Response to the evidence presented by the Australian Glass and Glazing Association at the February 15, 2016 hearing of the Senate Economics Committee into Non conforming building products.

Responses and refutations are in red. Original text in black.

Page 30 of Hansard, from the testimony of Mr Overton:

"I want to make some further comments in regard to the issues this morning with the discussion around the safety glass standard, AS 2208, just to summarise the process and AGGA's involvement so far. The BD-007 committee, which is tasked with this particular area, has 20 representatives on it. AGGA has three of those representatives. Over the extensive period where these standards have been developed and discussed, typically those three representatives have all been from different companies."

This is misleading. At the date of the hearing all 3 AGGA representatives (Messrs Rice, Jones and Aspden) are employees of G.James Glass and Aluminium ("GJames"), and in recent years, there have often been more than one BD7 voting member employed by that company (though sometimes "representing" the interests of glass organisations other than AGGA). It is relevant to note here that the "cabal" as referred to by Dr Munz includes other entities who have commercial interests in common with G.James and/or who are suppliers of materials and services to them. Details of their activities in support of G.James' agendas, apart from support at committee meetings, are set out in the chronologies tabled with the presentations of Drs Munz and Jacob.

"The claim of a cabal approach, considering that these are three independent individuals out of a total of 20, is obviously something that we would refute."

"Refute" *def.* "to disprove, overthrow by argument". It is clear from my above detail that the cabal is proven to be truly alive and active, and has been so for some years. What AGGA really means is that it denies that a cabal has been operating and continues to do so, a denial that is contrary to all the objective evidence.

"Something we need to be cognisant of is that all the members of such a committee come from industry." **This statement is also untrue. Representatives from government bodies (such as ABCB) and universities are on the committee**. "That is why they have their expertise. They have all been employed by various companies at various times. The proponents who were claiming the cabal activity by AGGA have themselves been employed by other companies at other times. Everybody comes with history and knowledge, and that is why they are useful. That is why there are 20 people around the table to make those decisions." **Dissembling.**

"The current 2208 that is standing as it is now, which was finalised in 1996, was in fact under the chairmanship of Dr Leon Jacob, who appeared this morning. So that standard as it stands now was actually approved by Dr Jacob himself in 1996." **The Chairman does not "approve" any Standard. There is a process, and AGGA knows what it is as demonstrated by their skill in subverting it.**
As summarised (see Appendix 1) in Dr Jacob's presentation to the AS/NZS Working Group in 2008, Dr Jacob attended an ISO meeting in Brussels in 1999

as a representative of Standards Australia and advised ISO that Australia intended to carry out a test program to evaluate the new European double tyre impactor versus the AS/NZS 2208 lead shot-bag impactor. It was advised that this test program would include both laminated glass and toughened glass and would evaluate the breakage characteristics of toughened glass. Subsequently Dr Jacob submitted test reports to an ISO meeting in Tokyo in May 2000 on the results of three test programs he had personally conducted. These results along with test results by ISO representatives from China and Japan were formally presented to AGGA in November 2001 – refer to Appendix A of my original submission. "The new draft, yes, has taken a very long time. As we noted this morning, it has been going for some nine years now, and I think we are up to version 10 of a second iteration of that draft to try to get some conclusion.

To bring you up to date as to where we are with that standard at the moment: there was a meeting of BD-007 in the second half of 2015, at which Dr Munz was present. At that meeting it was tabled—I am sorry to go into some of the technical detail—that the fragmentation count would be increased significantly, from 30 to 50, and that would actually be in line with the much higher automotive glass standard. That was tabled and put to a smaller working group" **(not a Working Group, but a group led by a "drafting leader", who could be better described as a "cabal leader", and his willing helpers)** "to then work this up" **(excellent descriptive phrase!)** "and take it back to the BD-007 committee."

The claim that increasing the fragmentation count to a higher number without changing to a central impact point would solve the inadequacy of the current AS/NZS 2208 draft is untruthful. A detailed argument in support of this statement is set out later in this response to the similar but more detailed untruthful representations of Mr Jones.

"The document as it stands now was distributed to the BD-007 committee a month ago for consultation and comment. Once that process has been finalised, if the BD-007 committee itself can come to an agreement as to that draft document, it will then go out for public comment as well. So we would certainly refute" **("refutation" without substantiation = denial)** "any claim that there is a collusive or cabal activity. It is a very open process. Multiple parties are involved, and they all have the opportunity to make comment."

Pages 31-38 of Hansard, Questions from Senators, and replies by AGGA representatives, ie G.James Glass and Aluminium representatives:

Senator XENOPHON: Can someone explain to me why it has taken—how many years has it been—a 10th draft?

Mr Overton : About nine years.

Mr Rice : In 2208?

Senator XENOPHON: No.

Mr Rice : In the safety glass standards?

Senator XENOPHON: Yes.

Mr Rice : As the committee was told, we had a working group established in 2008 that developed some options for a revised standard that went to the committee, and there was no consensus reached, so it stopped. The working groups are not long-term bodies; they are designed to be short term, so you form them, get something done and abandon them. It goes back to the committee. And then, if the committee feels there is more work to be done, a new working group will be formed. So I do not think the working group has been active since 2008. I think there have been working groups active since then, but not a single group.

Mr Rice is fully aware that there was one Working Group ("WG") which produced a draft AS/NZS 2208 Standard, and that in November 2009, at what turned out to be the final meeting of the official Working Group, all members at the meeting in response to concern from industry on the size of the test sample in the draft agreed on further testing with the aim of reducing the test sample size from 1900 mm x 860 mm to 860 mm x 860 mm. It was anticipated from the discussion at the meeting that G.James Glass would provide the glass needed for this testing. Prior to minutes of the meeting being issued Mr Rice who had not attended the WG meeting despatched an email in which he claimed that no consensus had been reached at the meeting. Appendix 2 however contains an email dated 30th August 2011 from the BD-007 Chairman in which he acknowledged several times that agreement was indeed reached at the November 2009 WG meeting and in which claimed for the first time that the reason why the agreed-on test program had not been carried out was because G.James had declined to supply the glass (if this had been known the glass could have been sourced from other suppliers). Based on his false assertion on the result of the final WG meeting Mr Rice set himself up as a "drafting leader" with the approval of BD-007 to make major changes to the draft, including most outrageously to change the definition of Toughened Safety Glass ("TSG") which had been settled without dissent by the WG some years earlier and remained unchanged until then. The precise changes to the definition sought to be imposed by the "cabal" are very instructive in exposing their goal of allowing the continuing certification and supply to the community of glass which will not minimise cutting and piercing injuries in the event of human impact in accordance with the stated aims of the AS/NZS 2208 Standard. There was never a second WG established, and Mr Rice is being misleading by implying that his informal drafting group or groups had the same status as a formally constituted WG which would allow all BD7 Committee members, as well as invited experts to participate. The TSG definition in the WG draft, and that which was published in the first subsequent draft distributed by Mr Rice are in Appendix 3, and the deletions that were made by him clearly reveal his intention to subvert the key performance requirement for TSG, which is the minimisation of cutting and piercing injuries in the event of human impact.

Senator XENOPHON: It is an important standard, though, isn't it?

Mr Rice : Yes, it is.

Senator XENOPHON: Why the hold-up? I am trying to understand what it was.

Mr Rice : Because consensus cannot be reached. There is difficulty getting agreement amongst all of the members of the committee.

Senator XENOPHON: But there must be a point in time, Mr Rice—I am sorry to interrupt. If a consensus cannot be reached within a reasonable period of time, what mechanism is there to impose a new standard?

Mr Rice : It depends on what the basis for the difficulty in reaching consensus is. This is probably a question better answered by Adam, from Standards Australia; he is more involved in their procedure. Adam has been involved on a few occasions with our committee to help reach a consensus over different items. I do not think this was one of them. So Standards Australia will get involved and get parties involved to continue discussions.

Senator XENOPHON: You can understand an outsider looking at this, say from last year—

Mr Rice : Yes. But there is also an existing standard that is operating and operating well, so it is not as if the committee has abandoned Australia or the marketplace. There is a standard there.

There is indeed a Standard there. The way it operates is that it allows thousands of pieces of unsafe toughened glass to be certified, supplied and installed in Australia every day. This appears to constitute "operating well" for the cabal, and they have purposely dragged out the process in order to maintain the *status quo* until they can get a similarly inadequate "revision" of the Standard published.

Senator XENOPHON: No, but you heard the evidence that Drs Munz and Jacob provided.

Mr Rice : It is very dramatic, isn't it? Yes.

Senator XENOPHON: It is, what, 18 to 20 centimetres long—

Mr Rice : That is right.

Senator XENOPHON: and about seven millimetres wide—

Mr Rice : I have been subject to the same presentation as the committee has, which Dr Munz presented. I have seen it before, yes. It has also been presented, I believe, to the ISO committee, who also rejected it.

Mr Rice appears not to have read the account of the shenanigans at the ISO committee that allowed the ISO Standard to be subverted. This account has been provided to this Committee. Making a claim that "ISO rejected" something is a very effective distraction from the very real 180 mm x 7 mm shard, but does not change the fact that when a piece of certified TSG is broken by human impact it can generate hundreds of these shards as a result of the profound and proven and widely published inadequacy of the test procedure.

Senator XENOPHON: This is what, though?

Mr Rice : The basis for that presentation.

Senator XENOPHON: So you are saying that if you—

Mr Rice : If you break glass in a different way, you get a different result.

Senator XENOPHON: You do not get this result?

Mr Rice : I have not seen—actually, Phil might be able to answer that question. Is that okay?

Mr Rice was present at the AS/NZS 2208 Working Group meeting on 29 April 2008 when Dr Jacob gave his presentation on "ISO Safety Glass Test Programs - Results, Conclusions and Recommendations relating to AS/NZS 2208" (BD-007 Document No. N087). A number of the Dr Jacob's slides showed long glass splines resulting from both pendulum impact testing and as a result of impact of toughened glass by a metal punch at the geometric centre of the glass. In direct response to the presentation Mr Dennis Loudon of the Bevelite company who was a guest at the meeting and who at the time was the AGGA President offered the Bevelite toughened glass manufacturing and testing facilities for further testing to be conducted by the AS/NZS 2208 Working Group on Australian made glass. Subsequently four test programs were conducted under the supervision of the WG Chairman. Mr Rice did not attend any of these test programs. He is aware however of the presentation on the programs given by Dr Jacob at the WG meeting on "AS/NZS 2208 Test Results – Bevelite Factory 2008-2009" (see Appendix 10) which included slides showing dangerous splines both from the lead shot bag pendulum impact test and as a result of impact of toughened glass by a metal punch at the geometric centre of the glass. On 29 May 2013 Mr Rice also attended a presentation on a Viridian test program on breakage of toughened glass (see Appendix 11) which reported splines from punch impact at the panel centre, punch impact when the location of the punch is more than 54 mm from the edge and from lead shot bag pendulum impact tests.

Senator XENOPHON: Sure, of course.

Mr Jones : That particular test is not really related to real-world circumstances, and it has been a little disingenuous of Dr Munz not to include that in his presentation.

Mr Jones claims that Dr Munz was disingenuous. Dr Munz can show that this is manifestly false. In his presentation, Dr Munz stated that two pieces of 4 mm toughened glass were broken, one with centre fragmentation, and one using the shot bag impactor rig defined in the current revision of AS/NZS 2208. It was further stated that both pieces generated large numbers of these long blades. Video footage of the impact test as well as samples of the shards as generated are available to Senators. The shot bag test is recognised as the best simulation of human impact by Australian and overseas Standards. Mr Jones deliberately misrepresented the tests reported by pretending only the centre fragmentation test was carried out, and denying its correlation to glass fracture characteristics from human impact in an attempt to deny the formation of shards by glass that AGGA members deliver every working day.

The way that particular test as it is currently carried out is taken is that, if you take a given size square of glass and if you break it in a particular way, and if it satisfies a particular requirement, then that glass can be deemed to be safe for society. I would put it to you that, in all of the years that that standard has existed, it has served our community extremely well. **The issue of "extremely well" was covered above as code for "it suits the cabal".**

We are all familiar with the great press coverage of some poor unfortunate child or individual who has been sliced up by a broken window. I would put it to you—and I have looked for it as part of the BD-007 function—that, both within Australia and around the world, you cannot find significant numbers of accidents that have occurred when safety glass has been involved. **This is simply assertion, not evidence. It so happens that there are records collated in the USA in relation to glass injuries. Some of these are set out in Appendix 4 to this document, and clearly demonstrate that one can in fact, if one really looks, find "significant numbers of accidents that have occurred when safety glass has been involved". Mr Jones' assertion that "you cannot find.." has been proven incorrect.** Since this standard was introduced into the industry, those sorts of accidents have been significantly reduced. **But there is allegedly no data, so how do we know?**

Senator XENOPHON: Is there scope to reduce them even further, do you think, with some reasonable—

Mr Jones : I think there is always scope to reduce things. There is always scope to improve something. But, if you take a piece of glass of a different size and you break it in a different way, the industry understands and expects that you will get a different result. There is no surprise in that whatsoever. The problem here is that neither the test that is current to the standard nor the method that Dr Munz is suggesting relates to a real-world situation. People do not run around with a punch and break safety glass. It does not happen that way. **However, the WG conducted systematic experimentation to show that centre fragmentation results correlate with shot bag impact results, while edge fragmentation does not. The shot bag impact test is recognised to simulate human impact as set out in the Standard in Australia and many other jurisdictions. Appendix 5 to this document sets out details of Standards in other jurisdictions which specify the shot bag impact test.**

Senator XENOPHON: What do you mean by 'a punch'? A hammer or just a—

Mr Jones : No, it is a punch. It is a pre-loaded pressure punch. You go to the glass surface while it lies in a horizontal position and, if you are doing it properly, you restrain the sides in order that the stresses are released uniformly, and you assess the result. But that does not in any way mirror what happens in a real-world situation. **But Mr Jones and the cabal claim that a punch impact at the edge does mirror a real world situation? My previous comment elaborates on the correlation between centre point punch impact and human impact – which the cabal chooses to deny despite the definitive evidence.**

Senator XENOPHON: Thank you. I am sure these are things we can put to Dr Munz as well. I do not understand why we still have to wait another year and a bit for this standard for safety glass—no? We do not have to, Mr Rice?

Mr Rice : I was surprised today when that 2017 date came up, because my latest verbal correspondence with the new project manager for the BD-007 committee was that he was expecting the draft to be completed earlier this year. I think it was initially going to be at the beginning of February, but there were some comments received on the latest draft to be integrated into that, so I think it is March now. He wants a draft.

Senator XENOPHON: This was raised earlier. There seems to be some lack of precision or certainty about the test environment, the test criteria and whether it is pass or fail. We do not seem to have that at this stage, do we?

Mr Rice : Whether there is—

Senator XENOPHON: To develop the standard. Is there a lack of coherence or uniformity in terms of testing standards?

Mr Rice : No, I think we are very close. It is difficult to say we have consensus without a full meeting of the committee to discuss the draft that has been put in front of them, but I would think we were very close to consensus. That has been the aim of developing this latest draft: to get to consensus. Not all of Dr Munz's suggestions are included in that, but there are some. For example, Warren was talking about increasing the fragmentation count to bring it in line with automotive glass. **This is a furphy – see other comments**. That is incorporated into the latest draft.

Senator XENOPHON: If you do not resolve it this time round, what happens then?

Mr Rice : I am not sure what Standards' approach would be to that.

Senator XENOPHON: Thank you.

CHAIR: I have a couple of follow-up questions before I hand over to Senator Madigan. What do you say to Dr Munz's critique as to the method of testing that we currently have, which is an impact at the edge of a sheet of glass as opposed to testing with an impact in the middle of a sheet of glass, which, to my way of thinking, would probably more reflect a real-life situation of somebody walking through a sheet? What do you say to that? Perhaps, Mr Jones, you might comment.

Mr Jones : I endeavoured to cover that when addressing you a short while ago. I do not think either faithfully represents or duplicates what happens in a real-world circumstance. It is simply accepted by the industry that if the current test is passed against the current criteria, that glass will be released into the community. That serves the community well. I put it to you that the record of the product in the community supports that claim. **Here we go again – should say "The glass will not break in accordance with the product description, and is not fit for use where it may be subject to human impact, which is precisely where the regulations require it to be installed."**

CHAIR: So you do not believe that a shot-bag impactor targeted at the middle of a sheet of glass is reflective of a real-world situation?

Mr Jones : The shot-bag test is one that is more often associated with laminated glass**. This is an evasive response. It is true that the shot bag is used for laminated glass**

assessment, but as stated above and supported by the detail in Appendix 5, it is the recognised simulation in Australian and other national and international Standards for human impact, for assessing toughened safety glass where cutting and piercing injuries are to be minimised. In his presentation Dr Munz has looked to include photographs et cetera of that test being carried out, in order to substantiate his claim about the breakage pattern. But what he has declined to include in that presentation is that when a piece of glass is laminated, and it is broken, a percentage of the energy is dispersed back into the PVB and the breakage pattern is affected by that. It is affected in line with what Dr Munz has demonstrated. **This is a lot of irrelevant codswallop and intended to simply avoid the Chairman's question. I attach documents which demonstrate the wide acceptance of the shot bag test to simulate human impact. (Appendix 5).**

CHAIR: What would you say is the most appropriate way to test a sheet of glass to reflect a real-world situation?

Mr Jones : I would say that for Australia to achieve the best result it would be wisest for it to employ the matters that are used in every other country in the world.

CHAIR: Which is?

Mr Jones : Which is the current test that is in the draft proposal for the reviewed standard. **Not true – please see attached documents (Appendix 6), which show that current best practice for the automotive Safety Glass Standard (ECE 43, 2014) is centre fragmentation, which is not the current test that is in the draft proposal.**

CHAIR: I thought that Dr Munz indicated that overseas they have moved to the shot-bag impactor—

Mr Jones : There may be an environment that has done that, but it is not a universal **position.**

Mr Jones is incorrect in both statements.

Overseas safety glass standards including in the USA (ANSI and CPSC), Britain (BIS), Germany (DIN) and France (AFNOR) and Japan (JIS) have historically required that toughened (tempered) glass be classified as safe solely by the pendulum impact test. European toughened glass standard EN 12510-1 requires that if toughened glass is to be used in an application which offers protection to accidental human impact it must be classified by the pendulum impact test in European test standard EN 12600.

The 1989 and 1997 versions of the Japanese Industrial Standard for 'Tempered Glasses' JIS R 3206 required both the pendulum impact test and the edge fragmentation test. In 2001 Japanese members of ISO/TC160/SC2/WG6 'Safety glazing tests' representing the three float glass manufacturers in Japan carried out impact tests to compare pendulum impact results with the JIS R 3205 and JIS R 3206 lead shot bag with those obtained using the new double tyre impactor proposed in draft European Standard prEN 12600. The results of their studies on breakage of laminated and tempered glasses by pendulum impactors were reported in their Glass Processing Days 2001 paper "Investigation of

Repeatability and Reproducibility of the Shot Bag Impactor". Their paper presented the following findings on tempered glass breakage patterns which were illustrated by photographs in the paper:

1) **Splines were generated in 4 and 6 mm thick specimens, but they were not generated in 8 mm thick specimen.**
2) **Splines generated in 4 mm thick specimen were longer than those in 6 mm thick specimen.**
3) **Spline generation by double tire impactor was apt to increase in length compared with that by shot bag impactor.**
4) **Splines generated on the normal JIS rig were longer than those on the reinforced JIS rig.**

According to the Japanese paper "Spline" means a narrow and slender fragment of broken tempered glass having an elongated surface length (for example more than 75 mm) exceeding its thickness.

As detailed by Dr Jacob in his detailed submission to ISO/TC160/SC2/WG6 dated 8 September 2008 following the 6th meeting of ISO/TC160/SC2/WG6 in October 2002 a maximum spline length of 100 mm was included in version 'N57 rev 1' of the draft . This requirement remained in the draft standard until the 8th meeting of WG6 in Venice in May 2005 at which it was arbitrarily deleted by at the insistence of European delegates who had not attended previous WG6 meetings. The two Australian WG6 delegates were prevented from attending the Venice WG6 meeting and the deletion of the maximum spline length requirement was protested by the Chinese delegate at the meeting. After 19 years of development ISO standard ISO 29584:2015 "Glass in building – Pendulum impact testing and classification of safety glass" was issued.

CHAIR: What about the thickness of the glass that we use in Australia? I think Dr Munz talked about the fact that the Europeans have moved away from the four millimetre glass. What do you say to that?

Mr Jones : That is not quite an accurate statement. The majority of glazing that occurs overseas is done with double-glazing or insulating glass units, and it is quite common that four millimetre glass, toughened, is included within the assembly of the double-glazed unit.

CHAIR: For my understanding, what is the most common form of testing that is done for this safety glass standard. You have mentioned that there is something happening in other countries. What is that?

Mr Jones : It is typically in line with the ISO—

CHAIR: But please describe what it involves.

Mr Jones : It is the impact fragmentation test.

CHAIR: How is it done?

Mr Jones : Using a centre-punch in the middle of the longest edge of the sample size, and the sample size that is typically used is the 1,180 by 360 size. The problem with the larger size is that represents a very small percentage of glass that is glazed in that thickness. Most—and when I say most, a minimum of 85 per cent—of the glass that is used in industry in the four millimetre thickness is far smaller than the size that the swing-bag test exposes it to. The swing bag impact test specifies that only the largest size proposed to be supplied needs to be tested. But some 4 mm of size 860 x 1900 mm is supplied, and a huge quantity of 5 and 6 mm this size and larger.

CHAIR: I thought I heard you say earlier that the shot approach was not reflective of a real-world situation. Did I misunderstand what you said?

Mr Jones : You may have misunderstood me marginally, in that the only way use can successfully test four millimetre glass in that environment is to do it in a laminated glass format, because if you can get the glass to break the thin glass will just absolutely shattered and go everywhere and will leave the frame it is tested in. **Mr Jones knows very well (and it is documented in the final draft generated by the official WG, detailed in Appendix 7), that testing toughened safety glass with a shot bag is simply done by adhering an adhesive film to the impact face prior to impact. This film allows the glass to shatter, but holds the shattered particles together so they can be inspected and assessed. Dr Munz has repeated these tests which were first carried out by others in Japan, China and Australia and the reports of which are widely published and have been distributed multiple times to members of committee BD7 including the G.James contingent. Dr Munz is able to supply video footage of such tests, and even sections of broken glass held together by the film showing myriad long shards generated as a result of inadequate toughening. So the statement that** "the only way you can test four millimetre glass in that environment **(ie with the shot bag – writer's clarification of Mr Jones' obfuscation)** is to do it in a laminated glass format" **is untrue, and clearly intended to be misleading and deceptive. Further evidence that Mr Rice in particular, and probably Mr Jones were fully aware of the shot bag impact test using adhesive film, and the nomination of centre point impact for the fragmentation test in the WG final draft of the WG is explicit in the presentation made by Mr Rice to the AGGA conference in 2010, which was a "Standards Update" on AS/NZS2208. The slides shown at this presentation appear as Appendix11.**

The most interesting slide is Slide 11, which states that "the working draft is finished". This statement by Mr Rice unambiguously confirms that agreement to the WG draft was indeed reached by the WG, and that subsequent claims that agreement was not reached is manifestly false, and was used as the pretext for abandoning the sections that the cabal found disagreeable, by hijacking the process through appointment of Mr Rice as "drafting leader".

CHAIR: But we are talking about the safety glass standard.

Mr Jones : We are.

CHAIR: You have indicated to me that a shot approach on the edge of a sheet of glass is reflective of a real-world situation?

Mr Jones : No, I have indicated to you that a pre-loaded centre-punch is typical.

Mr Rice : I think there is some confusion about whether it is reflecting a real-world example or whether it is ensuring that safety glass is provided. While the fragmentation test might not be representative of real-world breakage, it is still a very effective way of demonstrating compliance with the standard and ensuring that the glass is adequately toughened to provide a safety glass at the end. **Simply untrue for edge fragmentation!** The issue with the swing-bag test is that it gives very dramatic results for thin glass, but if you were to move to thicker pieces of glass—eight, 10 or 12 millimetres—and hit it with the swing-bag, it does not break and you do not demonstrate anything apart from that the glass is very strong and the swing-bag did not break it. There have been some proposals at the committee by Dr Munz and Dr Jacob to deliberately damage the glass to cause it to break. To my mind, testing new products by damaging them is not a very sensible way **(why not if it produces results that will truly represent the breakage characteristics of the glass?)** of going about establishing anything **(but using an edge fragmentation test that allows dangerous glass to be certified establishes what – that the cabal is getting its way so far.)**, and that is why the swing-bag test is not universally used. Quite often, in overseas standards there will be a requirement to use the swing-based test and, then, when the glass does not break you use the impact test, the fragmentation test, to break it. **This is all fine, except that the fragmentation test needs to be carried out at the glass centre!**

Senator MADIGAN: Mr Jones, to get more clarity, we are talking about the pre-loaded centre-punch, which I am familiar with. Can you explain to the committee how a pre-loaded centre-punch simulates when a person, say, walks into a shower screen?

Mr Jones : I do not believe that it does in any way whatsoever. I do not think it is intended to.

Senator MADIGAN: What is it intended to represent?

Mr Jones : At the risk of repeating my words, it is endeavouring to say that, if you take a given piece of glass of a given size and break it in a prescribed manner and then assess that breakage via criteria, you will be able to ascertain that the product that is being released into the market is appropriately safe for the community. **Only if the test has been correlated with human impact results!**

Senator MADIGAN: I think the committee is finding it difficult to understand. I understand that you are referring to a given piece of glass of whatever size—I think you said 860 by 1,190—and you are referring to the length of the glass, roughly half an inch in from the frame.

Mr Jones : That is correct—on the longest edge.

Senator MADIGAN: You then referred to a spring-loaded centre-punch. We are just trying to understand how that relates to what happens out in the real world. Which is better test of the two?

Mr Rice : That gets back to the issue that I just discussed. If you have a swing-bag test, you cannot use it on all glass types, because the thick glasses do not break. **The major issue in relation to TSG is glass 6 mm and less in thickness, for which a swing bag test, or**

other correlated test, ie. fragmentation at the panel centre have been proven manifestly adequate and suitable! So with the swing-bag test all you are doing is demonstrating glass strength. **Not when it fractures.** Industry needs another method that is applicable to all glass thicknesses, and the one that is used internationally, and here, is the fragmentation test on the edge. **But this test has been shown to be uncorrelated to human impact fragmentation, allowing unsafe glass to "pass".** What that does for you as a toughened glass producer is allow you to get some feedback on how the glass you are manufacturing is toughened. If it is not toughened properly, the fragmentation—the number of pieces in a 50 by 50 square—will be less than if it is toughened properly. Those are the criteria that are used in the standard. Currently for four millimetre glass I think it is 30 fragments in a 50 by 50 inch square, in the worst case on the sample. I think the current standard proposed is that it is going to be 50, which is the automotive glass standard. **See other comments as to how this is misleading. Mr Rice mentions only the particle count, but conveniently does not mention that current best practice internationally for the automotive toughened glass Standards is centre fragmentation, as detailed in Appendix 6. Is this simply ignorance from the Chairman of the AGGA Technical committee, or another example of not telling the whole truth in an attempt to mislead the enquiry?**

Senator MADIGAN: You speak about the automotive glass standard and how a piece of automotive glass shatters to be like gravel. You are saying that the committee that is looking at the standard now is looking at the new standard replicating, for want of a better word, the automotive glass standard as to how the glass will break or collapse.

Mr Jones : The current draft has that fragmentation count in it, yes—the automotive glass one.

Mr Jones is also skilled at withholding disclosure that the key aspect of best current practice Automotive testing is by fragmentation at the panel centre. Particle count is not nearly as critical as centre fragmentation, which best simulates performance in the event of human impact or from other causes. Edge fragmentation has been conclusively proven to produce particle count results which are good when the glass is poorly toughened, and will generate long dangerous particles when broken from impact away from the edge.

Senator MADIGAN: Regarding the concerns with shards of glass, as we have been shown—which I would not want one of my children to come up against—are you saying that the proposed standard will address those concerns?

Senator XENOPHON: Senator Madigan is referring to the automotive glass standard.

Mr Overton : One of the issues we are facing here is that to produce shards like that requires you to take a centre-punch and break the middle of the glass. As Mr Jones was saying previously, that is not a realistic real-life scenario, so you are not going to get shards—

This is not true. Mr Overton should leave the attempts to deceive the committee to the technically qualified persons on his team. It would be reasonable to assume that Mr Overton is simply repeating what Messrs Rice and Jones have been saying, which is contrary to the hundreds of experimental results demonstrating that badly toughened

glass will produce shards "like that" when impacted by a lead shot bag, simulating human impact.

Senator MADIGAN: I have actually seen it break like that with the bag. I have physically gone and had a look at it and had a look at the drawing for the standard. I have seen the weight checked on the bag and I have seen it break like that. I have measured it. I am a tradesman myself, Mr Jones, and I am right into detail.

Mr Jones : Very good. One thing I would say to you is that if the glass has been toughened properly you will more likely than not find that the shard you have in your hand, when broken again, will break into the small pieces that are typical of the rest of the glass. It is the way that the glass has been broken—with the centre-punch in the centre—that can produce that result.

Misleading to say this only happens with centre fragmentation. In the shot bag test, when poorly toughened glass is impacted, and has not been secured with adhesive film, many long crack free particles fall to the floor and are not broken. We have many photographs of these, some of which have been circulated to the members of BD-007, and samples available. Mr Jones chooses to make unsupported assertions contrary to the experimental evidence and samples presented by Dr Munz , and witnessed by him earlier in the day which reported that a commercially supplied toughened glass supplied as conforming to the current AS/NZS 2208 Standard produced shards as shown in a lead shot bag impact test. According to Mr Jones, this piece of glass was "properly toughened". The centre fragmentation test correlated closely with the result of the lead shot bag test, but the supplier would have used the current profoundly inadequate Standard to certify the glass. How can this glass be claimed to be "toughened properly"? Furthermore all testing refers to the characteristics of the crack free particles that are generated by fracturing the glass. There is nothing in any Standard anywhere that refers to further breaking "again" any of these particles. This is another irrelevant statement attempting to distract/confuse the Senators.

Senator MADIGAN: But it was not broken with a centre-punch, Mr Jones—

Mr Jones : Well, very good—

Senator MADIGAN: I am just trying to understand what is going on.

Senator XENOPHON: Supplementary to Senator Madigan's line of questioning, mention has been made of the automotive standard. Quite simply, does the industry, does your association, support the automotive standard being used as a new standard for glass—for the toughened safety glass?

Mr Jones : It was our industry that suggested it and put it on the table.

If so, then centre fragmentation becomes the test!

Senator XENOPHON: Mr Overton, is that the case?

Mr Overton : Yes.

Senator XENOPHON: Mr Rice, is that your understanding?

Mr Rice : Having been involved in the small working group **(small working group = cabal controlled opaque process)** that came up with it, yes. **But not the most critical part of best practice automotive toughened glass testing – the centre point fragmentation of full size samples**.

Senator XENOPHON: So what is the hold-up? We would rather that it break like that, into gravel-type pieces, rather than shards. Is that not a better standard?

Mr Rice : That working group met, I think it was in September or October last year, and a draft was circulated to committee for comment, I think it was in December. Comments were asked for and have been received and they have been reinserted into the current draft for circulation to the committee.

Senator XENOPHON: It seems to be taking a very long time. If there is an automotive standard, how much more expensive will that make glass?

Mr Rice : Negligible, if at all.

Senator XENOPHON: But you acknowledge that it is a lot safer than the current toughened safety glass?

Mr Rice : It is safer, yes.

Senator XENOPHON: If it is negligible, what is the problem?

Mr Rice : Well—

Senator XENOPHON: I am not having a go at you. I just want to know what the hold up is.

Mr Rice : There is a group of people who have to reach consensus for the standard to be passed. I cannot speak on behalf of the people who are objecting to the standard. I do not know if they will accept the draft—

Senator XENOPHON: You are not suggesting that Dr Munz is to blame, are you?

Mr Rice : No, it is a group of 20 people. I cannot speak for the 20 people on the committee.

Senator XENOPHON: Why would anyone hold it up, though. If it is a negligible cost, as you quite frankly set out, and if it will be safer—I am trying to use cautious language—I do not understand what the hold up would be.

Mr Rice : I don't either.

Mr Overton : It is still in the seeking comments time. There is no official hold up yet. They do give people a fair amount of time write comments—

Senator XENOPHON: In terms of injuries, I have had a family member injured by glass and needed emergency treatment, and it could have been much worse. That was many years ago. That was not reported to anyone. You just get the problem fixed, you get the suturing and you are grateful that it was not anything worse. I am trying to understand this. You do not know how bad some of these injuries are, do you? Do we get reports back?

Mr Jones : I think there is a great deal of confusion in relating accidents that have happened with glass and wanting to say that they have happened with safety glass. I think that that is a leap that is too—

Senator XENOPHON: I was not making the leap at all. I am just trying to understand whether you get any feedback from time to time of injuries relating to glass including toughened safety glass. That is all I am asking. I am sorry if I did not express that elegantly.

Mr Overton : I have been contact with various data agencies and, unfortunately, when people present, as was stated earlier, they are busy fixing them rather than asking them, 'Can you tell me was it toughened glass?' So the data we get back at best says it was a glass impact, and there is no distinction as to whether it was toughened or not.

Senator XENOPHON: I do not think that people are thinking of contacting your association or Standards Australia at the time that they are in hospital.

Mr Overton : Exactly. We do get some inquiries. Very few inquiries come through to us where someone has hurt themselves and they want to know about the legislation.

Senator XENOPHON: How many inquiries do you get?

Mr Overton : I have only been in the role for 2½ years, and I might have had three or four of that nature.

Relevant data is to be found in Appendix 4.

Senator XENOPHON: So they are very rare?

