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FORENSIC TESTING PROGRAM

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Glass Analysis
Test No. 23-5481 Summary Report

Each participant received a sample set consisting of one known (Item 1) and two questioned (Items 2 and 3) glass fragments. Participants were requested to analyze and compare these and report their findings. Data were returned from 63 participants and are compiled into the following tables:

Report Contents:

This report contains the data received from the participants in this test. Since these participants are located in many countries around the world, and it is their option how the samples are to be used (e.g., training exercise, known or blind proficiency testing, research and development of new techniques, etc.), the results compiled in the Summary Report are not intended to be an overview of the quality of work performed in the profession and cannot be interpreted as such. The Summary Comments are included for the benefit of participants to assist with maintaining or enhancing the quality of their results. These comments are not intended to reflect the general state of the art within the profession.

Participant results are reported using a randomly assigned "WebCode". This code maintains participant's anonymity, provides linking of the various report sections, and will change with every report.

Manufacturer's Information

Each sample set contained three items consisting of one known (Item 1) and two questioned (Items 2 and 3) glass fragments. Participants were instructed to examine the questioned glass fragments and determine if any could have originated from the same source as the recovered known glass fragment. Items 1 and 2 were prepared from non-tinted ThermaStar window glass, while Item 3 was prepared from outdoor lamp glass.

SAMPLE PREPARATION: The glass was examined for defects and then broken. Differing items were cut with glass tools to remove the edges and unwanted areas, processed, and then packaged separately from each other to prevent cross-contamination.

ITEMS 1 AND 2 (ASSOCIATION): For the known Item 1 sample, two glass fragments approximately 1/8" x 1/8" in size were deposited and folded into a glassine bag, then placed into a pre-labeled envelope and sealed. For the questioned Item 2, two glass fragments approximately 1/16" x 1/16" in size were deposited and folded into a glassine bag, then placed into a pre-labeled envelope and sealed. Items 1 and 2 were taken within close spatial proximity to one another and were kept together as an identification group and packaged into the sample set as described below.

ITEM 3 (ELIMINATION): For the questioned Item 3 sample, two glass fragments approximately 1/16" x 1/16" in size were deposited and folded into a glassine bag, then placed into a pre-labeled envelope and sealed.

SAMPLE SET ASSEMBLY: For each sample set, Items 1, 2, and 3 were placed into a pre-labeled sample set envelope and sealed.

VERIFICATION: The predistribution laboratories reported the expected responses and used the following examination methods: Color, Thickness, nD Refractive Index (absorptive density), Long and Short UV Fluorescence, SEM/EDS, and XRS/XRF. The average refractive indices for the glass as reported by predistribution laboratories are as follows: Item 1 RI =1.519075, Item 2 RI =1.519015, and Item 3 RI =1.1.51721.

Summary Comments

This test was designed to allow participants to assess their proficiency in the examination, comparison, and interpretation of glass samples. Each sample set consisted of three items, one known (Item 1) and two questioned (Items 2 and 3) glass fragments. Participants were instructed to examine the questioned fragments and determine if any could have originated from the same source as the recovered known glass fragments. Items 1 and 2 were prepared from non-tinted ThermaStar window glass, while Item 3 was prepared from outdoor lamp glass. (Refer to the Manufacturer's Information for preparation details.)

Of the 63 responding participants, 61 (97%) identified Item 2 and eliminated the Item 3 glass fragments as having originated from the same source as the Item 1 known glass fragments. Of the remaining two participants, one reported that neither Items 2 nor 3 could have originated from the same source as the Item 1 known glass fragments and the last one reported that both Items 2 and 3 could have originated from the same source as the Item 1 known glass fragments.

The most commonly reported examination procedures include: Thickness (92%), Color (79%), Refractive Index (nD) (71%), and Short UV (71%).

Examination Results

Could the questioned glass fragments recovered from the suspect (Item 2 and Item 3) have originated from the broken bathroom window as represented by Item 1?

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
2R3Q6A	Yes	No	GN7FME	Yes	No
3DWUL8	Yes	No	GT2ZXP	Yes	No
3TDTQ9	Yes	No	HD8YEP	Yes	No
4CWGBJ	Yes	No	HJT79E	Yes	No
4F2RNM	Yes	No	HK269Q	Yes	No
6EL6BQ	Yes	No	HXAPU4	Yes	No
6YQKTH	Yes	No	J3GHH9	Yes	No
769F7Q	Yes	No	J8FZT9	Yes	No
7D3HBN	Yes	No	JHWVGK	Yes	No
7LG6NX	Yes	No	JNHNTK	Yes	No
7LWN4P	Yes	No	JV3RZM	Yes	No
7VAFXT	Yes	No	LEN3X7	Yes	No
82DRKK	Yes	No	LF3PCE	Yes	No
8WWDMB	Yes	No	LKVWR3	Yes	No
9C6PUV	Yes	No	LPAF76	Yes	No
AC2KTR	Yes	No	MB4VQH	Yes	No
AU492H	Yes	No	NEGZYC	Yes	No
BNMKFC	No	No	NN6QMP	Yes	No
BP68FE	Yes	No	QXM77A	Yes	No
BXZDAF	Yes	No	QYYLXQ	Yes	No
C7KGMW	Yes	No	R4NRPX	Yes	No
C9DRR9	Yes	No	RDQJ4G	Yes	No
C9QJKP	Yes	No	RLKNXH	Yes	No
CK89JV	Yes	No	TUJXDJ	Yes	No
F46ZQX	Yes	Yes	U8XKYM	Yes	No
FLM49J	Yes	No	UKNCKQ	Yes	No
GDL4B3	Yes	No	UZEGQY	Yes	No

TABLE 1

WebCode	Item 2	Item 3	WebCode	Item 2	Item 3
V4XVUY	Yes	No			
V9RM4H	Yes	No			
VEDLR6	Yes	No			
WDTZ4B	Yes	No			
XRUFZZ	Yes	No			
Y8MA9K	Yes	No			
YCEJCQ	Yes	No			
YY9MTP	Yes	No			
ZG7J2A	Yes	No			

Response Summary

Total Participants: 63

Could the questioned glass fragments recovered from the suspect (Item 2 and Item 3) have originated from the broken bathroom window as represented by Item 1?

