

APPENDIX A

Scenario Results Data Tables

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Table A: Summary Results for All Scenarios (see notes for explanation of column titles)

Scenario	Lamp type	Maximum ^a	< 300 ^b	1 hour Ave ^c	8 hour Ave ^d	24 hour Ave ^e
S1 Three trials at two heights <ul style="list-style-type: none"> Break on wood floor with no lamp cleanup or ventilation. Measure air concentration continuously until highest concentration is reached. 	"Brand A" 14watt, 60 watt equivalent	At 5 feet: 176 962 499 At 1 foot: 8,533 34,954 23,244	At 5 feet: 0 18.00 1.41 At 1 foot: 18.75 10.34 60+	At 5 feet: 133 254 120 At 1 foot: 269 319 624		
S2 Three trials at two heights <ul style="list-style-type: none"> Break on wood floor. Ventilate room. Clean up glass over 3/8" by hand, clean smaller pieces with index cards, tape and wet wipe, and remove waste from room. Measure continuously 	"Brand A" 14watt, 60 watt equivalent	At 5 feet: 745 765 489 At 1 foot: 10,040 9,173 17,569	At 5 feet: 2.25 1.83 1.42 At 1 foot: 2.00 0.66 4.00	At 5 feet: 108 (30 min. average) 26 29 At 1 foot: 199 (30 min. average) 50 126		
S3 Four trials at two heights <ul style="list-style-type: none"> Break on short pile rug. Otherwise same as S2. 	"Brand A" 14watt, 60 watt equivalent	At 5 feet: 1,200 811 533 535 At 1 foot: 10,788 6,033 10,606 5,866	At 5 feet: 5.5 7.33 4.83 3.84 At 1 foot: 5.67 7.08 6.17 6.59	At 5 feet: 121 (30 min. average) 115 78 94 At 1 foot: 140 127 142 108	At 1 foot: 23	

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Scenario	Lamp type	Maximum ^a	< 300 ^b	1 hour Ave ^c	8 hour Ave ^d	24 hour Ave ^e
S4 Three trials at two heights <ul style="list-style-type: none"> Long pile “shag” rug. Otherwise same as S2. 	“Brand A” 14watt, 60 watt equivalent	At 5 feet: 651 258 544 At 1 foot: 22,176 6,564 8,262	At 5 feet: 2.66 0 5.33 At 1 foot: 9.50 1.41 3.33	At 5 feet: 72 53 73 At 1 foot: 159 72 126		
S5 Three trials at two heights <ul style="list-style-type: none"> Short pile rug. Ventilate room. Clean up glass over 3/8” by hand, vacuum with Kenmore canister vacuum, and remove waste pieces and vacuum bag from room. Measure continuously/ take discrete measurements at vacuum locations. 	“Brand A” 14watt, 60 watt equivalent	At 5 feet: 628 328 315 At 1 foot: 18,578 8,815 3,953	At 5 feet: 5.25 1.66 5.5 At 1 foot: 7.83 2.08 5.83	At 5 feet: 97 123 61 At 1 foot: 202 128 77		

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Scenario	Lamp type	Maximum ^a	< 300 ^b	1 hour Ave ^c	8 hour Ave ^d	24 hour Ave ^e
<p>S5T3 Re-vacuum: One trial at two heights</p> <ul style="list-style-type: none"> No new bulbs were broken as part of this scenario. This was a revacuum of S5T3 short nap carpet. It was vacuumed by a Kenmore beater vacuum as part of S5T3. During this scenario, a non beater Hoover 400 wand vacuum was used and the room was not ventilated³⁵. 	<p>“Brand A”</p> <p>14watt, 60 watt equivalent</p> <p>Broken and cleaned up 28 days earlier.</p>	<p>At 5 feet: 72</p> <p>At 1 foot: 130</p>	<p>At 5 feet: 0</p> <p>At 1 foot: 0</p>	<p>At 5 feet: 57</p> <p>At 1 foot: 40</p>	<p>At 5 feet: <20</p> <p>At 1 foot: 13</p>	
<p>S6 Three trials at two heights</p> <ul style="list-style-type: none"> Long pile “shag” rug. Vacuumed with Dirt Devil Power Sweeper. Otherwise same as S5. 	<p>“Brand A”</p> <p>14watt, 60 watt equivalent</p>	<p>At 5 feet: 350 414 236</p> <p>At 1 foot: 1,811 16,942 1,811</p>	<p>At 5 feet: 2.16 1.67 0</p> <p>At 1 foot: 3.33 3.08 2.16</p>	<p>At 5 feet: 99 72 48</p> <p>At 1 foot: 86 133 41</p>		
<p>SA Two trials at two heights</p> <ul style="list-style-type: none"> Same as S2. 	<p>“Brand B”</p> <p>26w, 90watt equivalent.</p>	<p>At 5 feet: 1,640 9,893</p> <p>At 1 foot: 7,410 61,037</p>	<p>At 5 feet: 15.5 65.5</p> <p>At 1 foot: 10.41 252.42</p>	<p>At 5 feet: 199 815</p> <p>At 1 foot: 185 1,398</p>		

³⁵ For the purposes of this table, references to “no ventilation” mean that no deliberate ventilation occurred such as with an open window in the study room or open door to the study room. It does not refer to unintentional ventilation from the closure of the overhead door in the area adjacent to the study room.

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Scenario	Lamp type	Maximum ^a	< 300 ^b	1 hour Ave ^c	8 hour Ave ^d	24 hour Ave ^e
SB Two trials at two heights <ul style="list-style-type: none"> • Break for the first trial on short pile rug and for the second trial on wood floor. • Otherwise same as S2. 	"Brand C" 13w, 60watt equivalent	At 5 feet: 1,777 1,139 At 1 foot: 8,125 9,523	At 5 feet: 24.50 11.75 At 1 foot: >350spikes 14.58	At 5 feet: 161 155 At 1 foot: 264 220		
SBvac1 One trial at two heights <ul style="list-style-type: none"> • No new bulbs were broken as a part of this scenario. This was a vacuum of SB short nap carpet. This carpet had not been previously vacuumed but a lamp had been broken and cleaned up with traditional cleanup techniques 21 days earlier. It was vacuumed with a Hoover 850 beater vacuum. • This is the first vacuum of the carpet. No ventilation of room. • Measure continuously. 	"Brand C" 13w, 60watt equivalent Broken and cleaned up 21 days earlier.	At 5 feet: 4,529 At 1 foot: 14,779	At 5 feet: >81 At 1 foot: >350spikes	At 5 feet: 3,406 At 1 foot: 2,554	At 5 feet: No data At 1 foot: 677 (6 hour average)	
SBvac2 One trial at two heights <ul style="list-style-type: none"> • This is the second vacuum of the carpet. The bulb was cleaned up 24 days earlier. • Otherwise same as SBvac1. 	"Brand C" 13w, 60watt equivalent Broken and cleaned up 24 days earlier.	At 5 feet: 3,090 At 1 foot: 3,077	At 5 feet: 88.08 At 1 foot: >350spikes	At 5 feet: 1114 At 1 foot: 714	At 5 feet: 266 (6 hour average) At 1 foot: 223 (6 hour average)	

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Scenario	Lamp type	Maximum ^a	< 300 ^b	1 hour Ave ^c	8 hour Ave ^d	24 hour Ave ^e
SBvac3 One trial at two heights <ul style="list-style-type: none"> This is the third vacuum of the carpet. The bulb was cleaned up 27 days earlier Otherwise same as SBvac1. 	"Brand C" 13w, 60watt equivalent Broken and cleaned up 27 days earlier.	At 5 feet: 680 At 1 foot: 2,001	At 5 feet: 167.08 At 1 foot: 146.33	At 5 feet: 584 At 1 foot: 422	At 5 feet: 253 At 1 foot: 180	
SBvac4 One trial at two heights <ul style="list-style-type: none"> This is the fourth vacuum of the carpet. The bulb was cleaned up 28 days earlier. Otherwise same as SBvac1. 	"Brand C" 13w, 60watt equivalent Broken and cleaned up 28 days earlier.	At 5 feet: 228 At 1 foot: 427	At 5 feet: 0 At 1 foot: Spikes at 0.25, 77.92, & 299.17	At 5 feet: 172 At 1 foot: 113	At 5 feet: 79 (6 hour average) At 1 foot: 52 (6 hour average)	
SC Two trials at two heights <ul style="list-style-type: none"> Same as S2. 	"Brand D" 14w, 60 watt equivalent	At 5 feet: 4,257 5,927 At 1 foot: 27,224 6,164	At 5 feet: 30.83 25.67 At 1 foot: 21.92 21.00	At 5 feet: 424 298 At 1 foot: 684 310		
SD Two trials at two heights <ul style="list-style-type: none"> Bulb on for one hour prior to break. Otherwise same as S2. 	"Brand A" 14w, 60 watt equivalent	At 5 feet: 1,443 268 At 1 foot: 12,016 11,447	At 5 feet: 3.41 0 At 1 foot: 1.75 1.17	At 5 feet: 110 43 At 1 foot: 123 68		
SE Two trials at two heights <ul style="list-style-type: none"> Same as S2. 	"Brand B" 26w, 100watt equivalent	At 5 feet: 7,288 4,206 At 1 foot: 65,094 25,399	At 5 feet: 23.67 48.50 At 1 foot: 40.50 39.84	At 5 feet: 527 806 At 1 foot: 1,048 738		

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Scenario	Lamp type	Maximum ^a	< 300 ^b	1 hour Ave ^c	8 hour Ave ^d	24 hour Ave ^e
SF One trial at two heights <ul style="list-style-type: none"> Open window and wait 40 minutes to clean up Otherwise same as S2. 	"Brand B" 26w, 100watt equivalent	At 5 feet: 8,285 At 1 foot: 54,142	At 5 feet: >90 At 1 foot: >90	At 5 feet: 2,992 At 1 foot: 2,745		
SG One trial at two heights <ul style="list-style-type: none"> Open window and wait 10-20 minutes to clean up Otherwise same as S2. 	"Brand D" 23w, 100watt equivalent	At 5 feet: 956 At 1 foot: 8,603	At 5 feet: 16.00 At 1 foot: 16.08	At 5 feet: 111 At 1 foot: 377		
SH One trial at two heights <ul style="list-style-type: none"> Open window and wait 5 minutes to clean up Otherwise same as S2. 	"Brand E" 15w, 60watt equivalent	At 5 feet: 4,543 At 1 foot: 17,178	At 5 feet: 15.50 At 1 foot: 11.08	At 5 feet: 232 At 1 foot: 263		
SI One trial at two heights <ul style="list-style-type: none"> Open window and wait 5 minutes to clean up Otherwise same as S2. 	"Brand F" 15w, 50watt equivalent	At 5 feet: 485 At 1 foot: 687	At 5 feet: 2.67 At 1 foot: 5.50	At 5 feet: 54 At 1 foot: 70		
SJ One trial at two heights <ul style="list-style-type: none"> Crack lamp instead of crush. Otherwise same as S2. 	"Brand A" 14w, 60watt equivalent	At 5 feet: 617 At 1 foot: 7,412	At 5 feet: 2.58 At 1 foot: 2.16	At 5 feet: 122 At 1 foot: 133		
SK One trial at two heights <ul style="list-style-type: none"> Break on long pile "shag" rug. After traditional cleanup was vacuumed using a Hoover Quick-Broom bag less vacuum. Otherwise same as S2. 	"Brand B" 26w, 90watt equivalent	At 5 feet: 2,034 At 1 foot: 2,392	At 5 feet: 24.0 At 1 foot: 32.67 Spikes at 193.84	At 5 feet: 241 At 1 foot: 368		

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Scenario	Lamp type	Maximum ^a	< 300 ^b	1 hour Ave ^c	8 hour Ave ^d	24 hour Ave ^e
SL One trial at two heights <ul style="list-style-type: none"> • Break on short pile rug. • No ventilation, clean up only big pieces and put in trash in room, vacuum rest of debris with a Hoover 850 beater vacuum. • Measure continuously. 	“Brand B” 26w, 100 watt equivalent	At 5 feet: 23,720 At 1 foot: 133,955	At 5 feet: >1,500 At 1 foot: >1,500	At 5 feet: 16,814 At 1 foot: 21,262	At 5 feet: 12,364 At 1 foot: 14,384	At 5 feet: 4,490 At 1 foot: 5,130
SLvac2 One trial at two heights <ul style="list-style-type: none"> • No new bulbs were broken as a part of this scenario. This was a revacuum of SL short nap carpet. This carpet had been previously vacuumed as a means of cleaning up a lamp breakage 4 days earlier. It was vacuumed with a Hoover 850 beater vacuum. • This is the second vacuum of the carpet. • Otherwise same as SL. 	“Brand B” 26w, 100 watt equivalent Broken and cleaned up 4 days earlier.	At 5 feet: 3,135 At 1 foot: 36,397	At 5 feet: 530.75 At 1 foot: >1,200 spikes ³⁶	At 5 feet: 2,623 At 1 foot: 2,444	At 5 feet: 1,429 At 1 foot: 1,471	At 5 feet: 691 (20 hour average) At 1 foot: 729 (20 hour average)
SLvac3 One trial at two heights <ul style="list-style-type: none"> • This carpet had been previously vacuumed as a means of cleaning up a lamp breakage 5 days earlier. • This is the third vacuum of the carpet w/ same vac. • Otherwise same as SL. 	“Brand B” 26w, 100 watt equivalent Broken and cleaned up 5 days earlier	At 5 feet: 3,708 At 1 foot: 19,270	At 5 feet: 539.33 At 1 foot: >1,200 spikes ³⁷	At 5 feet: 2,671 At 1 foot: 2,768	At 5 feet: 2,590 At 1 foot: 2,587	At 5 feet: 1,038 (20.5 hour average) At 1 foot: 1,236 (20 hour average)

³⁶ Still spiking over 1,000 ng/m3.

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Scenario	Lamp type	Maximum ^a	< 300 ^b	1 hour Ave ^c	8 hour Ave ^d	24 hour Ave ^e
SLvac4 One trial at two heights <ul style="list-style-type: none"> This carpet had been previously vacuumed as a means of cleaning up a lamp breakage 6 days earlier. This is the 4th vacuum of the carpet with same vac. Otherwise same as SL. 	"Brand B" 26w, 100 watt equivalent Broken and cleaned up 6 days earlier.	At 5 feet: 3,288 At 1 foot: 12,367	At 5 feet: 523.75 At 1 foot: >1,200 spikes ³⁸	At 5 feet: 1,986 At 1 foot: 1,871	At 5 feet: 1,502 At 1 foot: 2,244	At 5 feet: 574 (20 hour average) At 1 foot: 1,085 (20 hour average)
SLcarpet One trial at two heights <ul style="list-style-type: none"> Carpet alone in room after SLvac4. Room ventilated prior to placing carpet square in room. Measure Continuously. 	"Brand B" 26w, 100 watt equivalent Broken and cleaned up 7 days earlier.	At 5 feet: 1,186 At 1 foot: 5,679	At 5 feet: 652.42 At 1 foot: >1,600 spikes over 800 ng/m ³	At 5 feet: 135 At 1 foot: 699	At 5 feet: 491 At 1 foot: 1,056	At 5 feet: 255 At 1 foot: 561

a Maximum = the maximum mercury concentration observed during trial including lamp break and cleanup in ng/m³

b below 300 = the time (minutes) elapsed between lamp break and when concentrations at the identified intake fell below 300 ng/m³

c 1 hour average = the mercury concentration (ng/m³) averaged over one hour from the lamp break

d 8 hour average = the mercury concentration (ng/m³) averaged over 8 hours from the lamp break

e 24 hour average = the mercury concentration (ng/m³) averaged over 24 hours from the lamp break

³⁷ Still spiking above 1,000 ng/m³.

³⁸ Still spiking above 300 ng/m³.

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APPENDIX A. Results for Individual Scenarios

Scenarios for “Brand A” 60 Watt Equivalent CFL (original six scenarios)

The first six scenarios were repeated three times each, using Philips 60 watt equivalent CFLs. Two graphs (one graph representing the air at five feet over the broken CFL (high) and one graph representing the air at one foot above the breakage (low)) were generated for each trial (each of the first six scenarios had three trials). Included below are the high and low graphs for all the trials. Scenarios and trials were labeled S2T1, S2T2, etc. to represent Scenario 2 Trial 1, Scenario 2 Trial 2, etc. For each scenario below, graphs for the trials with the highest peak of mercury were included first. The other trials and their graphs follow. A line at 300 ng/m³ was added to each graph to show concentrations of mercury relative to this Maine Ambient Air Guideline (MAAG).

Scenario 1: Wood Floor, No Venting, No Cleanup

The first three trials for this scenario are not included in this report. For those trials, the air exiting the Lumex instruments was mistakenly not vented back into the study room. For the next three trials, S1T4, S1T5, and S1T6, and for the rest of the study, another plastic tube was attached to the front of each Lumex to carry analyzed air back under the door and into the study room.

For Scenario 1, a “Brand A” 60 watt equivalent CFL was thoroughly broken with a hammer and left in the room with the window closed and the door closed. For Scenario 1, Trial 5 (S1T5), on 5/25/07, mercury peaked at 962 ng/m³ at the five foot height and peaked at 34,954 ng/m³ at the one foot height. Concentrations of mercury in the room at both heights were less than 300 ng/m³ after approximately 18 minutes. As expected, mercury in the air decreased more slowly over all in this scenario than the other scenarios when a “Brand A” lamp was broken and a window was opened. The other two trials for this scenario looked similar, although there was some variability in the initial peaks of mercury. Mercury peaked at 23,244 ng/m³ at the one foot height on one of the other trials and 8,533 ng/m³ at the one foot height on the other.

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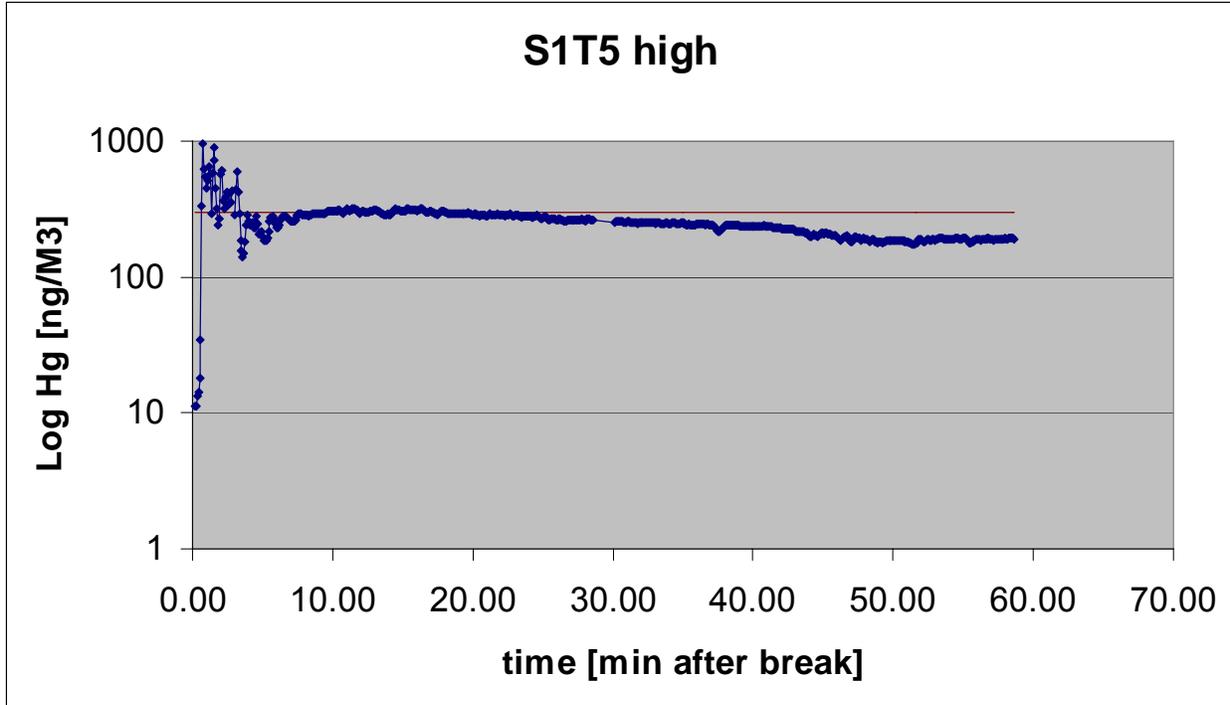


Figure A-1. Scenario 1, Trial 5 at Five-Foot Height (5/25/07)

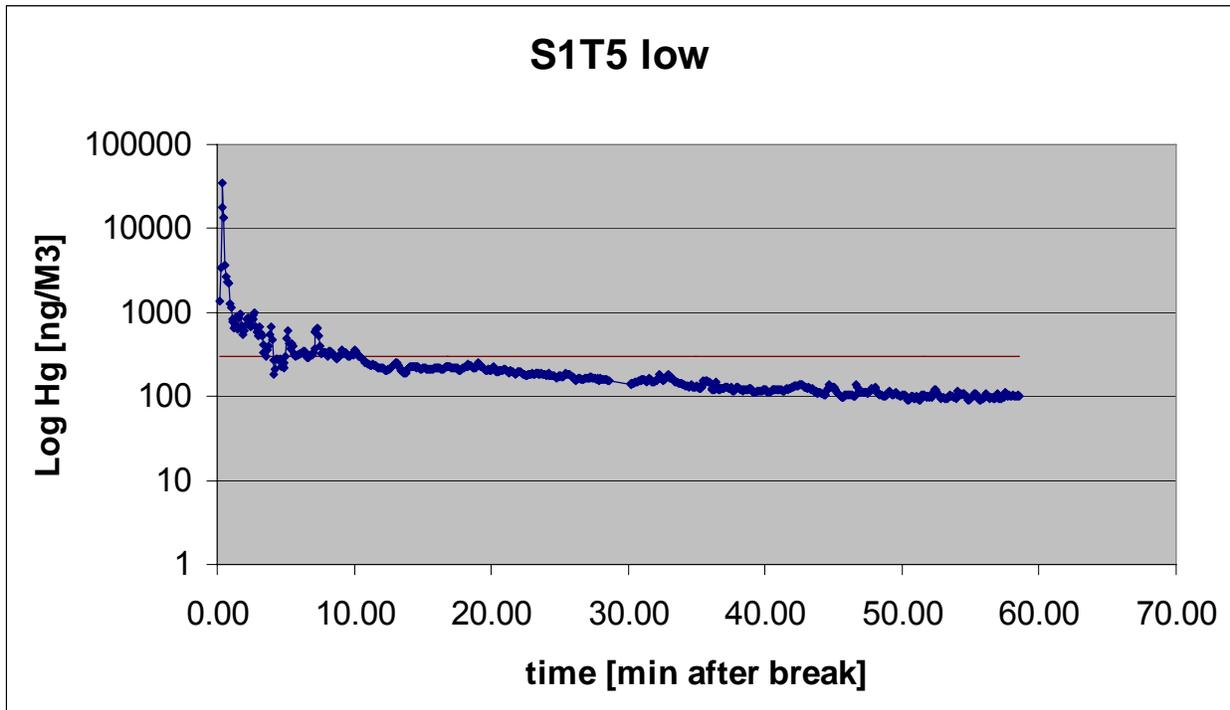


Figure A-2. Scenario 1, Trial 5 at One-Foot Height (5/25/07)

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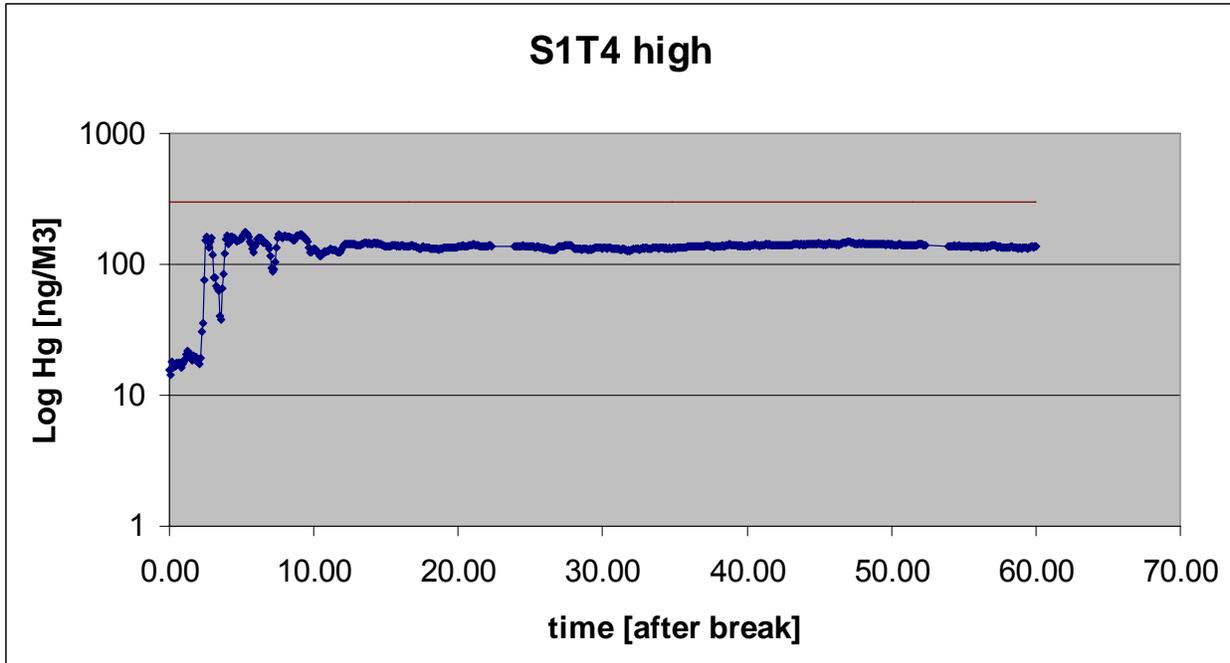


Figure A-3. Scenario 1, Trial 4 at Five-Foot Height, (5/25/07)

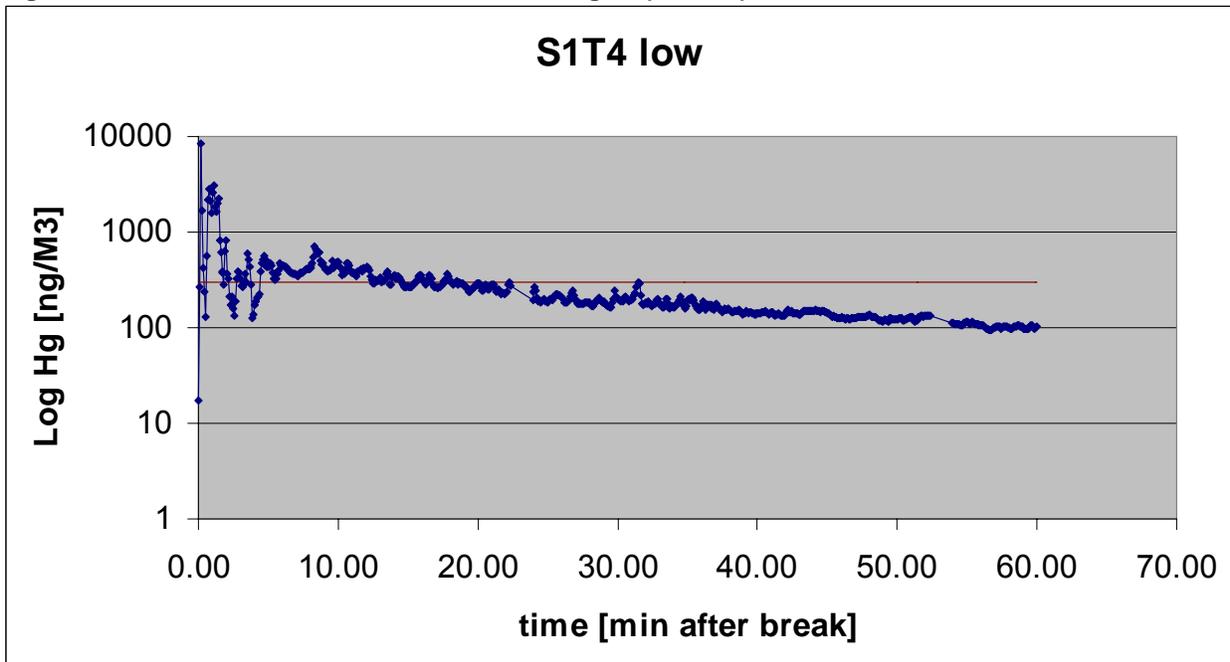


Figure A-4. Scenario 1, Trial 4 at One-Foot Height, (5/25/07)

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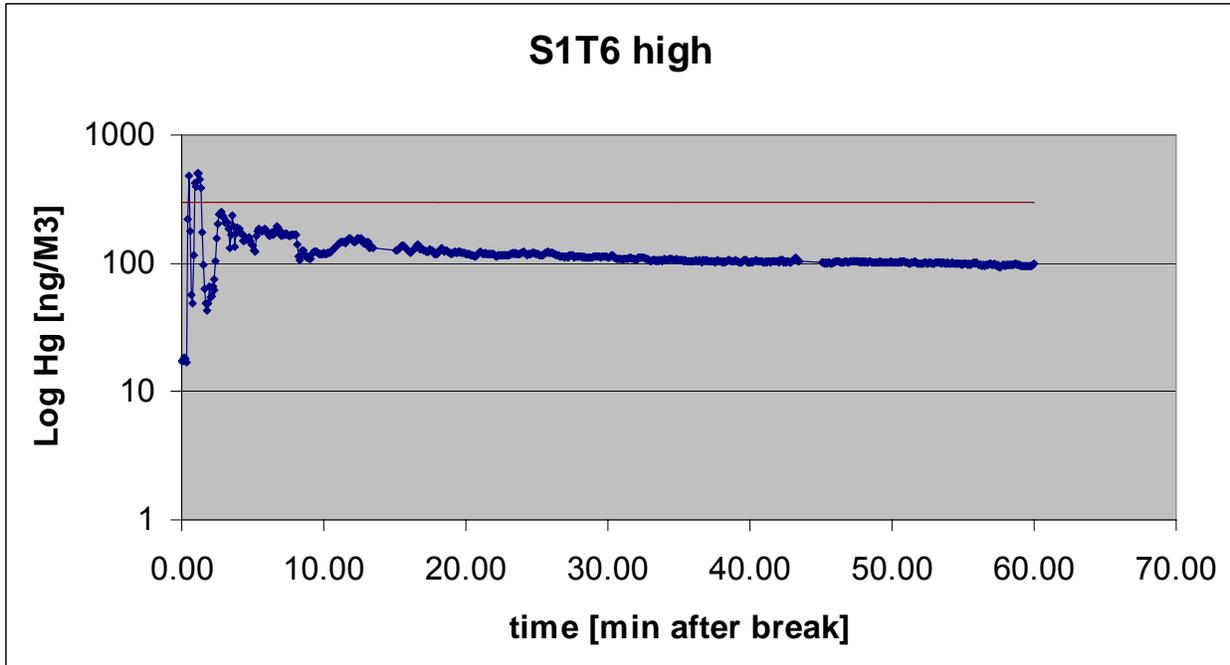


Figure A-5. Scenario 1, Trial 6 at Five-Foot Height, (5/25/07)

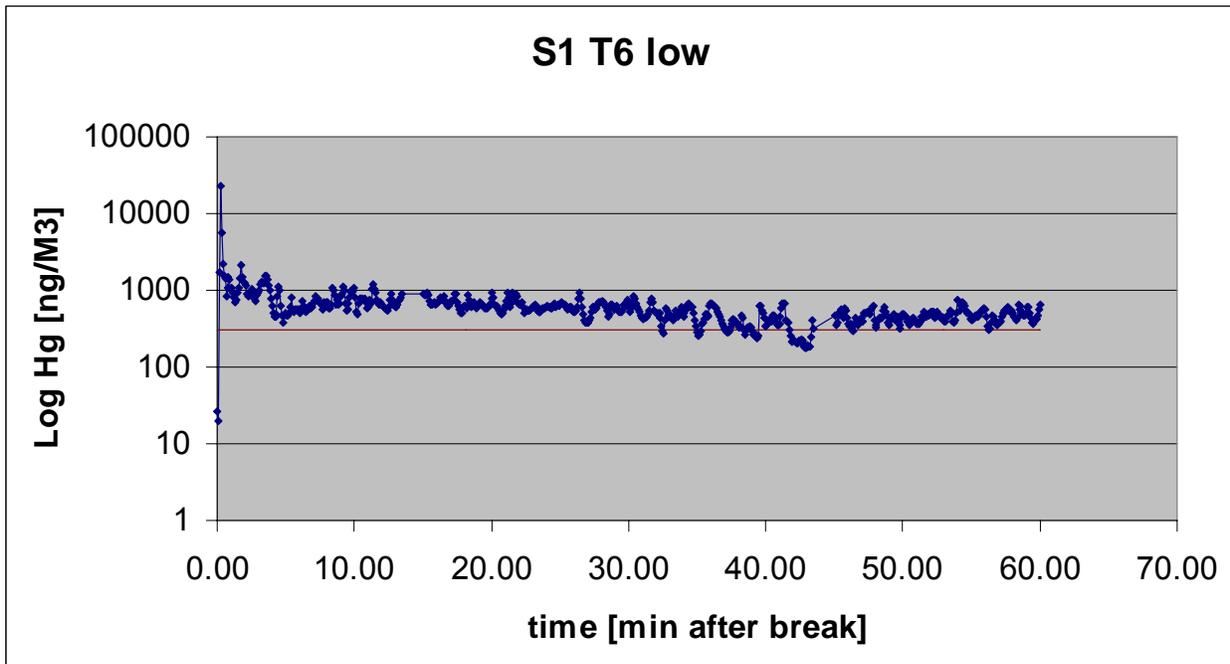


Figure A-6. Scenario 1, Trial 6 at One-Foot Height, (5/25/07)

Scenario 2: Wood Floor, Venting, Cleanup

A "Brand A" 60 watt equivalent lamp was thoroughly broken with a hammer on the hardwood floor, and was cleaned up using the pre-study cleanup guidance. (The window was opened, and the lamp was cleaned up with index cards, tape and a wet wipe. The waste was placed in a

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re-sealable plastic bag.) The waste was removed from the room, the door was closed, and the waste was put in a hazardous waste drum. For Trial 3, on 5/29/07, mercury peaked at 489 ng/m³ at the five foot height and peaked at 17,569 ng/m³ at the one foot height. Concentrations of mercury in the room at both heights was less than 300 ng/m³ after 4.0 minutes from breakage. All three trials for Scenario 2 looked similar.

