	US 301,1.5MI NW OF MAXVILLE	BALDWIN	
Escambia	CRIST PLANT COAL ASH MONOFILL	END OF PATE STREET	PENSACOLA	
	PERDIDO LANDFILL	BEULAH-MUSKOGEE RD	MUSCOGEE	

Table F.3: Listing of Active Landfill Survey Recipients

County	Facility Name	Address	City	Telephone
	ROCK CROSSING (CHAMPION PAPER)	MUSCOGEE RD, 1 MI S JACKS BRANCH	CANTONMENT	
Franklin	FRANKLIN COUNTY CENTRAL LANDFILL	SR65, 1.2MI N OF US HWY 98	GREENPOINT	
Gadsden	BYRD LANDFILL	1.5MI FROM SR10 ON SELMAN RD	QUINCY	
Glades	GLADES COUNTY LANDFILL	1/4 MI N OF SR78, W OF US27	MOOREHAVEN	
Gulf	FIVE POINTS LANDFILL	0.75 MI E OF HWY 71 2MI NE OF	PORT ST. JOE	
	FL COAST PAPER (HIGHLAND VIEW DISP SITE)	HIGHLAND VIEW	PORT ST. JOE	
Hamilton	HAMILTON COUNTY LANDFILL	BASIN SWAMP RD & S CEMETERY RD	JASPER	
Hardee	HARDEE COUNTY REGIONAL LANDFILL	AIRPORT RD, N SR636	WAUCHULA	
Hendry	LEE/HENDRY CO REGIONAL LANDFILL	SOUTH CHRUCH ROAD, HENDRY CO	FELDA	
Hernando	HERNANDO CO NORTHWEST LANDFILL	US90 & TATUM ROAD	BROOKSVILLE	
Highlands	HIGHLANDS COUNTY SW MGMT CENTER	12700 ARBUCKLE CREEK ROAD	SEBRING	
	SEBRING TRASH SITE	CEMETARY ROAD	SEBRING	
	AVON PARK LANDFILL & TRANSFER STATION	N HIGHLANDS AVE & SR17A	AVON PARK	
Hillsborough	DAVID J JOSEPH LANDFILL	KINGSWAY RD, 0.5MI N OF I4	TAMPA	
	SOUTHEAST COUNTY LANDFILL (PICNIC LF)	.2MI W OF CR39, N OF CR 672	PICNIC	
Indian River	INDIAN RIVER COUNTY LANDFILL - CLASS I	RANGE LINE ROAD	OSLO	
Jackson	SPRINGHILL REGIONAL LANDFILL	1.5MI SW CAMPBELLTON, WSR273	CAMPBELLTON	
	APALACHEE CORRECTIONAL INSTITUTION	US 90 & SR 271	SNEADS	
Lake	LAKE CO SOLID WASTE MGMT FACILITY	W OF SR561	ASTATULA	
Liberty	LIBERTY COUNTY LANDFILL	SR 271, 1/3 MI SE OF SR 12	BRISTOL	
Lee	GULF COAST LANDFILL	11990 SR-82, E OF FT MYERS	FT MYERS	
Leon	US 27 SOUTH LANDFILL	5MI E SR261 & US27	TALLAHASSEE	
	US 27 SOUTH LANDFILL	5MI E SR261 & US27	TALLAHASSEE	
Levy	LEVY CO SW MANAGEMENT FACILITY	4MI SE BRONSON OFF SR27	BRONSON	
	LEVY CO SW MANAGEMENT FACILITY	4MI SE BRONSON OFF SR27	BRONSON	
Madison	AUCILLA AREA SW FACILITY	US 221, 1 MI SE OF GREENVILLE	GREENVILLE	
	AUCILLA AREA SW FACILITY	US 221, 1 MI SE OF GREENVILLE	GREENVILLE	
Manatee	LENA ROAD COUNTY LANDFILL	SR64 & LENA ROAD	BRADENTON	

Table F.3 (con’d): Listing of Active Landfill Survey Recipients

County	Facility Name	Address	City	Telephone
Marion	BASE LINE LANDFILL	BASELINE ROAD	OCALA	
	BAYSIDE OF MARION LANDFILL	41ST STREET	SILVER SPRINGS	
Martin	MARTIN COUNTY PALM CITY II LANDFILL	3.7MI W TURNPK OVERPASS SR714	PALM CITY	
	MARTIN COUNTY PALM CITY II LANDFILL	3.7MI W TURNPK OVERPASS SR714	PALM CITY	
Monroe	CUDJOE KEY LANDFILL	CUDJOE KEY RD, WEST OF MM 21.5	CUDJOE KEY	
Nassau	WEST NASSAU LANDFILL	2.5MI N CALLAHAN OFF US1	CALLAHAN	
Okeechobee	OKEECHOBEE LANDFILL, INC	10800 NE 128TH AVENUE	OKEECHOBEE	
Orange	ORANGE CO LF (AKA DEMONSTRATION)	CURRY FORD ROAD	ORLANDO	
	KEENE ROAD LANDFILL	KEENE ROAD, NEAR	APOPKA	
Orange	BAY LAKE C&D LANDFILL	1.5MI W MAGIC KINGDOM THEME PK	ORLANDO	
Osceola	CITY OF ST. CLOUD LANDFILL	W 17TH ST	ST CLOUD	
	SOUTHPORT ROAD LF, PHASE I & II	3/4MI E JCT SR531&SOUTHPORT RD	KISSIMMEE	
Palm Beach	N CO RESOURCE RECOVERY FACILITY	45 STREET & FLORIDA TURNPIKE	RIVIERA BEACH	
Pasco	EAST PASCO LANDFILL (DADE CITY LF)	AUTON ROAD & RIVER ROAD	DADE CITY	
	WEST PASCO RRF ASH MONOFILL	HAYS RD & CR52, SE OF ARIPEKA	ARIPEKA	
	WEST PASCO LANDFILL	HAYS RD & CR52, SE OF ARIPEKA	ARIPEKA	
Pinellas	BRIDGEWAY ACRES CLASS I LANDFILL	SW OF I-275 & ROOSEVELT BLVD	ST PETERSBURG	
Polk	NORTH CENTRAL LANDFILL (SITE 201)	SR540, 5.4MI E US98	EATON PARK	
	NORTH CENTRAL LANDFILL (SITE 201)	SR540, 5.4MI E US98	EATON PARK	
	SOUTHEAST POLK LANDFILL (SITE 203)	GOLFVIEW CUT-OFF ROAD	LAKE WALES	
	PEMBROKE-FORT MEADE LANDFILL	3400 N CHARLESTON AVE (US17 N)	FT MEADE	
	CEDAR TRAIL LANDFILL	1881 E F GRIFFIN ROAD	BARTOW	
Putnam	PUTNAM COUNTY CENTRAL LANDFILL	US17 @ SR209-S, N OF PALATKA	PALATKA	
	PUTNAM CO CENTRAL LANDFILL	4 MI NORTH OF PALATKA	PALATKA	
Santa Rosa	STERLING FIBERS, INC	1801 CYANAMID ROAD	MILTON	
	SANTA ROSA CENTRAL LANDFILL	GALT CITY ROAD	BAGDAD	
	SANTA ROSA CENTRAL LANDFILL	GALT CITY ROAD	BAGDAD	
Sarasota	SARASOTA CENTRAL LANDFILL COMPLEX	N END OF KNIGHTS TRAIL ROAD	SARASOTA	
Seminole	OSCEOLA ROAD LANDFILL (SEMINOLE CO)	1930 OSCEOLA ROAD	GENEVA	
St. Johns	TILLMAN RIDGE LANDFILL	S SR214, W ALLEN NEASE ROAD	ST AUGUSTINE	

