ACEA European Automobile Manufacturers Association

JAMA Japan Automobile Manufacturers Association, Inc.

KAMA 한국자동차산업협회 Korea Automobile Manufacturers Association

Submission of Joint Associations to Stakeholder Consultation on Entry 8j

This document provides the consolidated submission of the automotive associations ACEA, JAMA and KAMA and the associated glass makers AGC, NSG, Guardian and Central Glass represented by these automotive associations to the "Stakeholder Consultation on Renewal of Exemption 8(j) of Annex II to Directive 2000/53/EC (ELV)". All three associations are registered[1] as stakeholders.
The consultation was announced on 09-September-2013 and concludes on 04-November-2013. Reference is made to the consultation questionnaire for entry 8j "Review of exemption 8(j) "Lead in solders for soldering in laminated glazing". The submitters request an extension of entry 8j.

At first an introduction is given. Then the answers are given in a summarized comprehensive version as requested in the stakeholder consultation ("compact and comprehensive information"). Detailed information is given in a separate file (entry 8j details.docx) which is attached.

Introduction

Figure 01shows a laminated glazing structure. Between two thinner panes of glass a polymer layer is embedded. For electrical functions contacts are necessary on glass surface 2 or glass surface 3, inside the polymer film or on glass surface 4.

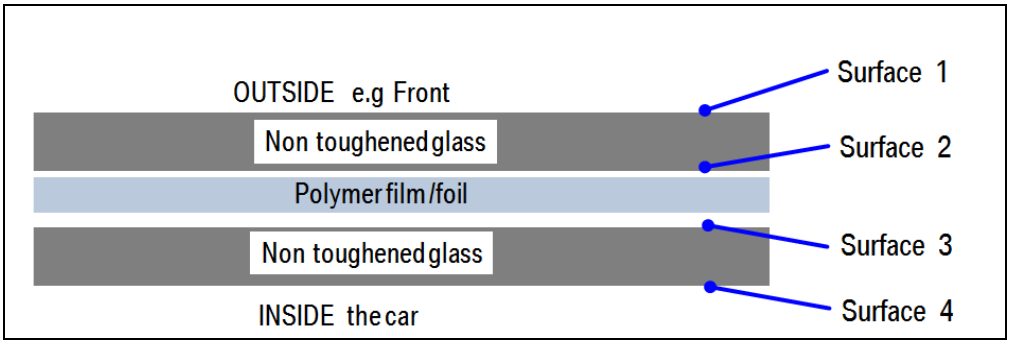

Figure 01: Structure of laminated glazing [2] (term surface in the following text identical to position)

Typical uses of Lead containing solders within laminated glazing structures are:

- Wire heated windscreens with wires embedded into/on the foil between the two glass plies
- Printed heated device circuit on the inner surfaces of the windscreen (surface 2 or surface 3)
- Antenna or sensors wire products (wires embedded into/on the foil)
- Printed antenna device circuit on laminated glass surface 4
- Printed heated circuits on laminated glass surface 4
- Connection joints to electrically conductive films within the laminate
- Wire heated wiper rest area windscreens
- Capacitive coupling connectors soldered on position 4

[1] Registration numbers see cover letter p. 1

[2] Source BMW

Soldering of laminated glazing structures may be applied on a silver print on the non toughened glass, or on the silver print on top of the black Lead-free enamel print of the glass, or to wires- /films inside/on the foil. Wire materials are tungsten or copper. For a more detailed description of the applications see entry 8j details information file.

For laminated automotive glazing structures (covered by exemption entry 8(j)), the technologies and demands are different compared to soldering on toughened glasses (which are covered by exemption entry 8(i)), and Lead-free soldered solutions for laminated glazing structures are still at the screening stage (-with the exception of some pilot applications). The challenges for contacting electrical joints in laminated glass structures are component and vehicle specific in a high degree.

