ALUMINUM SIGN RECYCLING

Final Report

SR 500-510

Oregon Department of Transportation

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SR 500-510

by

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16. Abstract

The intent of this investigation was to determine whether aluminum signs that underwent the hydro-stripping process would meet ODOT's specification for sign blanks based primarily on whether the anti-corrosive coating was removed during stripping process. Due to a change in the anti-corrosive coating applied to new sign blanks, which resulted in two types of coatings in ODOT's sign inventory, the outcome of the investigation was a set of baseline measurements for the hydro-stripping process.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit	(F-32)/1.8	Celsius	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
m^2	meters squared	1.196	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius	1.8C+32	Fahrenheit	°F

*SI is the symbol for the International System of Measurement

ACKNOWLEDGEMENTS

The author would like to acknowledge the Technical Advisory Committee members for their help in seeing this project through to the end. Other people with significant contributions included Greg Stellmach, Gary Farnsworth, Wendy Every, and Annette Liebe.

DISCLAIMER

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1.0 INTRODUCTION

Hydro-stripping is a process that uses water at a high pressure to remove reflective sheeting from aluminum. It offers an innovative way to reuse highway signs that would typically be scrapped, and therefore has the potential to create a more sustainable sign manufacturing option that saves money and is better for the environment. While hydro-stripping presents a number of advantages, the ability of hydro-stripped signs to meet performance standards and sign specifications is unknown.

The Oregon Department of Transportation's (ODOT) sign fabrication materials include three components: the aluminum sheeting that serves as the base of the sign, the anti-corrosive coating that is applied to the aluminum, and the reflective sheeting that is adhered to the coated aluminum. The intent of this investigation was to determine whether aluminum signs that underwent the hydro-stripping process would meet ODOT's specification for sign blanks based primarily on whether the anti-corrosive coating was removed during stripping process. Due to a change in the anti-corrosive coating applied to new sign blanks, which resulted in two types of coatings in ODOT's sign inventory, the outcome of the investigation was a set of baseline measurements for the hydro-stripping process. Long term performance monitoring to test how reflective sheeting will adhere to hydro-stripped signs is being conducted internally by ODOT using signs that were hydro-stripped during this research project.

2.0 STANDARD PRACTICE AND SIGN SPECIFICATIONS

The majority of ODOT's signs are fabricated internally by purchasing materials, cutting to size, adhering reflective sheeting and assembling the signs. In few circumstances ODOT outsources fabrication to external entities (pre-made for specific construction projects by vendors). The signs are numbered and documented within a sign database. Signs are then released to the requesting district for deployment.

Sign fabrication is guided by specifications ASTM B209, which details the aluminum alloy grade needed for the sign, as well as ASTM B449-93, which requires an adequate amount of anti-corrosive coating of chromate be applied to the aluminum. The process to measure the amount of chromate present is by precise weight differences of the sheet aluminum just before and after the addition of the chromate conversion layer. Application is commonly done by a dipping or immersion process (*NEWMOA 200*3) or may also be done by spray or wipe-on methods. In most cases the chromate layer thickness is extremely thin, measured in ten thousandths of an inch. The weight differences between before and after the addition of a chromate layer by this method are recorded and entered into a formula to calculate mass per unit area, which is an acceptable industry standard to prove an adequate amount (and presence of) chromate (*ISO3892 2001*).

ODOT accepts a certificate from the aluminum sheeting manufacturer stating they have applied the anti-corrosive layer according to the standard when the sheeting is received. ODOT staff also inspect the aluminum sheeting for thickness levels to meet The Aluminum Association's thickness tolerances for aluminum alloys (*Aluminum ANSI 2009*).

Through the course of this project, the research team discovered that aluminum suppliers had moved away from the more toxic chromate anti-corrosive coating to a titanium-based coating. It was found that the sign specifications had not kept pace with this change and in turn need to be updated to account for the anti-corrosive coatings currently being used by aluminum sheeting suppliers. One of the major factors behind the change was likely the product's toxicity level and potential health risk to the workers exposed to it. Illustrating this danger was the 2006 Occupational Safety and Health Administration (OSHA) change which reduced occupational exposure of hexavalent chromium use from 52 $\mu g/m^3$ to 5 $\mu g/m^3$ (*OSHA n.d.; La Scala 2009*).

3.0 DOCUMENTED BENEFITS AND SURVEY

A search during the spring of 2012 revealed no direct primary research publications that provided information regarding effects of hydro-stripping on anti-corrosive conversion coatings. Information about the potential benefits of hydro-stripping including the cost and environmental advantages was uncovered and is described in Section 3.1 below.

State DOTs along with a number of maintenance offices were surveyed to obtain information about their experiences using hydro-stripping. The survey instrument is provided in Appendix C and the results are presented in Section 3.2.