Table F.3 (con'd): Listing of Active Landfill Survey Recipients

County	Facility Name	Address	City	Telephone
St. Lucie	ST LUCIE COUNTY GLADES ROAD LANDFILL	LANDFILL RD & GLADES CUTOFF RD	FT PIERCE	
Suwannee	SUWANNEE COUNTY CENTRAL LANDFILL	.75MI OFF US129,6MI S LIVE OAK	SUWANNEE	
Union	NEW RIVER REGIONAL LANDFILL	2.5 MILES NORTH OF RAIFORD	RAIFORD	
	NEW RIVER REGIONAL LANDFILL	2.5 MILES NORTH OF RAIFORD	RAIFORD	
Volusia	TOMOKA FARMS ROAD LANDFILL	TOMOKA FARMS RD, 2MI S I-4	DAYTONA BEACH	
Wakulla	LOWER BRIDGE LANDFILL	CR 368, 2MI E OF CRAWFORDVILLE	CRAWFORDVILLE	
Walton	WALTON COUNTY CENTRAL LANDFILL	4 MI N DEFUNIAK SPRINGS	DEFUNIAK SPRINGS	

Table F.3 (con'd): Listing of Active Landfill Survey Recipients

Owner	Contact	Address	City	Phone
Koppers Industries	Donald Surrency	200 NW 23rd Ave	Gainesville	(904) 376-5144
University of Florida	Alex Green	Space Science Research	Gainesville	(904) 342-2001
US Forest Industries	Jack Prescott	PO Box 2560	Panama City	(904) 785-4311
Louisiana Pacific Corp	Dennis McCormick	PO Box 3107	Conroe	(409) 760-5921
C&D Paving	Charles Montes	15150 Golden Point Ln.	West Palm Beach	(407) 523-0004
Jefferson Smurfit Corp.	Hollis Elder	PO Box 150	Jacksonville	(904) 798-5600
Champion Intern. Corp	F. Doug Owenby	PO Box 87	Cantonment	(904) 968-2121
Higdon Furniture Co.	J.W. Higdon	PO Box 978	Quincy	(904) 627-7564
Coastal Lumber Co.	John G. Kynoch	HWY 27 N, PO Box 1128	Havana	(904) 539-6432
Mactavish Furniture Industries	Hershel Shepard	PO Box 430	Quincy	(904) 627-7561
Manatee Inter. Wood Products	Roy Boyd	2035 NW 8th ave	Ocala	(904) 351-8000
Timber Energy Resources	Harry George	PO Box 199	Telogia	(850) 379-8341
Florida Plywoods	John Maultsby	PO Box 458	Greenville	(904) 948-2211
Madison Biomass Plant	David Brown	4000 Kruse Way PL, Bldg, 1	Lake Oswego	(503) 636-9620
Fleming Lumber Co	H. Fleming	PO Box 68	Crestview	
Atlantic Sugar Association	John Fanjul	PO Box 1570	Belle Glade	(561) 996-6541
Osceola Farms	Carlos Rionda	PO box 679	Pahokee	(407) 924-7156
Bartow Ethanol, Inc.	David Hall	12900 34th st. N	Clearwater	(813) 573-3040
Ridge Generating Station, L>P>	George Woodward	3131 K-ville Ave.	Auburndale	(941) 665-2255
Florida Furniture Ind.	Kenneth Loyless	PO Box 610	Palatka	(904) 328-3444
Georgia-Pacific Corp.	Tobin Finely	223 Gordon Chapel Road	Hawthrone	(904) 584-4573
Perry Lumber Company	Paul Dickert	1509 S. Byron Butler Pkwy	Perry	(904) 584-3401
FL DOC- Union Corr. Inst.	Ron Kronenberger	PO Box 2211	Raiford	(904) 488-3800
Georgia-Pacific Corp.	Myra Carpenter	Georgia-Pacific Corp.	Palatka	(904) 325-2001
Buckeye Florida, Lim. Part.	Charles Aiken	Buckeye Florida	Perry	(904) 584-1121
Recovery Corp. of America	R.L. Torrens	102 Star Ln.	Butler	
Gulfstream Park	Jack Blair	901 S. Federal Highway	Hallandale	(305) 454-7000
Quadrex Alternate Energy	Roger Garra, Pre	7108 Fairway Dr.	Palm Beach Gardens	(561) 627-7700
Combustor Inc.	R. Hoover	6663 Hollandale Dr.	Boca Raton	(305) 368-7100
Florida Coast Paper	Ferrel O. Allen	Florida	Port St. Lucie	(904) 227-1171
USEPPA Inn and Dock Co.	Vincent Formosa	PO Box 2276	Bokeelia	(941) 227-1171
Safety Harbor Club	Jack Hunt	PO Box 2276	Pineland	(941) 472-1019
Rudolf Krause & Sons	Rudy Krause	RTE. 4 Box 331	Summerland Key	(305) 872-4000
Tonley Founder & Machine	J.O. Townley	PO Box 221	Candler	(904) 355-9930
Jefferson Smurfit Corp.	Warren Flenniken	N 8th St.	Fernandina Beach	(904) 261-5551
Rayonier Inc.	Stephen Olsen	PO Box 2002	Fernandina Beach	(904) 261-3611
Boca Raton Resort & Club	Jesse Perera	501 E. Camino Real	Boca Raton	(407) 395-3000
St. Lucie Incineration	Wayne Holland	2300 Virginia Ave	Fort Pierce	(407) 468-1707
Robbins Manufacturing Co.	Brad Alston	PO Box 17939	Tampa	(813) 971-3030
Lakeland Drum Sevice	Randy Guy	PO Box	Auburndale	(941) 967-3388
Environ-Lectric, Inc.	Wayne Bodir	PO Box 507	De Funiak Spgs.	(850) 892-2711
North Florida Lumber	C. Finley McRae	PO Box 7	Graceville	(904) 263-4457
Okeelanta Corp	Ricardo Lima	PO Box 86	South Bay	(407) 996-9072
Forestry Resources	John Caauthen	4353 Michigan Link	Fort Myers	(941) 332-4206
Royal Oak Enterprises, Inc.	Jim Stroup	1921 NW 17th Place	Ocala	(352) 732-0005

