Appendix B



P.O. BOX 188 LAB B
LONGVIEW, WA 98632
Report on:

LC₅₀ VALUE OF A LAUAN PLYWOOD
USING THE UNIVERSITY OF
PITTSBURGH TOXICITY TEST
APPARATUS

Conducted on:
LAUAN PLYWOOD
WITH A POLYVINYL CHLORIDE
LAMINATE

Conducted for:
WILLIAM J. GROAH
HARDWOOD PLYWOOD
MANUFACTURERS ASSOCIATION
1825 MICHAEL FARADAY DRIVE
RESTON, VA 22090

Completed on: June 27, 1989

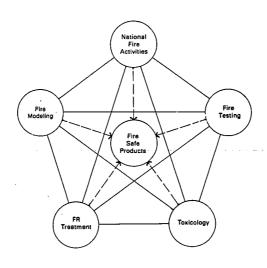


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Hardwood Plywood Manufacturers Association University of Pittsburgh Test Methodology

NOTICE

This test method is intended to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or the fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.

INTRODUCTION

For this report, a Lauan plywood with a polyvinyl chloride (PVC) laminate was received from the Hardwood Plywood Manufacturers Association. Testing of this plywood was in accordance to the University of Pittsburgh Test Methodology as described in Article 15 Part 1120 of the New York State Uniform Fire Prevention and Building Code [1].

This report includes dimensions of the particleboards, test methodology, and the

test results.

METHOD

The protocol used is published under Article 15 of the New York State Uniform Fire Prevention and Building Code [1]. The LC50 values and their confidence intervals

were calculated by the Weil method [2].

The UPITT apparatus consisted of a Lindberg furnace (Pittsburgh, PA) connected to an animal exposure chamber. Within the furnace there was a weight load cell upon which the specimen was placed. There was an air flow of eleven (11) liters/minute proceeding from the furnace toward the animal exposure chamber. That air flow was mixed, cooled and diluted with nine (9) liters/minute of cold air (~15°C) before being presented to the animals. The furnace temperature was ramped 20° C/minute. The furnace, however, was not connected to the animals exposure chamber until the specimen had loss 1% of its weight as indicated by the weight load cell. The time at which this occurred was the beginning of the thirty (30)-minute animal exposure. The animal exposure chamber simultaneously housed four (4) male Swiss-Webster mice (Simenon Laboratories, Inc.; Gilroy, CA) in a head-only exposure mode. The decomposition products passed to gas analyzers (carbon monoxide, carbon dioxide and oxygen) after being presented to the animals. The apparatus and protocol were according to the methodology of New York State Protocol [1].

Procedurally, a ten (10)-gram quantity of the material was placed in the furnace after which the ramping of the furnace started. At the 1% weight loss, the animal exposure chamber was connected to the furnace. After the thirty (30)-minute exposure was completed, the animals were observed for an additional ten (10) minutes. Any deaths occurring during these forty (40) minutes were used in the determination of the LC₅₀ value. If all the animals died with the ten (10) grams, the next experiment would be with a lower weight. If no animals died, then a higher weight would be used in the next experiment.

That next weight would be determined by a geometric factor. The geometric factor was necessary because of the statistical procedure [2] used for determining the LC50 values. This factor (for example, 1.1) would be multiplied by the weight to determine the next higher weight, or the weight would be divided by the factor to determine the next lower weight. Using this statistical procedure, four consequent weights (spaced by the geometric factor along with the corresponding deaths as required by the tables supplied in the reference) were needed to determine an LC50 value.

A program was written for a Macintosh® Plus Computer in conjunction with a Fluke 2400A (A/D and D/A measurement and control link) to specifically operate this apparatus. Ramping of the furnace was accomplished by the Macintosh® monitoring the furnace temperature and varying the power supply to the furnace. The specimen weight, the percent of weight loss, concentrations of carbon monoxide (CO), carbon dioxide (CO₂) and oxygen (O₂), time (from the initiation of ramping and from the 1% weight loss), temperatures of the furnace and chamber, and the difference between the actual and theoretical furnace temperatures were displayed on the computer monitor during the experiment as well as recorded on a diskette. The O₂ gas analyzer was a Servomex O₂ Analyzer OA 580 (Sybron/Taylor), and the CO/CO₂ analyzer was a Dual Gas Analyzer (Infrared Industries, Inc.)

In order to confirm that there were no leaks in the system and that the pump, air flow and flowmeters were operating properly, the flow rates of nine (9) and twenty (20) liters/minutes were tested prior to each test with a Mini-Buck Calibrator (A.P. Buck, Inc., Orlando, FL). This flowmeter is traceable to the National Institute of Standards and Technology (formerly National Bureau of Standards). Calibration of the CO and CO₂ analyzers was performed with calibration gases (CO - 0.9% and CO₂ - 5%) certified by Alphagaz Division (Tacoma, WA). The O₂ analyzer was calibrated with room air.

TEST RESULTS

The LC₅₀ values and their confidence intervals are presented. A number of parameters are reported in a summary table, such as the minimum oxygen concentration, the maximum carbon monoxide and carbon dioxide concentrations, the maximum animal exposure chamber temperature, the maximum furnace temperature, and the percentage of the specimen weight. Tabulation of the data required by New York State is included. These data are from a specimen weight close to the LC₅₀ value. The concentration-time (Ct) products for carbon monoxide and carbon dioxide plotted with the specimen weight are presented. [This Ct product is a value calculated by multiplying the gas concentration, such as carbon monoxide, with the time of animal exposure to the gas concentration. In other words, it is the area under the curve of the gas concentrations vs time.]

REFERENCES

- 1. Article 15, Part 1120 -- New York State Fire Prevention and Building Code. New York Standards & Fire Information Network, Office of Fire Prevention and Control. Albany, NY.
- 2. Weil, C.S., Tables For Convenient Calculation Of Median-Effective Dose (LC₅₀ or ED₅₀) And Instructions In Their Use. *Biometrics* 8: 249-263, 1952.

SAMPLE PREPARATION

This plywood was stored in a conditioning room $(23.8 \pm 2.8^{\circ})$ C and $50 \pm 10\%$ Relative Humidity) for at least 48 hours prior to testing. Each specimen placed in the furnace was a piece of a wood product cut to a specific weight.

