

Department of Wood and Paper Science  
Campus Box 8005, Dan Allen Dr.  
Raleigh, NC 27695-8005 USA

919.515.5807  
919.513.3496 or 919.515.6302(fax)

**Hodges Wood Products Laboratory**

919.515.2881

**Dr. Constantine A. LaPasha**  
919.515.2850

A Report to  
  
Melatone LTD  
  
from  
  
North Carolina State University  
Wood Products Laboratory  
  
on  
  
NEMA LD3-2005  
Laminate Tests

14 March 2008  
Project Number: WPL 08-1081

Principal Investigator

---

Dr. C. A. LaPasha

Department of Wood & Paper Science  
Rm.110 Hodges Wood Products Lab  
Campus Box 8005, 411 Dan Allen Drive  
Raleigh, NC 27695-8005 USA

919.515.2850  
(fax) 919.513.3496  
calfor@unity.ncsu.edu

## IMPORTANT

- These tests were conducted according to the procedures described in NEMA standards LD3-2005 except where noted.
- The NEMA LD3-2005 test procedures and standards were designed for high pressure decorative laminates, and their use with other products may produce misleading or irrelevant results.
- We do not certify a manufacturer's laminate. We report only on the results of a given sample of laminate which has been submitted to our laboratory.
- The name of the University is not to be used in any type of advertising or promotional efforts.
- We have undertaken high pressure decorative laminate testing as an independent testing laboratory largely as a service to the laminate manufacturers and the furniture industry. However, our main purpose is that of education and research, which means that we cannot always respond quickly to requests for testing.

Melatone LTD submitted 2 samples, identified below, for testing according to the test methods in NEMA LD3-2005. The following tests were requested:

LD3-2005

- 3.1 Appearance
- 3.2 Surface Finish
- 3.3 Light Resistance
- 3.4 Cleanability/Stain Resistance
- 3.5 Boiling Water Resistance
- 3.6 High Temperature Resistance
- 3.7 Glass Scratch Resistance
- 3.7 Diamond Resistance
- 3.8 Ball Impact Resistance
- 3.9 Dart Impact Resistance
- 3.10 Radiant Heat Resistance – coil method
- 3.11 Dimensional Change
- 3.12 Dimensional Stability
- 3.13 Wear Resistance
- 3.14 Formability
- 3.15 Blister Resistance

Samples are coded as follows:

sample#	description
#1	Post-Forming/HGP size:1.0Tx4'x8'
#2	Post-Forming/VGPsize:0.7Tx4'x8'

Results of the tests follow. A summary table of test results is appended.

## TEST RESULTS

### 3.1 APPEARANCE

#### TEST RESULTS

##### 3.1.4 Visual Inspection for type A, B, C defects

	type A defects	type B defects	type C defects
sample # 1	0	0	0
sample # 2	0	0	0

##### 3.1.5 Warpage – height of highest corner

	height of highest corner (mm)
sample # 1	30
sample # 2	53

##### 3.1.6 Broken Corners – number / distance to corner

	number	size (mm)
sample # 1	0	0
sample # 2	0	0

##### 3.1.7 Squareness – difference in cross-corner lengths

	Squareness (mm)
sample # 1	2
sample # 2	2

##### 3.1.8 Edge Straightness – mm deviation per meter of edge

	Straightness (mm/m)
sample # 1	<0.5mm/m
sample # 2	0.5mm/m

### 3.2 SURFACE FINISH

#### TEST RESULTS

sample	60 degree gloss measurement	
	machine direction	cross-machine direction
sample # 1	8.8	8.9
sample # 2	9.4	9.3

### 3.3 LIGHT RESISTANCE

#### TEST CONDITIONS

black panel temp	70C
wet bulb depression	11C
conditioning water	20C
calibration at	420nm
irradiance rate	1.09 W/m <sup>2</sup> (1.10 ± 0.03)
<b>total irradiance</b>	<b>285.1 kJ/m<sup>2</sup></b>