Mr Overton : Very rare. All of those ones who have contacted our office are people who have impacted with non-safety glass. The problem is that there is glass already in existing houses, which met the code way back when that house was built, and it is non-safety glass and the owners are not obliged to change. They only have to upgrade it if it is broken. So there is glass and regular annealed glass. Most of the inquiries we get are from people who have impacted with that glass, and that is where the serious injuries happen. **What this evidence says is that calls to the AGGA office in relation to glass injuries are very rare. This is because only a very small percentage of the population knows of the existence of AGGA, and only a small proportion of those would call the office if they sustain a glass injury.**

Senator XENOPHON: Given Senator Madigan's line of questions about the automotive glass, which appears to be a better standard with negligible additional cost, when are we likely to hear about the outcome of that process?

Mr Rice : I would expect the middle of this year.

Senator XENOPHON: That long?

Mr Rice : That is for us to finalise the draft, have it circulated to the committee for committee comment and then out for public comment. There are time delays built into it to enable people to comment on it—including the committee itself and the public so that interested parties outside the committee can give their feedback on it—and then it goes to Standards Australia. There is a significant amount of pressure and encouragement from Standards Australia to complete this process. For example, the last draft that went out needed to include the New Zealand perspective, because it is a joint Australia and New Zealand standard.

Senator XENOPHON: Can New Zealand veto us?

Mr Rice : No. What happens is they choose to go their own way, which they did with 1288, so there will not be a veto but we have been waiting for them to provide comment because they are working on their version of the 1288 standard—the selection and installation standard. So that delayed it by a couple of weeks; it was not a long time, but it was still a delay.

Mr Jones : Within that consensus environment that takes place at BD-007, not all parties are equals. While BD-007 can in fact produce a standard and even have it certified as a standard, you have the Building Codes Board, which can tell you that it will not call up that standard if it does not like it. So the cost-benefit analysis that was being discussed previously is a requirement of the Building Codes Board. If you produce a standard that they are not prepared to accept, then the standard will be produced but it will not be called up in the Building Code of Australia. The BCA has attempted to impose constraints on the decisions of committee BD7 for many years. It has always been my view that with regard to safety, it is up to Technical experts to determine what is fir for purpose, and Australian standards must not be compromised by commercial or indeed political considerations. If the BCA choose to refrain from making a safety Standard mandatory, it will be on their head. Professional specifiers and engineers, courts and indeed consumersrely on the technical correctness of Standards and expect them to be implemented where relevant.

Senator XENOPHON: Why wouldn't they accept it? Let us, for argument's sake, say you recommend automotive glass for buildings instead of a new standard; what reason could the Building Codes Board possibly have for not accepting it? Could you think of any?

Mr Jones : I believe their only consideration in that case will be the cost-benefit analysis, and I do not believe that they would have a basis on which to reject it.

Senator XENOPHON: Mr Rice has said it is going to be a negligible cost increase.

Mr Jones : That is correct. However, within that environment of consensus, that is one of the things that I would think Standards Australia are very wary of: what is the point in them having a glass standard that the Building Codes Board refuses to call up in the Building Code of Australia? I can assure you that that happens because, within the BD-007 room and discussion environment, I have been told that by the Building Codes Board representative.

Senator MADIGAN: As to the composition of the committee, you said there are 20 members of the committee and your organisation has three members on the committee. Could you give us some idea of the composition of the rest of the committee for our benefit so that we understand?

Mr Rice : If you give me a few moments to open my iPad, I can because the interested parties are in the front of the standard. Can I refer you to that?

Senator MADIGAN: Right.

Mr Rice : Or I can get the composition of the standard and email it to you, rather than going from memory.

Senator MADIGAN: If you have three members, that represents, say, 15 per cent. What I am interested in is community and consumer representatives—the end users. What sort of number do you have there, and who are they?

Mr Rice : That is a very good question. I cannot answer that question.

Senator MADIGAN: I have just had a look at the list. There are really no consumer representatives on that committee. They are all industry representatives. The consumer has no representation, or no representation by a consumer representative body, on the standards committee. Would you agree?

Mr Rice : If you have the list in front of you, I will agree with what you are reading.

Senator MADIGAN: I am going by it. They are all industry bodies. End consumers or groups representing end consumers have no representation on that body. It is good we have cleared that up. When we talk about a consensus—so that we have clarity here; I am trying to understand this—could you explain to me what you mean when you say consensus?

Mr Rice : I believe it would be a majority of the committee.

Senator MADIGAN: Okay.

Mr Jones : It is not unanimous. I do not think it is 51 per cent, but I am not—

Senator MADIGAN: Fair enough. At the moment you do not have a consensus. Can you get for the committee the definition of what Standards Australia calls a consensus?

Mr Rice : I think it is 75 per cent, but I am not entirely certain.

Senator MADIGAN: What I want to understand is: does scientific fact come into the consensus for the—

Mr Rice : We have a couple of members from different universities across Australia, and scientific fact is very definitely part of it.

Senator MADIGAN: That only applies, though, if they are in your 75 per cent or whatever percentage it is that you need for a consensus. I am trying to understand what the definition of a consensus is and what you are using to say that you have a consensus. You have to have facts, have you not?

Mr Rice : Yes.

Senator MADIGAN: What I am asking is: have you got a definition of what a consensus is for the agreeing parties so we can understand how you reach a consensus?

Senator XENOPHON: I can summarise that briefly. It is both in terms of the numbers—in other words, is it a two thirds majority or 75 per cent et cetera—and in terms of what Senator Madigan was asking. If somebody says, 'I'm not agreeing to this because I don't like the colour of the paper the report is being printed on'—to give an absurd example—must there be a basis of reasonableness in a consensus not being reached, in terms of some reasonable standard or objective standard? That is the question.

Mr Rice : In my experience, there has been. Even if I do not agree with somebody's opinion—and there is some stuff that is being presented that I do not agree with—I do not question their belief in it. I think they think they are doing the right thing. I think that people who object are objecting on sound, logical reasons that sound logical to them. It may not be to the rest of the committee. I have not encountered a situation where someone has objected to a proposal or to a change in the standard for trivial reasons.

Senator XENOPHON: And the weighting we give to each vote. Could you take that on notice? In other words, who has more weight?

Mr Rice : One person, one vote.

Senator XENOPHON: One person, one vote.

Senator MADIGAN: As I understand it, around Australia there are currently 100 or more toughening furnaces operating. Is that approximately right?

Mr Rice : There are quite a lot of them, but it is in that order of magnitude.

Senator MADIGAN: Are many of the smaller companies members of your organisation?

Mr Overton : Not as many as we would like. A considerable number are not.

Senator MADIGAN: In your communications with your members who operate toughening furnaces, have you discussed the AS 2208 and the conjecture around that standard with them?

Mr Rice : The AS 2208 standard has been up for public comment on a previous occasion and that was distributed to members, seeking feedback. From memory, we did not get very much feedback.

Senator MADIGAN: Was that distributed in your newsletter?

Mr Rice : We let people know that it was available for download. You give them a website address so they can go to the Standards Australia website and download a copy of it.

AGGA regularly updates its members and others on Standards development through its magazine. Never has the issue of alternative test methods for toughened safety glass been mentioned, nor has there been any disclosure to its broad membership of the line

that AGGA has been pushing, or the alternative views. So much for "representing the industry".

Mr Overton : Our plan would be, if it gets through BD7 as it is now, it would once again go out for public comment and we would ensure we contact all of our members—not all of them are our members.

Senator MADIGAN: If you cannot ascertain whether your members who are in this part of the industry have read it or are aware of it, is there a better way to address your members so that they know what is going on? Taking into account that a lot of your members would be incredibly busy—they have BAS statements to do, they have quotes to do, they have to deal with occupational health and safety—would there be a better way of communicating with members to let them know the state of play?

Mr Overton : Senator Madigan, you have probably hit on one of the biggest issues we always have as an association—trying to communicate with our members and have them pay attention. My colleagues here are probably going to roll their eyes when I say that we are putting a new system in place to improve our communications in these things. It is a constant challenge for us to get that information out there. In many ways it relates back to the whole issue of non-compliance. They are too busy running their businesses and they think they are doing the right thing, but getting that information to them is often very difficult. That is why, when I mentioned our accredited company program, within that there is continuing professional development requirement. We will be starting to make it a requirement for accreditation that you have to be across this sort of information. The short answer is: yes, we could improve it and it is something we are looking very strongly at at the moment.

Senator MADIGAN: Would you be able to furnish the committee with information that explains how AGGA points to the ISO standard as a credible reference for AS 2208? Has your association got the rationale to support your reference to ISO, saying why AS 2208 is good? What is the argument so that we can understand it? There is something you obviously refer to to make that statement.

Mr Rice : Standards Australia's position is to participate quite strongly in the ISO process. We are a representative on the ISO technical committee for glass—160, I think it is. We participate in that as part of an Australian Standards committee. Sixteen or 17 other countries also have input into that particular ISO standard. I will defer to Adam again, but the preference is to default to an ISO standard, if available, in certain circumstances rather than defaulting to another national standard.

Senator MADIGAN: If there is not a national standard you default to the ISO standard, whether or not the ISO standard is suitable to Australian conditions?

Mr Rice : I would have to check the wording on that but it is along that line, yes. When you say 'whether it is suitable or not', you have experts from 17 countries in that particular field, so the idea that it is not suitable would be pretty tricky.

Senator MADIGAN: Mr Rice, that is why we made cars in Australia for a long time—to make them to Australian conditions. It is not necessarily correct to say that an international standard might be the best applicable standard for Australia, is it?

Mr Rice : No.

CHAIR: Thank you very much gentlemen for appearing before the committee today.

ISO Safety Glass Test Programs

Results, Conclusions and Recommendations Relating to AS/NZS 2208

Dr. Leon Jacob
AS/NZS 2208 Working Group Meeting
Standards Australia
29 April 2008

BD-007 Document No. N0847

The Objective of SC2/WG6
‘Safety glazing tests’

“To develop an ISO test method for determining the safe breakage characteristics of glasses which are to be used in critical safety locations in buildings”.

ISO/TC160/SC2 meeting Tokyo 6 December 1996

WG 6 Convenor's Report
SC 2 Meeting, Tampere, June 1999

"Proposals will be drawn up for developing the test method, in respect of simulation of human impact, to reduce cutting and piercing injuries to persons."

Meetings of ISO/TC160/SC2/WG6

- London, BSI, 17-18 May 1999 (No Australians could attend.)
- Lathom, Test Program, 17-18 Nov 1999 (No Australians attended)
- Tokyo, FGMAJ, 23-24 May 2000
- Sydney, SAI, 20-21 February 2001
- Beijing, CBMA, December 2001
- Singapore, SPRING, October 2002
- Singapore, SPRING, 19-20 May 2003
- Sydney, SAI, 17-18 October 2003
- Singapore, Hotel,11-12 February 2004
- Venice, UVPSTDV, 12-13 May 2005 (No Australians could attend.)

SC1/WG3 'Laminated Glass' Meeting Brussels, February 1999

Australia had cast a negative vote on ISO/FDIS 12543-2 'Laminated safety Glass' (along with USA, Japan and the UK) in November 1997 because of lack of test data on the equivalence of the prEN 12600 twin tyre impactor to the ANSI Z97.1/AS1288 lead shot bag impactor.

At the meeting it was affirmed (SC1/WG3 N2) that Australia intended to carry out a test program to evaluate the prEN 12600 impactor versus the AS 2208 lead shot-bag impactor. It was advised that this test program would include both laminated glass and toughened glass and would evaluate the breakage characteristics of toughened glass.

ISO SC1/WG2 ‘Toughened Safety Glass Meeting Brussels, February 1999

Australia advised in writing (SC1/WG2 N12):

“It is our intention, in Australia, to review our safety glass standards using some rational thought and not just accept standards as they have been written in the past.”

Australian Impact Test Program
December 1999-May 2000

Consistent with Australia's response to ISO/FDIS 12543-2 Australia carried out an impact test program in 1999 to compare the impact results obtained with the twin tyre impactor versus those with a lead shot bag impactor.

• An AS 2208 Impact test rig was built to conduct a test program to compare impact test results for the AS 2208 lead shot bag versus the prEN 12600 Twin Tyre impactor.

• The GGF supplied tyres for a prEN 12600 Twin Tyre impactor.

• An AS 2208 Lead Shot Bag impactor and a prEN 12600 Twin Tyre impactor were fabricated.

• Impact tests were conducted on 6.38 mm laminated glass and 4mm, 5 mm and 6 mm toughened glass.

Australian Impact Test Program Results

A report (SC2/WG6 N31) on results of the Australian impact test program and a video of the testing were presented at the SC2/WG6 meeting in May 2000.

The conclusions included:

- The coefficient of restitution of the lead shot bag is significantly different to that of the twin tyre impactor – the lead shot bag broke toughened glass at drop heights as low as 450 mm while the Twin Tyre Impactor seldom broke toughened glass even at 1200 mm drop height.
- The difference in the fracture characteristics between toughened and laminated glass must be reflected in the requirements of the standard.
- Further research work on the impact resistance of ‘Safety Glass’ is essential.

SC2/WG6 Meeting – May 2000

It was agreed to incorporate the following cautionary text (SC2/WG6 N32) on toughened glass breakage characteristics into the future ISO standard.

ISO TC 160/SC2/WG6

24 May 2000

The breakage behavior of toughened glass is generally characterised by the formation of small relatively harmless particles. However under certain conditions, depending on the method of framing and means of breakage, there can be clumping together of small particles or the formation of shards. If these breakage patterns occur, they may increase the risk of injury.

This statement has been incorporated into AS 1288-2006 (Appendix E2).

SC2/WG6 Meeting – May 2000, continued

In view of lack of consensus on prEN12600 it was decided:

“ To suspend development of an ISO impact standard “

and

“To propose to ISO/SC2 that a Technical Report (Type 2) be developed as a provisional standard to allow information and experience on its use to be gathered.”

EN 12600 Safety Glass Impact Test Standard

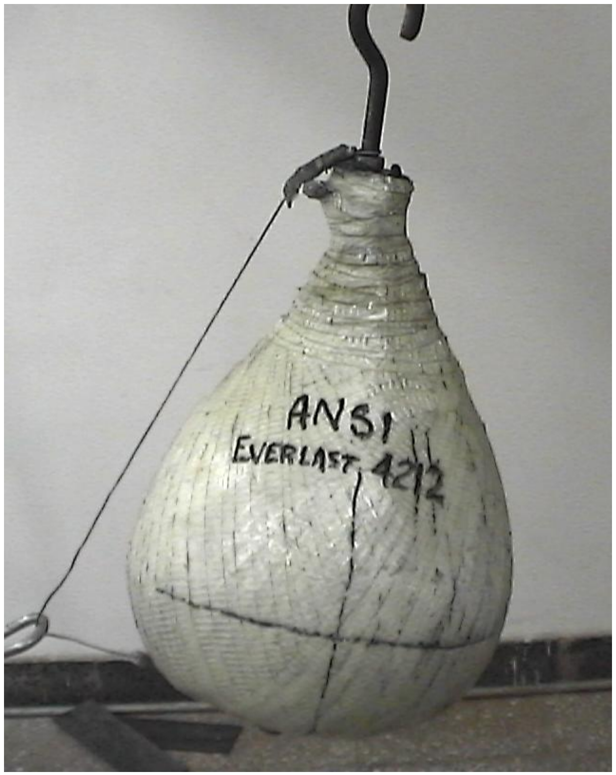
- European Standard EN 12600:2002 adopted a new impactor for testing and classification of safety glass products. This replaced the traditional lead shot bag impactor.

- EN 12600 also introduced a classification (**φ**) for the 'containment' characteristics of the material ie. if toughened glass does not break at the drop height of 1200 mm it receives the highest containment rating.

- This new impactor had been proposed for an ISO standard on impact testing of safety glass products.

- The JIS 'soft' lead shot bag was also proposed (by Australia) and accepted as an alternative impactor for an ISO standard.

Safety Glass Impact Test Impactors



ANSI Z97.1
Lead Shot Bag
Everlast 4212 Bag

JIS 'Soft'
Lead Shot Bag

EN 12600
Twin Tyre

Leather Bags for Lead Shot Bag Impactors

JIS 'Soft' Bag

ANSI Z97-1 Bags

China Safety Glass Test Programs

In support of ISO/TC160 Resolutions 37 (SC1) and 69 (SC2) and 71 (SC2) [London 2000] the China Safety Glass Certification Centre (CSGC) of the China Building Materials Academy (CBMA) offered to conduct extensive and objective testing of tempered and laminated glass at their laboratory in Beijing.

Horizontal Strain* versus Drop Height for Pendulum Impactors

Drop Height (mm)	EN 12600 Twin Tyre	JIS LSB	ANSI Z97.1 E-4207 LSB	ANSI Z97.1 E-4212 LSB
200	1241	1209	1633	1763
250	1403	1381	1771	2011
300	1531	1616	1905	2182
450	1799	1958	2231	2595
700	2050	2402	2737	3129
1200	2448	3057	3467	3931

*Using 10 mm ‘Supertough’ glass

China Test Programs – Toughened Glass

- These tests involved normal commercial grade toughened glass from numerous manufacturers with lower and higher than normal quenching rates to obtain a range of glass surface compressions.

- In addition to pendulum impact tests fragmentation (metal punch) tests were conducted on EN 12150 and EN 12600 size panels with breakage at both the edge point and the centre of the panel.

Test Programs – Laminated Glass

Program	Date	Laminates	Comments
		Impacted	
China # 1	Dec-00	37	Breakage patterns vs drop height for TT & ANSI 4212 LSB
China # 2	Oct-01	44	MPH determined for ANSI 4212 LSB, JIS LSB & TT
China # 5	Oct-02	43	MPH determined for TT (20mm spindle), JIS LSB & ANSI 4207
China # 7	Apr-04	45	MPH determined for TT (30mm spindle) & JIS LSB
UK	June-03	38	MPH determined for TT (30mm spindle) & JIS LSB
Australia	May-00	8	Breakage patterns vs drop height for TT and AS LSB
	Total	215	

Staircase Testing of 6.38mm Laminated Glass

Staircase testing of 6.38mm laminated glass to determine mean penetration height was facilitated by development by the CSGC of an improved force gauge And probe (76mm sphere) assembly

The test result is a "Pass" if the sphere does not pass through the impacted laminated glass with an applied force of 25 Newtons. At this force a "beep" occurs.

Laminated Glass Testing
Roadblock & Breakthrough

EN 12600 Twin Tyre - Drop Height, mm			
600	700	800	900
		Pass	
			Fail
		Pass	
			Fail
		Pass	
			Fail
		Fail	
	Fail		
Pass			
	Fail		
Fail			

Staircase impacts with 6.38 mm laminated glass with twin tyre impactor having a 20 mm diameter spindle shaft

While good staircase impact results could be obtained with lead shot bag impactors in the China test programs this was not initially possible with the European twin tyre impactor.

It was eventually found that the 20mm Diameter spindle shaft in the impactor was bent.

This was replaced by a 30 mm diameter shaft and good staircases were obtained.

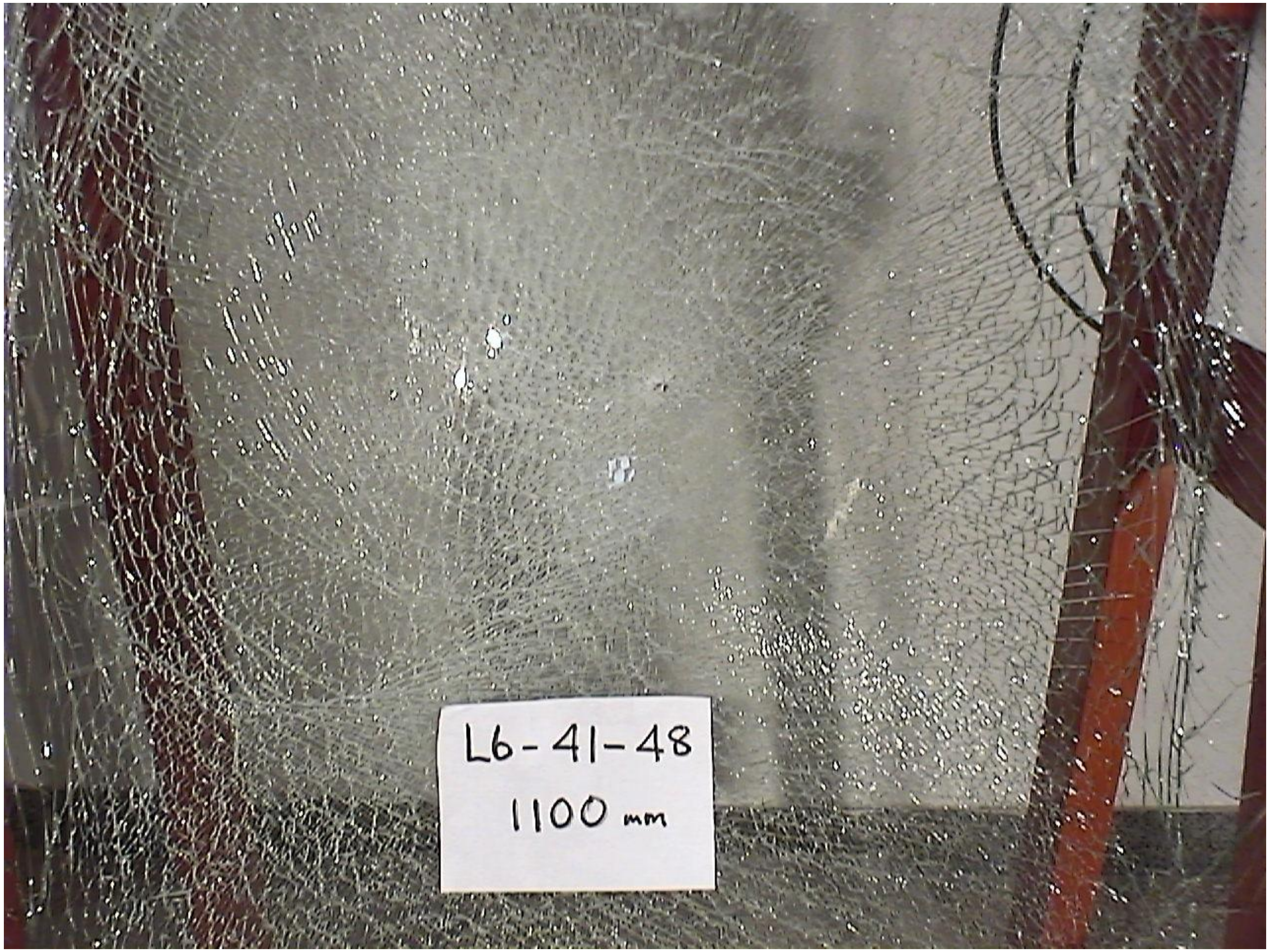
Pendulum Impact Tests on 6.38 mm Laminated Glass
JIS Lead Shot Bag versus EN Twin Tyre

Tests conducted at the GGF Test Laboratory, UK – June 2003

GGF JIS LSB Impactor - Drop Height, mm							
700	800	900	1000	1100	1200	1300	1400
Pass							
	Pass						
		Pass					
			Pass				
				Pass			
					Pass		
						Pass	
							Fail
						Fail	
					Fail		
				Pass			
					Fail		
				Pass			
					Fail		
				Fail			
			Pass				
				Pass			
					Pass		
Mean Support Height: 1183 mm							

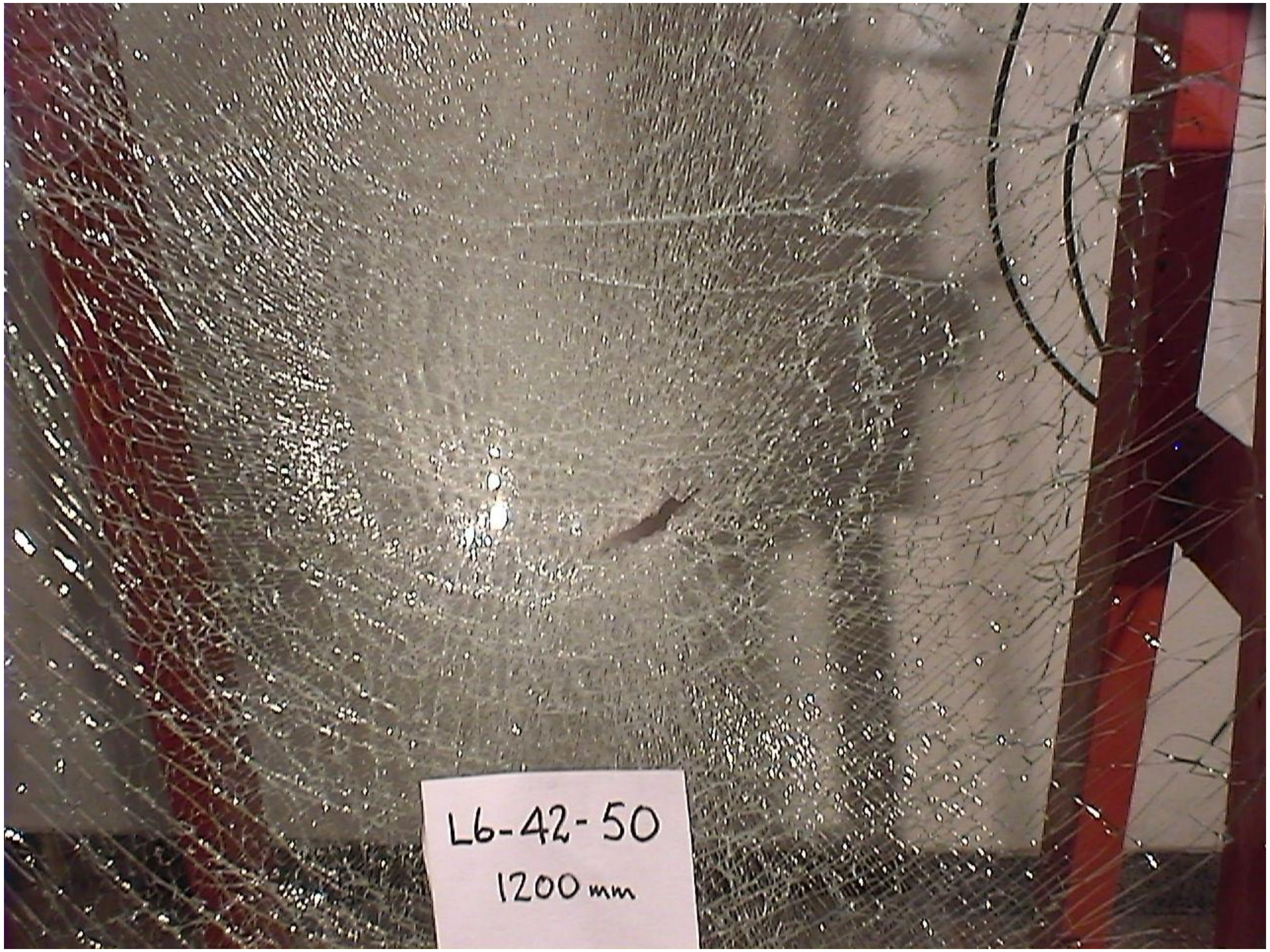
GGF EN 12600 Twin Tyre - Drop Height, mm						
700	800	900	1000	1100	1200	1300
Pass						
	Pass					
		Pass				
			Fail			
		Pass				
			Pass			
				Pass		
					Fail	
				Fail		
			Pass			
				Fail		
			Pass			
				Pass		
					Pass	
						Fail
					Fail	
				Pass		
					Pass	
						Fail
					Pass	
Mean Penetration Height: 1113 mm						

6.38 mm Laminated Glass – Staircase Impact



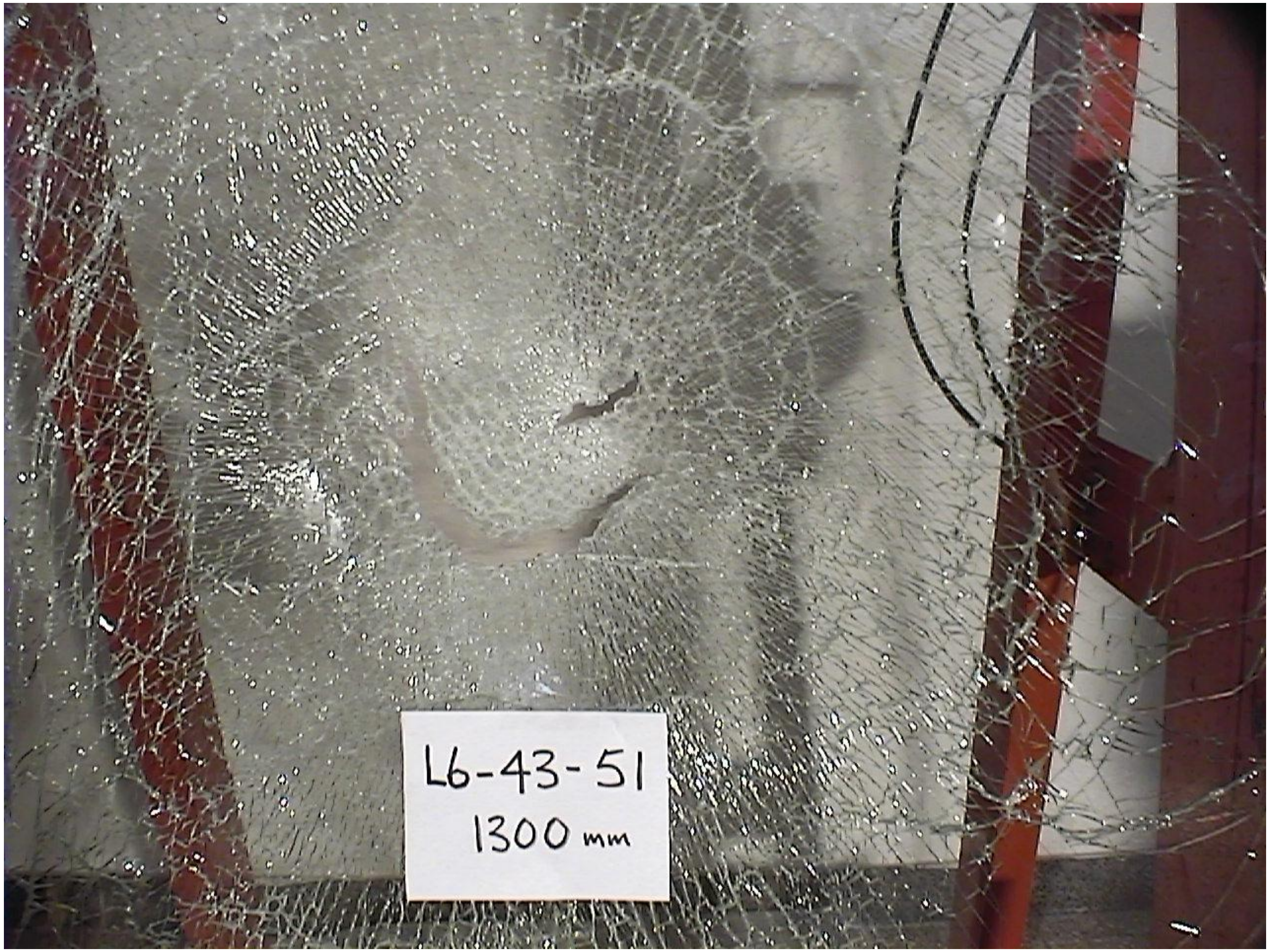
JIS Lead Shot Bag – 1100 mm Pass

6.38 mm Laminated Glass – Staircase Impact



JIS Lead Shot Bag – 1200 mm Pass

6.38 mm Laminated Glass – Staircase Impact



JIS Lead Shot Bag – 1300 mm Fail

Pendulum Impact Tests on 6.38 mm Laminated Glass
JIS Lead Shot Bag versus EN Twin Tyre

Tests conducted at the China Building Materials Academy – April 2004

CSGC JIS LSB - Drop Height, mm			
1000	1100	1200	1300
Pass			
	Pass		
		Pass	
			Fail
		Pass	
			Fail
		Fail	
	Pass		
		Pass	
			Fail
		Fail	
	Pass		
		Pass	
			Fail
		Pass	
Mean Penetration Height 1235 mm			

CSGC EN 12600 Twin Tyre (40mm Spindle) - Drop Height, mm						
700	800	900	1000	1100	1200	1300
	Fail					
Pass						
	Pass					
		Pass				
			Pass			
				Fail		
			Pass			
				Pass		
					Pass	
						Fail
					Pass	
						Fail
					Pass	
						Fail
					Pass	
	Mean Penetration Height: 1178 mm					

Test Programs – Toughened Glass

Program	Date	Toughened Glass Panels Tested				
		4 mm	5 mm	6 mm	10 mm	Total
China # 1	Dec-00			46		46
China # 2	Oct-01	38		52	2	92
China # 3	Dec-01		8			8
China # 4	Jan-02				4	4
China # 5	Oct-02					
China # 6	Feb-04		25			25
China # 7	Apr-04			10		10
China # 8	Jul-04	28				28
UK	Jun-03	20		13		33
Australia	May-00	2	2	8		12
	Total	88	35	129	6	258

Impact Test Results versus Impactor Type
6 mm Toughened Glass

Sample ID	SC MPa	Drop Height to Break, mm		
		EN 12600	JIS LSB	ANSI LSB
B6 - 4	102	DNB at 1200		450
B6 - 5	100	DNB at 1200		
B6 - 6	99	DNB at 1200		
B6 - 7	105	DNB at 1200		450
B6 - 8	115	DNB at 1200		450
B6 - 9	109	DNB at 1200		
B6 - 10	109	DNB at 1200	1050	
B6 - 11	115	DNB at 1200	1050	
B6 - 12	104	DNB at 1300		
B6 - 13	109	DNB at 1300	900	
C6 - 1	109	DNB at 1200		450
C6 - 2	122		450	
C6 - 3	104	DNB at 1200	750	
C6 - 4	104	DNB at 1200		
C6 - 5	115			1050
C6 - 7	109	DNB at 1200		
C6 - 9	104			300
S6 - 4	109		600	
S6 - 5	106		450	
S6 - 6	122	DNB at 1200		450
S6 - 7	115	DNB at 1200		900
S6 - 9	101	DNB at 1200		
S6 - 10	104	DNB at 1200	900	

Comments:

These results show a big difference in impact performance of 6 mm toughened glass for the twin tyre impactor versus the lead shot bags.

