Appendix B

Weyerhaeuser

FIRE TECHNOLOGY LABORATORY

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

Report on:

LC_{50} VALUE OF A LAUAN PLYWOOD USING THE UNIVERSITY OF PITTSBURGH TOXICITY TEST APPARATUS

Conducted on:

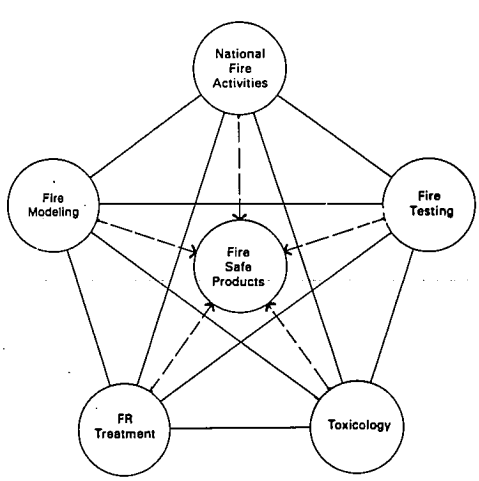
LAUAN PLYWOOD WITH A POLYVINYL CHLORIDE LAMINATE

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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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 LC_{50} 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 (CO_2) 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/CO_2 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 CO_2 analyzers was performed with calibration gases (CO - 0.9% and CO_2 - 5%) certified by Alphagaz Division (Tacoma, WA). The O_2 analyzer was calibrated with room air.

TEST RESULTS

The LC_{50} 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 LC_{50} 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 (LC_{50} or ED_{50}) And Instructions In Their Use. *Biometrics* 8: 249-263, 1952.

SAMPLE PREPARATION

This plywood was stored in a conditioning room (23.8 ± 2.8° C and 50 ± 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)
Lauan Plywood-PVC Laminate	48	12	0.23

LC_{50} Value and its Confidence Interval

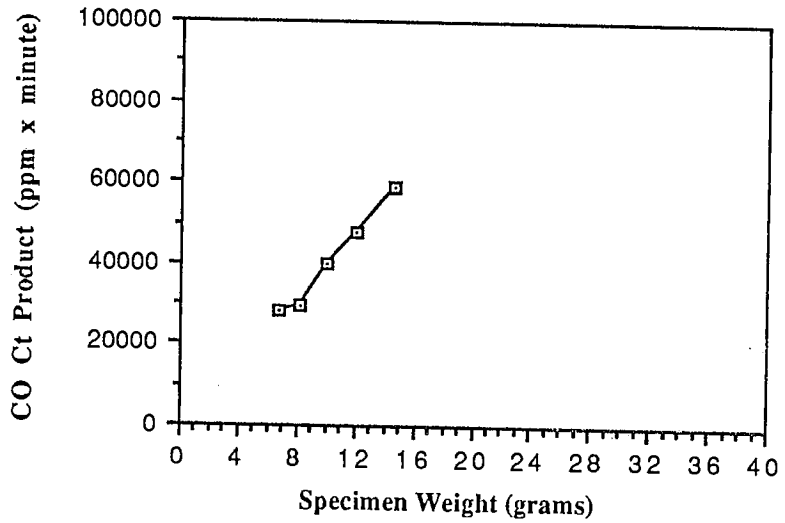
Wood Product	LC50 Value (grams)	95% Confidence Interval	
		Low Value	High Value
Lauan Plywood-PVC Laminate	9.5	8.7	10.5

Lauan Plywood - PVC Laminate

Test Sequence	Test 1	Test 2	Test 3	Test 4	Test 5
Specimen Weight (grams)	10.00	12.10	8.26	6.83	14.64
Maximum Chamber Temperature (°C)	37.98	46.23	40.6	36.3	39.78
Maximum Furnace Temperature (°C)	837.9	830.5	829.8	841.3	830.3
Weight Loss (%)	73.1	76.9	77.3	72.8	75.3
Minimum Oxygen Concentration (%)	19.80	19.73	20.19	20.16	19.61
Maximum CO Concentration (ppm)	6118	7830	4108	3966	9613
Maximum CO2 Concentration (ppm)	6057	7678	5486	5199	7327
Number of Animals Exposed	4	4	4	4	4
Number of Dead Animals	3	4	0	0	4
Lethality (%)	75	100	0	0	100
Ct Product for CO (ppm x min)	39648	47996	29358	27817	58780
Ct Product for CO2 (ppm x min)	85411	112245	70833	68466	113514
T1% (°C)	240	230	230	235	230

New York State Data

	Lauan Plywood - PVC Laminate
Number of Samples Tested	5
Furnace Temperature at 1% Sample Mass Loss (°C)	230
Maximal Concentration of Carbon Monoxide in the Exposure Chamber (ppm)	6118
Furnace Temperature at the Point of Maximal Carbon Monoxide (°C)	483
Maximal Concentration of Carbon Dioxide in the Exposure Chamber (%)	0.61
Furnace Temperature at the Point of Maximal Carbon Dioxide (°C)	676
Minimal Concentration of Oxygen in the Exposure Chamber (%)	19.8
Furnace Temperature at the Point of Minimal Oxygen (°C)	484
Number of Times the Exposure Chamber Temperature Exceeded 45°C	0
Average Duration of Exposure Chamber Temperature in Excess of 45°C (sec)	0
Eye Condition of Test Animals: (1) All apparently normal, (2) Some appparent damage, (3) Some severe damage	2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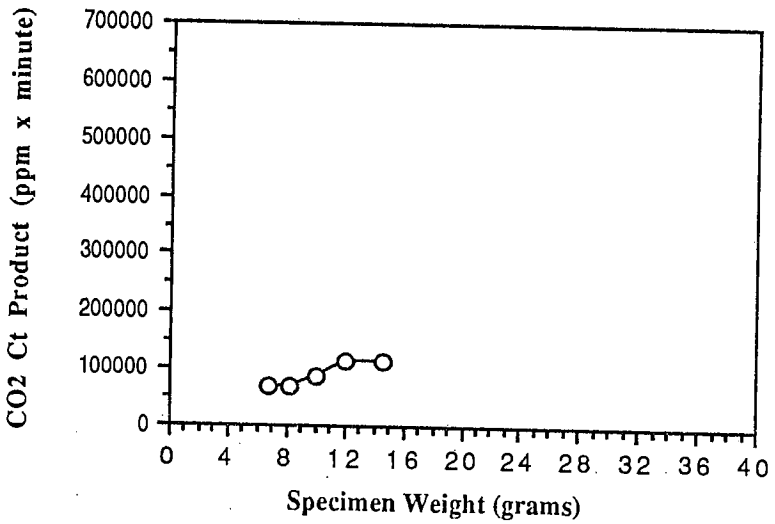
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400000
300000
200000
100000
0
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Specimen Weight (grams)