As of today, the use of Lead is still unavoidable for some applications for laminated glasses due to the facts that:

a. Compared with toughened glasses, laminated glasses crack much easier when a certain stress is applied. The internal stress in laminated glass is not uniform and varies with the edge distance (see 8j details file section 1&2). Positive results with the same solder and connector can fail with the change of the position of the solder joint on the same glass.

b. Compared with Lead solders, Lead-free solders give much higher stress to the glass to which the solders are attached.

c. As a result, compared with toughened glasses, more advanced technologies are required to attach Lead-free solders to laminated glazing structures - and to pass specifications of the OEM´s.

The 5 years development of Lead-free solders for single sheet toughened glass (entry 8i), as communicated in previous consultations, is nearly completed. Now there is intensified development capacity on establishing available Lead-free solders applications for laminated glazing in laboratory and later full-scale. This challenge will require 5 more years at least (and possibly more) for complete industrialization based on our estimation.

In the following text you find the consolidated stakeholder submission to the questionnaire. Answers are listed under “bullets” directly below each question. Several details have been transferred into a separate document (entry 8j details.docx). This document is enclosed.

Answers to the questionnaire:

1. *Please explain whether the use of lead in the application exempted under exemption 8(j) of the ELV Directive is still unavoidable so that Art. 4(2)(b)(ii) of the ELV Directive would justify the continuation of the exemption:*

- Generally Lead is required to match the different coefficients of thermal expansion (CTE) of the materials used in laminated glazing structures (i.e. the mechanical stress-sensitive glass, the solder material and the connector) to avoid a glass failure by cracking. Since soldering is carried out at high temperature, the CTE mismatch, for example between the glass and the solder while cooling needs to be compensated by the ductility of the solder.

- Currently there is no sufficient, sustainable, Lead-free solder available providing the high ductility of Lead-containing solder (that fulfils the requirements of OEM´s), especially since glass panes used for laminated glass are thinner and non-toughened resulting in higher glass crack sensitivity. - In addition there are limitations in temperature process windows.

- No failure of the electric contacts in laminated glazing structures during vehicle life time is acceptable because this directly would affect vehicle safety aspects. Any potential substitute has to prove at least the same performance as the current solution.

- For some components emerging solutions for the contacting inside the foil are on the way but in general and for the majority of applications Lead-free solders are still subject of intensive R&D efforts. Testing has confirmed repeatedly that Lead-free solders fail to fulfill the customer specifications. This is valid for in laminate soldering, where first solutions are available and complete industrialization needs sufficient implementation time and especially challenging for soldering in laminated glass panes with structure contacts (e.g. silver prints) either directly on the glass or on top of a ceramic layer.

- The global supply chain cannot provide sufficient Lead-free solutions for entry 8j which sufficiently fulfill the specifications of the OEM´s. Due to efforts dedicated to tempered glass' solutions, and the lack of validations by our glass-makers, we did not have for the moment any possibility of evaluating soldering on face 2,3 and 4 of laminated glazing structure.

- Technical production situation is not capable / given that a technical solution has not yet been verified and therefore it is not feasible to identify investment requirements

- The principal application of Lead-based solders in laminated glazing structures are currently required to enable (reliable electrical contacting) production of:

    - Fine Wire Heating Grid (for de-icing of the entire windshield)

    - Local coating and printing on position 2 and 3 (for windshield de-icing frozen wipers)

    - Local printing on position 4 (for antenna on windshield for radio, TV systems or alarms and sensors)

    - In general silver prints on surface 2, surface 3 and surface 4

    - Contacts on position 4 of laminated glazing structures (for reliable contacts to antenna, heating, alarm or sensor circuits)

2. *In case the substitution of lead is not viable, please explain the efforts you undertook to find a lead-free alternative.*

- OEM´s have been evaluating new solutions for toughened glass since 2008, with big failures during the first years, and have been constantly in contact with their glass-makers. Because of the timing of the expiry of exemption 8i, the successful development of Lead-free solders for that application has been the priority. This is still on-going. When the remaining challenges e.g. of industrialization have been met, the experiences can be used for development of entry 8j i.e. non toughened glass issues.