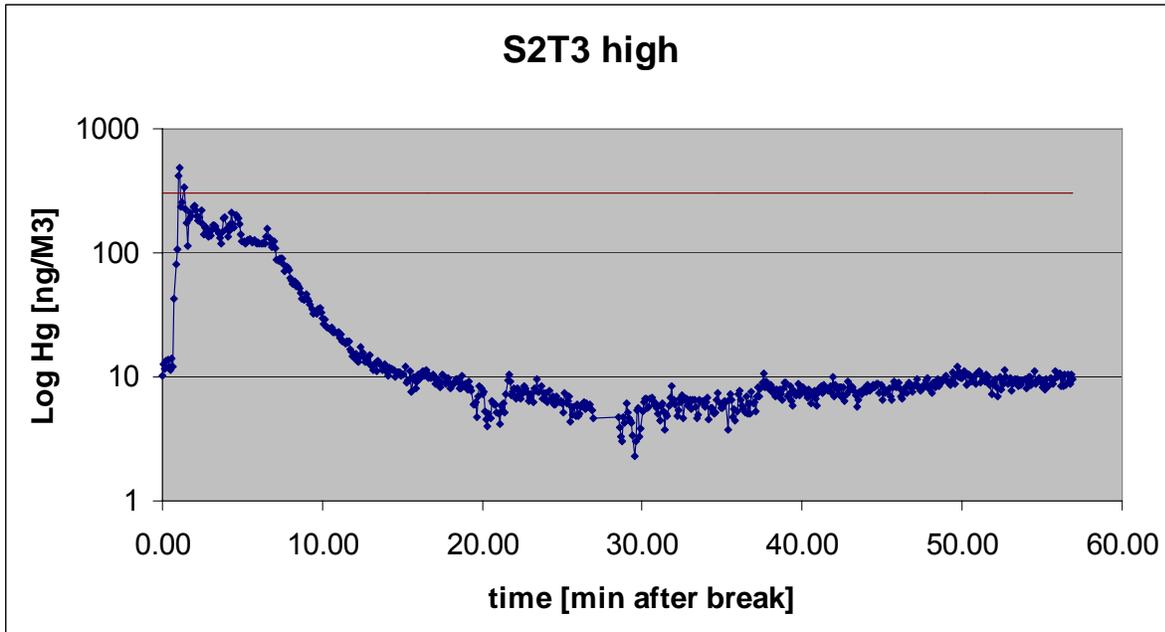


Figure A-7. Scenario 2, Trial 3 at Five-Foot Height (5/29/07)

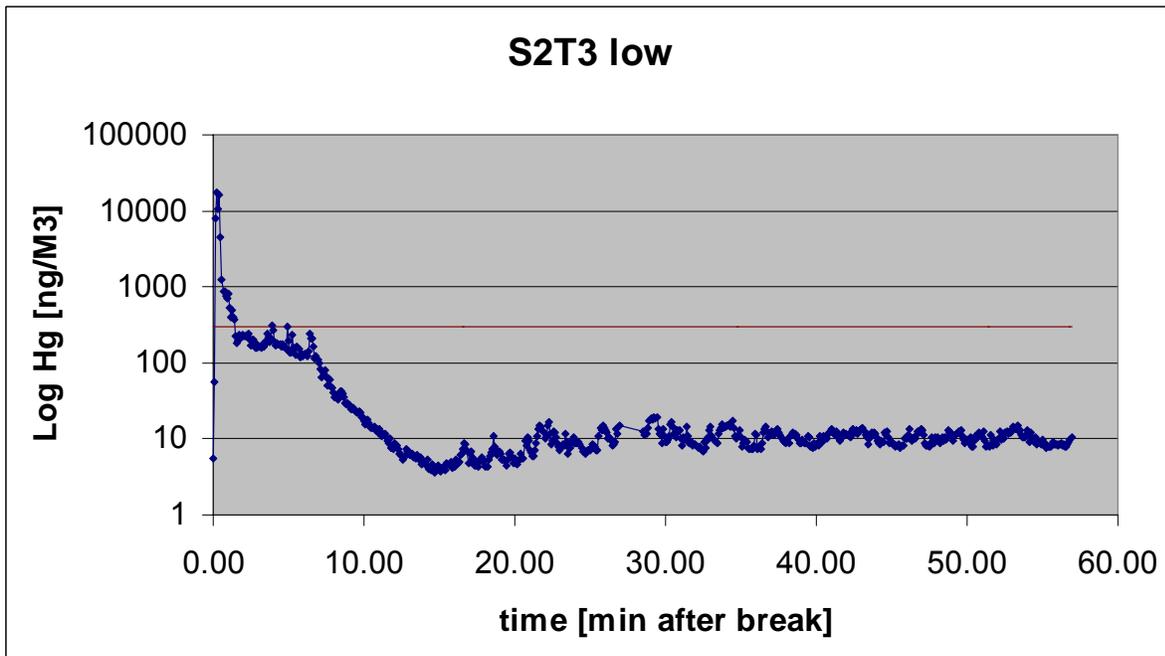


Figure A-8. Scenario 2, Trial 3 at One-Foot Height (5/29/07)

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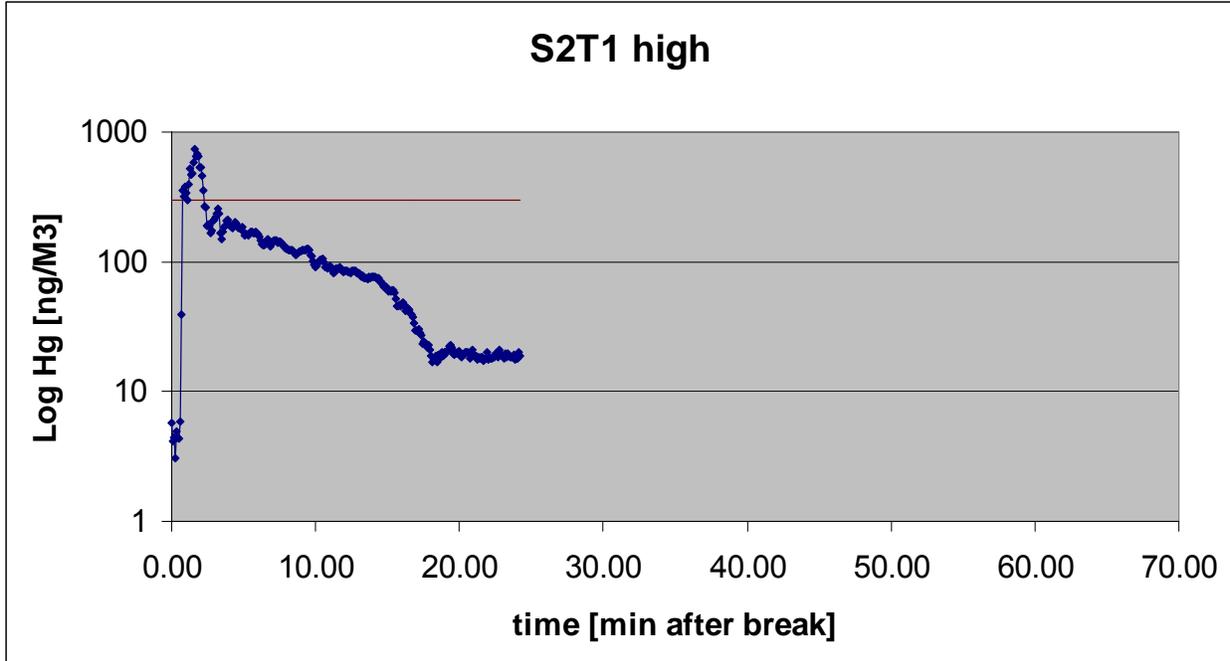


Figure A-9. Scenario 2, Trial 1 at Five-Foot Height, (5/29/07)

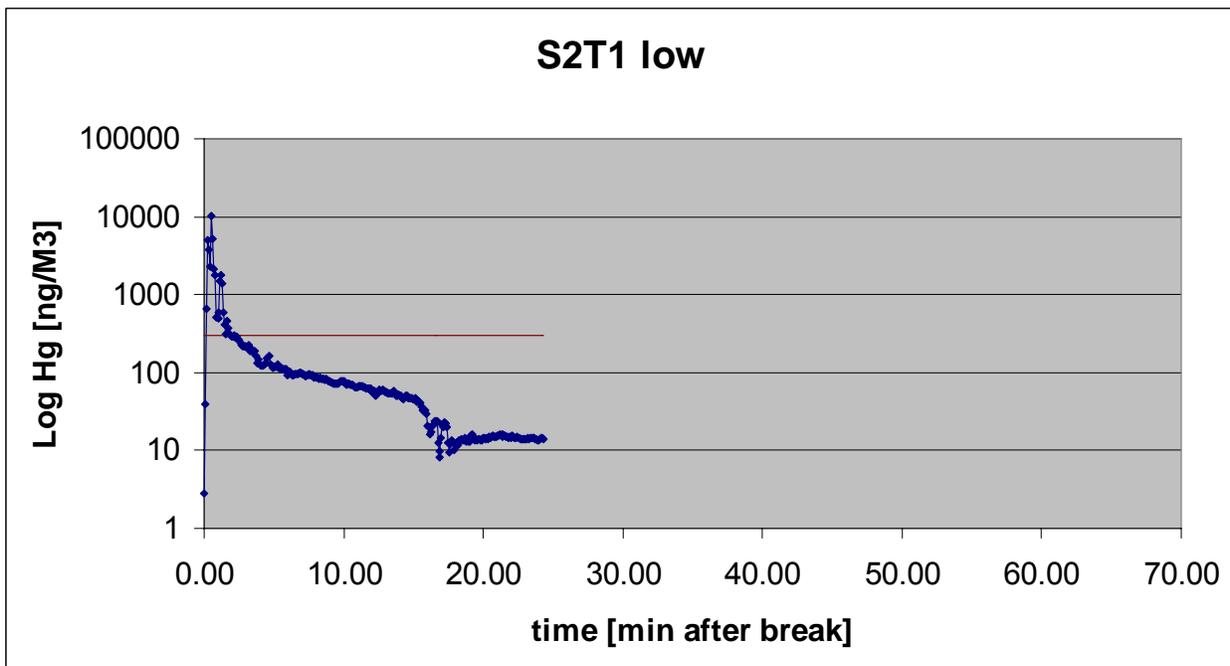


Figure A-10. Scenario 2, Trial 1 at One-Foot Height, (5/29/07)

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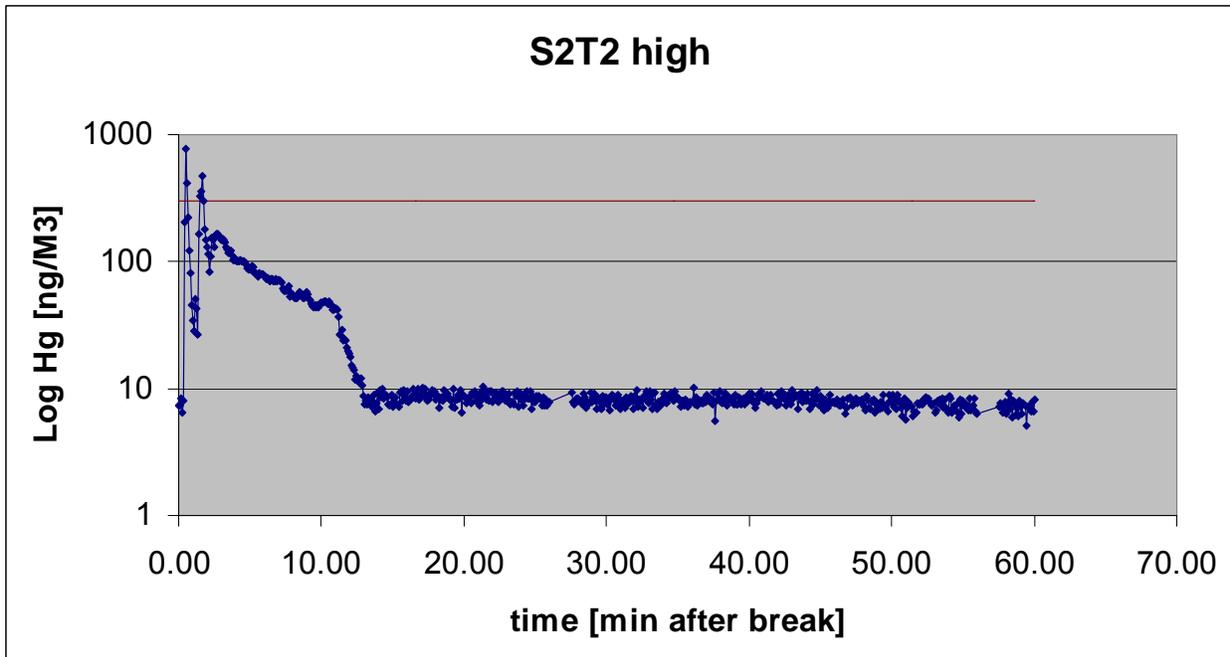


Figure A-11. Scenario 2, Trial 2 at Five-Foot Height (5/29/07)

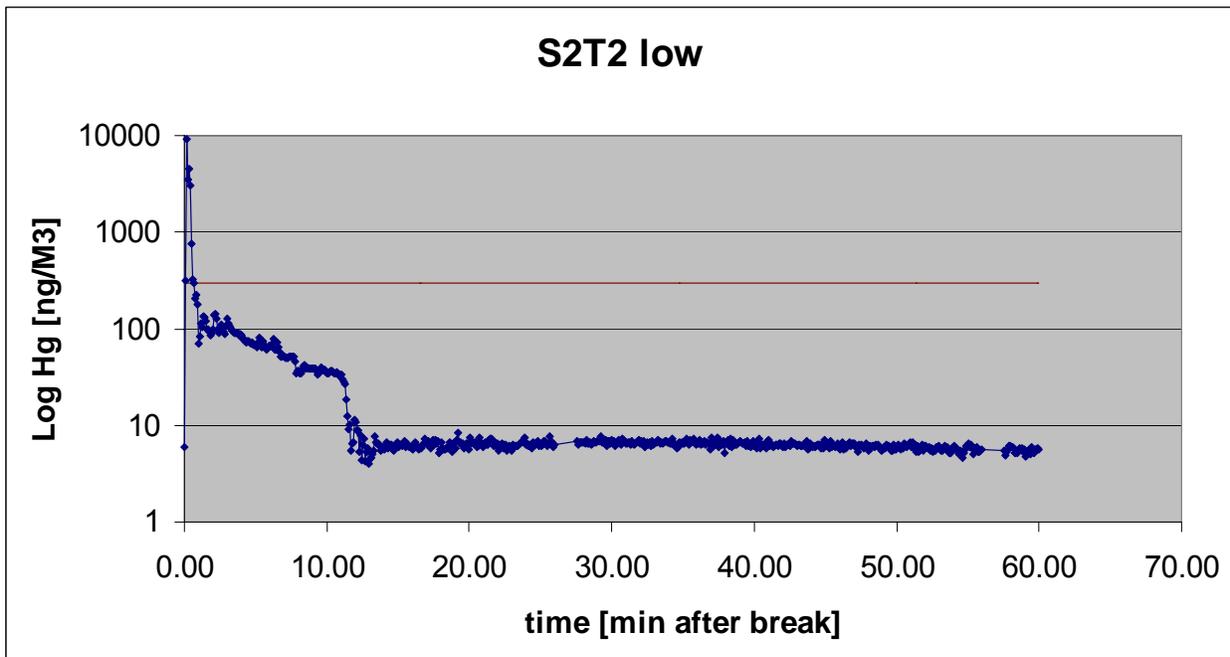


Figure A-12. Scenario 2, Trial 2 at One-Foot Height (5/29/07)

Scenario 3: Short Nap Carpet, Venting, Cleanup

A "Brand A" 60 watt equivalent lamp was thoroughly broken with a hammer on the short carpet, and was cleaned up using the pre-study cleanup guidance. (The window was opened, and the lamp was cleaned up with index cards, tape and a wet wipe. The waste was placed in a re-

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sealable plastic bag.) The waste was removed from the room, the door was closed, and the waste was put in a hazardous waste drum.

All trials for this scenario had similar looking graphs. The trial with the highest peak of mercury is summarized at follows: mercury peaked at 1,200 ng/m³ at the five-foot height and peaked at 10,788 ng/m³ at the one-foot height. The high and low graphs appear below for this Trial 1 that occurred on 5/29/07.

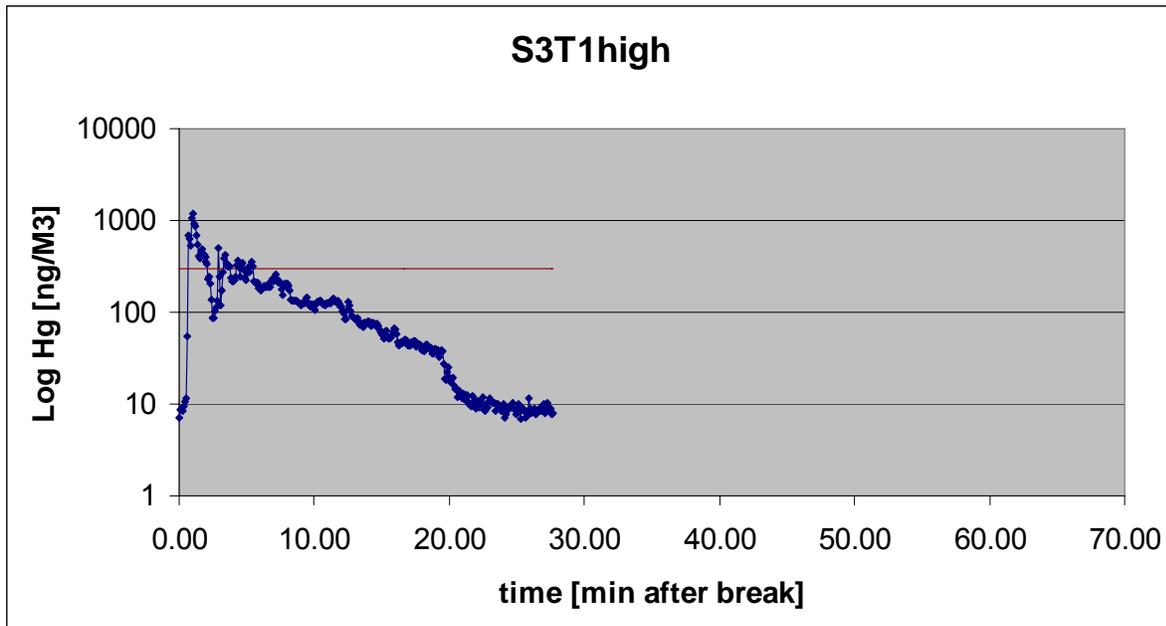


Figure A-13. Scenario 3, Trial 1 at Five-Foot Height (5/29/07)

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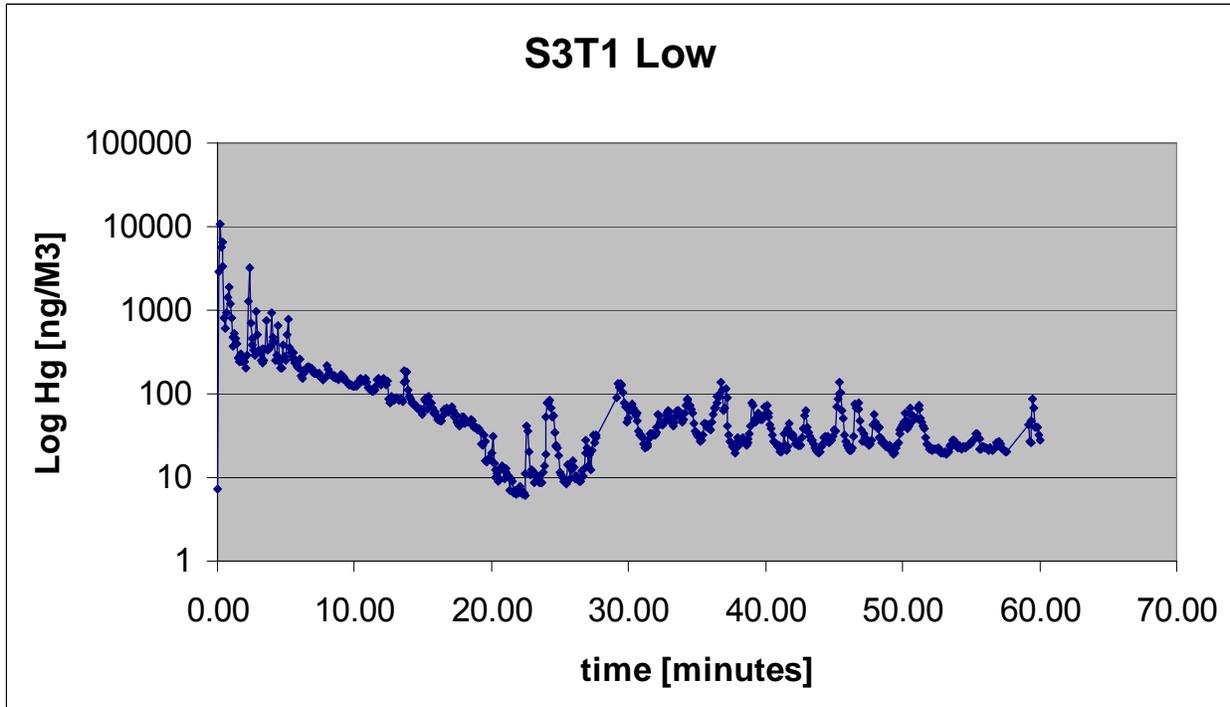


Figure A-14. Scenario 3, Trial 1 at One-Foot Height (5/29/07)

Scenario 3, trials 2 and 3 (S3T2 and S3T3) below were performed slightly different from S3T1 and S3T4 and S3T5. For S3T2 and S3T3, the lamp was broken, the window was opened, and cleanup was postponed five minutes. There was no five minute wait for S3T1, S3T4 and S3T5. (S3T4 appeared to be a “dud” lamp with very little mercury emissions and was ended early and accidentally not saved).

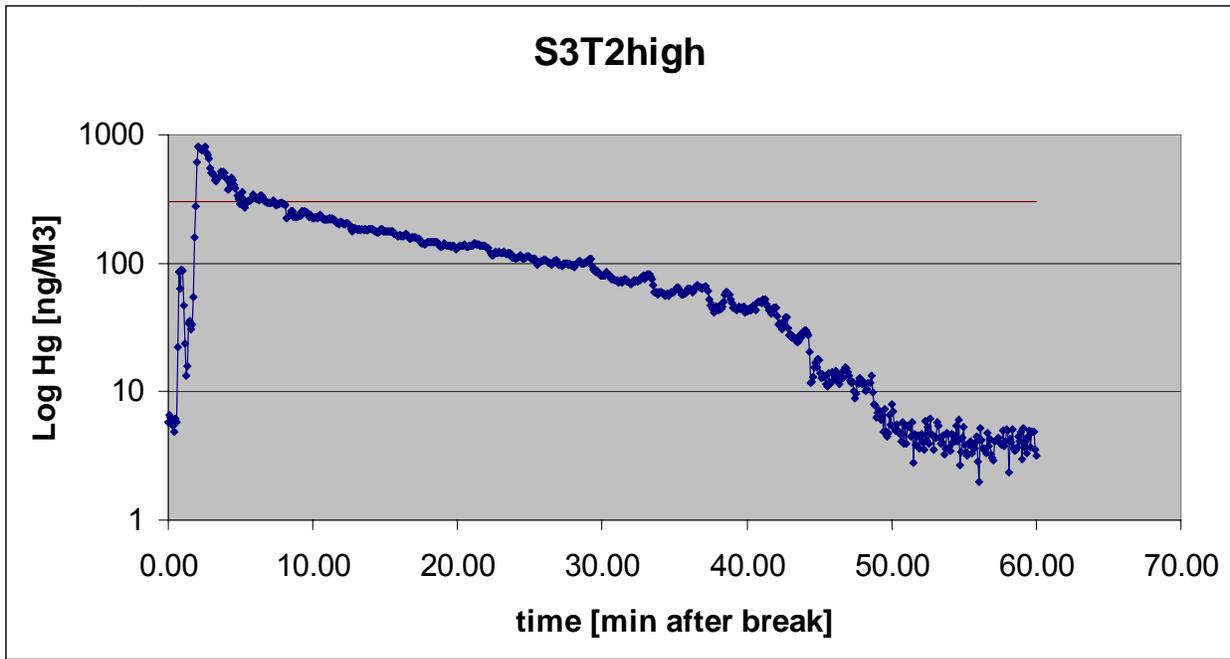


Figure A-15. Scenario 3, Trial 2 at Five-Foot Height (5/30/07)

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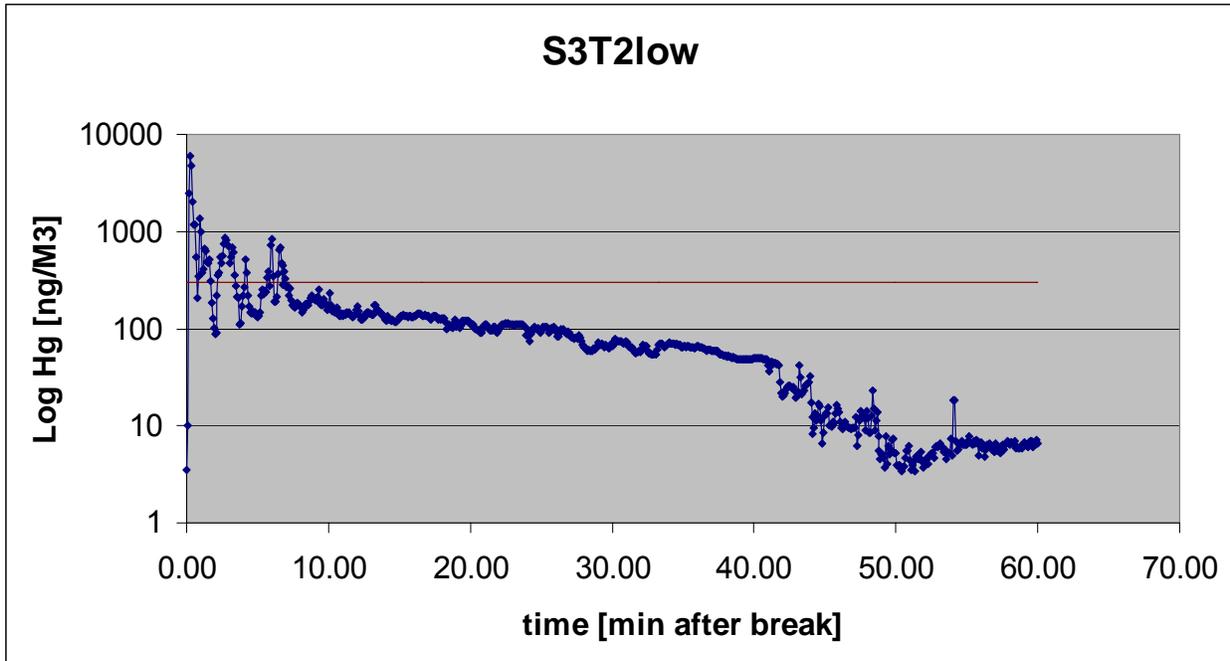


Figure A-16. Scenario 3, Trial 2 at One-Foot Height (5/30/07)

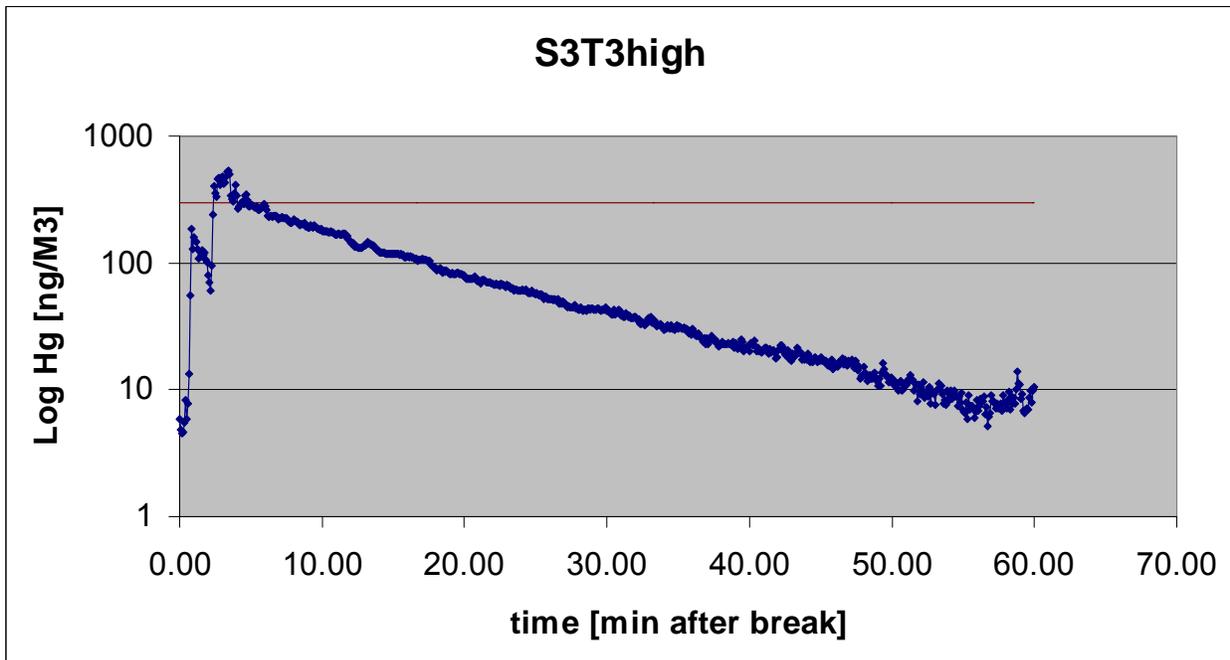


Figure A-17. Scenario 3, Trial 3 at Five-Foot Height (5/31/07)