SIGNATURE PAGE

Prepared by,

James C. Norris, Ph.D.
Toxicologist

James R. Shaw
Director

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APPENDIX D

LC_{50} 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:

LC_{50} VALUES OF PARTICLEBOARDS USING THE UNIVERSITY OF PITTSBURGH TOXICITY TEST APPARATUS

Conducted on:

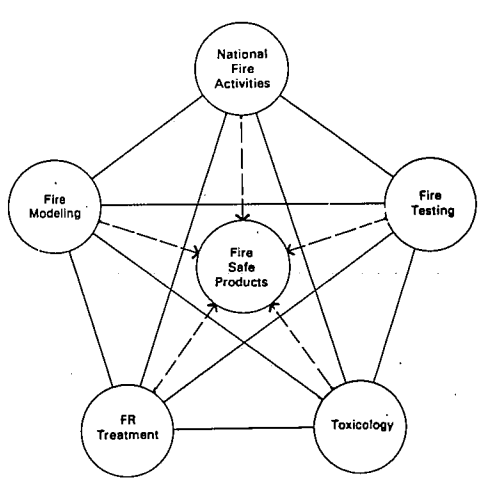
FIVE PARTICLEBOARDS

Conducted for:

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

Completed on:

December 30, 1988



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INTRODUCTION

Five particleboards were received from various members of National Particleboard Association for testing. The toxic potency values or LC_{50} 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 LC_{50} 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 (CO_2)

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/CO_2 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 CO_2 analyzers was performed with calibration gases (CO - 0.9% and CO_2 - 5%) certified by Alphagaz Division (Tacoma, WA). The O_2 analyzer was calibrated with room air.

TEST RESULTS

The LC_{50} 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 LC_{50} 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 (LC_{50} or ED_{50}) And Instructions In Their Use. *Biometrics* 8: 249-263, 1952.

SAMPLE PREPARATION

These wood products were stored in a conditioning room (23.8 ± 2.8° C and 50 ± 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: LC_{50} Values and their Confidence Intervals

Wood Product	LC50 Value	95% Confidence Interval	
	(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 Sequence	Test 1	Test 2	Test 3	Test 4	Test 5
Specimen Weight (grams)	14.99	8.16	9.79	11.74	14.09
Maximum Chamber Temp (°C)	49.3	47.2	44	54.9	48.8
Maximum Furnace Temp (°C)	803.6	850.7	817.8	815.4	823.6
Weight Loss (%)	79.79	76.1	80.08	92.5	65.22
Minimum Oxygen (%)	19.38	20.15	19.81	19.77	19.58
Maximum CO Concentration (ppm)	8888	4188	4482	6425	8152
Maximum CO2 Concentration (ppm)	8401	4735	5420	6641	7619
Number of Animals Exposed	0	4	4	4	4
Number of Dead Animals	-	0	2	4	2
% Lethality	-	0	50	100	50
Ct Product for CO (ppm x min)	51655.44	26070.52	29490.41	36883	46510.56
Ct Product for CO2 (ppm x min)	154052.25	103538.88	100604.13	122544.77	138721.95
T1% (°C)	211.2	255.8	221.2	221.8	228.8

"B" Particleboard

Test Sequence	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7
Specimen Weight (grams)	10.00	12.40	13.64	11.27	13.64	15.01	16.51
Maximum Chamber Temp (°C)	42.7	43.5	41.7	39.8	46.2	39.8	39.7
Maximum Furnace Temp (°C)	881.1	877.2	875.9	875.4	848.9	843.9	846.2
Weight Loss (%)	76.1	83.2	84.4	88.3	81.4	83.0	80.0
Minimum Oxygen (%)	19.99	19.55	19.59	17.54?	19.66	18.23	18.67
Maximum CO Concentration (ppm)	5095	6803	5986	5414	6693	6449	8816
Maximum CO2 Concentration (ppm)	6671	8288	10201	8022	7807	9344	11084
Number of Animals Exposed	0	4	4	4	4	4	4
Number of Dead Animals	-	1	3	1	0	3	3
% Lethality	-	25	75	25	0	75	75
Ct Product for CO (ppm x min)	33572	43402	44799	35126	41763	45440	54410
Ct Product for CO2 (ppm x min)	137686	171398	224024	153730	152282	177176	188365
T1% (°C)	269	270	270	270	240	240	240

"C" Particleboard

Test Sequence	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
Specimen Weight (grams)	10.00	12.40	10.25	15.01	13.64	11.27
Maximum Chamber Temp (°C)	44.46	45.74	40.21	42.15	40.02	44.07
Maximum Furnace Temp (°C)	908.6	918.7	918.6	911.01	913.4	912.9
Weight Loss (%)	79.1	84	80.1	79.27	81.1	75.9
Minimum Oxygen (%)	18.81	19.48	19.76	19.2	19.29	19.62
Maximum CO Concentration (ppm)	6147	9317	6718	12483	11329	9048
Maximum CO2 Concentration (ppm)	6052	9124	6426	10945	10176	8994
Number of Animals Exposed	0	4	4	4	4	4
Number of Dead Animals	-	2	1	4	2	2
% Lethality	-	50	25	100	50	50
Ct Product for CO (ppm x min)	30934	47481	37346	57880	51570	42898
Ct Product for CO2 (ppm x min)	110734	152599	134359	186380	171233	142330
T1% (°C)	300	310	310	310	310	310

"D" Particleboard

Test Sequence	Test 1	Test 2	Test 3	Test 4
Specimen Weight (grams)	8.42	10.06	12.07	14.43
Maximum Chamber Temp (°C)	35.8	45.7		45.0
Maximum Furnace Temp (°C)	846.0	837.7		827.2
Weight Loss (%)	72.8	78.0		not reliable
Minimum Oxygen (%)	20.04	19.89		19.36
Maximum CO Concentration (ppm)	4874	5718	data not saved	9045
Maximum CO2 Concentration (ppm)	6837	6104		8645
Number of Animals Exposed	4	4	4	4
Number of Dead Animals	1	0	4	3
% Lethality	25	0	100	75
Ct Product for CO (ppm x min)	32578	34441		53358
Ct Product for CO2 (ppm x min)	141835	118154		157221
T1% (°C)	250	243	232	230