While the lead shot bags always broke the glass, the twin tyre impactor never broke the glass in this series of tests.

Testing of Toughened Glass with Twin Tyre Impactor

- It was found in the test programs that whereas lead shot bags readily broke tempered glass the European twin tyre impactor typically did not break the glass even at the highest (1200 mm) drop height.

- In Europe this results in the highest containment rating for tempered glass and prevents the fragmentation characteristics of the glass from being evaluated in the pendulum impact test.

IN AUSTRALIA WE REQUIRE THAT SAFETY GLASS BE BROKEN TO DETERMINE ITS FRACTURE CHARACTERISTICS

- It was found that if a very light scratch was applied to a panel of toughened glass at or near the impact point the impact resistance of the glass was greatly reduced.

- A method was developed using a Vickers indenter with a controlled force to apply a reproducible spot of damage to the impact point of tempered glass panels. This damage is typical of that incurred during glass use and results in breakage at 300mm drop height with the twin tyre impactor of panels that had remained unbroken at 1200mm drop height.

Results of impact tests on 6 mm toughened glass

Panel	Surface	Height to Break
	Compression, MPa	mm
T6-10	101	DNB 1200
T6-9	100	DNB 1200
T6-9 VI		300
T6-8	99	1200
T6-7	101	DNB 1200
T6-7 VI		300
T6-6	98	1200
T6-5	92	DNB 1200
T6-4	88	1200
T6-3	92	1200
T6-2	95	DNB 1200
T6-2 VI		300

Flaws were applied with a Vickers indenter (VI) at 25N to panels that did not break (DNB) at 1200 mm drop height

Safety Glass Test Methods & Product Definitions

Test method standards performance criteria for safety glass products should be consistent with definitions of what classifies them as safety glasses

Thermally Toughened Safety Glass Definitions

ANSI Z97.1 - 1966

Tempered glass, when broken at any point, the entire piece immediately breaks into innumerable small granular pieces.

AS 2208 – 1978

A glass which has been converted to a safety glass by subjection to a process of prestressing so that, if fractured, the entire disintegrates into small, relatively harmless particles. The residual surface compression is a minimum of 69 MPa.

Google – Toughened Glass

Google 'tempered glass' and you get the following:

(http://www.wisegeek.com/what-is-tempered-glass.htm) :

"Tempered glass is one of two kinds of safety glass regularly used in applications in which standard glass could pose a potential danger. Tempered glass is four to five times stronger than standard glass and **does not break into sharp shards when it fails**. .... The brittle nature of tempered glass causes it **to shatter into small oval-shaped pebbles when broken**. This eliminates the danger of sharp edges. Due to this property, along with its strength, tempered glass is often referred to as safety glass. ... Tempered glass breaks in a unique way. **If any part of the glass fails, the entire panel shatters at once**. "

Australian Standard AS 2208

Preface, 1978

“The performance of safety glazing materials is evaluated by an impact test to simulate human impact of such energy that it could result in cutting and piercing injuries.

Toughened safety glass has intrinsic properties which enable its impact performance to be determined by a simplified test procedure.” (Fragmentation test at edge of glass using a centre-punch – no size of panel prescribed).

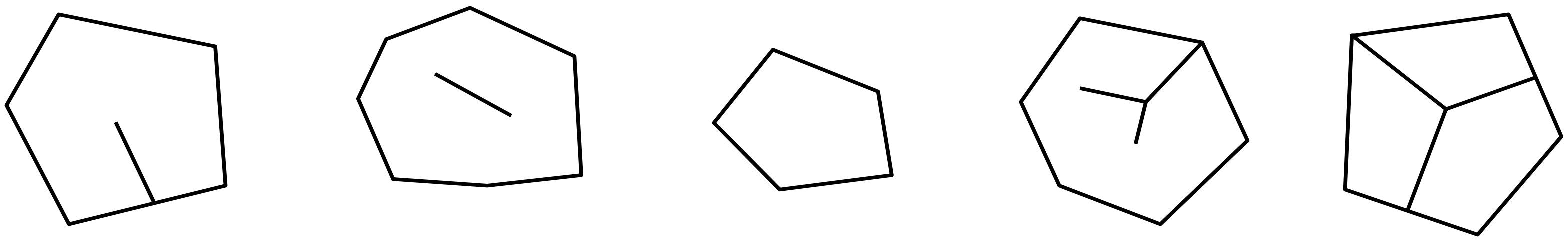
Toughened Glass Pendulum Impact Test Criterion

ANSI Z 97-1, EN 12600

In the event of glass disintegration the weight of the 10 largest ‘crack-free’ particles collected within three minutes after impact must not exceed the mass equivalent to 6,500 mm^2 of the original test piece.

Definition of ‘crack free’ Particle

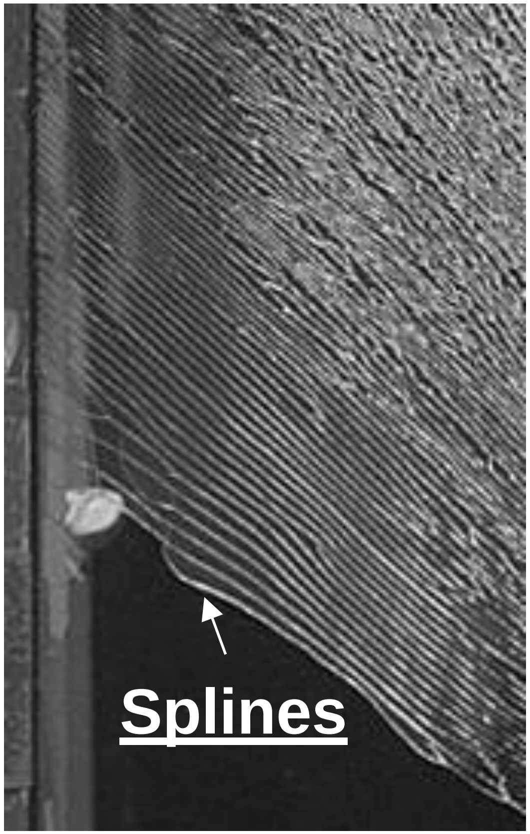
Toughened Glass Standard EN 12150 provides the following illustration for crack free particles



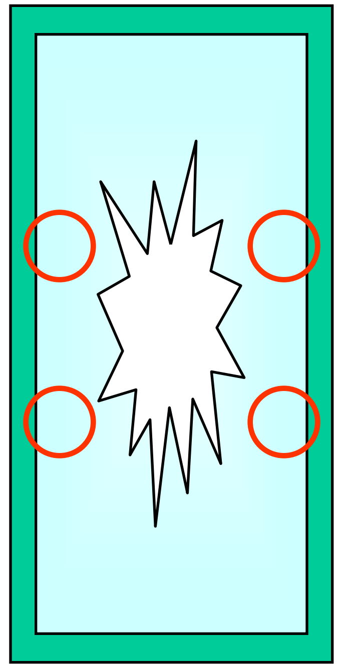
1 1 1 1 3

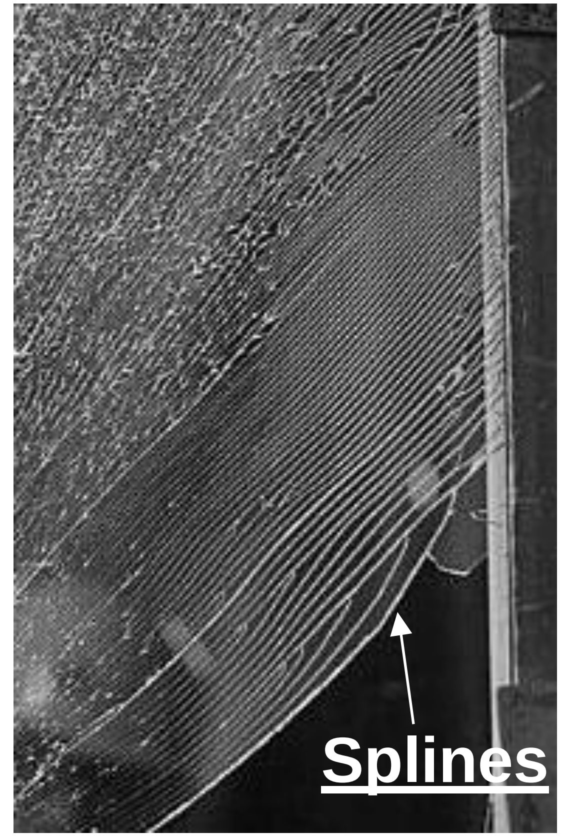
GPD 2001 Paper – Oketani et Al

Fracture Patterns of 4mm Thick Tempered Glasses



SN shot bag
h=300mm





Double tire
h=300mm

Splines : 4mm and 6mm tempered glasses
No Splines : 8mm tempered glass

Long Particles – GPD 2001, Vitkala

Figure 8 If the glass temperature is not correct or even enough before tempering, it will not fulfil the requirements of tempered safety glass. If the glass breaks, it breaks in fragments that are too large or too long.

6 mm Toughened Panel B6-15

Panel produced with 4kPa
Quench pressure versus
Normal 2.5 kPa

Surface Compression
GASP 98 MPa

Impacted with ANSI Z97.1
Everlast® 4212 LSB
Drop height: 300 mm

Previously did not break on
impacts with EN 12600 impactor
at 600, 900 & 1200 mm

Good fragmentation
No splines

T6-122-738-HB300
3 Dec 01

CSCG Test Program
6 mm Panel S 6-1-5

Surface compression

Manufacturer:
GASP 86 MPa

CSGC:
GASP 94 MPa
DSR   105 MPa

6 mm Toughened Panel Q 6-2

Surface compression:
DSR 99 MPa

Impactor:
ANSI Z97.1 Everlast® 4212 LSB
Drop Height: 450 mm

CSGC Test Program 1_Dec 2000

5 mm Toughened Panel B 5-2 – Splines

876mm x 1938mm

Surface compression:
GASP 91 MPa
DSR 90 MPa

Broken by EN12600 TT Impactor
Drop height: 600mm
Scratch imparted to panel centre

CSGC Test Program
December 2001

5 mm Toughened Panel B 5-2 – Splines

876mm x 1938mm

Surface compression:
GASP 91 MPa
DSR 90 MPa

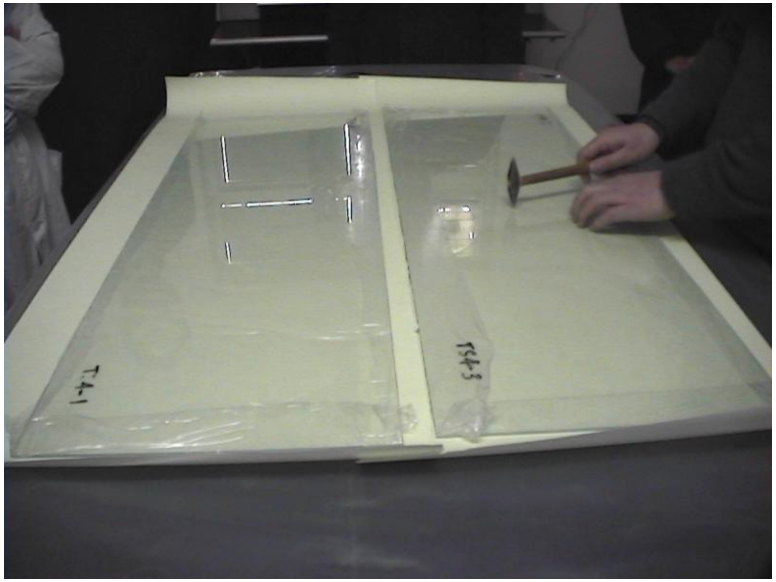
Broken by EN12600
TT Impactor

Drop height: 600mm
Scratch imparted to panel centre

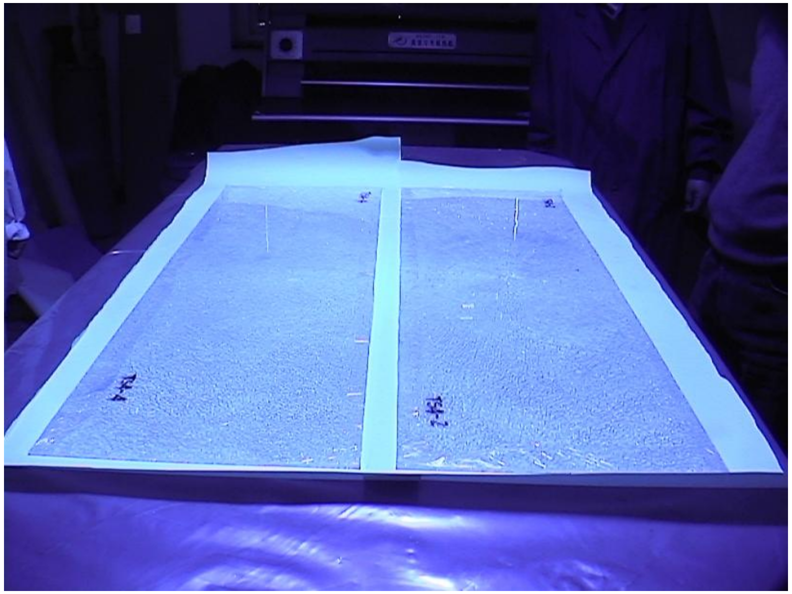
CSGC Test Program
December 2001

Weight of 10 largest crack-free particles: 44 grams (versus 78.5 grams permitted)

Fragmentation Test
Edge Break Versus Centre Break



EN 12150 size panels
360 mm x 1100 mm



4 mm Toughened Glass Punch Test Results
CSGC – July 2004

Panel*	SC MPa	Punch Location	Minimum PC	Longest Particle mm
TS4-1	93.6	Edge	113	
TS4-2	96.6	Centre		110
TS4-3	99	Centre		80
TS4-4	95.4	Edge	132	
TS4-5	88.2	Edge	36	
TS4-6	84	Centre		145
TS4-7	88.8	Centre		167
TS4-8	88.8	Edge	21	
TL4-1	85.8	Edge	9.5	
TL4-2	84	Centre		330
TL4-5	83.4	Edge	8	
TL4-6	81	Centre		233
TL4-9**	90.6 -> 91.8	Centre		294
TL4-10**	98.4	Edge	87	
TL4-11	97.8/	Centre		150
TL4-12	97.2	Edge	82	
TL4-13	97.2	Centre		260
TL4-14	97.8	Edge	114	
TL4-15**	103.8 -> 97.8	Edge	80	
TL4-16	94.2	Centre		184

Comments:

These results show substantial differences in fragmentation results for the edge impact point versus the centre impact point.

- *Edge impact produced no long particles.*
- *Centre impact produced particles up to 330 mm in length.*
- *Fragmentation results were significantly worse with the larger panel size.*

*** S = 360 mm X 1100 mm   L = 876 mm x 1938 mm   ** = Heat Soaked**

4 mm Toughened Glass Fragmentation Results Relationship to Panel Size

Toughening Process: Normal quench pressure, July 2004

Panel	Size mm	Surface Compression MPa	Punch Location	Minimum Particle Count	Longest Particle mm
TS4-1	360 x 1100	94	Edge	113	
TS4-2	360 x 1100	97	Centre		110
TS4-3	360 x 1100	99	Centre		80
TS4-4	360 x 1100	95	Edge	132	
TL4-9	876 x 1936	91	Centre		294
TL4-10	876 x 1936	98	Edge	87	
TL4-11	876 x 1936	98	Centre		150
TL4-12	876 x 1936	97	Edge	82	
TL4-13	876 x 1936	97	Centre		260
TL4-14	876 x 1936	98	Edge	114	
TL4-16	876 x 1936	94	Centre		184

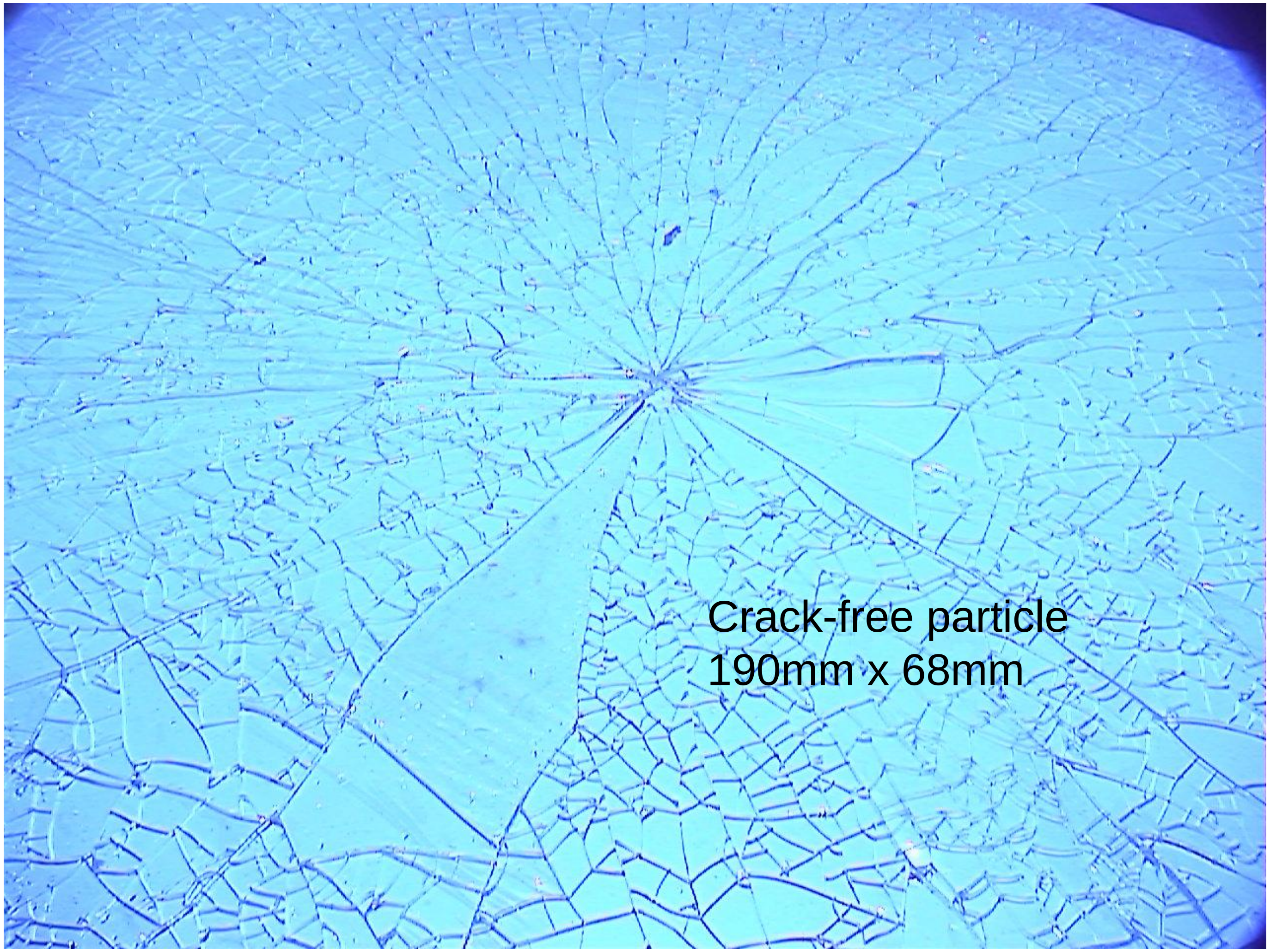
Toughened Glass Fragmentation Results Relationship to Panel Size

Toughened Process: Lower than normal quench pressure, July 2004

Panel	Size mm	Surface Compression MPa	Punch Location	Minimum Particle Count	Longest Particle mm
TS4-5	360 x 1100	88	Edge	36	
TS4-6	360 x 1100	84	Centre		145
TS4-7	360 x 1100	89	Centre		167
TS4-8	360 x 1100	89	Edge	21	
TL4-1	876 x 1936	86	Edge	9.5	
TL4-2	876 x 1936	84	Centre		330
TL4-3	876 x 1936	83	Edge	8	89
TL4-4	876 x 1936	81	Centre		233

4 mm Toughened Glass Panel TL4-2

876mm x 1938mm

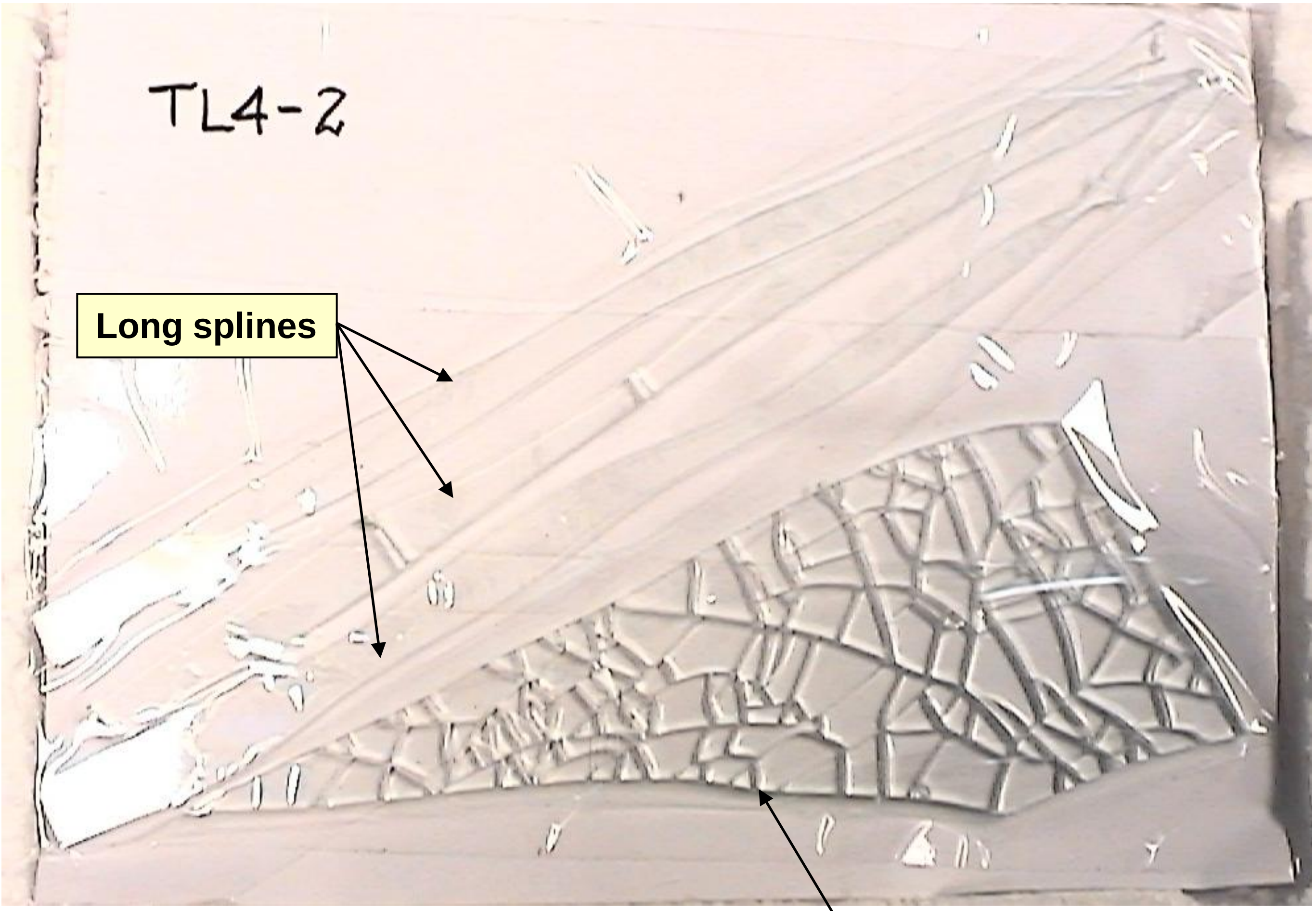


Surface compression: DSR 84 MPa

Fragmentation test at panel centre

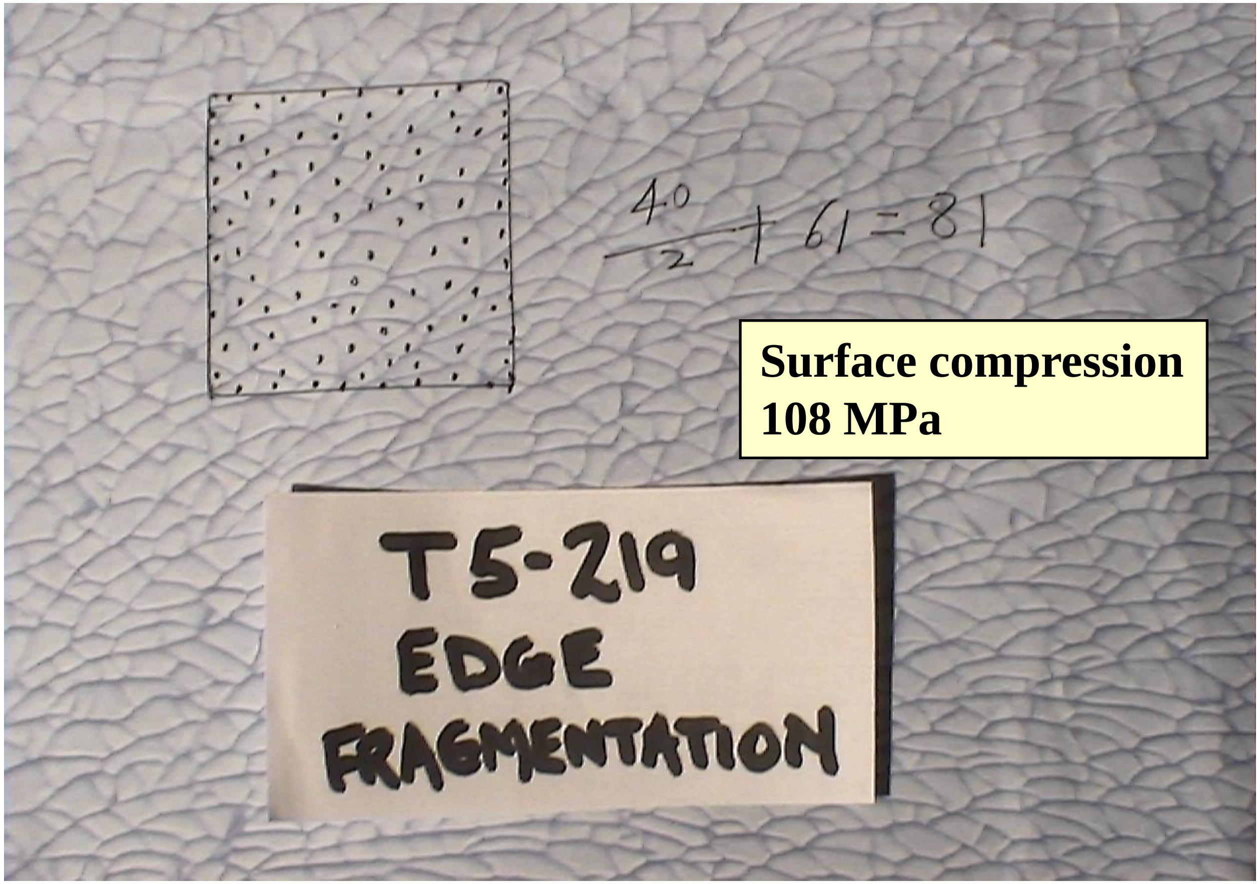
4 mm Toughened Glass Panel TL4-2

876mm x 1938mm



Fragments from test panel

Particle Count on 5 mm Toughened Glass
Edge Punched

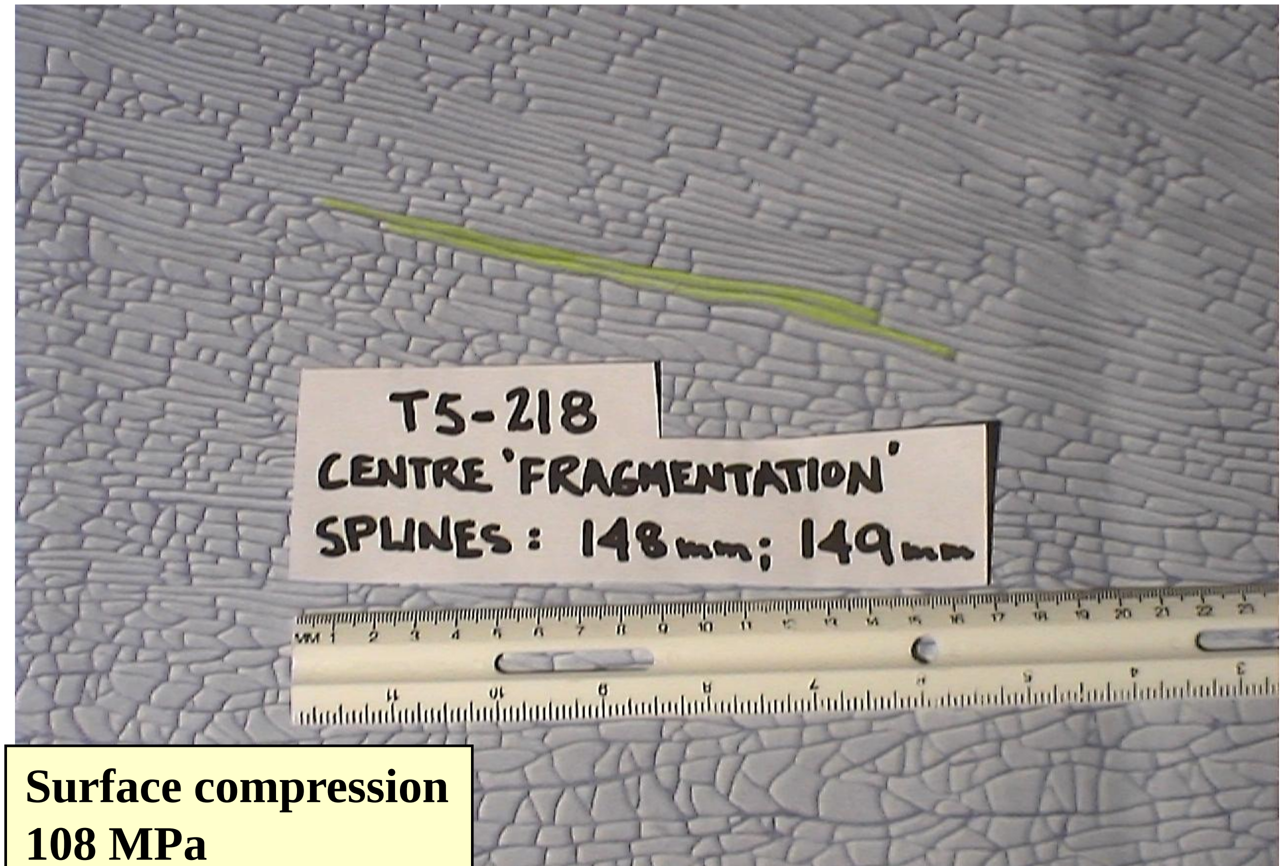


Surface compression 108 MPa

Comment:

Particle count is double the minimum EN 12150 standard of 40.

Fragmentation Result – 5 mm Toughened Glass
Location of punch – Centre of panel



Surface compression 108 MPa

Comment:

Punching at the centre of the panel produced long particles ('splines') whereas punching at the Edge of the panel did not.

Fragmentation Test

Effect of Point of Impact on Formation of Long Particles

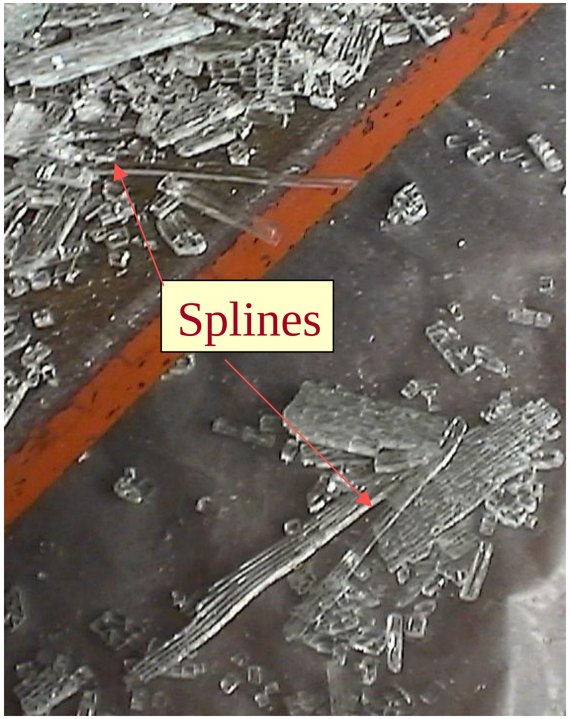
Panel size: 876mm x 1938mm

Sample ID	SC - MPa	Point of Impact	Minimum	Longest Particle
	GASP		Particle Count	(mm)
	CSGC			
B 5 - 4	93	Centre of panel		165
B 5 - 5	96	Edge of panel*	73	0
B 5 - 7	94	Edge of panel*	40	0
B 5 - 8	93	Centre of panel		360

* Edge impact was 13 mm in from the longest edge of the test specimen at the mid-point of that edge as specified in EN 12150 Clause 8.3

5 mm Toughened Glass
Pendulum Impact Test Result

T5-203
Result of impact from 450 mm with JIS LSB



Surface compression 108 MPa

Comment:

The splines on the ground and remaining in the frame are similar to those found with panel T5-218 which was centre punched at the panel centre..