Response	Item 2	Item 3
Yes	62 *(98.4%)*	1 *(1.6%)*
No	1 *(1.6%)*	62 *(98.4%)*
Inconclusive	0 *(0.0%)*	0 *(0.0%)*

Examination Procedures

TABLE 2

	Refractive Index							Elemental		UV		
WebCode	nD	nF	nC	ΔRI	Color	Density	Thickness	SEM/ EDS	XRS/ XRF	Long	Short	Other
2R3Q6A	✓			✓	✓		✓		✓	✓	✓	visual exam, microscopy, probing for hardness, solubility in water
3DWUL8							✓	✓				
3TDTQ9	✓						✓					
4CWGBJ	✓				✓		✓		✓	✓	✓	
4F2RNM					✓	✓	✓			✓	✓	None
6EL6BQ				✓			✓		✓	✓	✓	
6YQKTH	✓				✓		✓		✓	✓	✓	
769F7Q	✓	✓	✓				✓	✓				
7D3HBN	✓				✓		✓		✓		✓	
7LG6NX				✓	✓		✓	✓		✓		
7LWN4P	✓				✓		✓		✓	✓	✓	
7VAFXT	✓				✓		✓		✓		✓	
82DRKK	✓				✓		✓	✓	✓			TXRF
8WWDMB	✓				✓		✓	✓			✓	
9C6PUV	✓				✓		✓		✓	✓	✓	LA-ICP-MS
AC2KTR	✓				✓		✓		✓	✓	✓	Stereomicroscopy, high power and polarized light microscopy
AU492H				✓	✓	✓		✓		✓	✓	
BNMKFC					✓	✓	✓	✓		✓	✓	
BP68FE	✓				✓		✓		✓	✓	✓	
BXZDAF	✓				✓		✓		✓	✓	✓	Macroscopic and microscopic examinations of glass type/morphology
C7KGMW	✓				✓		✓				✓	ICP-OES
C9DRR9	✓				✓		✓			✓	✓	
C9QJKP	✓				✓		✓	✓		✓	✓	
CK89JV	✓				✓		✓	✓			✓	

TABLE 2

	Refractive Index							Elemental		UV		
WebCode	nD	nF	nC	ΔRI	Color	Density	Thickness	SEM/ EDS	XRS/ XRF	Long	Short	Other
F46ZQX												Laser Induced Breakdown Spectroscopy (LIBS)
FLM49J	✓				✓		✓			✓	✓	LIBS
GDL4B3	✓				✓		✓	✓			✓	
GN7FME	✓				✓		✓		✓	✓	✓	
GT2ZXP	✓						✓				✓	LA-ICP-MS
HD8YEP							✓		✓			LA-ICP/MS
HJT79E						✓			✓			LIBS
HK269Q												ICP-MS
HXAPU4	✓				✓		✓		✓	✓	✓	
J3GHH9					✓		✓		✓			
J8FZT9	✓				✓		✓		✓		✓	
JHWVGK	✓				✓		✓	✓		✓	✓	
JNHNTK	✓				✓		✓		✓	✓	✓	
JV3RZM	✓				✓		✓			✓	✓	
LEN3X7	✓				✓		✓		✓	✓	✓	
LF3PCE					✓		✓				✓	LA-ICPMS
LKVWR3	✓				✓		✓		✓	✓	✓	
LPAF76				✓	✓		✓					
MB4VQH							✓	✓				
NEGZYC				✓	✓		✓				✓	
NN6QMP	✓				✓		✓	✓	✓			
QXM77A	✓						✓				✓	
QYYLXQ	✓			✓	✓		✓				✓	
R4NRPX	✓	✓			✓		✓		✓		✓	
RDQJ4G	✓				✓		✓				✓	ICP-OES
RLKNXH	✓				✓		✓			✓	✓	
TUJXDJ				✓	✓		✓	✓				RI
U8XKYM	✓				✓		✓	✓		✓	✓	
UKNCKQ	✓			✓	✓		✓					

TABLE 2

	Refractive Index							Elemental		UV		
WebCode	nD	nF	nC	ΔRI	Color	Density	Thickness	SEM/ EDS	XRS/ XRF	Long	Short	Other
UZEGQY	✓				✓		✓			✓	✓	ICP/MS
V4XVUY	✓				✓		✓	✓		✓	✓	
V9RM4H				✓	✓		✓					
VEDLR6	✓			✓	✓		✓					Surface Analysis
WDTZ4B	✓			✓	✓		✓	✓			✓	
XRUFZZ	✓				✓		✓				✓	
Y8MA9K	✓				✓		✓	✓			✓	
YCEJCQ								✓				FTIR
YY9MTP	✓						✓		✓		✓	
ZG7J2A	✓			✓	✓		✓		✓		✓	

Response Summary

	Refractive Index							Elemental		UV	
Participants	nD	nF	nC	ΔRI	Color	Density	Thickness	SEM/ EDS	XRS/ XRF	Long	Short
63	45	2	1	13	50	4	58	19	25	27	45
Percent	*71%*	*3%*	*2%*	*21%*	*79%*	*6%*	*92%*	*30%*	*40%*	*43%*	*71%*

Conclusions

TABLE 3

WebCode	Conclusions
2R3Q6A	Lab Item #2 could have originated from the same source as Item #1 (known fragment) or another source exhibiting all of the same analyzed characteristics.
3DWUL8	The elemental composition of all three items was consistent with a soda-lime type of glass. The composition was primarily composed of silicon, oxygen, sodium, and calcium. Enough magnesium was also present to suggest that this glass is consistent with a type of float glass which is commonly found in windows. Analysis of the major, minor, and trace elements showed that Items 1 and 2 were compositionally indistinguishable from one another, but Item 3 was different.
3TDTQ9	The fragments recovered from the suspect (Item 2) show the same results in all the analyses performed than the known glass fragments recovered from the broken bathroom window (Item 1). The fragments recovered from the suspect (Item 3) show different results in all the analyses performed than the known glass fragments recovered from the broken bathroom window (Item 1).
4CWGBJ	The glass from Item 2 is similar to Item 1 in physical characteristics, elemental composition and refractive index. The glass from Items 2 could have originated from the same source as the submitted standard (Item 1) or from a different source of broken glass with the same physical characteristics, elemental composition, and refractive index. The glass from Item 3 is different than Item 1 in color, thickness, and fluorescence. The glass from Item 3 could not have come from the same source as the submitted standard (Item 1.) Items 1, 2, and 3 were examined visually and using stereomicroscopy, polarized light microscopy (PLM), a digital caliper, and a UV light box. Items 1 and 2 were also analyzed using X-Ray fluorescence spectroscopy (XRF), and Glass Refractive Index Measurement System (GRIM3). Samples collected and analyzed during the examination of the items in this case (ex. pillboxes and glass slides) have been returned to and retained with the original items.
4F2RNM	Examination on the questioned glass fragments recovered from the suspect (Item 2) were consistent to those of the known glass fragments from the broken bathroom window (Item 1) in color, density, thickness and reaction to UV fluorescence. Examination on the questioned glass fragments recovered from the suspect (Item 3) were consistent to those of the known glass fragments from the broken bathroom window (Item 1) in color. However, questioned glass fragments (Item 3) were not consistent to those of the known glass fragments (Item 1) in density, thickness and reaction to UV fluorescence. Based on the above findings, in my professional opinion; (a) Questioned glass fragments recovered from suspect (Item 2) could have originated from the broken bathroom window as represented by Item 1. (b) Questioned glass fragments recovered from suspect (Item 3) could not have originated from the broken bathroom window as represented by Item 1.
6EL6BQ	The questioned glass fragments have been analyzed by refraction index and x-ray spectroscopy. The questioned glass fragments item 2 from the suspect could not be differentiated from item 1, from the broken bathroom window. The questioned glass fragments item 3 from the suspect are found to be different from item 1, from the broken bathroom window.
6YQKTH	Exhibit 1 (known glass fragments from the broken bathroom window) disclosed the presence of two full thickness fragments of colorless flat glass. (The two fragments are from a single source so only one fragment was tested). Exhibit 2 (questioned glass fragments) and Exhibit 3 (questioned glass fragments) each disclosed the presence of two full thickness fragments of colorless flat glass. (The two fragments within each exhibit are from a single source so only

