

NHTSA Questions on Failures of Panoramic Sunroofs and Proposed Amendments to GTR 6:

Data on Existing Panoramic Sunroofs:

- During the 2nd, 3rd and 4th IWG sessions NHTSA requested additional information on the panoramic sunroofs experiencing breakage. We thank the Korean Delegation and the members of OICA and CLEPA for providing information on the dimensions of glazing and CPA (see PSG-04-06 and PSG-04-07), but have additional questions for which we request answers as follows:
 - We note from the KATRI data that 33 cases were reported in 2013, of which 5 were on imported vehicles. Can KATRI provide more detailed information on the vehicle models from these cases? We would like to compare this data against the data collected by NHTSA on breakages.

 Examples of sunroof experiencing breakage from customer complaints in 2013

No.	Manufacturers	Vehicles	Year	Contents	Reports
1	HYUNDAI	SONATA	2010	Panoramic sunroof breakage during driving	Recall Center
2	HYUNDAI	SANTAFE	2013	Panoramic sunroof breakage	"
3	KIA	SPORTAGE	2013	Panoramic sunroof breakage during driving	"
4	HYUNDAI	GRANDEUR	2014	Panoramic sunroof breakage	"
5	KIA	SPORTAGE	2013	Panoramic sunroof breakage during driving	"
6	HYUNDAI	VELOSTER	2013	Panoramic sunroof breakage	"
7	HYUNDAI	SONATA	2012	Panoramic sunroof breakage during driving	"
8	HYUNDAI	SANTAFE	2013	Panoramic sunroof breakage	"
9	KIA	SPORTAGE	2011	Panoramic sunroof breakage during driving	"
10	HYUNDAI	SANTAFE	2013	Panoramic sunroof breakage during driving	"
11	Renault Samsung	QM5	2010	Panoramic sunroof breakage during parking	"
12	Renault Samsung	SM7	2012	Panoramic sunroof breakage during driving	"
13	Renault Samsung	SM7	2012	Panoramic sunroof breakage	"
14	HYUNDAI	SANTAFE	2013	Panoramic sunroof breakage	"
15	HYUNDAI	SANTAFE	2013	Panoramic sunroof breakage during driving	"
16	KIA	SPORTAGE	2013	Panoramic sunroof breakage	"

17	KIA	K5	2011	Panoramic sunroof breakage during driving	"
18	HYUNDAI	SONATA	2010	Panoramic sunroof breakage during driving	"
19	HYUNDAI	SANTAFE	2012	Panoramic sunroof breakage during driving	Customer Agency
20	KIA	SORENTO	2014	Panoramic sunroof breakage during driving	Recall Center
21	HYUNDAI	GRANDEUR	2013	Panoramic sunroof breakage during driving	Customer Agency
22	KIA	K7	2012	Panoramic sunroof breakage during driving	Recall Center
23	KIA	SORENTO	2010	Panoramic sunroof breakage during driving	"
24	HYUNDAI	TUCSON	2011	Panoramic sunroof breakage during driving	"
25	Renault Samsung	SM5 LPLi	2010	Panoramic sunroof breakage	"
26	KIA	SORENTO	2009	Panoramic sunroof breakage during driving	Customer Agency
27	Peugeot	Nouvelle Peugeot 207	2008	Panoramic sunroof breakage during parking	Recall Center
28	Mercedes-Benz	E350	2010	Panoramic sunroof breakage	Customer Agency
29	Toyota	CAMRY	2012	Interference between sunroof and chassis	Recall Center
30	Mercedes-Benz	E320	-	Panoramic sunroof breakage	Press
31	HYUNDAI	GRANDEUR	2012	Panoramic sunroof breakage during driving	Recall Center
32	KIA	SORENTO	2010	Panoramic sunroof breakage during driving	Customer Agency
33	Audi	Audi	-	Panoramic sunroof breakage	The Press

☞ Q) Can NHTSA provide US defect investigation in detail as well?

- Data collected during NHTSA's defects investigation of the Kia Sorrento panoramic sunroof glazing indicates a similar split between Korean manufacturers and other

manufacturers' vehicles. What is different about the Korean products and the rest of the world?

- ☞ There is no differences between Korean products and others.
- ☞ Toughened glasses for sunroof in Korea are manufactured by 3 Korean manufacturers and 4 imported manufactures.
- ☞ Test results

Toughened glass manufacturers	Thickness	Height of glass broken with 227g ball			Remarks
		Annealed glass	Toughened glass	Ceramic coated toughened glass	
KAC(Korea)	4mm	2.6m	Not broken at 10m	1.4m	Limit of testing device : 10m
HCL(Korea)	4mm	3.2m	Not broken at 10m	1.2m	Limit of testing device : 10m
Sejin(Korea)	4mm	3.2m	Not broken at 10m	1.8m	Limit of testing device : 10m
Saint-Gobain Sekurit(France)	4mm	2.6m	Not broken at 3m	1.8m	Limit of testing device : 3m
Asahi Glass(Japan)	4mm	2.3m	Not broken at 3m	1.4m	Limit of testing device : 3m
Pilkington(Germany)	-	-	-	-	Agree to KATRI's test result

☞ Q) Does it mean differences between vehicle manufacturers? Or, (Panoramic sunroof)glazing manufacturers? For Sorento manufactured by KIA but sold in US, its glazing is even manufactured in US.