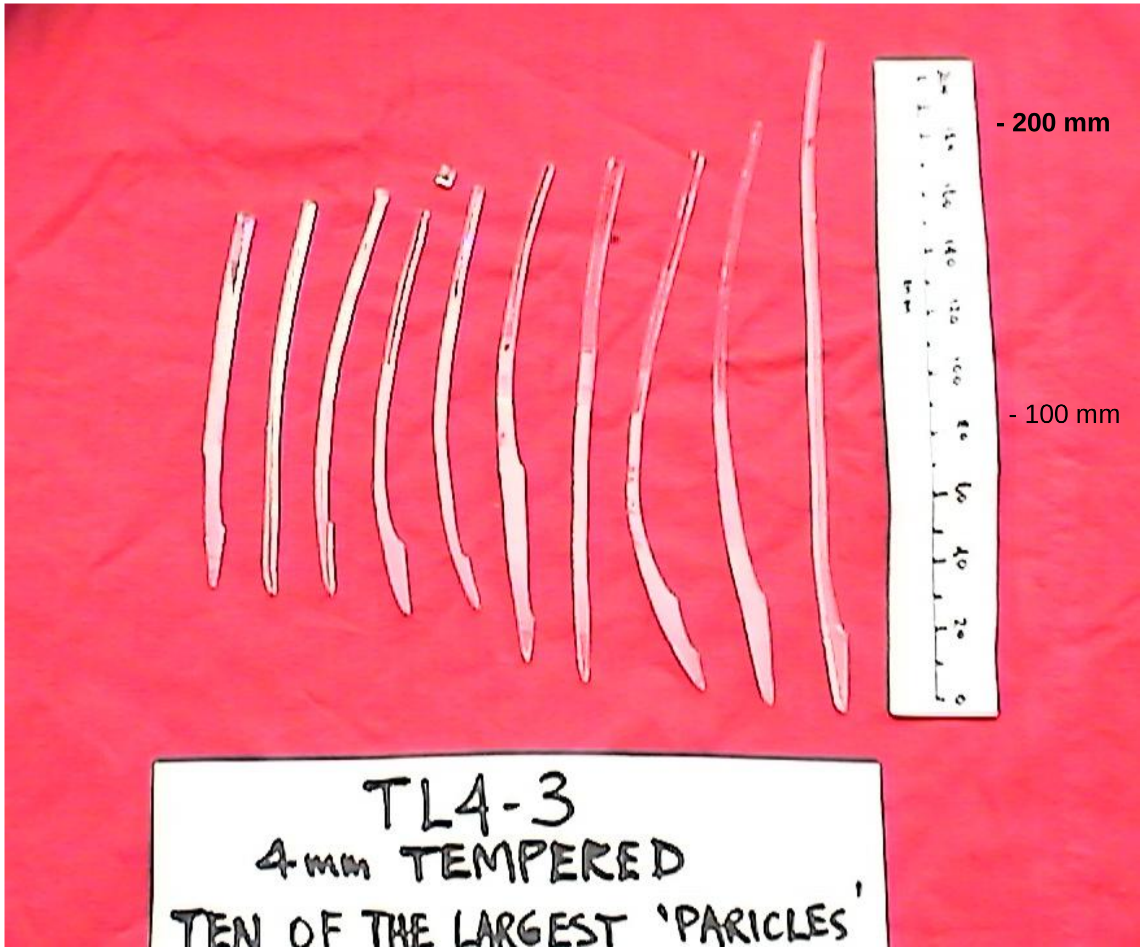
Long Particles – Pendulum Impact Test

4 mm Toughened Glass (TL4-7 Feb 04) – Surface compression 86 MPa

Fracture Pattern

5 mm Toughened Glass SC 110 MPa

Long ‘Crack-Free’ Particles
Pendulum Impact Test



Sample TL4-3, Feb 2004
Surface compression – 88 MPa

Weight of 10 Largest ‘Crack-Free’ Particles

Maximum weight permitted for ‘Pass’ classification – 65 grams

Long Particles - EN 12150*

"In order to classify the glass as thermally toughened soda lime silicate toughened safety glass the length of the longest particle shall not exceed 100 mm."

* Punch test at edge of 360 mm x 1100 mm panel

Investigation of ‘Long Particles’ with thin toughened glass Melbourne Safety Glass Manufacturer – Nov 2001

In view of the results obtained at the CSGC fragmentation tests (edge and centre impacts) were conducted at a leading Australian safety glass manufacturer on 5 mm toughened glass door panels.

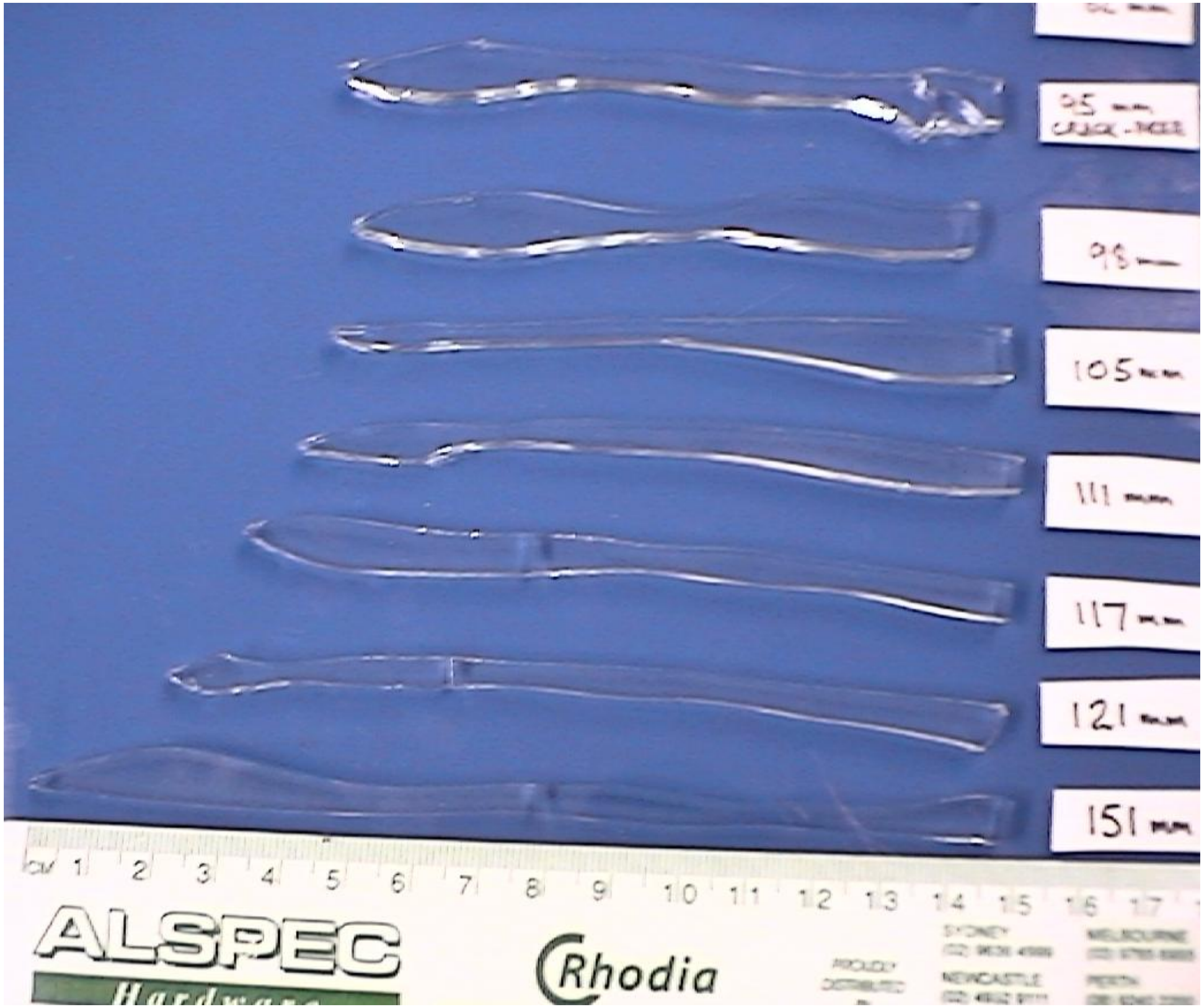
To the Manufacturer’s great surprise, panels with >100 MPa surface compression and high minimum ‘particle count’ (80+) in the AS2080 test method gave long particles (>150 mm) on impact at the panel centre – similar to the results obtained at the CSGC (see video clip).

5mm Toughened Glass from Sydney Manufacturer

5 mm Toughened Glass was produced at the Mfr's standard conditions.

Particle count (AS 2208) was around 50 versus AS 2208 min. PC of 40

A panel punched at the panel centre produced these 'splines'.



ECE R 43 Standard
Automotive Toughened Glass

ECE R 43 requires the measurement of long particles for centre break position

"Many years of experience of working with ECE R43 and the JIS standard, which contain several breaking positions, have demonstrated that a centre break position is the most stringent. In practice glass manufacturers in Europe and Japan routinely break from the centre for CoP testing, because a satisfactory fracture indicates a good tempering process and predicts a good performance for other breaking positions. "

CLEPA (European Association of Automotive Suppliers)

Indian Standard IS 2553 (Part 1: 1990)

Annex A (Clause 5.2.3) FRAGMENTATION TEST

Toughened glass (commercial production sample) is broken by giving it a sudden punch and the number of broken particles per unit area are counted. The points of impact shall be as specified in Fig. 1

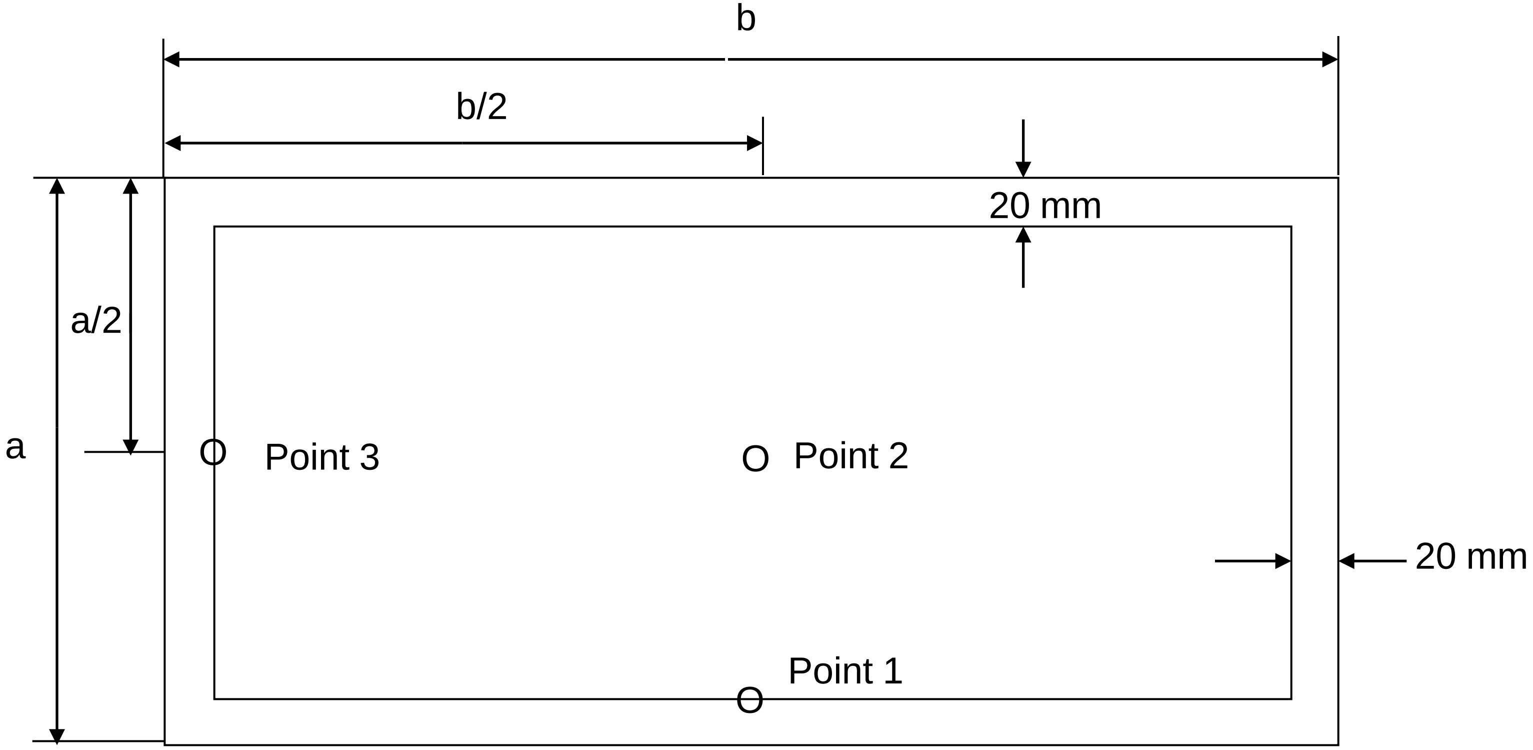


Fig. 1 Points of Impact for Fragmentation Test

Conclusions & Recommendations
Toughened Glass

- 4 mm, 5 mm and 6 mm “toughened safety glass” complying with fragmentation test ‘particle count’ requirements can produce particles longer than 100 mm and up to 300 mm in length when broken by pendulum impact.

- Particle count and spline length is significantly higher for EN 12600 (836mmx) than EN 12150 size (360mmx1100mm) panels made at the same toughening furnace conditions and having the same surface compression.

- Long particles are found when EN 12600 (876 mm X 1938 mm) size panels are broken by a centre punch at the centre of the panel.

- The fragmentation (punch) test at the centre of the panel on production size panels is the most suitable test for AS/NZS 2208 to determine safe breakage characteristics.

- Surface compression of 4 mm and 5 mm toughened glass must exceed a level of around 120 to 125 MPa to avoid particles of length greater than 100 mm possibly generated by any form of impact.

- The minimum surface compression limit for each glass thickness must be specified in AS/NZS 2208.

- A long particle requirement (100 mm maximum?) must be introduced into AS/NZS 2208.

Position Paper to Venice May 2005 WG6 Meeting

The JIS ‘soft’ lead shot bag and an EN 12600 twin tyre impactor with a 30 mm diameter screw spindle produce essentially equivalent impact results with 6.38 mm laminated glass.

Some 4 mm, 5 mm and 6 mm “toughened safety glass” complying with fragmentation test ‘particle count’ requirements produce particles longer than 100 mm (up to 300 mm) when broken by pendulum impact. Similar long particles are found when EN 12600 size panels are broken by a centre punch at the centre of the panel.

The test method must take account of these long particles.

Surface compression of 4 mm and 5 mm toughened glass must exceed a level of around 120 MPa to avoid particles of length greater than 100 mm possibly generated by any form of impact.

The introduction of a small flaw in toughened glass representative of handling damage by means of a Vickers indenter using 25 Newtons force provides a method to ensure breakage of toughened glass with the EN 12600 impactor thereby allowing breakage characteristics of the glass to be determined. It is recommended that use of the Vickers indenter be incorporated into the Technical Report Type 2 to ensure breakage of toughened glass.

A detailed specification for the construction of the test rig and maintenance of the test rig will ensure reproducible test results without the need for calibration.

Containment must be deleted from the standard

Conclusions & Recommendations Laminated Glass

- The JIS ‘soft’ lead shot bag and an EN 12600 twin tyre impactor with a 30 mm diameter screw spindle produce essentially equivalent impact results with 6.38 mm laminated glass.
- Impact results were found to be relatively independent of the impactor type.
- The JIS ‘Soft’ Lead Shot Bag is recommended for AS/NZS 2208.
- ‘Calibration’ of the test rig appears unnecessary for AS/NZS 2208 and is of concern for cost implications

1. Definition appearing in the last published AS/NZS 2208 Standard - 1996.

Toughened safety glass

A glass which has been converted to a safety glass by subjection to a process of prestressing so that, if fractured, the entire piece disintegrates into small, relatively harmless particles. The residual surface compression is a minimum of 69 MPa.

2. Definition in draft of AS2208 developed by the BD7 Working Group.

1.3.1 Toughened safety glass (Thermally toughened)

Glass in which a permanent minimum surface compressive stress has been induced, resulting in increased and predictable resistance to fracture from imposed mechanical and thermal stresses. In the event of fracture of thermally toughened safety glass complying with this Standard, the entire piece will granulate into small relatively harmless particles.

3. The definition that has been procured by the Cabal, which was published in a draft being prepared for "public comment" (sic) and publication.

Toughened safety glass (Thermally toughened)

Glass satisfying the relevant requirements of this Standard in which a permanent minimum surface compressive stress has been induced, resulting in increased and predictable resistance to fracture from imposed mechanical and thermal stresses.

NOTE: For the purpose of this Standard, Toughened safety glass is Thermally toughened safety glass. Also known as tempered safety glass

Please note the deletion in the proposed draft of the key performance requirement relating to the breakage characteristics ("the entire piece will granulate into small relatively harmless particles"), which appears in the current (1996) version as well as the official Working Group draft.

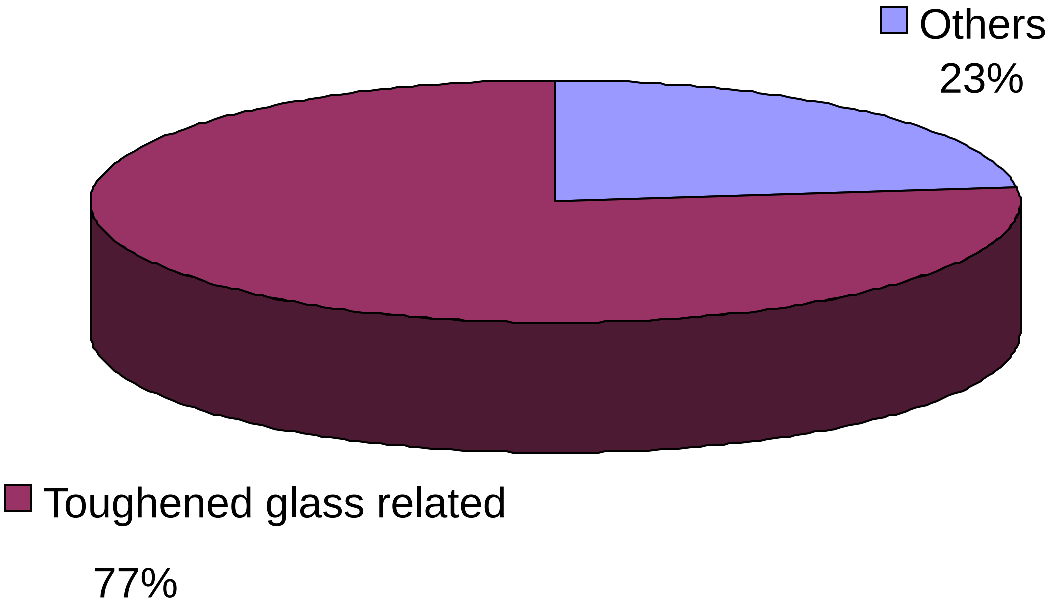
CPSC NEISS Statistics – Glass Injuries, 2001

Product Summary Report: Source - NEISS, US CPSC. CY 2001

(Executive summary based upon the report for all products for calendar year 2001)

					Age Percents				
Product Code	**Product Description**	**National Estimate**	**CV**	**Sample Count**	0-4	5 to 14	15-24	25-64	65-up
0609	Glass Bathtub or Shower Enclosures	1642	0.19	38	1.5	39.2	15	26.3	18.1
1823	Storm Doors with Glass Panels	3605	0.19	89	13.3	30.8	18.2	31.6	6.1
1825	Sliding Glass Doors	9131	0.18	219	21.2	13.7	13.2	35.9	16
1826	Storm Windows	2255	0.22	50	7.3	12.2	8.3	61.9	10.3
1875	Other Windows or Window Glass	8732	0.13	164	1	17.5	32.1	45	4.4
1882	Other Glass Doors	4592	0.15	121	5.2	36.8	21.6	28.2	8.2
1883	Glass Doors, not specified	18792	0.08	513	7.3	28.2	28.9	33.4	2.3
1873	Windows or Window Glass, not specified	127411	0.1	3554	8	17.4	31.5	39.5	3.6
1836	Jalousie Glass Windows			2					
1867	Fixed Floor-Length Glass Panels			17					
	Total	174518							

Bathtub & Shower Enclosures
- CPSC Reported Incidents



26% of toughed glass related Incidents caused injuries

146 Reported incidents – 1980 to 2002
86 involved exploded or shattered tempered glass
11 additional incidents of shattered glass which was probably toughened

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NEISS Query Results

http://www.cpsc.gov/en/Research--Statistics/NEISS-Injury-Data/

National Electronic Injury Surveillance System (NEISS)

Sample Case Detail

Glossary

PSU = Primary Sampling Unit (Hospital) Weight = Statistical Weight
Stratum = Size/type of hospital (S= Small, M=Medium, L=Large, V=Very Large, C=Children's Hospital)

NEISS Code 0609 - 2014

http://www.cpsc.gov/cgibin/NEISSQuery/QueryResults.aspx?TotalCt=64

CPSC Case #: 140208741 **Treatment Date:** 02/01/2014 **PSU:** 61 **Weight:** 14.3089 **Stratum:** V
Age: 38 - 38 YEARS **Sex:** 2 - FEMALE **Race:** 4 - ASIAN **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 36 - LOWER LEG
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 38 YOF LACERATIONS TO LOWER LEGS FROM BROKEN GLASS WHEN SHOWER DOOR BROKE

CPSC Case #: 140732708 **Treatment Date:** 07/07/2014 **PSU:** 5 **Weight:** 37.4149 **Stratum:** L
Age: 216 - 16 MONTHS **Sex:** 2 - FEMALE **Race:** 3 - OTHER **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 82 - HAND
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 16 MO F WAS IN THE BATHTUB WHEN THE GLASS SHOWER DOOR BROKE. DX: MULT SUPERFICIAL TINY LACS HANDS & FEET.

CPSC Case #: 140755402 **Treatment Date:** 05/25/2014 **PSU:** 24 **Weight:** 81.576 **Stratum:** M
Age: 26 - 26 YEARS **Sex:** 2 - FEMALE **Race:** 1 - WHITE **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 36 - LOWER LEG
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: *26YOF,AT HOME CLOSED SHOWER DOOR,GLASS SHATTERED,LANDED ON HAND,FEET,F ACE,DX:LAC LOWER LEG,MULTIPLE

Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: LAC LOW ARM 18YOM PUNCHED GLASS SHOWER DOOR AT HOME DX: LAC FOREARM

CPSC Case #: 140755402 **Treatment Date:** 05/25/2014 **PSU:** 24 **Weight:** 81.576 **Stratum:** M
Age: 26 - 26 YEARS **Sex:** 2 - FEMALE **Race:** 1 - WHITE **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 36 - LOWER LEG
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: *26YOF,AT HOME CLOSED SHOWER DOOR,GLASS SHATTERED,LANDED ON HAND,FEET,F ACE,DX:LAC LOWER LEG,MULTIPLE

CPSC Case #: 140814159 **Treatment Date:** 08/02/2014 **PSU:** 73 **Weight:** 82.3076 **Stratum:** S
Age: 73 - 73 YEARS **Sex:** 2 - FEMALE **Race:** 0 - N.S. **Race Other:**
Diagnosis: 62 - INTER ORGAN INJURY **Diag Other:**
Body Part: 75 - HEAD
Disposition: 4 - TREATED & ADMITTED FOR HOSPITALIZATION, HOSPITALIZED
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES, 649 - TOILETS
Narrative: 73YOF SITTING ON THE TOILET AND PASSED OUT FELL OFF TOILET INTO A GLASS SHOWER ENCLOSURE CLOSED HEAD INJURY ADMITTED FOR SYNCOPE

CPSC Case #: 140962030 **Treatment Date:** 09/23/2014 **PSU:** 73 **Weight:** 82.3076 **Stratum:** S
Age: 30 - 30 YEARS **Sex:** 1 - MALE **Race:** 0 - N.S. **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 82 - HAND
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 30YOM FELL THROUHG A GLASS SHOWER ENCLOSURE AND SUSTAINED A HAND LACERA TION

CPSC Case #: 141000234 **Treatment Date:** 09/01/2014 **PSU:** 54 **Weight:** 50.1602 **Stratum:** M
Age: 76 - 76 YEARS **Sex:** 1 - MALE **Race:** 1 - WHITE **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 82 - HAND
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 76YOM WAS TRYING TO PUT SHOWER DOOR BACK ON TRACK WHEN THE GLASS BROKE CAUSING CUTS TO RT HAND & CHEST. DX; HAND LAC INVOLVING TENDON.

CPSC Case #: 141019988 **Treatment Date:** 09/27/2014 **PSU:** 5 **Weight:** 37.4149 **Stratum:** L
Age: 23 - 23 YEARS **Sex:** 2 - FEMALE **Race:** 1 - WHITE **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 92 - FINGER
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 23 YOF WAS OPENING GLASS SHOWER DOOR WHICH BROKE. DX: L LONG FINGER LAC 4 CM.

NEISS Code 0609 - 2013

CPSC Case #: 141125135 **Treatment Date:** 11/07/2014 **PSU:** 24 **Weight:** 112.1671 **Stratum:** M
Age: 57 - 57 YEARS **Sex:** 2 - FEMALE **Race:** 1 - WHITE **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 33 - LOWER ARM
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 57 Y/O F FELL THROUGH SHOWER DOOR LAC LOWER ARM, CHEST, LEG

CPSC Case #: 141146805 **Treatment Date:** 11/15/2014 **PSU:** 90 **Weight:** 5.7174 **Stratum:** C
Age: 3 - 3 YEARS **Sex:** 1 - MALE **Race:** 1 - WHITE **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 82 - HAND
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 3YOM- PT WAS PLAYING WITH THE SHOWER GLASS DOOR WHEN DOOR SHATTERED CUT LEFT HAND. DX- LACERATION TO LEFT HAND.

CPSC Case #: 141218384 **Treatment Date:** 12/04/2014 **PSU:** 21 **Weight:** 15.6716 **Stratum:** V
Age: 93 - 93 YEARS **Sex:** 1 - MALE **Race:** 0 - N.S. **Race Other:**
Diagnosis: 62 - INTER ORGAN INJURY **Diag Other:**
Body Part: 75 - HEAD
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES, 1807 - FLOORS OR FLOORING MATERIALS
Narrative: 93YM S'D&F IN THE BR FLOOR STRIKING HEAD ONTO SHOWER ENCLOSURE NO LOC >>CHI/ABRS/ARM SKIN TEAR

CPSC Case #: 150238970 **Treatment Date:** 09/22/2014 **PSU:** 37 **Weight:** 5.7174 **Stratum:** C
Age: 6 - 6 YEARS **Sex:** 1 - MALE **Race:** 0 - N.S. **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 34 - WRIST
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 6 YO M WAS CUT BY GLASS SHARDS OF BROKEN GLASS SHOWER DOOR WHEN BABY BR O SLAMMED IT SHUT CAUSING IT TO BREAK. DX: LAC TO L WRIST AND R HEEL

2013

CPSC Case #: 130139111 **Treatment Date:** 01/19/2013 **PSU:** 46 **Weight:** 76.7142 **Stratum:** S
Age: 31 - 31 YEARS **Sex:** 2 - FEMALE **Race:** 1 - WHITE **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 34 - WRIST
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES, 611 - BATHTUBS OR SHOWERS
Narrative: 31YOF DX: LACERATION WRIST.SLIPPED IN THE SHOWER @ HOME & FELL INTO GLA SS SHOWER DOOR, GLASS BROKE & LACERATED RT WRIST*

CPSC Case #: 130345272 **Treatment Date:** 01/06/2013 **PSU:** 41 **Weight:** 14.8537 **Stratum:** V
Age: 23 - 23 YEARS **Sex:** 2 - FEMALE **Race:** 0 - N.S. **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 32 - ELBOW
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 0 - UNKNOWN **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES, 611 - BATHTUBS OR SHOWERS
Narrative: 23YOF SLIPPED GETTING OUT OF SHOWER AND LT ELBOW WENT THROUGH GLASS DOO R OF SHOWER. DX ELBOW LAC

CPSC Case #: 130418286 **Treatment Date:** 03/07/2013 **PSU:** 40 **Weight:** 14.8537 **Stratum:** V
Age: 17 - 17 YEARS **Sex:** 1 - MALE **Race:** 2 - BLACK/AFRICAN AMERICAN **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 33 - LOWER ARM
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 5 - OTHER PUBLIC PROPERTY **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES, 611 - BATHTUBS OR SHOWERS
Narrative: 17YOM SLIPPED & FELL IN SHOWER AT FACILITY, BROKE GLASS SHOWER DOOR & INJURED HIS LT FOREARM. DX - LT FOREARM LAC

CPSC Case #: 130419778 **Treatment Date:** 03/05/2013 **PSU:** 54 **Weight:** 44.4806 **Stratum:** M
Age: 23 - 23 YEARS **Sex:** 2 - FEMALE **Race:** 1 - WHITE **Race Other:**
Diagnosis: 53 - CONTUSION OR ABRASION **Diag Other:**
Body Part: 34 - WRIST
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES, 611 - BATHTUBS OR SHOWERS
Narrative: 23YOF GLASS DOOR FELL WHILE TAKING A SHOWER,INJ RT WRIST DX: WRIST CON TUSION

CPSC Case #: 130709668 **Treatment Date:** 06/27/2013 **PSU:** 34 **Weight:** 14.8537 **Stratum:** V
Age: 21 - 21 YEARS **Sex:** 2 - FEMALE **Race:** 1 - WHITE **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 82 - HAND
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 21 YOF FELL THROUGH A SHOWER DOOR AND BROKE THE GLASS. DX HAND LAC

CPSC Case #: 130764273 **Treatment Date:** 07/24/2013 **PSU:** 24 **Weight:** 88.4147 **Stratum:** M
Age: 78 - 78 YEARS **Sex:** 2 - FEMALE **Race:** 1 - WHITE **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 82 - HAND
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 78 Y/O F FELL IN SHOWER AND CUT LEG ON GLASS SHOWER DOOR LACERATION HAND

CPSC Case #: 130772351 **Treatment Date:** 07/28/2013 **PSU:** 89 **Weight:** 77.2173 **Stratum:** L
Age: 61 - 61 YEARS **Sex:** 1 - MALE **Race:** 1 - WHITE **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 81 - UPPER LEG
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 61 YO M PT WAS LEANING AGAINST SHOWER GLASS DOORS WHICH BROKE CUTTING RT THIGH. DX 4CM LACERATION RT THIGH

CPSC Case #: 130815396 **Treatment Date:** 08/04/2013 **PSU:** 77 **Weight:** 14.8537 **Stratum:** V
Age: 28 - 28 YEARS **Sex:** 2 - FEMALE **Race:** 4 - ASIAN **Race Other:**
Diagnosis: 53 - CONTUSION OR ABRASION **Diag Other:**
Body Part: 92 - FINGER
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 28 YOF REPORTS INJURY TO RT THUMB WHEN GLASS SHOWER DOOR BROKE AND FELL ON HAND. DX ABRASION%

CPSC Case #: 130828655 **Treatment Date:** 08/07/2013 **PSU:** 21 **Weight:** 14.8537 **Stratum:** V
Age: 55 - 55 YEARS **Sex:** 1 - MALE **Race:** 0 - N.S. **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 33 - LOWER ARM
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 1807 - FLOORS OR FLOORING MATERIALS, 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 55YM SLIPPED ON WET FLOOR&FELL PUTTING ARM THRU GLASS SHOWER DOOR >>ARM LAC

CPSC Case #: 130840171 **Treatment Date:** 08/15/2013 **PSU:** 5 **Weight:** 38.8395 **Stratum:** L
Age: 68 - 68 YEARS **Sex:** 2 - FEMALE **Race:** 0 - N.S. **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 76 - FACE
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 68 YOF WAS STRUCK IN EYE BY PIECE OF GLASS FROM GLASS SHOWER DOOR WHICH SHATTERED. DX: FACIAL CONT, EYELID LAC.

CPSC Case #: 131252376 **Treatment Date:** 12/05/2013 **PSU:** 93 **Weight:** 14.8537 **Stratum:** V
Age: 44 - 44 YEARS **Sex:** 1 - MALE **Race:** 3 - OTHER **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 76 - FACE
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 611 - BATHTUBS OR SHOWERS, 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 44 YOM FELL IN BATHTUB THROUGH GLASS SLIDING DOOR. DX: ACUTE ALCOHOL INTOX, MULT LACS FACE AND ARMS.

CPSC Case #: 140130035 **Treatment Date:** 12/09/2013 **PSU:** 24 **Weight:** 80.377 **Stratum:** M
Age: 14 - 14 YEARS **Sex:** 1 - MALE **Race:** 1 - WHITE **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 35 - KNEE
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: *14YOM,AT HOME,CLOSED SHOWER DOOR,BROKE,GLASS FLEW,CUT HIM,DX:LAC KNEE

NEISS Code 0609 - 2012

CPSC Case #: 120757288 **Treatment Date:** 07/21/2012 **PSU:** 21 **Weight:** 15.5286 **Stratum:** V
Age: 32 - 32 YEARS **Sex:** 2 - FEMALE **Race:** 0 - N.S. **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 33 - LOWER ARM
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES
Narrative: 32YF GLASS SHOWER DOOR SHATTERED CUTTINER ARMS/LEGS >>LAC

CPSC Case #: 121144790 **Treatment Date:** 11/17/2012 **PSU:** 89 **Weight:** 94.1799 **Stratum:** L
Age: 3 - 3 YEARS **Sex:** 1 - MALE **Race:** 1 - WHITE **Race Other:**
Diagnosis: 59 - LACERATION **Diag Other:**
Body Part: 33 - LOWER ARM
Disposition: 1 - TREATED & RELEASED, OR EXAMINED & RELEASED WITHOUT TRTMNT
Location: 1 - HOME **Fire Involvement:** 0 - NO FIRE OR NO FLAME/SMOKE SPREAD
Products: 609 - GLASS BATHTUB OR SHOWER ENCLOSURES, 1395 - TOYS, NOT SPECIFIED
Narrative: 3YO M PLAYING WITH BROTHER WHEN BROTHER THREW TOY AT GLASS SHOWER DOOR & DOOR SHATTERED ON BOTH CHILDREN. DX: ARM LACERATION.