Table F.4: Listing of Power Plant Survey Recipients

County	Director	Address	City	Phone
Alachua	Cliff Crawford	PO Box 490, Station #24	Gainesville, FL	(352) 334-5067
Alachua	Jerry Bratcher	110 NW 1st Ave	High Springs, FL	(904) 454-1416
Bay	Charles Smith	825 Ohio Ave.	Lynn Haven, FL	(850) 271-5547
Bay	Veryl McIntyre	1900 W. 11th St	Panama City, FL	(850) 872-3199
Bay	Al Svitenko	16200 Back Beach Rd.	Panama City Beach, FL	(850) 234-5065
Bradford	Cheryl Conova	PO Box 1146	Starke, Fl	(904) 964-6792
Brevard	Nancy Hanson	105 Polk Ave.	Cape Canaveral, FL	(407) 868-1227
Brevard	Laird McLean	PO Box 320280	Cocoa Beach, FL	(407) 868-3274
Brevard	Ann Scott	1233 Yacht Club Boulevard	Indian Harbor Beach, FL	(407) 773-0552
Brevard	Mary Ann Kise	1551 Highland Ave.	Melbourne, FL	(407) 255-4608
Brevard	Steve Riser	1502 Port Malabar Blvd	Palm Bay, FL	(407) 952-3441
Brevard	Kerry Stoms	520 Cinnamon Drive	Satellite Beach, FL	(407) 773-6458
Brevard	Bob Crawford	2285 Minton Rd	West Melbourne, FL	(407) 727-7700
Broward	Scott Sundermeier	4800 W Copans Rd	Coconut Creek, Fl	(954) 973-6740
Broward	Kenneth Richardson	PO Box 290910	Cooper City, FL	(954) 434-4300
Broward	Rick Engle	9551 W Sample Rd.	Coral Springs, FL	(954) 345-2110
Broward	Thomas E. Messenheimer	9551 W Sample Rd.	Coral Springs, FL	(954) 344-1841
Broward	Michael McGoun	12441 Royal Palm Blvd.	Coral Springs, FL	(954) 345-2122
Broward	Kristen Jones	100 W Dania Beach Blvd.	Dania, FL	(954) 921-8700
Broward	Sharon Kent	6591 SW 45th St	Davie, FL	(954) 797-1145
Broward	Vincent Kendrick	150 NE 2nd Ave.	Deerfield Beach, FL	(954) 480-4423
Broward	Thomas L. Tapp	1350 W Broward Blvd.	Fort Lauderdale, FL	(954) 761-5348
Broward	Johnny Farmer	401 SE 3rd St	Hallandale, FL	(954) 457-1450
Broward	Christine Thrower	2600 Hollywood Blvd, City Hall Annex	Hollywood, FL	(954) 921-3404
Broward	Irvin Kiffin	2000 City Hall Dr.	Lauderhill, FL	(954) 730-3080
Broward	John L. Trudel	220 NE 38th St.	Lighthouse Point, FL	(954) 784-3439
Broward	George McNeill	5790 Margate Blvd.	Margate, FL	(954) 972-6458
Broward	Steven Cash	6700 Miramar Parkway	Miramar, FL	(954) 967-1600
Broward	Michael Sargis	701 Southwest 71st Ave.	North Lauderdale, FL	(954) 724-7060
Broward	Robert Frank	250 Northeast 33rd St.	Oakland Park, FL	(954) 561-6280
Broward	Jim Cowen	6500 Parkside Drive	Parland, FL	(954) 753-5040
Broward	Dean Combs	501 NW 103rd Ave	Pembroke Pines, FL	(954) 435-6520
Broward	James Romano	9151 NW 2nd St	Plantation, FL	(954) 452-2519
Broward	Tim Tracy	1801 NE 6th St.	Pompano Beach, FL	(954) 786-4191
Broward	Don Campbell	9525 W. Oakland Park Blvd	Sunrise, FL	(954) 572-2263
Broward	Kathleen Margoles	7525 NW 88th Ave	Tamarac, FL	(954) 722-5900
Broward	Jeff Skidmore	2500 Weston Rd, Suite 101	Weston, FL	(954) 385-2010
Broward	Richard Rothe	524 NE 21st Court	Wilton Manors, FL	(954) 390-2115
Citrus	Russ Kreager	123 NW Highway 19	Crystal River, FL	(352) 795-6149
Citrus	Patricia Smith	212 W Main St.	Inverness, FL	(352) 726-3913
Clay	Gloria Neely	2042 Park Ave	Orange Park, FL	(904) 264-2635
Collier	Don Wirth	735-8th Street, Sount	Naples, FL	(941) 434-4683
Columbia	Roger Little	PO Box 1687	Lake City, FL	(90) 475-8540
Columbia	Patrick Cann	4331 NW 36th St.	Lauderdale Lakes, FL	(954) 733-7804
Dade	Rober Sherman	2999 NE 191st St., Ste. 500	Aventura, FL	(305) 466-8930
Dade	Joe Abel	405 University Dr.	Coral Gables, FL	(305) 460-5604

Table F.5: Listing of Municipal Parks and Recreational Services Survey Recipients