3.1 HYDRO-STRIPPING BENEFITS

3.1.1 Cost Advantages

Both the New Hampshire Department of Transportation (NHDOT) and the Missouri Department of Transportation have documented cost savings from using hydro-stripping An AASHTO publication which was a part of NCHRP Project 25-25, Task 4, National Cooperative Highway Research Program Transportation Research Board (*Venner 2004*), was quoted: "NHDOT also began hydro-stripping worn aluminum traffic signs. This has resulted in lower resource use, and lower cost to deploy signing, since the reused blanks are 40 percent less costly than new material. The Missouri Department of Transportation (MoDOT) explained how their sign reclamation program evolved from its beginnings in 1978 and resulted in significant cost savings:

> "The total cost of the original sign reclamation plant and its operation was $1.1 million. The use of the aluminum sign blanks, which were refinished that year in lieu of purchasing new aluminum sign blanks, saved MoDOT more than the total cost of construction and operation of the reclamation operation. In each year of operation the plant has returned to MoDOT as much as the original cost of the investment ($1.1 million). The original plant was equipped with a metal sander, a press to straighten damaged blanks, along with a metal shear, which was used to cut away damaged parts of a blank in order to create a smaller sign blank rather than scrapping the damaged sign.
>
> In 1997, the reclamation operation was turned over to the Missouri Department of Corrections since they could do the work at an even greater savings to MoDOT. Since that time various improvements have been incorporated to enhance the operation. A major change involved switching from a sanding operation to remove the sheeting material to a Hydro-Stripper which performs the cleaning operation. This method has an added advantage of not removing the aluminum coating of chromate that is used to provide better adherence of reflective sheeting or paint. The current cost of reclaiming rather than purchasing new sign blanks is a 75 percent savings. For the larger extruded structural signs the saving is slightly less. The saving to MODOT in 2003 was $3.5 million dollars (*Venner 2004)*."

In a 2010 update, MoDOT's newsletter (*Roadside Review 2010*) confirmed approximately 70% of the state highway signs have been recycled and saved at total of $714,000.00 in 2007.

3.1.2 Environmental Advantages

The AASHTO publication (*Venner 2004*) continued with findings from North Carolina that speak to the recycling potential hydro-stripping represent:

> "…aluminum sign recycling is conducted through arrangements between the NCDOT and Department of Corrections. DOC purchased a hydro-stripper that utilizes a high pressure water system to remove old reflective material from the signs. Because it uses water, the signs are not ground away which allows the aluminum to be used over and over. The most outstanding feature of this method is that the aluminum is not affected during the cleaning process, thereby eliminating the need to reapply the chromate coating (*Venner 2004*)."

3.1.3 Ease of Use of Hydro-Stripping Process

ODOT officials toured a hydro-stripping operation on 7/26/2011. Their findings included the following observations:

- The process is simple.
- The hydro-stripping machine controls water pressure outflow and is monitored. The water is passed through a number of jet heads. If the jet heads are broken or defective, they could be easily replaced.
- The hydro-stripping machine controls the head distance and speed as it passes over the signs during cleaning. The automation allows for more consistency when removing reflective sheeting.
- Signs can easily be put through the cleaning process again, if areas are missed or difficult to remove.
- Extruded aluminum signs or oddly shaped signs are easily accommodated.

3.2 DOT SURVEY

A survey was sent to all 50 state DOTs, Canadian provinces, other U.S. Territories, all Oregon city maintenance offices, and all Oregon county maintenance offices. The survey results were compiled in August 2011. Appendix C provides a copy of the survey instrument. In summary, 15 DOTs, 12 Oregon counties, and 24 Oregon cities responded. The responses indicated that 8 DOTs, 5 Oregon counties, and 9 Oregon cities use or have used hydro-stripping services for their aluminum signs.

Summary interpretations of survey:

- Three DOTs reported positive experiences with hydro-stripping.
- The technology has been in use with other agencies for up to 10 years.

- Wisconsin and South Carolina DOTs allow hydro-stripping and claimed to have completed testing for chromate. South Carolina reported that they have been using hydro-stripping since 2007 and "there was no depreciable difference in the level of chromate after hydro-stripping", however both DOTs did not report testing methods or quantifiable results. Follow-up interviews claim they don't remember any negative effects to chromate levels.

- Several DOTs allow hydro-stripping, but also have ASTM B-449 as a specification, which requires a chromate anti-corrosive coating. No results were found from their quality assurance/quality control efforts.

- Other states have no anti-corrosion specification or use liberal terminology for a supplier to state what anti-corrosive layers exist.

- Indiana reported the process was "too labor intensive to be cost effective".

- The City of Salem in Oregon reported "minimal" savings.

4.0 TESTING AND RESULTS

The objective of this research was to explore whether hydro-stripping affected signs' ability to meet ODOT specifications. Chromate presence testing was done to investigate whether the anti-corrosive coating on signs was affected by hydro-stripping. Sign thickness was measured before and after hydro-stripping to assess whether a used hydro-stripped sign would fall within specification tolerance levels.

4.1 CHROMATE TESTING

Chromate coating measurements were done using the quantitative analysis described in ASTM B-449 Appendix X.1 (A*STM 2004*). The qualitative test involves using a lead nitrate solution and confirms a minimum amount of chromium present, which is 5 mg (milligrams) per meter squared. The chromate confirmation tests were conducted using an independent laboratory and are detailed in Appendix B.

4.1.1 Chromate Presence Testing Prior to Hydro-stripping

Coupon samples from both blank stock aluminum sheeting and signs removed from the field were sent to UL labs to be tested for chromate presence prior to a hydro-stripping process. All five of the blank aluminum sign samples indicated no presence of chromate. An older blank aluminum sheet was afterward sent to the lab and tested positive for chromate. It was through this process that the research team discovered that there was a mismatch between the coating specification and new aluminum stock (see Section 2.0). This change was then confirmed with an aluminum sheeting supplier who indicated that the current product being used is the titanium based coating, Alodine 5200, in accordance with ASTM-B-921. The Department of Defense tested chromate coatings compared to titanium-based coatings, and the results indicated that chromate and titanium-based coatings were comparable and both performed well in corrosion tests *Placzankis et al 2003a; Placzankis et al 2003b*).The supplier estimated this change occurred in 2006. This change explains why the new sheeting fabricated in 2010 showed no presence of chromate, while the older aluminum of blank, estimated to be fabricated prior to 2008, tested positive for chromate presence.