"E" Medium Density Fiberboard

Test Sequence	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
Specimen Weight (grams)	10.00	10.25	12.40	15.01	13.64	11.27
Maximum Chamber Temp (°C)	41.53	43.67	42.6	34.65000	40.65	40.06
Maximum Furnace Temp (°C)	895.2	896.6	898.2	896.40000	900.8	899.98
Weight Loss (%)	79.6	75.3	81.3	81.20000	80.4	78.8
Minimum Oxygen (%)	19.68	20.18	19.62	19.59	19.56	19.76
Maximum CO Concentration (ppm)	5140	5646	7277	8448	8176	6657
Maximum CO2 Concentration (ppm)	5983	6814	10061	10063	9662	7679
Number of Animals Exposed	0	4	4	4	4	4
Number of Dead Animals	-	0	1	4	2	1
% Lethality	-	0	25	100	50	25
Ct Product for CO (ppm x min)	27862	28396	35019	42521	38759	32461
Ct Product for CO2 (ppm x min)	123524	134888	174940	183770	167141	156285
T1% (°C)	292	290	290	290	290	290

Table 7: New York State Data

	"A" Particleboard	"B" Particleboard	"C" Particleboard	"D" Particleboard	"E" Medium Density Fiberboard
Number of Samples Tested	5	7	6	4	6
Furnace Temperature at 1% Sample Mass Loss (°C)	221	240	310	243	290
Maximal Concentration of Carbon Monoxide in the Exposure Chamber (ppm)	4482	6449	9317	5718	8176
Furnace Temperature at the Point of Maximal Carbon Monoxide (°C)	451	457	482	429	488
Maximal Concentration of Carbon Dioxide in the Exposure Chamber (%)	0.6	0.93	0.91	0.61	0.97
Furnace Temperature at the Point of Maximal Carbon Dioxide (°C)	534	444	482	426	485
Minimal Concentration of Oxygen in the Exposure Chamber (%)	19.8	18.2	19.5	19.9	19.6
Furnace Temperature at the Point of Minimal Oxygen (°C)	485	469	480	426	488
Number of Times the Exposure Chamber Temperature Exceeded 45°C	0	0	1	2	0
Average Duration of Exposure Chamber Temperature in excess of 45°C (sec)	0	0	74	14	0
Eye Condition of Test Animals: (1) All apparently normal, (2) Some appparent damage, (3) Some severe damage	1	1	1	1	1

GRAPHS

CARBON MONOXIDE CT PRODUCT

VS

THE SPECIMEN WEIGHT

Figure 1: "A" Particleboard

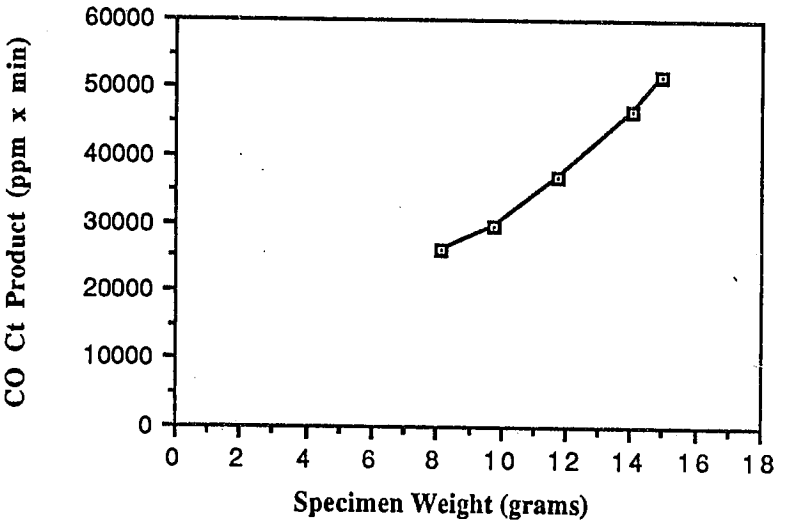
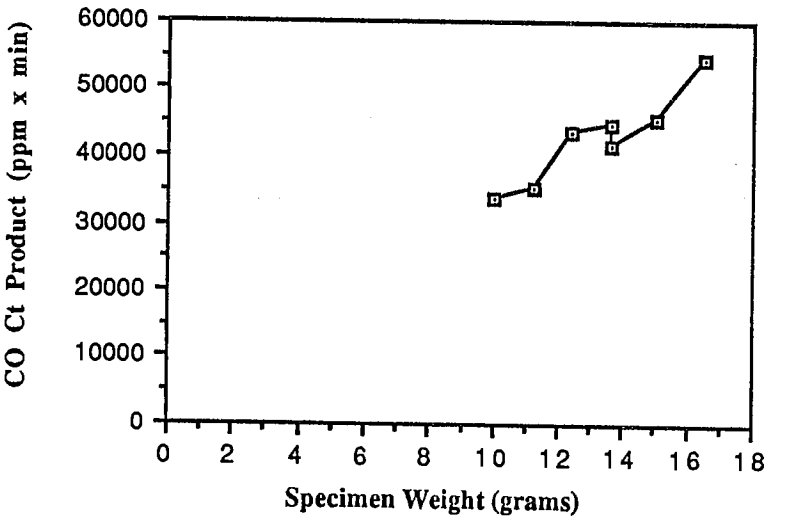


Figure 2: "B" Particleboard



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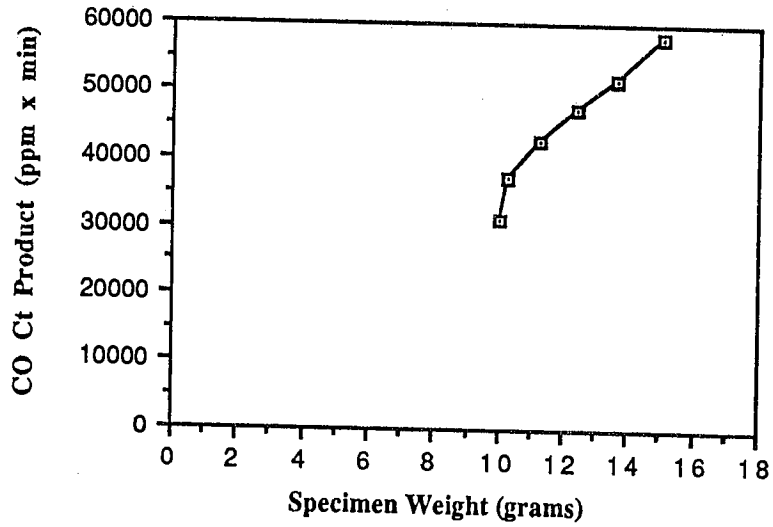