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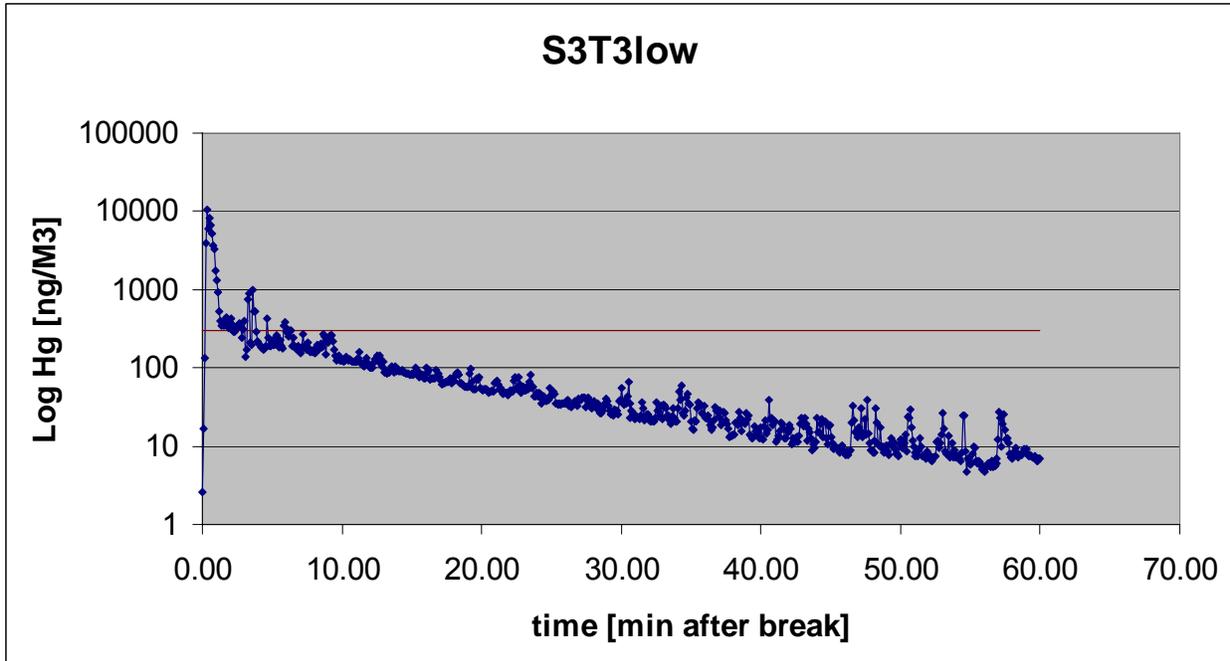


Figure A-18. Scenario 3, Trial 3 at One-Foot Height (5/31/07)

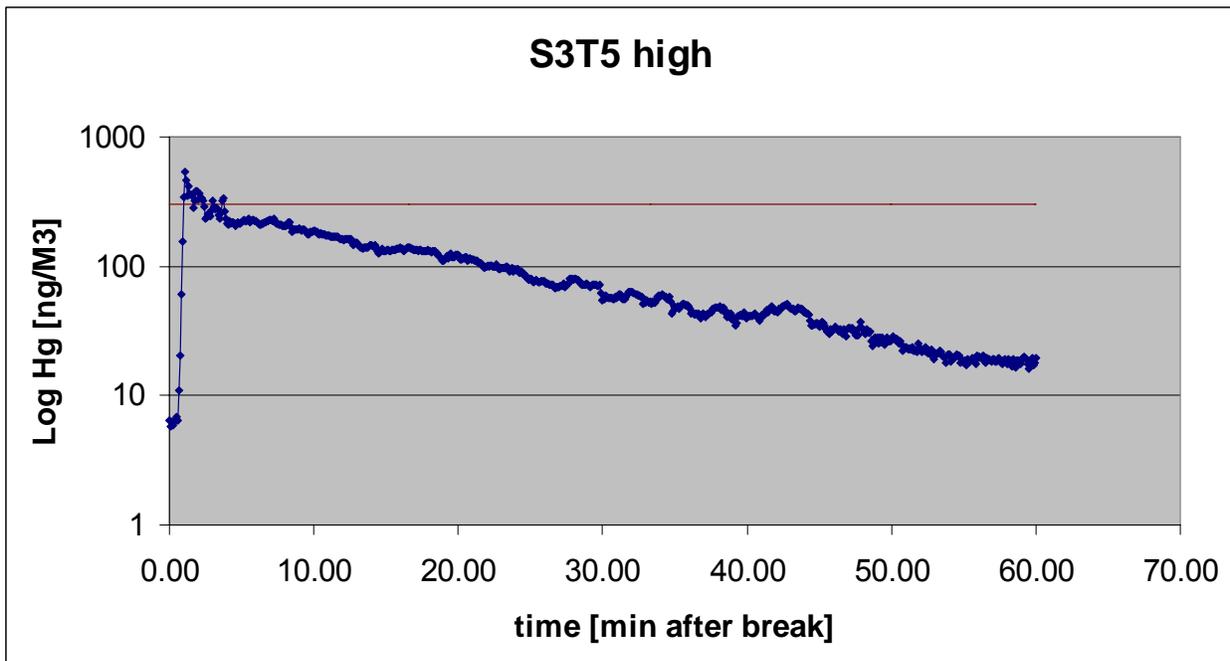


Figure A-19. Scenario 3, Trial 5 at Five-Foot Height (5/31/07)

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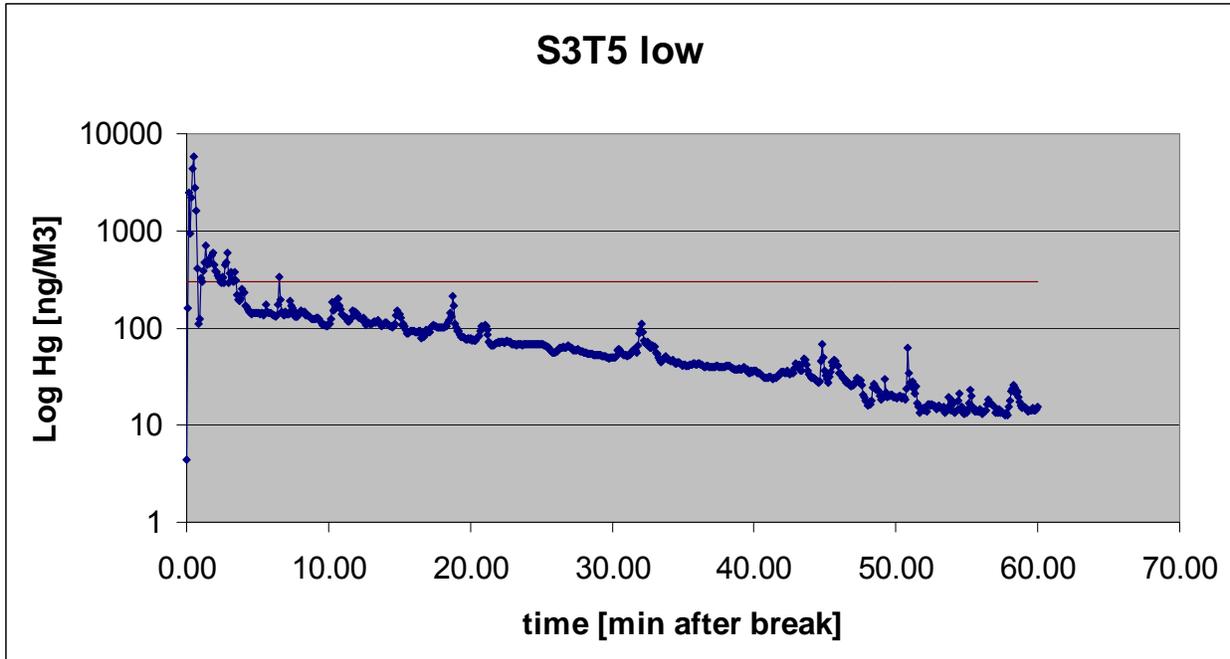


Figure A-20. Scenario 3, Trial 5 at One-Foot Height (5/31/07)

Scenario 4: Longer Carpet, Venting, Cleanup

A "Brand A" 60 watt equivalent lamp was thoroughly broken with a hammer on the shag carpet, and was cleaned up using the pre-study cleanup guidance. (The window was opened, and the lamp was cleaned up with index cards, tape and a wet wipe. The waste was placed in a re-sealable plastic bag.) The waste was removed from the room, the door was closed, and the waste was put in a hazardous waste drum.

For Trial 3, on 6/7/07, mercury peaked at 544 ng/m³ at the five foot height and peaked at 8,262 ng/m³ at the one foot height. Concentrations of mercury in the room at both heights was less than 300 ng/m³ after 5.33 minutes. The other two trials for Scenario 4 looked similar.

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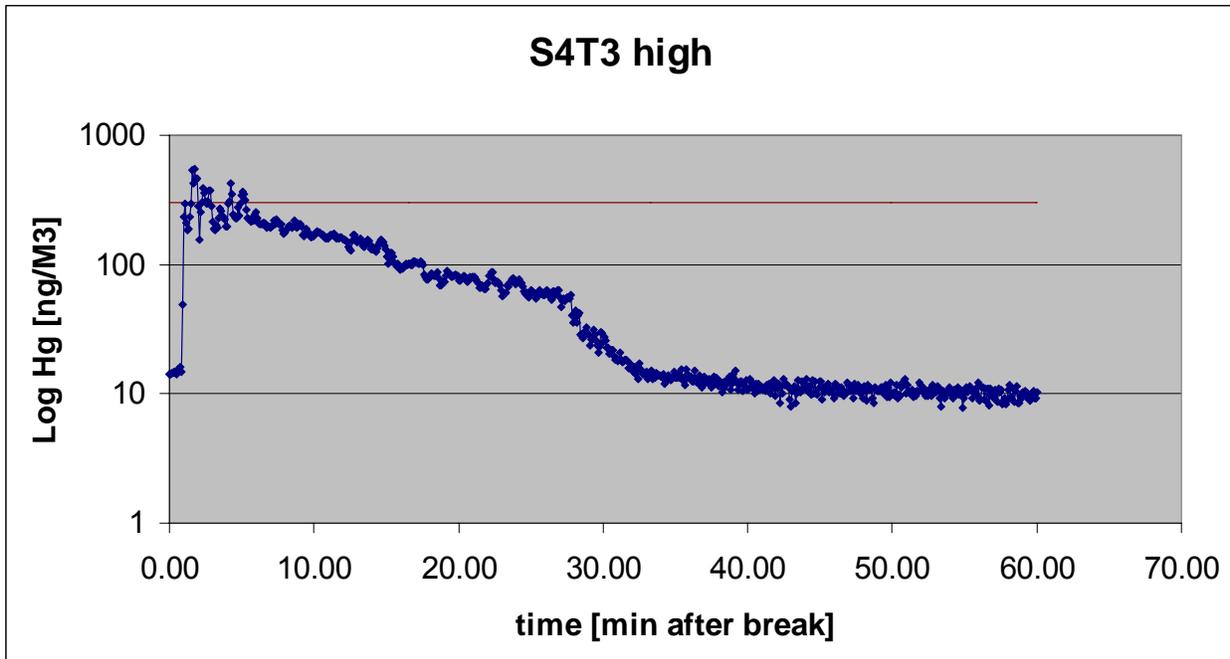


Figure A-21. Scenario 4, Trial 3 at Five-Foot Height (6/7/07)

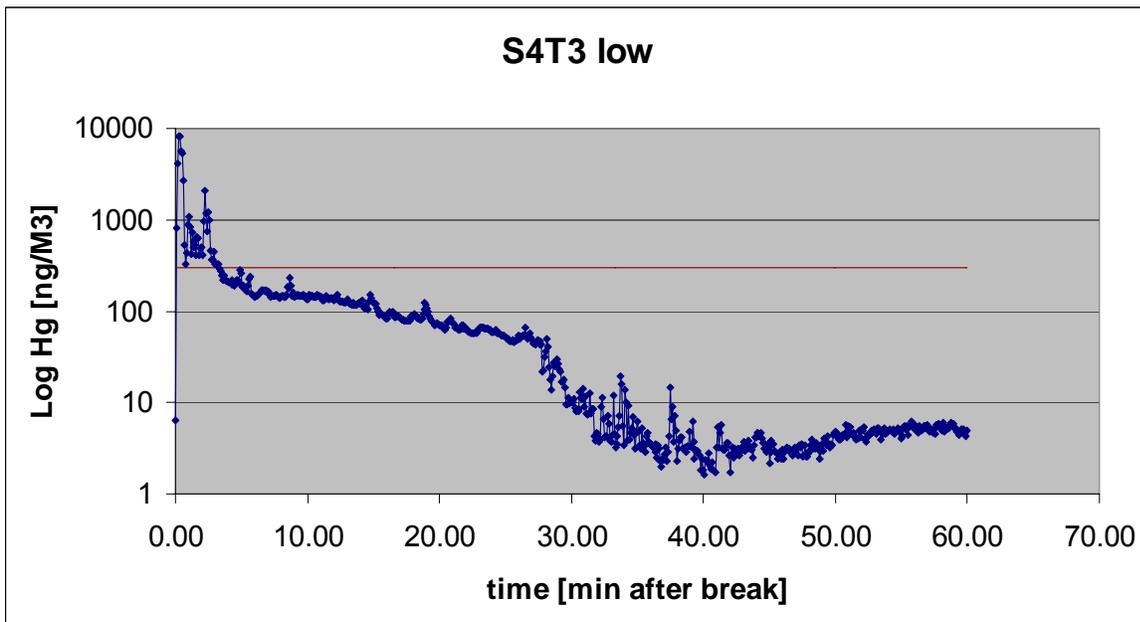


Figure A-22. Scenario 4, Trial 3 at One-Foot Height (6/7/07)

As this study progressed, it was observed that the floorings, even after cleanup, often contained a source of mercury that the third Lumex could pick up when held close to the flooring, and that agitation made a significant difference in measured concentrations. On each floor type, the readings were variable depending on where the Lumex was located. For example, moving the Lumex over an inch or two on the flooring could dramatically increase or decrease the numbers.

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Table A-1 lists results from Lumex scans of Scenario 4 flooring after a CFL had been broken and cleaned up. Results recorded are the highest concentrations of mercury observed while scanning flooring in ng/m³.

Table A-1

Scenario	S4T2		S4T3	
Date of Breakage	6/7/2007		6/8/2007	
Floor Type	long carpet (shag)		long carpet (shag)	
Date Measured ↓	calm	agitated	calm	agitated
6/8/2007	<20	108	<20	99
6/11/2007	<20	413	<20	112
6/12/2007	<20	129	<20	55
6/13/2007	22	273	<20	190
6/14/2007	<20	303	<20	54
6/15/2007	<20	398		
6/19/2007	<20	511		
6/21/2007	25	512		
6/22/2007	28	1083		
6/25/2007	<20	1096		
6/26/2007	22	506		
6/27/2007	<20	1025		
6/28/2007	<20	618		
6/29/2007	<20	1640		
7/2/2007	<20	401		
7/3/2007	<20	307		
7/5/2007	61	1241		
7/6/2007	<20	392		
7/9/2007	<20	742		
7/10/2007	26	543		
7/11/2007	26	199		

Appendix A

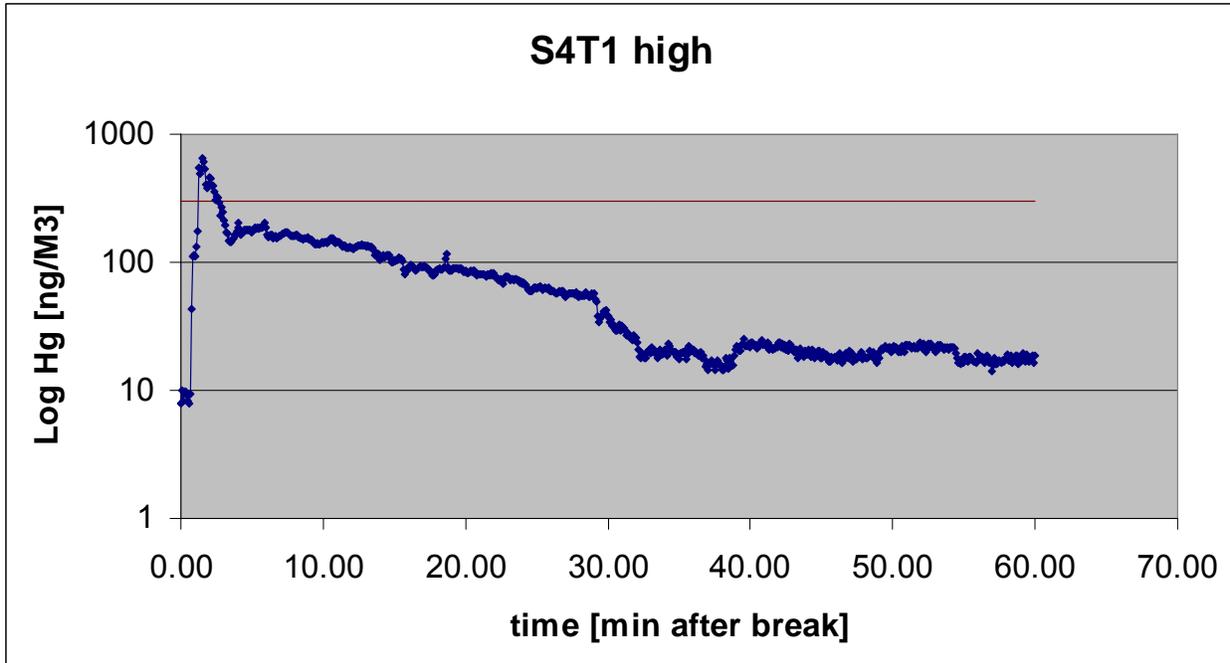


Figure A-23. Scenario 4, Trial 1 at Five-Foot Height (6/6/07)

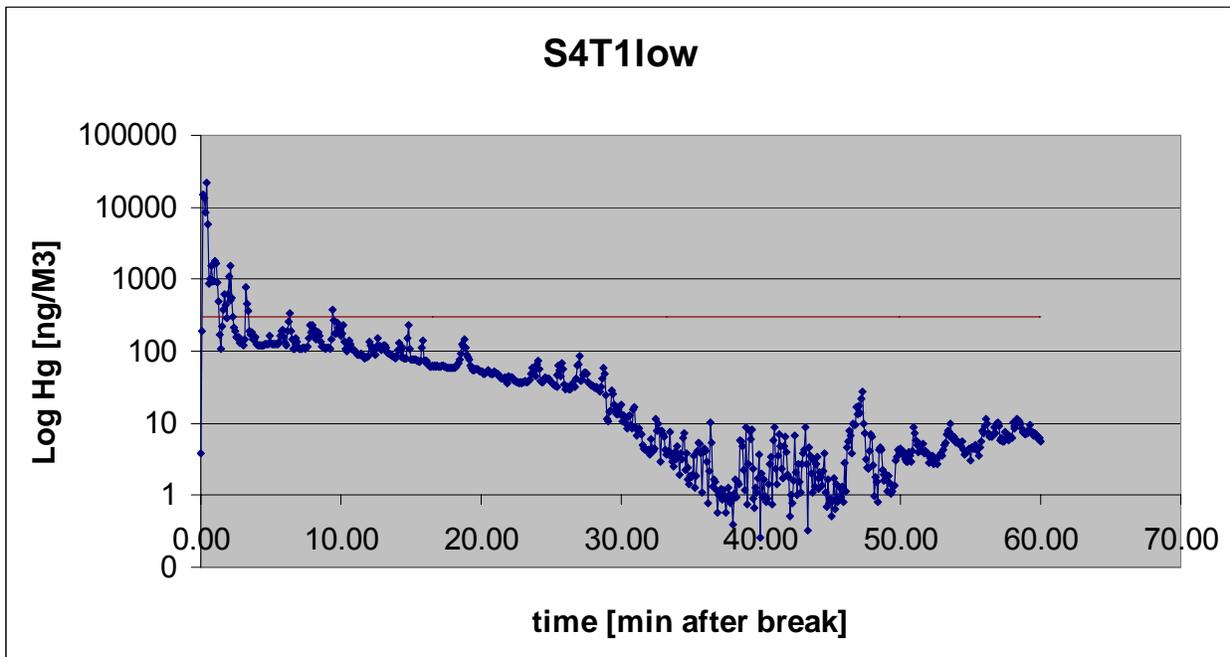


Figure A-24. Scenario 4, Trial 1 at One-Foot Height (6/6/07)

Appendix A

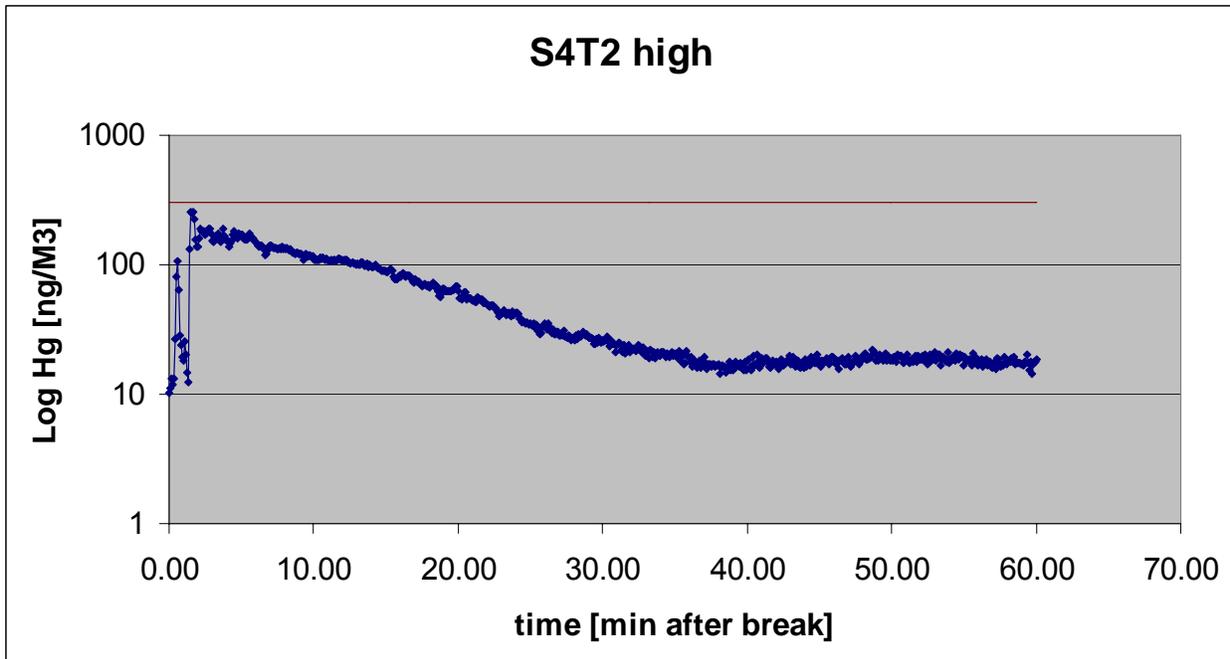


Figure A-25. Scenario 4, Trial 2 at Five-Foot Height (6/7/07)

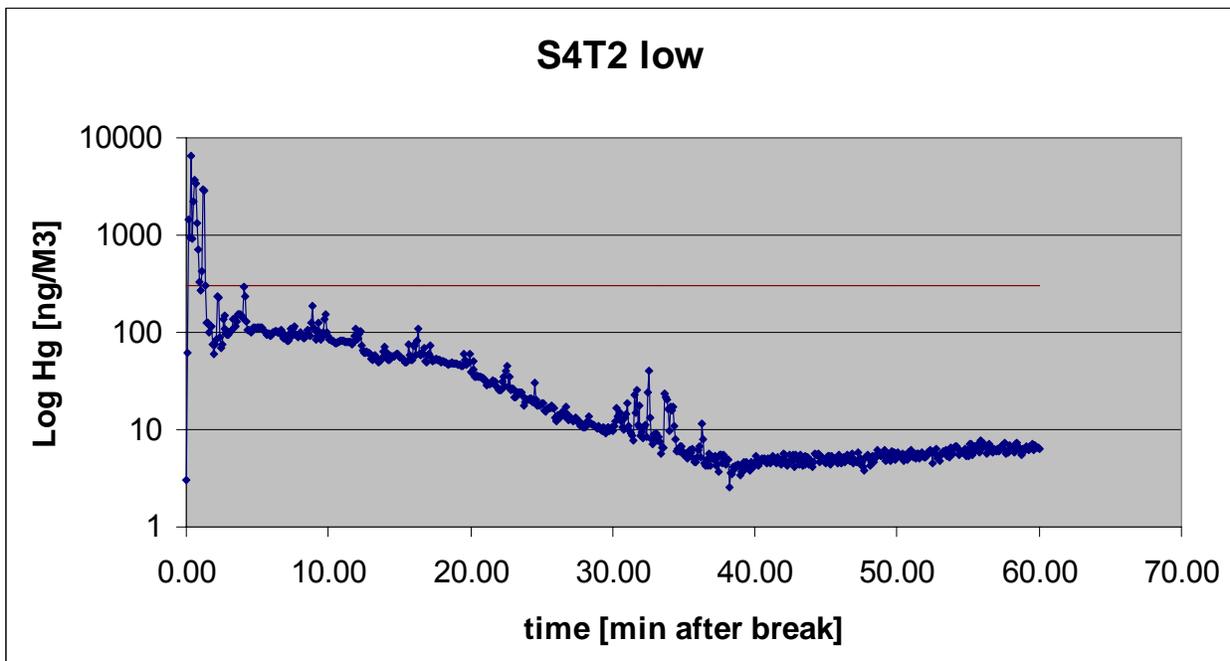


Figure A-26. Scenario 4, Trial 2 at One-Foot Height (6/7/07)

Scenario 5: Short Nap Carpet, Venting, Vacuuming

A "Brand A" 60 watt equivalent lamp was thoroughly broken with a hammer on the short nap carpet, the window was opened, and the larger pieces of broken lamp were put in a re-sealable bag. A Kenmore canister vacuum with beater floor attachment, filter and bag was used for the

Appendix A

smaller pieces of debris. The vacuum beater was then wiped down with a wet wipe. The waste and vacuum bag were taken out of the room, and disposed of in the hazardous waste drum.

For the first trial for Scenario 5, on 6/1/07, mercury peaked at 628 ng/m³ at the five foot height and peaked at 18,578 ng/m³ at the one foot height. Concentrations of mercury in the room, at both heights, were less than 300 ng/m³ after about eight minutes.

The carpet for the third trial (S5T3) was used later in a vacuum scenario as part of the additional cleanup scenarios section. For S5T3 on 6/4/07, mercury peaked at 315 ng/m³ at the five foot height and peaked at 3,953 ng/m³ at the one foot height. Concentrations of mercury in the room, at both heights, were less than 300 ng/m³ after 5.83 minutes. This carpet was vacuumed about four weeks later with a Hoover 400 Futura vacuum. See Figures A-78 and A-79.



Figure A-27. Kenmore Canister used in Scenario 5.

Appendix A

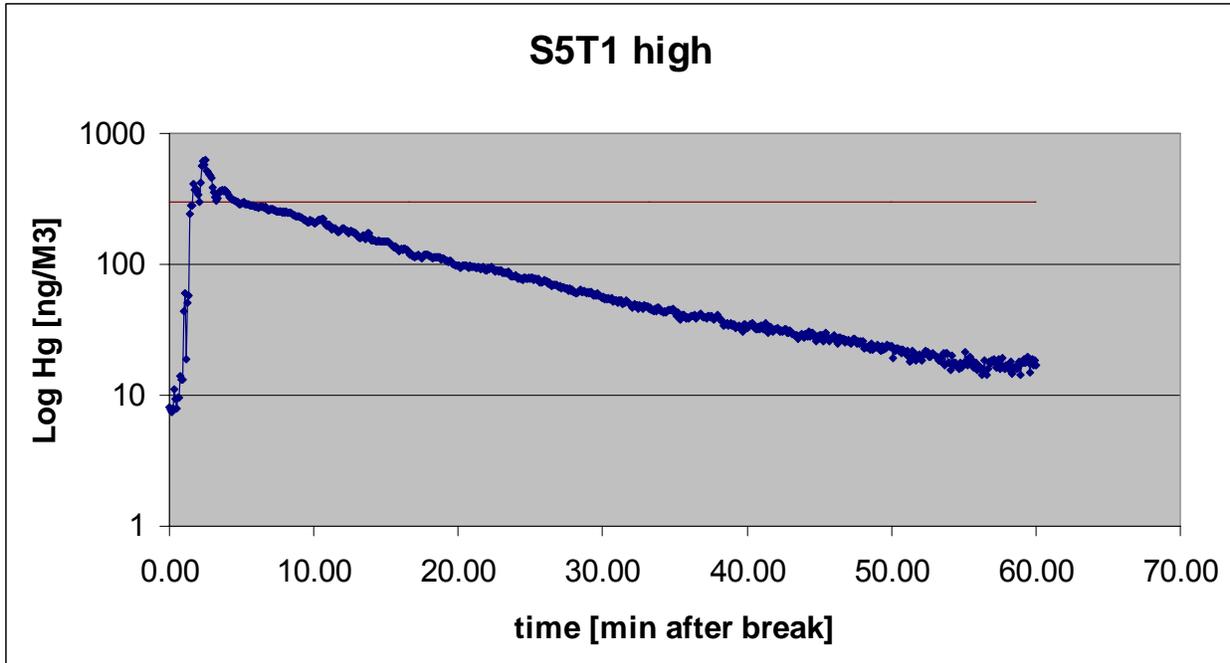


Figure A-28. Scenario 5, Trial 1 at Five-Foot Height (6/1/07)

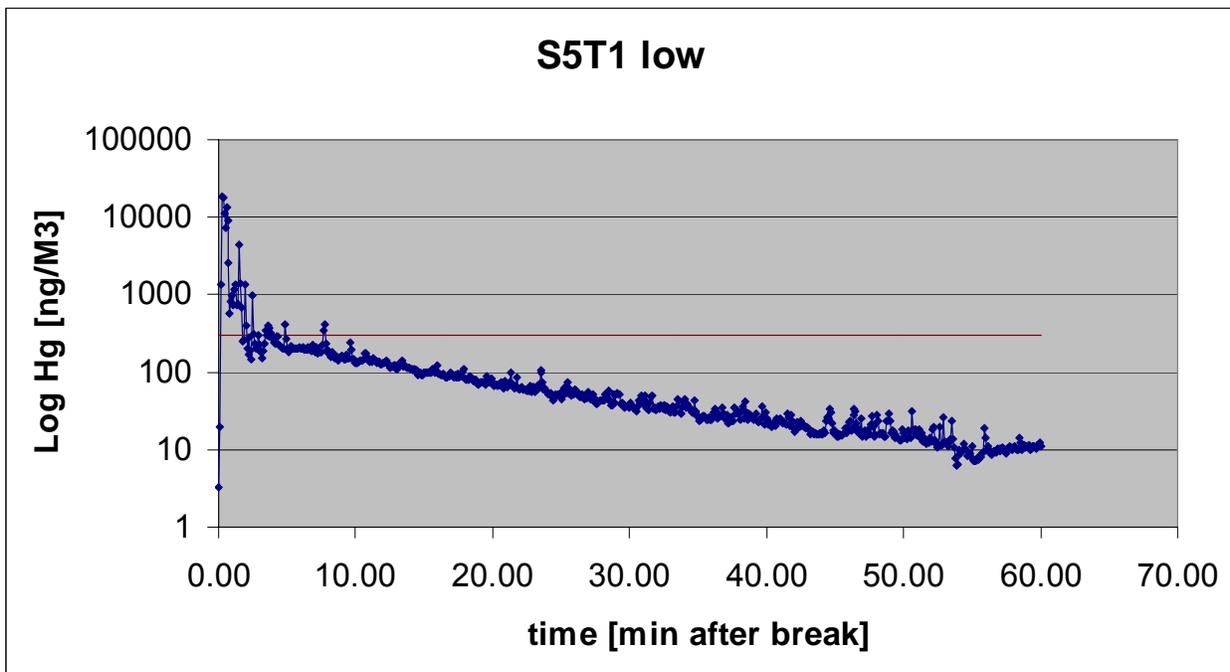


Figure A-29. Scenario 5, Trial 1 at One-Foot Height (6/1/07)

Appendix A

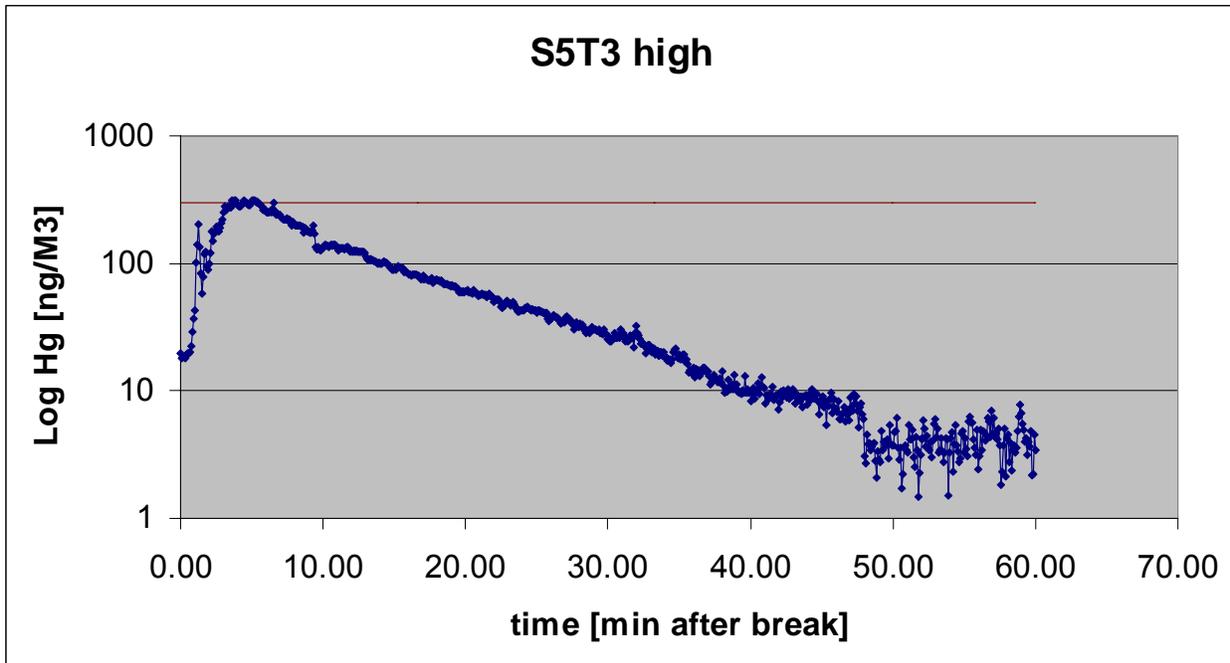


Figure A-30. Scenario 5, Trial 3 at Five-Foot Height (6/4/07)