Coupons from the signs in the field were taken from the least damaged sections of the signs, typically areas close to where the post was attached. The tests were conducted on the back of the sign, in which there was no reflective sheeting. Chromate presence tests showed mixed results with two of the five signs showing no chromate present on both coupons tested, while two signs had mixed results with one coupon showing a positive indication and another coupon showing a negative indication. For one sign, only one coupon was tested and it tested positive for chromate. The results for both aluminum sign blanks as well as used field signs are presented in Table 4.1 below. Lab test results are detailed in Appendix B.

Table 4.1: Sign Chromate Test Results, Not Hydro-Stripped

Sign Number	Coupon Tested	Description	Test	Result	Test Date	Install Date
1	A	No Left Turn	ASTM*	No Chromate	3/13/2012	2006
1	D		ASTM*	No Chromate	12/15/2011	2006
2	A	¼ Mile Exit	ASTM*	No Chromate	3/13/2012	2003
2	D		ASTM*	No Chromate	12/15/2011	2003
8	A	Historical Marker	ASTM*	Chromate Present	3/13/2012	~2003
8	D		ASTM*	No Chromate	12/15/2011	~2003
12	A	Route 30	ASTM*	Chromate Present	3/13/2012	N/A
12	D		ASTM*	No Chromate	12/15/2011	N/A
17	A	State Road 7	ASTM*	Chromate Present	3/13/2012	N/A
18	C	New sheet stock	ASTM*	No Chromate	3/13/2012	~ 2010
19	C	New sheet stock	ASTM*	No Chromate	3/13/2012	~ 2010
20	C	New sheet stock	ASTM*	No Chromate	3/13/2012	~ 2010
21	C	New sheet stock	ASTM*	No Chromate	3/13/2012	~ 2010
22	C	Older Sheet Stock	ASTM*	Chromate Present	3/13/2012	2008**
Blank	A	New sheet stock	ASTM*	No Chromate	12/15/2011	~ 2010

*ASTM B449, Appendix X1.2, Lead nitrate test
**Crew confirmed sign stock to be in shop for at least 5 years.

4.2 RE-COATED HYDRO-STRIPPED SIGNS

A manufacturing company hired by Northwest Recycling (*Morisette unpublished data*) measured thickness levels with a micrometer on three aluminum signs before and after hydro-stripping. After subtracting the standard thickness of the reflective sheeting, they found all signs were within tolerance levels, as per The Aluminum Association and ANSI's Thickness Tolerances of Aluminum Alloys (*Aluminum ANSI 2009*). This is important because it verifies the used signs are structurally sound and still within tolerance levels to be re-used. Northwest Sign Recycling took two of the three used hydro-striped signs and re-coated them with a chromate coating using a dipping process (*Morisette unpublished data)*. The two newly re-coated signs were then hydro-stripped again, after which Morisette concluded that hydro-

stripping does not remove the chromate coating. See Appendix A for Morisette's letter and addendum documenting their results.

4.3 DECISION TO DISCONTINUE CHROMATE TESTING

The Technical Advisory Committee (TAC) overseeing the research met after discovering that aluminum sheeting suppliers were no longer using chromate as their anti-corrosive coating. The TAC decided that given this change it did not make sense to spend resources testing for chromate after the hydro-stripping process.

4.4 COST COMPARISON

ODOT has a sign inventory of approximately 165,000 signs and estimates it replaces approximately 4,000 aluminum signs each year with the life expectancy of a sign being approximately 7-12 years (*M. Kimlinger unpublished data*). ODOT's sign crew leaders explained that corrosion has not been a factor in replacement of signs (*R.Williams unpublished data*).

As part of this research effort, the ODOT Sign Shop conducted a comparison of costs using hydro-stripping services compared to the current standard method of scrapping and purchasing anew. During the evaluation, 441 signs of flat aluminum sizes ranging from 12" x 24" to 48" x 60" were hydro-stripped and returned for re-use. Percentage savings per size ranged from 5% to 56%. Overall the average unit price was $18.20 with an average savings of $7.54/per sign using hydro-stripping services. Assuming the 441 signs taken from the sign shop's old sign inventory are a fairly accurate representation of the sizes of signs being replaced, it is possible to estimate ODOT's potential annual savings. Using the average per sign savings multiplied by the estimated number of aluminum signs replaced ODOT would potentially save an estimated $30,160 each year using hydro-stripping on flat aluminum signs.

4.5 LABELING

Labeling and capturing information regarding the sign and history of hydro-stripping was a concern discovered during the DOT survey and again during discussions with Illinois DOT (*Brown unpublished data*). In response to those concerns, ODOT required a label to be placed on the back of the refurbished sign to indicate the number of times the sign had been hydro-stripped and the date (day, month, year) the hydro-stripping was performed with the vendor's information. Figure 5.1 illustrates an example of the label.

Figure 5.1: Newly Implemented Label Design for ODOT, Placed on Back of Hydro-Stripped Signs

Additionally, ODOT's sign inventory database was augmented to allow hydro-stripped signs to be identifiable within their unique identifying key number. These measures will ensure ODOT has data to determine sign performance and are able to distinguish hydro-stripped signs from new aluminum blank signs.

5.0 SUMMARY DISCUSSION AND CONCLUSION

This research project set out to examine the impact of hydro-stripping through the lens of ODOT's signs specifications. Through the course of the project, the team discovered that while hydro-stripped signs were able to meet thickness specifications, the specification detailing the chromate anti-corrosive coating had not kept pace with the new coating that aluminum sheeting vendors currently provide. Long term performance monitoring of hydro-stripped signs will be an important source of information as ODOT moves forward with hydro-stripping.