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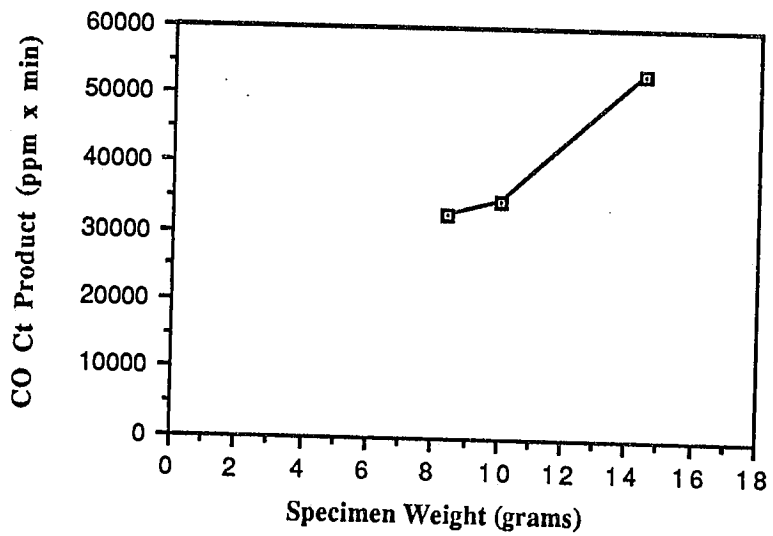

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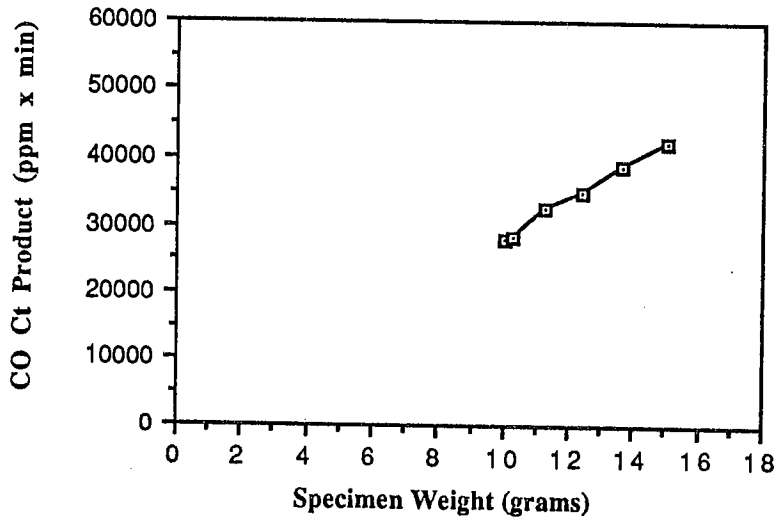