#### TEST RESULTS

	Light Resistance =
sample # <b>1</b>	<b>NO EFFECT</b>
sample # <b>2</b>	<b>NO EFFECT</b>

*No Effect = no visible color or gloss change under the specified viewing conditions*

*Slight Effect = difficult to perceive change in color or gloss visible only at certain viewing angles or directions*

*Moderate effect = difficult to perceive change in color or gloss visible at all viewing angles or directions*

*Severe Effect = easily perceived change in color or gloss, or permanent change/damage to the decorative surface*

## 3.4 CLEANABILITY/STAIN

## TEST RESULTS

Sample #	Cleanability	Stain Resistance <i>(reagents not listed = no effect)</i>
sample # 1	9	no effect – reagents 1-15
sample # 2	9	no effect – reagents 1-15

reagent #	stain reagent
1	Distilled water
2	50:50 SD-3A ethyl alcohol:water
3	Acetone
4	Household ammonia (non-sudsing)
5	10% Citric acid solution
6	Vegetable cooking oil
7	Freshly prepared coffee
8	Freshly prepared tea
9	Tomato catsup
10	Plain prepared yellow mustard
11	Povidone iodine (10%)
12	Permanent Marker Pen
13	#2 pencil
14	Wax crayon
15	Shoe polish (black paste)

Cleaning steps: *(see NEMA LD3 2000 for full descriptions)*

1. tap water -- removed = (0)
2. BCS + sponge w/ 1 kg weight -- 25 cycles -- rinse w/ tap water -- removed = (1)
3. BCS + baking soda + brush -- 25 cycles -- rinse w/ tap water -- removed = (2).
4. cotton ball + nail polish remover -- rub  $\leq$  2 minutes -- rinse w/ tap water -- removed = (3)
5. cotton ball w/ bleach -- 2 minutes -- rinse w/ tap water -- removed = (4).
6. if reagent remains visible = (5).

*Cleanability = sum of reagent cleaning scores*

*Stain Resistance = No Effect / Moderate Effect / Severe Effect -- (reagents with cleaning score=5)*

*No Effect = no visible color or surface change under the specified viewing conditions*

*Moderate effect = difficult to perceive stain visible at all viewing angles or directions*

*Severe Effect = easily perceived stain, or permanent change/damage to the decorative surface*

**TEST DATA**

reagent	sample 1						cleanability score	stain	sample 2						cleanability score	stain		
	cleaning steps					cleanability score			stain	cleaning steps							cleanability score	stain
	0	1	2	3	4					0	1	2	3	4				
1	water						0	N						0	N			
2	ethanol						0	N						0	N			
3	acetone						0	N						0	N			
4	ammonia						0	N						0	N			
5	citric acid						0	N						0	N			
6	veg. oil	1					1	N	1					1	N			
7	coffee						0	N						0	N			
8	tea						0	N						0	N			
9	catsup						0	N						0	N			
10	mustard						0	N						0	N			
11	iodine						0	N						0	N			
12	perm. marker	1	1				2	N	1	1				2	N			
13	pencil	1	1				2	N	1	1				2	N			
14	crayon	1	1				2	N	1	1				2	N			
15	shoe polish	1	1				2	N	1	1				2	N			
<b>Cleanability</b>							<b>9</b>		<b>Cleanability</b>							<b>9</b>		

cleaning steps: (cleanability score)	0 = removed with water 1 = 20 cycles spray cleaner on sponge 2 = 20 cycles baking soda +spray cleaner on brush 3 = nail polish remover 4 = bleach 5 = not removed -- describe stain as Moderate (M) or Severe (S)
Stain Resistance	N = No Effect (=cleaning scores 0-4) M = Moderate Effect -- difficult to perceive stain S = Severe Effect -- easily perceived stain, or damaged surface
cleanability =	NEMA LD3 cleanability score = sum cleaning score for reagents 1-15

