Enclosure 4: Industry activity roadmap 2011 to 2016

"Lead in solders in electrical glazing applications on glass except for soldering in laminated glazing"

The following figures and the text of this paper are detailing and completing the roadmap sent during the last stakeholder consultation in June 2009.

Figure 4.1 gives a generic survey on the issues to be tackled to validate a potential substitute.

1. R&D activities investigation new possible substitutes	New solder alloys; alternative joining techniques;
2. Process /production technology development	Deveplomentson production implementation technologies
3. Industrialisation trials	Production feasibilty pilot tests
4. Component tests	Tests at suppliers; Tests at OEM
If not OK back to 1.	
5. Vehicle tests (Summer /Winter)	Absolving winter test programs in test cars Absolving summer tests in test cars
6. Long Term reliability vehicle tests	Long term field tests in pre-series cars

Figure 4.1: survey on activity issues

The next figure (4.2) presents the updated roadmap of the automotive industry from the last stakeholder consultation. This roadmap is based on some prerequisites.

Prerequisites to roadmap 2011 -2016:

- There is currently no "drop-in" replacement for lead containing solders for this application for mass production for every model.The roadmap is based on the assumption to have a technical solution for a substitute available within the next months. On Aug. 25 2011 one supplier has stated for the first time that he is quite sure to have found a technical solution. Further companies then announced confidentially to have finished some promising substitute developments soon. These will be evaluated. Results will not be available within the time period of this stakeholder consultation. A technical solution may not be exclusively from one company. A single company is unable to provide the volume for all new type-approved vehicles
- If the validation of a technical solution is found later than expected and only becomes available later, the start of production has to be postponed accordingly.
- After having a validated technical solution available the implementation in new type approved cars needs at least 3 to 5 years. This period is in line with all requests of the automotive industry within the last stakeholder procedures of annex II revisions. - The detailed specific timeline for entry 8i from last stakeholder consultation is still valid.

- Successfully passed component specs tests are the prerequisite for entering vehicle tests. They are no guarantee that vehicle tests will bring positive tests only. So additional vehicle tests are essential to check that new or changed components are safe and reliable over calculated lifetime.

