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INVESTIGATION OF THE TOXIC POTENCY OF THE COMBUSTION PRODUCTS OF NEWMAT U.S.A. STRETCH CEILING SYSTEMS IN ACCORDANCE WITH THE REQUIREMENTS OF THE CITY AND STATE OF NEW YORK

FINAL REPORT
SwRI Project No. 01-7523-012
January 1996

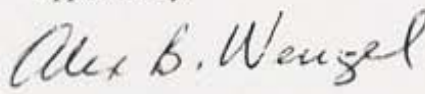
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NOTICE

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 the factors that are pertinent to an assessment of the fire hazard of a particular end use.

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I. OBJECTIVE

The objective of this program was to obtain required data on the toxic potency of the combustion products of a PVC white flexible ceiling covering identified as Newmat Stretch Ceiling Systems submitted for evaluation by Newmat U.S.A. of Huntington, New York. This sample was tested in accordance with the test methodology outlined in "Article 15, Part 1120, Combustion Toxicity Testing, New York State Uniform Fire Prevention and Building Code" December 16, 1986 (1). The intent of this testing was to evaluate the performance of the test article in relation to wood as required by Section 27-348(e) of the Building Code of the City of New York. The test procedure is a modification of the combustion toxicity protocol developed at the University of Pittsburgh.

This report contains a description of the material tested, the test procedure, and the test results. Note that the test results only apply to the specimen tested, in the manner tested, and not to the entire production of this material or similar materials, nor to the material's performance when used in combination with other materials.

II. TECHNICAL APPROACH

The major function of the University of Pittsburgh (UPitt) laboratory test method is to provide a means of evaluating the lethal toxic potency of thermal decomposition products of test materials (2).

The protocol provides for the conduct of experiments under continuously changing temperature conditions (20°C/minute), and the test system generates decomposition products which continuously change in chemical composition as the temperature increases. Animals are exposed to the decomposition products starting when the test specimen loses 1 percent of its initial weight.

The UPitt protocol utilizes rodent (mouse) lethality as the primary toxicological endpoint in evaluating the toxicity of the combustion atmosphere produced by a material. Separate groups of animals are exposed to the combustion atmospheres generated from different initial quantities of the test material in order to establish a concentration-response relationship. From this relationship, the concentration (defined by the protocol as the weight of sample loaded into the test furnace) estimated to produce lethality in 50 percent of the animals within the specified time is obtained by interpolation. This concentration, commonly termed the LC_{50} , is a measure of the toxic potency of the combustion atmosphere.

In accordance with NYS UFPBC Article 15, animal lethality data are supplemented with observations of the eye condition of the test animals, expressed as "all apparently normal," "some apparent damage," or "some severe damage."

III. EXPERIMENTAL DESIGN

A. Description of Test Materials

The test material was received from the client on December 29, 1995. A complete description is presented in Table 1.

Upon receipt, the material was identified, weighed, recorded, and then conditioned at a temperature of $23 \pm 3^{\circ}\text{C}$ and a relative humidity of 50 ± 5 percent for a period of at least 48 hours.

**Table 1. Description Of Material
Newmat U.S.A.
SwRI Project No. 01-7523-012**

Date Received	December 29, 1995
Date Tested	January 17 - 18, 1996
Description ⁽¹⁾	PVC white, flexible sheeting ("Newmat Stretch Ceiling Systems")
Amount Received	40 ft (12.2 m), 0.006 in. (0.16 mm) thick
Total Weight of Test Sample	206.96 g ⁽²⁾

⁽¹⁾ Information provided by client

⁽²⁾ The total 40 ft (12.2 m) of material was too heavy to weigh. A piece 25-1/4 x 60 in. (.7 x 1.6 m) was cut off and weighed. This piece was used for testing.

B. Combustion

The thermal decomposition of the test material was accomplished by heating the sample in the system depicted in Figure 1. The combustion device is a Lindbergh Box Furnace (Model 51894-S-PIT) with inside dimensions of 229 x 241 x 357 mm and a volume of 19.7 liters. The weighed test specimens were heated, starting at a temperature no greater than 70°C, at a rate of 20(±2)°C/minute. Continuous weight loss was monitored by a load cell connected to the sample specimen platform. The thermal decomposition products were transferred to the animal exposure chamber by a glass tube¹ approximately 0.80 m in length having an inside diameter of 19 mm. The furnace chamber was aspirated at a rate of 11 L/minute, and the furnace effluent was cooled and diluted by an additional 9 L/minute of cooled medical grade breathing air, resulting in a total flow of 20 L/minute through the animal chamber. The diluent air is run through coiled copper tubing (0.25 in. O.D.) immersed in an icebath filled with ice and tap water. Prior to each test run, the accuracy of the flowmeters was checked with a primary standard gas flowmeter (Mini-Buck Calibrator™, Model M-30) by connecting it to the inlet of the Pyrex glass tube leading to the animal exposure chamber. Values are obtained with and without the dilution air flowing into the test chamber. During each test, both flowmeters were continuously monitored visually and readjusted to their pre-test setting as necessary.