Testing of TSG in Standards around the world

Following is a history of world-wide standards development relating to toughened safety glass:

USA

- The first safety glazing standard developed was the voluntary American National Standard ANSI Z97.1.1966 'American National Standard Performance Specifications and Methods of Test for Transparent Safety Glazing Material Used in Buildings'. The standard introduced the Lead Shot Bag (Pendulum) Impact Test as the sole test classification method for safety glasses (Laminated Glass and Tempered Glass). It gave the following definitions for Safety Glazing Materials and Tempered Glass:

  *"**Safety Glazing Materials** are glazing materials so constructed, treated or combined with other materials as to minimize the likelihood of cutting and piercing injuries resulting from human contact with this glazing material."*

  *"**Tempered Glass:** When broken at any point the entire piece immediately breaks into innumerable small granular pieces."*

  Section 4.1.3 of the standard provided the following ***Interpretation of Results***:

  The impact test shall have been judged to have been satisfactorily completed if any of the following safety criteria shall be met by three of four samples tested:
  1. *When breakage occurs at either 12 inches (300 mm) or 48 inches (122 mm), numerous cracks and fissures may occur but no shear opening through which a 3-inch (75 mm) diameter sphere may be freely passed may develop.*
  2. *When disintegration occurs at either 12 inches or 48 inches and results in several pieces, the largest crack-free particles obtained 3 minutes subsequent to test, shall weigh no more than 0.15 oz (4.5 grams).*
  3. *When breakage occurs at the 12- or 48- inch impact level and results in several separate pieces, none shall be of such a nature or shape that it could be described as sharp-edged, pointed or dagger-like.*
  4. *The specimen remains intact after one 48-inch drop test, though not necessarily remaining within the frame.*

- In the 1972 revision of the ANSI Z97.1 standard Safety Criteria #1 and #2 above were modified as follows:
  1. *When breakage occurs at 12 inches, 18 inches or 48 inches, numerous cracks and fissures may occur but no shear opening through which a 3-inch diameter sphere may be freely passed may develop.*
  2. *When disintegration occurs at 12 inches, 18 inches, or 48 inches, the ten largest crack-free particles selected 5 minutes subsequent to the test shall weigh no more than the equivalent weight of 10 square inches (6,452 square mm) of the original test specimen.*

In the 1975 revision of the ANSI Z97.1 standard all definitions apart from the definition of safety glazing materials were eliminated along with following two safety criteria.

- *"When breakage occurs at the 12-inch, 18-inch, or 48-inch impact level and results in several separate pieces, none shall be of such a nature or shape that it could be described as sharp edged, pointed, or dagger-like".*
- *The specimen remains intact after one 48-inch drop test, though not necessarily remaining within the frame.*

A safety criterion added relating to safety plastics was added.

Australian standard AS 2208-1978

Australian standard AS 2208-1978, 'Safety glazing materials in buildings' was based on the ANSI Z97.1-1975 'safe break' criteria.

The preface to AS 2208-1978 however stated:

"The performance of safety glazing materials is evaluated by an impact test to simulate human impact of such energy that it could result in cutting and piercing injuries. Toughened safety glass has intrinsic properties which enable its impact performance to be determined by a simplified test procedure".

USA Federal Regulation 16 CFR 1201

In the USA, in 1977 the Consumer Protection Safety Commission (CPSC) created federal regulation 16 CFR 1201 for safety glass in doors. The Commission decided that the minimum impact level in Z97.1 was too low and found fault with the Z97.1 impact test protocol. For protection against full body impacts the CPSC regulators decided that safety glass for panels having areas greater than 9 square feet (0.83 square metres) must pass the 48-inch drop height level in the Z97.1 shot bag impact test (CPSC Category II). ANSI Z97.1 continued to apply to safety glass applications other than doors.

ANSI Center Punch Fragmentation Test Ballot (2002)

A Center Punch Fragmentation test (at the panel edge) was included in a proposed new draft of ANSI Z97.1 in 2002. However as a consequence of opposition to this test by the Glass Association of North America (GANA) Tempering Division the test was struck out of the draft. This was done by means of a ballot (B-021115.02 'Center Punch Fragmentation Ballot') issued by the ANZI Z97.1 Secretariat on December 6, 2002. The ANSI Z97.1 Secretariat advised that an overall negative vote on the ballot would leave the document as approved by the ANSI Z97.1 Accredited Standards Committee, in which case the draft standard would be submitted to ANSI for public comment in relation to the Center Punch Fragmentation, while an affirmative vote would strike the test from the draft. The result of the ballot was affirmative and the proposed Center Punch Test was therefore removed from the ANSI Z97.1 proposed draft. Several negative votes however were cast including one by Mr harry Miles. An article on Harry Miles in US Glass Magazine, Volume 34, No. 11, November 1999, included the following:

"Miles is perhaps best known for the work he has done as a consultant for the Glass Tempering Association and then the Glass Association of North America for the past ten years. During those ten years, he was in the middle of some of the biggest—and most challenging—discussions in the industry. He was known as an expert technician with knowledge beyond reproach and a skilled negotiator able to forge compromise when others thought it was not possible."

Mile's comments in his negative vote included the following three points:

5. "The Center Punch test, as written, is more stringent for fragment size than the Swing Shot Bag test. It was designed to be so. The current maximum fragmentation size, which is by weight, for the Swing Shot Bag was written many years ago when tempering technology was still a teenager and most of the tempering furnaces were vertical with the glass hanging from tongs. Obtaining uniform fragmentation was difficult and the largest ten-particle test was written with that in mind."

6. "Glass that will only just pass the Swing Shot Bag test is prone to have very long narrow pieces of dice, or "straws" or "pipes", when broken in use in addition to the desired squared fragments."

9. "The Center Punch test provides a better method of evaluating Tempered glass and increases the safety characteristics (dice size and uniformity) of the product."

These comments reveal that the tempering glass industry was aware of occurrences of long particles in the pendulum impact test ('Swing Shot Bag test'). The safety glass test programs carried out in support of ISO resolutions along with those carried out by the AS/NZS 2208 Working Group demonstrate however that Miles was incorrect in insinuating that "The Center Punch Test" proposed in the 2002 draft ANSI Z97.1 standard "would increase the safety characteristics" of tempered glass.

Guardian Glass Publications on Breakage Characteristics of Tempered Glass

In their 1995 Architectural Product Guide Guardian Glass in the USA included the following statement in the section on Tempered Glass:

"Tempered glass is called "safety glass". However, even glass which is fully tempered is susceptible to breakage. Tempered glass may occasionally break into large shards rather than in the classic tiny piece pattern, and some injuries may result."

This following statement on tempered glass is currently displayed on the Guardian Europe website
https://www.guardian.com/cs/groups/guardianeurope/documents/web_content/stg_031540.pdf:

"Tempered glass has a breakage pattern of small particles, that are much safer than the large and sharp pieces from a broken lite of annealed glass. It is therefore called 'safety glass'. "

UK

Beginning in 1995 Mr John Weir, Standards Secretary British Glass & Glazing Federation travelled the UK giving a lecture entitled 'The Principles of Safe Glazing' JW-20-5-6-1.lec.

The lecture includes the following passage:

"(BS 6206) Amendment No. 5 is the fruit of painstaking deliberations within BSI (British Standards Institute) following a fatal accident involving glass in a conservatory door which was allegedly toughened. The main advance is the inclusion of an extra test which assesses the fracture characteristics of toughened glass. Under the new Amendment toughened glass will have to pass, not only the swinging bag test, but also a centre punch test."

It is incredulous in view of the fact that the fatality of the 6 year old boy reported in the lecture by Mr Weir was due to a long glass particle that the painstaking deliberations mentioned in the lecture did not take account of the length of particles resulting from glass breakage in the pendulum (swinging bag) impact test or that in the centre punch test only the a point near the mid-point of the long edge of the panel was employed. Knowledge had long existed from automotive standard for toughened glass UN ECE R 43 that the critical impact point for the centre punch test is the mid-point of the glass panel.

ISO

The following documents summarise the activities of the Working Group 6 (WG6) within Sub-committee 2 (SC2 – 'Use considerations') of ISO Technical Committee 160 (ISO/TC160) 'Glass in building':

- Submission by Dr Leon Jacob to ISO/TC160/SC2/WG6 "ISO Safety Glass Test Programs" dated 1 September 2008 – see Appendix 8.
- Presentation by Dr Leon Jacob "ISO Safety Glass Test Programs - Results, Conclusions and Recommendations relating to AS/NZS 2208" to AS/NZS 2208 Working Group on 29 April 2008 (BD-007 Document Number N087) – see Appendix 1.
- Presentation by Dr Leon Jacob "AS/NZS 2208 Test Programs – Bevelite Factory, 2008-2009" to AS/NZS 2208 Working Group on 31 March 2009 – see Appendix 9.

As detailed by Dr Jacob in his detailed submission to ISO/TC160/SC2/WG6 dated 8 September 2008 following the 6th meeting of ISO/TC160/SC2/WG6 in October 2002 a maximum spline length of 100 mm was included in version 'N57 rev 1' of the draft . This requirement remained in the draft standard until the 8th meeting of WG6 in Venice in May 2005 at which it was arbitrarily deleted at the insistence of European delegates who had not attended previous WG6 meetings. Unfortunately the two Australian WG6 delegates were prevented from attending the Venice WG6 meeting. The deletion of the maximum spline length requirement was protested by the Chinese delegate at the meeting. After 19 years of development ISO standard ISO 29584:2015 "Glass in building – Pendulum impact testing and classification of safety glass" was issued.

China

Refer to GPD2005 China paper by Professor JJ Yang. This includes the following on China Standard GB 9963 (New Number GB 15763.2):

"In the case that breakage occurs (in the pendulum impact test at any drop height) any splines retained in the frame (are to be) no longer than 120 mm. This is a new requirement agreed to be added among technical experts from SAC/TC250 China National Technical Committee for Architectural Glazings, which at the moment, is not required by other countries in the world. The reason for this is because the retained long splines might cause serious lacerations or (be) even fatal to the person who accidently impacts with them."

The paper by Professor JJ Yang also includes the following comment resulting from the extensive test programs carried out at the China Building Materials Academy in support of the ISO resolutions on toughened glass adopted at the London 2000 meeting of TC160:

"In current practice, fragmentation of tempered glass is caused by breaking it near the edge using a sharp punch, which does not generate long splines, regardless of how good or poor the temper is, thus may conceal the potential splines, which are hazardous to human bodies, to be generated at central area. To comprehensively evaluate the status of fragmentation, it is suggested to adopt the method similar to the auto tempered glass, of breaking at corner, edge and center. In the next revision, this will be further studied and majority of consent needs to be reached among our technical experts from SAC/TC255."

Documents detailing use of centre fragmentation in International and Australian Standards and Australian Design Rules (ADR).

Fragmentation Test – Toughened Safety Glass
Proposed Global Standard for Vehicle Safety Glazing

"Many years of experience of working with ECE R43 and the JIS standard, which contain several breaking positions, have demonstrated that a centre break position is the most stringent. In practice glass manufacturers in Europe and Japan routinely break from the centre for CoP testing, because a satisfactory fracture indicates a good tempering process and predicts a good performance for other breaking positions. For this reason, only a single break position at the geometric centre of the glass pane is specified."

CLEPA (European Association of Automotive Suppliers)

Slide 38 from Presentation to ISO/TGC160/SC1/WG2 'Toughened Glass' Meeting, Berlin, 25 June 2004

ECE R 43 Standard
Automotive Toughened Glass

ECE R 43 requires the measurement of long particles for centre break position

"Many years of experience of working with ECE R43 and the JIS standard, which contain several breaking positions, have demonstrated that a centre break position is the most stringent. In practice glass manufacturers in Europe and Japan routinely break from the centre for CoP testing, because a satisfactory fracture indicates a good tempering process and predicts a good performance for other breaking positions. "

CLEPA (European Association of Automotive Suppliers)

Slide 59 from Presentation by Dr Leon Jacob to AS/NZS 2208 Working Group

Vehicle Standard (Australian Design Rule 8/01 – Safety Glazing Material) 2005

Compilation:	3 (up to and including Vehicle Standard (Australian Design Rule 8/01 – Safety Glazing Material) 2005 Amendment 3)
Compilation Date:	1 July 2015
Compiled by:	Vehicle Safety Standards, Department of Infrastructure and Regional Development.

Excerpts

Addendum 42: Regulation No. 43

Revision 3
Incorporating all valid text up to:
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Supplement 9 to the original version of the Regulation - Date of entry into force: 12 June 2007
Supplement 10 to the original version of the Regulation - Date of entry into force: 10 November 2007
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Supplement 13 to the original version of the Regulation - Date of entry into force: 9 December 2010
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Corrigendum 1 to Revision 3 of the Regulation - *(Erratum by the secretariat)*
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Supplement 1 to the 01 series of amendments - Date of entry into force: 18 November 2012
Supplement 2 to the 01 series of amendments - Date of entry into force: 3 November 2013
Corrigendum 1 to Supplement 2 to the 01 series of amendments - *(Erratum by the secretariat)*

Uniform provisions concerning the approval of safety glazing materials and their installation on vehicles

UNITED NATION

* Former title of the Agreement: Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958.

Annex 3

General test conditions

1. Fragmentation Test

1.1. The glass pane to be tested shall not be rigidly secured; it may however be fastened on an identical glass pane by means of adhesive tape applied all round the edge.

1.2. To obtain fragmentation, a hammer of about 75 g or some other appliance giving equivalent results shall be used. The radius of curvature of the point shall be 0.2 ± 0.05 mm.

1.3. One test shall be carried out at each prescribed point of impact.

1.4. The examination of the fragments shall be made using any method validated on its accuracy of the counting itself and on its ability to find the correct location where the minimum and the maximum counting shall be done.

Permanent recording of the fragmentation pattern shall start within 10 seconds and shall end within 3 minutes after the impact. The technical service shall keep the permanent recordings of the fragmentation pattern.

Annex 5

Uniformly-toughened glass panes*

2.5. Points of impact (see Annex 17, Figure 3)

2.5.1. For flat glass panes and curved glass panes the points of impact represented respectively in Annex 17, Figures 3(a) and 3(b) on the one hand, and in Annex 17, Figure 3(c) on the other hand, shall be as follows:

Point 1: In the geometric centre of the glass.

2.6. Interpretation of results

2.6.1. A test shall be deemed to have given a satisfactory result if fragmentation satisfies the following conditions:

2.6.1.1. The number of fragments in any 5 cm x 5 cm square is not less than 40.

2.6.1.2. For the purposes of the above rule, a fragment extending across a side of a square shall count as half a fragment.

2.6.1.3. Fragmentation shall not be checked in a strip 2 cm wide round the edge of the samples, this strip representing the frame of the glass; nor within a radius of 7.5 cm from the point of impact.

2.6.1.4. When a fragment extends beyond the excluded area only the part of the fragment falling outside of the area shall be assessed.

2.6.1.5. Fragments of an area exceeding 3 cm^2 shall not be allowed except in the parts defined in paragraph 2.6.1.3. above.

2.6.1.6. No fragment longer than 100 mm in length shall be allowed except in the areas defined in paragraph 2.6.1.3. above provided that:

2.6.1.6.1. Fragment ends do not converge to a point.

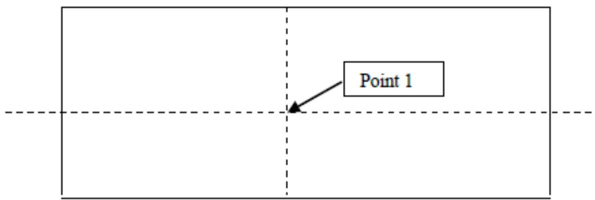
2.6.1.6.2. If they extend to the edge of the pane they do not form an angle of more than 45° to it.

2.6.2. A set of test pieces submitted for approval shall be considered satisfactory from the point of view of fragmentation if at least three of the four tests carried out at each of the points of impact prescribed in paragraph 2.5.1. above have given a satisfactory result.

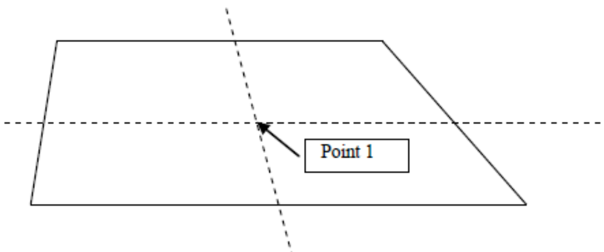
2.6.3. If the above-mentioned deviations are found, they shall be noted in the test report and permanent recording(s) of the fragmentation pattern of the relevant parts of the glass pane shall be attached to the report.

Figure 3

Prescribed points of impact for uniformly toughened glass panes



3(a) Flat glass pane



3(b) Flat glass pane

https://www.comlaw.gov.au/Details/F2015C00542/Download

Point 1: In the geometric centre of the glass.

Point 2: For curved glass panes having a minimum radius of curvature "r" of less than 200 mm. The point shall be selected on the largest median in that part of the pane where the radius of curvature is smallest.

2.5.2. Four test pieces shall be tested from each point of impact.

2.6. Interpretation of results

2.6.1. A test shall be deemed to have given a satisfactory result if fragmentation satisfies the following conditions:

2.6.1.1. The number of fragments in any 5 cm x 5 cm square is not less than 40.

2.6.1.2. For the purposes of the above rule, a fragment extending across a side of a square shall count as half a fragment.

2.6.1.3. Fragmentation shall not be checked in a strip 2 cm wide round the edge of the samples, this strip representing the frame of the glass; nor within a radius of 7.5 cm from the point of impact.

2.6.1.4. When a fragment extends beyond the excluded area only the part of the fragment falling outside of the area shall be assessed.

2.6.1.5. Fragments of an area exceeding 3 cm^2 shall not be allowed except in the parts defined in paragraph 2.6.1.3. above.

2.6.1.6. No fragment longer than 100 mm in length shall be allowed except in the areas defined in paragraph 2.6.1.3. above provided that:

2.6.1.6.1. Fragment ends do not converge to a point.

2.6.1.6.2. If they extend to the edge of the pane they do not form an angle of more than 45° to it.

2.6.2. A set of test pieces submitted for approval shall be considered satisfactory from the point of view of fragmentation if at least three of the four tests carried out at each of the points of impact prescribed in paragraph 2.5.1. above have given a satisfactory result.

2.6.3. If the above-mentioned deviations are found, they shall be noted in the test report and permanent recording(s) of the fragmentation pattern of the relevant parts of the glass pane shall be attached to the report.

Excerpt from final draft of AS2208 generated by the Working Group detailing the procedure for shot bag testing and centre punch testing of TSG.

3.2.4 Procedure

The procedure shall be as described in Appendix D with the following additional requirement. An adhesive film shall be applied to the impact surface of the toughened glass, which is capable of retaining all the glass particles after fracture. When the panel is broken make a count of the particles of broken glazing material within 3 minutes of the fracture of the glazing material. The particle count shall be made in the region of the coarsest fracture (the aim being to obtain the minimum value.) The particle count shall be made by placing a mask of (50 ± 1) mm x (50 ± 1) mm on the test piece (see Figure 3.5). The number of crack-free particles within the mask shall be counted In the particle count, all particles wholly contained within the square and all the particles only partially contained by two adjacent edges of the square shall be counted (see figure 3.6). All particles only partially contained by the other two adjacent edges of the square shall not be counted (see figure 3.7). Only particles containing both original faces shall be counted. A particle is 'crack-free' if it does not contain any cracks that run from one edge to another (see figure 3.4).

NOTE: The purpose of the film is to ensure the fragments are retained for inspection.
The type of film is not critical but should be of low adhesion and easy to peel off for convenience

3.4 FRAGMENTATION TEST

This Clause sets out the method for determining the fracture characteristics of flat toughened safety glass. When samples of toughened safety glass are tested in accordance with this Clause, a sample which complies with the minimum particle count specified in Table 3.2 shall be deemed to comply with the impact test requirements for safety glass specified in clause 3.2.

3.4.1 Apparatus

The following apparatus shall be used:

Any flat surface such as a table, wooden board or the floor (see Paragraph 3.4.2).

A pointed metal tool such as a centre punch and hammer or spring-loaded centre-punch.

3.4.2 Principle

The specimen is laid horizontally on a surface that supports it over its entire area, and is broken by a punch applied at a predetermined location. The number of particles of broken glass within a given area are counted.

3.4.3 Samples

(i) Sampling

Samples shall be tested at a sufficient frequency to assure that glass certified to this Standard will pass this test when tested. Suggested testing protocols are set out in Appendix F, F2.3 (a)

(ii) **Specimen size**

Each specimen shall be a minimum of 1900 x 860 mm, or the maximum size available if smaller.

(Note: If substantially larger sizes are to be manufactured, it is necessary to test the largest size produced, unless data is available to confirm that the fragmentation performance of the smaller size is representative of the largest size. Also, variations in respect of furnace loading and bed position of the glass need to be checked.)

3.4.4 Procedure (for fragmentation test)

The procedure shall be as follows:

(a) Place the specimen horizontally upon a table, wooden board or the floor that will support the test specimen on its entire surface. Provide a means to prevent any substantial spreading of the fragments.

(b) Break the test specimen by means of a pointed metal tool such as a centre punch and hammer or spring-loaded centre-punch. The punch blow shall be applied at the geometric centre of the panel (See Figure 3.2).

(c) Make a count of the particles of broken glazing material within 3 minutes of the fracture of the glazing material. The particle count shall be made in the region of the coarsest fracture (the aim being to obtain the minimum value).

The particle count shall be made by placing a mask of (50 ± 1) mm x (50 ± 1) mm on the test piece (see Figure 3.5). The number of crack-free particles within the mask shall be counted In the particle count, all particles wholly contained within the square and all the particles only partially contained by two adjacent edges of the square shall be counted (see figure 3.6). All particles only partially contained by the other two adjacent edges of the square shall not be counted (see figure 3.7). Only particles containing both original faces shall be counted. A particle is 'crack-free' if it does not contain any cracks that run from one edge to another (see figure 3.4).

(d) Fragments of an area exceeding 300 mm^2 shall not be allowed.

(a) (e) Fragments of elongated shape shall be allowed provided that their length does not exceed 50 mm

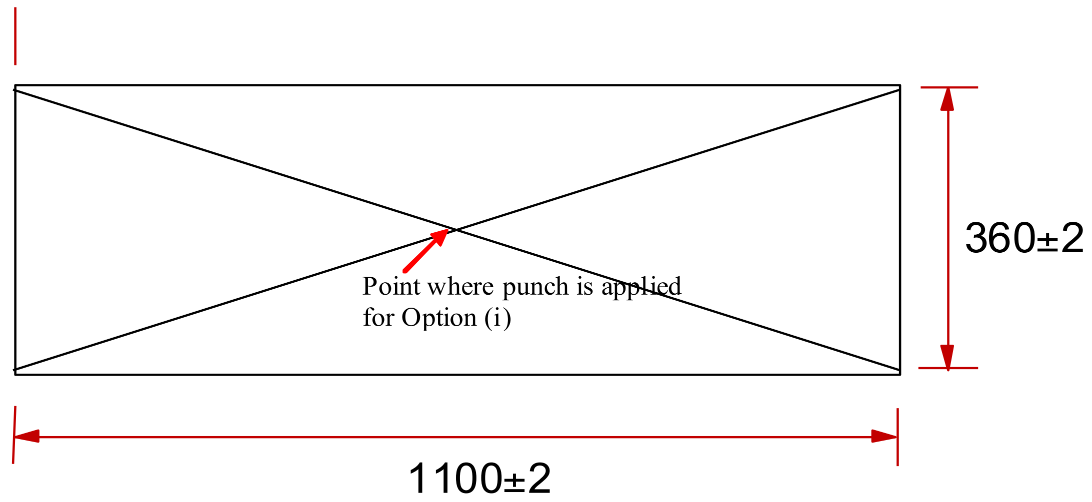


Fig 3.2

Jacob & Associates Pty Ltd

313 Canterbury Road address
Canterbury NSW 2193
Australia

61 2 9718 2222 phone

61 2 9718 0001 fax

1 September 2008

To: Members of ISO/TC160/SC2/WG6

From: Leon Jacob

Subject: ISO Safety Glass Test Programs

Today I am taking the opportunity to comment in person on concerns and issues arising from the May 2005 WG6 meeting in Venice and the November 2007 WG6 meeting in Humen Town, China.

I think it appropriate firstly to list a number of the developments on safety glass testing that have taken place during my past twelve years of involvement with ISO/TC160.

SC2 Meeting, Tokyo, 6 December 1996

The Objective of SC2/WG 6 was defined as:

> *"To develop an ISO test method for determining the safe breakage characteristics of glasses which are to be used in critical safety locations in buildings."*

Joint ISO/CEN meetings on Laminated Glass (SC1/WG3) and Toughened Glass (SC1/WG2), Brussels, 21-22 February 1999

Australia had cast a negative vote on ISO/FDIS 12543-2 (along with USA, Japan and the UK) in November 1997 because of lack of test data on the equivalence of the prEN 12600 twin tyre impactor to the ANSI Z97.1/AS1288 lead shot bag impactor.

At the Brussels meetings it was affirmed (SC1/WG3 N2) that Australia intended to carry out a test program to evaluate the prEN 12600 impactor versus the AS 2208 lead shot-bag impactor. It was advised that this test program would include both laminated glass and toughened glass.

Australian Impact Test Program – December 1999-May 2000

- An AS 2208 impact test rig was constructed to conduct a test program to compare impact test results for the AS 2208 lead shot bag versus the prEN 12600 Twin Tyre impactor.

- An AS 2208 Lead Shot Bag impactor was fabricated.
- The GGF supplied a prEN 12600 Twin Tyre impactor.
- Impact tests were conducted on 6.38 mm laminated glass and 4mm, 5 mm and 6 mm toughened glass.

WG6 Meeting , Tokyo, 23-24 May 2000:

A report (WG6/N31) and video on the results of the Australian test program was presented. Based on the test program results it was unanimously agreed that the following cautionary text (SC2/WG6 N32) on toughened glass breakage characteristics be incorporated into the future ISO standard.

> *"The breaking behaviour of toughened glass is generally characterised by the formation of small relatively harmless particles. However, under certain conditions, depending on the method of framing and means of breakage, there can be clumping together of small particles or the formation of shards. If these breakage patterns occur, they may increase the risk of injury."*

SC2 Meeting, London, 31 October 2000

- The WG6 Convenor's report (SC2 N100) stated that the cautionary text (WG6 N32) on the breakage behaviour of toughened glass *"would be included in the test method document to be put forward by WG6 for publication."*
- Australia proposed a new work item (SC2 N89) to develop an ISO impact test method that includes criteria on safe breakage required for classifying toughened safety glass.
- The WG6 Convenor (Mr. John Weir) replied that the issues raised by N89 would be addressed by SC2/WG6.
- The following U.S. proposed resolution (69, SC2) was accepted:

> ***SC 2 Resolution 69 [London 10: 2000]***
> *It was resolved that ISO/TC/SC 2/WG 6 consider the technical input provided by Australia in document N89. Working Group 6 must also consider Resolution 37 adopted by SC 1.*

SC1 Resolution 37 was as follows:

> ***SC 1 Resolution 37 [London: 10/2000]***
> *ISO/TC 160/SC 1 resolves to direct SC 1/WG 2 (Toughened Glass) to develop an AWI (Approved Work Item) which will establish the product definitions for 'toughened glass' and 'toughened safety glass' and establish performance characteristics which identify it as 'toughened safety glass'.*

- On the basis of the above Australia withdrew N89.
- Resolution 71 also from the U.S. was passed to instruct WG6 to develop one or two ISO Technical Report(s) Type 2 covering pendulum impacting testing to

include both impact and performance requirements for the dual-tire impact test and the shot bag impact test.

After the formal meeting the delegation leader from China, Professor Jianjun Yang of the China Building Materials Academy (CBMA) in Beijing offered the use of his laboratory to carry out testing in support of Resolutions 69 and 71 and to further evaluate the performance of the prEN12600 twin tyre impactor versus lead shot bag impactors with both 6.38 mm laminated glass and toughened glass.

CBMA Impact Test Program 1, 13-21 December 2000:

- An ANSI Z97.1 Lead Shot Bag impactor was fabricated using an Everlast® 4212 leather bag. Though this is one of the two Everlast® leather bags cited in ANSI Z.97.1-1984 extreme effort was required to pack the required amount of #7-1/2 chilled lead shot into the bag to obtain the required total weight of the shot bag assembly of 100 pounds (45.4 kg.). Also it was noted that the ANSI procedure stipulates that the "rubber bladder be left in place and filled through a hole cut into the upper part". This instruction evidently relates to earlier versions of the Everlast 4212 bag. The rubber bag in the 4212 bag obtained for this impact program was an inflatable rubber connected to the bottom of the bag by a valve which had to be cut out in order to install the threaded metal rod assembly.
- The test program employed the prEN 12600 twin tyre impactor that had been used in the Australian test program.
- An impact test program with the two impactors was carried out on the China GB test rig on 6.38 mm laminated glass and 4 mm and 6 mm toughened glass from three Chinese manufacturers.
- Measurements of micro-strain were obtained with commercially available standard data logging equipment and strain gauges. The the values of strain for each drop height were lower with the twin tyre impactor on the GB test rig that the values in the reference curves in prEN 12600 while the values for the ANSI lead shot bag were higher than the prEN 12600 reference curve values.

A report (SC2/WG6 N44) on the results of this test program was presented along with video of the testing to a meeting if ISO/TC160/SC2/WG6 'Safety glazing tests' in Sydney on 20 February 2001.

WG6 Meeting 4, Sydney, 20-21 February 2001:

- A report (SC2/WG6 N44) on the results of the December 2000 China test program was presented along with video of the testing.
- Japan presented a report (SC/WG6 N45) on "Impact Test by Shot Bag Impactor with Double Tyre Impactor". The report included data on testing of toughened glass. Long particles ('splines') were documented with 4 mm and 6 mm toughened glass. The following results were reported along with photographs

showing glass retained in the test rig following breakage of the glass by the impactors:

"The generation of edge splines differed with the thickness of specimens and impactor type as observed below;
1) Splines were generated in 4 and 6 mm thick specimens, but they were not generated in 8 mm thick specimen.
2) Splines generated in 4 mm thick specimen were longer than those in 6 mm thick specimen.
3) Spline generation by double tire impactor was apt to increase in length compared with that by shot bag impactor.
4) Splines generated on the normal JIS rig were longer than those on the reinforced JIS rig.
'Spline' means a narrow and slender fragment of broken tempered glass having an elongated surface length (for example more than 75 mm) exceeding its thickness."

- The Convenor suggested that Members should hold discussions on the performance characteristics of safety glasses jointly with SC1/WG2 and SC1/WG3.
- It was agreed to adopt the JIS 'Soft' Lead Shot Bag impactor.
- It was agreed that the scope of WG6 includes the responsibility for testing and evaluation of all safety glazing products.

CBMA Impact Test Program 2, 12-21 October 2001:

- Following the December impact test program the CBMA had constructed a new impact test rig to prEN12600:Feb 2001 specifications.
- Calibration measurements for the new test rig were carried out according to prEN 12600 Annex B using CBMA equipment.
- A JIS Soft Lead Shot Bag impactor was fabricated in accordance with the FGMAJ May 2001 video 'How to Fabricate an Impactor Shot Bag'.
- Impact tests were carried out on 6.38 mm laminated glass to determine mean penetration heights with the prEN 12600, JIS Soft LSB and ANSI Z97.1 LSB impactors on both the prEN 12600 test rig and the China GB test rig.
- Impact tests were conducted 4 mm and 6 mm toughened glass from two major Chinese processed glass manufacturers. The glass was produced both using normal quench air pressures and with lower than normal quench air pressures (in order to achieve a surface compression levels between 80 MPa and 90 MPa). A third lot of 6 mm toughened glass produced with higher than normal quench air pressure was obtained from a third Chinese processed glass manufacturer.
- In addition to impact testing, tToughened glass panels were also tested by the 'fragmentation' (centre punch) test with impact both at the edge and at the centre of the panels.
- Surprisingly the calibration results with the twin tyre impactor on the new test rig were appreciably below prEN 12600 Standard values and similar to those

obtained on the GB test rig. The strain results for the JIS lead shot bag were significantly higher than the twin tyre impactor results except at very low drop heights.

- The following conclusions were reached from the impact testing of 6.38 mm laminated glass:
  - MPH results were largely independent of impactor type or impactor rig used.
  - Strain is not critical to impact performance; hence test rig calibration is an unnecessary procedure.
- The following conclusions were reached from impact tests and fragmentation tests on the toughened glass panels:
  - Impact results were dependant on:
    - Impactor type (strain).
    - Glass thickness.
    - Glass surface compression.
    - Surface quality of the glass.
  - All the toughened glass panels passed the 10 largest particle impact test weight criterion despite the generation of long (>100 mm) particles ('splines') on impact of many of the panels and large clumps of tightly interlocked 'particles'. In view of these results the weight criterion in existing safety glass test method standards appears meaningless.
  - Splines were generated on impact of 4 mm and 5 mm toughened glass panels that complied with the EN 12150 minimum particle count criterion of 40 (Refer EN 12150 Section 8.5). Similar splines, however, as found in the impact tests were found when the fragmentation test was carried out at the panel centre, rather than at the mid point of the longest edge.
  - Fragmentation at the panel centre is an alternative to impact testing ensure toughened glass does not produce long particles on breakage.
  - Due to the high coefficient of restitution of the twin tyre impactor most glass panels produced at normal surface compression levels did not break on impact with this impactor at the maximum drop height of 1200 mm. These panels however broke at low drop heights after slight scratches were imparted to the centres of the panels thereby allowing the fracture pattern of the glass panels to be determined.