- Customer specified connectors have been tested with Pb-free solders (96.5Sn3.5Ag, 42Sn57Bi1Ag, 88Sn8In0.5Bi3.5Ag, 92.5Sn4Bi3.5Ag); flexible foil connectors with Pb free solders (98Sn2Ag, 55In2.5Ag42.5Sn); stainless steel connectors with Pb free solders (96.5Sn3Ag0.5Cu, 42Sn57Bi1Ag, 98Sn2Ag). Directly soldered wires to the print have been tested with Pb free solders (98Sn2Ag, 57Bi42Sn1Ag, 55In2.5Ag42.5Sn, 90In10Ag, 65In30Sn4.5Ag0.5Cu, 90Sn7.5Bi2Ag0.5Cu). They failed to meet the requirements.

  Further tests have been conducted with alloys having a lower melting point than 96.5Sn3.5Ag for example, hence less stress to glass by soldering, and with a much less bismuth content than 42Sn57Bi1Ag also understood as having bad thermodynamic effect on laminated glazing due to brittleness and CTE.

- In thermal cycle tests there are glass cracks with the following solders - 96.5Sn3.5Ag, 42Sn57Bi1Ag, 88Sn8In0.5Bi3.5Ag, 98Sn2Ag, 96.5Sn3Ag0.5Cu, 90In10Ag irrespective of connector type (copper, stainless steel, wires, foils). 55In2.5Ag42.5Sn and 65In30Sn4.5Ag0.5Cu do not produce glass cracks in thermal cycle tests but they do not pass high temperature test requirements as specified in the German OEM test specification.

- Positive R&D test results with Lead-free solutions for some specific components will need further validation on vehicle level and then a decision for volume production is feasible. The estimations vary between end of 2016 and 2018 and will be dependant from further positive component test results. So no concrete timing is possible today.

- Conductive gluing: this method is not working for heating functions on surface S2 or S4 due to current density they need; there is an inevitable compromise between mechanical resistance and conductivity. This presents technical barriers to developing applicable solutions that would even partially meet the OEM requirements, especially for durability. The technology is applied e.g. for embedded heated wires or heatable coated glass, but the conductivity is then stabilized by the pressure of glass panes assembled after auto-claving.

- A technology screening has been made, to clarify if there are usable solutions in other industry sectors like photovoltaic cell production. Use of Lead-based solder was found to be state of the art there as well and a transferable and broad applicable Lead-free solution could not be identified. - The screening of alternative material has been going on since 2008.

3. *Please indicate how much lead would be used under this application and substantiate the amount of lead with a calculation for vehicles put on the European market, and worldwide.*

Electrical contacts in laminated glazing structures today are applied in a limited quantity of vehicles. In future, E-driven vehicles will need this application in general because of missing heat emission from ICE.

As base for calculation actual market development figures from the supply chain have been used. For each application group min / max values for the applied Lead content have been used and then the numbers have been multiplied with the amount of vehicles of EU market using this equipment. Figures worldwide have not been investigated due to time constraints. For the EU market we see a total quantity of Lead in entry 8j applications in the range of 0,6 to 1,5 metric tons per year.

Quantity calculation; European Market					
	Lead per vehicle min; [g]	Lead per vehicle max; [g]	No of vehicles with application/y	Total min. [kg]	Total max. [kg]
Wired Heated	0,04	0,06	1200000	48	72
Wire Antenna	0,05	0,1	380000	19	38
Wire Heated Wiper Rest Area	0,63	1,5	84000	52,9	126
Printed Heated Wiper Rest Area	0,63	1,5	400000	252	600
Printed Heated Backlights	0,42	1,75	200000	84	350
Printed Camera Window	0,1	0,2	1000000	100	200
Printed Antenna	0,1	0,42	200000	20	84
			total [kg]	575,9	1426
			total [tons]rounded	*0,6*	*1,5*
density Lead 11,36 g/cm³			*Volume [m³]*	*0,05*	*0,13*

4. *Please provide a roadmap towards ELV-compliance if the use of lead is still unavoidable.*

- For current volume production of electrical connections within laminated glazing structures Lead-containing solders are still essential to enable the production of vehicles. It is self-evident that the generic roadmap towards ELV compliance (see figure 2) is not different from the timeline requested for entry 8i. The reason for that is that industry is more or less in a similar position as during the stakeholder consultation on entry 8i and the implementation time of an identified, valid solution -which is an ongoing issue- mainly depends on the positive tests results needed on vehicle level.