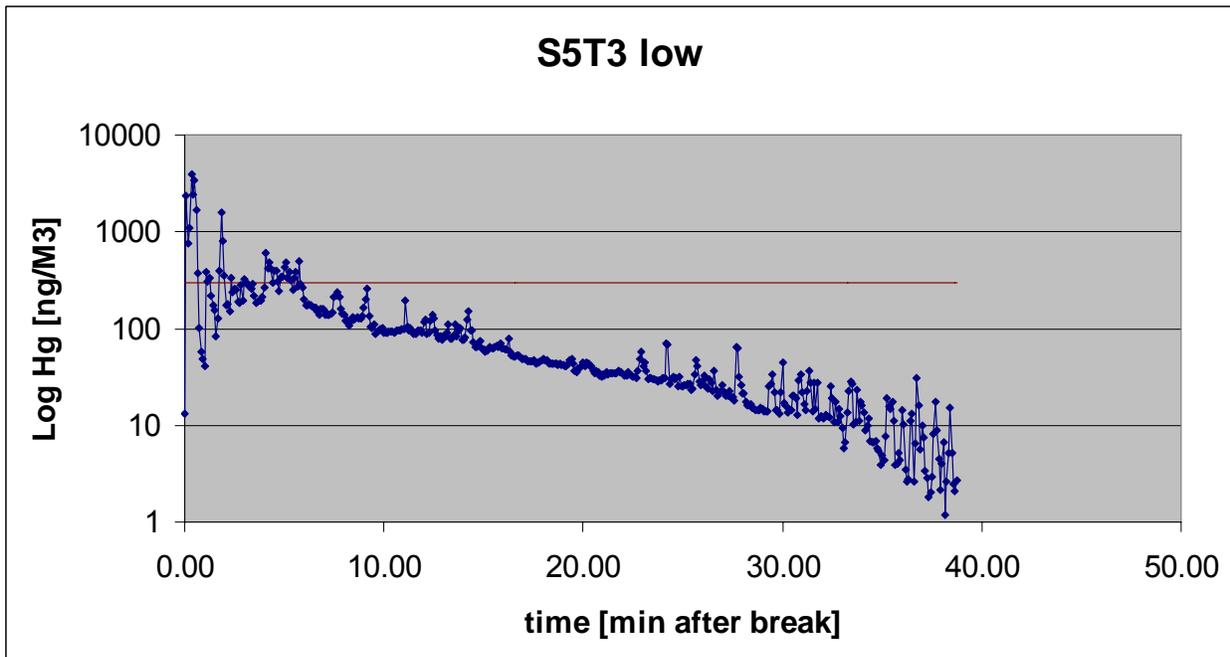


Figure A-31. Scenario 5, Trial 3 at One-Foot Height (6/4/07)

The third Lumex was used to take some readings up close to several of the Kenmore canister vacuum parts. See the Table A-2. below:

Appendix A

Table A-2.		Vacuum measurements with 3rd Lumex when room levels of mercury are low													
Kenmore canister		Vacuum ran for approx 10 min. to get warm vac or "hot" numbers													
		Measurements are in ng/m ³ , recorded within approx. an inch of vac part surface													
		Wet wipes used on vacuum													
		Vacuum Cleaner Part													
		Beaters				Plastic hose		Inside vac		Metal wand		Filter			
Date of Vacuuming	Date of Measurement	hot	hot agitated	cold	cold agitated	hot	cold	hot	cold	hot	cold	hot	hot agitated	cold	cold agitated
6/1/07AM	6/1/2007AM (about 1hr. After 1st vacuuming)	46		67		114	146	63	57	137	103	37		<20	
6/1/2007PM	6/1/2007PM (about 1hr. After 2nd vacuuming)			148		70	355				83	39		33	
	6/4/2007 8:41AM before 3rd break			<20			52		40		41				
6/4/2007 9AM	6/4/2007 approx. 600 seconds into run for this 3 rd vac	3,277				18,260		3,152		1,824		<room air			
	6/4/2007 approx. 10AM	330		357		858	608	170	240	428	109	75		<20	
	6/4/2007 approx. 1PM	163		383		578	654	43	56	256	615	32		<20	
	6/4/2007 4:20PM			179			305		22		48			<20	
	6/5/07 7:30AM	113		149		353	164	<20	20	201	184	<20		<20	
	6/5/07 5PM	92		87		476	488	50	51	878	171	60		20	
	6/6/2007	45		32		2,094	460	58	<20	608	472	42		<20	
	6/7/2007	291	444	<20	462	1,254	596	158	<20	282	120	35	91	<20	112
	6/8/2007	72	354	<20	520	247	184	84	<20	59	38	33	445	<20	251
	6/11/2007	32	136	26	263	372	511	68	<20	163	111	30	1,354	<20	454
	6/12/2007	36	725	39	105	1,709	759	60	23	122	200	26	899	<20	274
	6/13/2007	22	237	27	64	507	2009	51	30	52	55	33	82	<20	326
	6/14/2007	26	538	21	642	603	451	38	48	127	336	29	136	<20	180
	6/15/2007	27	1,050	<20	145	2,413	856	37	<20	82	53	34	168	<20	472

Table A-3 displays Lumex scans of Scenario 5 Trial 3 flooring after a CFL had been broken and cleaned up. Results recorded are the highest concentrations of mercury seen while scanning in ng/m³. This piece of carpet was vacuumed again, with the Hoover 400, on 7/2/07, represented by the shaded boxes below.

Table A-3

Scenario	S5T3vac	
Date of Breakage	6/4/2007	
Floor Type	short carpet	
Date Measured ↓	calm	agitated
6/12/2007	<20	345
6/13/2007	<20	380
6/14/2007	<20	732
6/15/2007	<20	775
6/18/2007	<20	4,240
6/19/2007	21	1,714
6/21/2007	<20	1,940
6/22/2007	30	2,719
6/25/2007	22	739
6/26/2007	<20	914
6/27/2007	62	1,888
6/28/2007	<20	1,387
6/29/2007	<20	332
7/2/2007 (before vac)	<20	2,165
7/2/2007 (after vac)		4,330
7/5/2007	43	1,826
7/6/2007	89	1,061
7/9/2007	<20	2,032
7/10/2007	30	967
7/11/2007	<20	790
7/26/2007	24	173

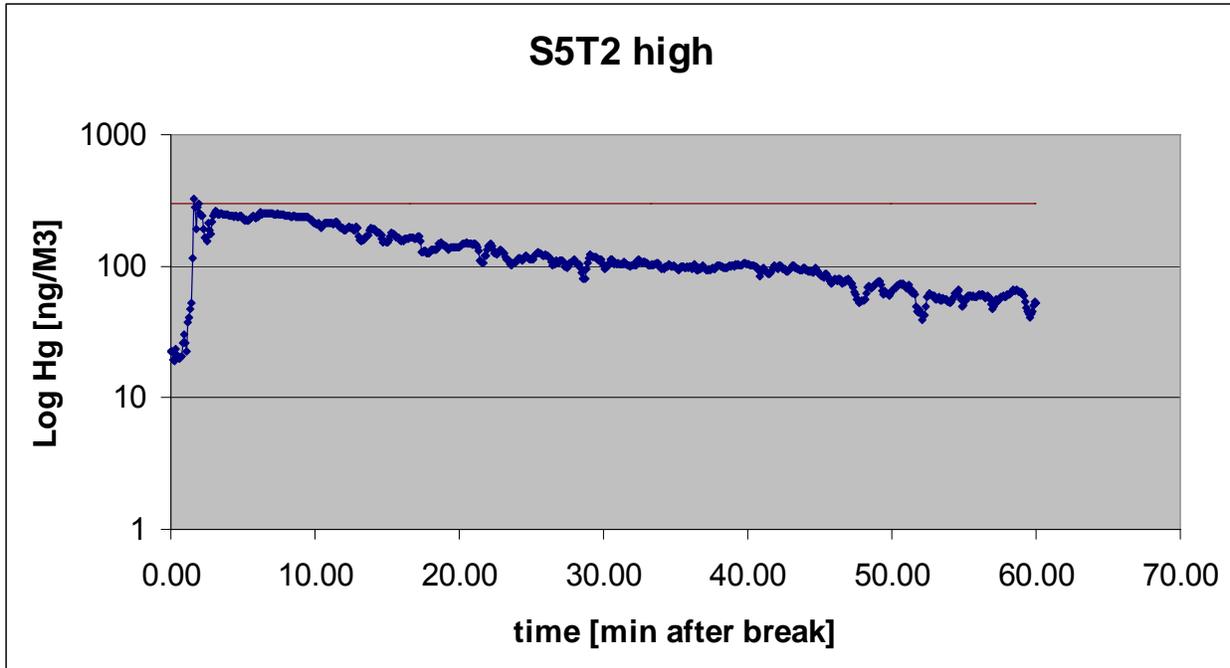


Figure A-32. Scenario 5, Trial 2 at Five-Foot Height (6/1/07)

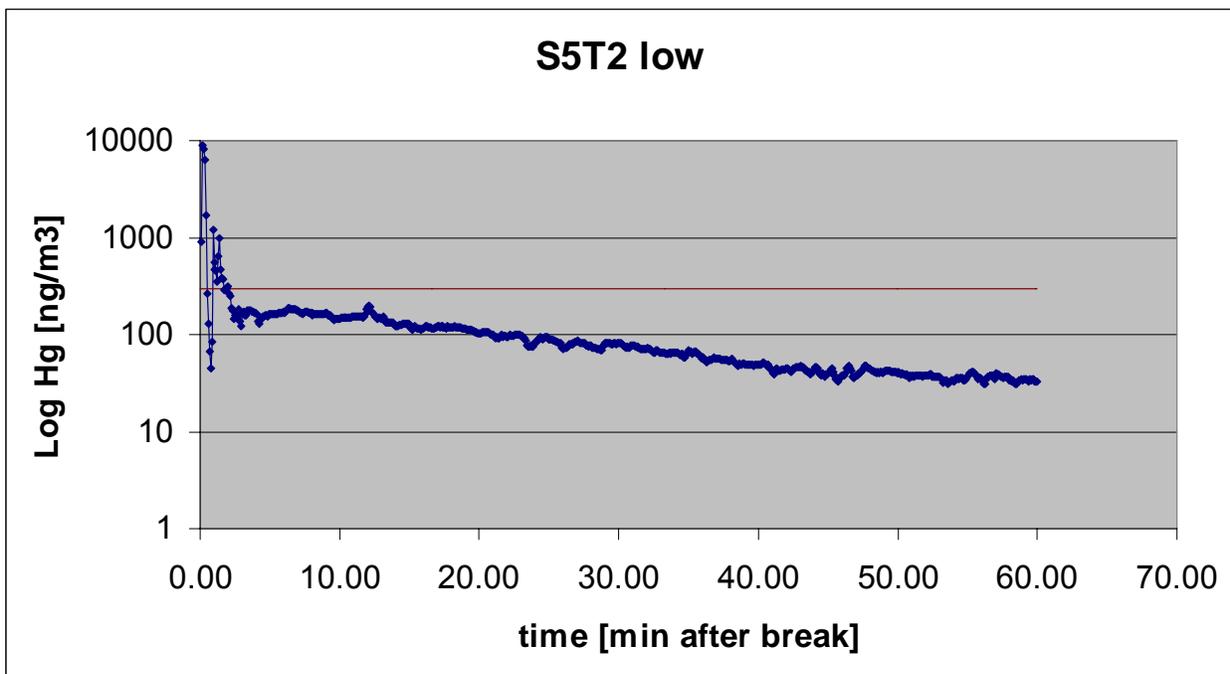


Figure A-33. Scenario 5, Trial 2 at One-Foot Height (6/1/07)

Scenario 6: Shag Carpet, Venting, Vacuuming with Lightweight Vacuum without Bag

For this scenario a “Brand A” 60 watt equivalent lamp was thoroughly broken with a hammer on the shag carpet, the window was opened, and the larger pieces of broken lamp were put in a re-sealable plastic bag. The vacuum, a motorized Dirt Devil power sweeper, was used for the smaller pieces of debris. The vacuum surface that had touched the debris was wiped down with a wet wipe. The vacuum was left in the room, but the waste was taken out of the room, and placed in a hazardous waste drum.

On 6/5/07, mercury from Trial 2 peaked at 414 ng/m³ at the five foot height and peaked at 16,942 ng/m³ at the one foot height. Concentrations of mercury in the room at both heights were less than 300 ng/m³ after 3.08 minutes.



Figure A-34. Dirt Devil motorized power sweeper used in Scenario 6



Figure A-35. Dirt Devil “beater”



Figure A-36. Dirt Devil detachable cup for emptying debris

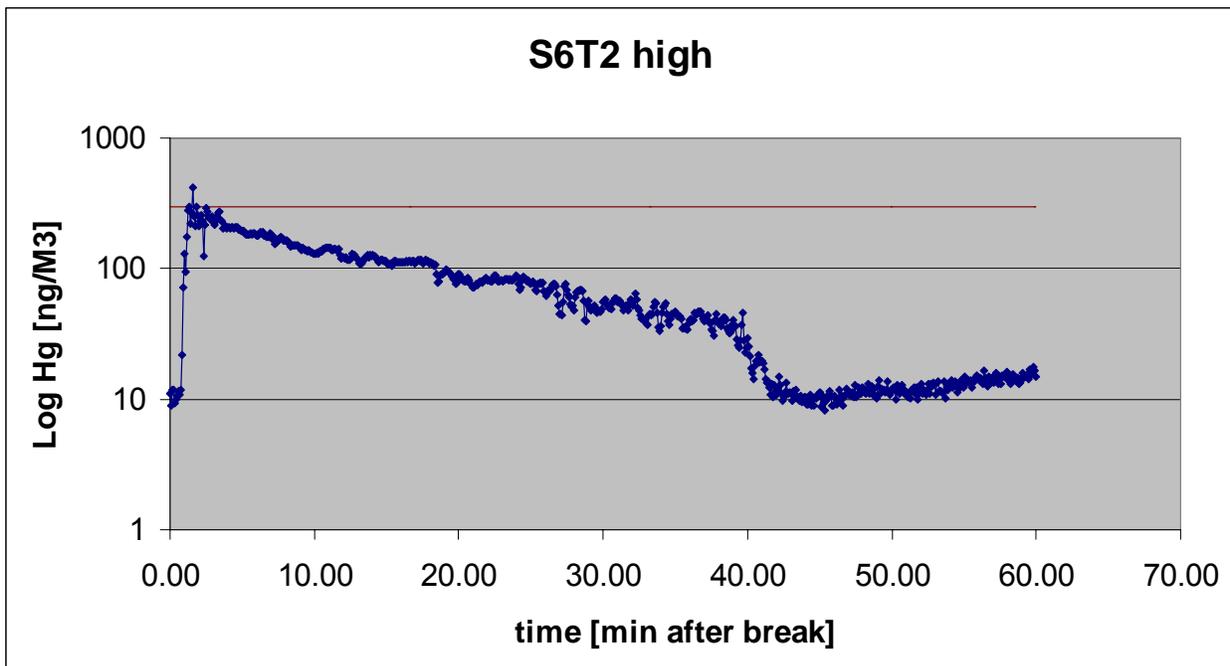


Figure A-37. Scenario 6, Trial 2 at Five-Foot Height (6/5/07)

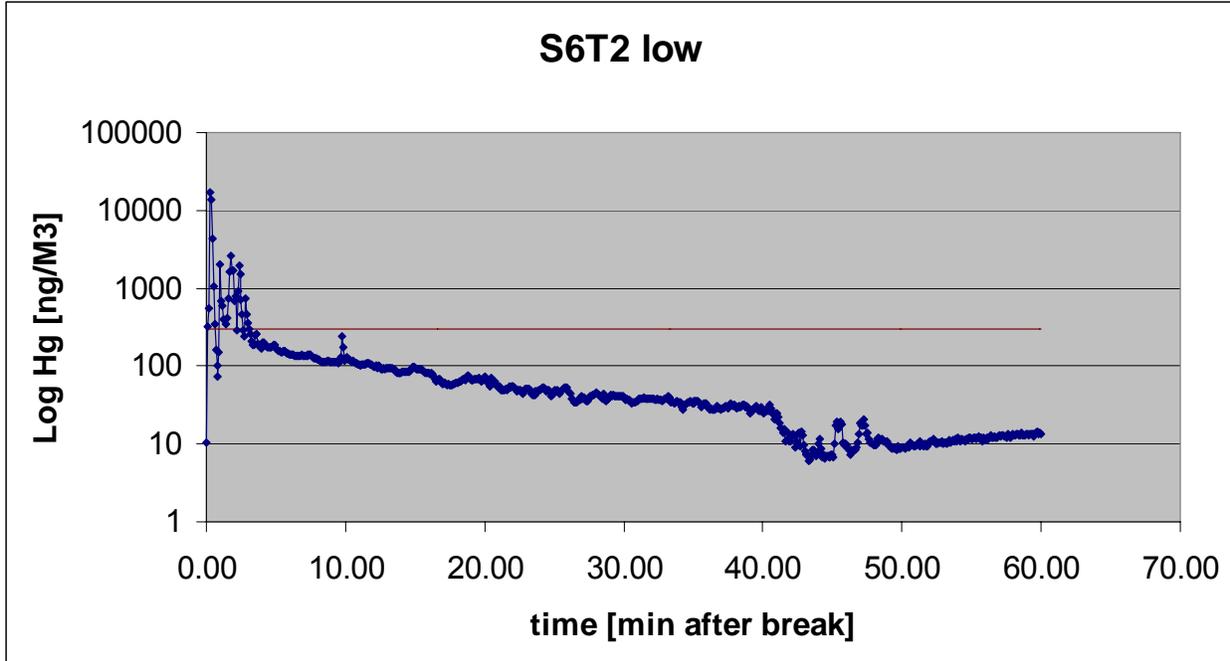


Figure A-38. Scenario 6, Trial 2 at One-Foot Height (6/5/07)

After about 15 minutes into the first trial of Scenario 6, the third Lumex was used to get some readings off the vacuum. Mercury in the air next to and within approximately an inch of the beaters equaled 370 ng/m³. Room air at that time was about 130 ng/m³. See table below for additional information:

Table A-4 shows mercury concentrations in ng/m³ recorded within approx. an inch of vac part surface for a Dirt Devil Power Sweep, purchased new June 4, 2007. Wet wipes were used on vacuum surfaces before each set of readings below except first row of results.

Table A-4. . Dirt Devil Power Sweep

Date of Lamp Breakage	Date of Vacuuming	Date of Measurement	Vacuum Cleaner Part		
			Beater	Handle	Cup
6/5/2007AM	6/5/2007AM	6/5/2007AM (14.6 minutes into run)	370	220	249
		6/5/2007AM (about 1 hr. after vacuuming)	22	<20	21
6/5/2007PM	6/5/2007PM	6/5/2007PM (about 45 min. after 2nd vacuuming)	39	<20	20
6/6/2007	6/6/2007	6/6/2007	close to ambient air	close to ambient air	close to ambient air

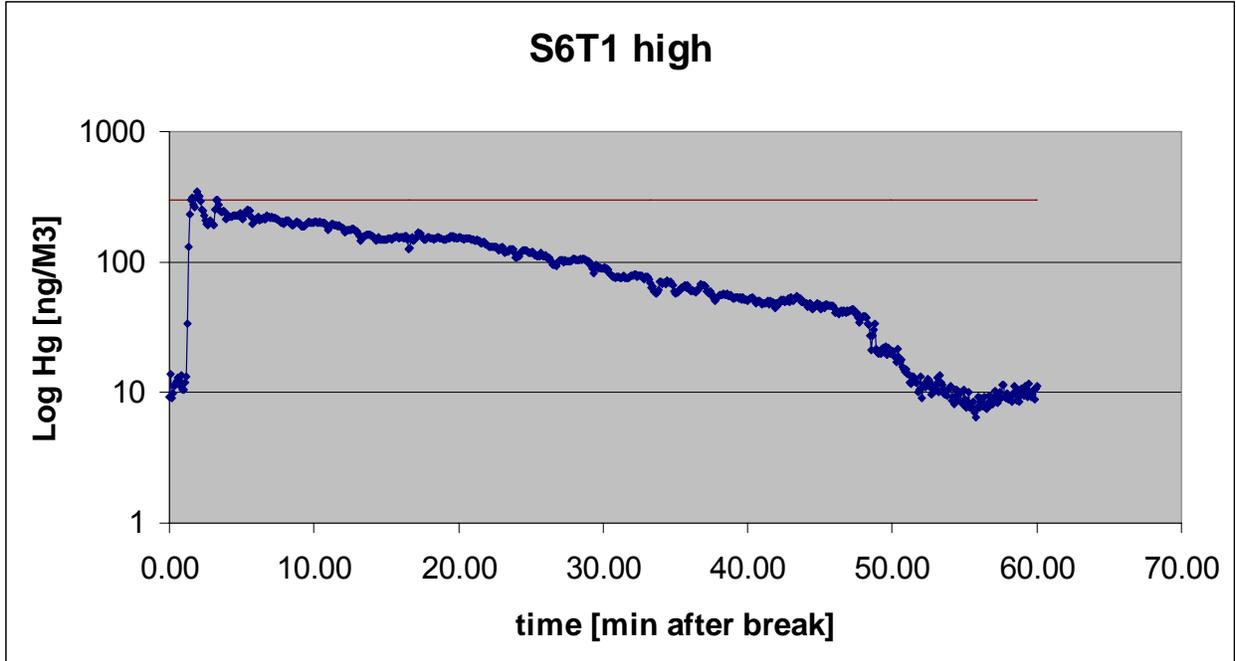


Figure A-39. Scenario 6, Trial 1 at Five-Foot Height (6/5/07)

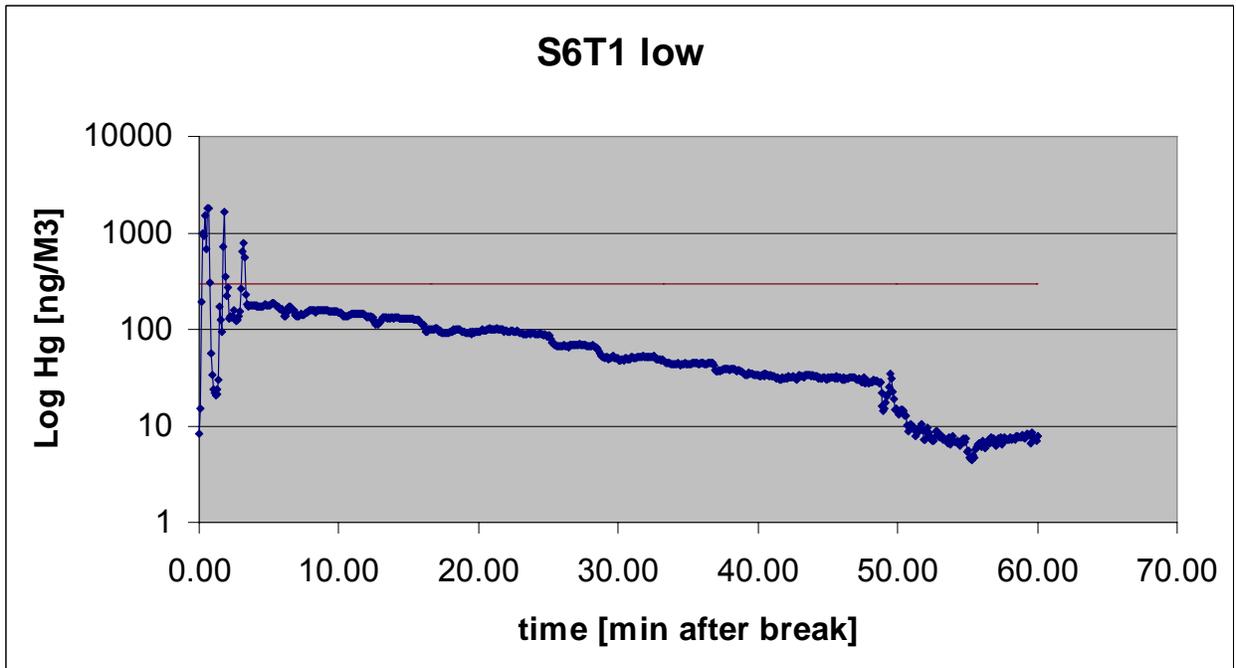


Figure A-40. Scenario 6, Trial 1 at One-Foot Height (6/5/07)

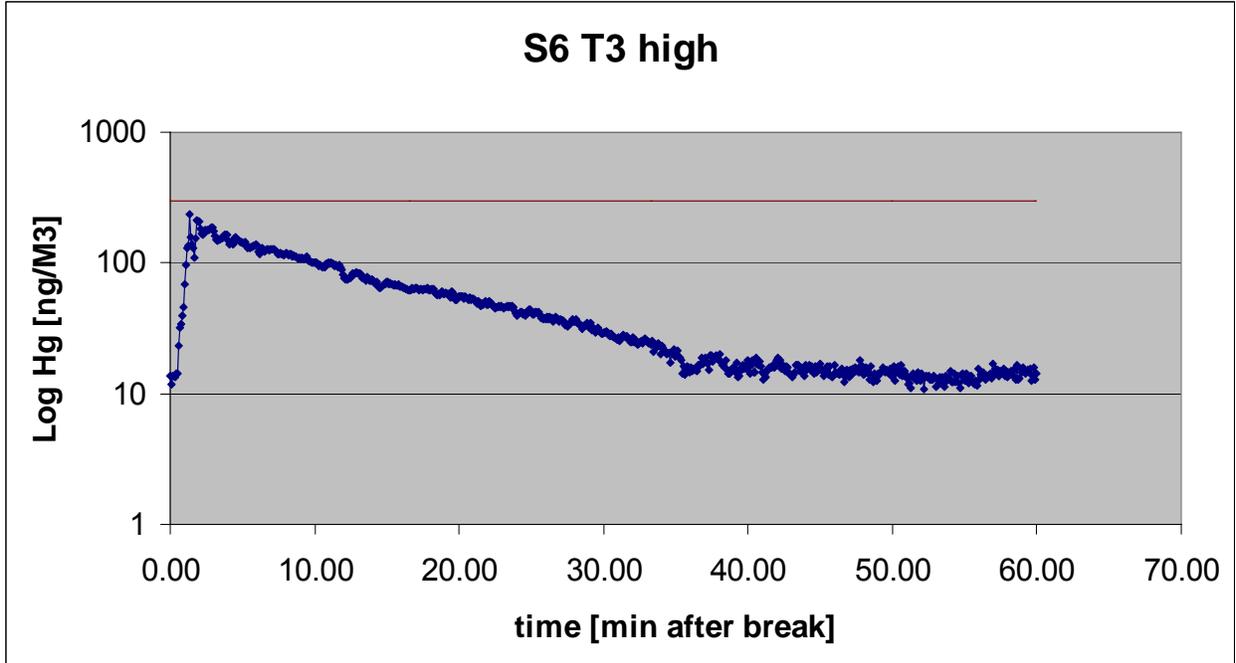


Figure A-41. Scenario 6, Trial 3 at Five-Foot Height (6/6/07)

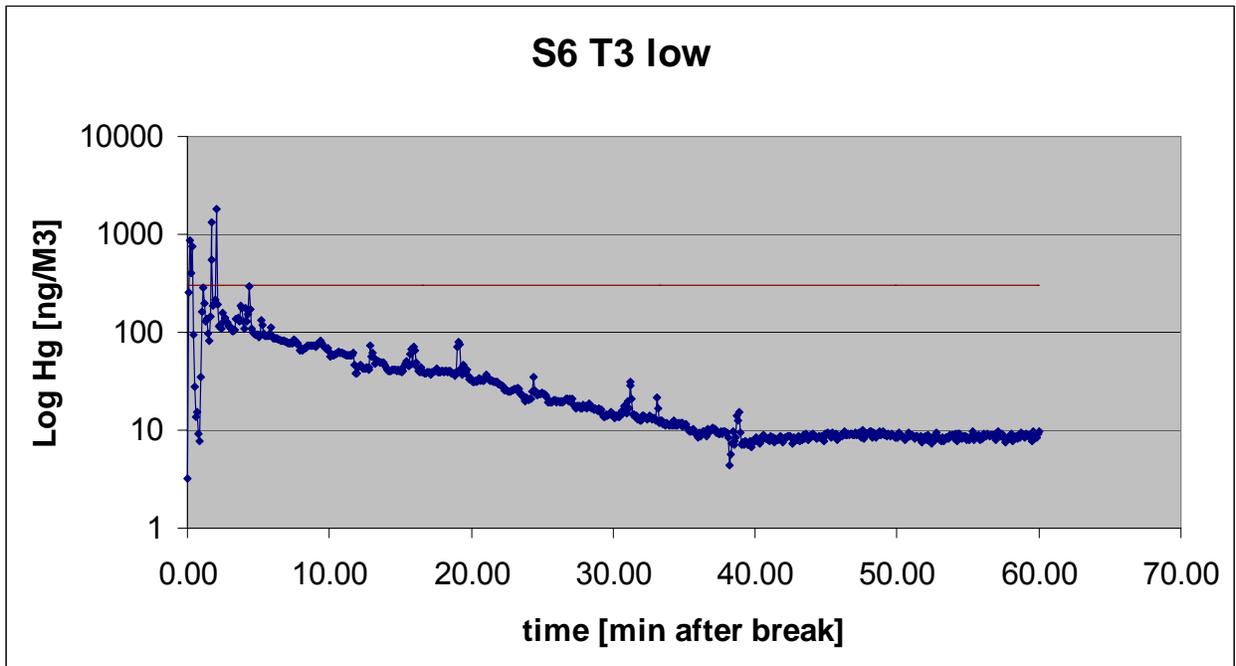


Figure A-42. Scenario 6, Trial 3 at One-Foot Height (6/6/07)

Additional Cleanup Scenarios

Scenario A: “Brand B” 90 Watt Equivalent, Wood, Venting, Cleanup. This was an older lamp donated from the Maine Public Utilities Commission. It was taller than the other lamps tested and consisted of four tall glass columns. Additional lamp information that is not listed in Table 2 is as follows: Product Order Code 21046, Description FLC26, RES.3719541, CG26-EC. Graphs for the first broken lamp and graphs for the duplicate are shown below because of the very different results.

For both trials of this scenario, the lamp was thoroughly broken on hardwood floor, the window was opened, the bigger pieces of debris were put into the re-sealable polyethylene bag. The smaller pieces were picked up with index cards, tape, and a wet wipe. The waste, in the re-sealable bag, was removed from the room, and put into the hazardous waste drum.

The first trial occurring 6/8/07, see Figures A-43 & A-44, showed mercury peaking at 1,640 ng/m³ at the five foot height and peaking at 7,410 ng/m³ at the one foot height. Mercury decreased to under 300 ng/m³ after 15.5 minutes at the five foot height and after 10.41 minutes at the one foot height.

The second trial on 6/11/07, a duplicate to the first trial, showed a much higher concentration of mercury in the air after breakage. Mercury peaked at 9,893 ng/m³ at the five foot height and peaked at 61,037 ng/m³ at the one foot height. Mercury decreased to under 300 ng/m³ at approximately 65 minutes for both the high and low levels, but spiked over 300 off and on for hours at the one foot height (see Figure A-47). For this trial, the third Lumex was used to measure mercury coming out of the room from under the door. At about 38 minutes from the start of the run, the third Lumex recorded mercury down the hall from the experiment room between 50-100 ng/m³ with readings on the floor a little higher than at the five foot breathing zone. At the end of the hall, approximately 40 feet from the study room, concentrations of mercury decreased to between 20 and 30 ng/m³. At about 47 minutes from the start of the run a camera with a tripod that was in the study room was removed from the study room. The third Lumex scanned the camera and noticed that the metal joints on the tripod legs appeared to be emitting some mercury. The joints on one tripod leg read 40 ng/m³, the joints on another leg read 27 ng/m³, and the joints on the other leg read <20 ng/m³. The exhaust tube connected to the Lumex that was reading the mercury at the five foot height, that vented the air back into the study room slipped off around 90 minutes from the start of the run. It also slipped off both Lumex instruments a couple of times later in the run, and was put back each time. The filters at the air intake were changed at the end of this run.