C. Animals

Male Swiss Webster mice, weighing from 22 to 30 g on the day of exposure, were used in these experiments. No formal randomization procedure was utilized in the selection of animals for each test group; animals were selected on the basis of appropriate body weight and obvious signs of good health.

Test animals 5 to 7 weeks old were ordered from a registered U.S.D.A. supplier (Hilltop Laboratories, Scottsdale, Pennsylvania). Upon receipt, the animals were individually identified by number and housed not more than eight to a cage. Animals were identified on their cages by group number and individual assigned number. Color coded indelible ink markings on the fur on the back of the animals were used for identification purposes. The cages were of the polycarbonate "shoe-box" type, 18 in. long, 9.5 in. wide, and 5 in. deep with commercial corncob bedding used as litter.

¹ As depicted in Figure 1, the glass "tube" is composed of two sections. The first section is manufactured of quartz and is inserted into the center region of the furnace chamber. The second section is manufactured of Pyrex® and has a sidearm for the connection of the diluting air supply. Ground glass ball joints and clamps provide for airtight containers.

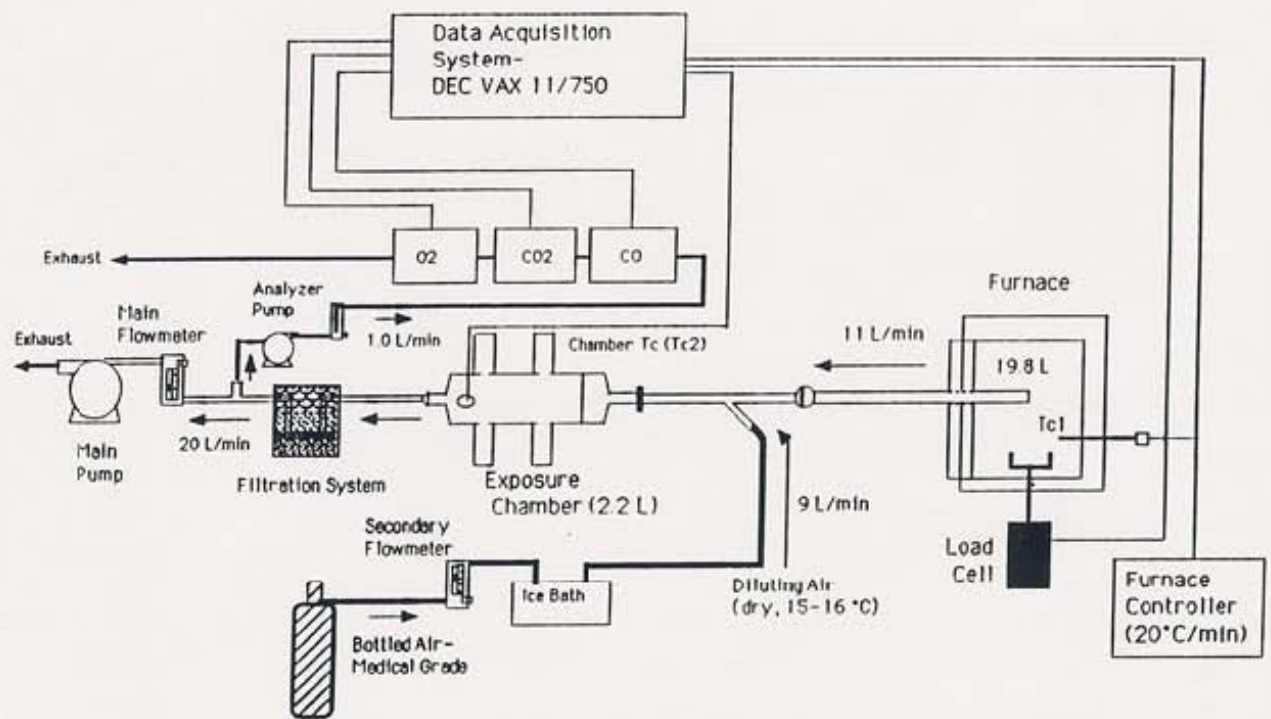


Figure 1. Schematic of Test System and Experimental Setup for Analysis of CO, CO₂, and O₂.

