

Science For A Better Life

# UN ECE - GRSG - IGPG 3<sup>rd</sup> Meeting Car Wash Round Robin Test

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# Information



At the 2<sup>nd</sup> meeting of the informal group on plastic glazing (IGPG) a car wash test according to the ISO standard 20566 was discussed as an alternative abrasion test for plastic glazing.

Therefore a task force was established to perform a Car Wash Round Robin test in order to determine the precision of this test especially in comparison to the results received in the IGPG Taber Round Robin test. So the objective of this Round Robin is to answer the question: "Has this car wash test a higher test precision than the Taber test and is this precision sufficient for an approval test?"

The test itself is generally described in ISO 20566 but this time applied to transparent substrates and evaluated using a haze measurement according to ECE R43. Due to this deviation from the international standard a description of the test procedure based on an adjustment of ISO 20566 to transparent substrates was elaborated by the task force.



IGPG - car wash  
round robin test procedure

Three members of the task force were willing to prepare samples and delivered the following different test sample types to the participating test laboratories:

- monolithic float glass
- one side coated PMMA sheets
- both sides coated PC sheets

# Information



Nine test laboratories showed interest and received test samples (3 samples for each of the three different sample types, 9 samples in total).

Five participating test laboratories were able to perform the test according to the distributed test procedure and delivered their test results before the 3<sup>rd</sup> meeting of the IGPG. Two members of the task force are performing a completely different car wash test (including different test equipment). Nevertheless they also received test samples in order to be able to compare the results from their car wash test with the ones from the Round Robin. Two further members of the task force using the equipment described in ISO 20566 were not able to perform the test right before the 3<sup>rd</sup> meeting . Maybe the results will be available later.

So the Car Wash Round Robin test results on the following pages are based on five test laboratories testing three different sample types with three identical samples for each type (three glass, three coated PMMA and three coated PC samples).