Hardwood Plywood Manufacturers Association University of Pittsburgh Test Methodology

WOOD PRODUCT DIMENSIONS

Wood Product	Length (inch)	Width (inch)	Thickness (inch)
Lauan Plywood- PVC Laminate	48	12	0.23

LC₅₀ Value and its Confidence Interval

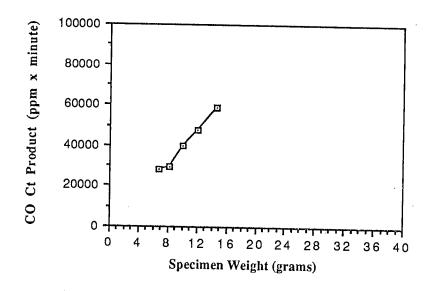
Wood Product	LC50 Value	95% Confi	dence Interval
	(grams)	Low Value	High Value
Lauan Plywood- PVC Laminate	9.5	8.7	10.5
			_1

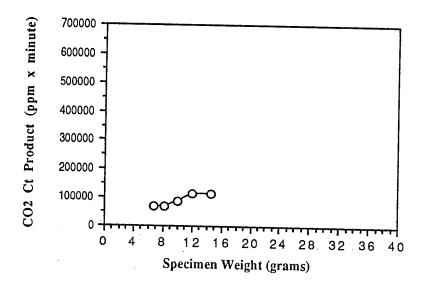
Lauan Plywood - PVC Laminate

Lest Seguence						
201120 201	lest	Testo	Toc+2			
Specimen Weight (grams)	10.00		2 162	lest 4	Test 5	
Maximum Chamber T.	00:01	12.10	8.26	. 83	7777	
maximum Chamber Temperature (°C)	37.98	16.00		20.0	14.64	
Maximum Furnace Temperature (oc)	0 100	27.04	40.6	36.3	39 78	
Weinh I am for	627.3	830.5	829.8	844.0		
weight Loss (%)	73.1	76.9	17.0	0.1.0	830.3	
Minimum Oxygen Concentration (%)	000	6:27	5.//	72.8	75.3	
700	00.61	19./3	00.00	0 + 00		
maximum CO Concentration (ppm)	6118	7830	21.21	20.16	19.61	_
Maximum CO2 Concentration /	0 1 1 0	1000	4108	3966	0613	
meaning of concentration (ppm)	605/	7678	FAOE		50.00	
Number of Animals Exposed	-		2400	5199	7327	
Mimbor of Dead A.		4	4	7		
Maillact Of Dead Animals	ო			F	4	
Lethality (%)	75			0	4	
	0.7	001	C			
of Product for CO (ppm x min)	3964B			0	001	
Ct Product for CO2 /nam 2			29358	27817	50700	
mm x midd con in connection	85411	112245	70000	11013	30/00	
(C)	0.70		10000	68466	113514	
	240	230	000	2 3 3		

New York State Data

Number of Samples Tested	Lauan Plywood - PVC Laminate
Furnace Temperature at 1% Sample Mass Law (90)	5
Maximal Concentration of Carbon Managed to 15 17	230
	6118
Concentration of Carnon Diavide in the D.	483
The rest of the roll of Maximal Contract to the contract of th	0.61
The Contentration of Oxygen in the Evansura Ct.	676
difface remperature at the Point of Minimus Co.	19.8
tumber of times the Exposure Chambar Tomas to	484
	0
eye Condition of Test Animals: (1) All apparently normal,	0
(2) Some appparent damage, (3) Some severe damage	2





Hardwood Plywood Manufacturers Association University of Pittsburgh Test Methodology

SIGNATURE PAGE

Prepared by,

James C. Norris, Ph.D. Toxicologist

THE WEYERHAEUSER FIRE TECHNOLOGY LABORATORY AUTHORIZES THE CLIENT NAMED HEREIN TO REPRODUCE THIS REPORT ONLY IF REPRODUCED IN ITS ENTIRETY.

APPENDIX D

LC₅₀ VALUES OF PARTICLEBOARDS USING THE UNIVERSITY OF PITTSBURGH TOXICITY TEST APPARATUS

FIVE PARTICLEBOARDS

Weyerhaeuser FIRE TECHNOLOGY LABORATORY

P.O. BOX 188 LAB B LONGVIEW, WA 98632

Report on:

LC₅₀ VALUES OF PARTICLEBOARDS

USING THE UNIVERSITY OF

PITTSBURGH TOXICITY TEST

APPARATUS

Conducted on:
FIVE PARTICLEBOARDS

Conducted for:
RICH MARGOSIAN
NATIONAL PARTICLEBOARD
ASSOCIATION
18928 PREMIERE COURT
GAITHERSBURG, MD 20879

Completed on: December 30, 1988

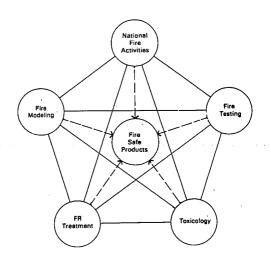


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National Particleboard Association University of Pittsburgh Test Methodology

Graphs: Car	bon D	ioxid	e Ct Product vs the Specimen Weight	20
Figu	re 6:	"A"	Particleboard	21
Figu	re 7:	"B"	Particleboard	21
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Figu	e 9:	"D"	Particleboard	22
Figur	e 10:	"E"	Medium Density Fiberboard	. 23

National Particleboard Association University of Pittsburgh Test Methodology

NOTICE

This test method is intended to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or the fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.

INTRODUCTION

Five particleboards were received from various members of National Particleboard Association for testing. The toxic potency values or LC₅₀ values for these wood products were determined using the University of Pittsburgh (UPITT) test procedure as described in Article 15 Part of the New York State Uniform Fire Prevention and Building Code [1].

This report includes dimensions of the particleboards, test methodology, and the

test results.

METHOD

The protocol used is published under Article 15 of the New York State Uniform Fire Prevention and Building Code [1]. The LC₅₀ values and their confidence intervals

were calculated by the Weil method [2].

The UPITT apparatus consisted of a Lindberg furnace (Pittsburgh, PA) connected to an animal exposure chamber. Within the furnace there was a weight load cell upon which the specimen was placed. There was an air flow of eleven (11) liters/minute proceeding from the furnace toward the animal exposure chamber. That air flow was mixed, cooled and diluted with nine (9) liters/minute of cold air (~15°C) before being presented to the animals. The furnace temperature was ramped 20° C/minute. The furnace, however, was not connected to the animals exposure chamber until the specimen had loss 1% of its weight as indicated by the weight load cell. The time at which this occurred was the beginning of the thirty (30)-minute animal exposure. The animal exposure chamber simultaneously housed four (4) male Swiss-Webster mice (Simenon Laboratories, Inc.; Gilroy, CA) in a head-only exposure mode. The decomposition products passed to gas analyzers (carbon monoxide, carbon dioxide and oxygen) after being presented to the animals. The apparatus and protocol were according to the methodology of New York State Protocol [1].