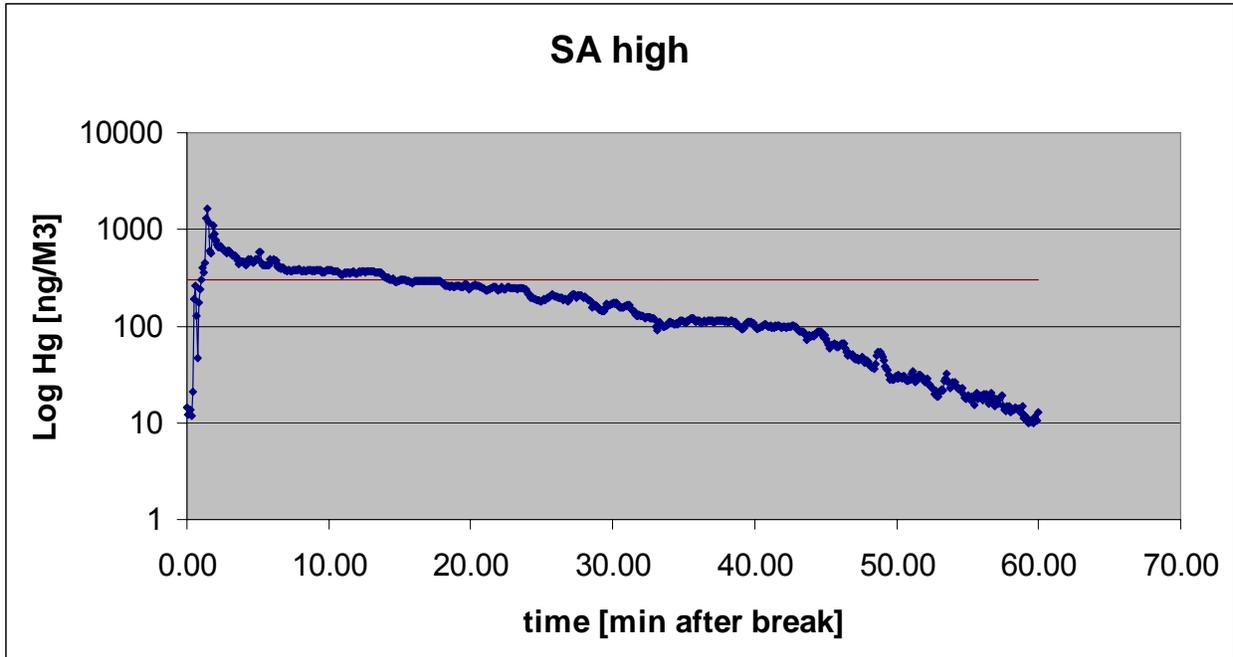


Figure A-43. Scenario A at Five-Foot Height (6/8/07)

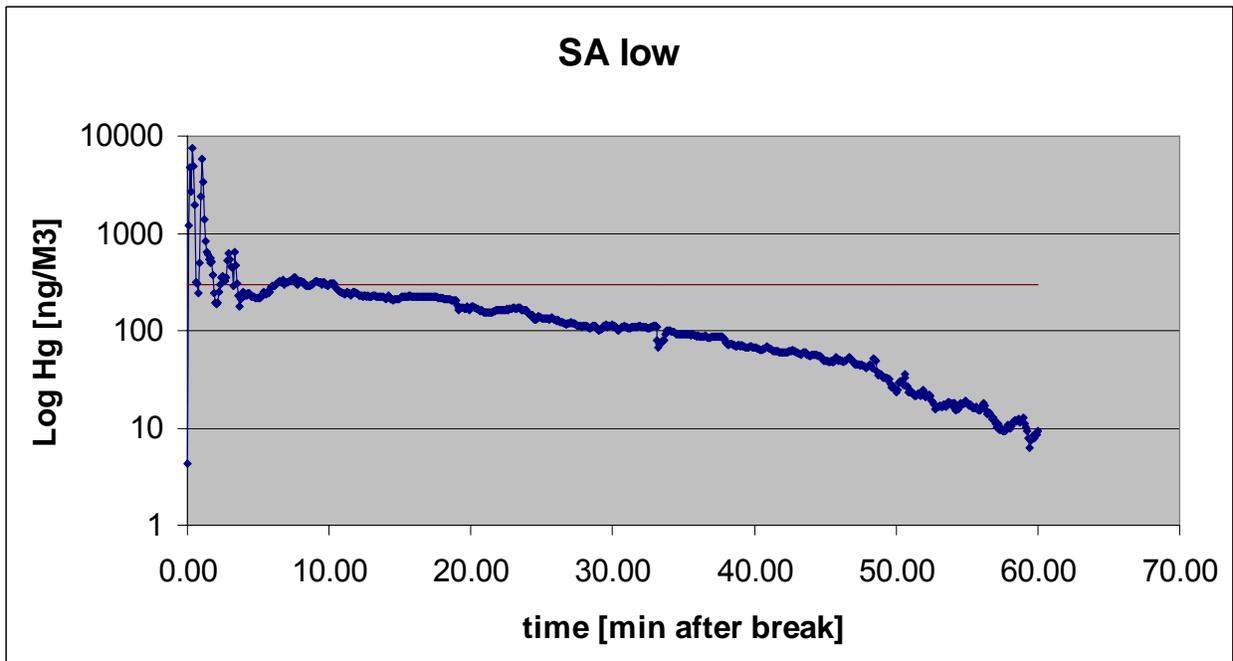


Figure A-44. Scenario A at One-Foot Height (6/8/07)

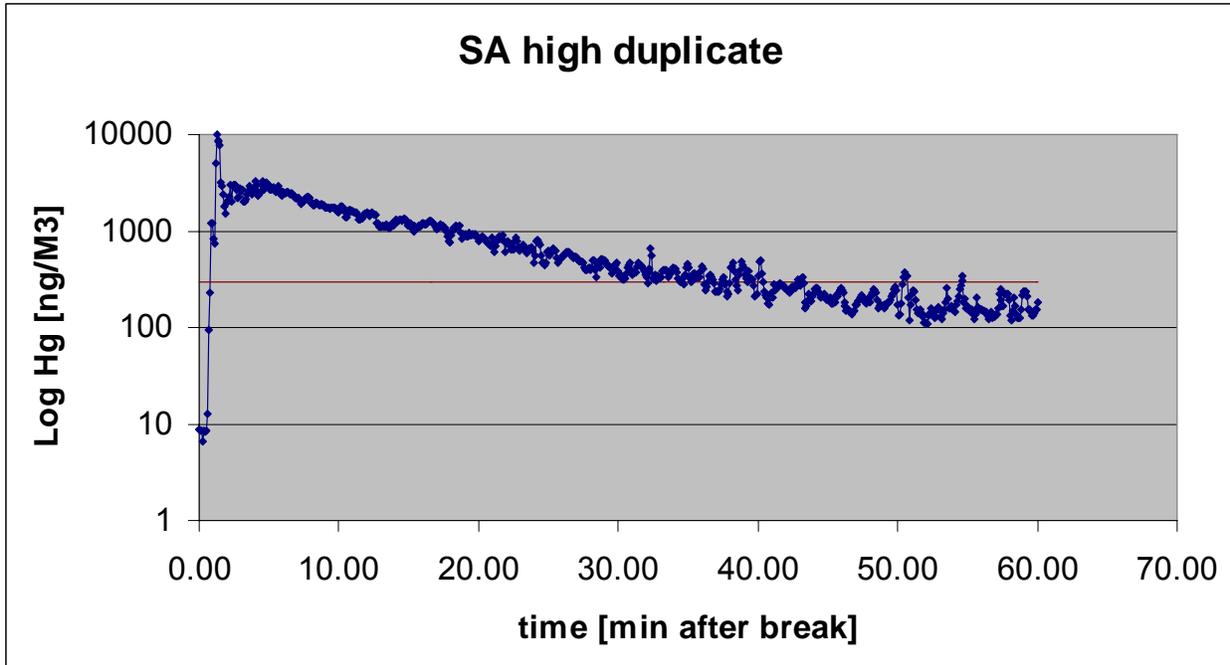


Figure A-45. Duplicate for Scenario A at Five-Foot Height (6/11/07)

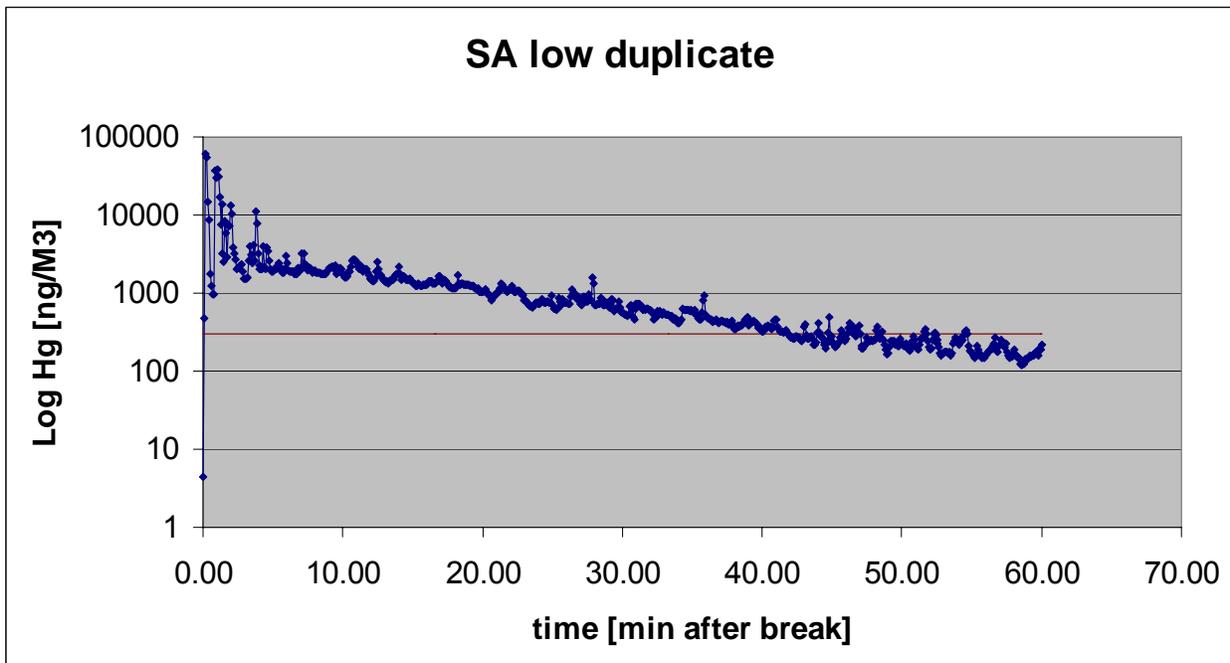


Figure A-46. Duplicate for Scenario A at One-Foot Height (6/11/07)

The following graph shows the concentration of mercury in the air one foot above the hardwood flooring AFTER the first hour since breakage had been recorded on the previous graph. The fifty minutes mark seen below, for example, represents an hour and fifty minutes from breakage.

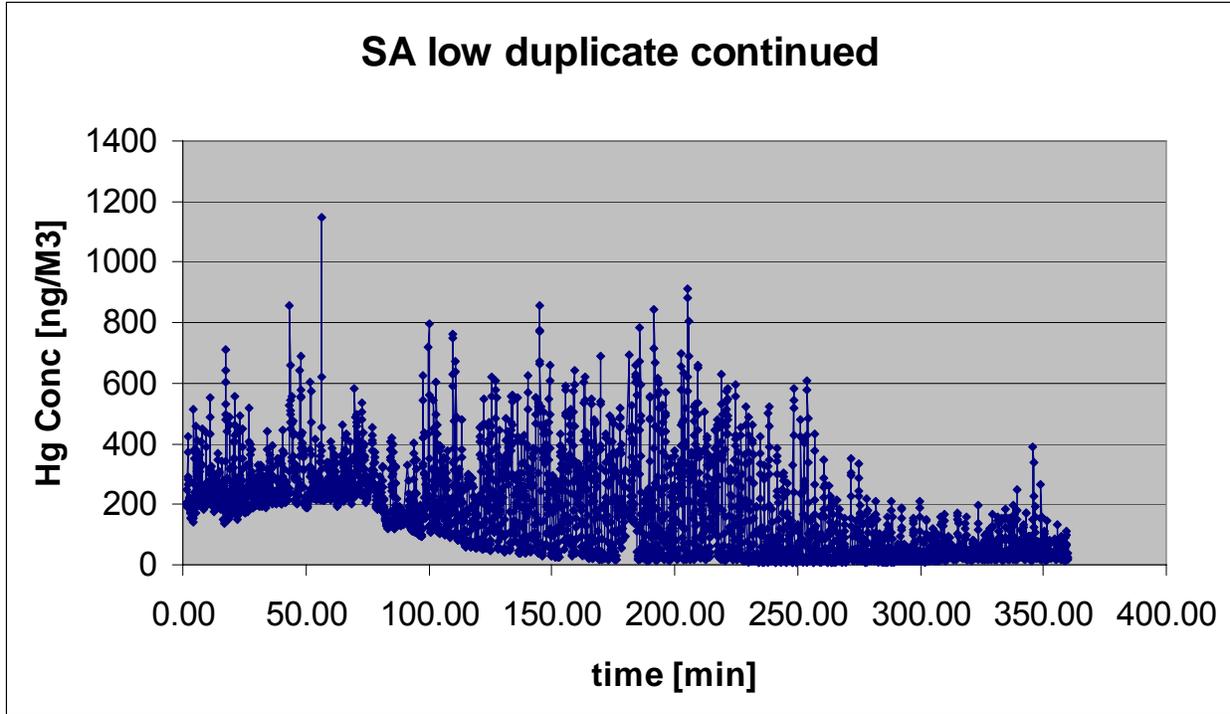


Figure A-47. Duplicate for Scenario A at One-Foot Height Continued (6/11/07)

Table A-5 displays Lumex scans of Scenario A flooring (duplicate) after a CFL had been broken and cleaned up. Results recorded are the highest concentrations of mercury seen while scanning in ng/m³.

Table A-5.

Scenario	SA-"Brand B" 90D	
Date of Breakage	6/11/2007	
Floor Type	wood	
Date Measured	calm	agitated
↓		
6/12/2007	254	797

Scenario B: "Brand C" 60 Watt Equivalent, Short Nap Carpet, Venting, Cleanup ("duplicate" broken on wood).

For this scenario a "Brand C" 60 watt equivalent lamp was thoroughly broken on short carpet, the room was vented, and the lamp was cleaned up with index cards, tape, a wet wipe, and the waste, in the re-sealable plastic bag, was removed from the room. The waste was disposed of in the hazardous waste drum.

After the mercury in the room was below detection limits of the Lumex, another "Brand C" 60 watt equivalent lamp was broken, with the same cleanup as the first only this time the break was on hardwood. Both breaks resulted in many spikes of mercury in the room. The third Lumex

was used to verify this spikiness. Figures A-48 & A-49 represent the break on short nap carpet, and the Figures A-50 & A-51 represent this lamp broken on hardwood.

For the break on short nap carpet, on 6/12/07, the mercury peaked at 1,777 ng/m³ at the five foot height and peaked at 8,125 ng/m³ at the one foot height. Mercury spiked above 300 ng/m³ off and on for hours at the one foot height.

For the break on hardwood, on 6/13/07, mercury peaked at 1,139 ng/m³ at the five foot height, and peaked at 9,523 ng/m³ at the one foot height. Mercury appeared to decrease to under 300 ng/m³ after 11.75 minutes at the low level (see Figure A-51).

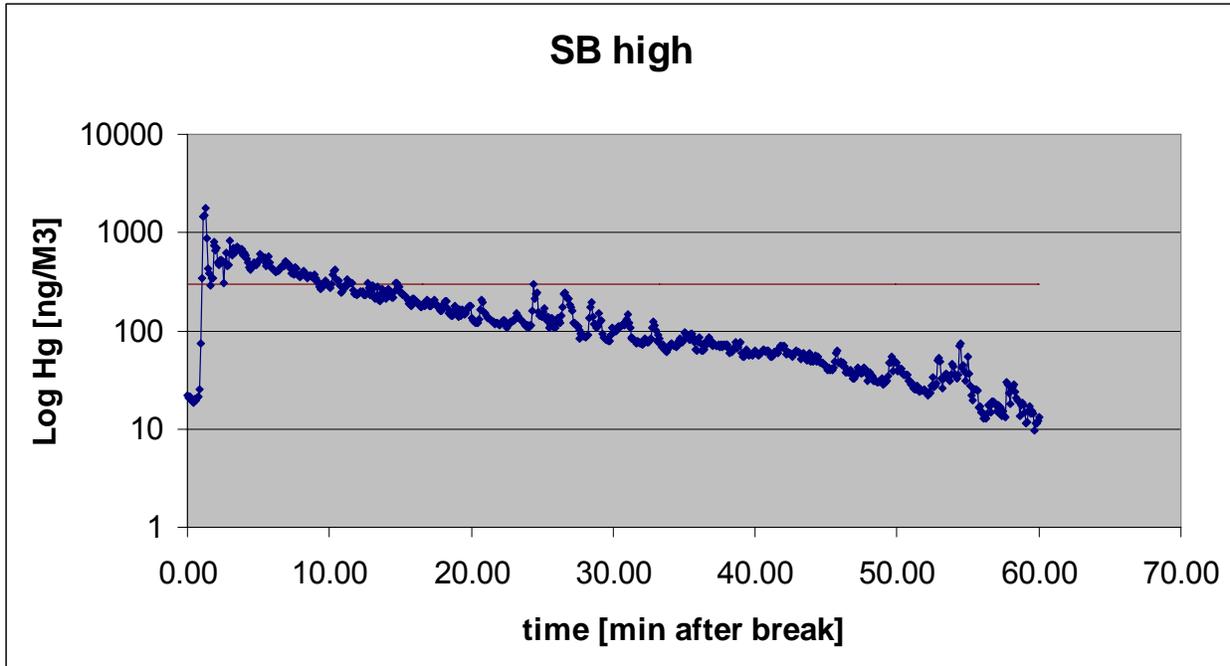


Figure A-48. Scenario B on Short Carpet at Five-Foot Height (6/12/07)

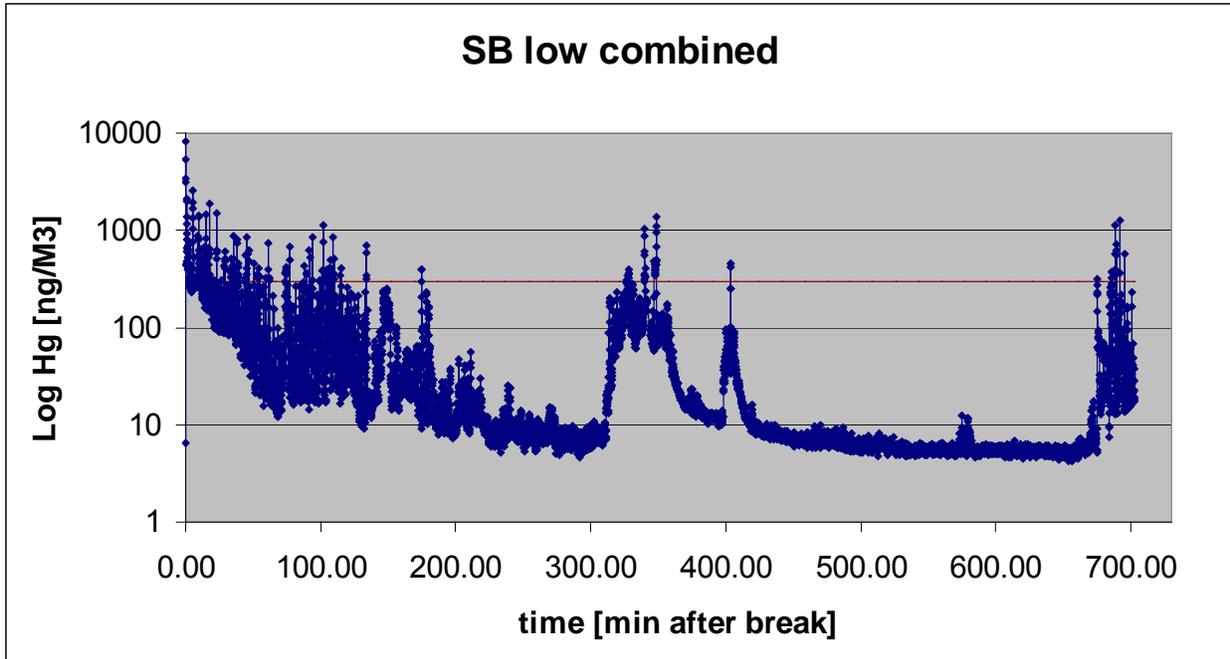


Figure A-49. Scenario B on Short Carpet at One-Foot Height (6/12/07)

The following two graphs are labeled “duplicate” but they represent a break on hardwood, and not the short nap carpet like the two graphs above.

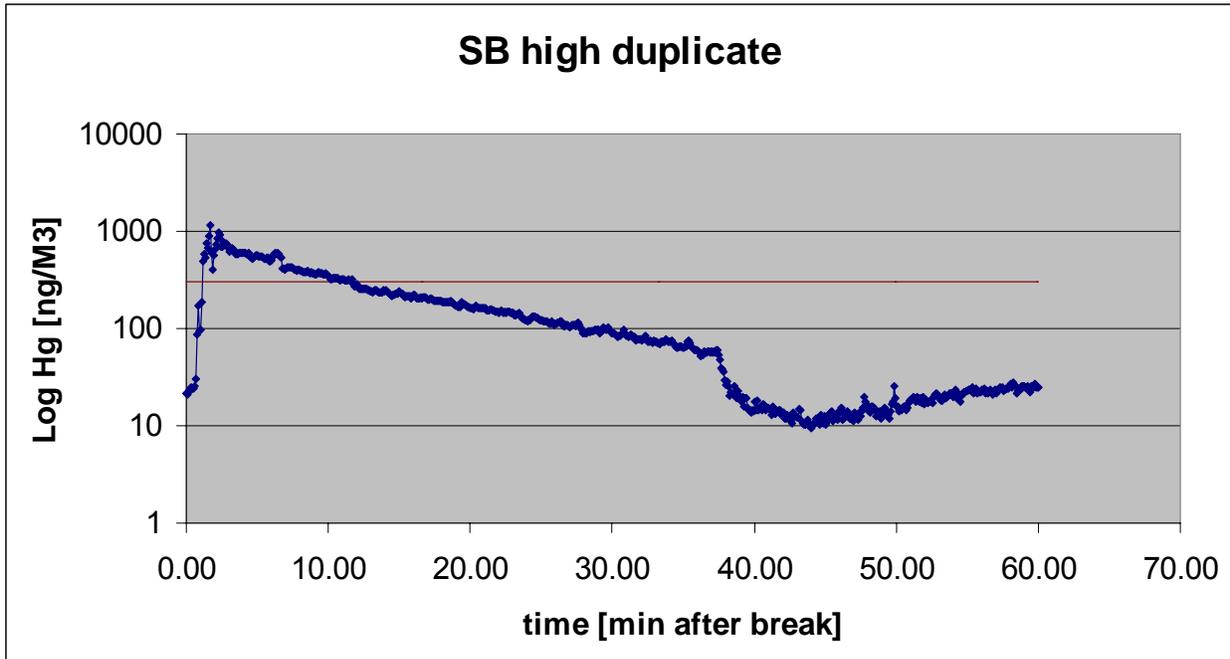


Figure A-50. Scenario B on Hardwood at Five-Foot Height (6/13/07)

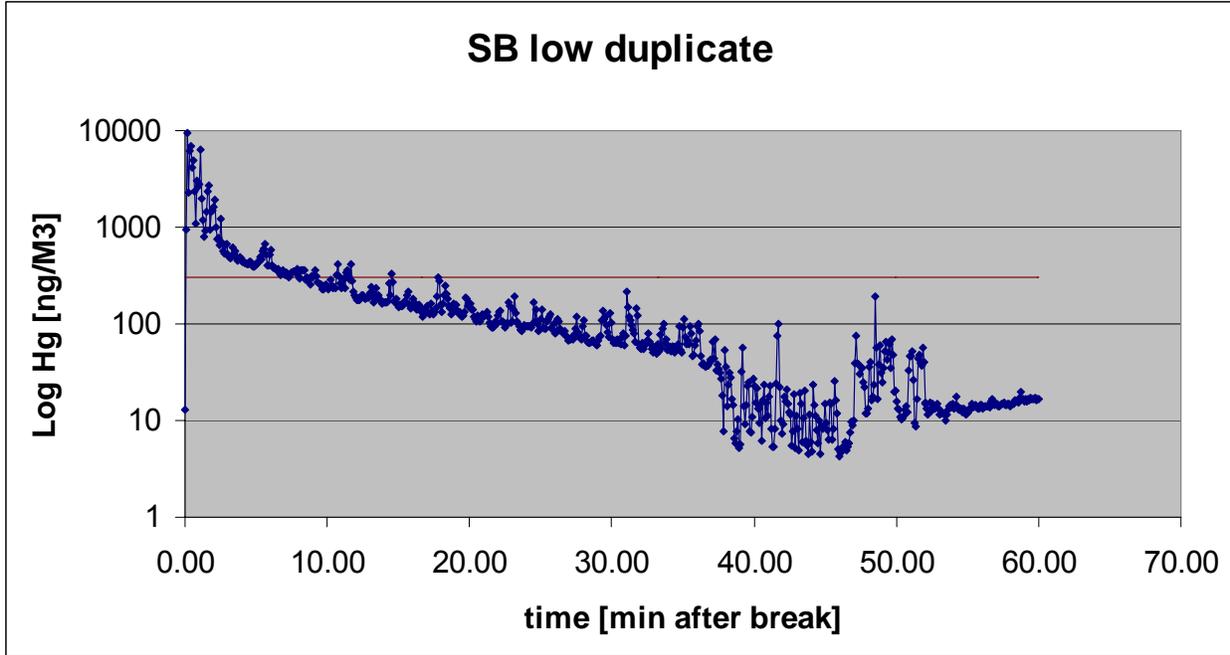


Figure A-51. Scenario B on Hardwood at One-Foot Height (6/13/07)

Table A-6 displays Lumex scans of Scenario B flooring after a CFL had been broken and cleaned up. Results recorded are the highest concentrations of mercury seen while scanning in ng/m^3 . The shaded boxes below represent the dates of a vacuuming event.

Table A-6: Flooring readings for Scenario B

Scenario	SB-“Brand C” 60A		SB-“Brand C” 60A Dup	
Date of Breakage	6/12/2007		6/13/2007	
Floor Type	short carpet		wood	
Date Measured ↓	calm	agitated	calm	agitated
6/13/2007	532	1,418		
6/14/2007	<20	1,820	27	828
6/15/2007	190	6,197		
6/18/2007	233	5,102		
6/19/2007	195	2,129		
6/21/2007	<20	1,220		
6/22/2007	289	2,900		
6/25/2007	215	947		
6/26/2007	351	6,531		
6/27/2007	1,004	9,197		
6/28/2007	207	4,697		
6/29/2007	544	1,983		
7/2/2007	233	570		
7/3/2007	195	5,694		
7/5/2007	1803	13,010		
7/6/2007	1,686	12,750		
7/9/2007	253	2,317		
7/10/2007	2,077	3,717		
7/11/2007	959	2,297		
7/26/2007	141	2,275		
7/27/2007	265	4,593		
7/30/2007	160	2,652		
7/31/2007	102	3,301		
8/1/2007	75	6,019		
8/2/2007	226	1,876		
8/3/2007	1,202	1,696		
8/7/2007	318	540		
8/9/2007 (in sun)	524	13,030		
8/10/2007	49	456		

Scenario C: “Brand D” 60 Watt Equivalent, Wood, Venting, Cleanup. This type of “Brand D” lamp was thoroughly broken for each of two trials on hardwood flooring. Both the results and duplicate results are included below and show differences in initial peaks of mercury. Additional information for this lamp is as follows: SKU# 423-599.

For both breaks (both on 6/14/07), lamps were broken on hardwood flooring, the room was vented, and the lamps were cleaned up with index cards, tape, wet wipes, and the waste was removed from the room.

Figures A-52 & A-53 below for the first trial show mercury peaking to 4,257 ng/m³ at the five foot height, and 27,224 ng/m³ at the one foot height. Mercury was under 300 ng/m³ after about 30 minutes for both heights. For the duplicate trial, mercury peaked to 5,927 ng/m³ at the five foot

height, and 6,164 ng/m³ at the one foot height. Mercury was under 300 ng/m³ after about 26 minutes for both heights. The two trials had results that looked similar but the peak of mercury at the one foot height was more than four times higher for the first trial.