  As stated above, when the remaining challenges e.g. of industrialization have been met in the supply chain, the experiences can be used for development of entry 8j i.e. non toughened glass issues, which is at our opinion even more challenging.

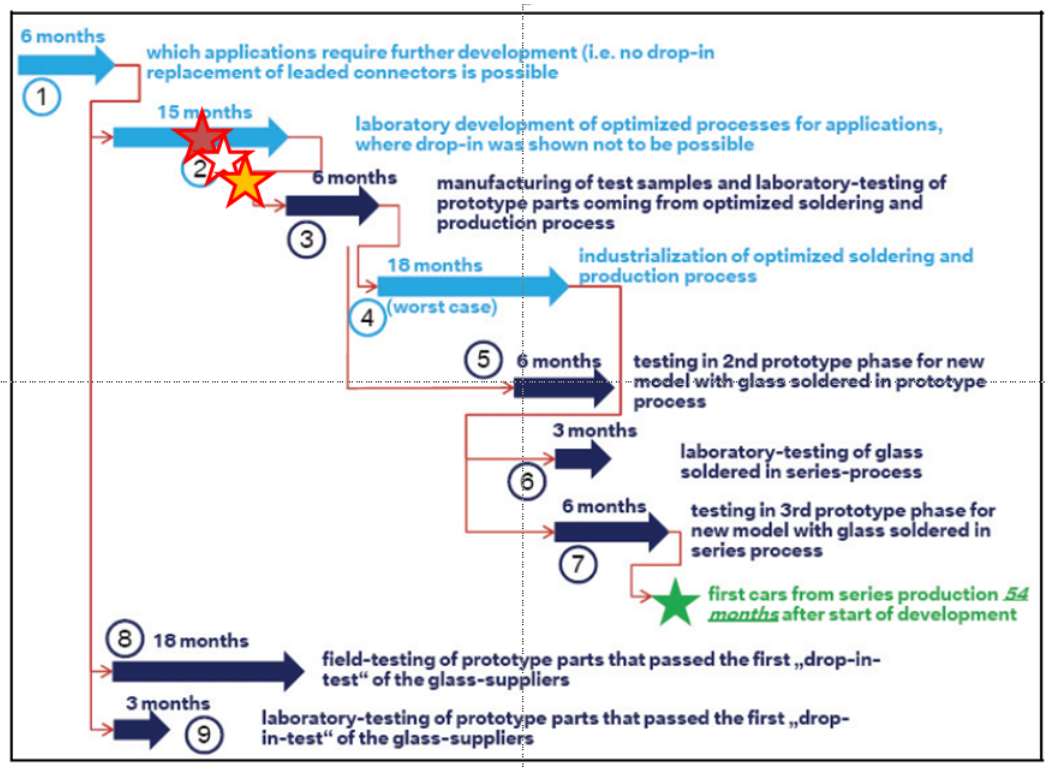

Figure 02: Timeline for soldering of laminated glass structures soldering on non toughened glass

- Based on solution availability on component level at least 36 resp. 48 to 60 months are necessary for validation on vehicle level and ramp up of production processes.

- The generic timeline given during entry 8i revision[3] is still valid and not repeated here again.

- More practical experience with pilot applications is necessary to collect knowledge on long term reliability as prerequisite for volume production.

- A limited access to recently patented potential solutions may influence further progress speed as negotiations may be challenging.