Procedurally, a ten (10)-gram quantity of the material was placed in the furnace after which the ramping of the furnace started. At the 1% weight loss, the animal exposure chamber was connected to the furnace. After the thirty (30)-minute exposure was completed, the animals were observed for an additional ten (10) minutes. Any deaths occurring during these forty (40) minutes were used in the determination of the LC₅₀ value. If all the animals died with the ten (10) grams, the next experiment would be with a lower weight. If no animals died, then a higher weight would be used in the next experiment.

That next weight would be determined by a geometric factor. The geometric factor was necessary because of the statistical procedure [2] used for determining the LC_{50} values. This factor (for example, 1.1) would be multiplied by the weight to determine the next higher weight, or the weight would be divided by the factor to determine the next lower weight. Using this statistical procedure, four consequent weights (spaced by the geometric factor along with the corresponding deaths as required by the tables supplied in the reference) were needed to determine an LC_{50} value.

A program was written for a Macintosh® Plus Computer in conjunction with a Fluke 2400A (A/D and D/A measurement and control link) to specifically operate this apparatus. Ramping of the furnace was accomplished by the Macintosh® monitoring the furnace temperature and varying the power supply to the furnace. The specimen weight, the percent of weight loss, concentrations of carbon monoxide (CO), carbon dioxide (CO₂)

and oxygen (O_2) , time (from the initiation of ramping and from the 1% weight loss), temperatures of the furnace and chamber, and the difference between the actual and theoretical furnace temperatures were displayed on the computer monitor during the experiment as well as recorded on a diskette. The O_2 gas analyzer was a Servomex O_2 Analyzer OA 580 (Sybron/Taylor), and the CO/CO₂ analyzer was a Dual Gas Analyzer (Infrared Industries, Inc.)

In order to confirm that there were no leaks in the system and that the pump, air flow and flowmeters were operating properly, the flow rates of nine (9) and twenty (20) liters/minutes were tested prior to each test with a Mini-Buck Calibrator (A.P. Buck, Inc., Orlando, FL). This flowmeter is traceable to the National Institute of Standards and Technology (formerly National Bureau of Standards). Calibration of the CO and CO₂ analyzers was performed with calibration gases (CO - 0.9% and CO₂ - 5%) certified by Alphagaz Division (Tacoma, WA). The O₂ analyzer was calibrated with room air.

TEST RESULTS

The LC₅₀ values and their confidence intervals are presented in Table 1. A number of parameters are reported in summary tables (Table 2-6), such as the minimum oxygen concentration, the maximum carbon monoxide and carbon dioxide concentrations, the maximum animal exposure chamber temperature, the maximum furnace temperature, and the percentage of the specimen weight. Tabulation of the data required by New York State is included (Table 7). These data are from a specimen weight close to the LC₅₀ value. The concentration-time (Ct) products for carbon monoxide (Figures 1-5) and carbon dioxide (Figures 6-10) plotted vs the specimen weight are presented for each of the five products. [This Ct product is a value calculated by multiplying the gas concentration, such as carbon monoxide, with the time of animal exposure to the gas concentration. In other words, it is the area under the curve of the gas concentrations vs time.]

REFERENCES

- 1. Article 15, Part 1120 -- New York State Fire Prevention and Building Code. New York Standards & Fire Information Network, Office of Fire Prevention and Control. Albany, NY.
- 2. Weil, C.S., Tables For Convenient Calculation Of Median-Effective Dose (LC₅₀ or ED₅₀) And Instructions In Their Use. *Biometrics* 8: 249-263, 1952.

SAMPLE PREPARATION

These wood products were stored in a conditioning room $(23.8 \pm 2.8^{\circ})$ C and $50 \pm 10\%$ Relative Humidity) for at least 48 hours prior to testing. Each specimen placed in the furnace was a piece of a wood product cut to a specific weight.

WOOD PRODUCT DIMENSIONS

Wood Product	Length (inch)	Width (inch)	Thickness (inch)
"A" Particleboard	24	24	0.75
"B" Particleboard	24	24	1.50
"C" Particleboard	24	24	0.75
"D" Particleboard	24	24	0.63
"E" Medium Density Fiberboard	24	24	0.75

Table 1: LC₅₀ Values and their Confidence Intervals

Wood Product	LC50 Value	95% Confide	Confidence Interval				
LAU D.	(grams)	Low Value	High Value				
A" Particleboard	9.79	7.93	12.09				
B" Particleboard	15.00	13.11	17 17				
C" Particleboard	12.40	8.47	18 16				
D" Particleboard	11.07	9.73	12.59				
E" Medium Density Fiberboard	13.21	11.96	14.59				

SUMMARY TABLES

"A" Particleboard

Test Comence	E				
annahar isa	l test l	Test 2	Test 3	Tect 4	Tores
Specimen Weight (grams)	14.00	0 1/		1 100	16317
- 1	14.77	0.10	6/.6	11.74	14.00
Maximum Chamber Temp (°C)	49.3	6 47 2	11		\0.F.
Marimum Furnace Town 1001	200	7:11	+	74.9	48.8
d'''2 1 2	803.6	850.7	817.8	8154	872 6
Weight Loss (%)	79.79	76.1	00 00		0.5.7.0
Minimum Orngon (Oc)	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	7.0.1	00.00	C.76	65.22
Strumming Oxygen (10)	19.38	20.15	19.81	10 77	10.50
Maximum CO Concentration (nnm)	8888	4100	1400	17:11	17.30
21	0000	4100	4482	6425	8152
Maximum CO2 Concentration (ppm)	8401	4735	5420	1177	2010
Number of Animals Franced			0710	0041	/019
		4	4	4	7
Number of Dead Animals	,		C	.,	-
% Lothality		٥	7	4	7
in principle	•	0	20	130	20
CI Froduct for CO (ppm x min)	51655.44	65 02096	20/00/41	20076	3
Ct Product for CO2 (nnm x min)	154050 25	100570	14.024.7	20003	46510.56
(100) 1011	134036.23	102236.68	100604.13	122544.77	138721.95
(0) (7)	211.2	255.8	221.2	2218	2200
			1	144	- ·