☞ It may differ from glazing manufactures depend on how panoramic sunroof is equipped. A Bottom-up type and a Top-loading type tend to have a different volume of breakage experience. In panoramic sunroof, Top-loading type is usually used, while Bottom-up type is used in normal sunroof. In case of panoramic sunroof, it might be more vulnerable to break due to widely exposed CPA and also, wider glazing area.

Although more cases of glass breakage were reported from top-loading type of panoramic sunroof, it does not necessarily mean that top-loading is weaker than bottom-up type. It was only because many manufacturers take top-loading type in panoramic sunroof equipped vehicles that we have received more reports from consumers.

- What models were measured in development of the CPA data from KATRI and CLEPA? Can this be provided in spreadsheet format with the model information for additional analysis?
- ☞ Domestic vehicle with panoramic sunroof sold in 2011-2014 manufactured by Korean manufacturer. See the another attachment for details.
- Can KATRI, OICA, and CLEPA provide information on the thickness of sunroof glazing and thickness of the ceramic paint used in manufacture of panoramic sunroofs?
- ☞ The thicknesses of sunroof glazing is 4-5 mm(See the table below)

☞ The thicknesses of ceramic paint are 20-25 µm(screen printed)

☞ Test results of 227g ball test(drop from 2m's height to ceramic painted area)

Manufacturers	Vehicles(sunroof)	Glass models (Thicknesses)	Toughened glass manufacturers	Test results
BMW	320d Touring (Rear fixed glass)	54107261733 (4mm)	Pilkington	Breakage
TOYOTA	E350 (Rear fixed glass)	63233-33090 (4mm)	Asahi Glass	Breakage
LINCOLN	LINCOLN MKX (Rear fixed glass)	7T4Z-18500A18-B (5mm)	Pilkington	Breakage
MERCEDES-BENZ	E-Class (Rear fixed glass)	A2127800221 (5mm)	Pilkington	Breakage
JAGUAR	All New XJ (Rear fixed glass)	C2D23454 (4mm)	Saint-Gobain Sekurit	Breakage
LAND-ROVER	Discovery4 (Rear fixed glass)	LR044767 (4mm)	Saint-Gobain Sekurit	Breakage
NISSAN	Murano (Rear fixed glass)	916041AA1A (4mm)	FUYAO	Breakage
CHRYSLER	300C	68127966AA (4mm)	GUARDIAN INDUSTRIES	Breakage
Audi	A8	4H4-877-072 (4.85mm)	Saint-Gobain Sekurit	Breakage
Volkswagen	The Beetle (5C5877071)	5C5-877-072 (4.85mm)	Pilkington	Breakage
Porsche	Cayenne	95B562056019B9 (4.85mm)	Saint-Gobain Sekurit	Breakage

- How do these thicknesses compare with the glazing exhibiting sudden breakage?

☞ The thicknesses of glass don't seem to affect exhibiting sudden breakage.

- Can KATRI, OICA, and CLEPA provide additional information on the glazing and ceramic paint compositions used in manufacture of panoramic sunroofs?

☞ Frit(50-70%) : Bi, Zn

Pigment(15-35%) : Cu, Fe, Mn, Ni, Cr

Medium(15-35%) : solvent, resins

- How do these compositions compare with the glazing exhibiting sudden breakage?

- What insight can the glazing and CPA manufacturers provide?
 - Chemical composition of the frit?
 - Coefficients of thermal expansions for frit and glass?
 - Processing parameters of glazing?
 - Heat treatment process for tempering?

Questions about proposed test methods and amendments to GTR:

- During the 3rd and 4th IWG meetings, limiting application of the proposed tests to overhead glazing was discussed. While NHTSA agrees that overhead glazing presents some unique issues, we remain unconvinced that similar failures could not occur in other glazing locations. From this standpoint, what is the technical justification for excluding other glazing locations? Should we not expect all toughened glazing with ceramic printed areas to perform as expected?
 - ☞ All toughened glazing CPA is significantly weaker than the annealed glass and much weaker than toughened glazing without CPA relatively as shown. But the reason for only limiting application to overhead glazing is that it is most vulnerable location which may cause secondary accident by interrupting drivers' sight when breakage happen. And also, to reflect industries' situation which doesn't have alternative technology now.
- Korean data from the 2nd IWG meeting (PSG-02-04) indicates that temperature (pg 3), vehicular velocity (pg 3), vehicle mileage (pg 4), self-explosion (pg 4), impact (pg 4), and speed bumps (pg 7) all were likely to affect the rate with which failures occur. It was later clarified in the 3rd IWG session that impacts from small objects were likely the cause. These impacts, however, do not explain the possible correlations with temperature, velocity, and age. Can Korea provide any additional information on these three correlations?
 - ☞ There was few data in the field and lack of detailed information at that time. The data may not available to determine a tendency from those factors. KATRI couldn't conclude obvious correlation with those factors.
 - Should the test methods be performed at an elevated temperature to simulate the failure conditions?
 - ☞ It doesn't need to be performed at such temperature because the toughened glass has already endured at a severe temperature(600-700°C) during manufacture. And the test at 40-50°C temperature doesn't seem to have a really different aspect.
 - Are there vibratory effects from vehicle velocity that are inducing bending moments that increase the likelihood of failure? Should bending or vibration be included as a parameter for testing?
 - ☞ CPA is proved to be more vulnerable than toughened glass when applied bending moments.(PSG-02-04, 16page)
 - ☞ KATRI's referential test(3 points bending moment and vibration test) results
 - 'Whether the area is printed or not' is more influential than 'how much area is printed' at the moment applied point same as 227g ball drop test.