### 3.5 BOILING WATER RESISTANCE

#### TEST RESULTS

	Boiling Water Resistance =
sample # 1	<b>NO EFFECT</b>
sample # 2	<b>NO EFFECT</b>

*No Effect = no visible color or gloss change under the specified viewing conditions*

*Slight Effect = difficult to perceive change in color or gloss visible only at certain viewing angles or directions*

*Moderate effect = difficult to perceive change in color or gloss visible at all viewing angles or directions*

*Severe Effect = easily perceived change in color or gloss, or permanent change/damage to the decorative surface*

### 3.6 HIGH TEMPERATURE RESISTANCE

#### TEST RESULTS

	High Temperature Resistance =
sample # 1	<b>NO EFFECT</b>
sample # 2	<b>NO EFFECT</b>

*No Effect = no visible color or gloss change under the specified viewing conditions*

*Slight Effect = difficult to perceive change in color or gloss visible only at certain viewing angles or directions*

*Moderate effect = difficult to perceive change in color or gloss visible at all viewing angles or directions*

*Severe Effect = easily perceived change in color or gloss, or permanent change/damage to the decorative surface*

### 3.7 LINEAR GLASS SCRATCH RESISTANCE

*Scratches at 20, 50, 100, 200g loading*

#### TEST RESULTS

	Scratch Resistance =
sample # 1	<b>&lt;200g</b>
sample # 2	<b>&lt;200g</b>

*"<20g" = 20g, 50g, 100g and 200g scratches visible under specified viewing conditions*

*"<50g" = 50g, 100g and 200g scratches visible under specified viewing conditions*

*"<100g" = 100g and 200g scratches visible under specified viewing conditions*

*"<200g" = 200g scratches visible under specified viewing conditions*

*">200g" = no scratches visible under specified viewing conditions*



### 3.7 DIAMOND SCRATCH RESISTANCE

*Scratches at 1N, 2N, 4N, 6N loading*

*“contrast media” rubbed into scratches and wiped off*

#### TEST RESULTS

	Scratch Resistance =
sample # <b>1</b>	<b>4</b>
sample # <b>2</b>	<b>4</b>

*1 = Scratches at 1N, 2N, 4N, 6N visible*

*2 = Scratches at 2N, 4N, 6N visible*

*3 = Scratches at 4N, 6N visible*

*4 = Scratches at 6N visible*

*5 = No scratches visible under specified viewing conditions*

### 3.8 BALL IMPACT RESISTANCE

#### TEST CONDITIONS

224g steel ball – 38.1mm diameter

*report drop height with no surface fracture in 3 replicate drops (see LD3 for details)*

#### TEST RESULTS

	Ball Impact Resistance ( <b>mm</b> )
sample # <b>1</b>	<b>950</b>
sample # <b>2</b>	<b>600</b>

### 3.9 DART IMPACT RESISTANCE

#### TEST CONDITIONS

25g dart – 5mm diameter spherical tip

*report drop height with no surface fracture prior to a series of 3 consecutive fractures (see LD3 for details)*

#### TEST RESULTS

	Dart Impact Resistance ( <b>mm</b> )
sample # <b>1</b>	<b>1025</b>
sample # <b>2</b>	<b>550</b>

### 3.10 RADIANT HEAT RESISTANCE – COIL METHOD

average time in seconds to failure of 3 test runs

#### TEST RESULTS

	Average Radiant Heat Resistance (seconds)
sample # 1	161
sample # 2	126

#### TEST DATA

Sample	Rep1	Rep 2	Rep 3
sample # 1	165	157	162
sample # 2	130	127	122

### 3.11 DIMENSIONAL CHANGE

average of 3 replicates

#### TEST CONDITIONS

conditioned at 50% RH 70F

wet = 93%RH 40C for 7 days

dry = convection oven at 70C for 24hrs

#### TEST RESULTS

	Dimensional Change	
	Machine Direction	Cross Machine Direction
sample # 1	0.21%	0.65%
sample # 2	0.35%	0.73%