'B" Particleboard

s sequence	Test	Test 2	Test 3	Test 4	Thet 5	Tect 6	Toct 7
Specimen Weight (grams)	10.00	1240	13.64	11 27	12.61	200	1531
Marinim Chamber Town 100)	107	2	12:01	11.2/	10.01	10.01	10.01
maximum Chamber 1emp (-C)	7.7	43.5	41.7	39.8	46.2	308	20.7
Maximum Furnace Temp (°C)	881.1	877.2	8750	1260	0 0 0 0		
Woight Lose (02)	1, 7, 2		7:7:0	4.070	0.040	845.9	846.7
11 cigni 12033 (70)	1.0/	83.7	84.4	88.3	814	83.0	0.08
Minimum Oxygen (%)	19 99	10 55	10 50	17540	100	0.00	2.00
Maximum CO Co.	2002	17:33	12.32	17.74	19.00	18.23	18.67
maximum co concentration (ppm)	2092	6803	2986	5414	6693	6440	8916
Maximum CO2 Concentration (ppm)	1299	8288	10001	6008	2002		0100
Number of Animale Errocad			10701	0022	1001	7344	11084
ramoer of animais tryposed	>	4	4	4	7	4	V
Number of Dead Animals	•		3			,	,
To I othality		20		-	>	2	•
of the second of		77	2	25	0	75	75
Ct Froduct for CO (ppm x min)	33572	43402	44799	35126	11762	75770	01777
Ct Product for CO2 (nnm x min)	127606	171200	100100	22.120	41/02	4,7440	04410
TIM (00)	000/61	1/12%	774074	155/30	152282	177176	188365
(7) %11	569	270	270	270	240	070	OVC
					7		1

"C" Particleboard

	Tect 6	1531	17.71	44 07	010	717.9	759	0,00	70.61	0000	0,5	8994		4	6	7	<u></u>	2	42898	140000	147220	(
	Test 5	1264	13.04	40.02	012/	713.4	81.1	10.00	17.29	11320	1000	9/101	~	†	2		2	61670	0/CIC	171722	1/14/3	210
	lest 4	15.01	10.01	42.15	911 01	10.11	17.61	10.7	17:5	12483	10015	10945	P		4	, CO F	3	V00L3	7/00N	186380	00000	
F	1 est 3	10.25	10.04	40.71	918.6	00 1	00.1	19.76	0110	0/18	9019	0740	4		Ţ	25	67	37346	0+070	134359	010	=
Tect	1531 2	12.40	1571	47.74	918.7	1/8	+0	19.48	0217	7217	9124		4	C	7	- 05		47481	150.50	152599	210	
Tect 1	1 100 1	10.00	44.46	01:00	9.08.6	79.1		18.81	6147	(+10	6052		>			1	, 0000	30934	110724	110/24	300	2
lest Sequence	Specimen Woickt	Specimen Height (grams)	Maximum Chamber Temp (°C)	Maximum Furnoce Town (60)	Weight I amuse temp (C)	reign Loss (%)	Minimum Orvagn (Oc)	11	Maximum CO Concentration (nnm)	Marinim CO3 C	in an in the concentration (ppm)	Number of Animals Franced	M. I. C. S. S. S. S. S. C. A. D. S. C. A.	Number of Dead Animals	% Lethality		Ct Product for CO (nnm : min)	Giran Sol Co (ppin a min)	Ct Product for CO2 (nnm r min)	TIO 1001	(2) 0/11	

"D" Particleboard

Test 2 Test 3		-	837.7		100 renable	19.89	5718 data not saved	-		4	0 4	0 100	34441		77/01	2/2
Test 1	8.42	35.8	846.0	77.8	7000	70.04	4874	6837		4		25	32578	141835	2001	050
Test Sequence	Specimen Weight (grams)	Maximum Chamber Temp (°C)	Maximum Furnace Temp (°C)	Weight Loss (%)		~I	Maximum CO Concentration (ppm)	Maximum CO2 Concentration (vom)	Number of Animale Frances	Manager of Antimais Exposed	Number of Dead Animals	% Lethality		Ct Product for CO2 (ppm x min)	(TIO) (OC)	

"E" Medium Density Fiberboard

Test Sequence	T. 2. 1	E				
	I cst I	Test 7	Test 3	Test 4	Test 5	Tect 6
specimen Weight (grams)	10.00	10.25	07 01		1031	10310
Charles Charle	10.00	10.23	12.40	15.01	13.64	11 27
rullmum Chamber Temp (C)	41.53	43 67	301	04 (5000		17:71
Maximum Furnace Town (OC)	0 300	10:00	42.0	24.02000	40.05	40.06
(a) dura camina i i i	2.0%	9.968	898.2	896 40000	8 UU0	00 000
meigni Loss (%)	70 6	75.2	010	20000	0.00	022.20
Minimum Orvoon (Oc)	2.5.	7.3.3	61.3	81.20000	80.4	78.8
10/ Jagen (10)	19.68	20.18	19.62	10 50	10 56	10.77
Maximum CO Concentration (nnm)	5140	21/2	20:01	17.37	17.30	19.70
(mdd)	2140	2040	1211	8448	8176	6657
maximum CO2 Concentration (ppm)	5983	6814	10061	10073	0/10	1000
Number of Animals Franced		1700	10001	10003	7996	1 629
is of minutes traposed	>	4	4	4	_	
Number of Dead Animals		<		-	-	4
On I othality			=	4	7	_
	1	_	25	3	65	-
Ct Product for CO (nnm v min)	07000		7.7	37	2	22
Post of Control A min)	708/7	28396	35019	42521	38750	22161
CI Froduct for CO2 (ppm x min)	123524	13/1999	174040	7777	20122	10470
(Jo) %IL	1000	000+61	1/4940	185//0	167141	156285
	767	290	290	000	000	000
			1		5	

Table 7: New York State Data

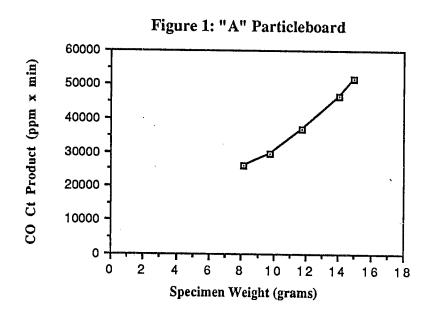
	"A" Particleboard I	"B" Particleboard	"A" Particleboard I "R" Particleboard "C" Particleboard	1"D. D	יביי וביי הייי בייי
Number of Complex Torted			C I districtional	D I AIRCICOCATU	E Medium Density Fiberboard
Named of Samples Lesten	S	_	9	7	Y
Turnace Temperature at 1% Sample Mass Loss (%)	200	0,0		<u> </u>	
Meriting Control of the Control of t	177	240	310	243	290
MAXIMAI Concentration of Carbon Monoxide in the Exposure Chamber (ppm)	4482	6449	9317	5718	8176
Furnace Temperature at the Point of Maximal Carbon Monoxide (°C)	45]	457	487	920	200
Maximal Concentration of Carbon Diovide in the Practice Chamber (#)	,,,		701	475	400
E TE TE TENTE CHI TO THE TENTE CHI THE THE TENTE CHI THE T	0.0	0.93	0.91	0.61	16.0
Furnace 1 emperature at the Point of Maximal Carbon Dioxide (°C)	534	444	482	70,	707
Minimal Concentration of Overson in the Dynamic Chamber (m)			700	420	463
$\sim \sim $	8.61	18.2	19.5	10 0	901
Furnace Temperature at the Point of Minimal Oxygen (°C)	485	1460	767		12.0
Number of Times the Persons Chamber T.	2	107	400	4.20	488
Children of Thines the Exposure Chamber remperature Exceeded 45°C	0	0	-	2	
Average Duration of Exposure Chamber Temperature in excess of 45°C (sec)	c	-	1,2	1	
Fre Condition of Test Animales (1) All annually		3	*,	14	0
The continuous of the following the state of	-			_	
(2) Some appparent damage, (3) Some severe damage		*		4	•