County	Director	Address	City	Phone
Dade	Johnnie Phillips	404 W Palm Dr.	Florida City, FL	(305) 248-6467
Dade	Ernest Horsley	PO Box 40	Hialeah, FL	(305) 687-2656
Dade	Alan Ricker	790 N Homestead Blvd	Homestead, FL	(305) 247-1801
Dade	Todd Hofferberth	85 W McIntyre St.	Key Biscayne, FL	(305) 365-8900
Dade	Alberto Rudder	444 SW 2nd Ave.	Miami, FL	(305) 416-1320
Dade	Kevin Smith	1700 Convention Center Dr.	Miami Beach, FL	(305) 673-7730
Dade	Jerry Estep	9617 Park Drive	Miami Shores, FL	(305) 795-2233
Dade	Edric de la Cruze	1401 Westward Drive	Maimi Springs, FL	(305) 888-1560
Dade	Jean H. Fountain	776 North East 125th St.	North Miami, FL	(305) 893-6511
Dade	Harriet Orr	17011 NE 19th Ave	North Miami Beach, FL	(305) 948-2958
Dade	Wayne Smalls	777 Sharazad Boulevard	Opa Locke, FL	(305) 688-4611
Dade	Loren Matthews	11551 South Dixie Highway	Pinecrest, FL	(305) 234-2116
Dade	Ana Garcia	6130 Sunset Drive	South Miami, FL	(305) 663-6319
Dade	Adele Weisberg	9301 Collins Ave	Surfside, FL	(305) 866-3635
Dade	Yioset De La Cruz	250 SW 114th Ave	Miami, FL	(305) 551-4774
Dade	Spencer Deno	6598 NW 38th Terrace	Virginia Gardens, FL	(305) 871-1120
Dade	Jim Gestwicki	901 SW 62nd Ave	West Miami, FL	(305) 263-8900
DeSoto	Don Waters	PO Box 351	Arcadia, FL	(941) 494-4712
Duval	Timmy Johnson	716 Ocean Blvd.	Atlantic Beach, FL	(904) 247-5828
Duval	Bill Potter	851 N Market St.	Jacksonville, FL	(904) 630-3543
Duval	Jim Wilkins	321 Penman Rd.	Jacksonville Bch, FL	(904) 247-6236
Escambia	William J. Vickrey	PO Box 12910	Pensacola,FL	(850) 435-1770
Gadsden	Forrest Scott	PO Box 1888	Chattahoochee, FL	(850) 663-2123
Gadsden		207 SW 5th St	Havana, FL	(850) 539-9451
Gadsden	Tim Lane	122 N Graves	Quincy, FL	(850) 875-2255
Hendry	Angie Kelly	110 W Osceola	Clewiston, FL	(941) 983-8566
Hernando	David Pugh	26 S Brooksville Ave	Brooksville, FL	(352) 544-5495
Highlands	Tony Anderson	110 E. Main St.	Avon Park, FL	(941) 452-4400
Hillsborough	Richard E. Calhoun	301 N. Dort St	Plant City, FL	(813) 757-9166
Hillsborough	Joe Abrahams	1420 Tampa St	Tampa, FL	(813) 223-8018
Hillsborough	Ross Ferlita	7525 North Blvd	Tampa, FL	(813) 931-2121
Hillsborough	none	6610 Whiteway Drive	Temple Terrace, FL	(813) 989-7180
Jackson	Jim Tyler	PO Box 936	Marianna, FL	(850) 482-4353
Lake	Mary Bryant	305 E Magnolia Ave.	Eustis, FL	(352) 357-7969
Lake	Sonny Bell	318 S 2nd St.	Leesburg, FL	(352) 728-9885
Lake	Judy Smathers	PO Box 176	Mount Dora, FL	(352) 735-7138
Lake	Bill Newkam	100 N. Disston Ave	Tavares, FL	(352) 742-6221
Lake	John B. Rohan	1403 Paradise Dr	Lady Lake, FL	(352) 753-0637
Lee	Stephen H. Pohlman	PO Box 150027	Caper Coral, FL	(941) 574-0823
Lee	Jim W. Barney	PO Drawer 2217	Fort Myers, FL	(941) 338-2287
Lee	Richard Noon	PO Box 43	Sanibel, FL	(941) 472-1413
Leon	Randy Trousdell	912 Myers Park Drive	Tallahassee, FL	(850) 891-3366
Manatee	Edward Bricker	1411 9th St. West	Bradenton, FL	(941) 706-6200
Manatee	Carl Taylor	600 17th St., W	Palmetto, FL	(941) 723-4580
Marion	David J. Prichard	829 NE Sanchez Ave	Ocala, FL	(352) 629-8358
Martin	Michael F. Kelly	201 SW Flagler Ave	Stuart, FL	(561) 288-5335
Monroe	Craig Reed	PO Box 568	Islamorada, FL	(305) 664-2345
Monroe	Randy Sterling	PO Box 1550	Key West, FL	(305) 294-3721
Nassau	Tommy Purvis	2500 Atlantic Ave.	Fernandina Beach,	(904) 277-7350

Table F.5(con'd): Listing of Municipal Parks and Recreational Services Survey Recipients

County	Director	Address	City	Phone
Okaloosa	Mike Wing	PO Box 1209	Crestview, FL	(850) 682-6131
Okaloosa	Muri Kersemac	4200 Two Trees Rd.	Destin, FL	(850) 654-5184
Okaloosa	Gene Peters	132 Jet Dr.	Fort Walton Beach, FL	(850) 243-3119
Okaloosa	James F. Cambell	205 North Partin Drive	Niceville, FL	(850) 678-6816
Orange	Candy McCrary	11 North Forest Ave.	Apopka, FL	(407) 889-1741
Orange	Leonard Carswell	1776 Independence Lane	Maitland, FL	(407) 644-8895
Orange	Bruce Nordquist	150 North Lakeshore Drive	Ocoee, Fl	(407) 656-3103
Orange	Herb Washington	649 W. Livingston St	Orlando, FL	(407) 246-2285
Orange	Larry Caskey	PO Box 1005	Winter Garden, FL	(407) 656-4155
Orange	Bill Carrico	401 Park Ave, South	Winter Park, FL	(407) 599-3334
Osceola	Dan Loubier	320 E Monument Ave.	Kissimmee, FL	(407) 932-4050
Osceola	John Jackson	3301 17th St	St. Cloud, FL	(407) 957-7243
Palm	Gary Preston	PO Box 3273	Tequesta, FL	(561) 575-6240
Palm Beach	Michael J. Underwood	110 SW Avenue E	Belle Glade, FL	(561) 996-0100
Palm Beach	Mickey Gomez	201 W Palmetto Park Rd	Boca Raton, FL	(561) 393-7810
Palm Beach	Melody Green	PO Box 310	Boyton Beach, FL	(561) 375-6221
Palm Beach	John Wildner	PO Box 310	Boyton Beach, FL	(561) 375-6220
Palm Beach	Joe Weldon	50 NW 1st Ave.	Delray Beach, FL	(561) 243-7251
Palm Beach	Pamela Post	525 Swain St	Greenacres, FL	(561) 642-2180
Palm Beach	Charlotte Presensky	13476 61st St,N	West Palm Beach, FL	(561) 793-0874
Palm Beach	Russ Ruskay	210 Military Trail	Jupiter, FL	(561) 746-5134
Palm Beach	Dale Dougherty	535 Park Ave	Lake Park, FL	(561) 845-0799
Palm Beach	Daryl Boyd	1121 Lucerne Ave.	Lake Worth, FL	(561) 533-7359
Palm Beach	Dan Reidy	500 Greynolds Circle	Lantana, FL	(561) 540-5751
Palm Beach	Mark Hadgskins	501 U.S. Highway 1	North Palm Beach, FL	(561) 627-7799
Palm Beach	Ronald Osborne	171 N. Lake Ave	Pahokee, Fl	(561) 924-2972
Palm Beach	Russell Bitzer	PO Box 2029	Palm Beach, FL	(561) 838-5485
Palm Beach	Dennis Stevenson	226 Cypress Lane	Palm Springs, FL	(561) 964-8820
Palm Beach	John L. Williams	600 W Blue Heron Blvd	Riviera Beach, Fl	(561) 845-4072
Palm Beach	Lou Recchio	100 Sweet Bay Lane	Riviera Beach, Fl	(561) 790-5124
Palm Beach	Debra Brisson	11700 Pierson Rd	Wellington, FL	(561) 791-4045
Palm Beach	Laura Schuppert	PO Box 3366	West Palm Beach, FL	(561) 835-7025
Pasco	Willie Broner	PO Box 1355	Dade City, FL	(352) 521-1460
Pasco	Bob Consalvo	6630 Van Buren Street	New Port Richey, FL	(813) 841-4563
Pinellas	John R. Yevich	901 Ponce de Leon Blvd.	Beleair, FL	(727) 584-5946
Pinellas	Kevin E. Dunbar	PO Box 4748	Clearwater, FL	(727) 562-4800
Pinellas	Harry Gross	903 Michigan Blvd.	Dunedin, FL	(727) 738-1889
Pinellas	Paulette Cowen	3050 Beach Blvd, S	Gulfport, FL	(727) 893-1067
Pinellas	Dan Gavin	300 Municipal Dr.	Madeira Beach, FL	(727) 392-0665
Pinellas	Jeff Clark	127 State St., West	Oldsmar, FL	(813) 855-5588
Pinellas	Steve Brinkley	PO Box 951	Palm Harbor, FL	(727) 785-9862
Pinellas	Allen Denson	PO Box 1100	Pinellas, FL	(727) 544-0769
Pinellas	Joel Garren	6051 78th Ave, N	Pinellas, FL	(727) 541-0070
Pinellas	T.K. Ronald	750 Main St	Saftey Harbor, FL	(727) 724-1555
Pinellas	Tracy A. Jones	9100-113th St	Seminole, FL	(727) 391-8345
Pinellas	D. Lee Metzger	1400 19th St	St. Petersburg, FL	(727) 893-7207
Pinellas	Charles Ames	7701 Boca Ciega Drive	St. Petersburg, FL	(727) 363-9243
Pinellas	Margie Prichard	PO Box 5004	Tarpon Springs, FL	(727) 942-5610
Pinellas	Scott Witt	PO Box 5004	Tarpon Springs, FL	(727) 942-5610
Pinellas	Cathy Hayduke	120 108th Ave	Treasure, FL	(727) 360-0811