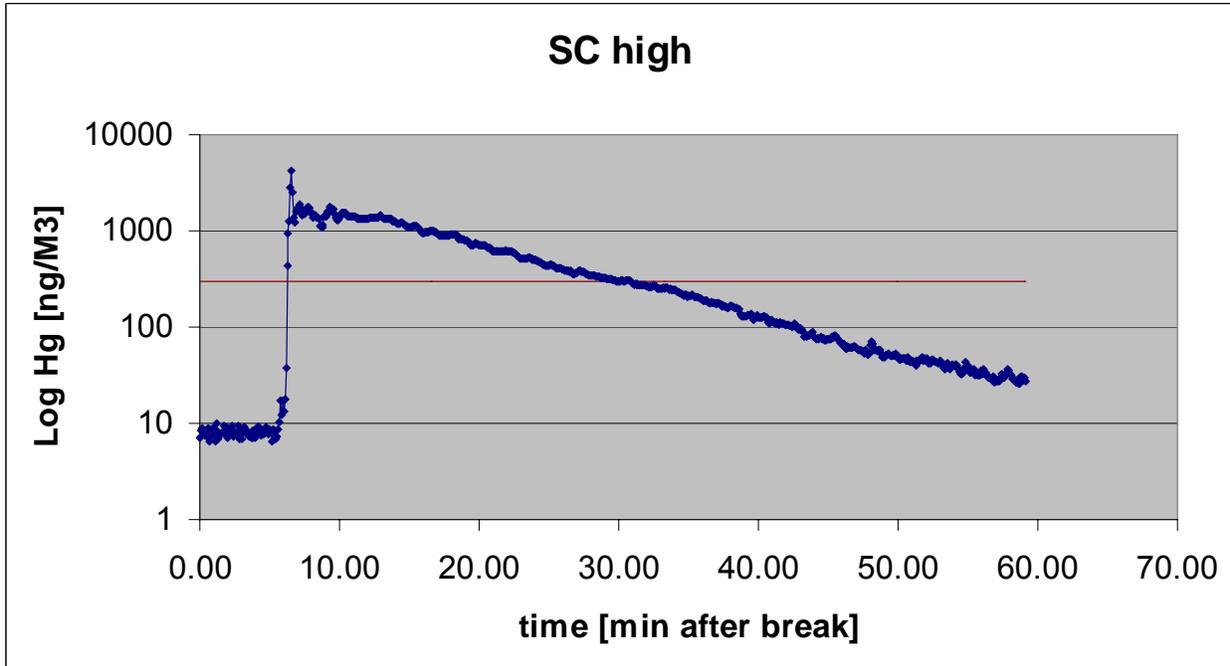


Figure A-52. Scenario C at Five-Foot Height (6/14/07)

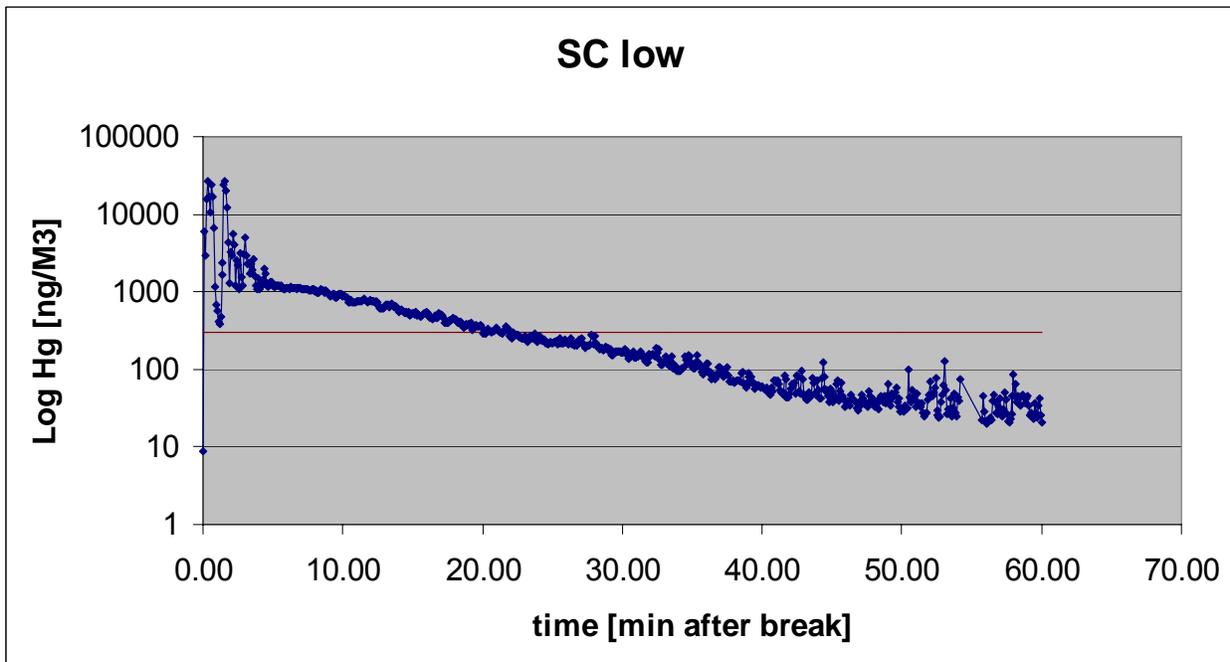


Figure A-53. Scenario C at One-Foot Height (6/14/07)

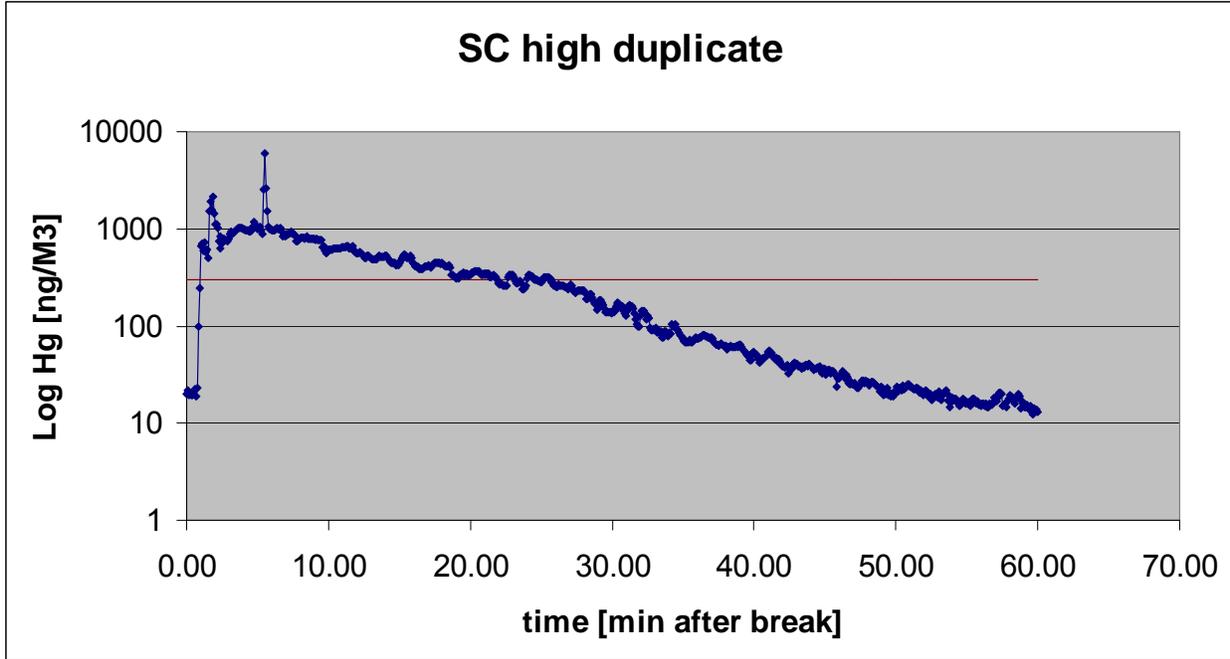


Figure A-54. Duplicate for Scenario C at Five-Foot Height (6/14/07)

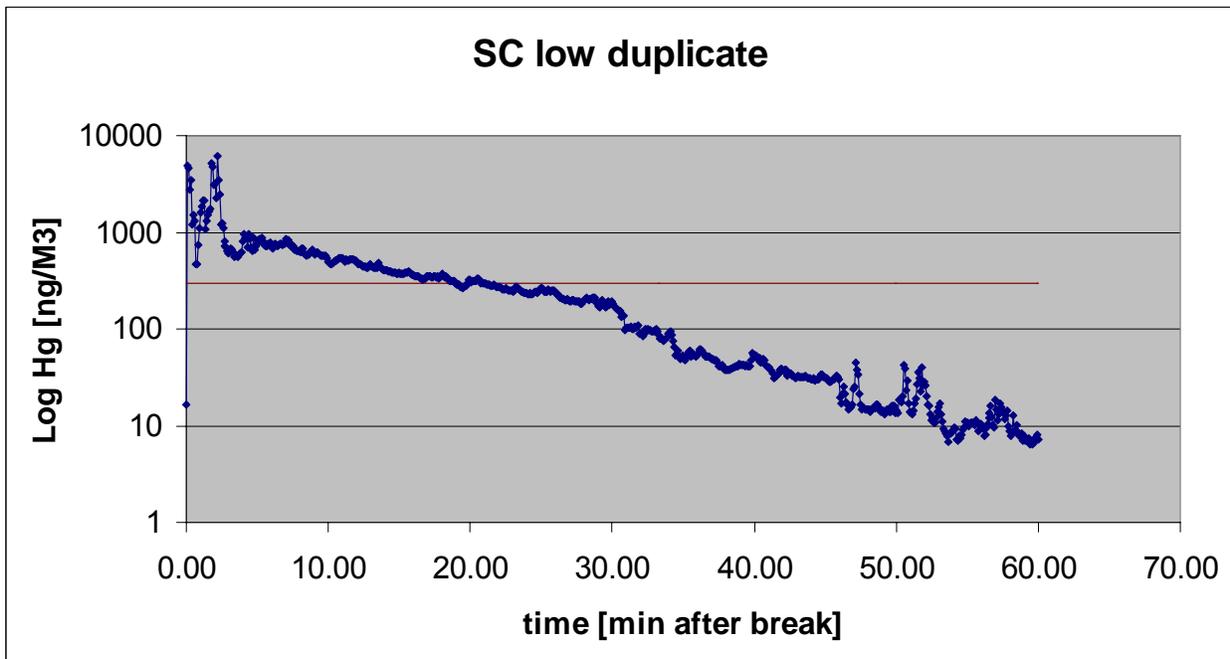


Figure A-55. Duplicate for Scenario C at One-Foot Height (6/14/07)

Table A-7 displays Lumex scans of Scenario C flooring after a CFL had been broken and cleaned up. Results recorded are the highest concentrations of mercury seen while scanning in ng/m³.

Table A-7: Flooring Readings for Scenario C

Scenario	SC-“Brand D” 60		SC-“Brand D” 60dup	
Date of Breakage	6/14/2007		6/14/2007	
Floor Type	wood		woodFromSBd up	
Date Measured ↓	calm	agitated	calm	agitated
6/15/2007	446	342	<20	564
6/18/2007	203	800	68	680
6/19/2007	<20	526	<20	367
6/21/2007	22	319	72	943
6/22/2007	92	242	27	452
6/25/2007	55	551	<20	1060
6/26/2007	83	634	<20	673
6/27/2007	161	718	56	376
6/28/2007	36	366	<20	574
6/29/2007	34	253	<20	200
7/2/2007	20	360	81	552
7/3/2007	33	282	<20	717
7/5/2007	35	211	<20	564
7/6/2007			43	559
7/9/2007			<20	173

Scenario D: “Brand A” 60 Watt Equivalent, Hot Lamp, Wood, Venting, Cleanup.

This scenario was performed twice (two trials) with similar results, the first on 6/15/07, and the second on 6/18/07. For both breaks, lamps were turned on for an hour and then were thoroughly broken on hardwood flooring, the room was vented, and the lamps were cleaned up with index cards, tape, wet wipes, and the waste was removed from the room.

Figures A-56 & A-57 for the first trial show mercury peaking to 1,443 ng/m³ at the five foot height, and 12,016 ng/m³ at the one foot height. Mercury was under 300 ng/m³ after 3.41 minutes at the five foot height and after 1.75 minutes at the one foot height.

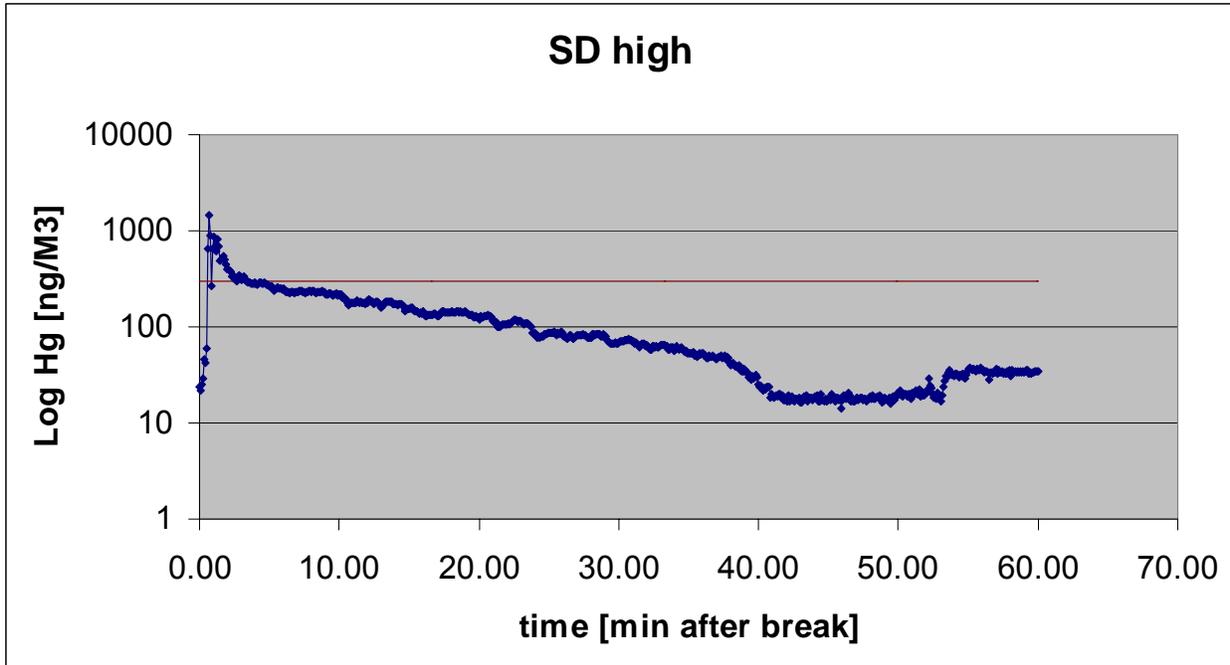


Figure A-56. Scenario D at Five-Foot Height (6/15/07)

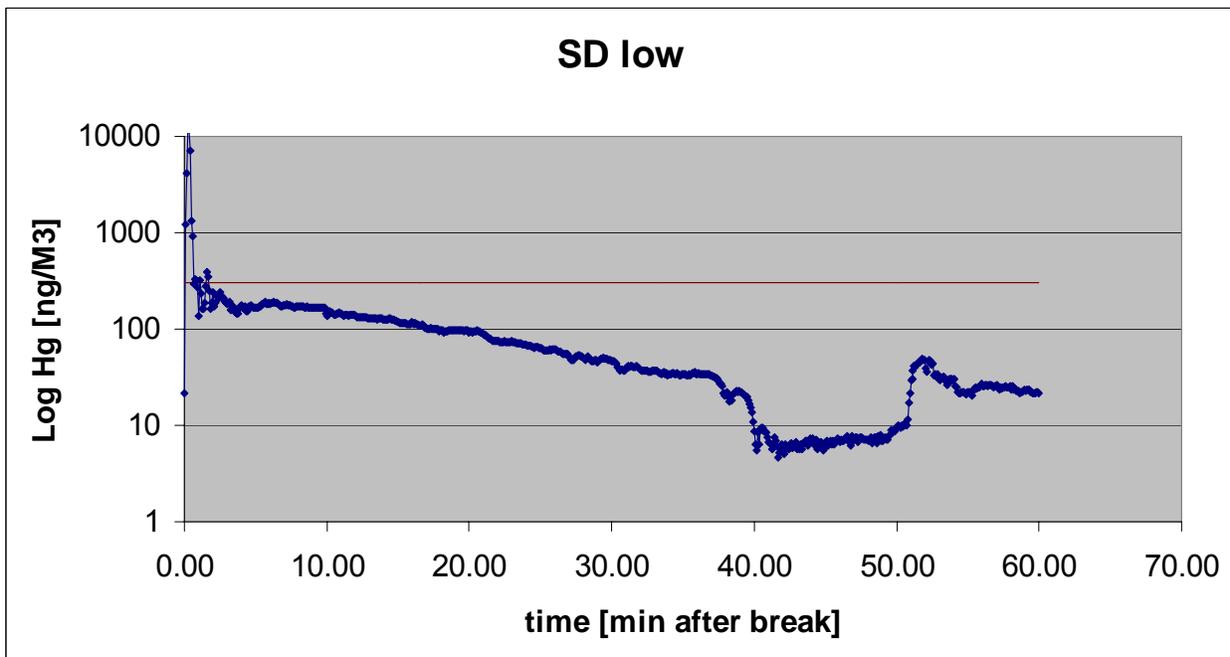


Figure A-57. Scenario D at One-Foot Height (6/15/07)

Table A-8 displays Lumex scans of Scenario D flooring after a CFL had been broken and cleaned up. Results recorded are the highest concentrations of mercury seen while scanning in ng/m^3 .

Table A-8: Flooring readings for Scenario D

Scenario	SD-P60 hot		SD-P60 hot dup	
Date of Breakage	6/15/2007		6/18/2007	
Floor Type	wood		wood	
Date Measured ↓	calm	agitated	calm	agitated
6/18/2007	<20	<20		
6/19/2007			<20	<20

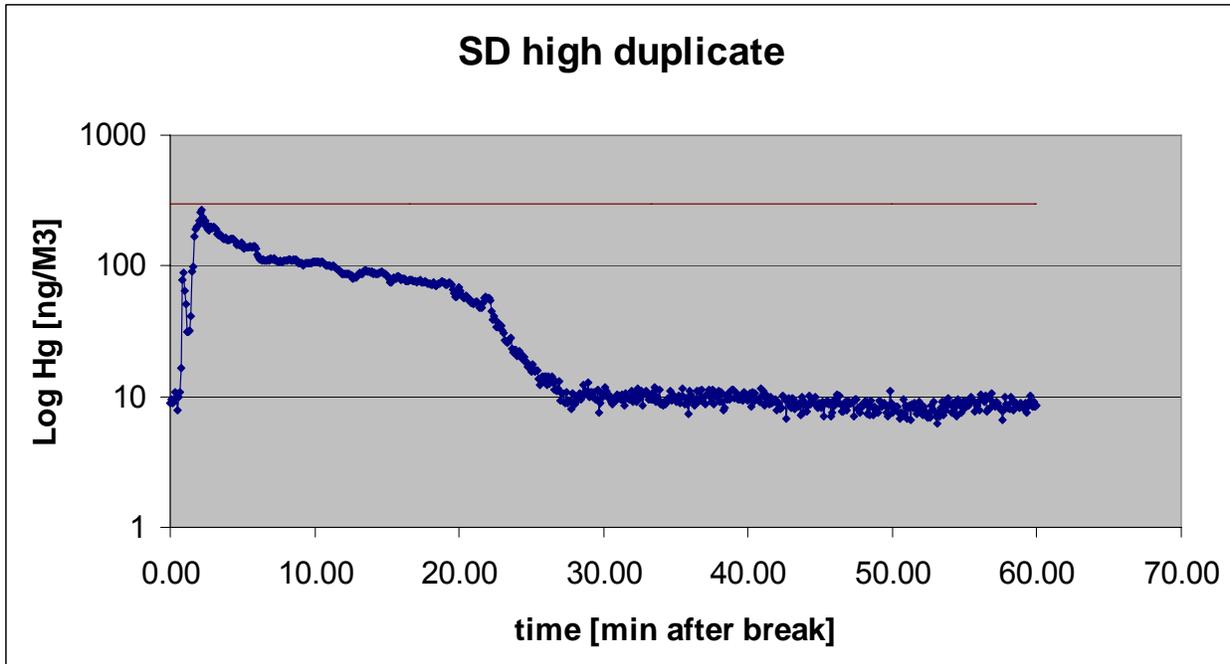


Figure A-58 Scenario D duplicate at five foot height (6/18/07)

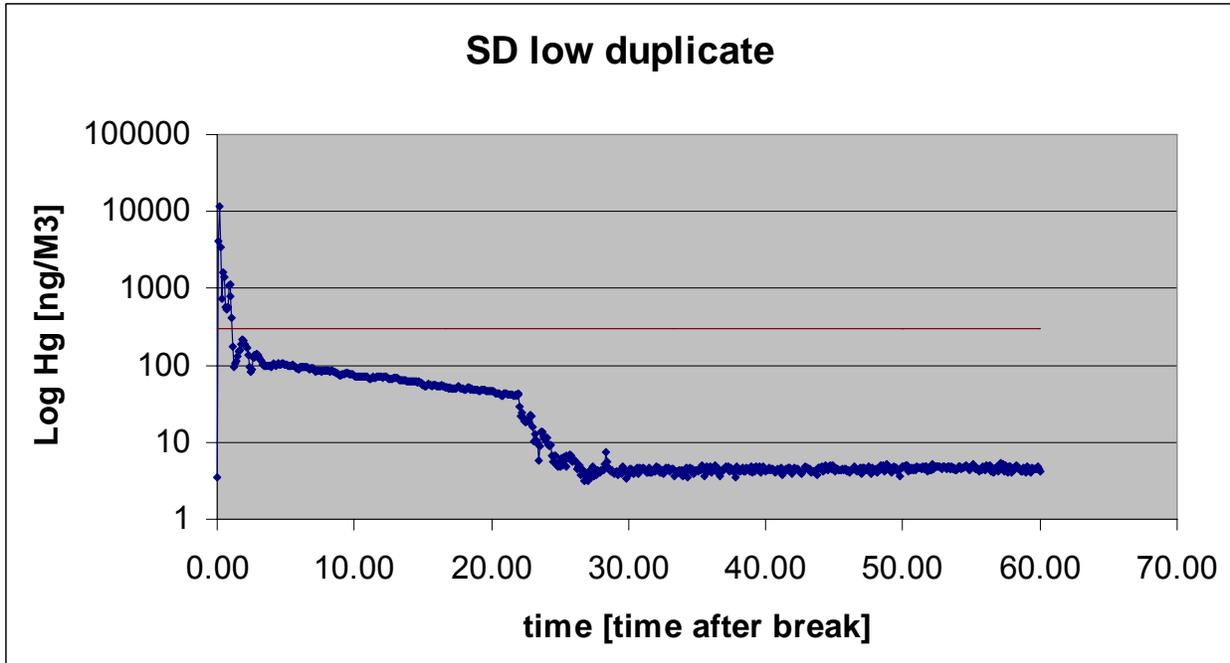


Figure A-59 Scenario D duplicate at one foot (6/18/07)

Scenario E: “Brand B” 100 Watt Equivalent, Wood, Venting, Cleanup. This “Brand B” 100 watt equivalent lamp was used here with a duplicate and also used in scenarios F and L. Additional information for this lamp that was not included in Table 2. is as follows: A Equiv, 120 VAC 60Hz 390mA, FLE26HT3/21 SW.

For both breaks for this scenario (the first on 6/18/07 and the second on 6/19/07), lamps were thoroughly broken on hardwood flooring, the room was vented, and the lamps were cleaned up with index cards, tape, wet wipes, and the waste was removed from the room.

Figures A-60 & A-61 for the first trial show mercury peaking to 7,288 ng/m³ at the five foot height, and 65,094 ng/m³ at the one foot height. Mercury was under 300 ng/m³ after 23.67 minutes for the higher height, and after 40.5 minutes for the lower height. The graphs for the duplicate run looked similar, but the mercury peak at the one foot height in the duplicate run peaked at 25,399 ng/m³.

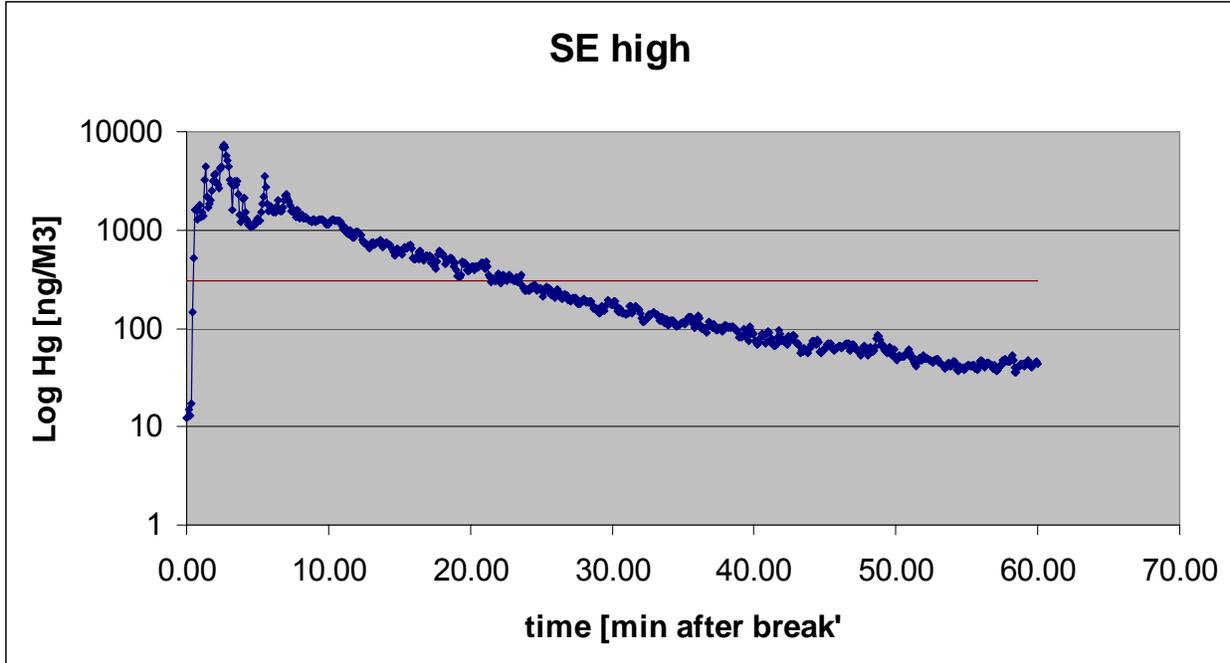


Figure A-60. Scenario E at Five-Foot Height (6/15/07)

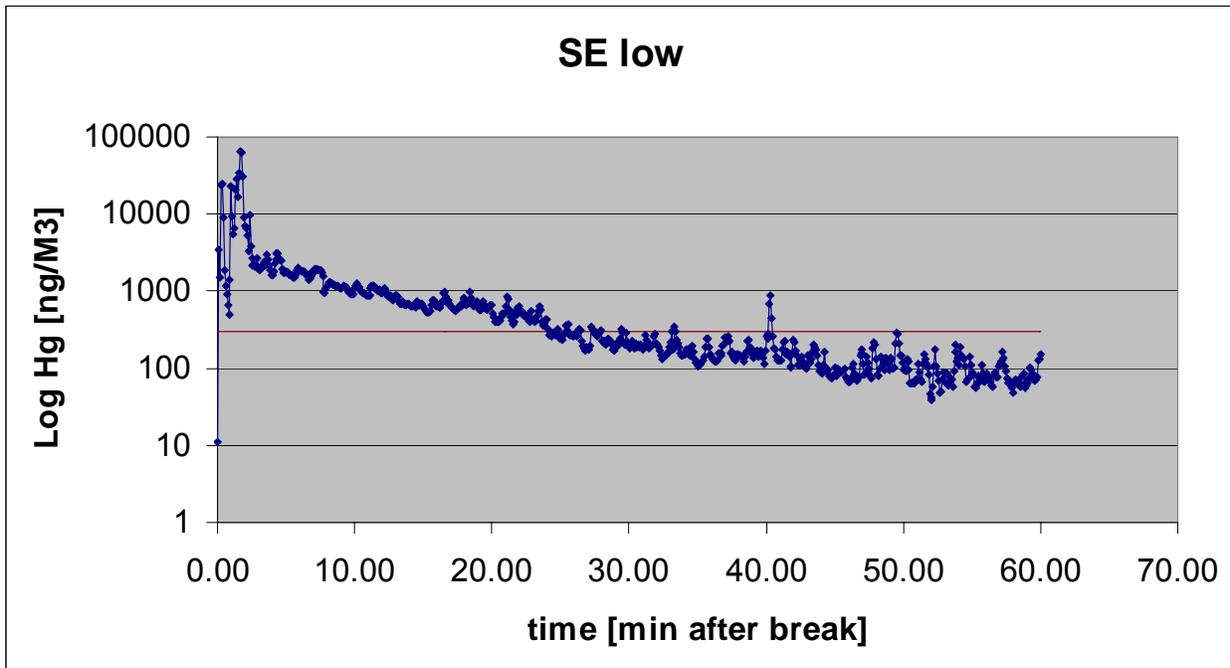


Figure A-61. Scenario E at One-Foot Height (6/15/07)

Table A-9 displays Lumex scans of Scenario E flooring after a CFL had been broken and cleaned up. Results recorded are the highest concentrations of mercury seen while scanning in ng/m^3 .

Table A-9: Flooring Readings for Scenario E

Scenario	SE "Brand B" 100		SE "Brand B" 100 dup	
Date of Breakage	6/18/2007		6/19/2007	
Floor Type	wood		wood	
Date Measured ↓	calm	agitated	calm	agitated
6/19/2007	149	2,056		
6/21/2007	23	165	35	1,282
6/22/2007			26	360

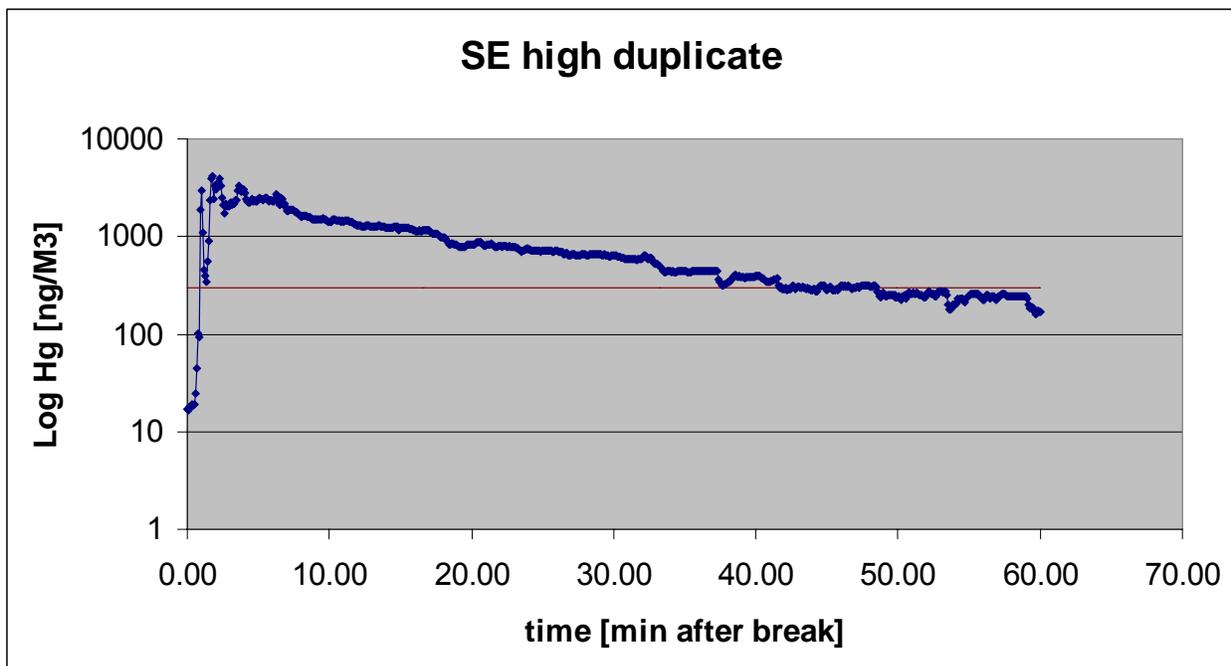


Figure A-62. Scenario E Duplicate at Five-Foot Height (6/19/07)

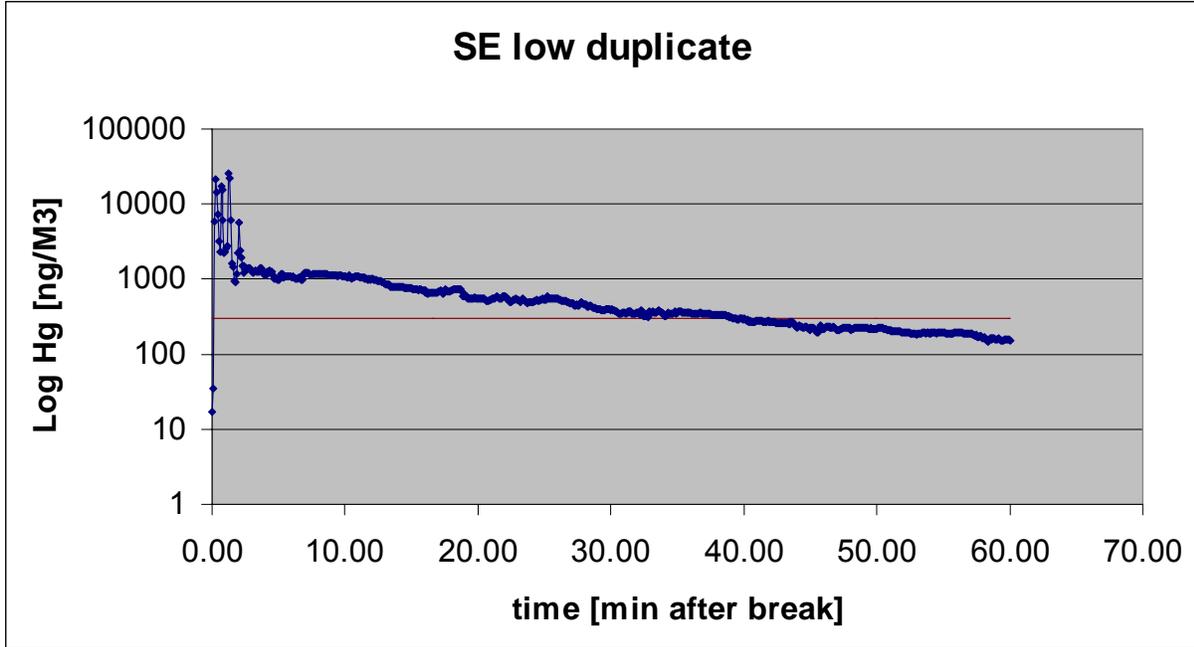


Figure A-63. Scenario E Duplicate at One-Foot Height (6/19/07)

Scenario F: “Brand B” 100 Watt Eq., Wood, Venting, Wait Before Cleanup

This scenario was only performed once. The lamp was thoroughly broken 6/19/07 on hardwood flooring, the room was vented, and 40 minutes later the lamp was cleaned up with index cards, tape, wet wipes, and the waste was removed from the room. Mercury peaked at to 8,285 ng/m³ at the five foot height, and 54,142 ng/m³ at the one foot height. Mercury was not under 300 ng/m³ after 60 minutes for either height.