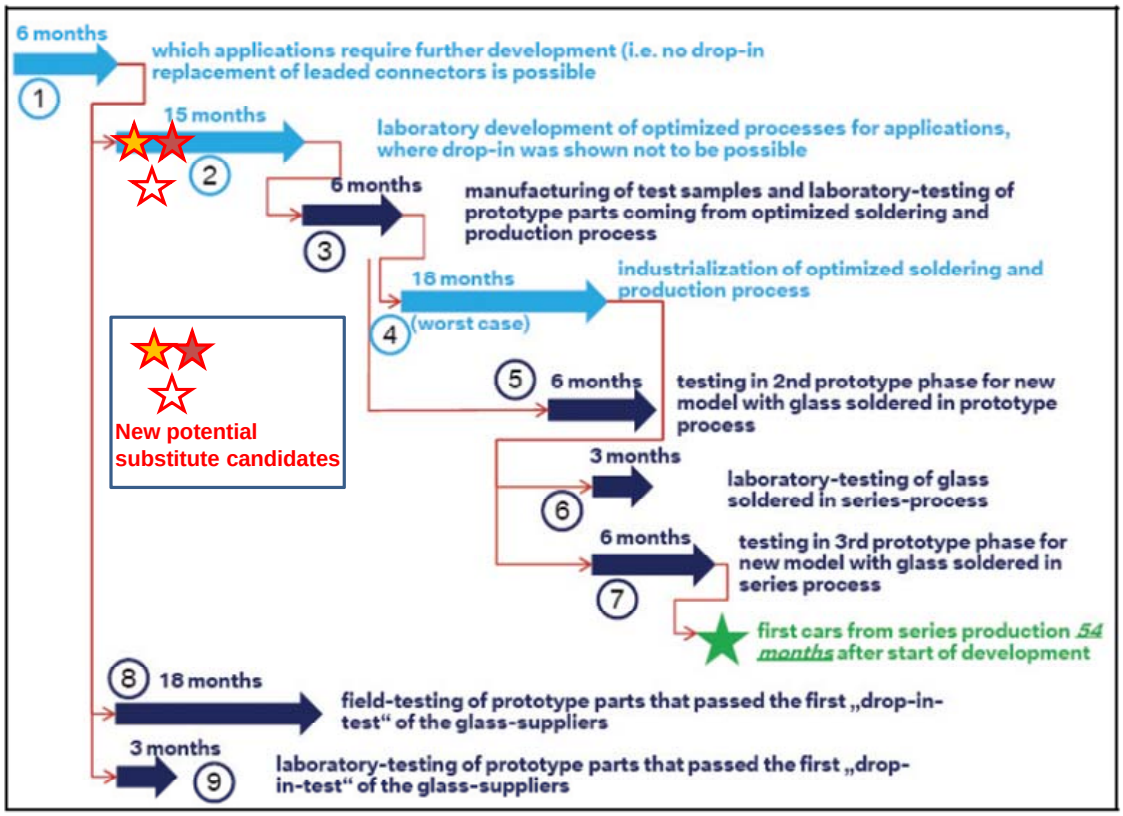

figure 4.2: updated roadmap for the implementation of a substitute for lead in solders in electrical glazing applications on glass

With some new potential substitutes claimed to be found recently, we are currently more or less at 54 month baseline point of the roadmap (see stars in figure 4.2). This gives evidence that there are around 3 to 5 years required for implementing the substitute in new type approved vehicles.

Please find enclosed the detailed timing for a substitute implementation, which was also provided during the last consultation.

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ACEA et al. describe the above roadmap in more detail (Pinsker 2009b):

1. Determination of applications requiring further development

a) Preparation of samples for all applications ➡ 3 months [Samples must originate from "normal" production]

b) Soldering ➡ 1 month [roughly: 20 applications x 200 connectors = 4000 connectors].

c) Since no adapted tooling for the series designs is available, all connectors must be processed by hand on a manual series production line.

d)Tests and evaluation ➡ 2 months.

Total: 6 months

2. A lab-development has to be started for all applications where no drop-in is feasible

a) Optimistically, the stakeholders assume for all such applications (only) two development cycles á lab-analysis of the failure-reasons, definition of process or product actions ➡ 1–2 months.

b)Execution of optimization ➡ 2 months [if new tooling is required (e.g. new printing screens), time of delivery has to be taken into account].

c)Preparation of samples incl. soldering ➡ 1/2 month.

d)Tests and evaluation ➡ 2 months.

Total: 6 months per cycle, ergo a good **12 months of development** [Parallelization of the developments for different applications are limited by man-power. Hence, if the number of applications is big (>3), delays are unavoidable].

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3. Presentation of prototypes for all applications at all OEMs, as all OEMs will want to apply their validation program

a) Preparation of prototypes on series or pilot lines ➡ 3–6 months, depending on OEM demands.

b) Validation program OEMs ➡ 3 months.

c) Field tests with prototypes ➡ 15 months, but can be done in parallel to industrialization.

d) After this validation introduction of the new technology into running development projects can start.

Minimum lead-time until SOP (start of production) is **1 year**, if no big engineering of production lines is required. Otherwise (e.g. new printing room), **1,5 – 2 years are realistic**.

4. Industrialization (here the case of a required invest is discussed)

a) Invest preparation (dossier) and decision ➡ 3 months.

b) Engineering (compilation of list of requirements until PO) ➡ 3–6 months.

c) Time of delivery: 3–6 months.

d) Waiting for shut-down ➡ 0–6 months [larger modifications of the shop floor, e.g. an additional printing room or a modification of an automated soldering line, are only possible during summer or Christmas shut-down]

e) Start-up and ramp-up ➡ 3 months.

Total: 1 to 1,5 years [The extent of the required actions is crucial, e.g. if no space on the shop floor is available to install a new printing machine + curing station (which unfortunately is quite often the case), it is necessary to change the complete line design. Then 1,5 year is quite challenging. If "only" a flux application apparatus has to be added to a line with amply shop floor space (and amply cycle time!!!), the engineering can be done in 6 months].

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5. Testing in 2nd prototype phase of OEM

a) In the 2nd prototype phase cars are produced with toolings that are either series or close to series.

b) The cars are used for thorough testing of the complete system. As for example chemicals used in the interior may interfere with the solder contacts, it is required that also the material used for the solder contacts is the same that will be used for series, thus the glass for these prototypes must have been produced under conditions close to series.

- car buildup (prototypes!)➡ 1 month
- laboratory testing (climate, shaker, ...)➡ 2 months
- summer- and winter testing➡ 2 months each, not including the time for waiting for correct weather conditions in the relevant countries.