### 3.12 ROOM TEMPERATURE DIMENSIONAL STABILITY

average of 3 replicate samples

#### TEST CONDITIONS

conditioned at 50% RH 70F

wet = 98%RH 70F for 4 days

dry = 10% RH at 70F for 4 days

#### TEST RESULTS

	Room Temperature Dimensional Stability	
	Machine Direction	Cross Machine Direction
sample # 1	0.20%	0.35%
sample # 2	0.20%	0.45%

### 3.13 WEAR RESISTANCE

#### TEST CONDITIONS

abrasive strip correction factor = 1.074

*wear resistance is the average of initial and final points for 3 samples, adjusted by the abrasive strip correction factor, and rounded to the nearest 50 cycles*

#### TEST RESULTS

**Average Corrected WEAR RESISTANCE rounded to nearest 50 cycles**

	Average cycles
sample # 1	<b>650</b>
sample # 2	<b>650</b>

#### TEST DATA

Sample	replicate	Initial Point (raw cycles)	Final Point (raw cycles)
sample # 1	1	275	900
	2	225	925
	3	250	925
sample # 2	1	275	900
	2	225	1000
	3	250	950

### 3.14 FORMABILITY

*reported as the minimum radius formed on 3 samples without failure (breaking, cracking crazing, discoloration)*

#### TEST RESULTS

sample	minimum forming radius	
	machine direction (mm)	cross-machine direction (mm)
sample # 1	<b>16</b>	<b>10</b>
sample # 2	<b>10</b>	<b>8</b>

### 3.15 BLISTER RESISTANCE

average time in seconds to failure of 3 test runs

*postforming grades only*

#### TEST RESULTS

	Average Blister Resistance (seconds)
sample # 1	66
sample # 2	50

#### TEST DATA

<i>Sample</i>	<i>Rep1</i>	<i>Rep 2</i>	<i>Rep 3</i>
sample # 1	65	67	66
sample # 2	50	51	50

**SUMMARY**

**Post-Forming/HGP size: 1.0T x 4' x 8'**

TEST			<i>1 (1.0T)</i>	HGP (standard)
LD3.1	Appearance			
	3.1.4 Visual			
	Type A defects - smudges/smears/streaks/fingerprints	#A	<b>0</b>	0
	Type B defects - single particles 0.60mm <sup>2</sup> or more	#B	<b>0</b>	0
	Type C defects - 3+, each 0.30mm <sup>2</sup> +, w/in 300mm d circ	#C	<b>0</b>	0
	3.1.5 Thickness		<b>1.00</b>	0.88-1.12mm
	3.1.6 Flatness	max ht	<b>30</b>	120
	3.1.7 Broken Corners	# / dist. to corner	<b>0 / 0</b>	<1@25mm or <2@13mm
	3.1.8 Squareness	dif. cross corner lens.	<b>2</b>	<=6
		cross corner lens.	2707 / 2705	
3.1.9 Edge Straightness	mm dev./ m edge len	<b>&lt;0.5mm</b>	1.5mm/m	
LD3.2	Surface Finish	md 60deg gloss	<b>8.8</b>	x
		cmd 60deg gloss	<b>8.9</b>	x
LD3.3	Light Resistance -- xenon arc	NE   SL   M   S	<b>N</b>	SL
LD3.4	Cleanability/Stain Resistance clean: sum of scores reagents 1-15 // stain: list all w/ M   S water:0   25/bc.sponge:1   25/bk.sod.br:2   solv:3   CIO:4   5	cleanability sum of scores	<b>9</b>	20
		1-10:NE   M   S	<b>N</b>	N
		11-15:NE   M   S	<b>N</b>	M
LD3.5	Boiling Water Resistance	NE   SL   M   S	<b>N</b>	N
LD3.6.3	High Temperature Resistance (oil)	NE   SL   M   S	<b>N</b>	SL
LD3.7.2	Linear Glass Scratch Resistance	<20   <50   <100   <200   >200	<b>&lt;200</b>	x
LD3.7.3	Diamond Scratch Resistance	1   2   3   4   5	<b>4</b>	x
LD3.8	Ball Impact	impact height (3rep)	<b>950</b>	750
LD3.9	Dart Impact Resistance	impact height (3con.brk)	<b>1025</b>	300
LD3.10.2	Radiant Heat Resistance (coil)	ave. 3 samp. in sec	<b>161</b>	100
LD3.11	Dimensional Change	ave md %	<b>0.21%</b>	1.10%
		ave cmd %	<b>0.65%</b>	1.40%
LD3.12	Dimensional Stability	ave md %	<b>0.20%</b>	1.00%
		ave cmd %	<b>0.35%</b>	1.30%
LD3.13	Wear Resistance	ave.corr.WR rounded(50)	<b>650</b>	400
LD3.14	Formability postforming grades only	md pass/fail 3@radius	<b>16</b>	16
		cmd pass/fail 3@radius	<b>10</b>	16
LD3.15	Blister Resistance	ave of 3 in sec	<b>66</b>	55