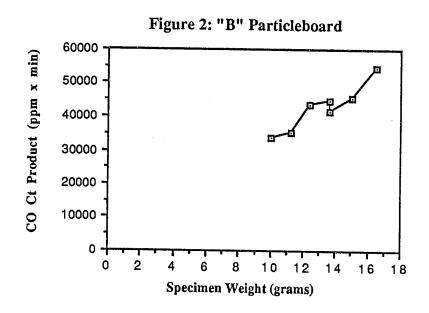
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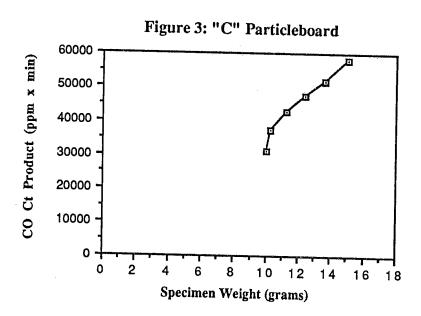
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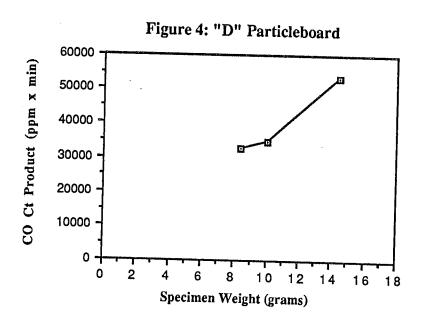
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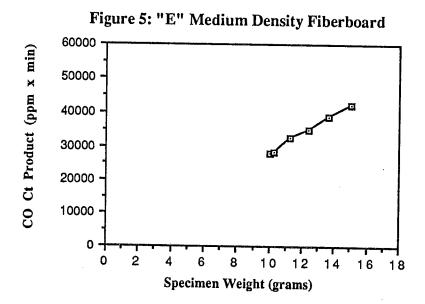
THE SPECIMEN WEIGHT











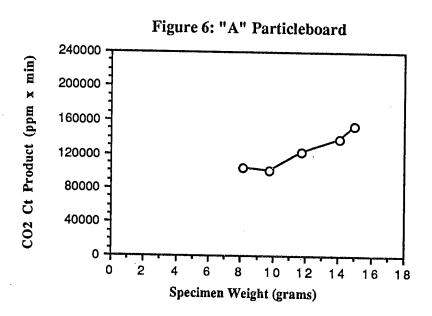
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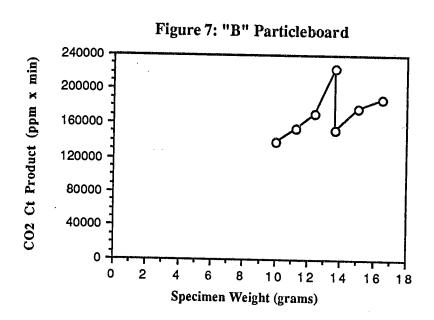
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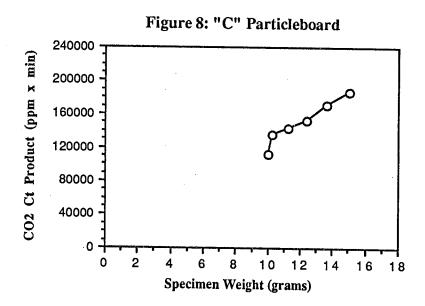
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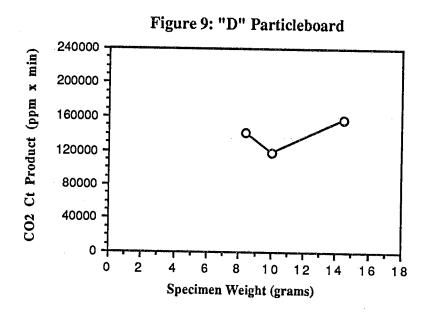
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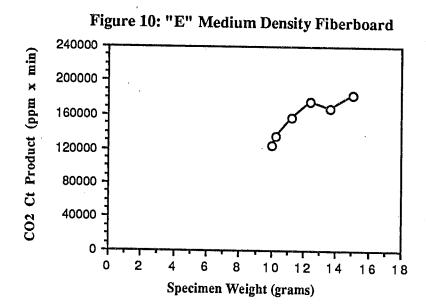
THE SPECIMEN WEIGHT











WEYERHAEUSER FIRE TECHNOLOGY LABORATORY

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Toxicologist

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APPENDIX E

LC₅₀ VALUES OF WOOD PRODUCTS
USING THE UNIVERSITY OF PITTSBURGH
TOXICITY TEST APPARATUS

FOUR WOOD PRODUCTS



P.O. BOX 188 LAB B LONGVIEW, WA 98632

LC₅₀ VALUES OF WOOD PRODUCTS
USING THE UNIVERSITY OF
PITTSBURGH TOXICITY TEST
APPARATUS

Conducted on:
FOUR WOOD PRODUCTS FOR
GENERIC CLASSIFICATION

Conducted for:
ROBERT W. GLOWINSKI
NATIONAL FOREST PRODUCTS
ASSOCIATION
1250 CONNECTICUT AVENUE
WASHINGTON, DC 20036

Completed on: June 27, 1989

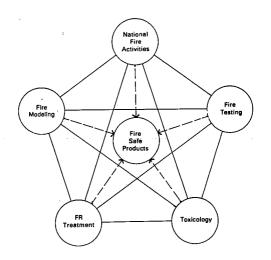


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Signature	Pag	e	• • • • • • • •	• • • • • • • • • • • • • • • • • • • •		• • • • • • •		.21

NOTICE

This test method is intended to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or the fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.