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APPENDIX A:
LETTER FROM MORISETTE MANUFACTURING

Morisette
Manufacturing LLC

May 19, 2011

Jon Lazarus, MBA, PMP
ODOT Research Coordinator
200 Hawthorne Ave. SE, Suite B-240
Salem, OR 97301

Northwest Sign hired me to measure the effects of hydrostripping aluminum highway signs to determine if the high-pressure water was diminishing the thickness or damaging the surface of such signs. Three samples were done on different signs and my findings are listed below. Please note that the initial measurement includes the reflective decal, which has a standard factory thickness of 7mil.

Thursday 4/28/2011

Sign Tests

3 signs were tested for thickness before and after hydrostripping:

Sign 1: Stop Sign 30" X 30"

Sign with decal .084"
Sign after hydrostripping .078"

Sign 2: Yield Sign 30" X 30"

Sign with decal .0835"
Sign after hydrostripping .0785"

Sign 3: Pedestrian Crossing Sign 30" X 30"

Sign with decal .085"
Sign after hydrostripping .0775"

Aluminum sheet tolerances: For aluminum sheet .080" thick the tolerance is +/- .0035 in widths up to 39.37". This would make factory tolerances .0765" to .0835", which would leave all of these signs well within original tolerances.

Respectfully,

Brian Morisette

Enclosures: photo documentation

1417 NW Murphy Ct, Prineville OR 97754 (541) 325-1300 www.morisettemfg.com

Morisette Manufacturing LLC

TOLERANCES

ALUMINUM THICKNESS TOLERANCES
FLAT SHEET – COILED SHEET – PLATE

Inches – Plus or Minus

2036	5083	5252	5456	Brazing Sheet
3004	5086	5254	5652	11,12,23,24
5052	5154	5454	6061	Also Alclad Alloys

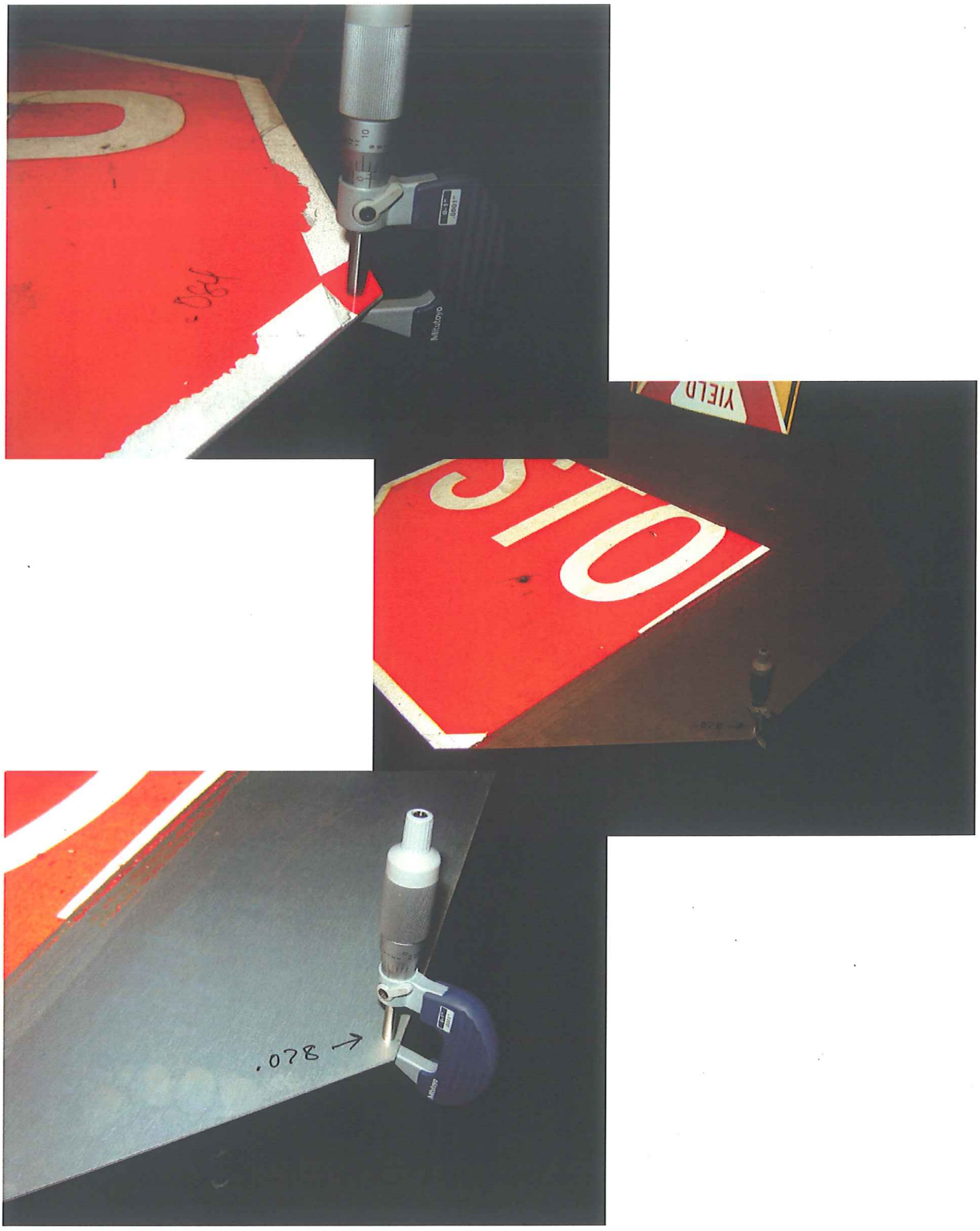
Specified Thickness In Inches	Specified Widths In Inches							
	39.37 and Under	Over 39.37-59.06	Over 59.06-78.74	Over 78.74-98.43	Over 98.43-118.11	Over 118.11-137.80	Over 137.80-157.48	Over 157.48-177.17
0.006-0.010	.0010	.0020	–	–	–	–	–	–
0.011-0.016	.0015	.0025	–	–	–	–	–	–
0.017-0.025	.0020	.0030	–	–	–	–	–	–
0.026-0.032	.0020	.0035	.0045	–	–	–	–	–
0.033-0.039	.0025	.0035	.0055	.007	–	–	–	–
0.040-0.047	.0030	.0040	.006	.008	.010	.011	–	–
0.048-0.063	.0030	.0045	.007	.009	.011	.013	–	–
0.064-0.079	.0035	.0055	.007	.010	.013	.015	–	–
0.080-0.098	.0035	.006	.008	.011	.015	.018	–	–
0.099-0.126	.0045	.007	.010	.013	.016	.020	–	–
0.127-0.158	.0055	.008	.012	.015	.018	.022	–	–
0.159-0.197	.007	.010	.015	.018	.022	.026	–	–
0.198-0.248	.009	.012	.017	.021	.025	.029	–	–
0.249-0.315	.012	.015	.019	.024	.029	.033	.041	.051
0.316-0.394	.017	.018	.022	.028	.033	.039	.047	.059
0.395-0.630	.023	.023	.028	.033	.039	.047	.059	.070
0.631-0.984	.031	.031	.037	.043	.051	.060	.070	.085
0.985-1.575	.039	.039	.047	.055	.065	.075	.090	.105
1.576-2.362	.055	.055	.060	.070	.090	.100	.115	–
2.363-3.150	.075	.075	.085	.100	.110	.125	–	–
3.160-3.937	.100	.100	.115	.130	.150	.160	–	–
3.938-6.299	.130	.130	.145	.165	–	–	–	–