Prior to testing, the animals were placed in a separate quarantine room for a minimum of one week. The quarantine room conditions were maintained at temperatures between 18 and 26°C and 40 to 70 percent relative humidity. Those animals that were unsuitable by reason of size, health, or other criteria were discarded. Animals were allowed free access to water and standard formula Purina® Laboratory Rodent Chow. The test animals were housed and cared for following standard procedures (3). Facilities for housing and care of animals are accredited under the rules and regulations of the American Association for Laboratory Animal Sciences and are licensed by the U.S.D.A. according to Public Law 91-579 (Animal Welfare Act of 1970).

D. Exposure

The weighed test specimen was placed in the quartz crucible resting on the pedestal within the furnace. The starting point for exposure of animals was established during an initial experiment with 10 g of the test material by recording the temperature at which 1 percent of the sample weight was consumed ($T_{1\%}$). This temperature was used in ensuing runs as the temperature at which animal exposures were initiated. Animal exposures were conducted for 30 minutes from the point of $T_{1\%}$. If all animals expired prior to 30 minutes, the test was terminated when recorded CO levels returned to baseline. Prior to the initiation of an animal exposure experiment, the animals were positioned with their heads protruding through latex dams (reinforced with duct tape) into the exposure chamber. Rubber stoppers sealed the open end of the animal ports and assisted in preventing the mice from backing out of the neck restraint. At the same time, a continuous flow of room air was maintained at a rate of 20 L/minute through the animal chamber. After the animals were allowed a brief acclimation period, the experiment was initiated by starting the furnace controller and activating the data logging system. At $T_{1\%}$, the exposure chamber was quickly connected to the furnace and the 30-minute exposure run initiated. Exposure chamber and furnace temperatures were monitored by thermocouple throughout the test period. All glassware was cleaned and dried between each test run. As necessary, stubborn residues in the quartz tube were treated with commercial oven cleaner and burned off with a torch. Ammonia-based cleanser, soap and water and ethanol were employed in the cleaning of the chamber and connecting glassware.

E. Biological Measurements

A sufficient number of experiments were conducted with varying amounts of sample weight to enable the development of the concentration-response relationship and the derivation of the LC_{50} and 95 percent confidence limits by the moving averages method of Weil (4). Each experiment was followed by a 10-minute recovery period, during which time the animals were observed for lethality and examined for the presence of eye damage (corneal opacity). As required by the referenced test method, the eye condition was scored as "no apparent damage," "some apparent damage," or "some severe damage."

F. Combustion Atmosphere Analysis

Analysis for O_2 , CO, and CO_2 was made continuously at a sampling rate of 0.5 to 1.0 L/min with the following instrumentation: Beckman OM-11 Analyzer (O_2); Beckman 865 Infrared Analyzers (CO and CO_2). The experimental setup for the analysis of CO, CO_2 , and O_2 is shown in Figure 1.

Routine calibration of the CO and CO_2 analyzers was performed prior to each day's testing. Calibration gases (1.0 percent CO, 10.0 percent CO_2 certified by Scientific Gas Products, Incorporated) were metered into the analyzers in the same way that unknown samples were introduced. The O_2 analyzer was calibrated with room air. Calibration of the analyzers was established to within 1 percent of full scale.

IV. TEST RESULTS

The combustion experiments with the test article were conducted January 17 and 18, 1996. A summary of the test results presented in a manner consistent with the New York State Article 15 filing format is provided in Table 2, and a tabular summary of the individual test runs is included in Appendix A. A graphical representation of the performance characteristics of the test material during thermal decomposition is provided in Figure 2. These curves depict continuous mass loss ($T_{1\%}$) and CO, CO_2 , and O_2 levels as a function of furnace temperature. Additional curves depicting exposure chamber and furnace temperatures are provided in Appendix B.