GRAPHS

CARBON DIOXIDE CT PRODUCT

VS

THE SPECIMEN WEIGHT

Figure 6: "A" Particleboard

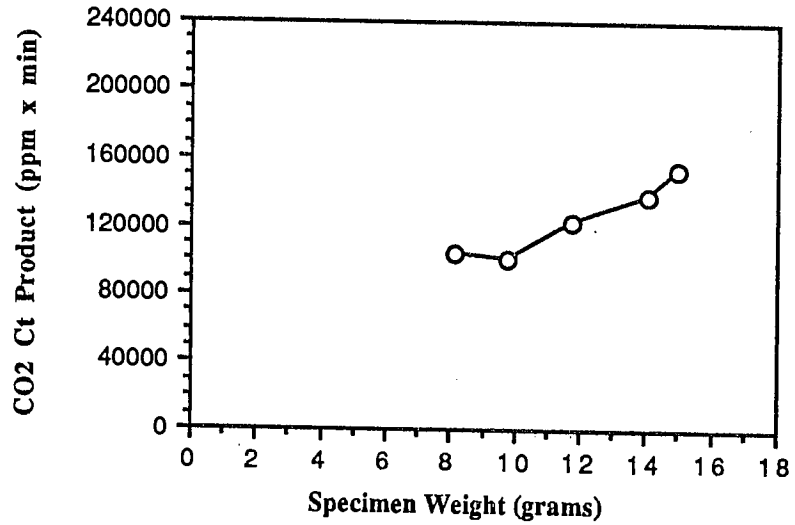


Figure 7: "B" Particleboard

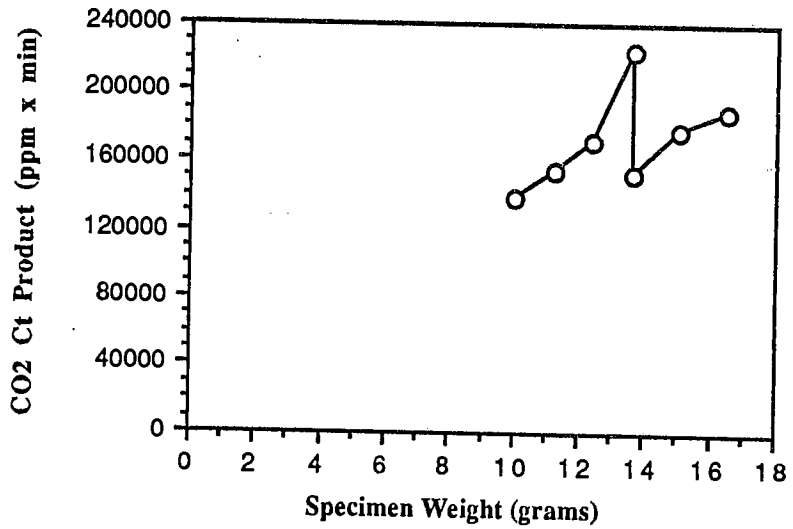


Figure 8: "C" Particleboard

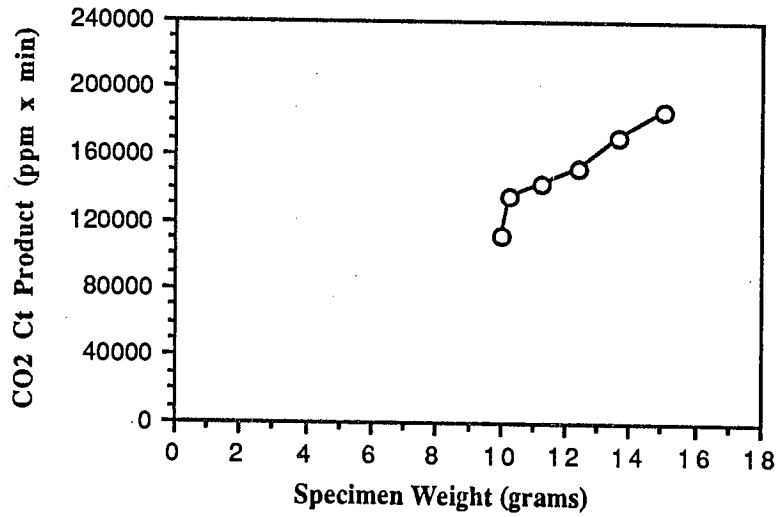


Figure 9: "D" Particleboard

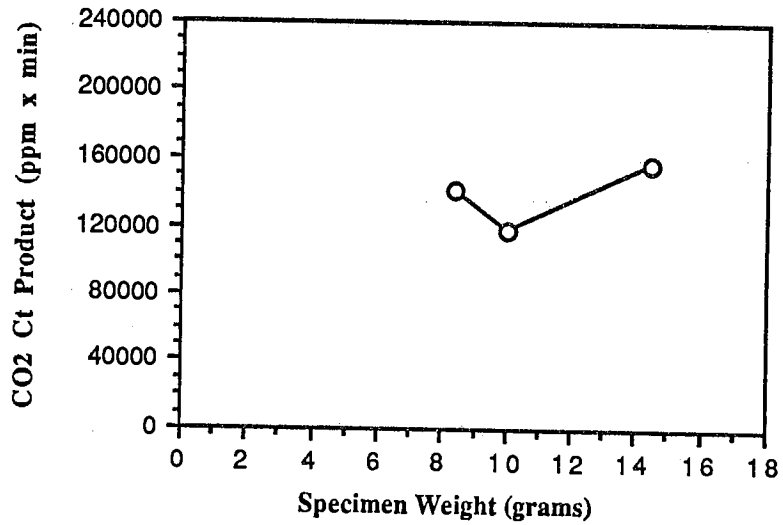
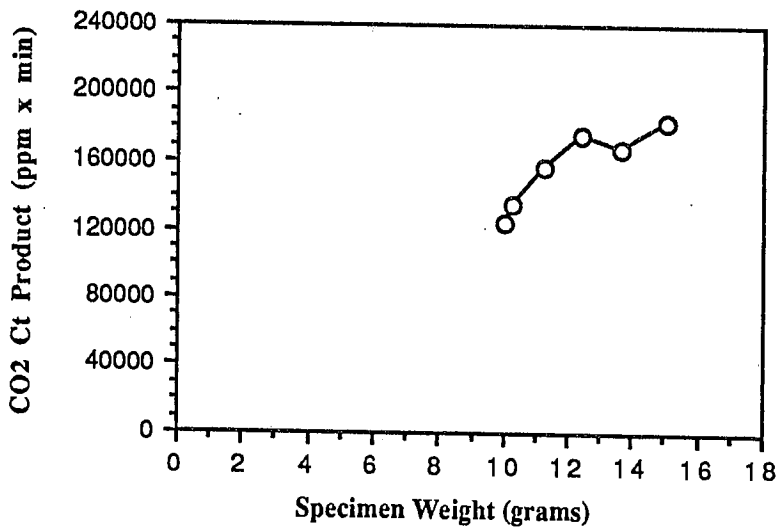


Figure 10: "E" Medium Density Fiberboard



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APPENDIX E

LC_{50} VALUES OF WOOD PRODUCTS USING THE UNIVERSITY OF PITTSBURGH TOXICITY TEST APPARATUS

FOUR WOOD PRODUCTS

Weyerhaeuser

FIRE TECHNOLOGY LABORATORY

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

Report on:

LC_{50} VALUES OF WOOD PRODUCTS USING THE UNIVERSITY OF PITTSBURGH TOXICITY TEST APPARATUS

Conducted on:

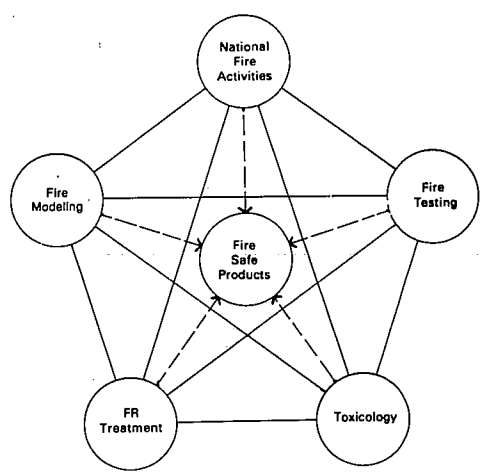
FOUR WOOD PRODUCTS FOR GENERIC CLASSIFICATION

Conducted for:

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

Completed on:

June 27, 1989



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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 LC_{50} 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 LC_{50} 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 (CO_2) 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/CO_2 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 CO_2 analyzers was performed with calibration gases (CO - 0.9% and CO_2 - 5%) certified by Alphagaz Division (Tacoma, WA). The O_2 analyzer was calibrated with room air.

TEST RESULTS

The LC_{50} 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 LC_{50} 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 (LC_{50} or ED_{50}) And Instructions In Their Use. *Biometrics* 8: 249-263, 1952.