INTRODUCTION

Wood products were received from members of National Forest Products Association for testing. These wood products do not necessarily represent any one product, but were made for a generic classification scheme for presentation to the state of New York. (The abbreviations, CCA, PVC and UF representing chromium/copper/arsenic, polyvinyl chloride, and urea formaldehyde, respectively, are used in conjunction with the wood products.) The toxic potency values or LC50 values for these wood products were determined using the University of Pittsburgh (UPITT) test procedure as described in Article 15 Part of the New York State Uniform Fire Prevention and Building Code [1].

This report includes dimensions of the wood products, test methodology, and the

test results.

METHOD

The protocol used is published under Article 15 of the New York State Uniform Fire Prevention and Building Code [1]. The LC₅₀ values and their confidence intervals

were calculated by the Weil method [2].

The UPITT apparatus consisted of a Lindberg furnace (Pittsburgh, PA) connected to an animal exposure chamber. Within the furnace there was a weight load cell upon which the specimen was placed. There was an air flow of eleven (11) liters/minute proceeding from the furnace toward the animal exposure chamber. That air flow was mixed, cooled and diluted with nine (9) liters/minute of cold air (~15°C) before being presented to the animals. The furnace temperature was ramped 20° C/minute. The furnace, however, was not connected to the animals exposure chamber until the specimen had loss 1% of its weight as indicated by the weight load cell. The time at which this occurred was the beginning of the thirty (30)-minute animal exposure. The animal exposure chamber simultaneously housed four (4) male Swiss-Webster mice (Simenon Laboratories, Inc.; Gilroy, CA) in a head-only exposure mode. The decomposition products passed to gas analyzers (carbon monoxide, carbon dioxide and oxygen) after being presented to the animals. The apparatus and protocol were according to the methodology of New York State Protocol [1].

Procedurally, a ten (10)-gram quantity of the material was placed in the furnace after which the ramping of the furnace started. At the 1% weight loss, the animal exposure chamber was connected to the furnace. After the thirty (30)-minute exposure was completed, the animals were observed for an additional ten (10) minutes. Any deaths occurring during these forty (40) minutes were used in the determination of the LC_{50} value. If all the animals died with the ten (10) grams, the next experiment would be with a lower weight. If no animals died, then a higher weight would be used in the next experiment.

That next weight would be determined by a geometric factor. The geometric factor was necessary because of the statistical procedure [2] used for determining the LC_{50} values. This factor (for example, 1.1) would be multiplied by the weight to determine the next higher weight, or the weight would be divided by the factor to determine the next lower weight. Using this statistical procedure, four consequent weights (spaced by the geometric factor along with the corresponding deaths as required by the tables supplied in the reference) were needed to determine an LC_{50} value.

A program was written for a Macintosh® Plus Computer in conjunction with a Fluke 2400A (A/D and D/A measurement and control link) to specifically operate this apparatus. Ramping of the furnace was accomplished by the Macintosh® monitoring the furnace temperature and varying the power supply to the furnace. The specimen weight, the percent of weight loss, concentrations of carbon monoxide (CO), carbon dioxide (CO2) and oxygen (O2), time (from the initiation of ramping and from the 1% weight loss), temperatures of the furnace and chamber, and the difference between the actual and theoretical furnace temperatures were displayed on the computer monitor during the experiment as well as recorded on a diskette. The O2 gas analyzer was a Servomex O2 Analyzer OA 580 (Sybron/Taylor), and the CO/CO2 analyzer was a Dual Gas Analyzer (Infrared Industries, Inc.)

In order to confirm that there were no leaks in the system and that the pump, air flow and flowmeters were operating properly, the flow rates of nine (9) and twenty (20) liters/minutes were tested prior to each test with a Mini-Buck Calibrator (A.P. Buck, Inc., Orlando, FL). This flowmeter is traceable to the National Institute of Standards and Technology (formerly National Bureau of Standards). Calibration of the CO and CO₂ analyzers was performed with calibration gases (CO - 0.9% and CO₂ - 5%) certified by Alphagaz Division (Tacoma, WA). The O₂ analyzer was calibrated with room air.

TEST RESULTS

The LC₅₀ values and their confidence intervals are presented in Table 1. A number of parameters are reported in summary tables (Table 2-5), such as the minimum oxygen concentration, the maximum carbon monoxide and carbon dioxide concentrations, the maximum animal exposure chamber temperature, the maximum furnace temperature, and the percentage of the specimen weight. Tabulation of the data required by New York State is included (Table 6). These data are from a specimen weight close to the LC₅₀ value. The concentration-time (Ct) products for carbon monoxide (Figures 1-4) and carbon dioxide (Figures 5-8) plotted vs the specimen weight are presented for each of the four products. [This Ct product is a value calculated by multiplying the gas concentration, such as carbon monoxide, with the time of animal exposure to the gas concentration. In other words, it is the area under the curve of the gas concentrations vs time.]

REFERENCES

- 1. Article 15, Part 1120 -- New York State Fire Prevention and Building Code. New York Standards & Fire Information Network, Office of Fire Prevention and Control. Albany, NY.
- 2. Weil, C.S., Tables For Convenient Calculation Of Median-Effective Dose (LC₅₀ or ED₅₀) And Instructions In Their Use. *Biometrics* 8: 249-263, 1952.

SAMPLE PREPARATION

These wood products were stored in a conditioning room (23.8 \pm 2.8° C and 50 \pm 10% Relative Humidity) for at least 48 hours prior to testing. Each specimen placed in the furnace was a piece of a wood product cut to a specific weight.

WOOD PRODUCT DIMENSIONS

Wood Product	Length (inch)	Width (inch)	Thickness (inch)
Southern Pine Lumber- 20% Fire Retardant	12	5.5	1.5
Southern Pine Lumber- 2.7% CCA	48	24	1.53
Southern Pine Particleboard- 10% PVC	20.5	12.5	0.21
Southern Pine Particleboard- 15% UF	21	13	0.51

Table 1: LC₅₀ Values and their Confidence Intervals

Wood Product	LC50 Value	95% Confid	lence Interval
Southern Pine Lumber- 20% Fire Retardant	(grams) 71.7	Low Value 57.3	High Value 89.7
Southern Pine Lumber- 2.7% CCA	45.9	40.2	52.6
Southern Pine Particleboard- 10% PVC	12.1	9.6	15.3
Southern Pine Particleboard- 15% UF	15.0	13.7	16.4