- Vibration test(408Hz, 30g ; 30 times resonance frequency at a real road situation) appeared no reaction regardless of ceramic printed.

☞ It is important that test condition of bending moments and vibration should reflect actual behaviors of vehicle in the fields.

- We find the age of the failed glazing suspicious. There appears to be some correlation to recently manufactured glazing. Can Korea provide any additional information on the age of the failed glazing? Was this an issue of a particular batch of materials used? Is this indicative of a design flaw rather than a regulatory issue?

☞ Years of vehicle manufactured is written in the table on page 1. We don't see the age, the mileage and batch flaws' effect.

- It has been proposed during the 3rd and 4th IWG meetings to limit testing to glazing with CPAs in excess of specific percentages of areas or widths. We understand the theory is that with larger CPA covered areas, the probability of striking an area with ceramic paint is higher, therefore the probability of breaking the glazing is higher given the potential for ceramic paint to affect the heat treatment of toughened glazing. What is the technical justification for the percentages and widths selected?

- What analyses have been performed to determine the sensitivity of printed area versus glazing strength?

☞ The rationale for limiting CPA with percentage

- From the test result, it is clearly proved that CPA is much weaker than non-CPA regardless how much ceramic printed on a sample. So reducing a possibility of being exposed externally is considered primarily.

- The test sample should represent whole glazing's characteristic. For **toughened glazing test**, a part without CPA should occupy the entire glazing dominantly due to different strength within CPA. So the percentage was chosen.

- What analyses have been performed to determine sensitivity of glazing strength to thickness of the ceramic paint layer, or relation between thickness of glazing and thickness of CPA, or relationship between full coverage CPA versus dot matrix CPA and glazing strength?

☞ No research on thickness.

- Can KATRI provide any additional information on the cases of breakage in Korea to correlate where failures have occurred and the CPAs of the affected and unaffected panoramic roofs? Specifically, what are the percentages of CPA coverage, widths of CPA side banding, and type of CPA coverages (full paint or dot matrix?) for both the models where failures are predominant and models where failures were less likely?

☞ No additional information.

- In each of the IWG meetings, it has been proposed to conduct a 227g ball drop test on both toughened and CPA glazing to ensure that the glazing meets certain performance requirements. We note that the proposed language does not actually specify separate

performance requirements, rather it specifies where specimens may be drawn from or equate to on panoramic roofs to determine performance. We also note that comparisons of various drop heights were discussed (PSG04-07, page 5), but not fully considered during previous IWG sessions.

☞ Not both toughened and CPA glazing. The current proposal means the test is conducted one type of sample either toughened glass or CPA. If clearer language is suggested, it would be welcomed.

- Why has the IWG not considered the 3 meter drop height in NHTSA's FMVSS No. 205 as an alternative to the drop height specified in GTR 6 and R.43? What is the technical justification for not harmonizing with the US standard?

☞ The height 2m was referred from GTR 6 rationale and justification.

☞ GTR 6 page 6, 10

6. Based upon analysis conducted by Japan, which demonstrated that the force from a drop height of 2.0 m represented the force of a typical object impacting a pane, it was decided that a drop height of 2.0 m could be retained.
30. Tests in Japan led to the conclusion that a drop height of 2.0 m is sufficient for this type of glazing. The typically encountered stone was determined to have a mass of 2-3 g.

☞ Q) Can NHTSA provide the technical justification of 3m height?

- We note that the shot bag test incorporated in the US standard induces bending loads on glazing that may indicate resistance to fracture from micro-cracks on the surface of CPAs. Given that bending loads may increase the propensity for failures to occur, specifically when vibratory loads are introduced during vehicle movement or flexion from traversing road hazards such as speed bumps, what analyses have been performed to determine if such a shot bag test, or equivalent, would be more appropriate for determination of strength degradation due to CPA applications?

☞ To be discussed

- What is the status of the areas of research proposed by Korea during the 3rd IWG under document number PSG-03-08?

☞ Research on temperature, vibration, bending moments, etc. was discontinued because the possibilities of breakage by those cases were very low and experts from IWG didn't have much necessity of further research.