SAMPLE PREPARATION

These wood products were stored in a conditioning room (23.8 ± 2.8° C and 50 ± 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: LC_{50} Values and their Confidence Intervals

Wood Product	LC50 Value (grams)	95% Confidence Interval	
		Low Value	High Value
Southern Pine Lumber- 20% Fire Retardant	71.7	57.3	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

Test Sequence	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10
Specimen Weight (grams)	10.00	17.72	14.64	8.26	12.10	55.60	98.49	81.40	67.27	21.44
Maximum Chamber Temperature (°C)	39.3	38.6	41.5	43.3	36.2	41.5	45.8	44.2	45.5	37.0
Maximum Furnace Temperature (°C)	853.5	849.6	851.3	849.8	850.3	854.0	853.4	848.1	850.0	848.5
Weight Loss (%)	63.5	59.2	55.5	59.3	59.4	59.3	61.7	61.7	64.5	61.7
Minimum Oxygen Concentration (%)	20.17	19.11	20.22	20.58	20.21	17.91	17.51	17.33	17.29	18.85
Maximum CO Concentration (ppm)	4109	4417	4730	2836	4489	6622	5822	7417	9724	5951
Maximum CO2 Concentration (ppm)	3893	14374	5203	3144	4283	27025	32775	30280	33101	15232
Number of Animals Exposed	4	4	4	4	4	4	4	4	4	4
Number of Dead Animals	0	0	0	0	0	1	4	2	2	0
Lethality (%)	0	0	0	0	0	25	100	50	50	0
Ct Product for CO (ppm x min)	30965	14788	26663	22364	29424	24914	34267	24079	30012	20442
Ct Product for CO2 (ppm x min)	61080	93626	62930	46901	59391	324518	446726	425488	400901	116958
T1% (°C)	250	250	250	250	250	250	250	250	250	250

Test Sequence	Test 11	Test 12	Test 13	Test 14
Specimen Weight (grams)	25.94	31.38	37.97	45.95
Maximum Chamber Temperature (°C)	37.8	38.0	36.5	37.6
Maximum Furnace Temperature (°C)	846.4	850.9	849.2	849.3
Weight Loss (%)	64.2	64.2	59.1	58.9
Minimum Oxygen Concentration (%)	18.46	18.47	19.41	18.9
Maximum CO Concentration (ppm)	5217	7053	3429	3490
Maximum CO2 Concentration (ppm)	19735	20879	14158	16289
Number of Animals Exposed	4	4	4	4
Number of Dead Animals	0	1	0	0
Lethality (%)	0	25	0	0
Ct Product for CO (ppm x min)	19092	24230	18402	18321
Ct Product for CO2 (ppm x min)	149875	166578	158422	184628
T1% (°C)	250	250	250	250

Table 3: Southern Pine Lumber - 2.7% CCA*

Test Sequence	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7
Specimen Weight (grams)	10.00	17.71	25.94	45.95	55.60	37.97	31.38
Maximum Chamber Temperature (°C)	40.25	35.7	36.5	40.6	40.75	40.5	36.89
Maximum Furnace Temperature (°C)	851.0	850.9	853.2	848.4	853.8	848.3	851.3
Weight Loss (%)	76.2	79.6	77.8	77.5	76.2	76.8	77.5
Minimum Oxygen Concentration (%)	18.34	16.75	16.28	14.77	13.93	15.20	15.46
Maximum CO Concentration (ppm)	5618	8343	8804	9899	12015	10284	8737
Maximum CO2 Concentration (ppm)	16135	33507	39128	55822	59291	50266	48003
Number of Animals Exposed	4	4	4	4	4	4	4
Number of Dead Animals	0	0	0	1	4	1	0
Lethality (%)	0	0	0	25	100	25	0
Ct Product for CO (ppm x min)	20851	22942	24120	29222	48417	26523	22045
Ct Product for CO2 (ppm x min)	125050	246807	353471	574571	686644	487653	429265
T1% (°C)	250	250	250	250	250	250	250

*CCA - chromium / copper / arsenic

Table 4: Southern Pine Particleboard - 10% PVC*

Test Sequence	Test 1	Test 2	Test 3	Test 4	Test 5
Specimen Weight (grams)	10.00	12.10	14.64	17.72	8.26
Maximum Chamber Temperature (°C)	37.4	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	19.05	20.19
Maximum CO Concentration (ppm)	5346	7001	5967	10764	3720
Maximum CO2 Concentration (ppm)	5082	6427	6909	8063	4611
Number of Animals Exposed	4	4	4	4	4
Number of Dead Animals	1	2	3	3	0
Lethality (%)	25	50	75	75	0
Ct Product for CO (ppm x min)	32237	40538	42857	58792	25504
Ct Product for CO2 (ppm x min)	77047	103820	124814	123427	71468
T1% (°C)	220	230	220	220	220

*PVC - polyvinyl chloride

Table 5: Southern Pine Particleboard - 15% UF*

Test Sequence	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
Specimen Weight (grams)	10.00	11.27	15.01	13.64	16.51	12.40
Maximum Chamber Temperature (°C)	32.0	37.6	40.6	42.2	41.4	38.1
Maximum Furnace Temperature (°C)	826.8	826.7	827.4	818.7	819.2	818.8
Weight Loss (%)	84.4	75.3	79.6	80.8	77.9	80.0
Minimum Oxygen Concentration (%)	20.03	18.26	19.45	19.48	17.13	19.4
Maximum CO Concentration (ppm)	5215	7609	9642	8327	11284	7930
Maximum CO2 Concentration (ppm)	8824	8267	10022	9477	12850	7786
Number of Animals Exposed	4	4	4	4	4	4
Number of Dead Animals	1	0	3	0	3	0
Lethality (%)	25	0	75	0	75	0
Ct Product for CO (ppm x min)	29179	38570	47427	40071	53008	38622
Ct Product for CO2 (ppm x min)	117670	133017	142731	131283	160919	114892
T1% (°C)	220	220	220	220	220	220

*UF = Urea Formaldehyde

Table 6: New York State Data

	Southern Pine Lumber - 20% Fire Retardant	Southern Pine Lumber - 2.7% CCA
Number of Samples Tested	14	7
Furnace Temperature at 1% Sample Mass Loss (°C)	250	250
Maximal Concentration of Carbon Monoxide in the Exposure Chamber (ppm)	9724	9899
Furnace Temperature at the Point of Maximal Carbon Monoxide (°C)	525	501
Maximal Concentration of Carbon Dioxide in the Exposure Chamber (%)	3.31	5.58
Furnace Temperature at the Point of Maximal Carbon Dioxide (°C)	549	552
Minimal Concentration of Oxygen in the Exposure Chamber (%)	17.3	14.8
Furnace Temperature at the Point of Minimal Oxygen (°C)	551	518
Number of Times the Exposure Chamber Temperature Exceeded 45°C	1	0
Average Duration of Exposure Chamber Temperature in Excess of 45°C (sec)	98	0
Eye Condition of Test Animals: (1) All apparently normal, (2) Some appparent damage, (3) Some severe damage	1	1