1060	**3003**	**5005**	**5657**
1100	**3005**	**5050**	**1100 Reflector Sheet**
1350	**3105**	**5457**	**Also Alclad Alloys**

0.006-0.010	.0010	.0015	–	–	–	–	–	–
0.011-0.016	.0010	.0020	–	–	–	–	–	–
0.017-0.025	.0015	.0020	.0030	.0035	–	–	–	–
0.026-0.032	.0020	.0025	.0035	.0040	–	–	–	–
0.033-0.039	.0020	.0030	.0035	.0045	.006	–	–	–
0.040-0.047	.0025	.0035	.0045	.0055	.007	–	–	–
0.048-0.063	.0030	.0035	.0055	.006	.007	.009	–	–
0.064-0.079	.0035	.0040	.006	.007	.008	.010	–	–
0.080-0.098	.0035	.0045	.007	.008	.010	.011	–	–
0.099-0.126	.0045	.0055	.007	.010	.011	.013	–	–
0.127-0.158	.0055	.007	.009	.011	.013	.015	–	–
0.159-0.197	.007	.009	.011	.013	.015	.018	–	–
0.198-0.248	.009	.011	.013	.015	.018	.022	.027	–
0.249-0.315	.012	.014	.015	.018	.022	.027	.036	.047
0.316-0.394	.017	.017	.020	.023	.027	.033	.041	.051
0.395-0.630	.021	.021	.027	.032	.037	.043	.053	.065
0.631-0.984	.031	.031	.037	.043	.051	.060	.070	.085
0.985-1.575	.039	.039	.047	.055	.065	.075	.090	.105
1.576-2.362	.055	.055	.060	.070	.090	.100	.115	–
2.363-3.150	.075	.075	.085	.100	.110	.125		
3.160-3.937	.100	.100	.115	.130	.150	.160		
3.938-6.299	.130	.130	.145	.165				

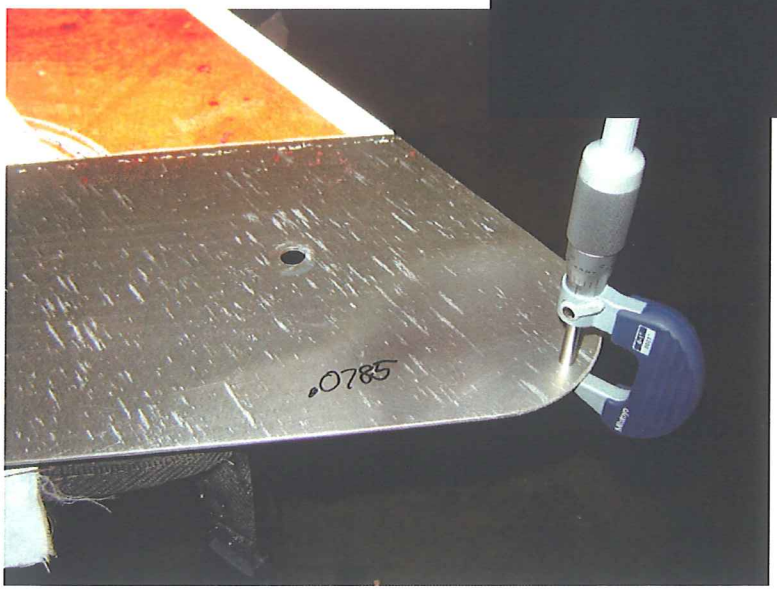
When a tolerance for a thickness is specified other than one of the equal bilateral tolerances, the value of the Limited Tolerance that which applies to the nearest of the maximum