CBMA, 27-29 January 2002 – 'Calibration' Trials (China Test Program 3)

In view of the surprising calibration results obtained at the CBMA in the October 2001 test program Steve Rice of the GGF brought to the CBMA the Vishay Data Collection System and CEA-06-125WT-350 strain gauges that had been used to generate the calibration reference curves in prEN 12600. The CBMA calibration trials were attended by Steve Rice, Yukihito Oketani of Japan and Phillip Davies.

- Calibration results were "within standard". This highlights the dependence of calibration results on the calibration hardware and software employed since calibration results previously obtained on the same test rigs using the equipment belonging to the CBMA were appreciably below standard.

- In view of BD7 subcommittee discussions following incidents with shower screens in Australia panels of 10 mm toughened glasses (876 mm x 1938 mm) with surface compressions (SC) of 74 -79 MPa and 113 MPa were tested both by pendulum impact and by 'fragmentation' using a punch at the panel centre.
    - All panels produced large clumps of interlocked particles which did not separate on breakage
    - A punch fragmentation test at the centre of panel with SC of 74 produced many splines measuring up to 200 mm in length.
    - One large spear shaped clump from a panel .with SC of 113 broken by the JIS lead shot bag weighed 310 grams.

CBMA Impact Test Program 4, 16-21 October 2002

- An ANSI Z97.1 Lead Shot impactor was fabricated using an Everlast® 4207 leather bag. Unlike the Everlast® 4212 bag fabricated for the first CBMA test program the 4207 bag was easy to fill will the required amount of lead shot. As was the case for the 4212 the inflatable rubber bag attached by a valve to the bottom of the bag had to be removed.
- A JIS 'Soft' Lead Shot Bag was fabricated using a Winning SB 4500 leather bag according to the procedure set out in the draft Technical Report.
- Mean break height (MBH) staircase impacts were conducted on 6.38 mm laminated glass with the JIS Soft Shot Bag, ANSI 4207 Lead Shot Bag and the prEN12600 impactor. The probe assembly detailed in Annex A of prEN 12600 was used to determine if the 76 mm diameter sphere could penetrate any opening in laminated glass following an impact. It was not possible to establish a MBH for the prEN12600 impactor due to a marked decline in impact results after a number of impacts. It was subsequently found that the likely cause of this was that the 20 mm diameter screw spindle in the impactor was bent. It was concluded that there is not a strong relationship between impact performance of laminated glass and the micro-strain measured in the prEN12600 'calibration' test. Valid 'equivalent' drop heights cannot therefore be established based on micro-strain measurements.
- Impact tests on 5 mm toughened glass with surface compression of ~108 Mpa again showed a large difference between the JIS and prEN impactors on the drop height required to break unscratched toughened glass. The prEN12600 impactor usually did not break toughened glass at even the 1200 mm drop height, whereas the average height to break the glass with the JIS impactor was ~700 mm (range 300 mm – 1200 mm). An 'equivalent' drop height for the two impactors with toughened glass therefore has no valid meaning.
- Long particles (>150 mm) were found on breakage of the 5 mm toughened glass both in the impact test and in the fragmentation test with impact at the panel centre despite a minimum 'particle count' (punch test at the panel edge) of 81.
- Heat soaking of a number of panels at 290 degrees Celcius dropped the 'particle count' from 81 to 22 while surface compression was little affected.

WG6 Meeting 6, Singapore, 23-24 October 2002

The China and Australian delegates presented the results of the just completed October 2002 China impact program and recommended that:A requirement on long particles (splines) for toughened glass be incorporated into the pendulum impact test requirements in the ISO Technical Report.

- SC1/WG2 'Toughened safety glass' should review the lack of correlation between the (EN 12150) edge fragmentation test and spline generation.
- An in-depth investigation should be carried out on the effect of heat soaking with regard to fragmentation of toughened glass.

It was agreed that a more in-depth investigation should be carried out on the effect of heat soaking on the breakage characteristics of toughened glass.

Following this meeting Clause 5 b) 'Test Requirements' of the draft Technical Report was amended (ISO/TC160/SC2/ WG6 N57 rev 1) as follows:

"When tested by the method given in clause 6 each test piece shall either not break or shall break as defined ….. :

Disintegration occurs and the ten largest crack free particles collected within three minutes after impact and weighed, all together, within five minutes of impact shall:

- weigh no more than the mass equivalent to 6,500 mm^2 of the original test piece.
- the length of the longest particle shall not exceed 100 mm."

The requirement a maximum particle length was however removed from the report at a subsequent WG6 meeting (Venice, 13 May 2005) without technical justification or any explanation.

UK Impact Test Program – 24-26 June 2003

In view of the irregular impact staircase results obtained on 6.38 mm laminated glass with the twin tyre impactor in the October 2002 CBMA impact test program Steve Rice arranged for a impact test program to be conducted at the GGF test laboratory at Telford, England to compare staircase impacts on 6.38 mm laminated glass with the GGF twin tyre impactor (30 mm diameter screw spindle) and a JIS soft lead shot bag. Phillip Davies attended the test program. The impact results with the two impactors were similar. Mean break heights of 1137 mm and 1183 mm respectively were obtained for the twin tyre impactor and the JIS lead shot bag. These results did not support a recommendation from Japan, based on strain measurements versus drop height on 10 mm toughened glass, that a 1000 mm drop height with the JIS lead shot bag be considered "equivalent" to a drop height of 1200 mm with the twin tyre impactor.

CBMA Impact Test Program 5, 2-5 February 2004

Henry Gorry (USA SC2 delegation leader) attended this test program.

- 4 mm toughened glass panels were obtained in two sizes - 360 mm x 1100 mm (EN 12150 fragmentation test size) and 876 mm x 1938 mm (EN 12600 pendulum impact test size). The panels were produced with two levels of surface compression – 80-90 MPa and 110-120 MPa.
- Particle counts using the EN 12150 test method (edge fragmentation) were much higher for the EN 12150 size panels than for the EN 12600 size panels (average PC of 29 versus 9 for SC of 87 MPa; average PC of 123 versus 91 for SC of 97 MPa).
- No splines were found in any of the panels when tested according to EN 12150.
- Splines were found with all the 4 mm toughened glass panels when the fragmentation test was conducted at the panel centre.
- The length of splines was greater with the EN 12600 panels than the EN 12150 panels (average maximum spline length of 300 mm with EN 12600 size panels versus 156 mm with EN 12150 size panels with SC of 87 MPa; average maximum spline length of 208 mm with EN 12600 size panels versus 95 mm with EN 12150 size panels with SC of 97 MPa).
- A maximum spline length of 270 mm was obtained in pendulum impact tests of panels with surface compression of 87 MPa – very similar to the spline length (270 mm - 330 mm) obtained with panels of the same size and surface compression in the fragmentation test with impact at the panel centre.

CBMA Impact Test Program 6, 18-20 April 2004

This test program was attended by Henry Gorry and Dr. Stephen Bennison from the U.S. along with Phillip Davies.

- A new twin tyre impactor was fabricated by the CBMA using a 30 mm diameter spindle screw as used by the GGF test laboratory.
- Staircase impacts were carried out on 6.38 mm laminated glass with the new twin tyre impactor and the JIS soft lead shot bag impactor.
- Similar results were obtained with both impactors. Mean break heights (MBH) of 1178 mm and 1235 mm respectively were obtained for the twin tyre impactor and the JIS lead shot bag. These results are very similar to the results obtained at the GGF laboratory. (Note that the MBH result for the JIS lead shot bag in both the GGF and this test program was 4% to 5% higher with the lead shot bag compared to the twin tyre impactor despite the fact that micro-strain in the ‘calibration test’ at a drop height of 1200 mm is 20% higher for the JIS lead shot bag that the twin tyre impactor.)
- A Vickers diamond indenter was used with a specially fabricated probe assembly to impart damage with a regulated force to panels of toughened glass. (A Vickers indenter imparts damage to glass representative of contact damage and surface erosion.) 6 mm toughened glass panels that did not break on impact with the twin tyre impactor at a drop height of 1200 mm broke at 300 mm after a flaw was imparted with a force of 25 Newtons by the Vickers indenter.
- The Vickers indenter with a force of 25 Newtons was also used to impart damage to panels of 6.38 mm laminated glass. Staircase impacts were carried out on these

panels with the twin tyre impactor. A mean break height of 883 mm was obtained (lowest height at which a panel failed was 800 mm; the highest height at which panels passed was 900 mm.) The flaws imparted by the Vickers indenter reduced the MBH of 6.38 mm laminated glass with the twin tyre impactor by 25% - from 1178 mm to 883 mm.

China Impact Test Program 7, 19-22 July 2004

This test program was attended by Steve Rice and Graham Bannerman from the U.K. and Phillip Davies.

The objectives of the test program were

1. Evaluate the use of the Vickers indenter for testing of toughened glass.
2. Further investigate edge and centre of panel fragmentation results with EN 12510 and EN 12600 size panels of 4 mm toughened glass.
3. Test the effect of test rig clamping pressure on spline formation.
4. Determine effect of a Vickers indent at 25 Newton force on the impact resistance of 12 mm annealed glass.

Test results and conclusion:

- 4 mm toughened glass panels with surface compressions ranging from 80 MPa to 90 MPa that did not break at a drop height 1200 mm on impact with the twin tyre impactor broke at drop height of 300 mm following application of a flaw with the Vickers indenter using a force of 25 Newtons.
- The maximum length of splines following impact testing varied from 54 mm with a panel with surface compression of 90 MPa to 289 mm for a panel with surface compression of 80 MPa. Similar spline lengths were obtained in fragmentation tests at the centre of EN 12600 size panels
- The fragmentation test results for EN 12150 size panels versus EN 12600 size panels were very similar to those obtained in the February 2004 test program.
- Reduction in clamping pressure (normal 0.5 MPa) in the pendulum impact test resulted in an increase in the number of splines. At zero clamping pressure a panel with surface compression of 78 MPa produce a multitude of long splines (up to 235 mm in length) none of which were retained in the test rig frame.
- A panel of 12 mm annealed glass did not break when impacted at a drop height of 1200 mm with the twin tyre impactor. It however broke into extremely dangerous fragments when impacted from a height of only 190 mm after a flaw was imparted to the centre of the panel with the Vickers indenter using a force of 25 Newtons. (This no doubt explains why a DuPont employee was seriously injured when he walked into a panel of 10 mm annealed glass which he mistook for a doorway.)
- Conclusion: The Vickers indenter provides a good tool for testing toughened glass with the twin tyre impactor.

WG6 Meeting 10, Venice, 13 May 2005:

As it was not possible for Leon Jacob or Phil Davies to attend this meeting a position paper was prepared by them in conjunction with Professor Yang of China to ensure that their conclusions and recommendations were clearly summarised. The paper (WG6 N91a) was presented to the meeting by Professor Yang. The following conclusions and recommendations were contained in the paper:

- The JIS 'soft' lead shot bag and an EN 12600 twin tyre impactor with a 30 mm diameter screw spindle produce essentially equivalent impact results with 6.38 mm laminated glass.
- Some 4 mm, 5 mm and 6 mm "toughened safety glass" complying with fragmentation test 'particle count' requirements produce particles longer than 100 mm (up to 300 mm) when broken by pendulum impact. Similar long particles are found when EN 12600 size panels are broken by a centre punch at the centre of the panel. The test method must take account of these long particles.
- Surface compression of 4 mm and 5 mm toughened glass must exceed a level of around 120 MPa to avoid particles of length greater than 100 mm possibly generated by any form of impact.
- The introduction of a small flaw in toughened glass representative of handling damage by means of a Vickers indenter using 25 Newtons force provides a method to ensure breakage of toughened glass with the EN 12600 impactor thereby allowing breakage characteristics of the glass to be determined. It is recommended that use of the Vickers indenter be incorporated into the Technical Report Type 2 to ensure breakage of toughened glass.
- A detailed specification for the construction of the test rig and maintenance of the test rig will ensure reproducible test results without the need for calibration.
- Containment must be deleted from the standard.

The minutes of the meeting recorded the following three items:

> *"It was the general consensus of the meeting that the work presented by Prof Yang had a bias towards the use of laminated glass safety, and was contemptuous to the use of toughened glass."*
>
> *"The 'Test Requirement' section was modified to remove reference to particle length. The 100 mm maximum length requirement was removed from both laminated safety glasses and toughened safety glasses."*
>
> *"Delegates from Itlay, France, and Belgium voiced extreme concern of the terminology used within the note (WG6/N32) regarding breakage behaviour. .... It was agreed that the convenor took the topic in its entirety to the ISO TC 160 meeting."*

Comments:

1. It surprised me greatly that the Venice meeting decided to remove from the Technical Report the 100 mm maximum length requirement for toughened glass particles. This requirement had been in the draft TR document for over two years and through three WG6 meetings.

A question was put forward on my behalf at the November 2007 WG6 meeting on the technical justification for this. The minutes of the November 2007 meeting gave the following explanation.

> *"BW stated that when performing impact testing, on toughened glass, historically the weight of the 10 largest particles had greater significance than their length."*

Presumably the historical basis referred to by BW is the ANSI Z97.1 standard which was first published in 1966. Note that the 1966, 1972, 1975 and 1984 ANSI Z97.1 standards all contain the following definition for toughened (tempered) safety glass:

> *"Tempered glass, when broken at any point, the entire piece immediately breaks into innumerable small granular pieces."*

This definition does not permit any shaped particles other than "granular" shaped pieces. Long particles are not permitted by this definition.

Note also that in addition to the weight of the 10 largest particle requirement the ANSI Z97.1 1966 and 1972 standards included the following test requirement:

> *"When breakage occurs at the 12-inch, 18-inch, or 48-inch impact level and results in several pieces, none shall be of such a nature or shape that it could be described as sharp-edged, pointed, or dagger-like."*

While on the subject of the history of safety glass testing I would like to remind the WG that back in 1997 John Weir, the first convenor of WG6, provided a copy of his safety glass lecture in which he pointed out that BS 6206 Amendment No.5 was "the fruit of painstaking deliberations within BSI following a fatal accident involving glass in a conservatory door which was allegedly toughened." The 1987 newspaper report of that fatality included the following:

> *The six year old boy died after falling through glass in a conservatory which had been erected under the guarantee that the materials met the toughened standards.*
>
> *Before the accident, the Croydon Borough Council had sought improvements to the existing British standard for safety glass. It argued that the current specification only took account of the weight and not the length of the shattered pieces.*
>
> *"Croydon said that the glass broke far too easily, producing "lethal spikes as long as 10 inches."*

John Weir's lecture detailed that "under the new Amendment, toughened glass will have to pass, not only the swinging bag test, but also a centre punch test."

It is amazing that the "painstaking deliberations" within BSI did not include centre punch testing at the panel centre such as been historically required for automotive toughened glass by the ECE R 43. It is well known that the centre impact point is the critical point in meeting the limitation of a particle length of 75 mm imposed by ECE R 43.

It is equally incredible that since the boy was evidently killed by a long particle that a long particle requirement was not added to the pendulum impact test. I will be passing out some samples of long particles from 4 mm toughened glass obtained in pendulum impact testing in China.

2. It is appropriate that an explanation be provided by those present at the Venice meeting as to what aspects of Professor Yang's presentation were contemptuous and how so? How can this Working Group justify its apparent suppression of documented, systematic test programs thus allowing the classification as toughened safety glass which can break dangerously.

3. Item 7.6 of the minutes (SC2/N168) of the SC2 meeting Tampere, 16 June 2005, failed to record that in his report the WG6 Convenor said that toughened glass spline length was the "stumbling block" in getting agreement from Australia and China on the draft Technical Report. I sent a letter dated 23 August 2006 to the SC2 Secretary for distribution at the September 2006 SC2 meeting in Guilin to correct SC2/N168. However this letter was not tabled. I wish to table it today with this letter.

In conclusion, considerable effort and resources have been invested over a number of years to better understand the breakage characteristics of toughened glass. This has resulted in the discovery of a test method (fragmentation by punch impact at the panel centre) which can assure the safe breakage characteristics of the toughened glass. It is unconscionable that some WG6 members appear to have conspired to suppress the implementation of simple tests which would ensure that toughened safety glass breaks safely in accordance with the reasonable expectations of consumers and the product definition.

Yours truly,

Jacob & Associates Pty Ltd

313 Canterbury Road address
Canterbury NSW 2193
Australia

61 2 9718 2222 phone

61 2 9718 0001 fax

23 August 2006

Ms. Valerie L Block
Secretary
ISO/TC 160/SC 2 'Use considerations'
E-mail: Valerie.L.Block@usa.dupont.com

Subject: Report of the Plenary Meeting, Tampere, Finland – Morning 16 June 2005
Document: ISO/TC 160/SC2 N168 - Item 7.6 - WG 6 Safety Glazing Tests – Stephen Rice

Dear Valerie,

As I will not be able to attend the SC2 plenary in Guilin on 27 September I am writing to correct the account given in Item 7.6 of SC2/N168 of the WG6 discussion at the Tampere plenary meeting and to comment on my true position in relation to toughened glass. I would appreciate these matters being brought to the attention of the Guilin SC2 meeting.

Apart from being very brief, Item 7.6 is inaccurate and possibly misleading.

Item 7.6 began with:

> *"Stephen Rice gave a report on the activities of WG 6. He said that the work of the members of the WG has been outstanding. The latest committee draft (CD) of the WG 6 document is:*
>
> *ISO/TC 160/SC 2/WG 6/N 95 'Glass in Building – Technical Report on Pendulum Impact Testing and Classification of 'safety' Glass for use in Building'.*
>
> *He said that it has been proposed that this draft be published as a technical report (TR). However, there is a major disagreement as to whether toughened glass should*

be included in the draft or not. Australia and China would like toughened glass to be removed. This is delaying the publication of the draft."

The meeting actually proceeded along the following lines:

- o In his opening comments Stephen Rice said: We have a stumbling block on toughened glass.

- o During the ensuing discussion it was noted that Stephen remarked:
    1. Apart from toughened glass it's a perfectly workable document.
    2. There is only one issue. The stumbling block is toughened glass – spline length – we cannot get agreement on this issue with Australia and China.
    3. The amount of work has been fantastic.
    4. The document is first class with the exception of this (spline) issue.

Item 7.6 failed to record that after the above remarks by Stephen Rice, and after the considerable discussion that ensued on what to do with the draft, China introduced a New Work Item proposal entitled 'Glass in building – Pendulum impact test for classifying laminated safety glass'. The reason given for this NWI proposal was that consensus exists on laminated glass testing but not on toughened glass testing and that the lack of consensus on toughened glass should not delay a test method standard for laminated glass.

The "stumbling block issue" reported by Stephen Rice was whether a spline length requirement for toughened glass should be included in the TR, not that "Australia and China would like toughened glass to be removed".

I would like to emphasize, as I have stressed on a number of occasions during ISO/TC160 proceedings, that I have had no desire to inhibit the use of toughened safety glass. Almost daily in my glass consulting business I recommend the use of toughened glass. I believe the fact that I was asked to be an invited speaker in the toughened glass session at GPD 2003 recognised my constructive approach on the testing and use of toughened glass. I received only positive feedback on my GPD paper entitled "Manufacturing Constraints, Performance Characteristics, Benefits and Limitations of Using Tempered Glass in Buildings' which included the results of my analytical work on the performance of toughened glass when supported using patch fittings.

The primary objective in my involvement with the ISO safety glass test working group has been to ensure that correct test methods are defined and implemented so as to eliminate improperly toughened glass being used in high risk locations. It is also important that safety glass in its various forms is not classified for use in applications in which it is not fit-for-purpose.

From my discussions with my European colleagues I have gained the perception that in Europe the minimum strength for toughened glass is 120 MPa at which level it is believed that splines will not occur on fracture of the toughened glass. This contrasts greatly with the ASTM C1048-04 and Australian standard AS 1288 minimum surface compression requirement of 69 MPa. Since the document we are creating in the working group will be referenced by itself as a stand-alone safety standard it is imperative that it ensures the desired quality expected of safety glass without reference to minimum strength requirements specified in other standards.

The Objective of SC2/WG 6 was defined (WG6 Convenor's Report, SC2 Plenary Meeting, Kyoto, 6 December 1996) as:

"To develop an ISO test method for determining the safe breakage characteristics of glasses which are to be used in critical safety locations in buildings."

The generation of long narrow shards (splines) on fracture of toughened glass does not constitute "safe breakage characteristics". Many existing safety glass standards define toughened safety glass as glass having the characteristic that when broken "the whole panel disintegrates into small granular (harmless) particles". It is clearly wrong, and perhaps an historical oversight, that these standards simply require that the particles be weighed and do not require that consideration be given to the length or shape of the particles. An ISO safety glass test method standard must ensure that the glass processor is made aware that the consequence of improper toughening can be the generation of splines in the event of fracture from human impact. Extensive testing has shown that tempered glass of 3 mm to 6 mm thickness may meet the weight requirement of existing standards but produce long splines, sometimes exceeding 200 mm in length, when door size panels are broken at the panel centre either by a pendulum impactor or by impact from a metal punch. It is the responsibility of SC2/WG6 to ensure that the ISO test method standard does not permit toughened glass to be classified as toughened safety glass if it can exhibit unsafe breakage characteristics.

It has been well documented from Australian and Chinese impact test programs that the dual tyre impactor, unlike lead shot bag impactors, seldom breaks toughened glass even with thickness as low as 4 mm. To enable the breakage characteristics of toughened glass to be established with the dual tyre impactor the China test programs established a suggested protocol using a Vickers diamond indenter with a controlled force to impart a flaw which would enable the glass to be fractured. This protocol, which was thought at the 2004 SC2 plenary meeting in Berlin might offer a "breakthrough" in relation to the classification of toughened safety glass, was presented by Prof. JJ Yang of China at the WG6 meeting held in Venice in May 2005 but was rejected. No Australian delegates were present at this meeting in view of the background provided below.

On the spline length requirement issue the following points need to be stated:

- Following much deliberation at WG6 meetings, a requirement on toughened glass spline length was incorporated into the working document on the draft Test Report (ISO/TC 160/SC 2/WG 6 N57 rev 1 dated 2003-01-07).
- This requirement remained in the document for over two years and through three WG6 meetings.
- It was deleted at the May 2005 WG6 meeting. It is to be noted that, while I was unable to be present, the Venice meeting attendees included a new European

delegate and two European delegates who had not attended any WG6 meetings since the May 2000 Tokyo meeting.

I was greatly surprised when I received a notice in the mail, without any prior consultation, that a WG6 meeting had been set for 12/13 May 2005 in Venice. In view of the fact that I was booked to travel in June to Tampere, Finland for Glass Processing Days and the ISO plenary meetings I requested that the meeting be postponed one month and held in Tampere. My request for this one month postponement was however ignored despite the following history of my involvement in the work of WG6 and the following record of cancelled meetings leading up to notification of the May 2005 meeting:

- My attendance at all ISO TC 160, working group meetings and specifically WG6 meetings has been entirely at my own expense. In addition to paying my own travel and accommodation expenses my participation in WG6 meetings has cost me in excess of 24 days of income.
- I am one of only a few members of the working group that attended all six meetings of the group over the period February 2001 to February 2004
- I also attended the SC2 plenary meeting and SC1/WG2 meeting in Berlin in June 2004. At the SC2 meeting in Berlin Stephen Rice reported that there would be a meeting in the 'fall' of 2004 to finalise the draft Technical report on the test method. The key participants for this meeting were to be him and me. The final draft was then to be reviewed at a WG6 meeting in Dusseldorf in November 2004. Accordingly I was advised by Stephen that he would meet me in Sydney in September 2004.
- I agreed to a request from Stephen to move the meeting to October 2004 in Singapore. However, I was later informed that this meeting was also cancelled.
- I then attempted unsuccessfully to set up a meeting to coincide with my visit to Germany in November 2005 for the Glasstec exhibition in Dusseldorf.
- At the Dusseldorf glass show Stephen proposed again that we meet in February, 2005 in Sydney. This meeting, however, also never eventuated.

At the 2005 Tampere SC2 plenary Stephen reported that "the spline length of toughened glass" was the only issue that agreement could not be obtained on with Australia and China. In fact there are two other issues that Australia and China have had with the draft. These are containment and the calibration procedure for the test rig. In view of the fact that I was unable to attend the Venice meeting I along with my Chinese and Australian colleagues submitted a position paper (SC2/WG6 N91a) to ensure that these two issues were not overlooked at the meeting.

On the containment issue I comment as follows:

- The stated objective for this working group -"to develop an ISO test method for determining the safe breakage characteristics of glasses which are to be used in critical safety locations in buildings" – has to do with safe breakage <u>and not with containment</u>.

- Minor surface damage has been shown to have a significant effect on the fracture resistance of toughened glass.

- On failure toughened the glass will evacuate the glazing frame and will not afford any containment.

- The foreword in Australian Standard AS 2208:1996 states:

  "The aim of the impact test is to assess the fracture characteristics of a safety glazing material which has been broken at some predetermined impact energy level dependant upon the intended application of the material. If the safety glazing material does not fracture at this minimum energy level, it must again be tested at higher energy levels until it is fractured <u>in order that the fracture characteristics can be assessed</u>."

In conclusion, I would like to say that I devoted my time and money to the work of WG6 in good faith believing that this work would result in a substantially improved test method standard for safety glass compared to existing standards to the benefit of the public good and the glass industry. In my view it would be tragic if after all the work that has been done the International community is presented with a test method standard which fails to determine the true breakage characteristics of glasses which are to be sold to the public as safety glasses.

Yours truly,

Jacob

Leon Jacob

AS/NZS 2208 Test Programs

Bevelite Factory

2008 – 2009

Thermally Toughened Safety Glass Definitions

ANSI Z97.1 - 1966

Tempered glass, when broken at any point, the entire piece immediately breaks into innumerable small granular pieces.

AS 2208 – 1978

A glass which has been converted to a safety glass by subjection to a process of prestressing so that, if fractured, the entire disintegrates into small, relatively harmless particles. The residual surface compression is a minimum of 69 MPa.

Objective – for Toughened Safety Glass Testing

Evaluate the Fracture Characteristics of Toughened glass by:

- Edge Fragmentation
- Centre Fragmentation &
- Lead Shot Bag Impacts

Using – 3,4,5 & 6 mm thick Toughened Glass with different levels of surface compression

Typical Fracture Pattern

4 mm Tempered Glass

Lead Shot Bag

300 mm Drop Height

Oketani et al GPD 2001

Horizontal Strain vs Drop Height for Pendulum Impactors

Drop Height (mm)	EN 12600 Twin Tyre	JIS LSB	ANSI Z97.1 E-4207 LSB	ANSI Z97.1 E-4212 LSB
200	1241	1209	1633	1763
250	1403	1381	1771	2011
300	1531	1616	1905	2182
450	1799	1958	2231	2595
700	2050	2402	2737	3129
1200	2448	3057	3467	3931

ISO Test Programs – Toughened Glass

Country	Date	Toughened Glass Panels Tested				
		4 mm	5 mm	6 mm	10 mm	Total
China						
# 1	Dec-00			46		46
# 2	Oct-01	38		52	2	92
# 3	Dec-01		8			8
# 4	Jan-02				4	4
# 5	Oct-02					
# 6	Feb-04		25			25
# 7	Apr-04			10		10
# 8	Jul-04	28				28
UK	Jun-03	20		13		33
Australia	May-00	2	2	8		12
	Total	88	35	129	6	258

ECE R 43 Standard Automotive Toughened Glass

- ECE R 43 requires the measurement of long particles for centre break position

“Many years of experience of working with ECE R43 and the JIS standard, which contain several breaking positions, have demonstrated that a centre break position is the most stringent. In practice glass manufacturers in Europe and Japan routinely break from the centre for CoP testing, because a satisfactory fracture indicates a good tempering process and predicts a good performance for other breaking positions. “

CLEPA (European Association of Automotive Suppliers)

4 mm Toughened Glass Fragmentation Results Relationship to Panel Size

Toughening Process: Normal quench pressure, July 2004

Panel	Size mm	Surface Compression MPa	Punch Location	Minimum Particle Count	Longest Particle mm
TS4-1	360 x 1100	94	Edge	113	
TS4-2	360 x 1100	97	Centre		110
TS4-3	360 x 1100	99	Centre		80
TS4-4	360 x 1100	95	Edge	132	
TL4-9	876 x 1936	91	Centre		294
TL4-10	876 x 1936	98	Edge	87	
TL4-11	876 x 1936	98	Centre		150
TL4-12	876 x 1936	97	Edge	82	
TL4-13	876 x 1936	97	Centre		260
TL4-14	876 x 1936	98	Edge	114	
TL4-16	876 x 1936	94	Centre		184

Toughened Glass Fragmentation Results Relationship to Panel Size

Toughening Process: Lower than normal quench pressure, July 2004

Panel	Size mm	Surface Compression MPa	Punch Location	Minimum Particle Count	Longest Particle mm
TS4-5	360 x 1100	88	Edge	36	
TS4-6	360 x 1100	84	Centre		145
TS4-7	360 x 1100	89	Centre		167
TS4-8	360 x 1100	89	Edge	21	
TL4-1	876 x 1936	86	Edge	9.5	
TL4-2	876 x 1936	84	Centre		330
TL4-3	876 x 1936	83	Edge	8	89
TL4-4	876 x 1936	81	Centre		233

Toughened Glass Pendulum Impact Test Criterion

EN 12600, ANSI Z 97-1

In the event of glass disintegration the weight of the 10 largest ‘crack-free’ particles collected within three minutes after impact must not exceed the mass equivalent to 6,500 mm^2 of the original test piece.

Australian Standard AS 2208

Preface, 1978

"The performance of safety glazing materials is evaluated by an impact test to simulate human impact of such energy that it could result in cutting and piercing injuries.

Toughened safety glass has intrinsic properties which enable its impact performance to be determined by a simplified test procedure" (fragmentation test at edge of glass using a centre-punch).

The 1996 Version implies that the simplified test is acceptable and not a deemed to comply test protocol

Our Thanks Go To

- Noel Stokes (Working Group Convenor)
  - General observer and supplier of toughened glass
- Dennis Loudoun
  - Supplier of toughened glass and assisted in the testing
  - Staff to assist in handling the glass
- Ian Loudoun & Danny Thouburn (Bevelite)
  - Surface compression measurements
- Phil Davies
  - Video recording, photographs and documenting the results.