[3] Please see final report O. Deubzer, S. Zangl: Review of exemption 8(i) Page 25 ff; Oeko Institute, Freiburg and IZM Berlin 10 March 2012;

The generic timeline for transition to replacement of Lead-containing solder provided by JAMA (see figure 3) for laminated glass de-icer and antenna terminals as well resumes a total program time period of 48 to 60 month, if no failures occur. It reconfirms that the overall timing in general is similar with the timeline shown in figure 2 with the difference that the procedure of supplier selection takes more efforts, resulting in an earliest implementation period of 48 months.

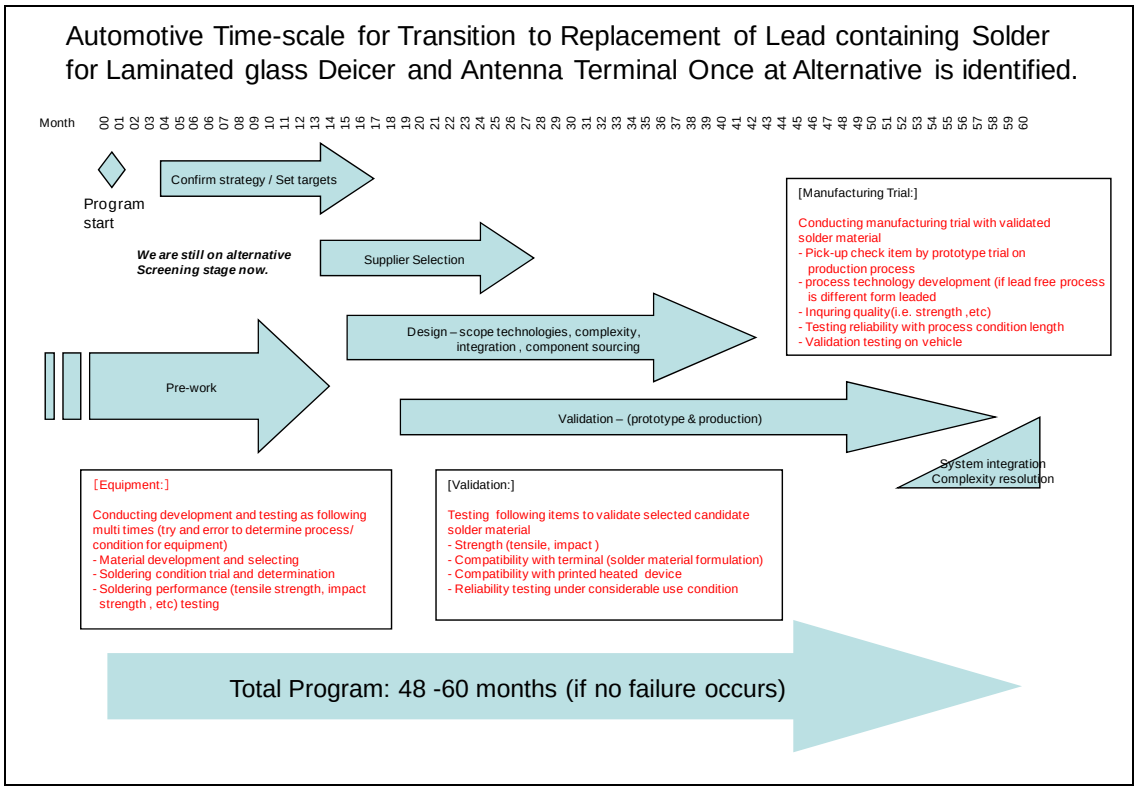

Figure 03: Timeline for laminated glass de-icer and antenna terminal (source JAMA)

Based on the facts specified above and in the separate entry 8j details document we have to state that today numerous component and vehicle specific challenges still need to be tackled before a general volume production of Lead-free soldered laminated glazing structures may be possible. Therefore our proposal for renewal of annex 8j is to continue the unlimited exemption and to have a review on the progress in 2017 earliest. This means:

- ***8(j) Lead in solders for electrical glazing applications of laminated glazing structures: To be reviewed.***

Date: 4 November 2013

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