KTA-Tator, Inc.
115 Technology Drive
Pittsburgh, Pennsylvania 15275
Phone 412-788-1300 - Fax 412-788-1306

March 9, 2004

Mr. Jeff Buratto
Lifelast, Inc.
2119 SE Columbia Way
Suite 280
Vancouver, WA 98661

SUBJECT: Results of Physical Testing; KTA Project No. 240061

Dear Mr. Buratto:

In accordance with Proposal Number PN030671-R1 and subsequent signed Authorization to Proceed dated January 19, 2004, KTA-Tator, Inc. (KTA) has analyzed samples of DuraShield 210 coating membrane to determine various physical characteristics described below. The methods of testing and results are contained in this report.

SAMPLES

The following samples were received from Lifelast, Inc. on January 23, 2004:

Sample #1 – Six 4" x 12" panels and three 4" x 4" panels coated one side; seven 16" long 2.375" OD coated Pipe; one 5" x 5" free film; one 12" x 12" free film; and three 2" diameter free film disks, designated as DuraShield 210.

The following sample was received from Lifelast, Inc. on February 19, 2004:

Sample #2 – One 4" x 12" panel, designated as DuraShield 210.

It should be noted that at no time did KTA personnel witness the preparation of the above samples.

LABORATORY INVESTIGATION

The laboratory investigation consisted of testing samples of DuraShield 210 for tensile adhesion, cathodic disbondment, flexibility, impact resistance, abrasion resistance, water absorption, durometer hardness, dielectric strength, X-cut adhesion, tensile strength/elongation, and chemical resistance. The test methods are described below and the results are provided in Tables 1 through 9. A summary of the results can be found in Table 10.

Tensile Adhesion Strength

Tensile adhesion (pull-off strength) was determined in accordance with ASTM-D4541, "Pull-Off Strength of Coatings Using Portable Adhesion Testers," Annex A4, "Self-Alignment Adhesion Tester Type IV." The coating was reportedly applied to abrasive blast cleaned steel panels by Lifelast, Inc. The testing surface was abraded gently using fine sandpaper. Pull-stubs with roughened surfaces were attached to the coating using a two-component epoxy adhesive (Araldite 2011), which was allowed to cure for 48 hours at ambient laboratory conditions. The pull-stubs were then detached using a self-alignment pneumatic adhesion tester (PATTI-Pneumatic Adhesion Tensile Testing Instrument) equipped with an F-8 piston. The force (in psi) required to remove each pull-stub was recorded along with the locations of break and approximate percentage of each. The location of break was defined as cohesive (within the coating) or glue (coating strength exceeds glue strength). The results of the testing can be found in Table 1.

Table 1 – Results of Tensile Adhesion Testing

Replicate ID	Tensile Strength (psi)	Location of Break	Average Tensile Adhesion Strength
A	3140	50% Cohesive, 50% Glue	2950 psi
B	3020	80% Cohesive, 20% Glue	
C	2690	75% Cohesive, 25% Glue	

Cathodic Disbondment

The coating was tested for cathodic disbondment in accordance with ASTM-G8 "Cathodic Disbonding of Pipeline Coatings" at ambient laboratory conditions (25°C). The panels were visually inspected for holidays. Coating thickness measurements were obtained on each sample using a calibrated QuaNix® Model 1500 non destructive dry film thickness gage. A 1/4" diameter holiday was drilled into the center of each specimen along with two 1/4" diameter holes used for suspending the specimen and for electrical attachments. The specimens were immersed in an electrolyte solution consisting of sodium chloride, sodium sulfate, and sodium carbonate (1% by mass of each chemical). A 1.5 V potential was impressed upon the samples for 30 days.

The samples were removed and evaluated for disbondment after the 30 day period. Adhesion was assessed at the 1/4" holiday and at one non-immersed site by cutting an "X" through the coating at the sites and manually peeling back the coating to determine the extent of coating adhesion loss. Coating thickness measurements and disbondment data are provided in Table 2.

Table 2 – Results of Cathodic Disbondment Testing

Replicate ID	Average Coating Thickness	Area of Disbondment
A	37.3 mils	None (0 mm)
B	40.0 mils	None (0 mm)

Flexibility (Mandrel)

Flexibility testing was performed in accordance with ASTM-D522, "Mandrel Bend Test of Attached Organic Coatings," Method B. One of the 12" x 4" panels was bent over the 1" cylindrical mandrel, and the other panel over the 3/4" mandrel. No cracking, chipping, or flaking could be seen on the panel bent over the 1" mandrel when observed with a Meiji Model DMZ stereo zoom microscope at 45x magnification. The panel bent over the ¾" mandrel exhibited cracking. The elongation of the material was calculated for the sample bent over the largest (1") mandrel (that exhibited no cracking) and is reported in Table 3.