Morisette Manufacturing LLC



1417 NW Murphy Ct, Prineville OR 97754 (541) 325-1300 www.morisettemfg.com

Morisette Manufacturing LLC



1417 NW Murphy Ct, Prineville OR 97754 (541) 325-1300 www.morisettemfg.com

Morisette Manufacturing LLC

1417 NW Murphy Ct, Prineville OR 97754 (541) 325-1300 www.morisettemfg.com

NORTHWEST SIGN RECYCLING LLC – ADDENDUM

After Brian Morisette had completed measurements of the signs before and after hydrostripping, the stripped signs were taken to Redmond Metal Finishing, 336 NE Hemlock Avenue #6, Redmond, OR 97756, (541) 548-1721.

Three signs were coated with chromate by using a dip process. Two of the three signs were then hydrostripped again to monitor the affect of the stripping process on the chromate coating. Hydrostripping does not remove the chromate coating.

The tasks we observed that did affect the chromate coating were - sponging to remove any additional adhesive residue, any grinding to remove burrs and straightening.

APPENDIX B:
UL LABORATORY RESULTS FOR PRESENCE OF CHROMATE

08/13/2012

Project No. 11CA58528 File TC8624 Page 1
LABORATORY DATA PACKAGE

Number of pages in this package __15__ [including additional pages _____]
(Fill in when using printed copy as record)

TEST LOCATION:					
[X]UL or Affiliate	[WTDP	[]CTDP	[]TPTDP	[]TCP	[]PPP
	[]WMT	[]TMP	[]SMT		
Company Name	UL Northbrook				
Address					

CLIENT INFORMATION	
Company Name	OREGON DEPARTMENT OF TRANSPORTATION
Address	5TH FL,355 CAPITOL ST NE SALEM,OR,UNITED STATES,97301

AUDIT INFORMATION:			
Description of Tests	Per Standard No. ASTM B449	Edition/ Revision Date	Issued 1993, revised in June 2010

[x] Tests Conducted by +	G. Manzella	
	Printed Name	Signature
[] UL Staff conducting or witnessing testing (WTDP, TMP, WMT only) [] UL Staff supervising UL Staff in training []Authorized Signatory (CTDP, TPTDP, TCP, PPP, SMT)		
	Printed Name	Signature, and include date for CTDP, TPTDP, TCP, PPP, WMT, TMP, SMT
Reviewed and accepted by qualified Project Handler	John Marke	John Marke
	Printed Name	Signature

TESTS TO BE CONDUCTED:

Test No.	Done +++	Test Name	[] Comments/Parameters []Tests Conducted by ++
1		ASTM B449 Chromium Test - Appendix X1.2	

Instructions -
+ - When all tests are conducted by one person, printed name and signature can be inserted here instead of including printed name and signature on each page containing data. Must indicate number of pages in the data package.
++ - When test conducted by more than one person, printed name and signature of person conducting the test can be inserted next to the test name instead of including printed name and signature on each page containing data. Must indicate number of pages in the data package.

+++ - Use of this field is optional and may be employed differently.

Special Instructions -

As per the client, please test the side opposite to the side stamped. When testing the material, please try to avoid testing the stamp portion as much as possible.

Also, on datasheets please ensure to indicate the client designator from the stamp for each tested set.

Unless specified otherwise in the individual Methods, the tests shall be conducted under the following ambient conditions. Confirmation of these conditions shall be recorded at the time the test is conducted.

Ambient Temperature, C	25 ± 10	Relative Humidity, %	50 ± 10	Barometric Pressure, mBar	N/A

RISK ANALYSIS RELATED TO TESTING PERFORMANCE:

The following types of risks have been identified. Take necessary precautions. This list is not all inclusive.

[ ] Electric shock	[ ] Radiation
[ ] Energy related hazards	[ ] Chemical hazards
[ ] Fire	[ ] Noise
[ ] Heat related hazards	[ ] Vibration
[ ] Mechanical	[ ] Other (Specify)__

Tested by: _____ Date _____

Printed Name Signature

TEST EQUIPMENT INFORMATION

Inst. ID No.	Instrument Type	Test Number +, Test Title or Conditioning	Function /Range	Last Cal. Date	Next Cal. Date

+ - If Test Number is used, the Test Number must be identified on the data sheet pages or on the Data Sheet Package cover page.

The following additional information is required when using client's or rented equipment, or when a UL ID Number for an instrument number is not used. The Inst. ID No. below corresponds to the Inst. ID No. above.

Inst. ID No.	Make/Model/Serial Number/Asset No.

[x] UL test equipment information is recorded on Meter Use in UL's Laboratory Project Management (LPM) database.

Tested by: _____ Date _____

Printed Name Signature

TEST SAMPLE IDENTIFICATION:

The table below is provided to provide correlation of sample numbers to specific product related information. Refer to this table when a test identifies a test sample by "Sample No." only.

Sample Card No.	Date Received	[] Test No.+	Sample No.	Manufacturer, Product Identification and Ratings
1301275-NW	2012/02/24	1	1-10	Ten ASTM B449 Road Sign samples - Sample of 8 x 8 inches provided.

+ - If Test Number is used, the Test Number or Numbers the sample was used in must be identified on the data sheet pages or on the Data Sheet Package cover page.