Table F.5(con'd): Listing of Municipal Parks and Recreational Services Survey Recipients

County	Director	Address	City	Phone
Polk	Cindy Hummel	202 Wiley Drive	Auburndale, FL	(941) 965-5546
Polk	Barbara C. Lawn	PO Box 1053	Bartow, FL	(941) 534-0120
Polk	Danielle Lauver	PO Box 1000	Dundee, FL	(941) 419-3100
Polk	Dennis Guenther	PO Box 856	Fort Meade, FL	(941) 285-8191
Polk	Sean McGraw	PO Box 308	Frostproof, FL	(941) 635-7866
Polk	Kelly Callihan	City Hall	Haines City, FL	(941) 422-9295
Polk	Troy Konemann	PO Box 1320	Lake Wales, FL	(941) 678-4089
Polk	Bill Tinsley	228 S Massachusetts Ave.	Lakeland, FL	(941) 499-6035
Polk	Cathy Santa	PO Box 296	Largo, FL	(727) 587-6720
Polk	Lar Moore	PO Box 707	Mulberry, FL	(941) 425-5492
Polk	Bob Sheffield	PO Box 2277	Winter Haven, FL	(941) 291-5656
Santa Rosa	Dick Smith	PO Box 640	Gulf Breeze, FL	(850) 934-5100
Santa Rosa	John T. Norton	PO Box 909	Milton, FL	(850) 623-4889
Seminole	William R. James	225 Newburyport Ave.	Altamonte Spgs., FL	(407) 869-2512
Seminole	Metthew Fortini	95 Triplet Lake Dr.	Casselberry, FL	(407) 263-7188
Seminole	John R. Holland	PO Box 950700	Lake Mary, FL	(407) 324-3017
Seminole	Sondra Lomax	175 W Warren Ave	Longwood, FL	(407) 260-3440
Seminole	Dru Boulware	400 Alexandria Boulevard	Oviedo, FL	(407) 359-5660
Seminole	Mike Kirby	PO Box 1778	Stanford, Fl	(407) 330-5688
Seminole	Chuck Pula	1126 E. State Rd 434	Winter Springs	(407) 327-6912
St. Lucie	Chuck Proulx	City Hall Plaza	Port St. Lucie, Fl	(561) 878-2277
Susan Miller	Susan Miller	10500 N. Military Trail	Palm Beach Gardens,FL	(561) 775-8270
Taylor	Glen Ratliff	PO Drawer 1907	Perry, FL	(850) 584-3006
Volusia	Pattie Evans	PO Box 2451	Daytona Beach, FL	(904) 258-3106
Volusia	Thomas W. Sperling	PO Box 449	DeLand, FL	(904) 734-5333
Volusia	Jack Corder	PO Box 100	Edgewater, FL	(904) 428-3245
Volusia	Chuck Beach	1065 Ridgewood Ave.	Holly Hill, FL	(904) 947-4120
Volusia	Elizabeth Yancey	210 Sams Avenue	New Smyrna Beach, FL	(904) 424-2175
Volusia	Laurie Crouteau	205 E. Graves Ave	Orange City, FL	(904) 775-5455
Volusia	Alan H. Burton	399 North US 1	Ormond Beach, FL	(904) 676-3279
Volusia	David E. Fleming	1000 City Center Circle	Port Orange, FL	(904) 756-5351
Volusia	Greg Bartholomew	PO Box 4960	South Daytona, FL	(904) 322-3070
Walton	Rodney J. Ryals	PO Box 685	DeFuniak Springs, FL	(850) 892-8500
Washington	Butch Granger	PO Box 1007	Chipley, FL	(850) 638-6348

Table F.5(con’d): Listing of Municipal Parks and Recreational Services Survey Recipients