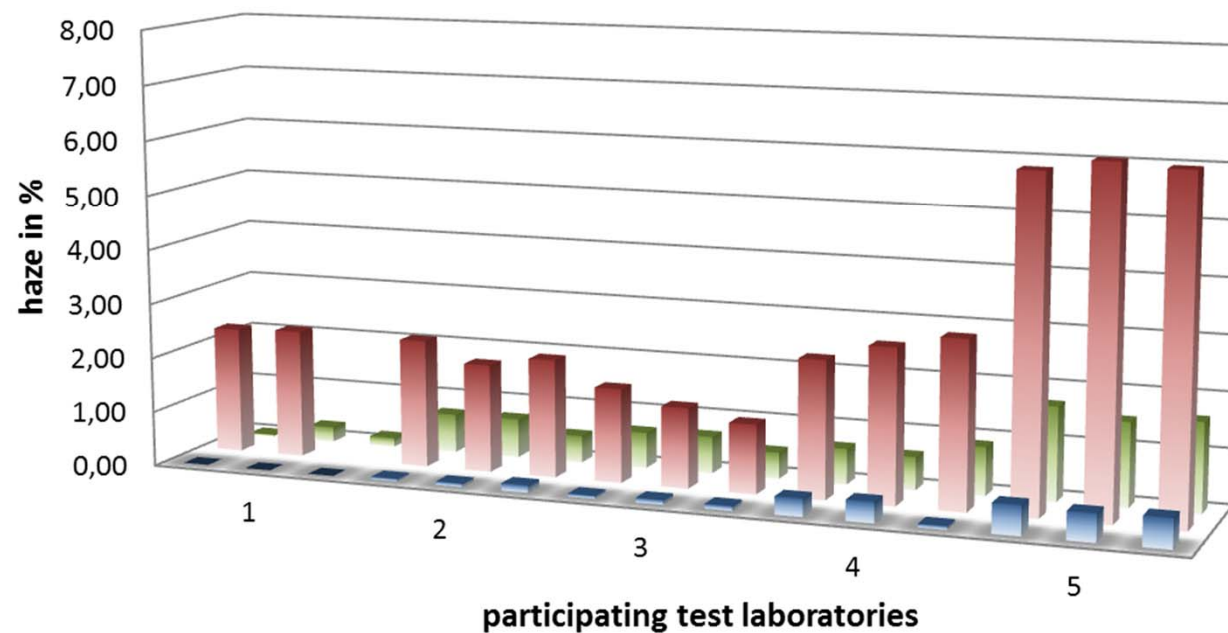
# Test results per sample

from the test labs using the distributed test description



**results for the individual samples  
obtained by the participating test laboratories  
in order of arrival**

- Glass
- coated PMMA
- coated PC





# Test results summary

## and comparison to the Taber Round Robin

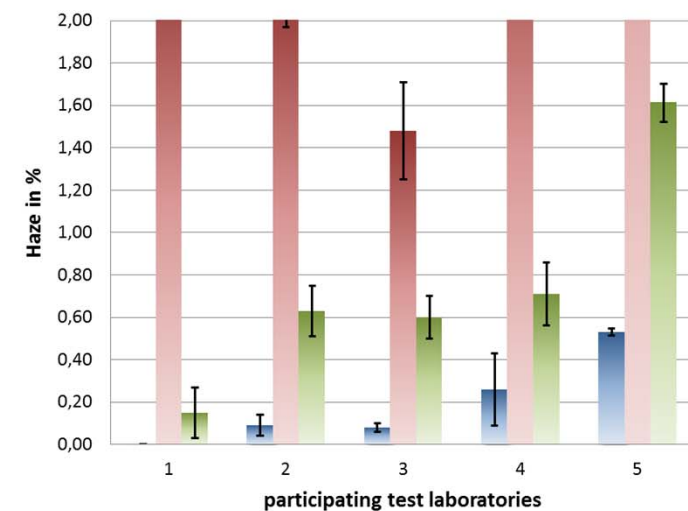
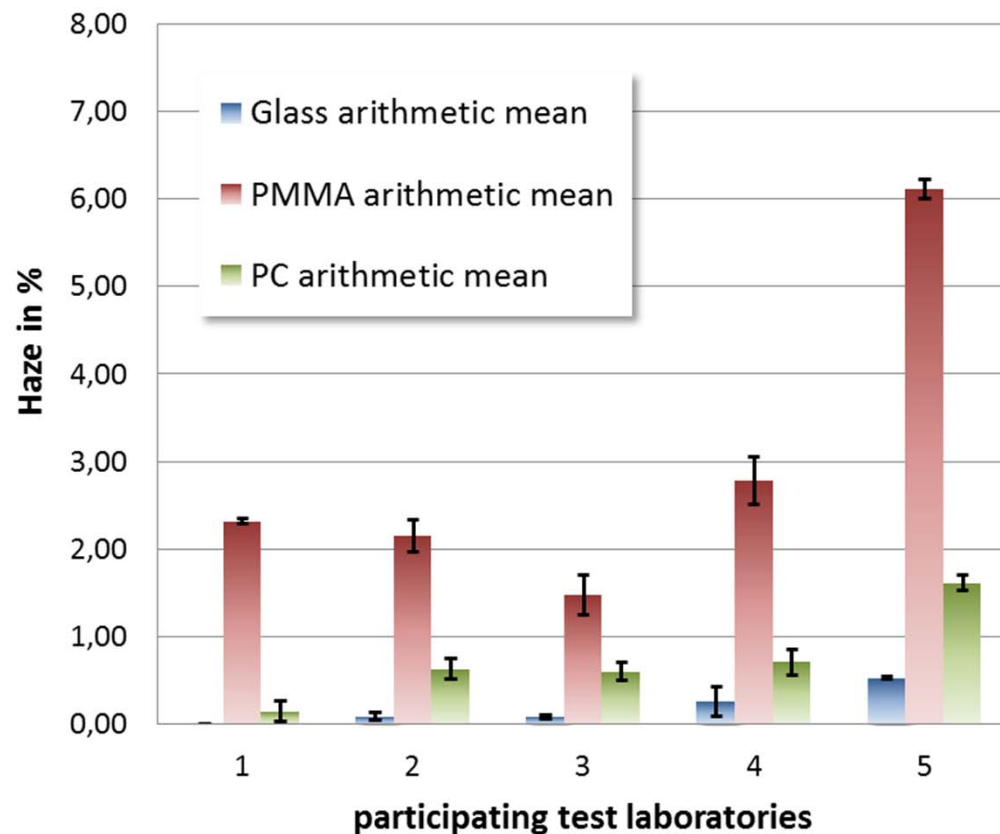
Car Wash Round Robin				Taber Round Robin			
	glass	coated PMMA	coated PC		glass	coated PMMA	coated PC
	Δ haze in %				Δ haze in %		
lowest measured value	0,00	1,26	0,03	lowest measured value	0,58	3,46	1,70
highest measured value	0,54	6,21	1,70	highest measured value	2,00	39,94	40,90
arithmetic mean of all values	<b>0,19</b>	<b>3,02</b>	<b>0,74</b>	arithmetic mean of all values	<b>1,18</b>	<b>15,44</b>	<b>10,52</b>
standard deviation	<b>0,21</b>	<b>1,75</b>	<b>0,50</b>	standard deviation	<b>0,37</b>	<b>10,59</b>	<b>13,11</b>

The standard deviation obtained for haze values on plastic substrates using the car wash test as abrasion test is significantly lower according to the Car Wash Round Robin test compared with the Taber Round Robin test.



# Detailed test results per participating test laboratory

## arithmetic means with standard deviation



Four labs measure almost the “same” values, one test lab (no. 5 \*) shows higher values for all substrates.