SUMMARY TABLES

Table 2: Southern Pine Lumber - 20% Fire Retardant

Sperimen Woinht /promet			2 (53)	1001	6250	lest 6	Tact 7	100		
Ten mergin (giants)	10.00	17.72	49.3	8.26	12.40	22.23		0 (23)	lest y	- SE 10
taximum Chamber Temperature (°C)	39.3	38.6	11.5	350	16.10	22.60	98.49	81.40	67.27	2144
(aximum Furnace Temperature (°C)	853.5	840 6	061.2	20.0	36.2	41.5	45.8	44.2	45.5	37.0
Weight Loss (%)	63.5	59.2	25.25	50.0	850.3	854.0	853.4	848.1	850.0	828 5
inimum Oxygen Concentration (%)	20.17	19.11	20.00	20.50	20.54	59.3	61.7	61.7	64.5	61.7
faximum CO Concentration (ppm)	4109	4417	4720	2000	50.51	16./1	17.51	17.33	17.29	18 85
faximum CO2 Concentration (ppm)	5893	14374	5203	2630	4489	6622	5822	7417	9724	5951
tumber of Animals Exposed	4	*	7	2 144	4283	27025	32775	30280	33101	15232
Number of Dead Animals	0	6	C	,	4 6	4	4	4	•	4
ethality (%)	0	0	c		0		4	2	2	0
? Product for CO (ppm x min)	30965	14 788	25563	125.00	20,00	62	100	50	50	0
Ct Product for CO2 (ppm x min)	61080	93626	62930	46901	2250	24914	34267	24079	30012	2042
(-C)	250	250	250	0.00	2520	324518	446726	425488	400901	116058
		25.3	2.30	062	250	252	250	0,0		

Test Sequence	. Issi 11	Tect 12	Toes 12	1001
Specimen Weight (grame)	70 30		20.00	41 153
	4.53	31.38	3/.9/	45.95
Maximum Chamber Temperature (°C)	37.8	38.0	36.5	376
Maximum Furnace Temperature (°C)	546.4	850 Q	840.9	6,000
Weight Loss (%)	6,2		31.51.5	949.5
Line of the second	4.	2.70	59.1	58.9
million Oxygen Concentration (%)	16.46	18.47	19.41	18.9
Maximum CO Concentration (ppm)	5217	7053	37.20	2000
Mariana COS Concession			67.5	06.50
midd lightering the mount of the	19/35	20879	14158	16289
Number of Animals Exposed	4	¥	7	
Wimber of Dood Animals	ľ		,	4
Ciprinitial Dead to the same	0		٥	0
remonth (%)	0	25	_	
Ct Product for CO foom x min)	10000	00000	3.3.	
C' Dead of far Con	2635	25.230	18502	18321
CI LIDORE IN COZ (DOM X MIN)	149875	166578	158422	18262B
(7% (°C)	250	250	.050	250
				3

Table 3: Southern Pine Lumber - 2.7% CCA*

lest Sequence	Test 1	Test2	Tect3	Toet	72.65		
Specimen Weight (grame)	0000		2122	+ 1631	c isa	93.6	Test 7
Singly Heryin (Signis)	10.00	1/./1	25.94	45.95	55.60	27.03	
Maximum Chamber Temperature (°C)	40.25	7.36	2 30	3,3,7	20.00	18.70	31.38
University of the second secon	22.52	7.00	30.3	40.6	40.75	40.5	36 80
maximum rumace temperature (°C)	851.0	850.9	853.2	848 4	853.8	0.40	60.00
Weight Loss (%)	76.2	70.6	77.0		0.000	546.3	851.3
	7.0.	0.57	0.//	6.//	76.2	76.8	77.5
minimum Oxygen Concentration (%)	18.34	16.75	16.28	74 77	1200	200	5.77
Maximum CO Concentration (nom)	0 1 2 2	0,00			13.33	15.20	15.46
יייי ביייי ביייי ביייי ביייי ביייי ביייי	3010	6343	8804	6686	12015	10001	0101
Maximum CO2 Concentration (ppm)	16135	33507	39128	FEBOO	2000	10204	6/3/
Number of Animals Expand	,		27.22	33055	18280	50266	48003
Compet of Amiliais Caposed	4	4	7	7	y	,	
Number of Dead Animals	0	c	-	*	,	4	4
Lethality (%)	0		3		4		0
	Ċ	0	-	25	C C	25	
Cf Product for CO (ppm x min)	20851	67666	24120	20000	177.00	6.3	0
Ct Product for CO2 (nom v min)	00000	100000	27 120	77767	4841/	26523	22045
יייי אייייי אייייי איייייי	153030	746807	353471	574571	686644	033267	10000
(2°) %(1)	250	250	250	C L C		20/00	429265
		223	200		250	C L C	

*CCA - chromium / copper / arsenic

Table 4: Southern Pine Particleboard - 10% PVC*

Test Sequence	Test 1	Test 2	Test 3	Toct A	Tocate
Specimen Weight (grams)	10.00	12.10	14 64	17.72	0 00 0
Marimum Chamber Temperature (oc)	7 70		10.1	11.16	07.0
maximum Chambel Temperature (-C)	3/.4	47.4	49.9	40.0	44.4
Maximum Furnace Temperature (°C)	821.2	827.5	820.5	820.0	816.2
Weight Loss (%)	70.6	78.3	79.3	75.6	75.5
Minimum Oxygen Concentration (%)	19.71	19.65	19.74	40.05	0.07
Waximum CO Concentration (nem)	50.45	2007	1000	19.00	20.19
	5340	1007	/965	10754	3720
Maximum CO2 Concentration (ppm)	5082	6427	6069	8063	1611
Number of Animals Exposed	4	4			
Number of Dead Animals	•		1 0	4	4
		7	5	יני	0
Lethality (%)	25	50	75	75	
Ct Product for CO (ppm x min)	32237	40538	42857	58702	25504
Ct Product for CO2 (ppm x min)	77047	103800	124014	400407	27,104
T40/ /cC1		0.2005	1047	129621	/1468
17% (2)	220	230	220	220	220

*PVC - polyvinyl chloride

Table 5: Southern Pine Particleboard - 15% UF

/ pot Spallence	-					
	l isa	lest 2	Test 3	Tect A	7004	, T
Specimen Weight (grams)	10.00	10 4		1001	C ISA	d ISB I
	0.0	17.11	15.01	13.64	16.51	12.40
Maximum Chamber Temperature (°C)	32.0	37 E	40.6	33,	20:0	14.40
Maximire Europe Tomporature (60)	0.000	2:15	40.0	42.2	41.4	333 1
meaning i gillace Telliperature (-C)	826.8	826.7	827.4	8187	010.0	0.00
Weight Loss (%)	84.4	75.3	70.6	200	2.610	818.8
Minimum Oxygen Concentration 19/1	0000	200	73.0	80.8	6.//	80.0
(o) 1101111111111111111111111111111111111	20.03	18.26	19.45	10.48	47.40	
Maximum CO Concentration (ppm)	5215	7500	0,00	01.0	17.13	19.4
Maximum COO Committee	200	6007	3042	8327	11284	7930
meaning cos concentration (ppm)	8824	8267	10000	0.477		2001
Number of Animals Exposed	V	,	22001	24//	12850	98//
	r	4	4	4		Y
Number of Dead Animals	y	C	c			ţ
Lethality (%)	3.0		0	D	m	0
	5.3	O	75	c	75	
Ct Product for CO (ppm x min)	29179	38570	17107	, = 0 0 ,	67	O
Of Broduct for COS /z== = ===		0.000	4/47/	400/1	53008	38622
Strong for COZ (ppin x min)	0/9/11	133017	142731	434000	0.000	77000
(°C)	220	000		207101	60818	114892
	6.60	720	220	200	000	000