County	Director	Address	City	Phone Number
Alachua	Robert Avery	PO Box 1188	Gainesville, FL	(352) 462-4557
Baker	Donald C. Combs	490 North Blvd.	Macclenny, FL	(904) 259-2590
Bay	Gary Buchanan	225 McKenzie Ave.	Panama City, FL	(850) 784-4065
Brevard	Charles Nelson	2575 St. Johns St.	Melbourne, FL	(407) 633-2046
Broward	Bob Harbin	950 NW 38th St.	Oakland Park, FL	(954) 357-8106
Charlotte	Laura Kleiss-Hoeft	4500 Harbor Blvd.	Port Charlotte, FL	(941) 743-1313
Citrus	Karen Barnett	PO Box 1439	Crystal River, FL	(352) 795-2202
Clay	Jack Brooker	3557 Highway 17	Green Cove Springs, FL	(904) 284-6378
Dade	Vivian Donnell-Rodriquez	275 NW 2nd St.	Miami, FL	(305) 755-7903
Escambia	Mark Thorton	10370 Ashton Brosnaham Dr.	Pensacola, FL	(850) 479-0923
Hamilton	Winston Warner	Rt. 1, Box 29	Jasper, FL	(904) 792-3098
Hardee	Jerry Katusta	901 West Main	Wauchula, FL	(941) 773-3173
Hendry	Phillip Pelletier	PO Box 1760	Labelle, FL	(941) 675-5347
Hernando	Charles "Pat" Fagan	20 North Main St.	Brooksville, FL	(352) 754-4027
Hillsborough	Edwin L. Radice	1101 River Cove St.	Tampa, FL	(813) 975-2160
Indian River/Vero	Patricia Callahan	1725 17th Ave.	Vero Beach, FL	(561) 567-2144
Jefferson	Kevin Aman	PO Box 491	Monticello, FL	(850) 342-0240
Lake		315 West Main St.	Tavares, FL	(352) 343-9761
Lake Cty Water	Dr. Robert W. Taylor	107 North Lake Ave.	Tavares, FL	(352) 343-3777
Lee	Barbara Manzo	3410 Palm Beach Blvd.	Fort Myers, FL	(941) 338-3312
Leon	Paul Cozzie	2890 Miccosukee Rd.	Tallahassee, FL	(850) 488-0221
Manatee	Daniel P. Hopkins	5502 33rd Avenue Drive W	Bradenton, FL	(941) 749-7123
Marion	Richard Noyes	8282 Southeast Highway 314	Ocala, FL	(352) 236-7919
Martin	Bob Denison	2401 Southeast Monterey	Stuart, FL	(561) 221-1326
Okeechobee	Darrell Enfinger	309 NW 2nd St.	Okeechobee, FL	(941) 763-6950
Orange		4801 W. Colonial Dr.	Orlando, FL	(407) 836-6200
Pasco	Jim D. Slaughter	4111 Land O'Lakes, Ste. 202	Land O'Lakes, FL	(813) 929-1260
Palm Beach	Dennis L. Eshleman	2700 6th Ave, South	Lake Worth, FL	(561) 964-4420
Pinellas	Diana Kyle	631 Chestnut St.	Clearwater, FL	(727) 462-3347
Putnam	Sweet Owens	PO Box 758	Palatka, FL	(904) 329-1268
Santa Rosa	Jimmy Stewart	PO Box 864	Milton, FL	(850) 623-1569
Sarasota	Walt Rothenbach	6700 Clark Rd.	Sarasota, FL	(941) 316-1172
Seminole	Bob Chorvat	264 W. North St.	Altamonte Spgs., FL	(407) 788-0405
St. Lucie		PO Box 760	Ft. Pierce, FL	(561) 462-1515
St. Johns	Leon Shimer	901 Pope Rd.	St. Augustine, FL	(904) 829-8807
Suwannee	Greg Scott	1201 Silas Dr.	Live Oak, FL	(904) 362-3004
Volusia	Bill Apgar	123 West Indiana Ave.	DeLand, FL	(904) 736-5953
Wakulla	Ray Gray	PO Box 1263	Crawford, FL	(850) 926-5769
Washington	David Corbin	1334 South Blvd.	Chipley, FL	(850) 638-6078

Table F.6: Listing of County Parks and Recreational Services Survey Recipients

District	Name	Address	City	Zip Code
Central	Jim Bradner	3319 Maguire Boulevard, Suite 232	Orlando	32803-3767
Northeast	Mary Nogas	7825 Baymeadows Way, Suite 200B	Jacksonville	32256-7590
Northwest	Jack McNulty	160 Government Center	Pensacola	32501-5794
South	William Krumbholtz	2295 Victoria Ave., Ste. 364	Ft. Myers	33901
Southeast	Mr. Lee Heofert	PO Box 15425	West Palm Beach	33416-5425
Southwest	Susan Metcalf	Post Office Box 340	Lecanto	34460-0340

Table F.7: Listing of District FDEP Offices

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APPENDIX G:
TECHNICAL ADVISORY GROUP MEMBERS

Name/Title	Organization	Address	Telephone	email
Kevin Archer, Ph.D. Product Development Manager	Chemical Specialties Inc.	One Woodlawn Green Suite 250 200 East Woodlawn Road Charlotte, NC 28217	(704)522-0825 (800)421-8661 Fax: (704)527-8232	kevina@chemspec.com http://www.chemspec. com http://www.treatedwood.com
Phil Badger	General Bioenergy, Inc.	P.O. Box 26 Florence, Alabama 35631-0026	(256)740-5634 Fax: (256)740-5530	pbadger@ bioenergyupdate.com
Lee Casey, Chief Environmental Compliance Division	Metro-Dade County Dept. of Solid Wste. Mgt.	8675 NW 53 Street Suite 201 Miami, FL 33166	(305)594-1670 Fax:(305)594-1581	le1@co.miami-dade.fl.us
Kenneth E. Cogan Plant Manager Alternate: Bob Gruber, Vice President Regulatory Affairs	Hickson Corporation	1579 Koppers Road Conley, GA 30027 1955 Lake Park Dr., Suite 250 Smyrna, GA 30080	(404)363-6300 Fax: (404)363-8585 (770)801-6600 Fax: (770)801-8170	ken_cogan@hicksoncorp. com bob_gruber@hicksoncorp.com
David Dee, Attorney Alternate: Pete Rosendahl, VP Environmental Relations	Landers & Parsons Florida Crystals Incorporated	310 West College Avenue P.O. Box 271 Tallahassee, FL 32302 316 Royal Poinciana Plaza Palm Beach, FL 33480	(850)681-0311 Fax: 850-224-5595 (561)655-6303 Fax:(561)659-9846	ddee@landersandparsons.com
Keith D. Drescher, Environmental Specialist Alternate: Russel S. Ketchem, Corporate Recycling Coordinator	Florida Power & Light	2455 Port West Blvd., Bldg. A West Palm Beach, FL 33407	(561)845-4968 (561)845-3366 Fax: (561)845-3308 (561)845-4976 Fax: (561)845-4889	keith_drescher@ email.fpl.com Russell_S_Ketchem@FPL.Com
Jeffrey Fehrs, P.E. Consultant	Jeffrey Fehrs, Consultant	20 Hideaway Lane Williston, VT 05495	(802)865-3480 Fax: (802)872-8255	jefehrs@together.net
Jim Gabbert	Meyer & Gabbert Excavating Contractors Recycling	8001 Fruitville Road Sarasota, FL 34241	(941)377-5370 (941)486-1352 Fax: (941)378-0844	jgabbert@co.sarasota.fl.us