[] Sampling Procedure -

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 1

Client/Set Designator: 1A

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 15 cm
Sample Surface Area: 300 cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [~~50 to 60°C~~]: Observed 133°F
[122 to 140°F]

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [ ] No

RESULTS:
Is presence of Yellow Precipitate present: ~~[ ] Yes~~ [x] No

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 2

Client/Set Designator: 2A

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 15 cm
Sample Surface Area: 300 cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [~~50 to 60°C~~]: Observed 129°F
[122 to 140°F]

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [ ] No

RESULTS:
Is presence of Yellow Precipitate present: ~~[ ] Yes~~ [x] No

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 3

Client/Set Designator: 8A

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 15 cm
Sample Surface Area: 300 cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [~~50 to 60°C~~]: Observed 129°F
[122 to 140°F]

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [ ] No

RESULTS: See notes at end
Is presence of Yellow Precipitate present: [X] Yes ~~[ ]~~ No [Very Faint Yellow]

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 4

Client/Set Designator: 12A

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 15 cm
Sample Surface Area: 300 cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [~~50 to 60°C~~]: Observed 131°F
[122 to 140°F]

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [ ] No

RESULTS:
Is presence of Yellow Precipitate present: [X] Yes ~~[ ] No~~

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set

Client/Set Designator: 17A

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 15 cm
Sample Surface Area: 300 cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [~~50 to 60°C~~]: Observed 132°F
[122 to 140°F]

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [ ] No

RESULTS:
Is presence of Yellow Precipitate present: [X] Yes ~~[ ] No~~

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 6

Client/Set Designator: 18C

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 15 cm
Sample Surface Area: 300 cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [~~50 to 60°C~~]: Observed 125°F
[122 to 140°F]

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [ ] No

RESULTS:
Is presence of Yellow Precipitate present: ~~[ ] Yes~~ [x] No

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 7

Client/Set Designator: 19C

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 15 cm
Sample Surface Area: 300 cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [~~50 to 60°C~~]: Observed 131°F
[122 to 140°F]

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [ ] No

RESULTS:
Is presence of Yellow Precipitate present: ~~[ ] Yes~~ [x] No

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 8

Client/Set Designator: 20C

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 15 cm
Sample Surface Area: 300 cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [~~50 to 60°C~~]: Observed 130°F
[122 to 140°F]

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [ ] No

RESULTS:
Is presence of Yellow Precipitate present: ~~[ ] Yes~~ [x] No

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 9

Client/Set Designator: 21C

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 15 cm
Sample Surface Area: 300 cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [~~50 to 60°C~~]: Observed 126°F
[122 to 140°F]

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [ ] No

RESULTS:
Is presence of Yellow Precipitate present: ~~[ ] Yes~~ [x] No

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 10

Client/Set Designator: 22C

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 15 cm
Sample Surface Area: 300 cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [~~50 to 60°C~~]: Observed 135°F
[122 to 140°F]

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [ ] No

RESULTS:
Is presence of Yellow Precipitate present: [X] Yes ~~[ ] No~~

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

NOTE: All samples were exposed to the solution 10 times and there was no apparent layer removal. Samples 12A, 17A and 22C show a yellow precipitate. Samples 12A and 17A were slow to develop the yellow precipitate, approximately 2-3 hours however sample 22C developed a yellow precipitate immediately upon adding lead nitrate. After 2 days sample 8A shows a very faint yellow. All of the rest of the samples show a white precipitate after 2 days.

Tested by: _____ Date _____

Printed Name Signature

END OF DATASHEET PACKAGE. THIS PAGE INTENTIONALLY LEFT BLANK

12/15/2011

LABORATORY DATA PACKAGE

Number of pages in this package __10__ [including additional pages ____]
(Fill in when using printed copy as record)

TEST LOCATION:					
[X]UL or Affiliate	[WTDP	[]CTDP	[]TPTDP	[]TCP	[]PPP
	[]WMT	[]TMP	[]SMT		
Company Name	UL Northbrook				
Address					

CLIENT INFORMATION	
Company Name	OREGON DEPARTMENT OF TRANSPORTATION
Address	5TH FL,355 CAPITOL ST NE SALEM,OR,UNITED STATES,97301

AUDIT INFORMATION:			
Description of Tests	Per Standard No. ASTM B449	Edition/ Revision Date	Issued 1993, revised in June 2010

[] Tests Conducted by +		
	Printed Name	Signature
[] UL Staff conducting or witnessing testing (WTDP, TMP, WMT only) [] UL Staff supervising UL Staff in training []Authorized Signatory (CTDP, TPTDP, TCP, PPP, SMT)	Printed Name	Signature, and include date for CTDP, TPTDP, TCP, PPP, WMT, TMP, SMT
Reviewed and accepted by qualified Project Handler	John Marke	John Marke
	Printed Name	Signature

TESTS TO BE CONDUCTED:

Test No.	Done +++	Test Name	[] Comments/Parameters []Tests Conducted by ++
1	+++	ASTM B449 Chromium Test - Appendix X1.2	G. Manzella/J. Garrett

Instructions -
+ - When all tests are conducted by one person, printed name and signature can be inserted here instead of including printed name and signature on each page containing data. Must indicate number of pages in the data package.
++ - When test conducted by more than one person, printed name and signature of person conducting the test can be inserted next to the test name instead of including printed name and signature on each page containing data. Must indicate number of pages in the data package.
+++ - Use of this field is optional and may be employed differently.