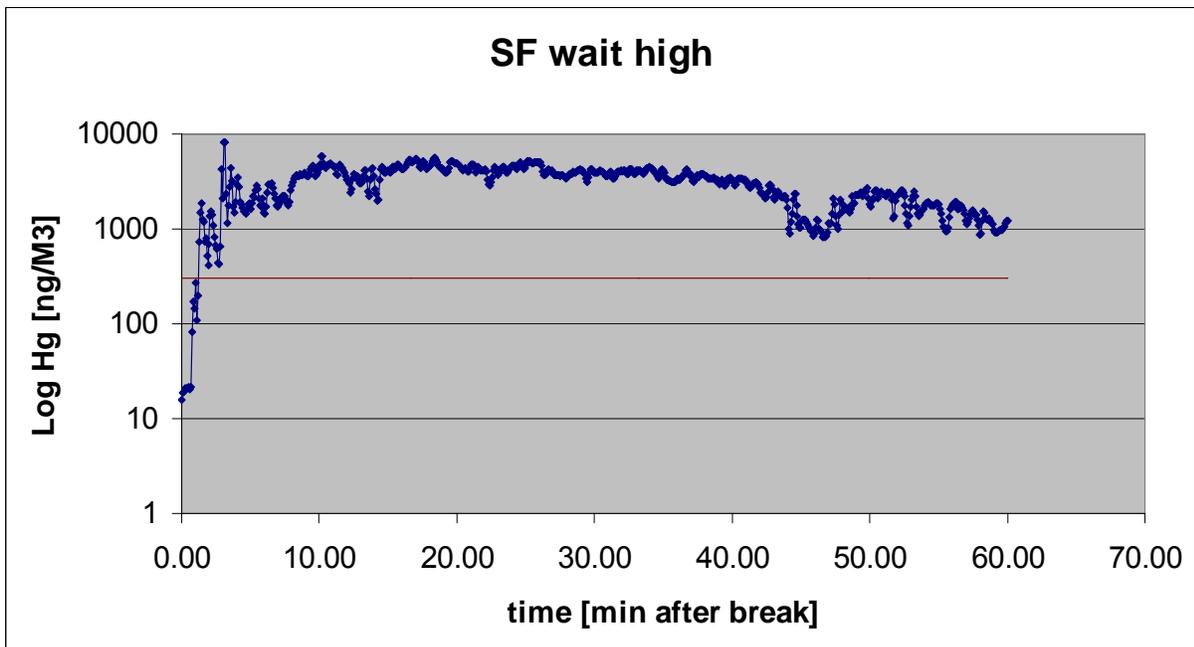


Figure A-64. Scenario F at Five-Foot Height (6/19/07)

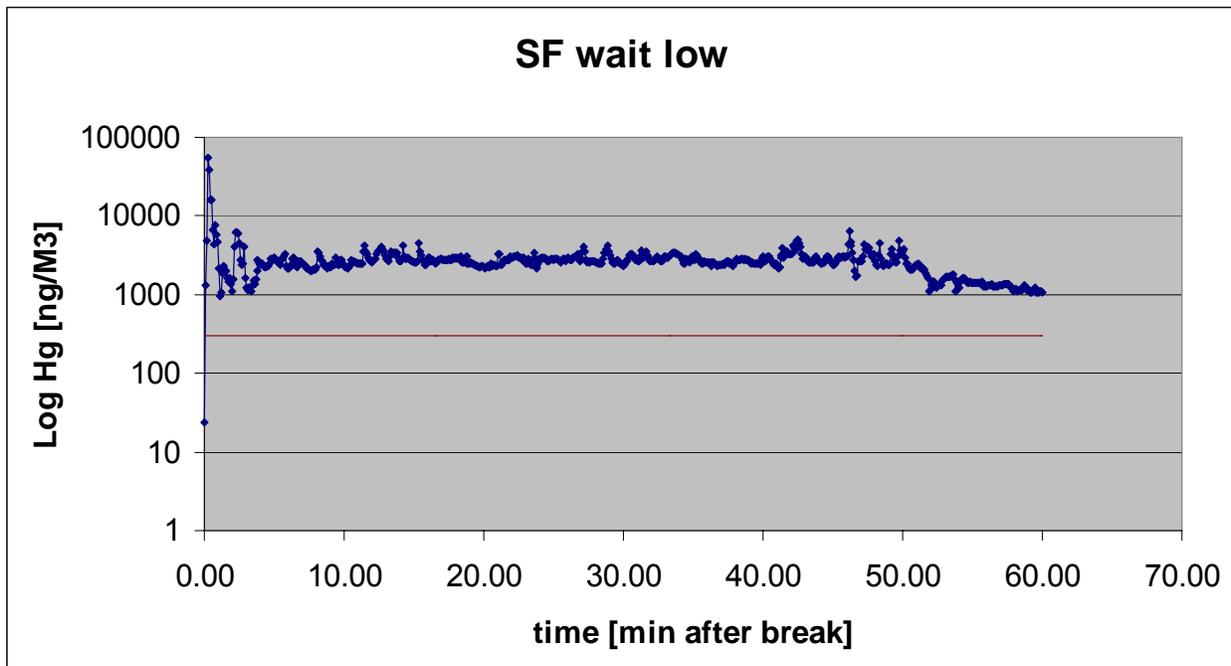


Figure A-65. Scenario F at One-Foot Height (6/19/07)

Table A-10: Flooring readings for Scenario F

Scenario	SF "Brand B" 100 wait	
Date of Breakage	6/19/2007	
Floor Type	wood	
Date Measured ↓	calm	agitated
6/21/2007	30	91

Results recorded are the highest concentrations of mercury seen while scanning in ng/m^3 .

Scenario G: "Brand D" 100 Watt Eq., Wood, Venting, Wait Before Cleanup. Additional information for this "Brand D" lamp is as follows: 120 volts, 738-704, SM823.

This scenario was repeated twice. The lamps were thoroughly broken on hardwood flooring, the room was vented, and a short wait later the lamp was cleaned up with index cards, tape, wet wipes, and the waste was removed from the room. After the first break, on 6/19/07, the lamp was cleaned up after a 10 minute wait. The first results are shown in Figures A-66 & A-67. Mercury peaked at $956 \text{ ng}/\text{m}^3$ at the five foot height, and $8,603 \text{ ng}/\text{m}^3$ at the one foot height. Mercury was under $300 \text{ ng}/\text{m}^3$ after approximately 16 minutes for both heights.

The second trial for this scenario, which occurred on the morning of 6/21/07, was manually stopped after an hour, before an important instrument background check. The background check occurs periodically through a run and saves the previous data. Since the background check was not run, the data that were collected were lost. From the study notes it appears that this run looked similar to the first, and because of that, it was stopped early.

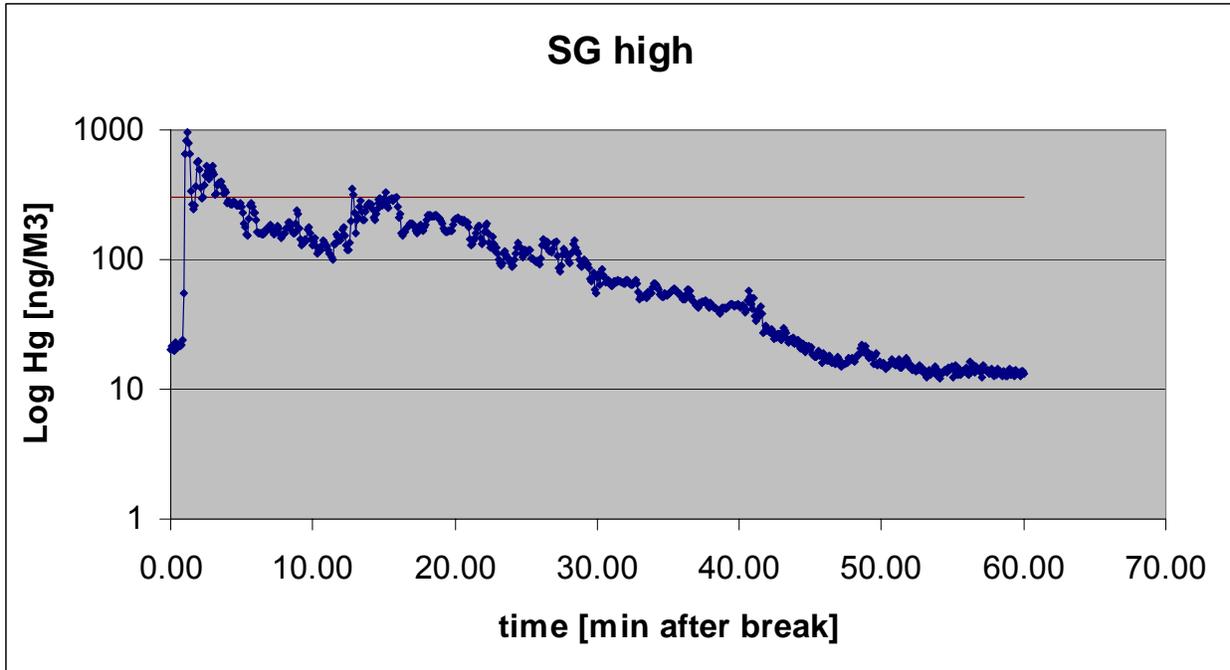


Figure A-66. Scenario G at Five-Foot Height (6/19/07)

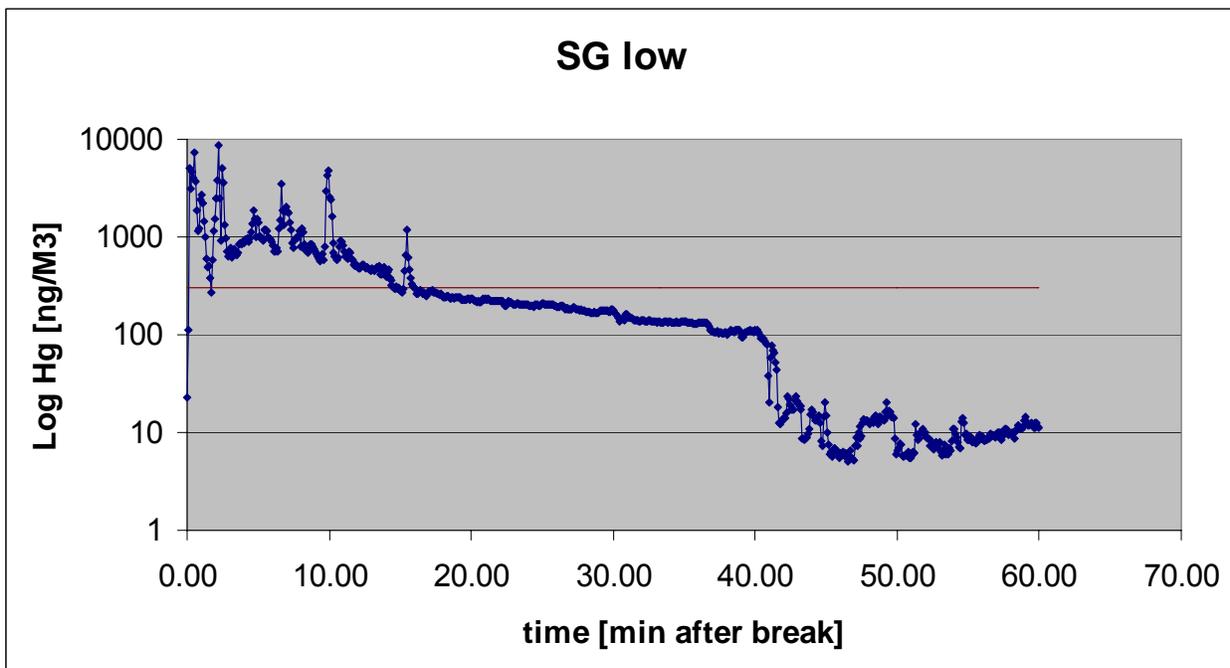


Figure A-67. Scenario G at One-Foot Height (6/19/07)

Table A-11. Flooring readings for Scenario G

Scenario	SG N Vis 100	
Date of Breakage	6/19/2007	
Floor Type	wood	
Date Measured ↓	calm	agitated
6/21/2007	<20	195

Results recorded are the highest concentration of mercury seen while scanning in ng/m^3 .

Scenario H: “Brand E” 60 Watt Eq., Wood, Venting, Wait Before Cleanup

This scenario was only performed once. The lamp was thoroughly broken 6/21/07 on hardwood flooring, the same piece of flooring as the last lamp that was broken, the room was vented, and a short wait later the lamp was cleaned up with index cards, tape, wet wipes, and the waste was removed from the room. The results are shown in Figures A-68 & A-69. Mercury peaked at $4,543 \text{ ng}/\text{m}^3$ at the five foot height, and $17,178 \text{ ng}/\text{m}^3$ at the one foot height. Mercury was under $300 \text{ ng}/\text{m}^3$ after 15.5 minutes for the higher level and after 11.08 minutes at the lower height.

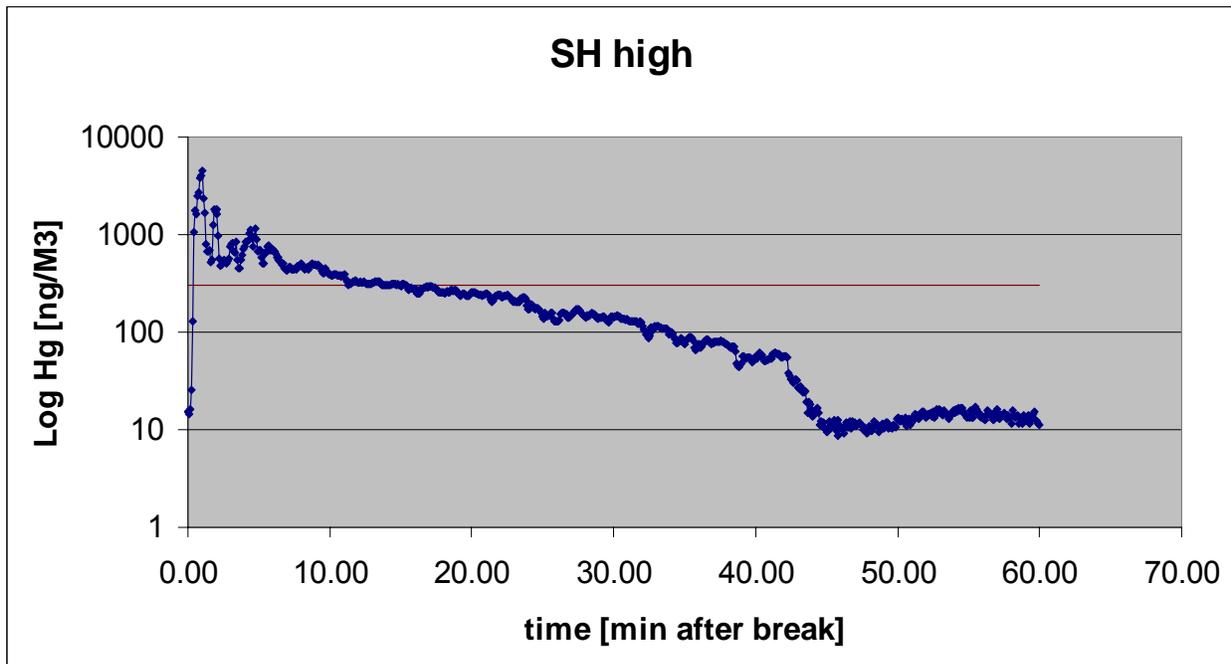


Figure A-68. Scenario H at Five-Foot Height (6/21/07)

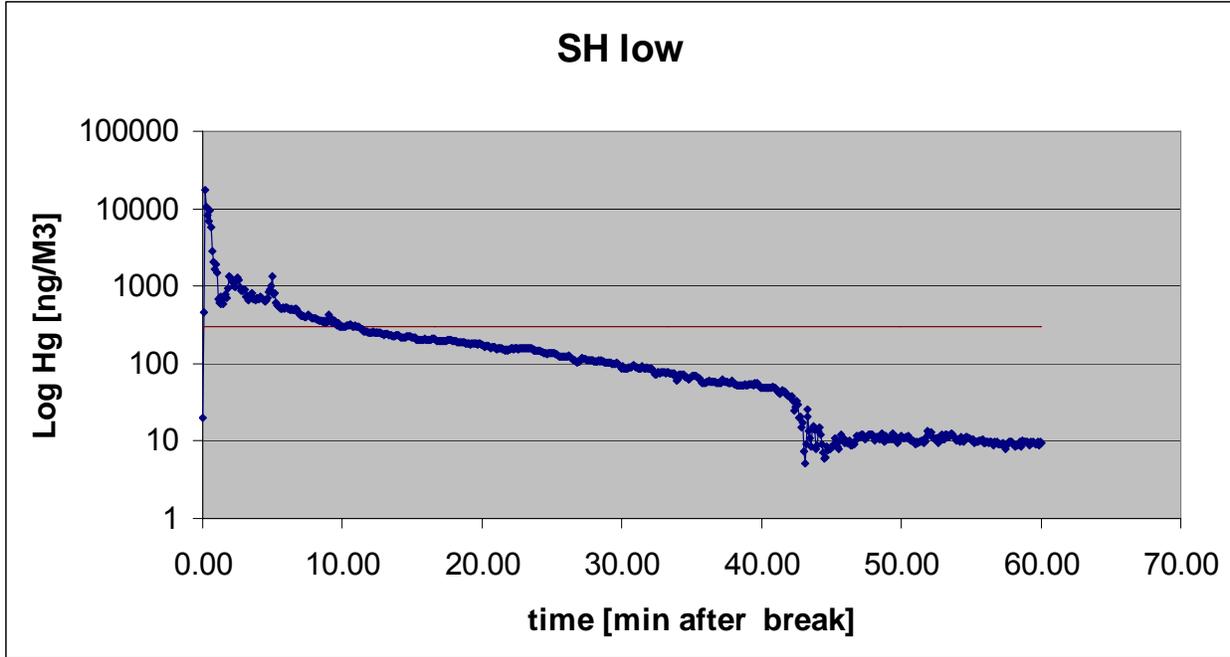


Figure A-69. Scenario H at One-Foot Height (6/21/07)

Table A-12. Flooring Readings for Scenario H

Scenario	SH "Brand E"	
Date of Breakage	6/21/2007	
Floor Type	wood from SG	
Date Measured ↓	calm	agitated
6/22/2007	39	199
6/25/2007	24	196

Results recorded are the highest concentration of mercury seen while scanning in ng/m³.

Scenario I: "Brand F" 50 Watt Eq., Wood, Venting, Wait Before Cleanup.

This dimmable "soft start lamp," as it was labeled on the packaging, uses new amalgam technology. Only one trial was completed for this scenario. It was realized after the study that this may be the only amalgam lamp broken that was probably created by placing a stable amalgam source within a CFL positioned such that it controls mercury vapor within the lamp. This technology allows lamps to be used over a broader temperature range. It is more expensive, and is generally limited to special use lamps, such as dimmable CFLs and those used in enclosures where temperatures are higher than normal room temperature.

The "Brand F" 50 watt equivalent lamp was thoroughly broken 6/21/07 on hardwood flooring, the room was vented, and a short wait later (7 minutes from breakage) the lamp was cleaned up with index cards, tape, wet wipes, and the waste was removed from the room. The results are shown in Figures A-70 & A-71. Mercury peaked at 485 ng/m³ at the five foot height, and 687 ng/m³ at the one foot height. Mercury was under 300 ng/m³ after 2.67 minutes for the higher level and after 5.5 minutes at the lower height.

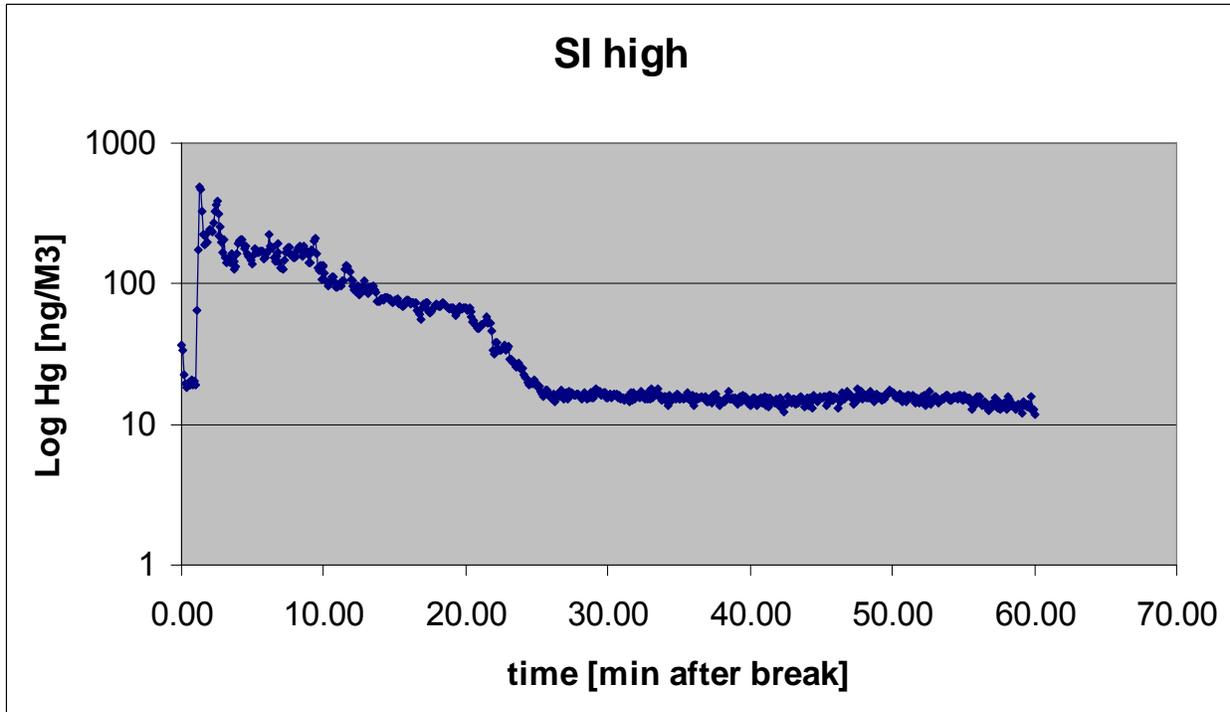


Figure A-70. Scenario I at Five-Foot Height (6/21/07)

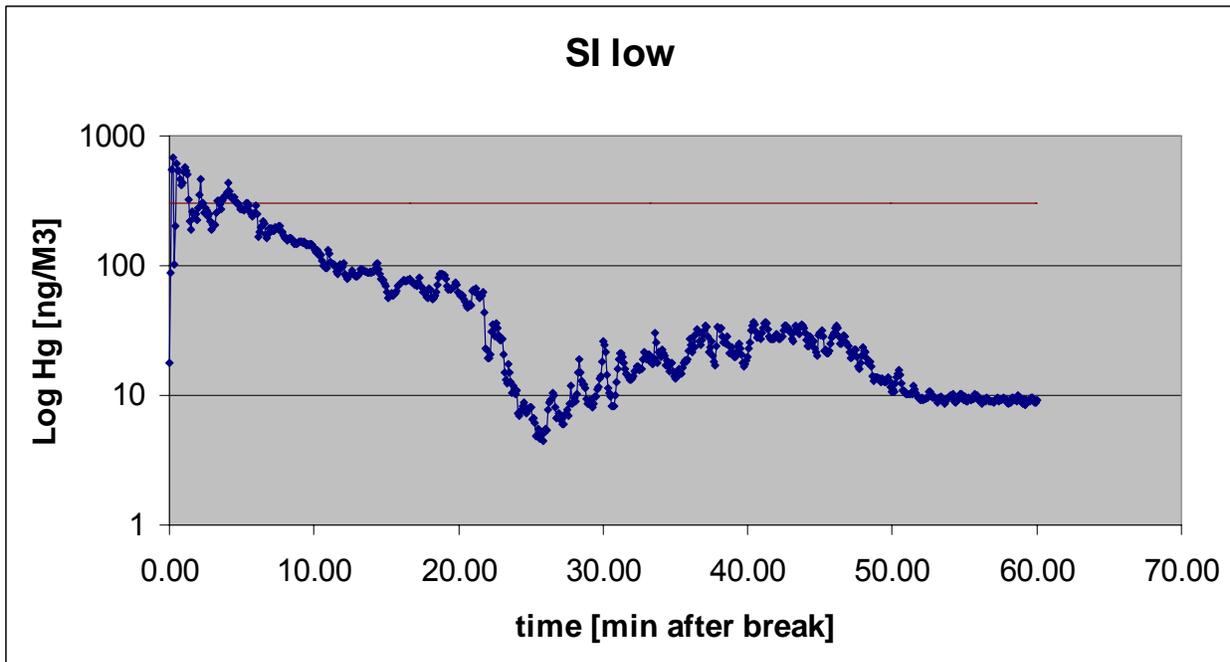


Figure A-71. Scenario I at One-Foot Height (6/21/07)

Table A-13. Flooring readings for Scenario I

Scenario	SI "Brand F" 50	
Date of Breakage	6/21/2007	
Floor Type	wood	
Date Measured	calm	agitated
↓		
6/22/2007	44	744
6/25/2007	<20	77

Results recorded are the highest concentration of mercury seen while scanning in ng/m^3 .

Scenario J: "Brand A" 60 Watt Eq., Cracked instead of Thoroughly Broken, Wood, Venting, Cleanup.

On 6/25/07 the lamp was cracked with the hammer instead of thoroughly broken. The flooring type was hardwood, the room was vented, and the lamp was cleaned up with index cards, tape, wet wipes, and the waste was removed from the room. The results are shown in Figures A-72 & A-73. Mercury peaked at 617 ng/m^3 at the five foot height, and $7,412 \text{ ng/m}^3$ at the one foot height. Mercury was under 300 ng/m^3 after approximately 3 minutes for both heights.

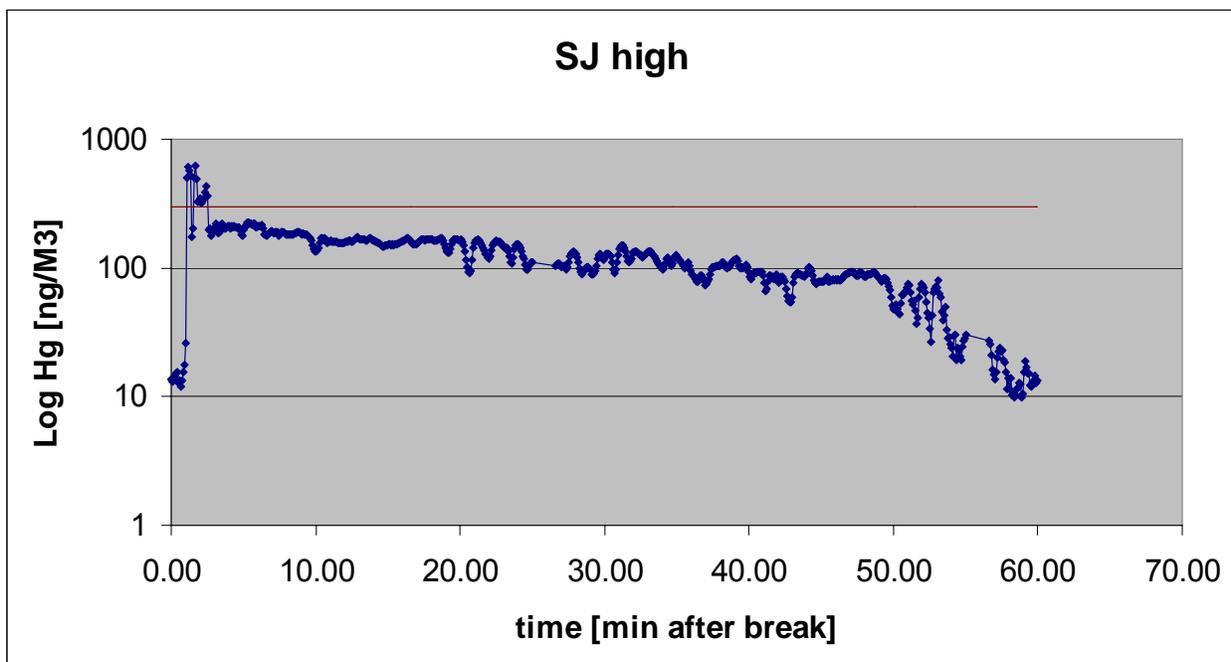


Figure A-72. Scenario J at Five-Foot Height (6/25/07)

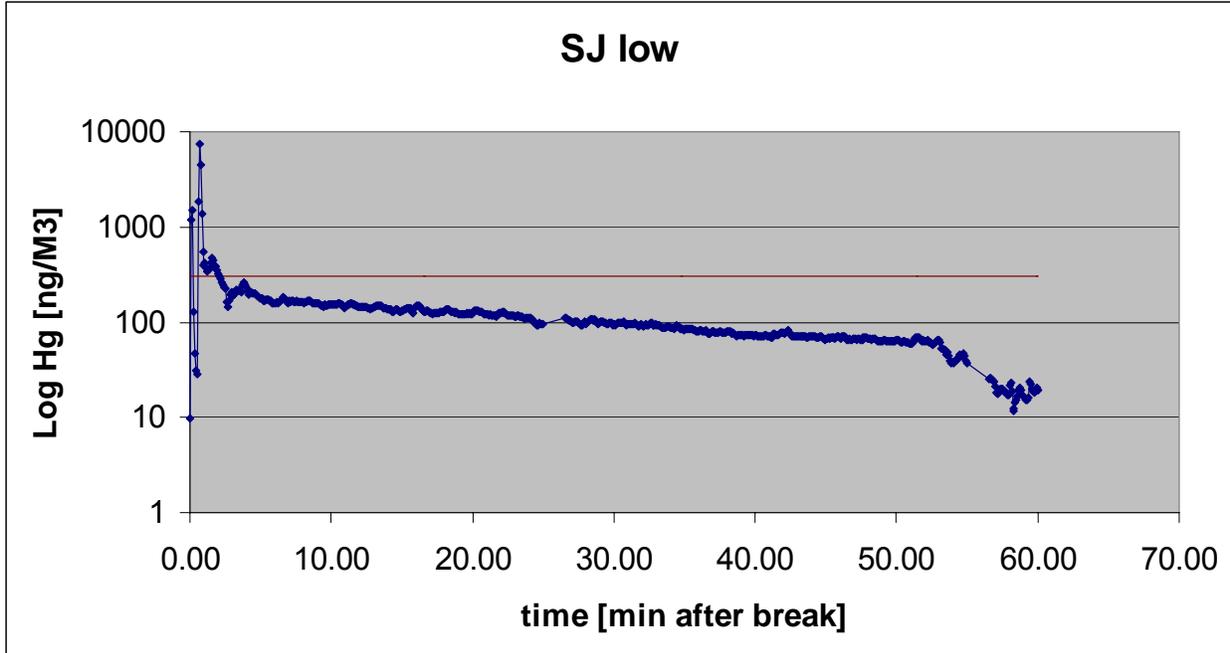


Figure A-73. Scenario J at One-Foot Height (6/25/07)

Table A-14. Flooring readings for Scenario J

Scenario	SJ P60 crack	
Date of Breakage	6/25/2007	
Floor Type	wood	
Date Measured	calm	agitated
↓		
6/26/2007	<20	31

Results recorded are the highest concentration of mercury seen while scanning in ng/m³.

Scenario K: “Brand B” 90 Watt Eq., Shag Carpet, Venting, Vacuuming.

On 6/25/07, the “Brand B” 90 watt equivalent lamp was thoroughly broken on shag carpet, the lamp was cleaned up with index cards, the room was vented, the rest of the debris was cleaned up with tape and wet wipes, and the waste was sealed into the plastic bag. A Hoover Quick-Broom Supreme, bagless, cyclonic action vacuum was then used over the carpet (see Figures A-74 & A-75). This was a used vacuum with model # 52535 and serial # 110000216769 that scanned clean with the third Lumex before use. The third Lumex was held over the vacuum during vacuuming at the vacuum exhaust area and the concentration of mercury appeared similar to room concentrations. After vacuuming, the vacuum cup was emptied into the plastic debris bag. The third Lumex read 5,526 ng/m³ when scanning close to the vacuum cup after emptied. A wet wipe was used to wipe vacuum head, inside of vacuum, and inside of vacuum cup. The lamp debris and plastic bag were then removed from the room. The results are shown in the next two graphs. Mercury peaked at 2,034 ng/m³ at the five foot height, and 2,392 ng/m³ at the one foot height. Mercury was under 300 ng/m³ after approximately 24 minutes for

the higher level and after approximately 34 minutes at the lower height, but had spikes over 300ng/m³ at 193.84 minutes.



Figure A-74. Hoover Quick-Broom Supreme, bagless, cyclonic action vacuum



Figure A-75. Removable cup for emptying debris.