*UF = Urea Formaldehyde

Table 6: New York State Data

	Southern Pine I makes 200 Ein not	Š
Number of Samples Tested	11 POR LEGISLAND - 20 M I DC NCIALUAINI	Southern Pine Lumber - 2.7% CCA
Furnace Temperature at 1% Sample More Very	44	
Maximal Concentration	250	250
Grading Concentration of Carbon Monoxide in the Exposure Chamber (ppm)	9779	007
		9899
The Target of the Control of the Con	525	501
Firmace Temporalise of the Division in the Exposure Chamber (%)	3.31	85 5
Street artificiation of Maximal Carbon Dioxide (°C)	540	053
Minimal Concentration of Oxygen in the Exposure Chamber (2)	7.5	700
Furnace Temperature at the Point of Minimal Owners (20)	17.3	14.8
Number of Times the Evacuation of Control of Times the Evacuation	551	518
Average Duration of Evacuation		C
Fve Condition of Tree Chamber Temperature in Excess of 45°C (sec)	36	
De Condition of lest Animals: (1) All apparently normal.		
(2) Some appparent damage, (3) Some severe damage	_	-
	a id	
Number of Samples Tested	Southern Pline Particle board - 10% PVC	Southern Pine Particle board - 15% UF
Sample Mag	5.	9
Maxima Concontration of Other Mass Loss (C)	220	220
=1	7001	0442
Maximal Carbon Monoxide (°C)	450	7507
Charling Concentration of Carbon Dioxide in the Exposure Chamber (%)	0.64	100
villace remperature at the Point of Maximal Carbon Dioxide (°C)	452	
Minimal Concentration of Oxygen in the Exposure Chamber (%)	201	496
Furnace Temperature at the Point of Minimal Owigan (cox	13.7	19.5
Number of Times the Evrosure Chamber Transfer (C)	451	504
Average Duration of Exposure Chamber Transportation & Steedage 45 C		0
Eve Condition of Test Animals, (1) An	415	O
(2) Some appparent damage (3) Some contract.	2	2
(c) come sever compage		

Carbon Monoxide Ct Product

V S

Specimen Weight

Figure 1: Southern Pine Lumber - 20% Fire Retardant

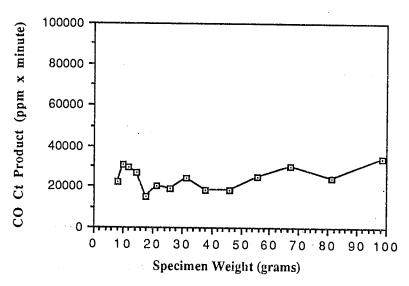
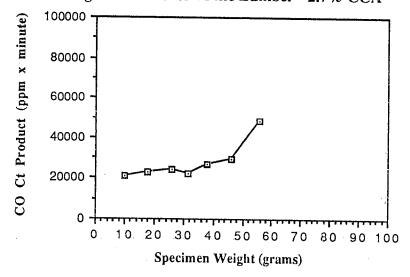


Figure 2: Southern Pine Lumber - 2.7% CCA



CO Ct Product (ppm x minute)

20000

Figure 3: Southern Pine Particleboard - 10% PVC

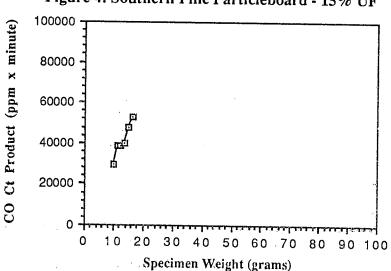
100000

80000 - 600000 - 60000 - 60000 - 60000 - 60000 - 60000 - 60000 - 60000 - 600000 - 600

Figure 4: Southern Pine Particleboard - 15% UF

Specimen Weight (grams)

10 20 30 40 50 60 70 80 90 100



Carbon Dioxide Ct Product

 $\mathbf{v}\mathbf{s}$

Specimen Weight

Figure 5: Southern Pine Lumber - 20% Fire Retardant

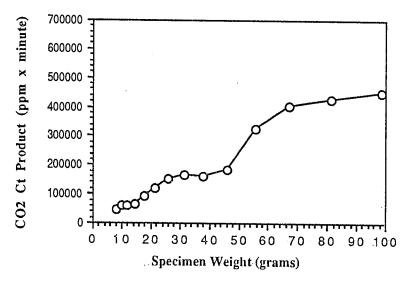
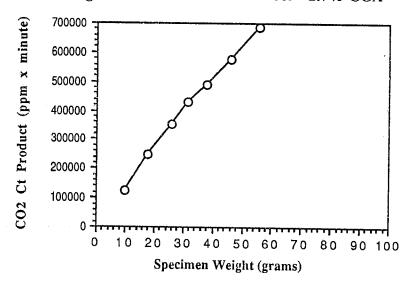
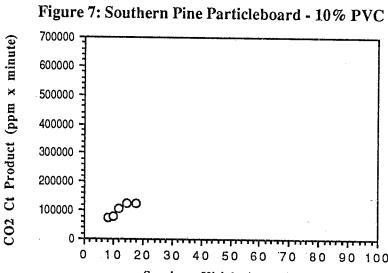
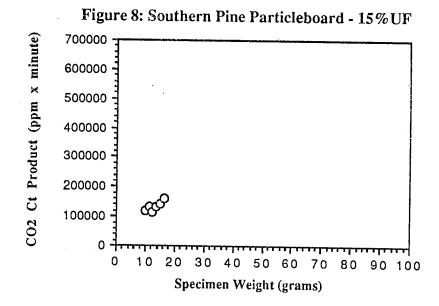


Figure 6: Southern Pine Lumber - 2.7% CCA





10 20 30 40 50 60 70 80 90 100 Specimen Weight (grams)



SIGNATURE PAGE

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Toxicologist

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