	Southern Pine Particleboard - 10% PVC	Southern Pine Particleboard - 15% UF
Number of Samples Tested	5	6
Furnace Temperature at 1% Sample Mass Loss (°C)	220	220
Maximal Concentration of Carbon Monoxide in the Exposure Chamber (ppm)	7001	9642
Furnace Temperature at the Point of Maximal Carbon Monoxide (°C)	450	501
Maximal Concentration of Carbon Dioxide in the Exposure Chamber (%)	0.64	1
Furnace Temperature at the Point of Maximal Carbon Dioxide (°C)	452	496
Minimal Concentration of Oxygen in the Exposure Chamber (%)	19.7	19.5
Furnace Temperature at the Point of Minimal Oxygen (°C)	451	504
Number of Times the Exposure Chamber Temperature Exceeded 45°C	1	0
Average Duration of Exposure Chamber Temperature in Excess of 45°C (sec)	415	0
Eye Condition of Test Animals: (1) All apparently normal, (2) Some appparent damage, (3) Some severe damage	2	2

Carbon Monoxide Ct Product

vs

Specimen Weight

Figure 1: Southern Pine Lumber - 20% Fire Retardant

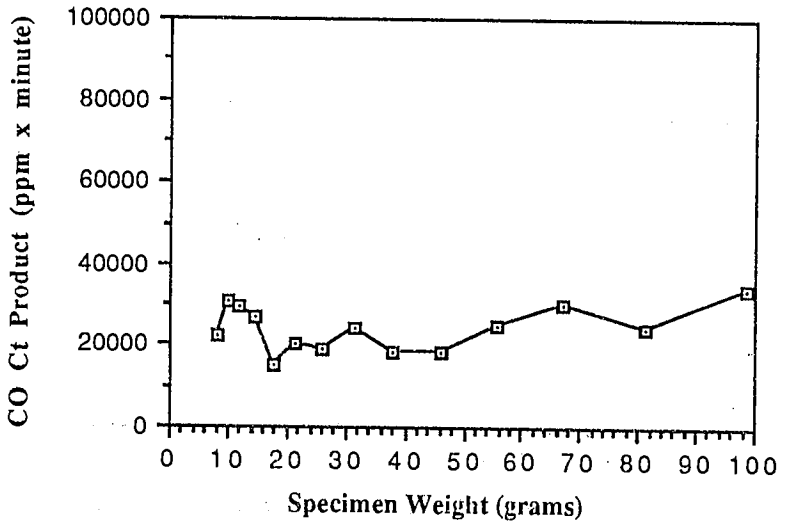


Figure 2: Southern Pine Lumber - 2.7% CCA

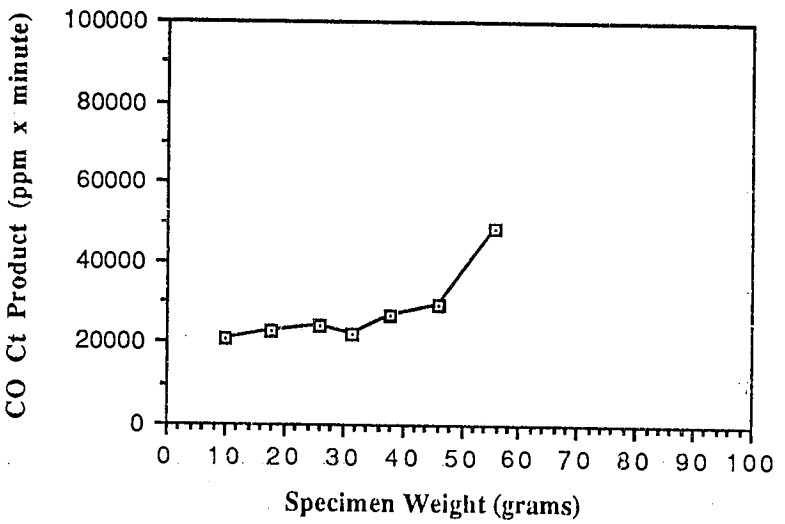


Figure 3: Southern Pine Particleboard - 10% PVC

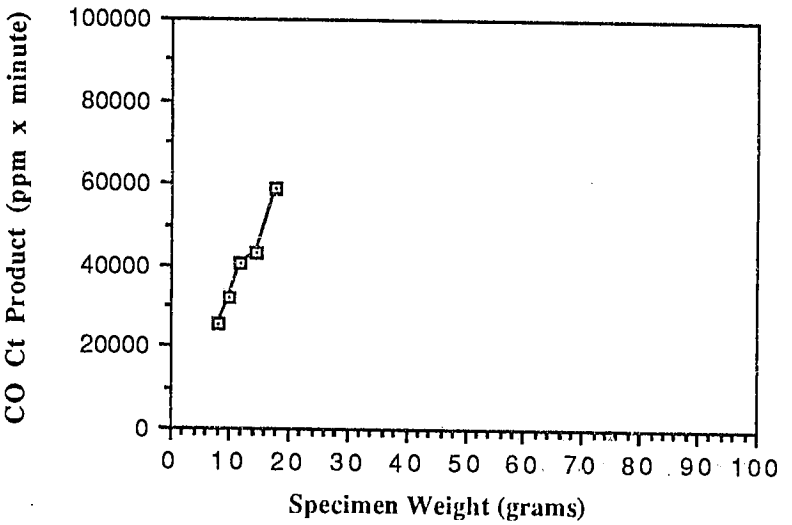
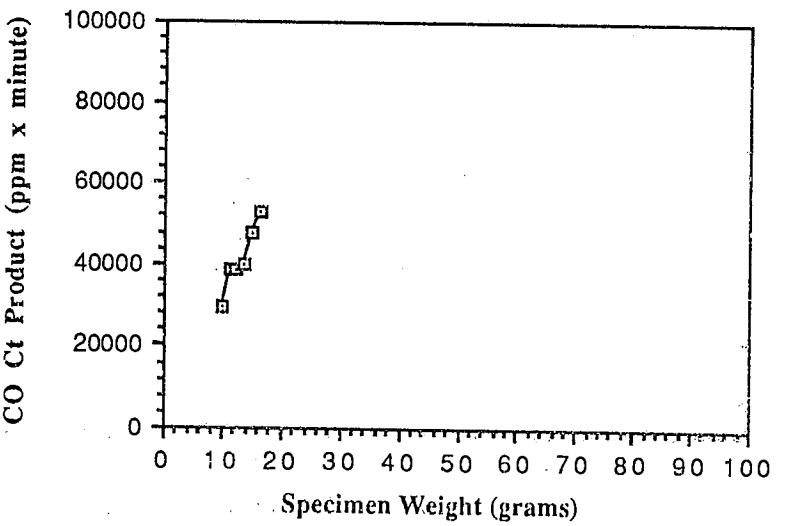