Special Instructions -

As per the client, please test the Non reflective side or rather the backside of the sign. THE TESTING SIDE SHOULD HAVE VISIBLE ALUMINUM AND BE CLEAN AND FREE OF DEBRIS (AS DONE BY THE CLIENT AND PROVIDED TO UL). This would be the same side that would have the sample designator stamped on IT. THE STAMP IS NUMERICAL WITH ONE ALPHA CHARACTER (E.G. "12 A") When testing the material, please try to avoid testing ON the stamped portion as much as possible. In addition to the four signs, the client also provided a fifth sample to test as a blank. Test the side with the stamp. If no stamp is present on the blank, test the cleanest side. Please designate in your report the sample that was not labeled.

Also, on datasheets please ensure to indicate the client designator from the stamp for each tested set.

Unless specified otherwise in the individual Methods, the tests shall be conducted under the following ambient conditions. Confirmation of these conditions shall be recorded at the time the test is conducted.

Ambient Temperature, C	25 ± 10	Relative Humidity, %	50 ± 10	Barometric Pressure, mBar	N/A

RISK ANALYSIS RELATED TO TESTING PERFORMANCE:

The following types of risks have been identified. Take necessary precautions. This list is not all inclusive.

[ ] Electric shock	[ ] Radiation
[ ] Energy related hazards	[ ] Chemical hazards
[ ] Fire	[ ] Noise
[ ] Heat related hazards	[ ] Vibration
[ ] Mechanical	[ ] Other (Specify)__

Tested by: _____ Date _____

Printed Name Signature

TEST EQUIPMENT INFORMATION

Inst. ID No.	Instrument Type	Test Number +, Test Title or Conditioning	Function /Range	Last Cal. Date	Next Cal. Date

+ - If Test Number is used, the Test Number must be identified on the data sheet pages or on the Data Sheet Package cover page.

The following additional information is required when using client's or rented equipment, or when a UL ID Number for an instrument number is not used. The Inst. ID No. below corresponds to the Inst. ID No. above.

Inst. ID No.	Make/Model/Serial Number/Asset No.

[x] UL test equipment information is recorded on Meter Use in UL's Laboratory Project Management (LPM) database.

Tested by: _____ Date _____

Printed Name Signature

TEST SAMPLE IDENTIFICATION:

The table below is provided to provide correlation of sample numbers to specific product related information. Refer to this table when a test identifies a test sample by "Sample No." only.

Sample Card No.	Date Received	[] Test No.+	Sample No.	Manufacturer, Product Identification and Ratings
1124150	2011/12/23	1	1-5	Five ASTM B449 Road Sign samples - Sample of about 300 cm2 surface is required.

+ - If Test Number is used, the Test Number or Numbers the sample was used in must be identified on the data sheet pages or on the Data Sheet Package cover page.

[] Sampling Procedure -

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 1

Client/Set Designator: Blank

SAMPLE DIMENSIONS
Sample Length: 15 cm
Sample Width: 7.5 cm
Sample Surface Area: 112.5 cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [50 to 60°C]: 57.4 °C

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [] No

RESULTS:
Is presence of Yellow Precipitate present: [ ] Yes [x] No

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 2
Client/Set Designator: 2D

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 14 cm
Sample Surface Area: 280 cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [50 to 60°C]: 53.0°C

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [ ] No

RESULTS:
Is presence of Yellow Precipitate present: [ ] Yes [x] No

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 3
Client/Set Designator: 8D

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 15 cm
Sample Surface Area: 300 cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [50 to 60°C]: 50.4 °C

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [ ] No

RESULTS:
Is presence of Yellow Precipitate present: [ ] Yes [X] No

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 4
Client/Set Designator: 12D

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 14.5cm
Sample Surface Area: 290cm^2

SURAFCE TRAEATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [50 to 60°C]: 50.6°C

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [ ] No

RESULTS:
Is presence of Yellow Precipitate present: [ ] Yes [x] No

[ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____
Printed Name Signature

DETERMINATION OF CHROMIUM TEST ASTM B449 Issued 1993, revised June 2010, App. X1.2

Set 5
Client/Set Designator: 1D

SAMPLE DIMENSIONS
Sample Length: 20 cm
Sample Width: 14.5 cm
Sample Surface Area: 290 cm^2

SURAFCE TREATMENT
50 mL 5 % Sodium Hydroxide Solution: [x] Yes [ ] No
5 mL 30 % Hydrogen Peroxide Solution: [x] Yes [ ] No
Solution Temperature [50 to 60°C]: 50.5 °C

PRECIPITATE SOLUTION
10% Lead Nitrate Solution: [x] Yes [] No

RESULTS:
Is presence of Yellow Precipitate present: [ ] Yes [x] No

{ASTM B449, App. X1.2A: Yellow precipitate shows the presence of hexavalent chromium. The least quantity of total chromium detectable by this method corresponds to about 5 mg chromium per square meter of surface.}

Tested by: _____ Date _____

Printed Name Signature

END OF DATASHEET PACKAGE. THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX C:
DOT SURVEY INSTRUMENT

Request for information on hydrostriping process for Highway Aluminum

1. Please indicate your State, County, City, Territory, or Region.

***2. Does your agency allow reused aluminum highway signs, which have been hydro-stripped (Y/N/Other)?**

- ◯ Yes
- ◯ No
- ◯ Other

Comment

3. If yes, have you done any testing with this process (Y/N)?

- ◯ Yes
- ◯ No

Other (please specify)

4. What were your results (if any)?

***5. Would you please provide a link to your aluminum sign specifications (and anti-corrosive coating specification) for our records and review?**

6. Would you provide us the contact information for the person in your agency who is most familiar with this topic?