TABLE 3

WebCode	Conclusions
	one fragment from each exhibit was tested). Comparative examinations of the glass fragment in Exhibit 1 with the glass fragment in Exhibit 2 disclosed them to be consistent in physical characteristics, refractive indices, and elemental compositions. Therefore, Exhibit 2 could have originated from the bathroom window as represented by Exhibit 1, or another source with the same characteristics (Type III Inclusion).This type of association was reached because the techniques utilized in this comparative analysis can typically distinguish most glass products. It should be noted that glass fragments can only originate from broken objects and not intact objects. Comparative examinations of the glass fragment in Exhibit 1 with the glass fragment in Exhibit 3 disclosed them to differ in physical characteristics. Therefore, Exhibit 3 could not have originated from the bathroom window as represented by Exhibit 1 (Exclusion).
769F7Q	Item 2 and Item 1 could have been originated from the same glass source or another glass source that features the same measured characteristics. Item 3 and Item 1 could not have been originated from the same glass source.
7D3HBN	The glass fragments recovered from the suspect in Exhibit 2 originated from the broken bathroom window as represented by Exhibit 1 or from another broken glass item with the same, physical, elemental, and optical properties. These combined methods of comparison have been shown to be highly discriminating between glass sources. This type of association provides very strong to extremely strong support for the proposition that the items originated from the same source as opposed to different sources. Coincidental associations of glass originating from different sources could occur but are expected to be highly unusual. Exhibit 3 was differentiated from Exhibit 1; therefore, the glass fragments recovered from the suspect in Exhibit 3 could not have come from the broken bathroom window as represented by Exhibit 1.
7LG6NX	On analysis, I found: i) The refractive index of the questioned glass fragments recovered from the suspect (Item 2) to be similar with the refractive index of the known glass fragments recovered from the broken bathroom window (Item 1). ii) The refractive index of the questioned glass fragments recovered from the suspect (Item 3) to be dissimilar with the refractive index of the known glass fragments recovered from the broken bathroom window (Item 1). Therefore, I am of the opinion that: i) The questioned glass fragments recovered from the suspect (Item 2) could have originate from the known glass fragments recovered from the broken bathroom window (Item 1). ii) The refractive index of the questioned glass fragments recovered from the suspect (Item 3) did not originate from the known glass fragments recovered from the broken bathroom window (Item 1).
7LWN4P	The questioned glass recovered from the suspect (Item 2) is associated to the known glass fragments recovered from the broken bathroom window (Item 1) upon comparison of optical, physical, and elemental properties and either originated from this item or from another item with same characteristics (Level III Association). The questioned glass recovered from the suspect (Item 3) is disassociated from the known glass fragments recovered from the broken bathroom window (Item 1) upon comparison of fluorescence and thickness (Elimination).
7VAFXT	Questioned glass fragments recovered from a suspect (Items 2 and 3) and known glass recovered from a broken bathroom window (Item 1) were compared using physical characteristics, fluorescence, refractive index measurements, and elemental analysis by X-Ray Fluorescence (XRF). The tested questioned glass fragments (Item 2) were similar in color, thickness, type (float glass), refractive index, and elemental composition to the known glass (Item 1). In the opinion of the examiner, the tested questioned glass fragments from Item 2 originated either from the window as represented by Item 1 or from another broken window with indistinguishable properties. Because similar glass has been manufactured that would be indistinguishable from the submitted evidence, an individual source cannot be determined.

TABLE 3

WebCode	Conclusions
	(Level 3 - Association) The tested questioned glass fragments (Item 3) differed in thickness, refractive index, and elemental composition from the known glass (Item 1). In the opinion of the examiner, the questioned glass (Item 3) did not originate from the broken bathroom window as represented by Item 1. (Elimination)
82DRKK	[No Conclusions Reported.]
8WWDMB	Both the known glass (Item 1) and recovered glass in Item 2 consisted of two small pieces of colourless, toughened, flat, float glass, of thickness 2.14 millimetres. In addition, the known glass (Item 1) and recovered glass (Item 2) were indistinguishable, with respect to their refractive indices, a physical property of glass, and elemental compositions. Therefore, the glass in Item 2 could have originated from the same source as the known glass (Item 1). The recovered glass in Item 3 consisted of two small pieces of toughened, non-float glass, that were also distinguishable to the known glass (Item 1) with respect to their thickness and refractive index. Therefore, the recovered glass in Item 3 could not have originated from the same source as the known glass (Item 1).
9C6PUV	The questioned glass fragments recovered from the suspect (Item 2) can come from the broken bathroom window (Item 1) or from another glass material with the same characteristics. The questioned glass fragments recovered from the suspect (Item 3) don't come from the broken bathroom window (Item 1).
AC2KTR	The questioned glass samples, Items 2 and 3, were examined and compared to the known sample, Item 1. Items 1 and 2 are similar in thickness and fluorescence; however Item 3 is different in thickness and does not exhibit fluorescence. Items were further analyzed for elemental composition and optical properties (refractive index). Known Item 1 and questioned Item 2 are both tempered flat glass, and are consistent with respect to their physical characteristics, elemental composition, and optical properties. Therefore, this glass sample from the suspect, Item 2, either came from the bathroom window, as represented by Item 1, or from another source of broken tempered flat glass exhibiting all of the same analyzed characteristics. Known Item 1 and questioned Item 3 are different in physical characteristics, elemental composition and optical properties; therefore this glass sample from the suspect, Item 3, did not come from the bathroom window, as represented by the submitted sample Item 1.
AU492H	The questioned glass fragments recovered from suspect (item 2) COULD BE originated from the glass fragments recovered from the broken bathroom window. (item 1). The questioned glass fragments recovered from suspect (item 3) COULD NOT have been originated from the glass fragments recovered from the broken bathroom window. (item 1).
BNMKFC	Neither Item 2 nor Item 3 have originated from Item 1
BP68FE	CONCLUSIONS: Two glass fragments identified as recovered from the suspect (Item 2) either originated from the bathroom window (Item 1) or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics. Two glass fragments identified as recovered from the suspect (Item 3) did not originate from the bathroom window (Item 1). RESULTS: Questioned glass fragments identified as recovered from the suspect (Items 2 and 3) were examined for the purpose of determining whether or not they are like the known glass standard from the broken bathroom window (Item 1). The known glass standard from the bathroom window (Item 1) is colorless non-tempered float sheet glass. Examination of the questioned glass fragments identified as recovered from the suspect (Item 2) revealed two full thickness glass fragments. Examination and comparison of these two questioned glass fragments with the known glass standard from the bathroom window (Item 1) revealed they