Table G.1: Technical Advisory Group Members for Year 3

Name/Title	Organization	Address	Telephone	email
Bill Gay, Wood Preserving Vice President Alternate: Jim Hickman	Langdale Forest Products Co.	P.O. Box 1088 Valdosta, GA 31603-1088	(912)333-2513 Fax: (912)3332533 (912)333-2501	wgay@surfsouth.com jhickman@surfsouth.com
Danny Kreiser Manager	East Coast Recycling	4880 Glades Cut-off Road Ft. Pierce, FL 34981	(561)461-5833 (561)595-0009	
William Krumbholz, Environmental Manager Alternate: Jeff Gould, Professional Geologist II, Waste Cleanup	Dept. of Env. Protection Solid Waste Division	2295 Victoria Ave., Suite 364 Ft. Myers, FL 33901 P.O. Box 2549 Ft. Myers, FL 33902-2549	(941)332-6975 Fax:(941)332-6969	Bill.Krumbholz@dep.state.fl.us Jeffrey.Gould@dep.state.fl.us
Dave Mason Engineer 2 Alternate: Richard Tedder, Professional Engineer 3	Dept. of Environmental Protection	2600 Blair Stone Road MS# 4565 Tallahassee, FL 32399-2400	(850)921-9237 Fax: (850)414-0414	David.Mason@dep.state.fl.us
Jim Nix, Head Operator	Kodiak, Inc.	PO Box 99 Hwy. 278 East at Airport Road Allendale, SC 29810	(803)584-9137 Fax: (803)584-2208	NixJ@Kodiakwood.com
George Parris, Ph.D Director of Environmental & Regulatory Affairs	American Wood Preservers Institute	2750 Prosperity Avenue, Suite 550 Fairfax, VA 22031-4312	(703)204-0500 Fax: (703)204-4610	internet site: http://www.awpi.org
Michael E. Provenza Environmental Health and Safety Manager Alternate: Gary Hurst, General Manager	Robbins Manufacturing	13001 N. Nebraska Ave. Tampa, FL 33612 P.O. Box 17939 Tampa, FL 33682	(813) 971-3030 Fax: (813)972-3980	
John Schert Executive Director	Florida Center for Solid and Hazardous Waste Management	University of Florida 2207 NW 13 Street, Suite D Gainesville, FL 32609	(352)392-6264 Fax: (352)846-0183	fcshwm@eng.ufl.edu
Chih-Shin Shieh, Ph.D Principal Researcher/Director	Florida Institute of Technology, Research Center for Waste Utilization,DMES	150 W. University Blvd. Melbourne, FL 32901	(407) 768-8000 x7240 Fax: (407)674-7212	cshieh@fit.edu

Table G.1 (con’d): Technical Advisory Group Members for Year 3

Name/Title	Organization	Address	Telephone	email
Helena Solo-Gabriele, Ph.D, P.E Assistant Professor (Graduate Students:Kelvin Gary, Naila Hosein, Bernine Khan, Monika Kormienko)	University of Miami, Dept. of Civil, Arch. & Environ. Engrg.	P.O. Box 248294 Coral Gables, FL 33124-0630	(305)284-3489 or (305)284-3391 Fax: (305)284-3492	hmsolo @miami.edu
August (Gus) Staats Manager of Environmental Services	Osmose Wood Preserving Division	P.O. Drawer 0 Griffin, Georgia 30224-0249	(770)228-8434 Fax: (770)229-5225	
Donald R. Surrency, Manager of Plant and Sales Alternate: Jim Healey, Plant Manager	Koppers Industries, Inc.	P.O. Box 1067 Gainesville, FL 32609 200 NW 23 Ave. Gainesville, FL 32605	(352)376-5144 1-800-342-6860 Fax: (352)371-4657	don_surrency@koppers.com jim_healey@koppers.com
Ram Tewari, Ph.D., P.E., Project Manager	Broward County Commission Solid Waste Operations Division	201 S. Andrews Avenue Fort Lauderdale, FL 33301	(954)765-4202 x254 (954)680-0087 x224 Fax:(954)765-4237	rtewari@co.broward.fl.us
Timothy Townsend, Ph.D Assistant Professor (Graduate Students: Kristin Stook, Jin-Kun Song, Thabet Tolaymat)	University of Florida Dept.of Environ. Engrg.Sci., Solid & Haz.Wst Prgrm	333 New Engineering Bldg. Gainesville, FL 32611-6450	(352)392-0846 Fax: (352)392-3076	ttown@eng.ufl.edu
George Varn, Jr. Project Manager Alternate:G. Micheal Hollingsworth, Comptroller	Varn Wood Products	P.O. Box 128 Hoboken, GA 31542	(912)458-2187 Fax: (912)458-2190	justpine@aol.com

Table G.1 (con'd): Technical Advisory Group Members for Year 3

Attendees of the Technical Advisory Group Meeting Held July 15, 1999
At Florida Power and Light's Distribution Environmental Facility
2455 Port West Boulevard, West Palm Beach, Florida

Kevin Archer, Chemical Specialties Inc., Charlotte, NC
Bill Benton, Florida Power and Light, Daytona, FL
Marc Bruner, Solid Waste Authority, West Palm Beach, FL
Vandin Calitu, University of Miami, Coral Gables, FL
Ken Cogan, Hickson Corp., Conley, GA
Keith Drescher, Florida Power and Light, West Palm Beach, FL
Bill Gay, Langdale Forest Products, Valdosta, GA
Jeff Gould, Florida Dept. of Environmental Protection, Ft. Myers, FL
Bob Graham, Florida Power and Light, West Palm Beach, FL
Jim Healey, Koppers Industries Inc., Gainesville, FL
Jim Hickman, Langdale Forest Products, Valdosta, GA
Katherine Kormienko, University of Miami, Coral Gables, FL
Monika Kormienko, University of Miami, Coral Gables, FL
Danny Kreiser, East Coast Recycling, Ft. Pierce, FL
Jerry McMullan, Florida Power and Light, West Palm Beach, FL
Katie O'Reilly, Florida Power and Light, West Palm Beach, FL
Dan Rawson, Florida Power and Light, West Palm Beach, FL
Roger Sanders, Florida Power and Light, Melbourne, FL
John Schert, Univ. Florida Florida Center for Solid and Haz. Waste Mgt., Gainesville, FL
Jeffrey Smith, Florida Dept. of Environ. Protection, West Palm Beach, FL
Helena Solo-Gabriele, University of Miami, Coral Gables, FL
Jin-Kun Song, University of Florida, Gainesville, FL
Kristin Stook, University of Florida, Gainesville, FL
Don Surrency, Koppers Industries Inc., Gainesville, FL
Susan Sweeney, Florida Power and Light, West Palm Beach, FL
Ram Tewari, Broward County Solid Waste, Broward County, FL
Thabet Tolaymat, University of Florida, Gainesville, FL
Timothy Townsend, University of Florida, Gainesville, FL

Attendees of the Technical Advisory Group Meeting Held December 9, 1999 at the University of Miami, College of Engineering, Coral Gables, Florida