\* The abrasiveness of this brush seems to be higher (the brush is more than 2 years old, but has only 5 operating hours (after 30 operating hours the brush should be exchanged (which is normally reach after 1 to 1,5 years)).



# Round Robin test result analysis

according to ASTM E 691

ASTM E 691: Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method.

Car Wash Round Robin (5 participating test laboratories with 3 replicates)						
(values in % haze)	average $\bar{x}$	standard deviation $s_x$	repeatability standard deviation $s_r$	reproducibility standard deviation $s_R$	repeatability $r$	reproducibility $R$
glass	0,1913	0,2118	0,0781	0,2212	0,22	0,62
coated PC	0,7420	0,5336	0,1193	0,5424	0,33	1,52
coated PMMA	3,0380	1,7949	0,3252	1,8144	0,91	5,08

**Repeatability** In comparing two averages for the same material, obtained by the same operator using the same equipment on the same day, the average should be judged not equivalent if they differ by more than the  $r$  value for that material and condition.

**Reproducibility** In comparing two averages for the same material, obtained by different operators using different equipment, the averages should be judged not equivalent if they differ by more than the  $R$  value for that material and condition.



# Round Robin test result comparison

according to ASTM E 691

## Car Wash Round Robin (5 participating test laboratories with 3 replicates)

(values in % haze)	average $\bar{x}$	standard deviation $s_x$	repeatability standard deviation $s_r$	reproducibility standard deviation $s_R$	repeatability $r$	reproducibility $R$
glass	0,1913	0,2118	0,0781	0,2212	0,22	0,62
coated PC	0,7420	0,5336	0,1193	0,5424	<b>0,33</b>	<b>1,52</b>
coated PMMA	3,0380	1,7949	0,3252	1,8144	<b>0,91</b>	<b>5,08</b>

## Taber Round Robin (11 participating test laboratories with 3 replicates)

(values in % haze)	average $\bar{x}$	standard deviation $s_x$	repeatability standard deviation $s_r$	reproducibility standard deviation $s_R$	repeatability $r$	reproducibility $R$
glass	1,1653	0,3839	0,1011	0,3927	0,28	1,10
coated PC	10,5227	13,4669	1,5813	13,5287	<b>4,43</b>	<b>37,88</b>
coated PMMA	15,5691	10,3459	3,5976	10,7548	<b>10,07</b>	<b>30,11</b>



# Summary



- All participating test labs are measuring **the same order (lowest to highest value) for the three different sample types**. Even more four labs measure almost the “same” values for the same sample types, only one test lab (no. 5) has higher values, but for all substrates.
- The **standard deviation** for all sample types are **significantly lower** compared to the one obtained in the Taber Round Robin test (e.g. for coated PC 0,5% compared to 13,1%). Which means the test precision of the car wash test according to ISO 20566 is low enough that different labs receive similar values when testing identical samples.
- There are coating systems for plastic glazing parts (which can be used for PC as well as for PMMA and determine the abrasion performance of the part) available which leads to a **test reproducibility of below 2%**. In this case it is feasible from a test precision side to fulfill an approval hurdle in that range or above (which is not possible with a reproducibility of more than 30% as received in the Taber test).

# Details



test laboratory	lab no. 1				lab no. 2			
tested according to	test procedure using an Amtec-Kistler laboratory car wash				test procedure using an Amtec-Kistler laboratory car wash			
test details	haze measurement with haze gard plus from BYK Gardner GmbH				haze measurement with haze gard plus from BYK Gardner GmbH			
test results	sample number	initial haze	final haze	delta haze	sample number	initial haze	final haze	delta haze
monolithic float glass from Pilkington	glass 66	0,00	0,00	0,00	glass 72	0,06	0,11	0,05
	glass 67	0,00	0,00	0,00	glass 73	0,05	0,12	0,07
	glass 68	0,00	0,00	0,00	glass 74	0,06	0,20	0,14
	standard deviation	<b>0,00</b>	<b>0,00</b>	<b>0,00</b>	standard deviation	<b>0,01</b>	<b>0,05</b>	<b>0,05</b>
	arithmetic mean	<b>0,00</b>	<b>0,00</b>	<b>0,00</b>	arithmetic mean	<b>0,06</b>	<b>0,14</b>	<b>0,09</b>
one side coated PMMA from Polyplastic	PMMA 62	0,00	2,30	2,30	PMMA 56	0,15	2,48	2,33
	PMMA 63	0,00	2,34	2,34	PMMA 57	0,13	2,10	1,97
	PMMA 64	0,00	2,34	2,34	PMMA 58	0,11	2,26	2,15
	standard deviation	<b>0,00</b>	<b>0,03</b>	<b>0,03</b>	standard deviation	<b>0,02</b>	<b>0,19</b>	<b>0,18</b>
	arithmetic mean	<b>0,00</b>	<b>2,32</b>	<b>2,32</b>	arithmetic mean	<b>0,13</b>	<b>2,28</b>	<b>2,15</b>
both sides coated PC from Bayer	PC1 13	0,00	0,03	0,03	PC1 07	0,07	0,77	0,70
	PC1 14	0,00	0,27	0,27	PC1 08	0,09	0,80	0,71
	PC1 15	0,00	0,16	0,16	PC1 09	0,06	0,55	0,49
	standard deviation	<b>0,00</b>	<b>0,12</b>	<b>0,12</b>	standard deviation	<b>0,02</b>	<b>0,14</b>	<b>0,12</b>
	arithmetic mean	<b>0,00</b>	<b>0,15</b>	<b>0,15</b>	arithmetic mean	<b>0,07</b>	<b>0,71</b>	<b>0,63</b>