- Total Man Hours Spent – 180 hrs

Suppliers

- Viridian – 3,4,5 & 6 mm Toughened glass
- Bevelite – 4,5 & 6mm Toughened glass

- All samples
  - 1900 mm x 860 mm
  - Three different levels of surface compression

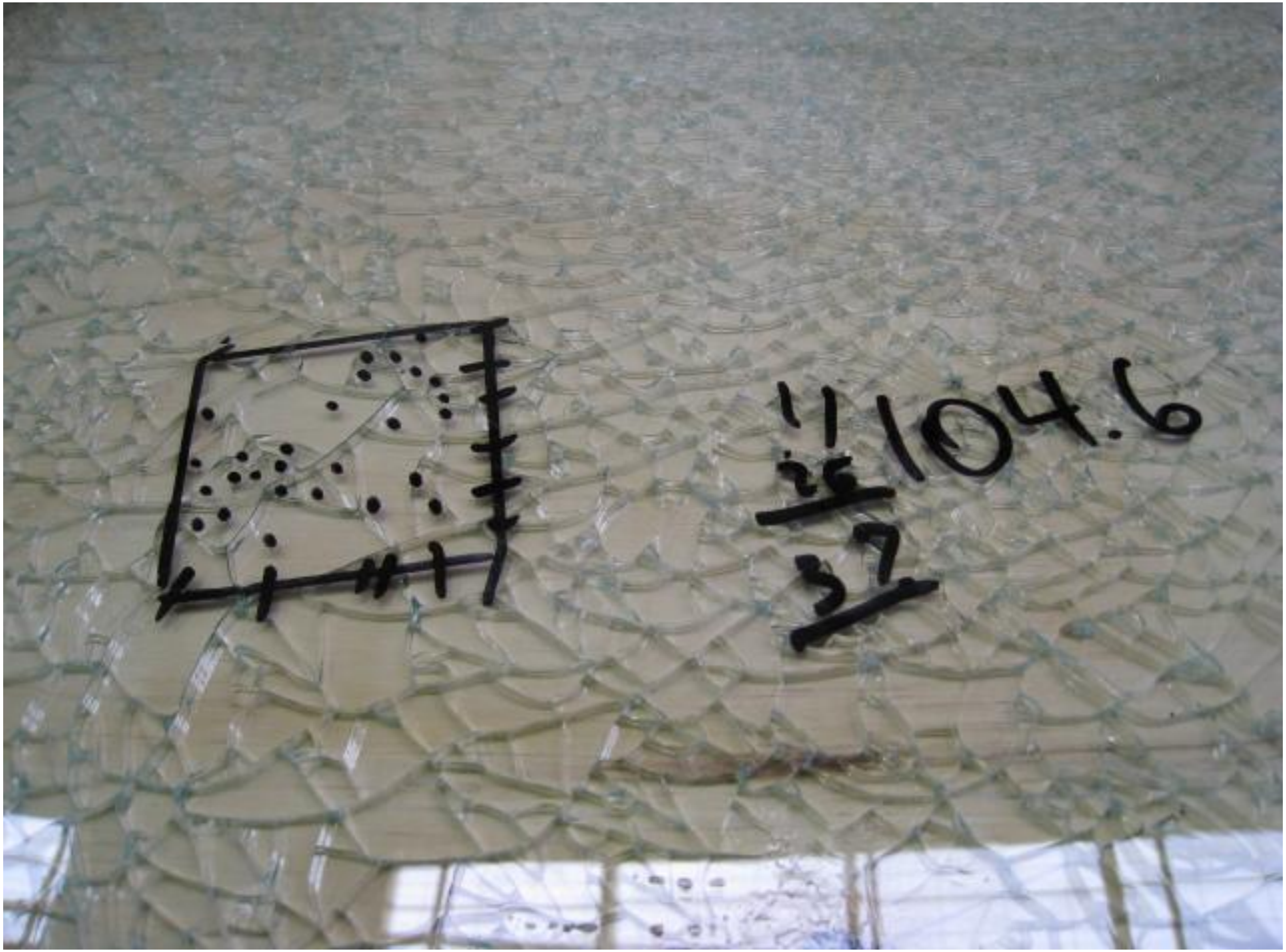
Facilities at Bevelite

AS/NZS 2208 WG Test Programs

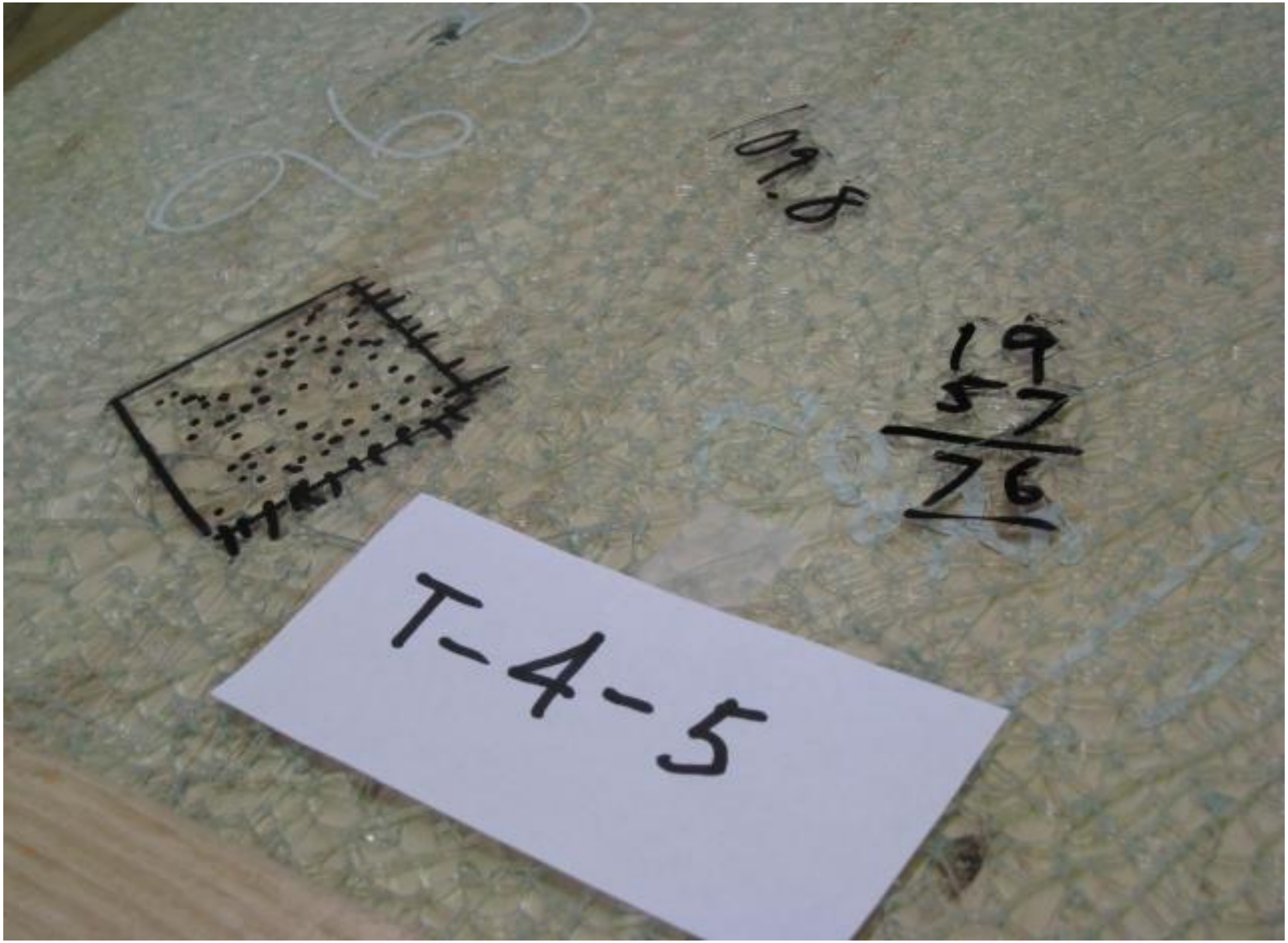
- 5 separate test programs
  - 15th October 2008
  - 2nd December 2008
  - 15th January 2009
  - 30th January 2009
  - 19th March 2009.
- Type of tests
  - Edge fragmentation
  - Centre fragmentation
  - Lead shot impact

Edge Fragmentation

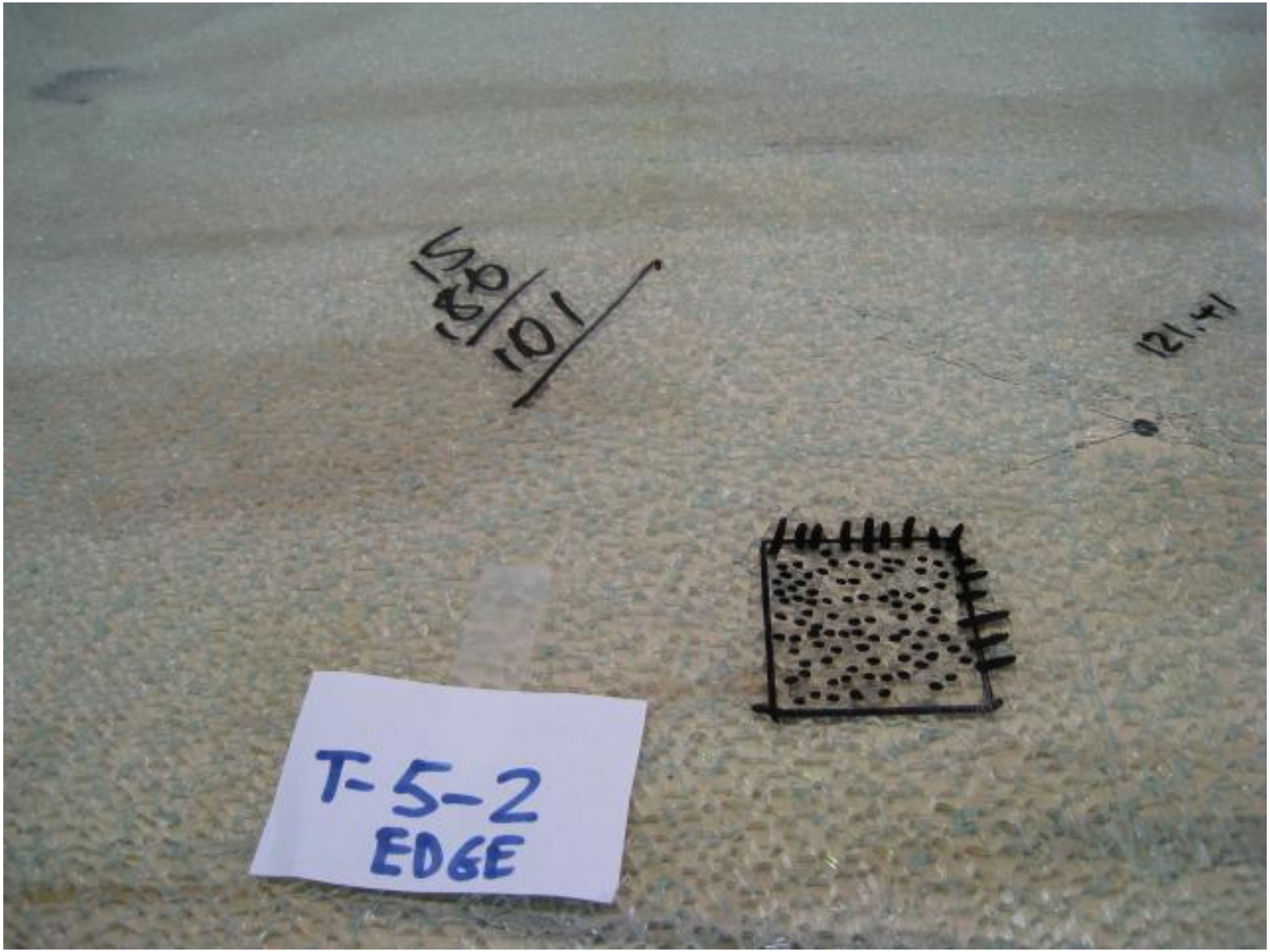
Sample No:	Surface Compression	Particle Count
3_3-1_V	121	60
1_4-2_V	104	52
1_4-4_V	104	37
1_4-4_V	109	76
1_5-2_V	121	101
1_5-4_V	107	92
1_5-6_V	118	96
1_5-8_V	111	89
2_5-2_B	120	120
2_5-4_B	94	42
2_5-6_B	125	108
2_5-8_B	116	92
1_6-1_V	109	92
1_6-2_V	105	76
1_6-3_V	107	78



4 mm Sample No. 1_4-4; SC 104 MPa: Edge Fragmentation - PC 37

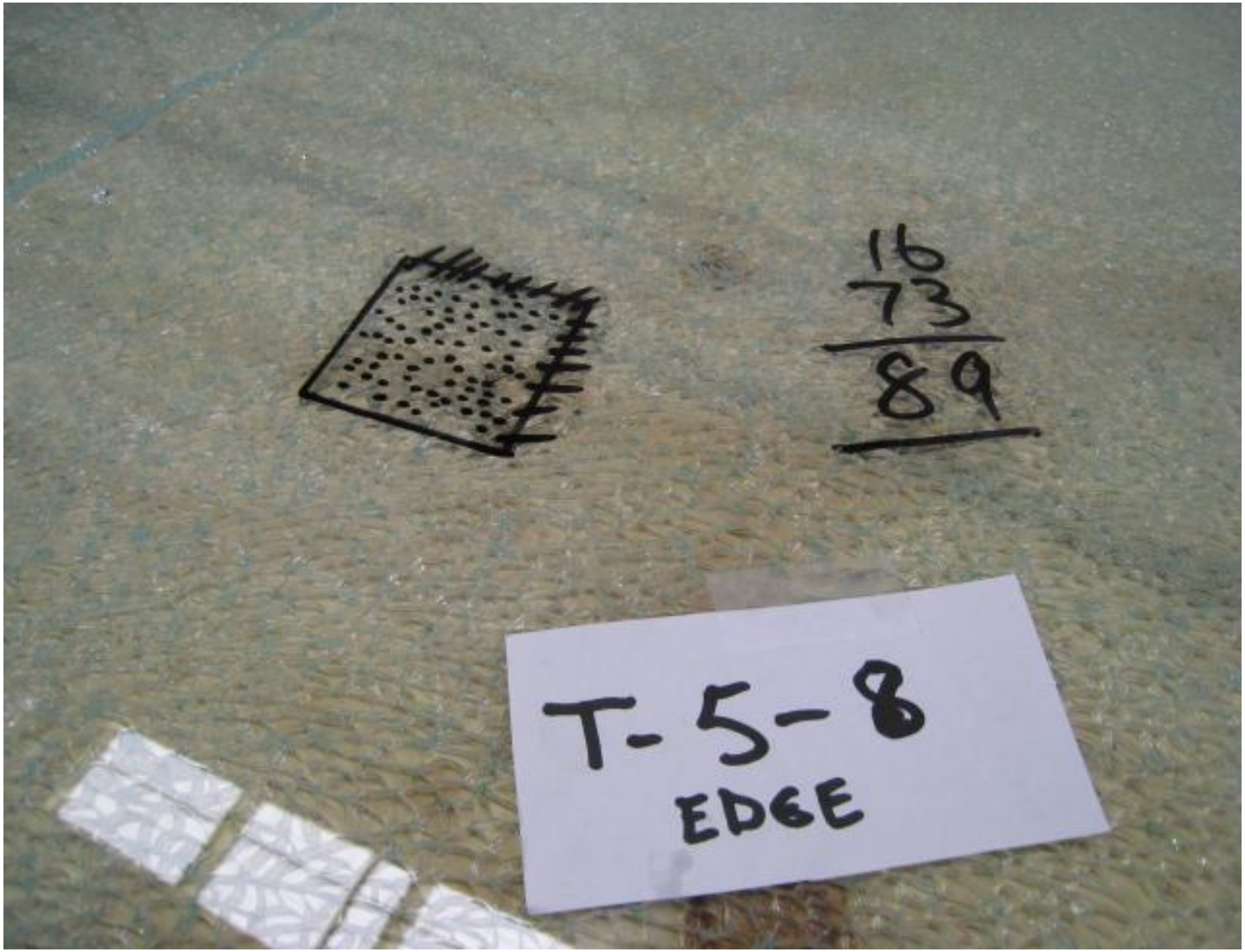


4 mm Sample No. 1_4-5; SC 109: Edge Fragmentation - PC 76

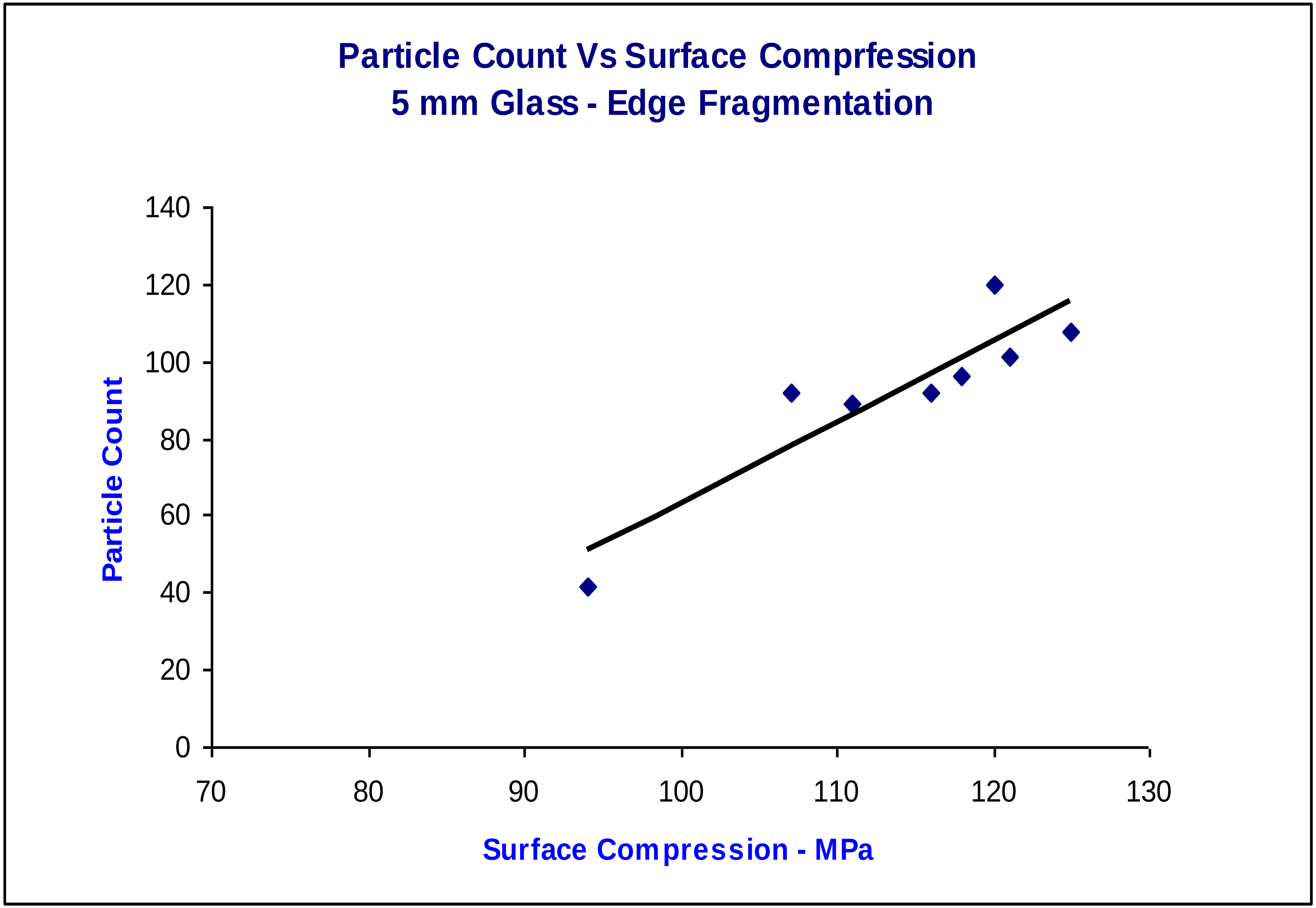


5 mm Sample No.1_5-2; SC 121: Edge Fragmentation - PC 101

5 mm Sample No.1-4-4; SC 107: Edge Fragmentation - PC 92



5 mm Sample No.1_5-8; SC 111: Edge Fragmentation - PC 89

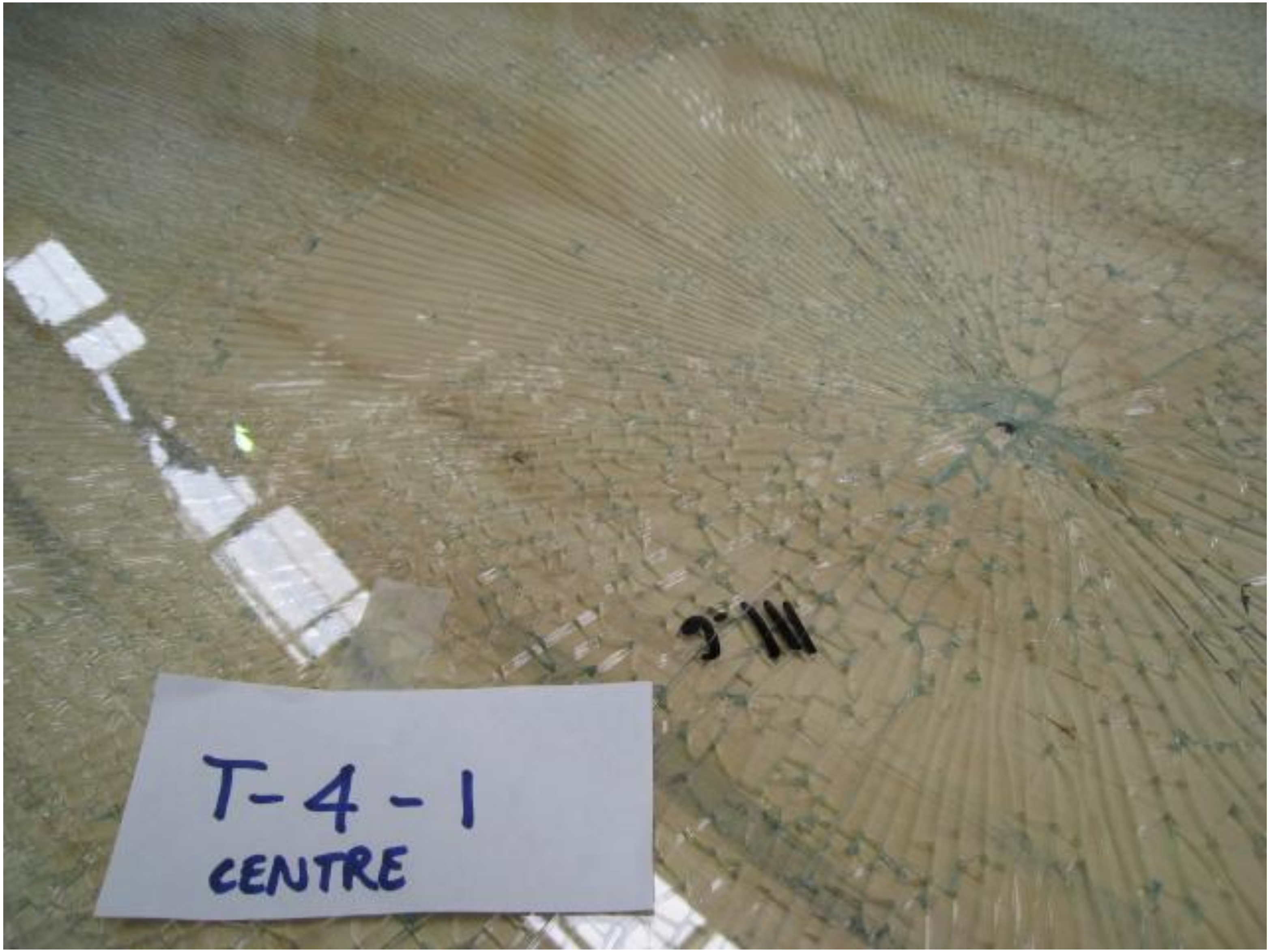

Particle Count Vs Surface Comprfession
5 mm Glass - Edge Fragmentation
Particle Count
0
20
40
60
80
100
120
140
70
80
90
100
110
120
130
Surface Compression - MPa

Edge Fragmentation

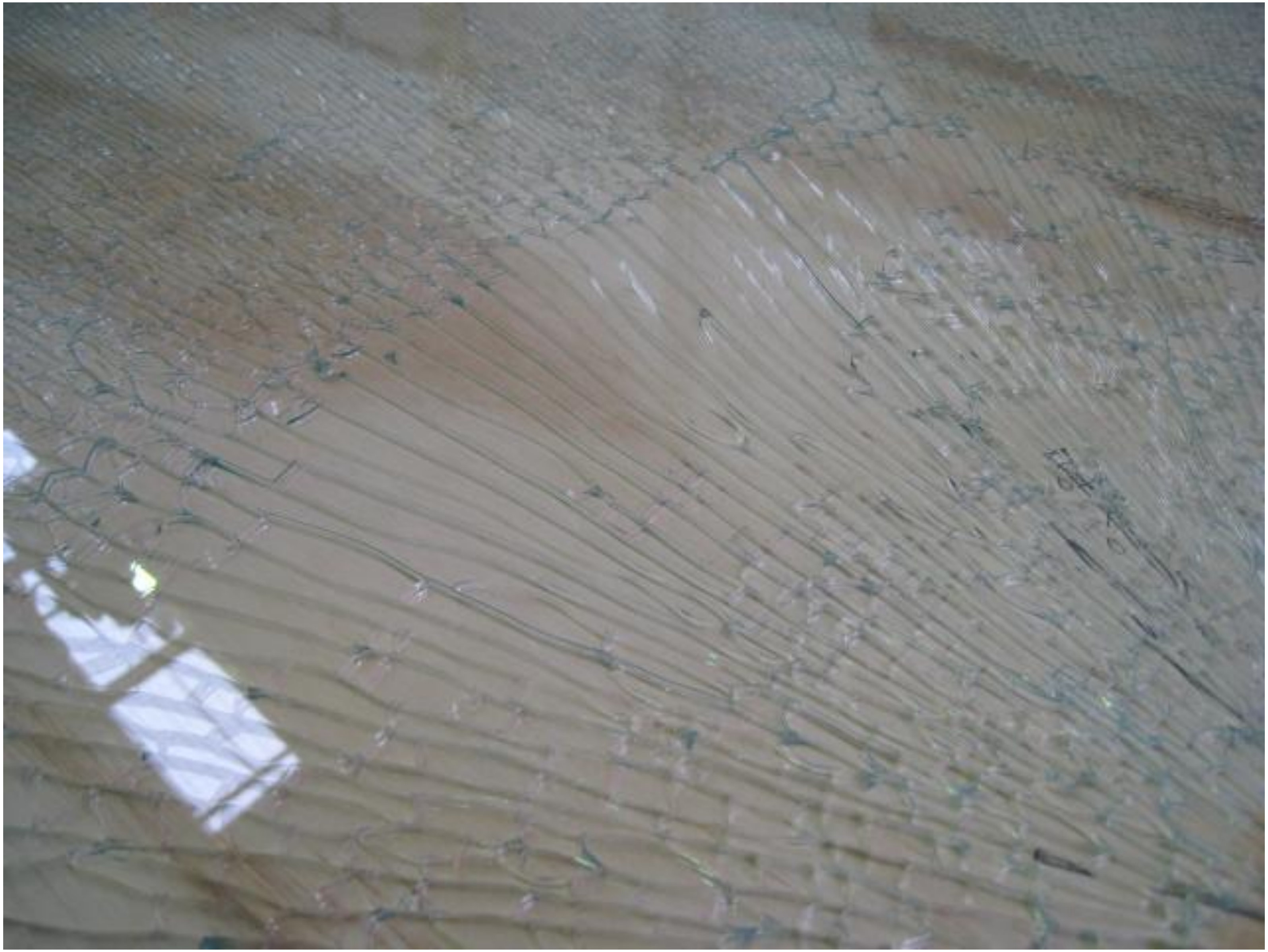
- Particle count is proportional to the surface compression
- No long particles developed
- At 69 MPa the test sample fails the particle count

Centre Fragmentation

Sample No:	Surface Compression	Length of Particle
3_3-2_V	121	140
1_4-1_V	111	176
1_4-6_V	113	170
2_4-1_B	120	57
1_5-1_V	115	135
1_5-3_V	107	140
1_5-5_V	107	160
1_5-7_V	116	151
1_5-9_V	114	140
2_5-1_B	128	75
2_5-5_V	94	300
2_5-7	109	200
4_5-2_B	93	360
4_5-4_B	127	50
1_6-4_V	113	100
3_6-1_V	118	*
3_6-3_B	135	*



4 mm Sample No.1_4-1; SC 111: Centre Fragmentation – Longest Particle 176 mm



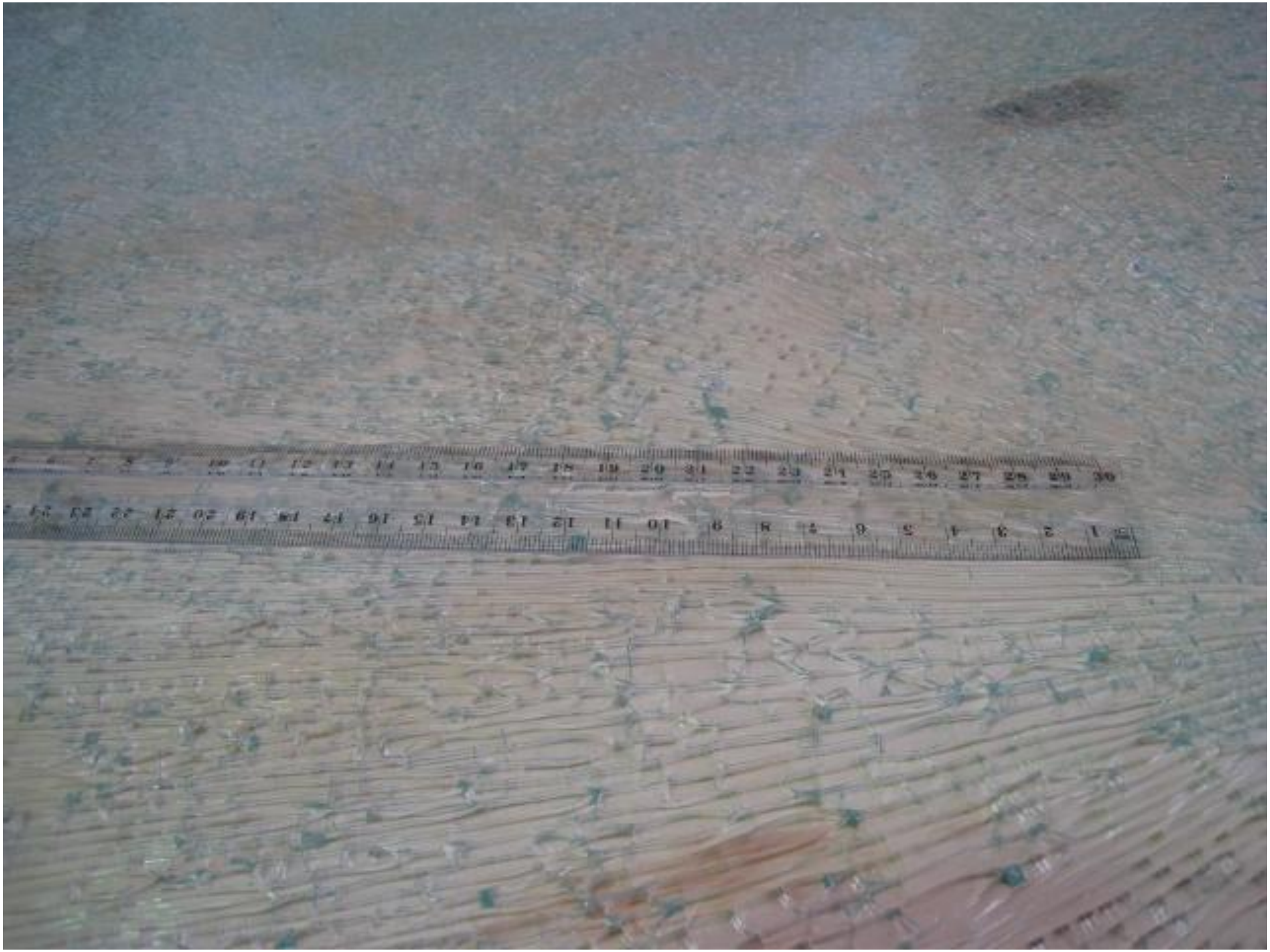
4 mm Sample No.1_4-6; SC 113: Centre Fragmentation, Longest Particle 170 mm

5 mm Sample No.1_5-7; SC 116; Centre Fragmentation - Longest Particle 151 mm

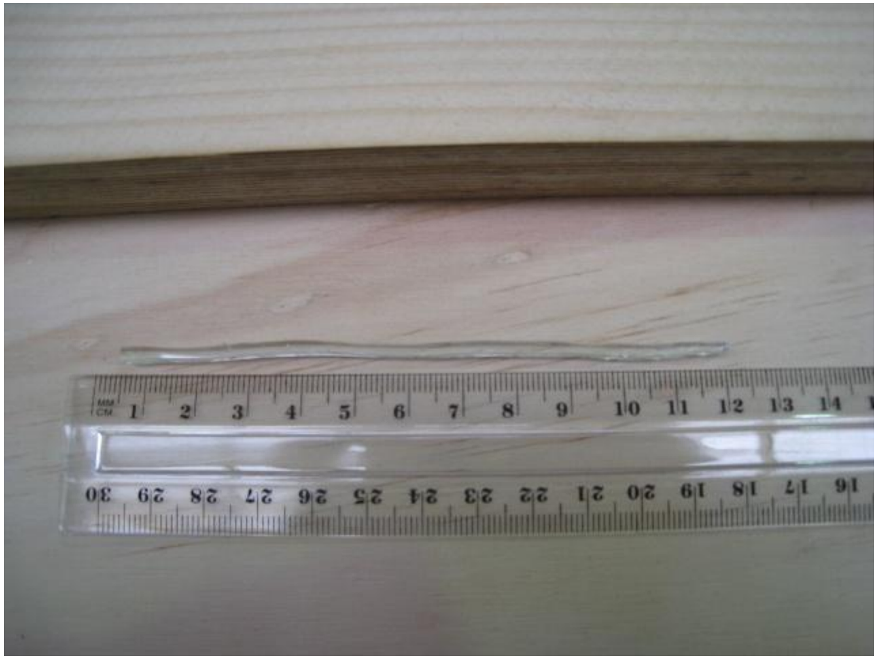
Splines from 5 mm Sample No.1_5-5; SC 107: Centre Fragmentation

5 mm Sample No. 1_5-9; SC 114: Centre Fragmentation – Longest Particle 140 mm

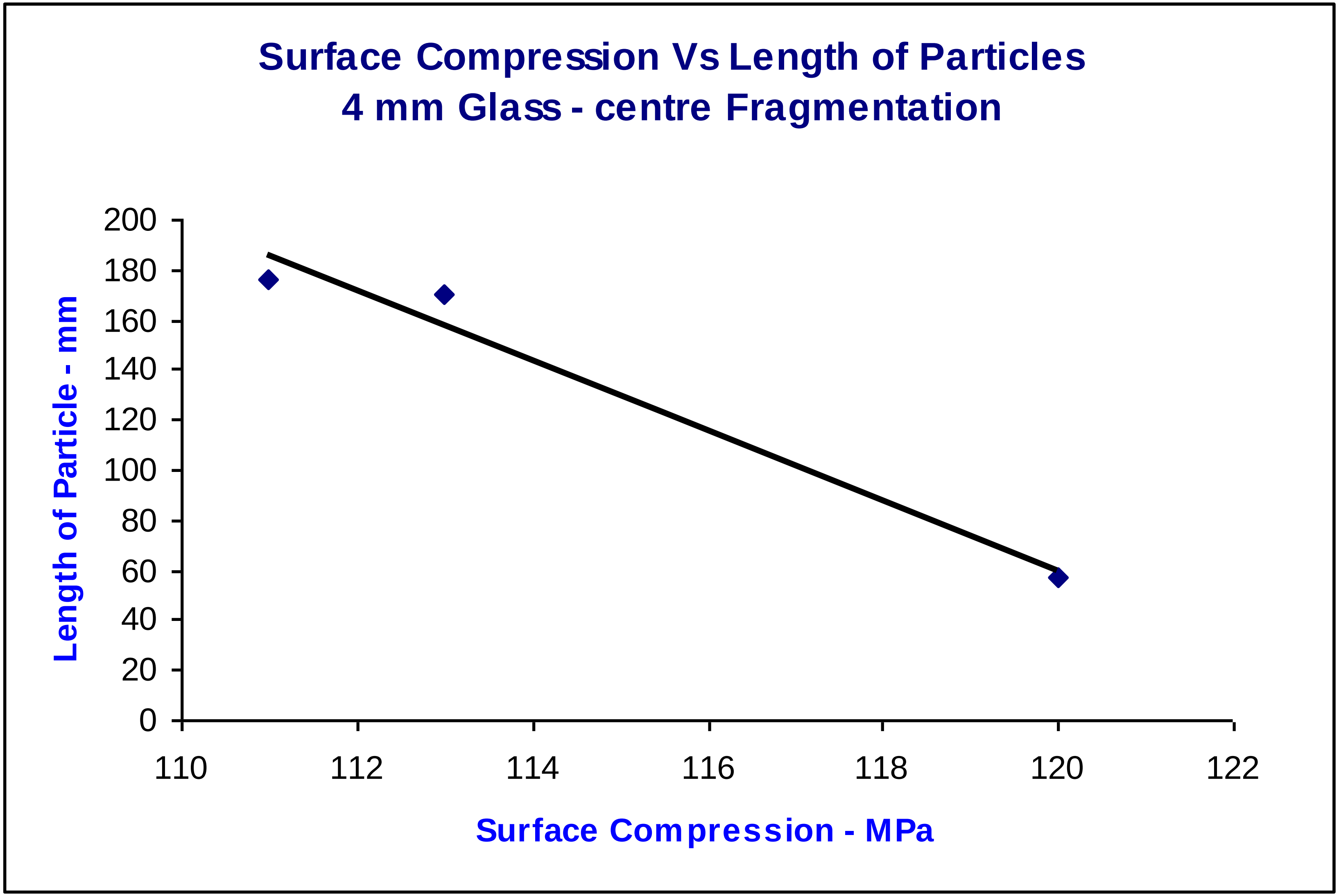
6 mm Sample No. 1_6-4; SC 113: Centre Fragmentation - Longest Particle 100 mm