Total: around 9 months.

6. Laboratory-testing of glass soldered in series-process

a) As for the 2nd prototype phase no parts from series-process may be available, additional laboratory testing is necessary with series parts.

Duration: 3 months including production of test specimen.

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7. Testing in 3rd prototype phase for new model with glass produced and soldered in series process

a) As for the 2nd prototype phase no parts from series-process may be available, there is only the 3rd.

b) prototype phase to test the parts coming from series tooling and series process.

- car buildup (prototypes!)➡ 1 month.
- laboratory testing (climate, shaker, ...)➡ 2 months
- summer- and winter testing➡ 2 months each, not including the time for waiting for correct weather conditions in the relevant countries.

Total: around 9 months.

8. Field-/laboratory testing of prototype parts that passed the first „drop-in-test“ of the glass-suppliers

a) In order to get first results and hints on what to focus on in the further development, first prototypes of glass with lead-free solder connectors are tested in laboratory as well as in current series-cars under heavy driving conditions and special climates.

b) Main purpose of this test and the corresponding laboratory-test is to get a comparison between laboratory and real-life conditions: does the laboratory test really reflect real-life conditions?
These tests do not influence the total time needed for the development, they are done in parallel.

The stakeholders confinet hat in all cases of mentioned periods it was assumed that all work can be perfectly parallelized for all applications, products, plants, lines, customers, etc. (Pinsker 2009b). Since this technology concerns all customers and all plants and service centers, the limiting resource is man-power. The required know-how according to the stakeholders is very specific and cannot be studied at universities. All engineers are trained by the glass industry and there are only about 15–20 experts in all companies in total all over the world. Such experts hence are difficult to find, according to the stakeholders (Pinsker 2009b).

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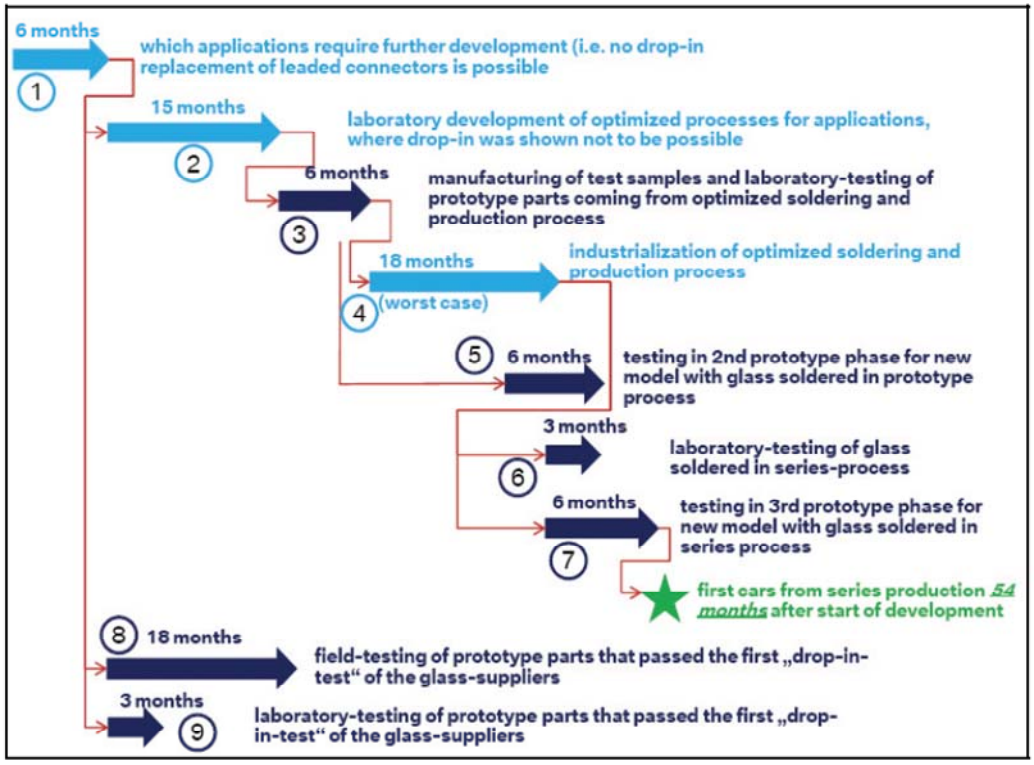

Figure 52 Proposed schedule for lead replacement in soldering on glass (Pinsker 2009b)