Kevin Archer, Chemical Specialties Inc., Charlotte, NC
Sean Bennie, University of Miami, Coral Gables, FL
Mark Bingham, Dade Recycling, Miami, FL
Scott Conklin, Universal Forest Products, Grand Rapids, MI
Diana Davis, Florida Power and Light, Juno Beach, FL
David Dee, Landers & Parsons, Tallahassee, FL
Louis DiVita, Delta Recycling Corp., Pompano Beach, FL
Rick Donaldson, Great Southern Wood Preserving, Bushnell, FL
Keith Drescher, Florida Power and Light, West Palm Beach, FL
Tom Evans, Coastal Lumber, Weldon, NC
Kelvin Gary, University of Miami, Coral Gables, FL
Bill Gay, Langdale Forest Products, Valdosta, GA
Alex Gomez, Dade Recycling, Miami, FL
Jeff Gould, Florida Dept. of Environmental Protection, Ft. Myers, FL
Bob Gruber, Hickson Corp., Smyrna, GA
Jimmy Harris, Great Southern Wood Preserving, Bushnell, FL
Jim Healey, Koppers Industries Inc., Gainesville, FL
Jim Hickman, Langdale Forest Products, Valdosta, GA
Naila Hosein, University of Miami, Coral Gables, FL
Gary Hurst, Robbins Manufacturing, Tampa, FL
Mitch Joiner, Osmose Wood Preserving, Griffin, GA
Russel Ketchem, Florida Power and Light, West Palm Beach, FL
Bernine Khan, University of Miami, Coral Gables, FL
Frank Klasnick, Osmose Wood Preserving, Griffin, GA
Monika Kormienko, University of Miami, Coral Gables, FL
Danny Kreiser, East Coast Recycling, Ft. Pierce, FL
William Krumbholz, Florida Department of Environmental Protection, Ft. Myers, FL
Jim Langdale, Langdale Forest Products, Valdosta, GA
Marc Laurent, Miami-Dade County Solid Waste, Miami, FL
Dave Mason, FL Dept. of Environ. Protection, Tallahassee, FL
Jerry McMullan, Florida Power and Light, West Palm Beach, FL
Russ Morgan, Occidental Chemical, Castle Hayne, NC
Don Pardue, Wood Treaters, Jacksonville, FL
George Parris, American Wood Preservers Inst., Fairfax, VA
Scott Ramminger, American Wood Preservers Inst., Fairfax, VA
Jay Robbins, Robbins Manufacturing, Tampa, FL
Tom Roberts, Delta Recycling Corp., Pompano Beach, FL
Steven Roundtree, Southeastern Lumber Manufacturers Assoc., Forest Park, GA
John Schert, Univ. Florida Florida Center for Solid and Haz. Waste Mgt., Gainesville, FL
Jim Seufert, Universal Forest Products, Grand Rapids, MI
Helena Solo-Gabriele, University of Miami, Coral Gables, FL
Gus Staats, Osmose Wood Preserving Division, Griffin, GA
Kristin Stook, University of Florida, Gainesville, FL
Thabet Tolaymat, University of Florida, Gainesville, FL
Tim Townsend, University of Florida, Gainesville, FL
George Varn Jr., Varn Wood Products, Hoboken, GA
Shakir Wissa, Southern Soft Wood Inc., Orlando, FL
Edward Zillioux, Florida Power and Light, Juno Beach, FL

Attendees of the Technical Advisory Group Meeting Held March 17, 2000 at the University of Florida, Reitz Union, Gainesville, Florida

Kevin Archer, Chemical Specialties Inc., Charlotte, NC
Allison Barnes, University of Florida, Gainesville, FL
David Bullock, Wood Protection Products, Charlotte, NC
Diana Davis, Florida Power and Light, Juno Beach, FL
David Dee, Landers & Parsons, Tallahassee, FL
Dottie Delfino, Univ. FL Florida Center for Solid and Haz. Waste Mgt., Gainesville, FL
Rick Donaldson, Great Southern Wood Preserving, Bushnell, FL
Keith Drescher, Florida Power and Light, West Palm Beach, FL
Kelvin Gary, University of Miami, Coral Gables, FL
Alex Green, University of Florida - Dept. of Mechanical Engineering, Gainesville, FL
Bob Gruber, Hickson Corp., Smyrna, GA
Tim Hannon, Pride of Florida, Starke, FL
Jim Healey, Koppers Industries, Gainesville, FL
Scott Hiaasen, Palm Beach Post, West Palm Beach, FL
Jim Hickman, Langdale Forest Products, Valdosta, GA
Naila Hosein, University of Miami, Coral Gables, FL
Jake Huffman, University of Florida - School of Forest Resources, Gainesville, FL
Gary Hurst, Robbins Manufacturing, Tampa, FL
Russel Ketchem, Florida Power and Light, West Palm Beach, FL
Kim Kochran, University of Florida, Gainesville, FL
Monika Kormienko, University of Miami, Coral Gables, FL
William Krumbholz, Ft. Myers, FL
Lena Ma, University of Florida - Soil and Water Science, Gainesville, FL
Dave Mason, FL Dept. of Environ. Protection, Tallahassee, FL
Ron Matus, Gainesville Sun, Gainesville, FL
Jerry McMullan, Florida Power and Light, West Palm Beach, FL
John Mousa, Alachua County Environ. Protection, Gainesville, FL
Kevin O'Donnell, Florida Power and Light, West Palm Beach, FL
Don Pardue, Wood Treaters, Jacksonville, FL
Michael Provenza, Robbins Manufacturing, Tampa, FL
Scott Ramminger, American Wood Preservers Inst., Fairfax, VA
Dan Rawson, Florida Power and Light, West Palm Beach, FL
Bill Robbins, Robbins Manufacturing, Tampa, FL
Jay Robbins, Robbins Manufacturing, Tampa, FL
Rhonda Rogers, Univ. FL Florida Center for Solid and Haz. Waste Mgt., Gainesville, FL
Steve Rountree, Southeastern Lumber, Forest Park, GA
Roger Sanders, Florida Power and Light, West Melbourne, FL
John Schert, Univ. Florida Florida Center for Solid and Haz. Waste Mgt., Gainesville, FL
Robert A. Schmidt, University of Florida - School of Forest Resources, Gainesville, FL
Jim Seufert, Universal Forest Products, Grand Rapids, MI
Helena Solo-Gabriele, University of Miami, Coral Gables, FL
Jin Kun Song, University of Florida, Gainesville, FL
Gus Staats, Osmose Wood Preserving Division, Griffin, GA
Kristin Stook, University of Florida, Gainesville, FL
Don Surrency, Koppers Industries, Gainesville, FL
Thabet Tolaymat, University of Florida, Gainesville, FL
Tim Townsend, University of Florida, Gainesville, FL
Yongchul Yang, University of Florida, Gainesville, FL
Edward Zillioux, Florida Power and Light, Juno Beach, FL

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