Table 3 – Flexibility Results

Sample Thickness	Mandrel Diameter	Elongation
30 mils	1"	9.6%

Impact Resistance

The impact resistance of the coating material was determined in accordance with ASTM-G14, "Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)." Seven 16" long Schedule 40, 2.375" OD pipe sections were reportedly coated by Lifelast, Inc. The dry film thickness was measured with a PosiTector® 6000 in the locations to be impacted, then the pipe was secured in the apparatus as described in the method. Two-pound and four-pound weights were dropped from various heights and the location of impact inspected for cracks or holidays in the coating film under 45x magnification with a Meiji Model DMZ Stereo Zoom microscope. Microscopic inspection was used in lieu of a low voltage holiday detector due to the thickness of the coating film. Twelve impact locations were observed and the impact strength calculated by employing height, weight, and frequency of coating failure data. Measured coating thickness ranged from 37 to 50 mils; the average coating thickness at the impact locations was 44 mils. The average impact strength was calculated to be 180 inch-pounds. The sample standard deviation was calculated to be 0.4 inch-pounds. Individual specimen data can be found in Table 4.

Table 4- Results of Impact Resistance Testing

Replicate No.	Coating Thickness (mils)	Impact Weight	Drop Height	Coating Condition by Inspection
1	42	2 lbs.	2' 0"	No breaks in film.
2	45	2 lbs.	3' 0"	No breaks in film.
3	47	2 lbs.	3' 4"	No breaks in film.
4	38	4 lbs.	2' 0"	No breaks in film.
5	50	4 lbs.	3' 0"	No breaks in film.
6	37	4 lbs.	3' 4"	Cracked film.
7	40	4 lbs.	3' 0"	Hole in film.
8	50	4 lbs.	3' 0"	No breaks in film.
9	45	4 lbs.	3' 0"	Small crack in film.

10	50	4 lbs.	3' 0"	No breaks in film.
11	40	4 lbs.	3' 2"	Cracked film.
12	40	4 lbs.	3' 0"	Cracked film.

Taber Abrasion Resistance

The Taber abrasion resistance was determined in accordance with ASTM-D4060, "Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser." Two 4" x 4", 0.032" coated panels were weighed then subjected to 1000 cycles using a 1000g load and CS-17 abrasion wheels. Post weights were acquired for both samples, and the weight loss (in mg) reported. The results of the testing are contained in Table 5.

Table 5 – Taber Abrasion Resistance Results

Replicate ID	Weight Loss (mg)	Average Weight Loss
A	67.7	69.4 mg
B	71.1	

Water Absorption

Water absorption of the coating material was measured in accordance with ASTM-D570, "Standard Test Method for Water Absorption of Plastics." Two 2" diameter, 0.134" thick free-film disks were initially weighed then immersed in room temperature (25°C) distilled water. The disks were removed at various intervals, wiped dry, weighed, and immediately replaced in the water. The disks were determined to be substantially saturated at ten days of immersion. The disks remained immersed for 30 days, then removed, wiped dry, and re-weighed. The average percent increase in weight was determined to be 0.583%. The average percent water-soluble matter lost was 0.119%. The percentage of water absorbed was 0.464% (calculated from the difference of the two previously mentioned values). Individual data from the specimens can be found in Table 6 below.

Table 6 – Results of Water Absorption Determination

Replicate ID	Percent Weight Increase	Percent Soluble Matter Lost	Average % Weight Increase	Average % Soluble Matter Lost	Average % Water Absorbed
A	**0.570%**	**0.128%**	**0.583%**	**0.119%**	**0.464%**
B	**0.595%**	**0.109%**			

Hardness (Durometer)

The hardness of the coating material was evaluated in accordance with ASTM-D2240, "Standard Test Method for Rubber Property-Durometer Hardness," using a Shore D durometer. Measurements were made on samples of varying thickness to ensure accuracy. The results are reported in Table 7.

Table 7 – Durometer Hardness Results (Shore D)

Individual Hardness Determinations	Average Hardness
74, 73, 75, 73, 74	74

Dielectric Strength

Dielectric strength testing was performed in accordance with ASTM-D149, "Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies." Testing was performed by Plastics Technology Laboratories, Inc. in Pittsfield, MA. A copy of the laboratory report is attached. The breakdown voltage was reported to be 470 Volts/mil.

X-Cut Adhesion

The adhesion of the coating system was determined in accordance with ASTM-D6677, "Standard Test Method for Evaluating Adhesion by Knife." Two 5" cuts were made with a new utility knife blade at 45° angles to each other. The knife blade was used to lift the coating up from the substrate beginning at the vertex of the "X." The coating was extremely difficult to remove and fragments no larger than 1/32" were able to be lifted, which was consistent with a rating of "10."