**Table 2. Summary of UPITT/NYS Testing
Newmat U.S.A.
SwRI Project No. 01-7523-012**

PERFORMANCE PARAMETER	RESULTS
LC ₅₀ (grams)	9.94
95% Confidence Limits (g)	8.0 - 12.3
LA ₅₀ (mm ²)	47880
Mean Percent Sample Residue (%)	17.02
Furnace Temperature at 1% Weight Loss (°C)*	250
Temperature Range at Major Decomposition (°C)**	237 - 352
Mean Temperature at Ignition (°C)	430
Peak CO (ppm)**	7523
Temperature at Peak CO (°C)	605
Peak CO ₂ (%)**	1.40
Temperature at Peak CO ₂ (°C)	627
Minimum O ₂ (%)**	19.1
Temperature at Minimum O ₂ (°C)	599
Number of Times the Exposure Chamber Temperature Exceeded 45°C **	0
Average Duration of Temperature Excursion (sec)	---
Eye Condition of Test Animals ***	B
Number of Tests Conducted	4

- * From test conducted at 10.0 grams.
- ** From test conducted within 5% of the LC₅₀ value (representative LC₅₀ test).
- *** Eye condition characterized as:
 - (A) all apparently normal;
 - (B) some apparent damage;
 - (C) some severe damage (from representative LC₅₀ test).

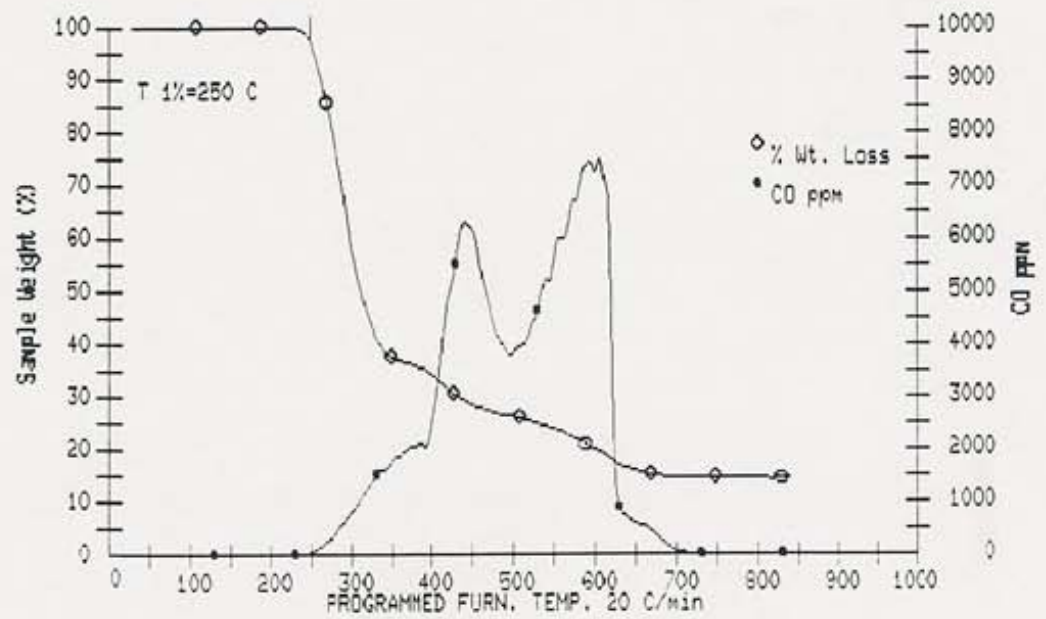
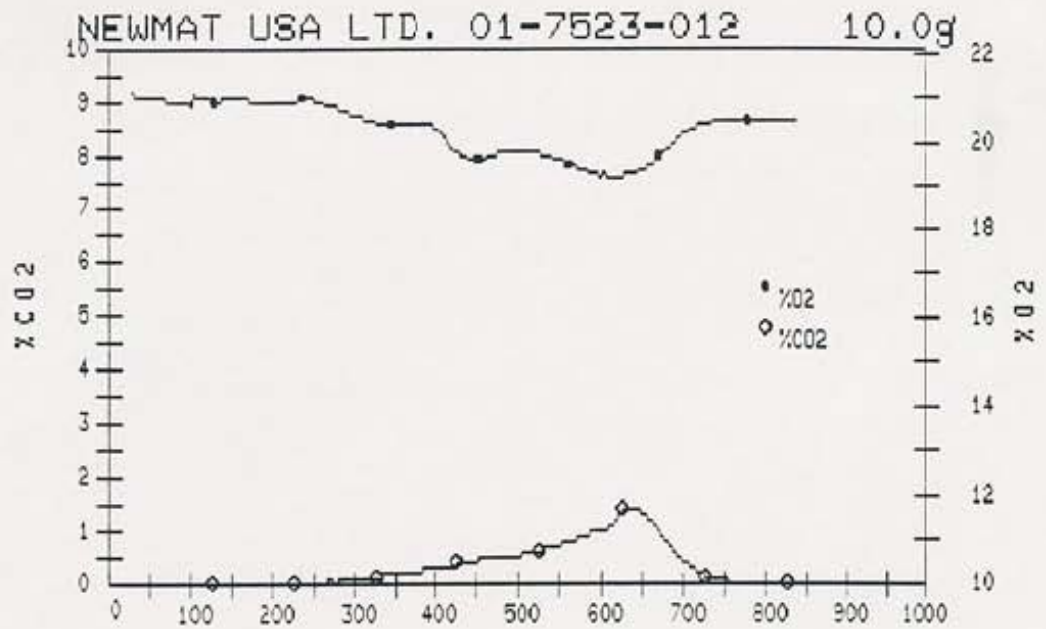