TABLE 3

WebCode	Conclusions
	are alike with respect to physical, optical, and chemical characteristics. It is therefore concluded that these two questioned glass fragments (Item 2) either originated from the bathroom window (Item 1) or another source of broken glass possessing the same distinct physical, optical, and chemical characteristics. Examination of the questioned glass fragments identified as recovered from the suspect (Item 3) revealed two full thickness glass fragments. Examination and comparison of these two questioned glass fragments with the known glass standard from the bathroom window (Item 1) revealed they are dissimilar with respect to fluorescence. It is therefore concluded that these two questioned glass fragments (Item 3) did not originate from the bathroom window (Item 1). METHODS OF ANALYSIS: Examinations were performed visually, by stereo microscopy, polarized light microscopy, ultraviolet fluorescence, micrometry, refractive index determination, and x-ray fluorescence spectroscopy.
BXZDAF	The sample in Item 1 consists of two colorless glass fragments that exhibit characteristics consistent with non-tempered float sheet (window) glass. These fragments have their full thickness and were used as standards for comparison to the glass in Items 2 and 3. Item 2 consists of two glass fragments that have their full thickness and exhibit characteristics consistent with non-tempered float sheet (window) glass. Macroscopic, microscopic and instrumental examinations and comparisons of Items 1 and 2 revealed that these questioned glass fragments are like the glass standard in Item 1 with respect to their color, thickness, refractive index values and chemical characteristics. It is therefore concluded that the glass fragments represented as having been recovered from the subject originated either from the broken bathroom window of the residence or from another source of broken non-tempered float sheet glass having these same characteristics. Item 3 consists of two glass fragments that have their full thickness and exhibit characteristics consistent with non-tempered, non-float, sheet (window) glass; no fluorescent original surface is present, which is an exclusionary difference compared to the Item 1 glass standard. (Macroscopic and microscopic examinations also revealed that these fragments have a very slight tinge of light blue-green color to them, compared to the colorless glass in the Item 1 standard.) Exclusionary differences between Item 3 and Item 1 were also observed with respect to their chemical compositions. It is therefore concluded that the Item 3 glass could not have come from the source of the Item 1 glass standard.
C7KGMW	Glass recovered from the suspect as represented by Item 2 is indistinguishable from glass from the broken bathroom window as represented by Item 1. Accordingly, the Item 2 glass fragments originated either from the broken bathroom window (Item 1) or from another source of broken glass indistinguishable in all of the measured or observed physical properties, refractive index, and elemental composition. See “Inclusion” in the Interpretation Section, below. Glass recovered from the suspect as represented by Item 3 is different from glass from the broken bathroom window as represented by Item 1. Therefore, the Item 3 glass fragments are eliminated as originating from the broken window (Item 1). See “Exclusion” in the Interpretation Section, below. [Table 4: Additional Comments]
C9DRR9	I formed the opinion based on the techniques used, that the glass fragments recovered form the suspect (item 2) had the same appearance and refractive index as the control glass collected from the broken bathroom window (item 1) and could have originated from it. I also formed the opinion based on the techniques used, that the glass fragments recovered from the suspect (item 3) had a different thickness and refractive index as the control glass collected from the broken bathroom window (item 1) and could not have originated from it.
C9QJKP	The glass fragments recovered from the suspect (Item #2) compare by physical, elemental, and optical properties to the glass fragment recovered from the bathroom window (Item #1), indicating that they could have come from the same piece of glass or another glass source

TABLE 3

WebCode	Conclusions
	with indistinguishable properties. The glass fragments recovered from the suspect (Item #3) do not compare to the glass fragments recovered from the bathroom window (Item #1).
CK89JV	Examination and comparison of representative glass in Items 1 and 2 were found to be similar in all measured physical and optical properties, and elemental composition. They could have come from the same source or any other source with the same properties/composition. Examination and comparison of representative glass from Items 1 and 3 were found to be dissimilar in all measured physical and optical properties. They could not have come from the same source.
F46ZQX	The questioned glass fragments (Items 2 and 3) recovered from the suspect were found to be strongly similar to the known glass fragment (Item1) recovered from the broken bathroom window.
FLM49J	The questioned glass in Item 2 is consistent with the known glass in Item 1 on the basis of color, luminescence, thickness, refractive index, and elemental composition. Therefore, the questioned glass in Item 2 could have originated from the known glass in Item 1. The questioned glass in Item 3 is not consistent with the known glass in Item 1 on the basis of thickness, refractive index, and elemental composition.
GDL4B3	The glass recovered from the broken bathroom window (item 1) was found to be composed of clear, colourless float glass. The glass recovered from the suspect (item 2) was found to consist of clear, colourless float glass. In relation to colour, thickness, fluorescence properties, refractive index and elemental composition these two fragments were found to be indistinguishable to the glass recovered from the broken bathroom window (item 1). Therefore the glass from these items may share a common origin. The two fragments of glass recovered from the suspect (item 3) were found to consist of clear, colourless non-float glass. These fragments were also found to have a slightly different thickness to the glass recovered from the broken bathroom window and therefore could not have originated from the window.
GN7FME	The following methodologies were used in the examination of this case: visual examination, physical examination, microscopy, digital calipers, UV fluorescence, XRF and GRIM3. Analysis showed the known glass fragments recovered from the broken bathroom window (item #1) and the questioned glass fragments recovered from the suspect (item #2) were consistent in physical properties, refractive index, and elemental composition. These fragments could have shared a common origin. Analysis showed the known glass fragments recovered from the broken bathroom window (item #1) and the questioned glass fragments recovered from the suspect (item #3) were not consistent in physical properties and elemental composition. These fragments could not have shared a common origin.
GT2ZXP	Item 1 comprised two full thickness fragments of colourless float glass collected from the broken bathroom window (control glass). Item 2 comprised two full thickness fragments of colourless float glass. These fragments corresponded in thickness, average refractive index and trace elemental composition to the control glass (Item 1). These results strongly support the proposition that the fragments recovered from the suspect originated from the broken bathroom window. Item 3 comprised two full thickness fragments of colourless glass. These fragments differed in thickness and average refractive index to the control glass (Item 1). These results do not support the proposition that the fragments recovered from the suspect originated from the broken bathroom window.
HD8YEP	Item 2 could have originated from the same source as Item 1 based on the physical characteristics (color and thickness) and trace elemental composition. However, Item 3 is not originated from the same source as Item I since the thickness and elemental compositions are