Figure 4: Southern Pine Particleboard - 15% UF



Carbon Dioxide Ct Product

vs

Specimen Weight

Figure 5: Southern Pine Lumber - 20% Fire Retardant

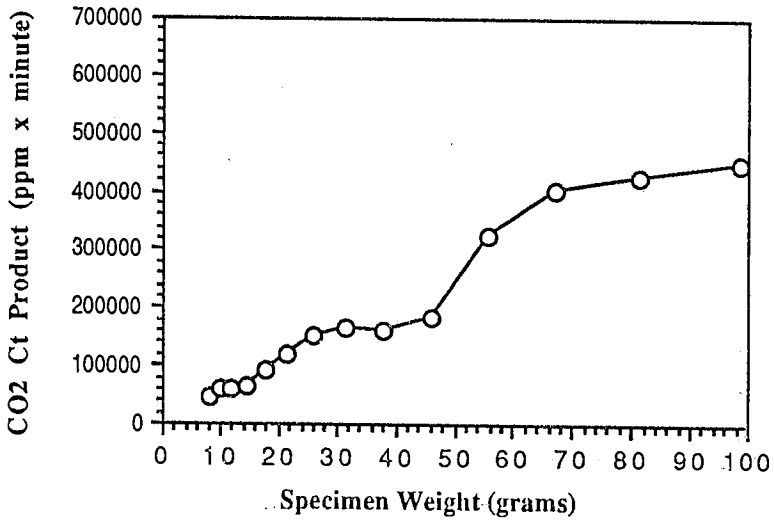


Figure 6: Southern Pine Lumber - 2.7% CCA

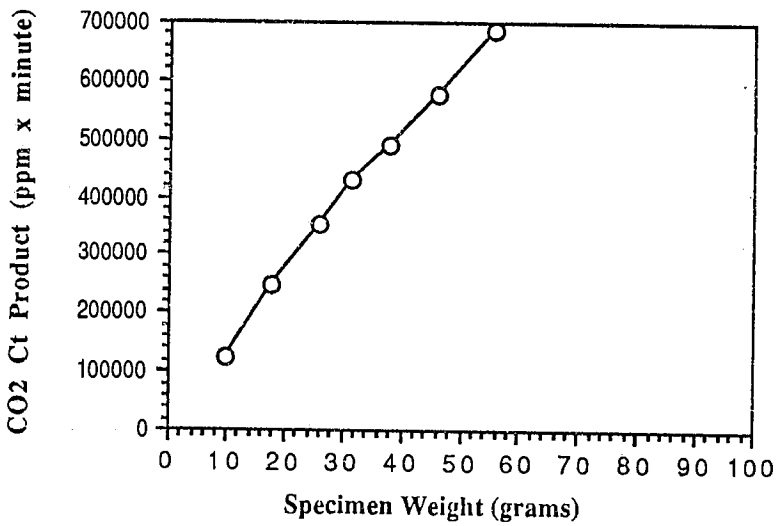


Figure 7: Southern Pine Particleboard - 10% PVC

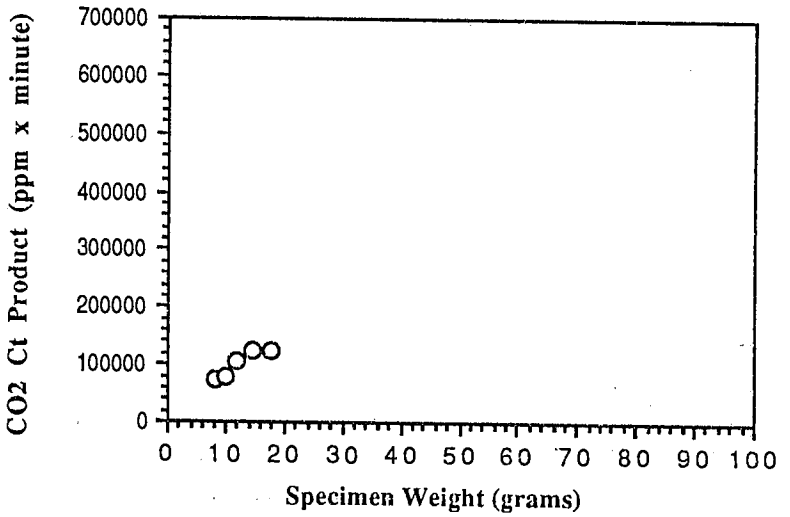
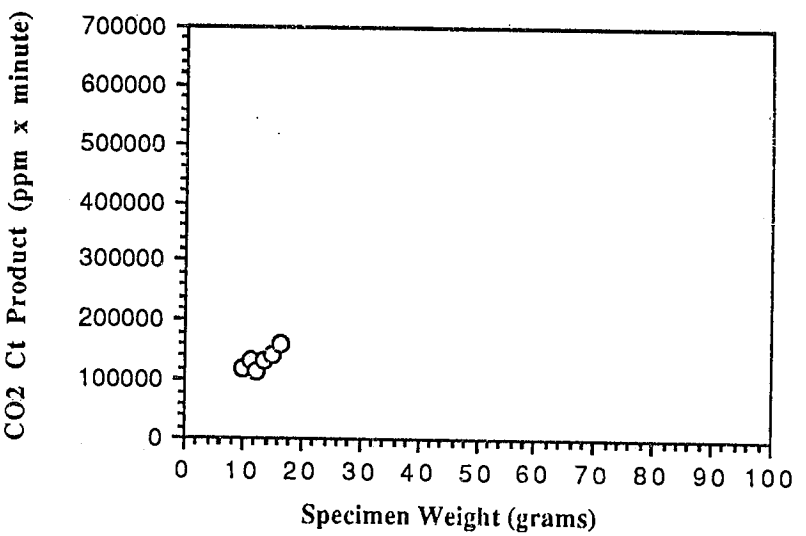


Figure 8: Southern Pine Particleboard - 15%UF



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