Figure 2. Physical Performance Characteristics of Newmat U.S.A. Stretch Ceiling System During Thermal Decomposition.

The LC₅₀ value (95 percent confidence limits) for the Newmat U.S.A. test sample was determined to be 9.94 (8.0 - 12.3) grams from a series of four combustion experiments ranging from 6.9 to 20.7 grams.

V. DISCUSSION

For products such as wallcoverings, guidelines on file with the New York City MEA provide for the comparison of these products to wood on the basis of the area of the exposed surface. For wallcoverings 0.036 in (0.91 mm) or less in thickness, the "passing value" has been established as 31,392 mm². A test material having an LA₅₀ value equal to or greater than this value can be considered to be "no more toxic than wood."

When tested under the controlled laboratory conditions specified in this report, the LA₅₀ value for the test item described in Table 1 was determined to be 47,880 mm²; therefore, this test material meets the requirements set forth in Section 27.348(e) of the Building Code of the City of New York.

VI. REFERENCES

1. "Regulations for Implementing Building Materials and Finishes Fire Gas Toxicity Data File, Article 15, Part 1120 Combustion Toxicity Testing," New York State Department of State (1986).
2. Alarie, Y. and Anderson, R.C. "Toxicology and acute lethal hazard evaluation of thermal decomposition products of synthetic and natural polymers," Toxicology and Applied Pharmacology, Vol. 51, 1979, pp. 341-362.
3. Guide for the Care and Use of Laboratory Animals, DHHS Publications No. (NIH) 85-23.
4. Weil, C. S., "Tables for Convenient Calculation of Median-Effective Dose (LD₅₀ or ED₅₀) and Instrumentation for Their Use," Biometrics, Volume 8, pp. 249-261 (1952).

APPENDIX A

**INDIVIDUAL SUMMARIES OF ANIMAL EXPOSURE DATA,
ANALYTICAL DATA AND MATERIAL PERFORMANCE CHARACTERISTICS**

(Consisting of 1 Page)

**TABLE A-1. SUMMARY OF ANIMAL EXPOSURE, ANALYTICAL DATA
AND MATERIAL PERFORMANCE CHARACTERISTICS FOR SwRI PROJECT No. 01-7523-012**

Newmat U.S.A. Stretch Ceiling Systems
Starting Temperature of Exposure: 250°C
LC₅₀: 9.94 grams (8.0 - 12.3)
LA₅₀: 47880 (38790 - 59100)

TEST ID

	017-PVC-2	017-PVC-1	018-PVC-3	018-PVC-4
Sample Weight, (g)	6.9	10.0	14.4	20.7
Percent Weight Loss	81.0	85.6	81.9	83.4
Flaming Temp. (°C)	DNI	DNI	429	432
Temp. Range at Most Rapid Weight Loss (°C)	267 - 387	237 - 352	236 - 363	269 - 395
Number Responding/Number Exposed	0/4	2/4	4/4	4/4
Percent Response	0	50	100	100
Maximum CO (ppm)	6401	7523	8415	8769
Total CO (Ct)(ppm-min)	55857	70347	72914	95908
Temperature at CO Maximum (°C)	617	605	616	629
Maximum CO ₂ Concentration (%)	1.0	1.4	4.0	3.7
Total CO ₂ (Ct)(percent-min)	8.07	12.78	24.67	30.29
Temperature at CO ₂ Maximum (°C)	658	627	424	447
Minimum O ₂ (%)	19.8	19.1	15.3	15.2
Temperature at O ₂ Minimum (°C)	613	599	423	452
Eye Condition ⁽¹⁾	b	b	-	-

- 1) Eye Condition of Surviving Animals:
 (a) All apparently normal;
 (b) some apparent damage;
 © some severe damage.

Mean Furnace Temp at Spontaneous Flame: 430°C
 Residue (Sample Avg.): 17.02%

APPENDIX B
EXPOSURE CHAMBER AND FURNACE TEMPERATURES
(Consisting of 1 Page)

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