TABLE 3

WebCode	Conclusions
	different from Item 1.
HJT79E	The chemical composition of all three samples was determined with LIBS and XRF. In addition, the density of the samples was determined. The results of the three analyses provide the following result: Item 2 originates from item 1. Item 3 has a different origin.
HK269Q	Based on the analysis of triplicate 2-4 mg portions of glass fragments by Inductively Coupled Plasma - Mass Spectrometry (ICP-MS) the concentrations of 46 elements in Item 2 were not distinguishable from the concentration of those elements in Item 1. The concentrations of 32 elements in Item 3 were distinguishable from the concentration of those elements in Item 1. Based on the results Item 2 could have originated from Item 1 and Item 3 could not have originated from Item 1.
HXAPU4	Item 1 and 2 were examined by stereomicroscopy, micrometry, ultraviolet light fluorescence, X-ray fluorescence spectroscopy, and refractive index determination. Item 3 was examined by stereomicroscopy, micrometry, and ultraviolet light fluorescence. Glass found in Item 2 was indistinguishable from the glass in Item 1 in optical, physical, and elemental properties (Type 3 Association). This means the glass fragments recovered from the suspect, labeled as Item 2, could have come from the broken bathroom window. Glass found in Item 3 was different from the glass in item 1 (Elimination). This means the glass fragments recovered from the suspect, labeled as Item 3, did not come from the broken bathroom window.
J3GHH9	All three items were identified as fragments of clear, colourless window/sheet glass. Item 1 was considered a possible source for Item 2, due to similar morphological properties such as thickness, and similar elemental compositions. Item 1 was not considered a possible source for Item 3, due to a difference in thickness and differences in elemental composition.
J8FZT9	The known glass from the broken bathroom window (item 1) and the questioned glass from the suspect (item 2) exhibit the same physical, optical, microscopic and chemical properties. Therefore, the questioned glass from the suspect (item 2) originated from the broken bathroom window or another broken glass with the same physical, optical, microscopic and chemical properties. The known glass from the broken bathroom window (item 1) and the questioned glass from the suspect (item 3) have different physical properties. Therefore, the questioned glass from the suspect (item 3) could not have originated from the broken bathroom window.
JHWVGK	1. The questioned glass marked “Item 2” could have originated from the same source as the known glass marked “Item 1”, or another source of glass with similar characteristics. 2. The questioned glass marked “Item 3” did not originate from the same source as the known glass marked “Item 1”.
JNHNTK	There is a high probability that item 2 has originated from the bathroom window. It can be excluded that item 3 has originated from the bathroom window.
JV3RZM	The glass from item-2 (questioned glass fragments recovered from the suspect) and the item-1 (known glass fragments recovered from the broken bathroom window) were consistent and could have the same source. The glass from item-3 (questioned glass fragments recovered from the suspect) and the item-1 (known glass fragments recovered from the broken bathroom window) were inconsistent and could not have the same source.
LEN3X7	The possible glass recovered from the suspect (item 2) was determined to be glass that is similar in color, thickness, fluorescence, elemental composition, and refractive index to the glass from the broken bathroom window (item 1). It is our opinion that the glass from the suspect could share a common origin to the glass from the broken bathroom window (item 1).

TABLE 3

WebCode	Conclusions
	The possible glass from the suspect (item 3) was determined to be glass that is dissimilar in thickness to the glass from the broken bathroom window (item 1). It is our opinion that the glass from the suspect did not originate from the same source as the submitted glass from the broken bathroom window (item 1).
LF3PCE	The results of the examination are considered under the following two hypotheses: H1: one or more float glass fragments from the examined items originate from the broken window. H2: all float glass fragments originate from (an)other glass pane. For item 2: The results of the examination are much more likely (100-10.000) if hypothesis 1 is true then if hypothesis 2 is true. For item 3: The elemental composition of the float glass traces is different from the elemental composition of the reference glass from the broken window. Hypothesis 1 can therefore be rejected and hypothesis 2 must be true.
LKVWR3	1. Comparative examinations of Exhibit 1 (known glass standard from bathroom window) with Exhibit 2 (questioned glass from the suspect) disclosed them to be consistent in their physical characteristics, ultraviolet fluorescence, refractive indices, and elemental compositions. As a result of these findings, Exhibit 2 could have originated from the source represented by Exhibit 1 or another source with the same characteristics. 2. A glass association is not a positive means of identification and the number of possible sources for a specific glass is unknown. 3. Comparative examinations of Exhibit 1 (known glass standard from bathroom window) with Exhibit 3 (questioned glass from the suspect) disclosed them to be inconsistent with respect to ultraviolet fluorescence, refractive indices, and elemental compositions. As a result of these findings, Exhibit 3 could not have originated from the source represented by Exhibit 1.
LPAF76	The results give moderate support to the hypotesis that Item 2 originates from the source Item 1. The hypothesis is held against the alternative, claiming that Item 2 has another origin/source, different from Item 1 (+2). The results give very strong support to the hypothesis that Item 3 originates from a source different from Item 1. The hypothesis is held against the alternative, claiming that Item 3 has the same origin/source as Item 1 (-3).
MB4VQH	Based on applied methods, the evidence (elemental composition of glass samples as well as the thickness measurements) provides support for the proposition that questioned glass fragments recovered from the suspect described as Item 2 could have originated from the broken bathroom window (Item 1) wile questioned glass fragments recovered from the suspect described as Item 3 could not have originated from the broken bathroom window (Item 1).
NEGZYC	Glass shards in Item 2 are similar glass to those in Item 1 regarding colour, thickness and glass grade. Glass shards in Item 3 are different glass from those in Item 1 regarding glass grade.
NN6QMP	Item 2 is indistinguishable from item 1 in terms of glass thickness, color, refractive index and elemental composition. This suggests that item 2 could have originated from item 1. Item 3 can be distinguished from item 1 based on the examination procedures performed.
QXM77A	The glass sample in item 2 was indistinguishable from the control source in terms of the tests employed. In my opinion, the glass sample in item 2 could have originated from the broken bathroom window, as represented by item 1. The glass sample in item 3 was distinguishable from the control source in terms of the tests employed. In my opinion, the glass sample in item 3 could not have originated from the broken bathroom window, as represented by item 1.
QYYLXQ	The glass sample recovered as Test Item 2 was found to show agreement in physical characteristics, Refractive Index and thermal history with the control glass Test Item 1 such that, in our opinion, they could have had a common origin. The glass sample recovered as Test Item 3 was found to show differences in physical characteristics and Refractive Index to