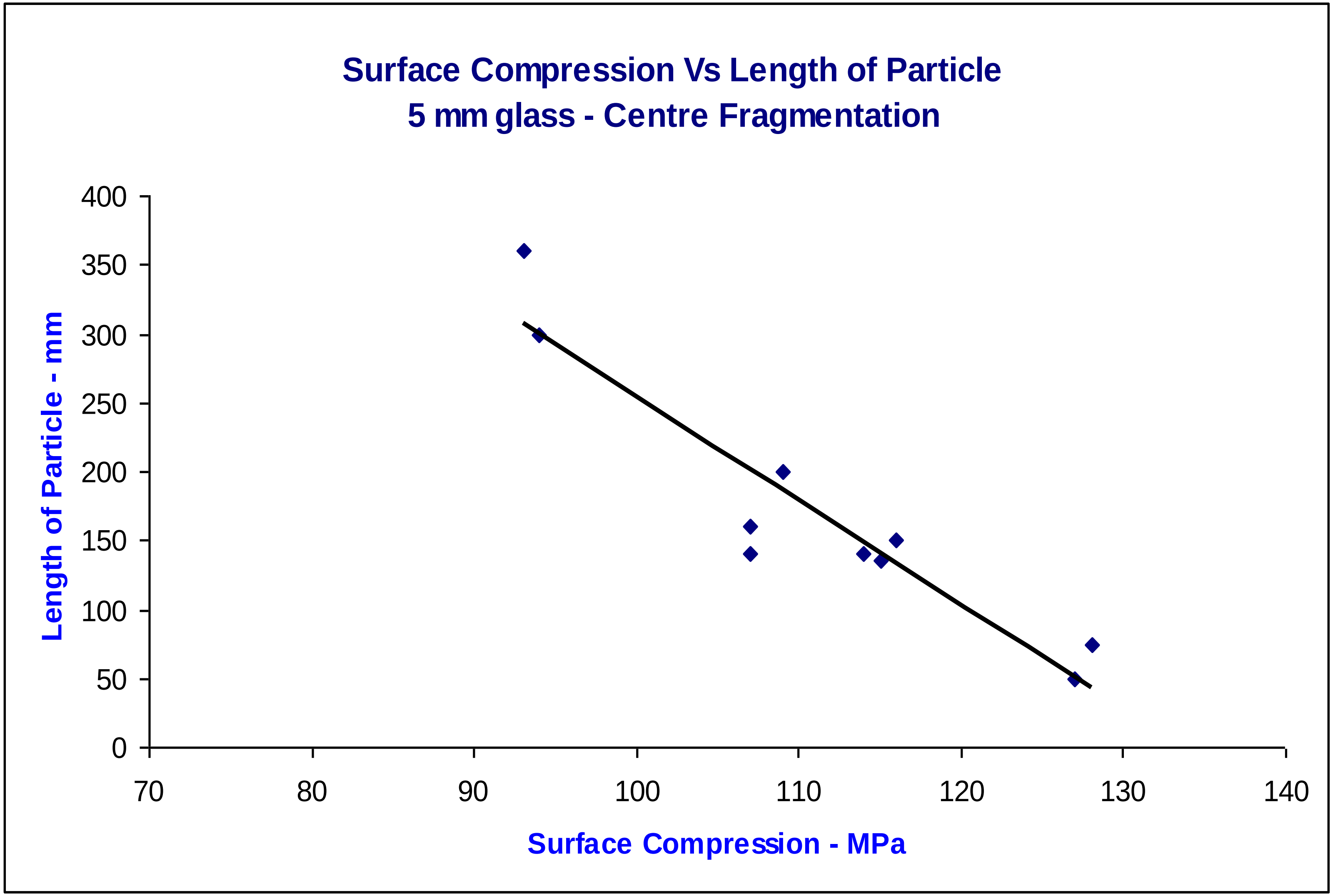


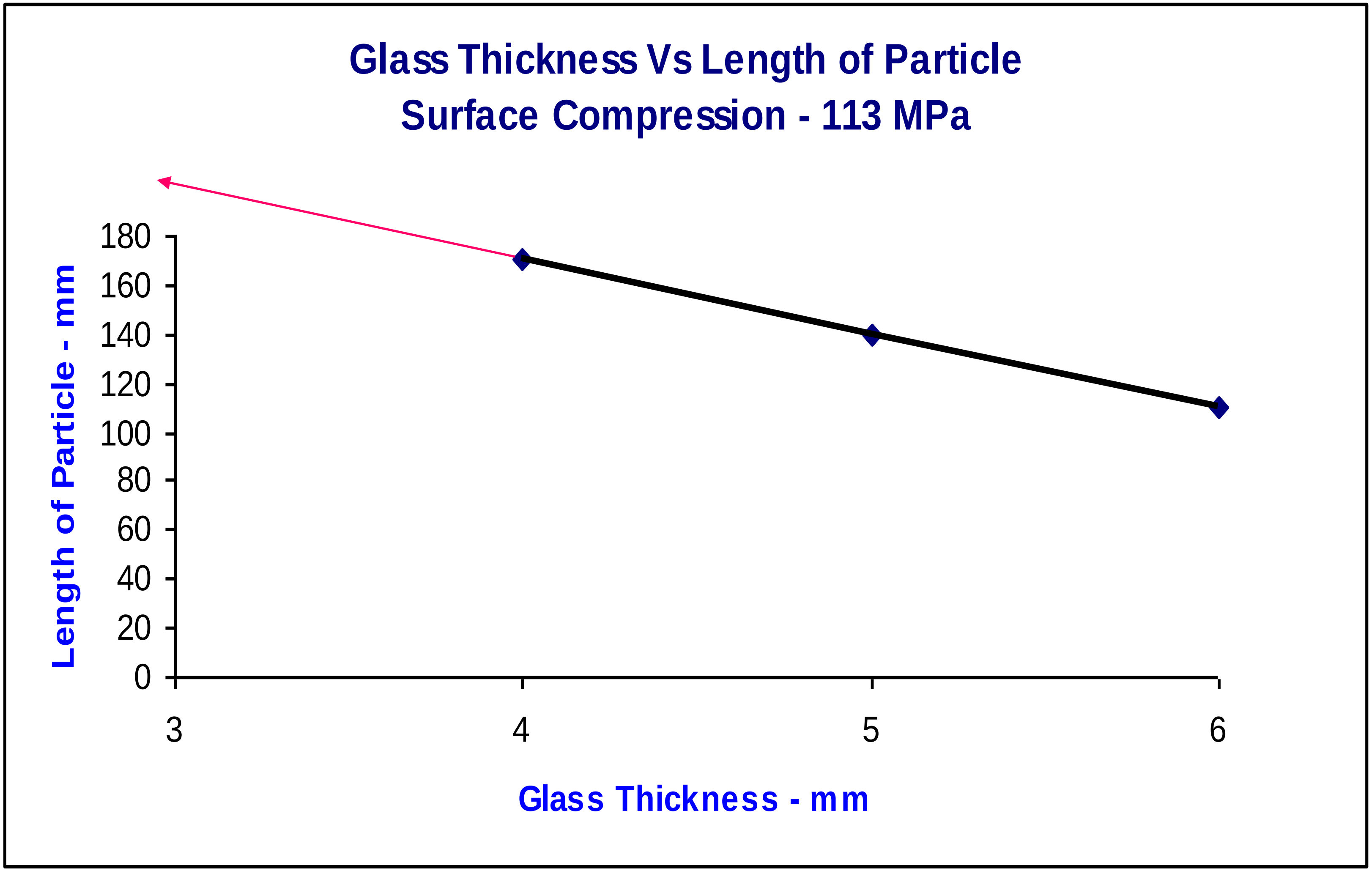
5 mm Sample No. 1_5-1; SC 115: Centre Fragmentation - Longest Particle 135 mm



5 mm Sample 1_5-3: SC 107: Centre Fragmentation – Longest Particle 140 mm


Surface Compression Vs Length of Particles
4 mm Glass - centre Fragmentation
Length of Particle - mm
200
180
160
140
120
100
80
60
40
20
0
110
112
114
116
118
120
122
Surface Compression - MPa


Surface Compression Vs Length of Particle
5 mm glass - Centre Fragmentation
Length of Particle - mm
400
350
300
250
200
150
100
50
0
70
80
90
100
110
120
130
140
Surface Compression - MPa



3 mm thick Glass with Surface Compression of 121 MPa developed 140 mm long particles

Centre Fragmentation

- At 69 MPa long fragments will develop
- Particle length is proportional to the surface compression
- At the same level of surface compression thicker toughened glass develops smaller long particles

Lead Shot Bag Impact

Sample No:	Surface Compression	Drop Height	Length of Particle
3_3-3_V	121	450	>100 mm
1_5-10_V	110	1500	No Long Particles
1_5-11_V	107	300*	No long Particles
1_5-12_V	112	200*	No Long Particles
1_5-13_V	108	200*	No Long Particles
2_5-3_V	94	300	> 200 mm
4_5-1_B	128	450sp	>30 mm
4_5-3_B	93	600	> 140 mm

4 mm Sample No.1_4-8; SC 100 MPa: LSB - Glass in frame

4 mm Sample No.1_4-8; SC 100: LSB - Glass in frame

4 mm Sample No. 1_4-8; SC 100 MPa: LSB impact – 10 largest particles

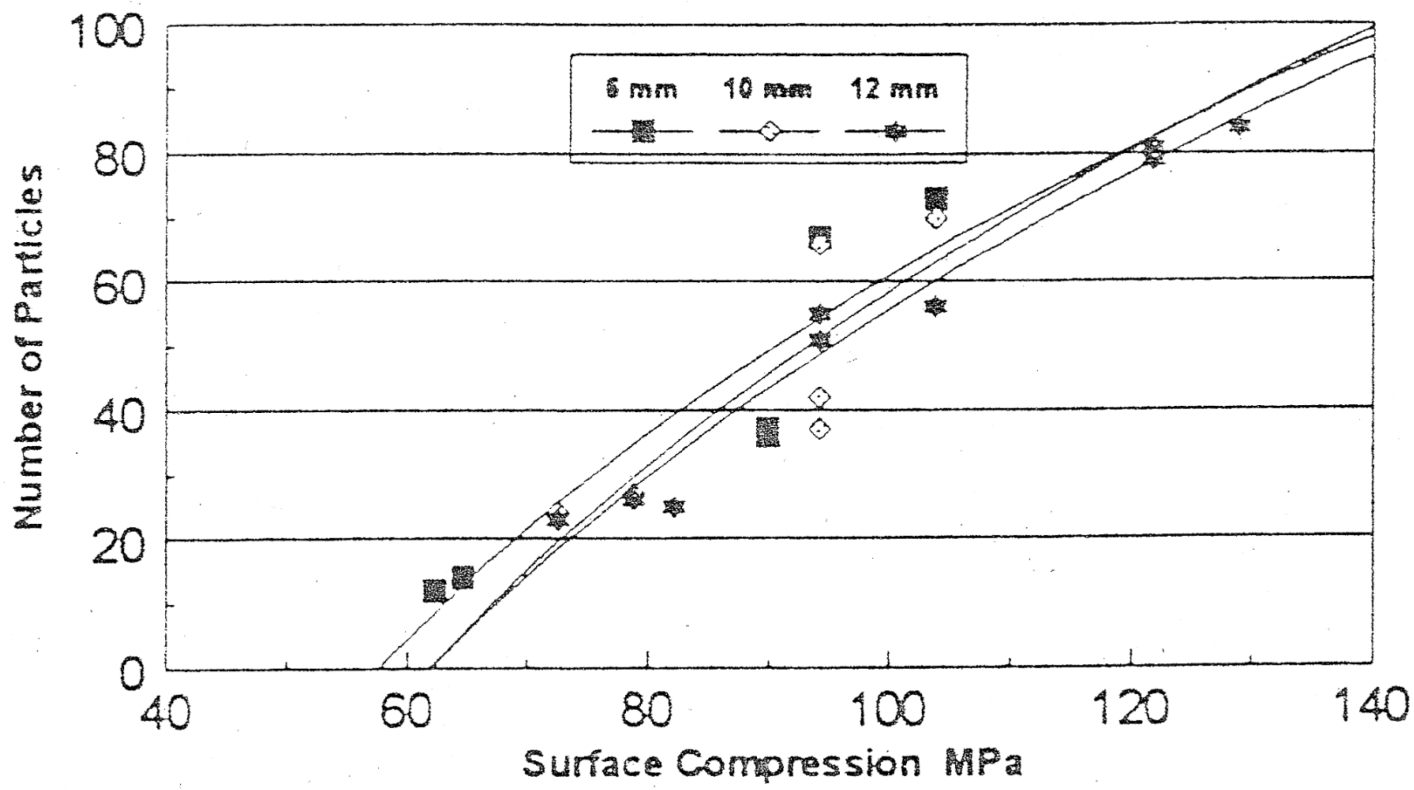
Weight 12.8 grams – permitted weight 100 grams

5 mm Sample No.1_5-12: LSB Impact – Fragments from impact point

Lead Shot Bag Impact

- At 69 MPa long fragments will develop
- Particle length is proportional to the surface compression
- All toughened glass will pass the weight of the 10 largest particles criteria even at low levels of surface compression

  (Actual measurement of the 10 largest particles varied between 10% to 40 % of the permitted weight)



Sample Size 500 x 500

Minimum no of particles for 6 mm - 40

Minimum no of particles for 10 mm &12 mm

Figure 22 Compressive Stress Measured Using GASP

Comments on 6th Working Group Draft AS2208
Greg Hayes
10th February 2009

"These new test methods are unlikely to be accepted by standards organisations such as ISO."

The following slides detail some history from my involvement on ISO (TC160/SC2/WG6) deliberations on an ISO standard for safety glazing materials.

From Minutes of :
ISO TC160/SC2/WG6
'Safety Glazing Tests'
Meeting – October 2002

Glass and Glazing Federation

Minutes of the meeting of ISO TC160/SCC2/WG6 Safety Glazing held at the offices of Spring Singapore, 2 Bukit Merah, Central Singapore 159835 on 23-24 October 2002

Present:	Mr S H Rice (Convenor)	United Kingdom
Messrs:	G Van Marcke	Belgium
	P Davies	Australia
	L Jacobs	Australia
	Y Jianjun	China
	K M Cheung	Singapore
	H K Sew	Singapore
	I Townend	United Kingdom
	Y Oketani	Japan
	C de Niet	Belgium
	M Debru	Belgium
Apologies:	B Waldron	United Kingdom
	J Weir	United Kingdom
	E Mognato	Italy

7. Toughened Glass Breakage Characteristics

Australia and China recommended that long particles (splines) should be recognised in the standard. It was also proposed that ISO TC160/SC1/WG2 should review this lack of correlation between the edge fragmentation test and spline generation. It was further agreed that a more indepth investigation should be carried out on the effect of Heat Soaking with regard to fragmentation.

8. Glass in Building – Technical Report on Pendulum Impact Testing and Classification of "Safety" Glass for use in Building

Mr Van Marcke submitted the above Document (N57). The Members proceeded to review and revise the text. A copy of the revised Document is enclosed for reference.

Based on discussions during the meeting, it was agreed that the following should be reviewed:-

Scope

Some wording will be added stating that this standard does not specify intended use of the products, but provides a classification in terms of performance. (To be developed by L Jacob).

Terms and Definitions

3.2 Safe Breakage (to be discussed at the next meeting).

Test Requirements

Check the mass criteria as in other standards.

Revisions to Draft Technical Report Type 2 (N57) made during the Oct 2002 WG6 Meeting in Singapore

5 Test requirements

When tested by the method given in clause 6 each test piece shall either not break or shall break as defined in one of the following ways :

a) numerous cracks appear, but no shear or opening is allowed within the test piece through which a 76 mm diameter sphere can pass when a maximum force of 25 N is applied (in accordance with annex C).
Additionally, if particles are detached from the test piece up to three minutes after impact, they shall, in total weigh no more than the mass equivalent to 10 000 mm² of the original test piece. The largest single particle shall weigh less the mass equivalent to 4 400 mm² of the original test piece. The longest particle shall not exceed 100 mm.

b) Disintegration occurs and the ten largest crack free particles collected within three minutes after impact and weighed, all together, within five minutes of impact shall:

- weigh no more than the mass equivalent to 6 500 mm² of the original test piece,
- the length of the longest particle shall not exceed 100 mm,.

The retention criteria shall be met when no break occurs or numerous cracks appear, but no shear or opening is allowed within the test piece through which a 76 mm diameter sphere can pass when a maximum force of 25 N is applied (in accordance with annex C).

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Validity unknown

Guy van Marcke

Digitally signed by Guy van Marcke
DN: cn=Guy van Marcke, o=Glaverbel SA, c=BE
Date: 2003.09.17 06:55:37 +01'00'

ISO/TC 000/SC 0 N 000

2003-01-07

ISO/WD nnn-n

ISO/TC 160/SC 2/WG 6 N57 rev 1

Secretariat: BSI

Glass in Building — Technical Report on Pendulum Impact Testing and Classification of “safety” Glass for use in Buildings

Minutes of the meeting of ISO TC 160/SC2/WG6 (Safety Glazing) held at the offices of Standards Australia on 17th and 18th September 2003

Present:	S Rice (Convenor)	UK
	G Bannerman	UK
	Leon Jacobs	Australia
	Claude De Niet	Belgium
	Ken Kikuta	Japan
	Hiroshi Nishimura	Japan
	Guy Van Marcke	Belgium
	Sam Guindi	Australia
	Noel Stokes	Australia
Apologies:	Philip Davis	Australia
	Ennio Moganato	Italy
	Yukitito Oketani	Japan

5. **Type 2 Technical Report**

The group proceeded to review and revise the attached type 2 technical report. Delegates are requested to forward any comments on the amendments, to the convenor as soon as possible.

6. **Delegates Papers**

- Dr Jacobs gave a presentation on the current thinking in Australia.

- Mr De Niet gave a presentation on the performance of scratched laminated glass with respect to performance.
- Dr Van Marke and Mr DeNiet reported that they were currently carrying out an in-depth study on 400 samples of 4-6-8-10and 12 toughened glass. A full report on the study will be submitted at the next group meeting.

9. **Date and venue of next meeting**

Shanghi - China - February/March 2004

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Guy Van Marcke

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DN: CN = Guy Van Marcke, C = BE, O = Glaverbel SA, OU = Environment and Standardisation
Date: 2004.01.06 17:22:04 +01'00'

ISO/TC 000/SC 0 N 000

2004-01-07

ISO/WD nnn-n

ISO/TC 160/SC 2/WG 6 N57 rev 2

Secretariat: BSI

Glass in Building — Technical Report on Pendulum Impact Testing and Classification of “safety” Glass for use in Buildings

Section 5 of the Draft Technical Report Type 2 (N57) confirmed at the Sep 2003 WG6 Meeting in Sydney

5 Test requirements

When tested by the method given in clause 6 each test piece shall either not break or shall break as defined in one of the following ways :

a) numerous cracks appear, but no shear or opening is allowed within the test piece through which a 76 mm diameter sphere can pass when a maximum force of 25 N is applied (in accordance with annex C).
Additionally, if particles are detached from the test piece up to three minutes after impact, they shall, in total weigh no more than the mass equivalent to 10 000 mm² of the original test piece. The largest single particle shall weigh less the mass equivalent to 4 400 mm² of the original test piece. The longest particle shall not exceed 100 mm.

b) Disintegration occurs and the ten largest crack free particles collected within three minutes after impact and weighed, all together, within five minutes of impact shall:

- weigh no more than the mass equivalent to 6 500 mm² of the original test piece,
- the length of the longest particle shall not exceed 100 mm,.

The retention criteria shall be met when no break occurs or numerous cracks appear, but no shear or opening is allowed within the test piece through which a 76 mm diameter sphere can pass when a maximum force of 25 N is applied (in accordance with annex C).

Section 5 remained unchanged at the Singapore April 2004 WG6 meeting

WG6 Meeting 9, Singapore, 11-12 February 2004

Australia was represented at the meeting by Leon Jacob.

(At the October 2003 Sydney meeting it had been decided that the next WG6 meeting would be held in Beijing in Feb/March 2004 meeting. The meeting venue however was changed to Singapore in February without China or Australia being consulted. As a result, due to other commitments, neither JJ Yang nor Phillip Davies could attend the meeting.)

WG6 Meeting 9, Singapore, 11-12 February 2004

The following are the meeting points and outcomes:

Dr. Van Marke gave a power point presentation entitled **'Toughened Glass Revisited Study'** summarizing the test work carried out by himself and Claude De Niet on toughened glass in follow up to the last meeting.

- Their findings on the results of punch tests at the panel edge versus the panel centre were in agreement with the results from the CBMA test programs. They had reached the same conclusion – that the panel centre was the most appropriate impact point for the fragmentation test.
- On 4 mm toughened glass they found that the surface compression needs to be a minimum of 120-140 MPa to prevent long particles when the fragmentation test is carried out with impact at the panel centre.
- They found 4 mm toughened glass is more susceptible to spline formation than thicker toughened glass.

Despite their finding that punch tests at the panel centre may produce splines which are not revealed by the edge fragmentation test, the European delegates would not agree to inclusion of a centre of panel fragmentation test in the Technical Report.

Note: No meeting minutes were issued.

Minutes of the meeting of ISO TC 160 WG 6 held at UNINDUSTRIA Vega Parco Scientifico Tecnologico Di Venezia S.c.a.r.l. 30175 Venezia (VE)on 12th & 13th May 2005.

Present:

Mr Steve Rice (Convenor)	Glass & Glazing Federation
Mr Ennio Mognato	Stazione Sperimentale Del Vetro – Italy
Mr Jean-Clement Nugue	Saint-Gobain, France
Ms Anne Minne	Saint-Gobain, Belgium
Dr Guy van Marcke de Lummen	Glaverbel, Belgium
Prof Jianjun Yang	CSGCC, China
Mr Brian Waldron	Convenor of TC 160
Dr Yukihito Oketani	Asahi Glass Company, Japan

Apologies:

Dr. Leon Jacob,	Jacob & Associates Pty Ltd
Mr. Phillip S. Davies,	Dupont (Australia) limited
Mr Graham Bannerman	Filmtek

In Attendance:

Mr T Blamey	Glass & Glazing Federation

- **Minutes of the meeting of ISO TC 160 WG 6 held at UNINDUSTRIA Vega Parco Scientifico Tecnologico Di Venezia S.c.a.r.l. 30175 Venezia (VE)on 12th & 13th May 2005.**

"The meeting discussed the results presented regarding fragmentation. The presentation suggests that long splines of glass result from a centre break and not from an edge break. These views are not the opinion of the European delegates, who have not experienced similar results during their own studies."

- The above contradicts the European findings that were communicated at the February 2004 WG6 meeting.
- I was prevented from attending this WG meeting due to its location and timing (a month prior to GPD).
- Several European delegates however attended the meeting who had not been at the previous six WG6 meetings.
- My concerns on the working of WG6 were submitted in a letter to the WG on 1 September 2008 during the ISO TC160 meetings in Sydney.

Letter: Leon Jacob to ISO/TC160/SC2/WG6
1 September 2008
Conclusion

- *“In conclusion, considerable effort and resources have been invested over a number of years to better understand the breakage characteristics of toughened glass. This has resulted in the discovery of a test method (fragmentation by punch impact at the panel centre) which can assure the safe breakage characteristics of the toughened glass. It is unconscionable that some WG6 members appear to have conspired to suppress the implementation of simple tests which would ensure that toughened safety glass breaks safely in accordance with the reasonable expectations of consumers and the product definition.”*

Summary of toughened glass testing at Viridian Wetherill Park

(November 2012 to April 2013)

Two main sample sizes tested being 1100mm x 360mm and 1900mm x 860mm used in 4mm, 5mm and 6mm monolithic clear toughened Viridian float glass.

80 samples were tested in total spread equally across the substances, predominantly to follow the draft proposals and then compare the results against those suggested in the latest draft of AS/NZS2208 (2208 Drafting Team Draft 1 .doc dated 6/2/2013) and these also included some toughened IGU samples.

Punch break tests (monolithic)

- All samples broken at the edge (13mm in on longest side) with a punch passed the fragmentation test with no splines evident with Surface Compressions from 90Mpa to 129Mpa.

- All samples of both sizes broken in the centre of the sample using a punch produced splines, and in most cases failed the fragmentation test. These tests were made on samples with Surface Compressions ranging between 90Mpa and 129Mpa.

DSCN1459.jpg

  - The location of any splines was generally always in the areas between the break and the top and bottom of the sample.

DSCN1397.jpg

- A range of intermediate punch breaks were also carried out on 6mm samples in locations between both the centre and long sides and also the centre and short sides. The breakages in these locations also produced splines, most above 100mm when broken more than 54mm from an edge.

Maximum Surface Compression values achieved for punch breaks were as follows:

4mm = 129Mpa 5mm = 122Mpa 6mm = 137Mpa

<u>Impact Tests</u> (1900mm x 860mm monolithic)

- 4mm Impact tests across a range of SC's from 115Mpa to 129Mpa that broke naturally without a back score, had splines less than 100mm long. (only 1 failure recorded)

- 4mm Impact tests broken with a back score per AS2208 draft; generally had splines longer than 100mm and therefore failed the suggested criteria.

    - The location of the splines on Impact tests was generally always in the areas between the break and the left and right of the sample. (different to the centre break punch results)

DSCN1506 (3).jpg

- 5mm Impact tests breaking naturally without back score also produce splines less than 100mm and passed the test.
- 5mm Impact tests with back score produced longer splines, mostly longer than 100mm failing the test.

- 6mm Impact tests breaking either naturally or with a back score produced splines less than 100mm.

Assumption- Scoring the back of an Impact test sample may cause longer splines.

Note:

All edge break punch tests and all but one naturally broken Impact tests passed the respective criteria of 40 particles or < 100mm splines.

All Centre broken punch tests and all 4mm and 5mm back scored Impact tests failed the criteria.

Maximum Surface Compression values achieved for Impact tests were as follows:

4mm = 137Mpa 5mm = 122Mpa 6mm = 137Mpa

IGU tests (1900 x 860 Impact and random sized Punch Tests)

- IGU's in toughened 4mm/ 6mm/4mm and 5mm/6mm/5mm configurations were Impact tested:
    - Only the panel receiving the impact blow broke when following the normal practice of increasing height until a break occurs.
    - No real difference in break heights compared to monolithic tests – would this indicate the impact panel on a toughened IGU breaks similarly to monolithic?
    - Non – impacted toughened panel never broke other than during destruction testing at 1500mm drop height but in these tests the impact actually ripped the glass from the spacer and out of the frame invalidating the result somewhat.

      

      27146525.jpg
    - Spline lengths on toughened IGU's were similar those seen in monolithic tests on similar products

- A range of toughened IGU in various sizes were punch tested.
    - All those punch broken on the edge passed the fragmentation test
    - All those broken in the centre failed the fragmentation test.

Conclusion:

The suggested centre break using a punch as described in section 3.4.4 and figure 3.2 results in 100% failure of the fragmentation test on both large and small, monolithic and IGU samples with respect to Particle Count Table 3.2 (this table is actually missing from latest draft) whereas the breaks carried out on the edge with a punch had 100% pass rate on all samples including the toughened IGU's tested.

Glass breaking on Impact tests without back score also passes the test producing splines less than 100mm and from this it would appear that the results produced from the edge breaks and impact tests pass the test and may be closely related.

These results were totally different to centre break results both on the small and large panels which fail the test.

Scoring the back of an Impact test seems to have the effect of increasing the length of the splines and possibly flaws the test. (Appendix D. Section "h").

In general the thicker the substance the shorter the splines.

These tests were completed in reference to what was the latest draft of AS/NZS2208 being (2208 Drafting Team Draft 1 .doc dated 6/2/2013) which was the most up to date version at that time. I am aware there may be a later revision which may require further cross reference.

Q) SC Variance? Clarification may be required regarding the suggested higher values and the +/- 20% (3.3.2.ii).

Q) Agreement with SC as a replacement for frag (with regular calibration check) but would like to know more about the suggested SC's in table 3.1.

Q) (AS1288 section 5.22 multiplication factor 1.5?)

Standards Update

Presented by Jamie Rice, George Fethers & Co.
at the AGGA Conference, 2010

Standards Update

AS1288: Amendment 2

AS/NZS 2208: Revision

AS/NZS 4666: Rewrite

AS1288
Amendment 2
Executive Summary

Amendment 2 in limbo since May 2009

AS1288

Clause 2.1.2

'When tested in accordance with ASTM C 1279, heat-strengthened glass shall have a surface compression of 24-52 MPa.'

AS1288

Clause 3.8

Selection of glass for applications where a risk of fracture due to nickel sulphide inclusion exists

AS1288

The use of toughened and some heat strengthened glass may involve a relatively small risk of breakage resulting from nickel sulphide inclusions.

AS1288

Breakage may cause the glass to evacuate the opening potentially causing injury or property damage.

AS1288

Glass shall be selected to minimise this risk.

Class 1 buildings (residential) are exempt.

AS1288

Types of glass to minimise risk

(a)Annealed

(b) Heat strengthened

(c) Laminated safety

AS1288

Toughened safety glass complying with….

- The glass has been heat soak tested
- Suitable protection is provided

AS1288

- Suitable protection?
- A projection (e.g., balcony) that extends from the building minimum 2/3 the height of the adjacent panel.

AS1288

"Heat soaking will significantly reduce but not totally eliminate the risk of fracture due to nickel sulphide."

AS1288

SWIMMING POOL BARRIERS/FENCES

- Use Grade A safety glass
- Design for wind load
- Difference in level >1000mm it's a Balustrade

AS1288

Clause 5.19

Making Glass Visible (Manifestation)

AS1288

<u>For doors & sidelights</u>

If the presence of glass is not made apparent by its construction the glass shall be marked to make it visible.

AS1288

NOT doors or side panels.

If a panel can be mistaken for a doorway or opening the glass shall be marked to make it visible.

AS1288

Marking, (where required)

- Opaque band
- More than 20 mm in height
- Located between 700 mm and 1200mm from the floor level.

AS1288

Marking must be readily apparent.

AS/NZS 2208 Working Group

AS/NZS 2208

AS/NZS 2208

Working Draft Finished !!

AS/NZS 2208

Separate Sections

- Toughened Safety Glass
- Laminated Safety Glass
- Organic Backed Mirror & Glass

AS/NZS 2208

Distortion Limits (New)

Local Bow & Warp $\leq$ 0.15mm

Edge Kink $\leq$ 0.3mm

AS/NZS 2208

Toughened Safety Glass Tests

- Impact or
- Fragmentation or
- Surface Compressive Stress AND Fragmentation

AS/NZS 2208

IMPACT TEST (Swing Bag)

Use adhesive film

Largest particle < 100mm long

Largest particle < 650mm² in area

AS/NZS 2208

FRAGMENTATION TEST;

- Min. sample 1100 x 360mm
- Impact is in centre of panel
- Data now includes 19 & 25mm

AS/NZS 2208

Elongated fragments allowed if

-They are not pointed, and

-They are less than 100mm long

AS/NZS 2208

If they extend to an edge, they do not form an angle less than 45°with the edge.

AS/NZS 2208

SURFACE COMPRESSIVE STRESS (SCS) and FRAGMENTATION TEST

- Done using a GASP
- Relationship between SCS and fragmentation count only true for each furnace. Not true between furnaces.

AS/NZS 2208

- Establish a SCS the corresponds to desired frag count
- Maintain that level of SCS
- Retest regularly to ensure SCS and frag count relationship is valid.

AS/NZS 2208

Requires further work

The SCS levels are MUCH higher than present.

e.g. 4mm 130MPa & 25mm 100MPa

Much higher than 69 MPa

AS4666

Insulating Glass Units

AS 4666

Draft Finished in April 2009

AS 4666

Draft presented to BD7 in May 2009

Public Comment ✓

AS 4666

Standards Australia engaged to manage project

AS/NZS 4666

Was to be "AS" NOW "AS/NZS"

AS/NZS 4666

INSTALATION

- Fundamental principles
- Site working and damage
- Glazing Materials
- Setting Blocks
- Location Blocks
- Distance Pieces
- Preparation of rebates and grooves
- Glazing Beads
- Structural Sealants
- Sloped And Overhead Glazing

AS/NZS 4666

MANUFACTURING AND PERIODIC TESTING

- Atmospheric Conditions
- Substrates
- Spacer and Ancillaries
- Desiccants
- Sealants
- Gassing of Units
- Completed Units

AS/NZS 4666

APPENDICES

- Muntin Bars
- Capillary Tubes and Bladders
- Thermal and Sound Insulation
- Visual Characteristics
- Principles of Glazing
- Glazing Methods
- Storage, Handling, Transport and Preservation
- Determination of Dimensional Properties

BD/7 Committee

A new project manager was appointed in August

Full BD7 meeting to be held October 2010