Tensile Strength/Elongation

The tensile strength of the coating material was determined in accordance with ASTM-D412, "Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers–Tension," Method A. Five specimens were cut into dumbbell shapes (Type IV, Die C) in accordance with the method. The specimens were pulled with a Tinius Olsen Universal Testing Machine at a rate of 2.0 inches per minute. The tensile strength was calculated using the force required to break the specimens along with the width and thickness of each. Benchmarks were used to determine the percent elongation to the nearest 10%. The individual results, along with the average, are reported in Table 8 below.

Table 8 – Results of Tensile Strength/Elongation Testing

Replicate ID	Tensile Strength	Elongation	Average Tensile Strength	Average Elongation
A	3070	10%	3030	10%
B	2890	10%		
C	3030	20%		
D	2920	10%		
E	3240	10%		

Chemical Resistance

The coating was evaluated for chemical resistance in accordance with ASTM-D543, "Test Method for Resistance of Plastics to Chemical Reagents," as well as the AWWA Standard for Urethane Linings. The chemical resistance was determined at ambient laboratory temperature (25°C) according to Practice A, Procedure I (Weight and Dimension Changes) of the ASTM method. Free-film samples

(0.012" thickness) were cut into twelve 1.5" x 5" strips that were then measured, conditioned, weighed, then completely immersed in one of four chemical solutions: including 10% sulfuric acid (H_2SO_4), 30% sodium chloride (NaCl), 30% sodium hydroxide (NaOH), or #2 diesel fuel. At the end of 30 days, the samples were removed and gently wiped dry. The samples were allowed to stand for 24 hours before being re-weighed and measured. The samples were then examined visually for evidence of blistering, cracking, softening, or deterioration. The results of the chemical resistance evaluation can be found in Table 9.

Table 9- Results of Chemical Resistance Testing

Sample ID	Immersion Solution	Percent Change in Length	Average % Change in Length	Percent Change in Width	Average % Change in Width	Percent Weight Change	Average % Weight Change	Visual Defects
A	10% H_2SO_4	+0.163%	+0.212%	-0.137%	-0.866%	+0.223%	+0.243 %	None
B	10% H_2SO_4	+0.231%		-2.19%		+0.242%		None
C	10% H_2SO_4	+0.242%		-0.270%		+0.265%		None
D	30% NaCl	-0.794%	-0.212%	+0.551%	+0.924%	+0.156%	+0.163 %	None
E	30% NaCl	-0.080%		+1.944%		+0.185%		None
F	30% NaCl	+0.239%		+0.278%		+0.148%		None
G	30% NaOH	-0.940%	-0.600%	+0.852%	+1.67%	+0.192%	+0.242 %	None
H	30% NaOH	0.000%		+3.33%		+0.264%		None
I	30% NaOH	-1.10%		+0.829%		+0.270%		None
J	#2 diesel fuel	-0.626%	-0.488%	-0.794%	+1.29%	+2.00%	+2.00 %	None
K	#2 diesel fuel	0.000%		+1.35%		+2.13%		None
L	#2 diesel fuel	-0.237%		+1.63%		+1.87%		None

Table 10 – Summary of Performance Data

Test Performed	Standard Method	Result
Adhesion	ASTM-D4541; Annex A2	2950 psi
Cathodic Disbondment	ASTM-G95, Method A	0 mm
Flexibility	ASTM-D522	1" diameter bend, 9.6% elongation
Impact Resistance	ASTM-G14	180 inch-pounds
Abrasion Resistance	ASTM-D4060	69.4 mg loss
Water Absorption	ASTM-D570	+0.464%
Durometer Hardness	ASTM-D2240	74 (Shore D)
Dielectric Strength	ASTM-D149	470 Volts/mil
X-Cut Adhesion	ASTM-D6677	10
Tensile Strength/Elongation	ASTM-D412	3030 psi; 10% elongation
Chemical Resistance	ASTM-D543, Procedure I Duration: 30 days	Less than 1% change in length, width, or weight in 10% H_2SO_4
		Less than 1% change in length, width, or weight in 30% NaCl
		Less than 2% change in length, width, or weight in 30% NaOH
		2.00% weight change and less than 2% change in length or width in #2 diesel fuel

Based on averages from Tables 1-9.

If you have any questions or comments, please do not hesitate to contact me at 412-788-1300, extension 230.

Very truly yours,

KTA-TATOR, INC.

Carly M. Pravlik
Analytical Technician

CMP/CLO/WDC:jas

JN240061
Jas04078