TABLE 3

WebCode	Conclusions
	the control glass Test Item 1 such that they could not have had a common origin.
R4NRPX	The glass fragments recovered from the broken bathroom window (item 1) did match in all investigated parameters with the questioned glass fragments of item 2, recovered from the suspect. That means, it is possible, that glass fragments of item 1 and of item 2 have the same source. The glass fragments recovered from the broken bathroom window (item 1) did not match in thickness, refractive index, XRF and UV-Flourescence with the questioned glass fragments of item 3, recovered from the suspect. That means the glass fragments of item 1 and item 3 have not the same source.
RDQJ4G	Glass recovered from the suspect (Item 2) is indistinguishable from glass from the bathroom window (Item 1). Consequently, the glass from the suspect (Item 2) either originated from the bathroom window (Item 1) or from another source of broken glass indistinguishable in all of the measured or observed physical properties, refractive index, and elemental composition. Glass recovered from the suspect (Item 3) is different in thickness from glass from the bathroom window (Item 1). Consequently, the glass from the suspect (Item 3) did not originate from the same source as the glass from the bathroom window (Item 1).
RLKNXH	The two (02) fragments of questioned glass recovered from the suspect (item2) have the same physical properties (thikness, colour, fluorescence and refractive index) to the two (02) fragments of known glass recovered from the broken bathroom window (tem01), therefore, the two (02) fragments of questioned glass recovered from the suspect (item2) could have originated from the glass of broken bathroom window or from another source exhibiting the same physical properties. The two (02) fragments of questioned glass recovered from the suspect (item3) have not the same physical properties (thikness, colour, fluorescence and refractive index) to the two (02) fragments of known glass recovered from the broken bathroom window (tem01), therefore, the two (02) fragments of questioned glass recovered from the suspect (item3) have not originated from the glass of broken bathroom window.
TUJXDJ	In my opinion Items 1 and 2 are indistinguishable by the properties tested. Therefore, in my opinion the findings provide moderately strong support that Item 2 originates from the same window as Item 1 rather than the view that they originate from different windows. In my opinion Item 3 is different from Item 1 by the properties tested. Therefore in my opinion Item 3 has not originated from the bathroom window as represented by Item 1.
U8XKYM	Two particles of questioned glass fragments recovered from the suspect (Item 3) are different from two known glass fragments recovered from the broken bathroom window (Item 1) in refractive index. Two particles of questioned glass fragments recovered from the suspect (Item 2) are consistent with two known glass fragments recovered from the broken bathroom window (Item 1) in color, thickness, UV fluorescence, refractive index, elemental composition and Raman spectrum. Item 2 could have originated from the broken bathroom window. Item 3 could not have originated from the broken bathroom window.
UKNCKQ	The sample of glass from the broken bathroom window (item 1) contained pieces of colourless, non-toughened, float glass with a thickness of approximately 2.18 mm (millimetres). The two samples of glass from the suspect (items 2 and 3) both contained two pieces of glass. These pieces of glass were compared to the glass from the broken bathroom window by their appearance, thickness and refractive indices. The two pieces of glass in item 2 were both colourless, non-toughened, float glass. These two pieces of glass had the same thickness and refractive indices as the glass from the bathroom window and therefore could have come from this window. However, other sources of glass are possible. Surveys show that approximately 0.8% of vehicle glass would have the same thickness and refractive index as these pieces of glass. In my opinion, the correspondence found strongly supports the

TABLE 3

WebCode	Conclusions
	suggestion that the pieces of glass in item 2 have come from the broken bathroom window. The two pieces of glass in item 3 were both colourless, non-toughened, non-float glass with a thickness of approximately 2.26 mm and therefore were a different type of glass with a different thickness compared to the glass from the bathroom window. These pieces of glass in item 3 also had a different refractive index value to the glass from the broken bathroom window. Therefore, in my opinion, the pieces of glass in item 3 have not come from the broken bathroom window.
UZEGQY	Physical, microscopic, and instrumental analysis and comparison of the glass from Item 2 to the glass from Item 1 revealed them to be the same with respect to physical properties, optical properties, and elemental composition. This is an association with highly discriminating characteristics. Therefore, the glass from Item 2 came from the source represented by the glass from Item 1 or another source of broken glass with identical physical properties, optical properties, and elemental composition. Physical analysis and comparison of the glass from Item 3 to the glass from Item 1 revealed them to be different with respect to optical properties. Therefore, the source represented by the glass from Item 1 is excluded as a possible source of the glass from Item 3. Results were confirmed by the following instrumentation: polarized light microscope, digital calipers, glass refractive index measurement system, and inductively coupled plasma mass spectrometry.
V4XVUY	The glass in item 2 was visually, microscopically and instrumentally (refractive index and elemental composition) consistent with the glass in item 1. This indicates that the glass in item 2 could have originated from the glass in item 1 or any other glass with the same physical and chemical characteristics. The glass in item 3 was visually (color and fluorescence) and instrumentally (refractive index) different from the glass in item 1. This indicates that the glass in item 3 did not originate from the glass in item 1.
V9RM4H	The refractive index measurements of the questioned glass fragment Item 2 match the refractive index measurements of the known glass fragments Item 1 and are undistinguishable. The refractive index measurements of the questioned glass fragment Item 3 do not match the refractive index measurements of the known glass fragments Item 1. The questioned glass fragments recovered from the suspect Item 2 could have originated from the known sample Item 1 recovered from the bathroom broken window.
VEDLR6	The above glass finding [See Tables 1 and 2] provide moderate support for the view that the matching glass fragments (item 2) recovered from the suspect originated from the bathroom window (item 1), rather than from another source. Note: No inference on the activity that led to the presence of the glass can be made. The remaining questioned glass fragments (item 3) did not originate from the bathroom window, they originated from another source.
WDTZ4B	The results give support for the hypothesis that the examined piece of glass in Item 2, from the suspect, originate from the broken bathroom window, represented by Item 1 (Level +2). The examined piece of glass in Item 3, from the suspect, does not originate from the broken bathroom window, represented by Item 1 (exclusion).
XRUFZZ	The glass fragments Item 1 and Item 2 are both float glasses, have a thickness of around 2.16 mm and cannot be differentiated by their refractive indices. The glass from Item 3 has a thickness of around 2.24 mm and shows no fluorescence on the surfaces in the UV-light. Item 3 also differs in its refractive indices from Item 1. Item 1 and Item 2 cannot be differentiated. But the glass fragments Item 1 and Item 3 can be diffrentiated by their glass-type, by their thickness and by their refractive indices.
Y8MA9K	The known glass sample item 1 comprised two colourless glass fragments of identical

TABLE 3

WebCode	Conclusions
	thickness. The questioned glass sample item 2 comprised two glass fragments, both found to agree in colour, thickness, UV fluorescence, elemental composition and refractive index with the known glass sample item 1. The questioned glass sample item 3 comprised two glass fragments, both found to differ in thickness and UV fluorescence from the known glass sample item 1. The above findings suggested that the questioned glass fragments in item 2 could have originated from the same source as the known glass fragments in item 1, whilst the glass fragments in item 3 did not.
YCEJCQ	Based on the SEM/EDS analysis it is concluded that Item 2 cannot be excluded from having originated from Item 1. However, Item 3 could not have originated from Item 1. This is based on the presence of Sn on side B of items 1 and 2, which is absent in item 3 and the presence of K on side B of item 3, which is absent in items 1 and 2. These results are consistent with those from the FTIR analysis.
YY9MTP	The questioned glass from Item #2 was consistent in thickness, optical properties and chemical composition with the known glass from Item #1; therefore, Items #1 and #2 could have originated from the same source (Level III association). The questioned glass from Item #3 was dissimilar in thickness from the known glass from Item #1; therefore, Item #3 and Item #1 did not originate from the same source (elimination). Terminology Key for Associative Evidence: The following descriptions are meant to provide context to the levels of opinions reached in this report. Every level of conclusion may not be applicable in every case nor for every material type. Level I Association: A physical match; items physically fit back to one another, indicating that the items were once from the same source. Level II Association: An association in which items are consistent in observed and measured physical properties and/or chemical composition and share atypical characteristic(s) that would not be expected to be readily available in the population of this evidence type. Level III Association: An association in which items are consistent in observed and measured physical properties and/or chemical composition and, therefore, could have originated from the same source. Because other items have been manufactured that would also be indistinguishable from the submitted evidence, an individual source cannot be determined. Level IV Association: An association in which items are consistent in observed and measured physical properties and/or chemical composition and, therefore, could have originated from the same source. As compared to a Level III association, items categorized within a Level IV share characteristics that are more common amongst these kinds of manufactured products. Alternatively, an association between items would be categorized as a Level IV if a limited analysis was performed due to the characteristics or size of the specimen(s). Level V Association: An association in which items are consistent in some, but not all, physical properties and/or chemical composition. Some minor variation(s) exists between the known and questioned items and could be due to factors such as sample heterogeneity, contamination of the sample(s), or having a sample of insufficient size to adequately assess the homogeneity of the entity from which it was derived. Inconclusive: No conclusion could be reached regarding an association/elimination between the items. Elimination: The items were dissimilar in physical properties and/or chemical composition, indicating that they did not originate from the same source.
ZG7J2A	The customer did not mention, from which object the items 2 and 3 were taken (garments, shoes, hair combings, floor of house or car …). Therefore, no background data could be applied. The final statement has to be on source level: The known glass sample from the broken bathroom window (item 1) could not be distinguished from the glass fragments recovered from the victim (item 2), but they could be well distinguished from the other sample, also recovered from the suspect (item 3). Hence, the results strongly indicate that some glass fragments found at the suspect (item 2) originate from the smashed bathroom window at the