# Details



test laboratory	lab no. 3				lab no. 4			
tested according to	test procedure using an Amtec-Kistler laboratory car wash				test procedure using an Amtec-Kistler laboratory car wash			
test details	haze measurement with haze gard plus from BYK Gardner GmbH				haze measurement with haze gard plus from BYK Gardner GmbH			
test results	sample number	initial haze	final haze	delta haze	sample number	initial haze	final haze	delta haze
monolithic float glass from Pilkington	glass 78	0,06	0,12	0,06	glass 75	0,05	0,38	0,33
	glass 79	0,06	0,15	0,09	glass 76	0,05	0,43	0,38
	glass 80	0,05	0,14	0,09	glass 77	0,05	0,12	0,07
	standard deviation	<b>0,01</b>	<b>0,02</b>	<b>0,02</b>	standard deviation	<b>0,00</b>	<b>0,17</b>	<b>0,17</b>
	arithmetic mean	<b>0,06</b>	<b>0,14</b>	<b>0,08</b>	arithmetic mean	<b>0,05</b>	<b>0,31</b>	<b>0,26</b>
one side coated PMMA from Polyplastic	PMMA 50	0,09	1,80	1,71	PMMA 53	0,15	2,65	2,50
	PMMA 51	0,11	1,57	1,46	PMMA 54	0,12	2,93	2,81
	PMMA 52	0,17	1,43	1,26	PMMA 55	0,13	3,17	3,04
	standard deviation	<b>0,04</b>	<b>0,19</b>	<b>0,23</b>	standard deviation	<b>0,02</b>	<b>0,26</b>	<b>0,27</b>
	arithmetic mean	<b>0,12</b>	<b>1,60</b>	<b>1,48</b>	arithmetic mean	<b>0,13</b>	<b>2,92</b>	<b>2,78</b>
both sides coated PC from Bayer	PC1 01	0,06	0,71	0,65	PC1 04	0,10	0,75	0,65
	PC1 02	0,08	0,75	0,67	PC1 05	0,08	0,68	0,60
	PC1 03	0,08	0,56	0,48	PC1 06	0,07	0,95	0,88
	standard deviation	<b>0,01</b>	<b>0,10</b>	<b>0,10</b>	standard deviation	<b>0,02</b>	<b>0,14</b>	<b>0,15</b>
	arithmetic mean	<b>0,07</b>	<b>0,67</b>	<b>0,60</b>	arithmetic mean	<b>0,08</b>	<b>0,79</b>	<b>0,71</b>

# Details



test laboratory	lab no. 5			
tested according to	test procedure using an Amtec-Kistler laboratory car wash			
test details	haze measurement with haze gard plus from BYK Gardner GmbH			
test results	sample number	initial haze	final haze	delta haze
monolithic float glass from Pilkington	glass 63	0,06	0,60	0,54
	glass 64	0,05	0,56	0,51
	glass 65	0,05	0,59	0,54
	standard deviation	<b>0,01</b>	<b>0,02</b>	<b>0,02</b>
	arithmetic mean	<b>0,05</b>	<b>0,58</b>	<b>0,53</b>
one side coated PMMA from Polyplastic	PMMA 68	0,10	6,10	6,00
	PMMA 69	0,09	6,30	6,21
	PMMA 70	0,14	6,27	6,13
	standard deviation	<b>0,03</b>	<b>0,11</b>	<b>0,11</b>
	arithmetic mean	<b>0,11</b>	<b>6,22</b>	<b>6,11</b>
both sides coated PC from Bayer	PC1 16	0,07	1,77	1,70
	PC1 17	0,11	1,63	1,52
	PC1 18	0,07	1,69	1,62
	standard deviation	<b>0,02</b>	<b>0,07</b>	<b>0,09</b>
	arithmetic mean	<b>0,08</b>	<b>1,70</b>	<b>1,61</b>



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# Thank you!

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