Post-Forming/VGPsize:0.7Tx4'x8'

TEST			2 (0.7T)	VGP (standard)
LD3.1	Appearance			
	3.1.4 Visual			
	Type A defects - smudges/smears/streaks/fingerprints	#A	0	0
	Type B defects - single particles 0.60mm <sup>2</sup> or more	#B	0	0
	Type C defects - 3+, each 0.30mm <sup>2</sup> +, w/in 300mm d.circ	#C	0	0
	3.1.5 Thickness		0.74	0.60-0.80mm
	3.1.6 Flatness	max ht	53	120
	3.1.7 Broken Corners	# / dist. to corner	0 / 0	<1@25mm or <2@13mm
	3.1.8 Squareness	diff. cross corner lens.	2	<=6
		cross corner lens.	2740 / 2742	
3.1.9 Edge Straightness	mm dev / m edge len	0.5mm	1.5mm/m	
LD3.2	Surface Finish	md 60deg gloss	9.4	x
		cmd 60deg gloss	9.3	x
LD3.3	Light Resistance -- xenon arc	NE   SL   M   S	N	SL
LD3.4	Cleanability/Stain Resistance clean: sum of scores reagents 1-15 // stain: list all w/ M    S water:0   25/bc.sponge:1   25/bk.sod.br:2   solv:3   ClO:4   5	cleanability sum of scores	9	20
		1-10:NE   M   S	N	N
		11-15:NE   M   S	N	M
LD3.5	Boiling Water Resistance	NE   SL   M   S	N	N
LD3.6.3	High Temperature Resistance (oil)	NE   SL   M   S	N	SL
LD3.7.2	Linear Glass Scratch Resistance	<20   <50   <100   <200   >200	<200	x
LD3.7.3	Diamond Scratch Resistance	1   2   3   4   5	4	x
LD3.8	Ball Impact	impact height (3rep)	600	500
LD3.9	Dart Impact Resistance	impact height (3con.brk)	550	200
LD3.10.2	Radiant Heat Resistance (coil)	ave. 3 samp. in sec	126	80
LD3.11	Dimensional Change	ave md %	0.34%	1.10%
		ave cmd %	0.73%	1.40%
LD3.12	Dimensional Stability	ave md %	0.20%	1.00%
		ave cmd %	0.45%	1.30%
LD3.13	Wear Resistance	ave.corr.WR rounded(50)	650	400
LD3.14	Formability  postforming grades only	md pass/fail 3@radius	10	13
		cmd pass/fail 3@radius	8	13
LD3.15	Blisters Resistance	ave of 3 in sec	50	40