TABLE 3

WebCode	Conclusions
	scene of crime (item 1). Due to the mass product character of glass products, a different source cannot be excluded with certainty. Among a casework database, which consists of 3987 control glass items, there was only one item, which matched the glass particles from the scene of crime (item 1) with respect to glass type, tinge, thickness and refractive index. The combination of these traits is therefore rare. No statement can be given with respect to the actions, which led to the transfer of the glass particles.

Additional Comments

TABLE 4

WebCode	Additional Comments
2R3Q6A	a) The examination of lab Item #2 and comparison to lab Item #1 disclosed that they are consistent and no exclusionary differences were observed with respect to color, appearance, thickness, UV fluorescence, elemental composition and refractive index. b) The exam of lab Item #3 and comparison to lab Item #1 disclosed that they are different with respect to thickness, UV fluorescence and elemental composition.
769F7Q	Average thickness [mm]: Item 1: 2.179; Item 2: 2.177; Item 3: 2.257 Average n(D): Item 1: 1.51878; Item 2: 1.51892; Item 3: 1.51668 Average n(C): Item 1: 1.52068; Item 2: 1.52082 Average n(F): Item 1: 1.51384; Item 2: 1.51396 SEM/EDS: Item 1 and Item 2: O, Si, Ca, Mg, Na, Al, K. Item 3: O, Si, Ca, Mg, Na, Al, K, Fe.
7D3HBN	When possible, agencies should submit at least 10 fragments from the known broken glass object so minor variations within the glass object can be assessed.
7LWN4P	Level of Association: Level I Association: A physical fit; items physically fit and/or align one another by way of corresponding surface characteristics. The associated items were once joined together to form a single item. Level II Association: Items correspond in all tested properties and share atypical characteristic(s) that would not be expected to be readily available in the population of this evidence type. No exclusionary differences are detected. Level III Association: Items correspond in all tested properties and, therefore, could have originated from the same source. Other items have been manufactured and/or are naturally occurring that would also correspond to the submitted evidence. No exclusionary differences are detected. Level IV Association: Items correspond in tested properties and, therefore, could have originated from the same source. The items share typical characteristics expected to be readily available in the population of this evidence type. No exclusionary differences are detected. Alternatively, an association between items could be categorized as a Level IV Association if a limited analysis is performed. The extent of limited analysis varies and is specified in the report. Definitions: Physical Fit: Associated items physically fit and/or align one another by way of corresponding surface characteristics. The associated items were once joined together to form a single item. Associated: The questioned sample is the same distinct type of material as the known standard based upon detected properties. In other words, one could not discern a questioned sample if it were to be mixed with an associated known standard. No exclusionary differences are detected. Disassociated: Exclusionary differences are detected upon comparison. Inconclusive: No conclusion could be reached regarding an association or an elimination. Elimination: The sample did not originate from the source represented by the known standard. Samples are disassociated from the standard due to detecting exclusionary differences upon comparison.
AC2KTR	The questioned glass Item 3 may be resubmitted for additional comparison(s), should a suspected source of similar glass become available. Methods of Analysis: Items analyzed using a combination of stereomicroscopy, high power and polarized light microscopy, and ultraviolet light examination. Micro X-ray Fluorescence Spectrometry (u-XRF) was used to analyze elemental composition. An automated Glass Refractive Index Measurement system (GRIM) was used to analyze optical properties (refractive index) of one piece from each item. XRF and GRIM are standard instrumental techniques. XRF data was compared using spectral overlay and elemental ratio comparisons.
BXZDAF	Examinations on the glass in Items 1, 2 and 3 were performed macroscopically, and by use of stereomicroscopy, ultraviolet fluorescence, a micrometer for thickness measurements, and x-ray fluorescence spectrometry. Items 1 and 2 were examined further using a refractive index measurement system.
C7KGMW	Sections about methods used, interpretations, limitations, reporting requirements, and

TABLE 4

WebCode	Additional Comments
	availability of laboratory notes and documentation would also be included in a report of examination.
C9DRR9	Elemental analysis not undertaken by this laboratory.
HJT79E	Density Item 1=2,4963 g/cm3, Density Item 2=2,4961 g/cm3, Density Item 3=2,4760 g/cm3
HXAPU4	Type 3 Association: Association with Conventional Characteristics: Items are consistent in all measured and observed physical properties, chemical composition, and/or microscopic characteristics, and therefore could have originated from the same source. Because other items have been manufactured or are naturally occurring that would also be indistinguishable from the submitted evidence, an individual source cannot be determined. Elimination: Items exhibit differences in one or more of the following: physical properties, chemical composition, or microscopic characteristics and therefore did not originate from the same source. It would also be helpful for report wording to not have both Q items with the same exact description.
J3GHH9	The distance between original surfaces (thickness) in both Item 1 and Item 2 was measured to be 2.16 mm. All elements observed under x-ray microfluoresence were present in similar %Wt concentrations. The distance between original surfaces in Item 3 was 2.23 mm. Furthermore, the elemental composition showed lower wt% calcium (Ca) and higher wt% potassium (K), aluminium (Al), iron (Fe) and sodium (Na) than Items 1 and 2. It was considered possible that Item 1 was a source of Item 2. It was not considered possible that Item 1 was a source of Item 3.
JHWVGK	3. The refractive indices for Item 1 to Item 3 were found to be: Item 1: 1.51894 to 1.51910 Item 2: 1.51895 to 1.51909 Item 3: 1.51685 to 1.51697 4. Item 1 to Item 3 were each found to consist of two pieces of clear colourless glass fragments. 5. The questioned glass marked “Item 2” was found to have no exclusionary differences in terms of colour, thickness, fluorescence, refractive index and elemental composition with the known glass marked “Item 1”. 6. The questioned glass marked “Item 3” was found to have no exclusionary differences in terms of colour, but different in terms of thickness, fluorescence, refractive index and elemental composition with the known glass marked “Item 1”.
MB4VQH	The thickness of glass fragments from item 3 differed from glass fragments from item 1 and item 2. Although accordingly, internal procedure LR calculation was introduced into quantitative element composition delivered by SEM/EDX clear differences in qualitative elemental composition were detected between item 1 and 2 vs Item 3 (ie., lack of K and Fe elements for item 1 and 2 wile presence of both elements for item 3).
QYYLXQ	It was unusual to encounter cubed glass that did not exhibit a typical toughened delta RI.
RDQJ4G	Our lab requests that as much of the known broken window be submitted as possible. Of these numerous submitted fragments, seven are analyzed for Refractive Index and three are analyzed for composition using an ICP-OES. We do this because our goal is to capture the full variability of the known glass. If we only capture some of the variability of the known glass, then the chances of a false exclusion increase significantly. CTS only sends two fragments of the known glass. An examination of my ICP-OES data show that the limited known glass fragments come very close (but not quite) to creating a false exclusion. In addition, four questioned fragments were submitted (two each for Items 2 and 3). The CTS claims that we can treat each Item (consisting of two fragments) as having come from a single source, however we would never make that assumption and would instead treat all four fragments as separate items. In both of these examples, the CTS test violates standard operating procedures that were designed to prevent errors from occurring in casework.
TUJXDJ	In live casework I would have sought further information in an attempt to evaluate the findings

TABLE 4

WebCode	Additional Comments
	at activity level rather than source level only. In my opinion it was not possible to comment at activity level because I was provided with no information regarding transfer and persistence issues. Information required would include: specific time delays between possible contact with the breaking and/or broken glass and clothing recovery; activity of the suspect before arrest; method of breaking of glass. I would also have liked to know whether any any other glass was recovered from the clothing? Whereabouts on the clothing was the glass recovered from? What were the retention properties of the clothing? Were any other individuals involved? Did different officers recover the control glass and arrest the suspect? Was there any damage on the clothing?
UZEGQY	Definitions are provided at the end of every glass report. DEFINITIONS: Association with Highly Discriminating Characteristics: This type of conclusion is reached because coincidental associations of glass originating from different sources could occur but are expected to be highly unusual. These glass fragments were associated based on characterization by elemental analysis by ICP-based methods in combination with optical or physical measurements. The estimated random match probability of the measured properties is very small. Association with Limitations: This type of conclusion is reached due to the limited number of characteristics available for comparison between the known and questioned sample. Limited sample or sample condition reduced the applicable analytical scheme to optical and physical measurements only, thereby limiting characterization. The estimated random match probability of the measured properties is relatively high. Inconclusive: This conclusion is reached when the questioned glass is insufficient to do most examinations (e.g. physical/optical examinations can identify it as glass but sample is too small for other comparison methods). Exclusion/Elimination: Physical, elemental, or optically exclusionary differences were observed between the compared glasses.
VEDLR6	Scale: I have chosen the above phrase [Table 3: Conclusions] from the following scale - weak support, moderate support, moderately strong support, strong support, very strong support, extremely strong support.
ZG7J2A	The following methods were applied: determination of the manufacturing process (i.e. float / non float) by UV fluorescence, comparison of the thickness, visual comparison of the colour, comparison of the refractive index in the original and annealed state, comparison of the semi quantitative elemental composition by x-ray fluorescence. The following match criteria were applied: Refractive index: Ten measurements were made at each sample. Then a Student-t-test was conducted where p-values above 1 percent would be assessed as a match. Elemental composition: Ten measurements were made at the original (antifloat-) surface of each sample. Semiquantitative analysis was performed for the 8 elemental ratios Ca/Mg, Ca/Ti, Ca/Fe, Ca/K, Ca/Na, Ca/Al, Ca/Mn and Ca/Sr calculated from the net intensities. A match was stated if the mean of the questioned sample matched the mean of the known sample plus/minus the threefold standard deviation of the known sample.

-End of Report-
(Appendix may follow)

Collaborative Testing Services ~ Forensic Testing Program

Test No. 23-5481: Glass Analysis

DATA MUST BE SUBMITTED BY **Aug. 07, 2023, 11:59 p.m. EDT** TO BE INCLUDED IN THE REPORT

Participant Code: U1234A WebCode: QH9YAD

The Accreditation Release section can be accessed by using the "Continue to Final Submission" button above. This information can be entered at any time prior to submitting to CTS.

Scenario:
Police were called to a crime scene at a residential house. They determined the point of entry to be the broken bathroom window and recovered glass fragments. The next morning, police apprehended a suspect and recovered glass fragments similar to those collected at the crime scene. Investigators are asking you to compare the glass fragments recovered from the suspect with the fragments recovered from the broken bathroom window and report your findings.

Please Note:
-Samples contained within each individual item are from a single source.
-CTS will not reproduce Interpretation Scales, Scale of Conclusions or Terminology Keys in the final report, please do not submit with the participant's data sheet.

Items Submitted (Sample Pack GL):
Item 1: Known glass fragments recovered from the broken bathroom window.
Item 2: Questioned glass fragments recovered from the suspect.
Item 3: Questioned glass fragments recovered from the suspect.

1.) Could the questioned glass fragments recovered from the suspect (Item 2 and Item 3) have originated from the broken bathroom window as represented by Item 1?

	Yes	No	Inconclusive
Item 2:	○	○	○
Item 3:	○	○	○

2.) Indicate the procedure used to examine the submitted items:

Refractive Index:		UV Fluorescence:		
☐ nD	☐ nC	☐ Long	☐ Color	☐ Thickness
☐ nF	☐ Δ RI	☐ Short	☐ Density	
		Elemental Analysis:		
☐ SEM/EDS	☐ XRS/XRF			

Other:

Please note: *Any additional formatting applied in the free form space below will not transfer to the Summary Report and may cause your information to be illegible. This includes additional spacing and returns that present your responses in lists and tabular formats.*

3.) What would be the wording of the Conclusions in your report?

4.) Additional Comments

RELEASE OF DATA TO ACCREDITATION BODIES

The Accreditation Release is accessed by pressing the "Continue to Final Submission" button online and can be completed at any time prior to submission to CTS.

CTS submits external proficiency test data directly to ASCLD/LAB, ANAB, and/or A2LA. Please select one of the following statements to ensure your data is handled appropriately.

○ This participant's data is intended for submission to ASCLD/LAB, ANAB, and/or A2LA. (Accreditation Release section below must be completed.)
○ This participant's data is **not** intended for submission to ASCLD/LAB, ANAB, and/or A2LA.

Have the laboratory's designated individual complete the following steps
only if your laboratory is accredited in this testing/calibration discipline
by one or more of the following Accreditation Bodies.

Step 1: Provide the applicable Accreditation Certificate Number(s) for your laboratory

ANAB Certificate No.
(Include ASCLD/LAB Certificate here)

A2LA Certificate No.

Step 2: Complete the Laboratory Identifying Information in its entirety

Authorized Contact Person and Title

Laboratory Name

Location (City/State)