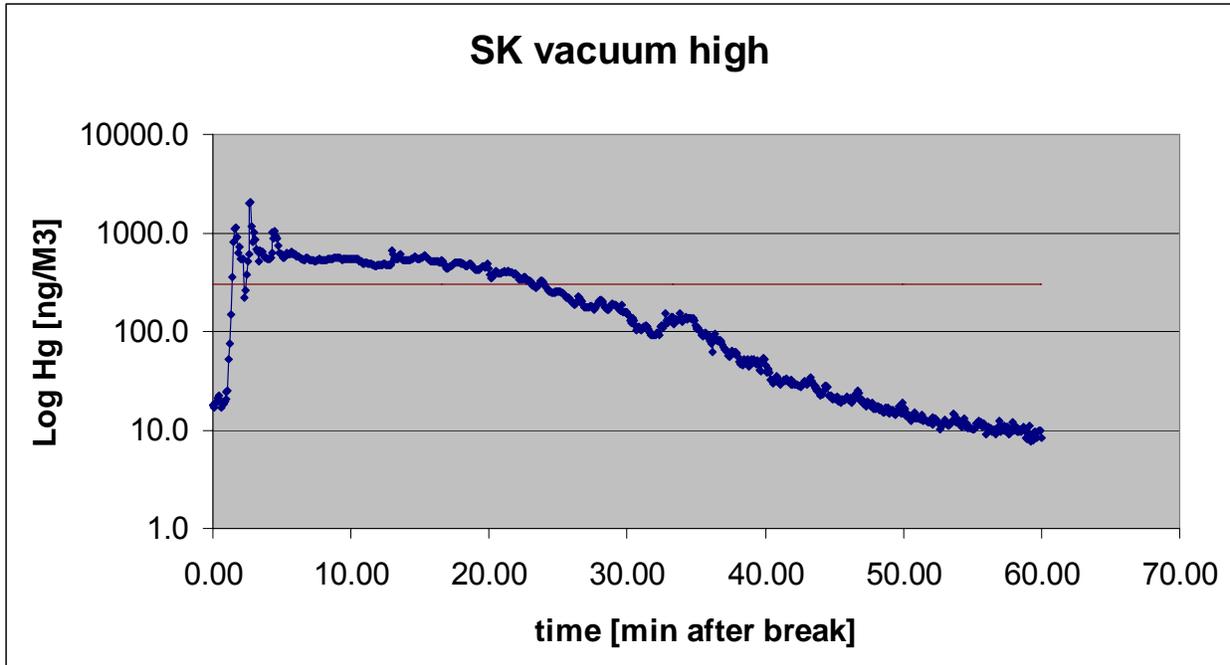


Figure A-76. Scenario K at Five-Foot Height (6/26/07)

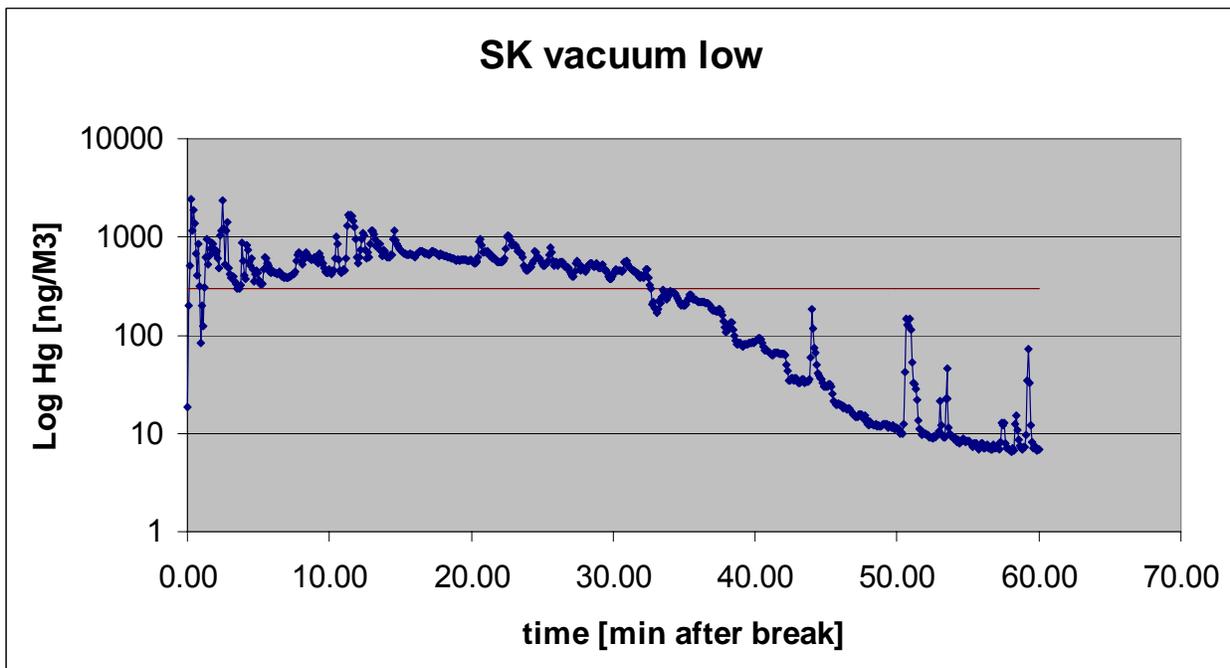


Figure A-77. Scenario K at One-Foot Height (6/26/07)

Table A-15. Flooring Readings for Scenario K

Scenario	SK-“Brand B” 90vac	
Date of Breakage	6/26/2007	
Floor Type	shag carpet	
Date Measured ↓	calm	agitated
6/26/2007	358	1,190
6/27/2007	551	3,623
6/28/2007	<20	2,197
6/29/2007	79	757
7/2/2007	<20	462
7/3/2007	34	1,574
7/5/2007	26	511
7/6/2007	27	417
7/9/2007	<20	406
7/10/2007	26	243
7/11/2007	23	278

Results recorded are the highest concentrations of mercury seen while scanning in ng/m^3 .

The third Lumex was used to scan the vacuum when the vacuum had not been running for a while and was “cold.” All readings were less and $100 \text{ ng}/\text{m}^3$. The vacuum was then turned on for approximately 10 minutes so that it was “hot.” The readings were still less than $100 \text{ ng}/\text{m}^3$ at various places around the vacuum. See Table A-16:

Table A-16. Hoover Quick-Broom Supreme

		Vacuum measurements with 3rd Lumex when room levels of mercury are low												
		Vacuum ran for approx 10 min. to get "hot" numbers												
		Measurements are ng/m3												
Hoover Quick-Broom Supreme, bagless, "cyclonic action." Model # 52535, Serial # 10000216769														
			Floor attachment				Cup				Near Motor			
Date of Lamp Breakage	Date of Vacuuming	Date of Measurement	hot	hot agitated	cold	cold agitated	hot	hot agitated	cold	cold agitated	hot	hot agitated	cold	cold agitated
6/25/2007	6/25/2007	6/25/2007, after about 17 minutes into run					5,526							
		6/26/2007, after wet wipe used on vac parts	<20	46	27	59	21	88	35	74	<20	25	39	31

S5T3 Re-vacuum: Hoover 400 Futura on Carpet that had been Previously Vacuumed

No new lamp was broken as part of this scenario. The vacuum used in this scenario was a Hoover 400 Futura, canister style vacuum, serial # 129300101061. The vacuum was an older model and had a metal wand. The floor attachment did **not** have a power head with beater brushes. This vacuum was used on the S5T3 short nap carpet that had a “Brand A” lamp broken on it 28 days earlier and was vacuumed 28 days earlier (with a different Kenmore canister vacuum) as part of that scenario. Immediately before this scenario, the carpet showed $<20 \text{ ng/m}^3$ of mercury un-agitated, and showed $2,165 \text{ ng/m}^3$ after being agitated. All measurements were taken with the third Lumex within an inch of the carpet surface. After vacuuming for this scenario with the Hoover 400 on 7/2/07, near carpet mercury concentrations were $4,330 \text{ ng/m}^3$ (see Table A-3).

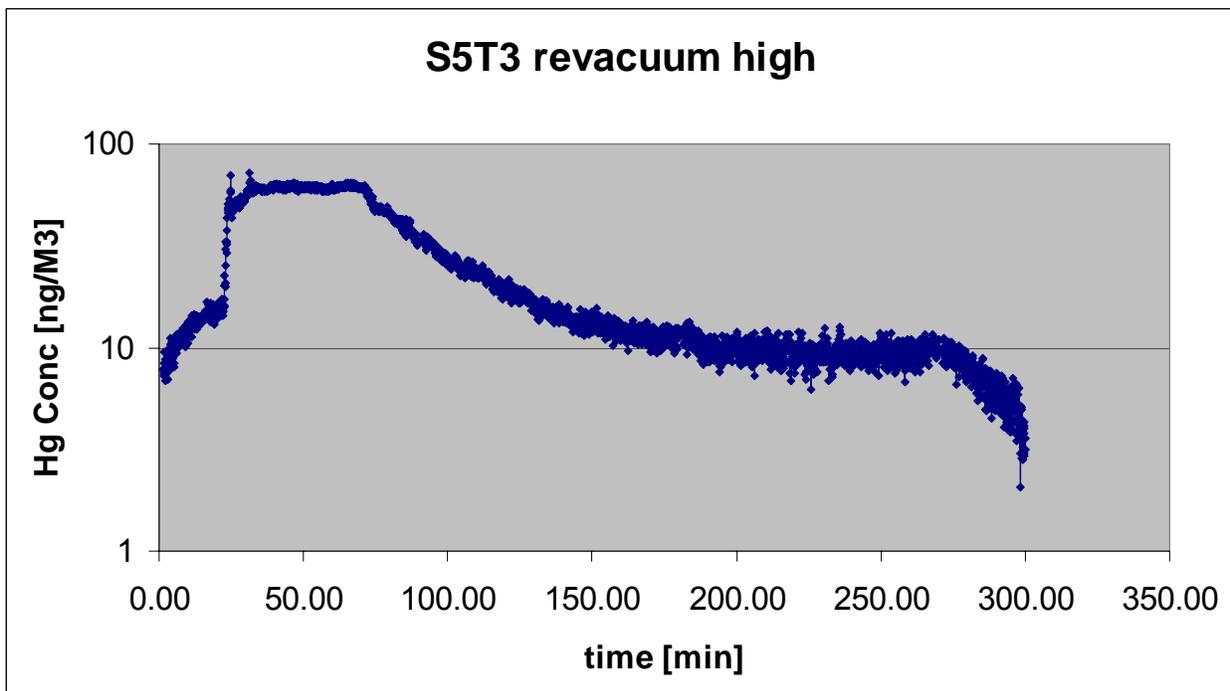


Figure A-78. Scenario “S5T3 Re-vacuum” at Five-Foot Height (7/2/07)

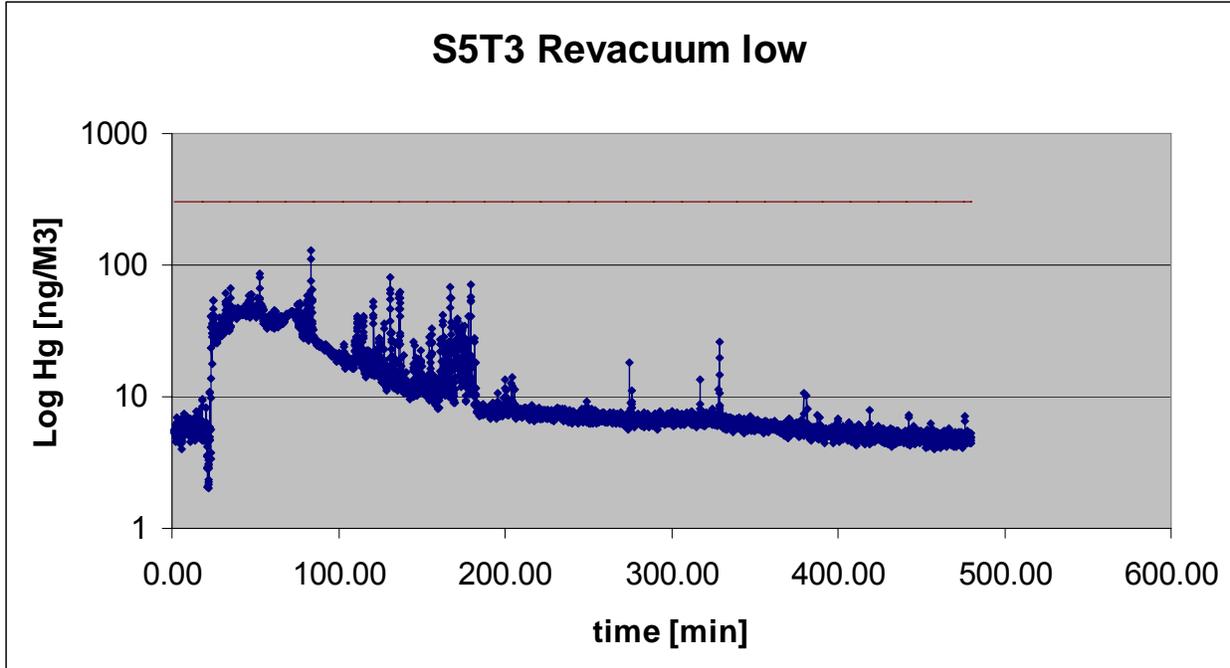


Figure A-79. Scenario “S5T3 Re-vacuum” at One-Foot Height (7/2/07)

On 7/2/07 directly after vacuuming, the Hoover 400 Futura vacuum had the following mercury readings: floor attachment 194 ng/m³ (347 ng/m³ agitated), hose connection to vacuum 172 ng/m³, and inside vacuum and bag 184 ng/m³. The floor attachment was cleaned. After this cleaning the third Lumex read 253 ng/m³ for the floor attachment. These readings were taken within approximately an inch of the vacuum parts and inside the study room with the window closed. See Table A-17 for other measurements taken next to this vacuum after this run.

Table A-17. Hoover 400 Futura, mercury results in ng/m³ recorded with Lumex within approx. an inch of vac part surface

Hoover 400 Futura, Serial # 129300101061			Vacuum Cleaner Part			
			Beaters (floor attachment)		Plastic flexible hose	Inside vac
Date of Lamp Breakage	Date of Vacuuming	Date of Measurement	cold	cold agitated	cold	cold
6/4/2007	6/4/07 (flooring vacuumed with Kenmore canister)					
	7/2/07 (same flooring as above vacuumed this time with Hoover 400)	7/2/2007	194	347	172	184
		7/2/07 (after cleaning)	253			
		7/3/2007	<20	45	<20	<20

5.3.13 SB Vacuum: A Hoover 850 on older Scenario B carpet – four vacuuming events

Before this vacuum was used for this scenario, the third Lumex showed 347 ng/m³ of mercury near the beaters. The beaters were cleaned and then the third Lumex showed 22 ng/m³ of mercury near the beaters. The other parts of the vacuum did not appear to be contaminated with mercury.

The carpet that was vacuumed for this scenario had not previously been vacuumed but a lamp had been broken on it 21 days earlier and cleaned up. No new lamp was broken. The previously cleaned short nap carpet was vacuumed four times during this scenario; 7/3/2007, 7/6/2007, 7/9/2007 and 7/10/2007 with the window closed.

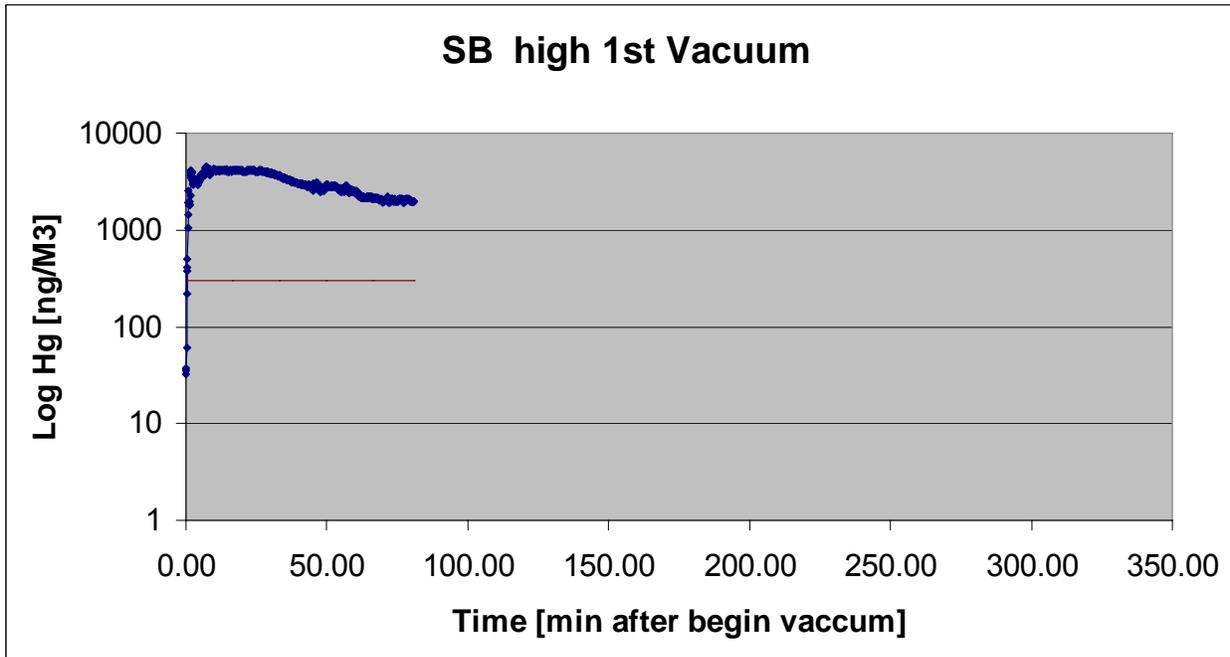


Figure A-80. Scenario “SB Vacuum” at Five-Foot Height (7/3/07)

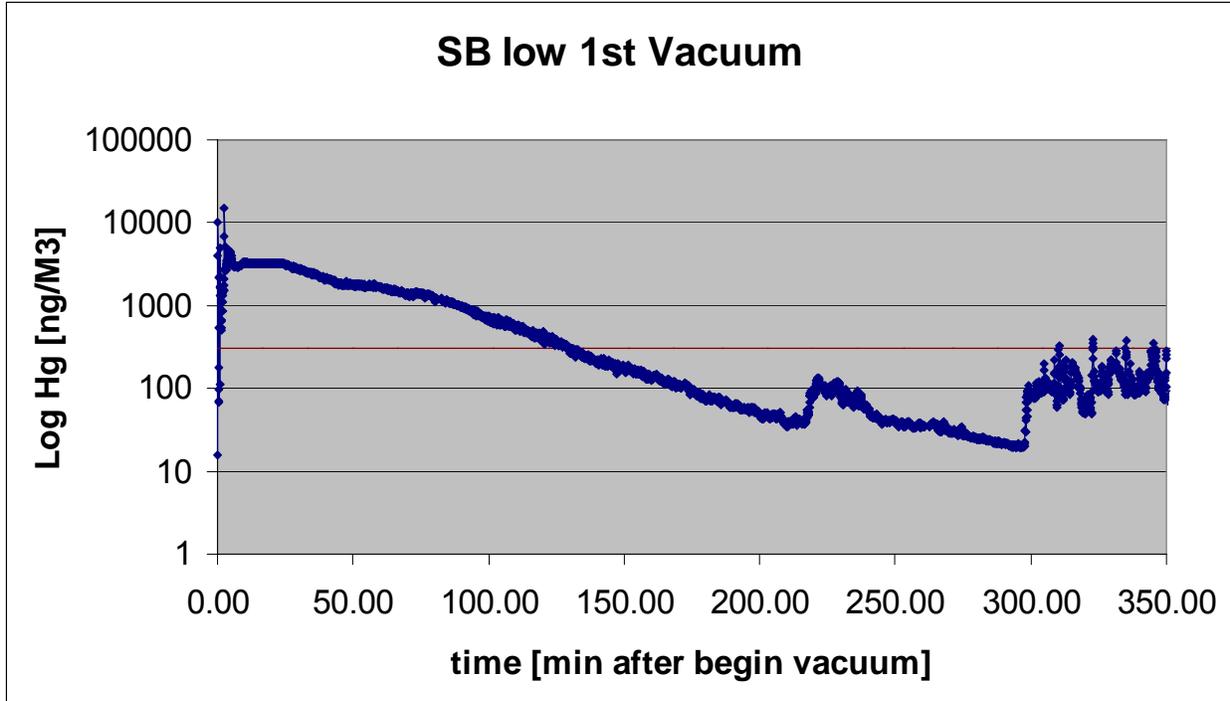


Figure A-81. Scenario “SB Vacuum” at One-Foot Height (7/3/07)

On 7/6/07 the carpet was vacuumed again with the same Hoover 850 vacuum.

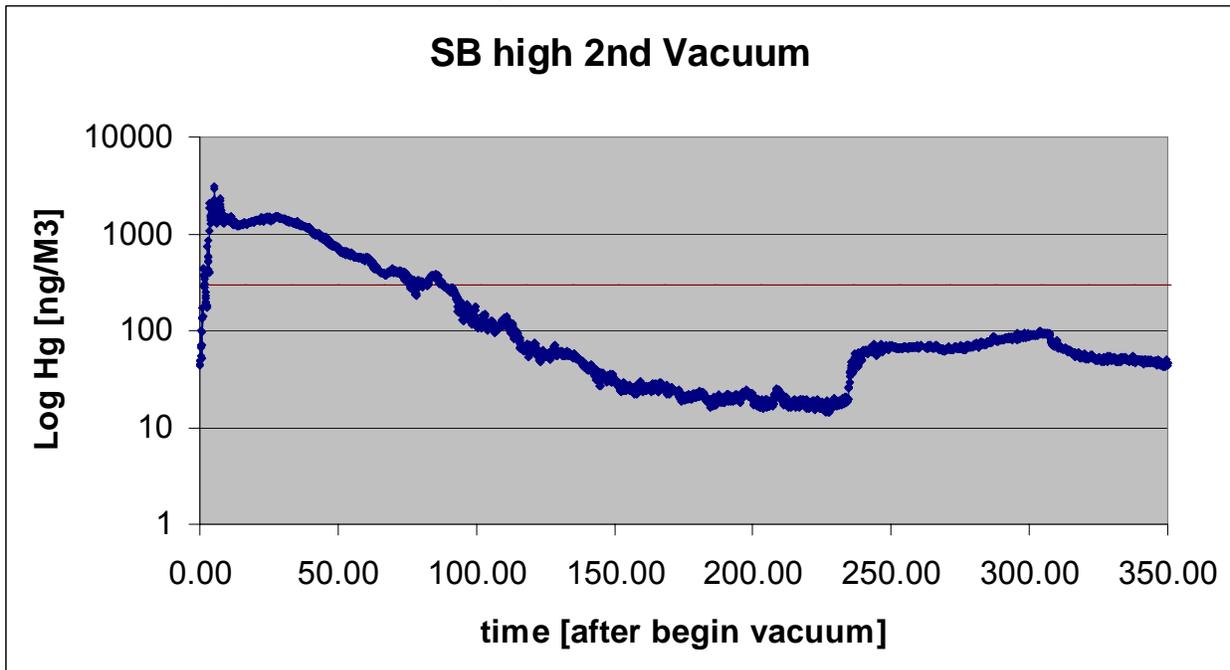


Figure A-82. Scenario “SB Vacuum” at Five-Foot Height (7/6/07)

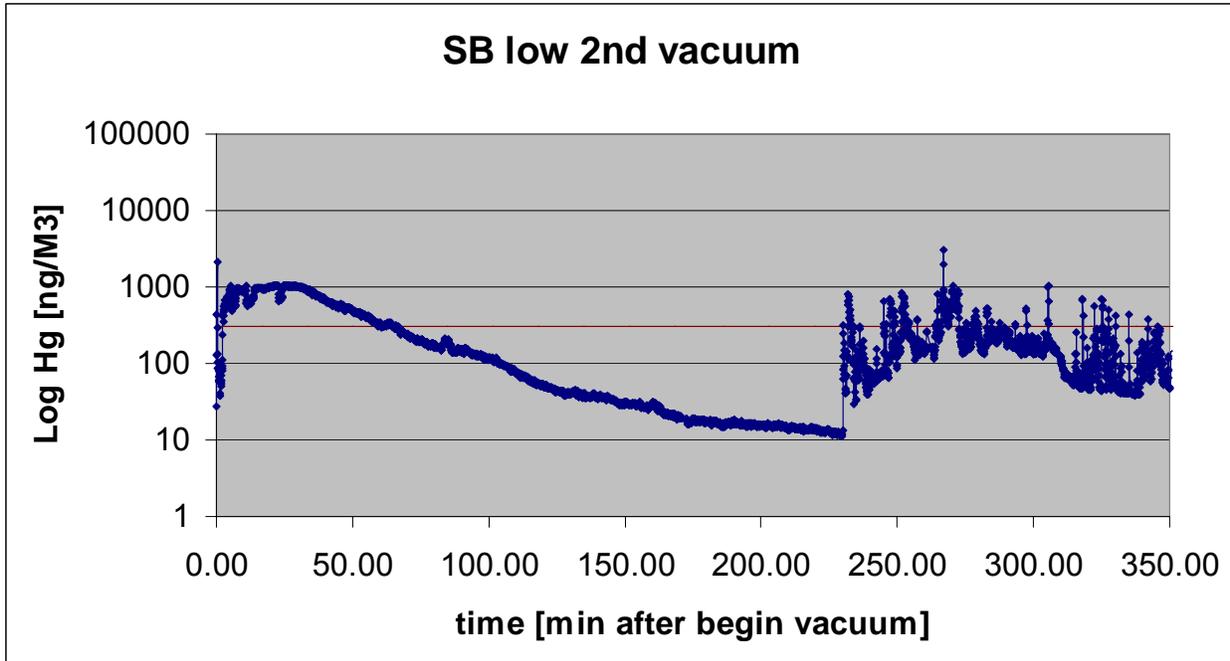


Figure A-83. Scenario "SB Vacuum" at One-Foot Height (7/6/07)

On 7/9/07 this carpet was vacuumed for a third time with a new bag in the vacuum.

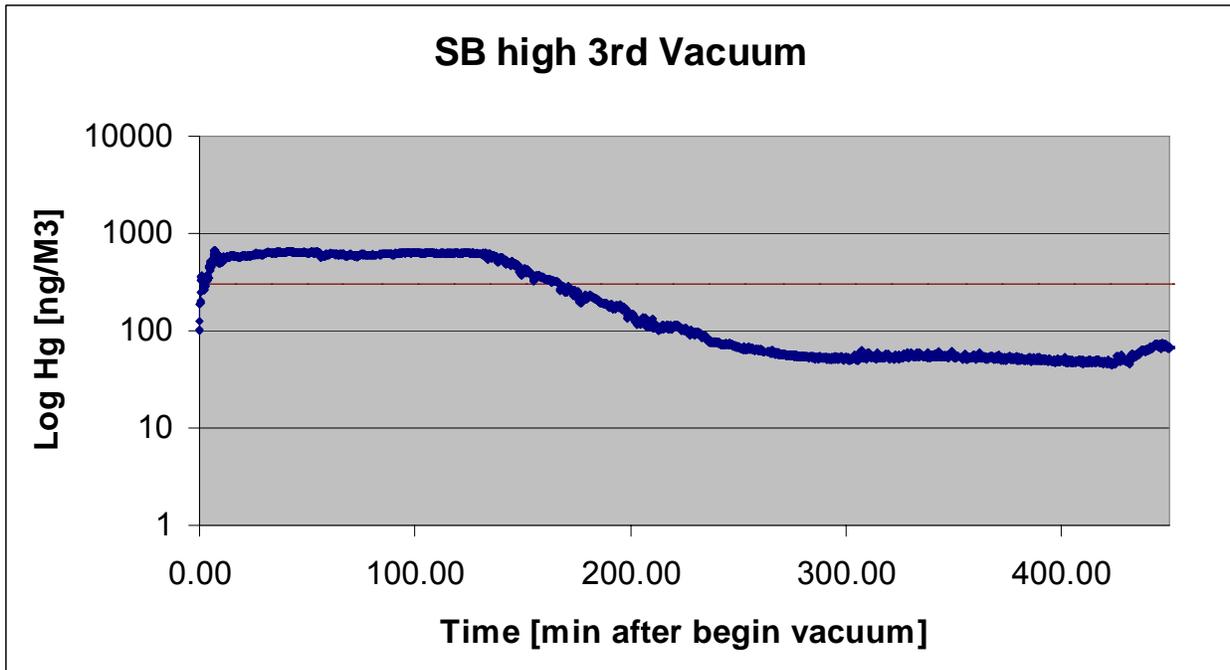


Figure A-84. Scenario "SB Vacuum" at Five-Foot Height (7/9/07)

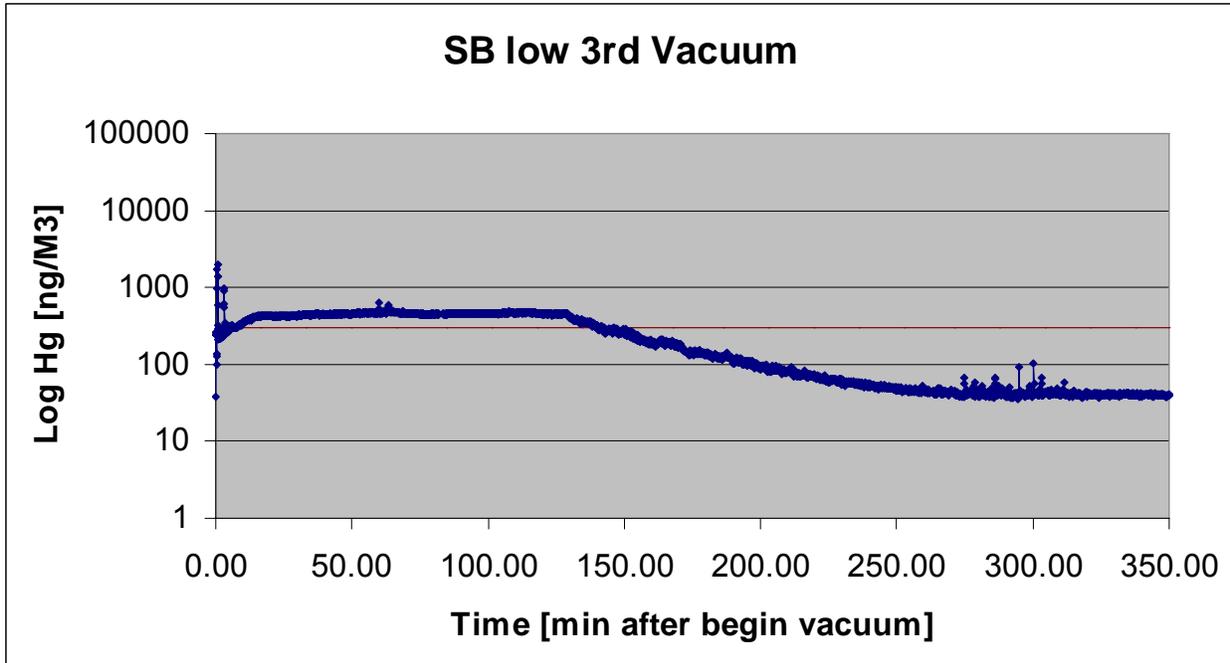


Figure A-85. Scenario "SB Vacuum" at One-Foot Height (7/9/07)

On 7/10/07 this carpet was vacuumed for a fourth time.

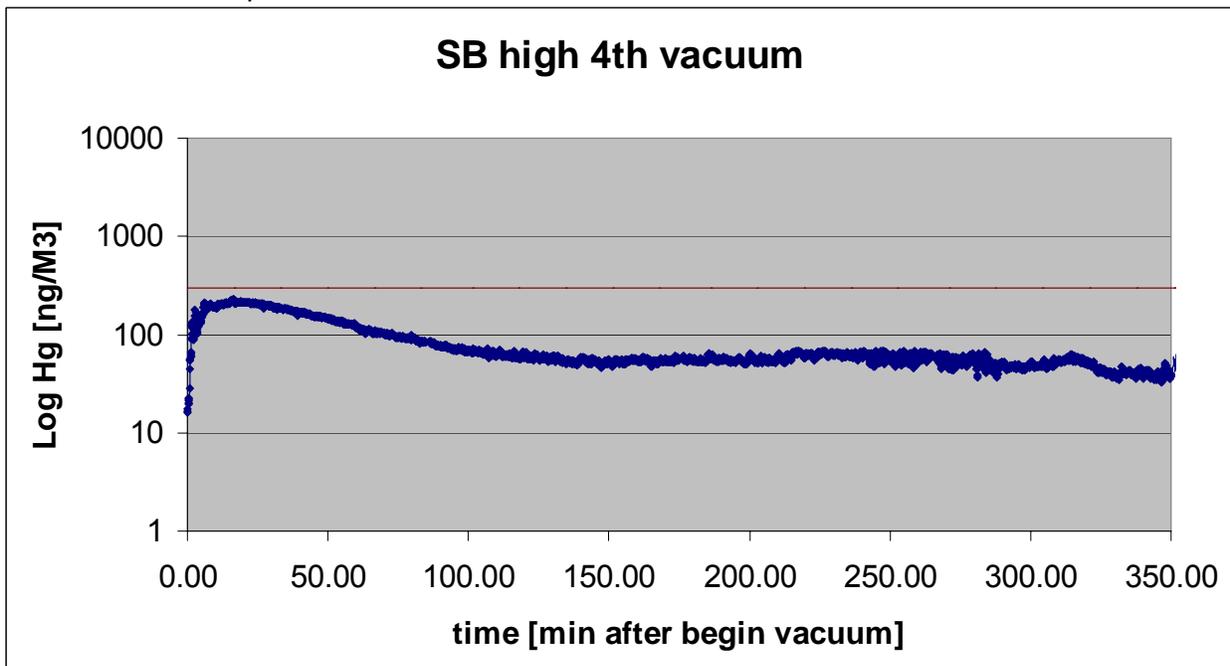


Figure A-86. Scenario "SB Vacuum" at Five-Foot Height (7/10/07)

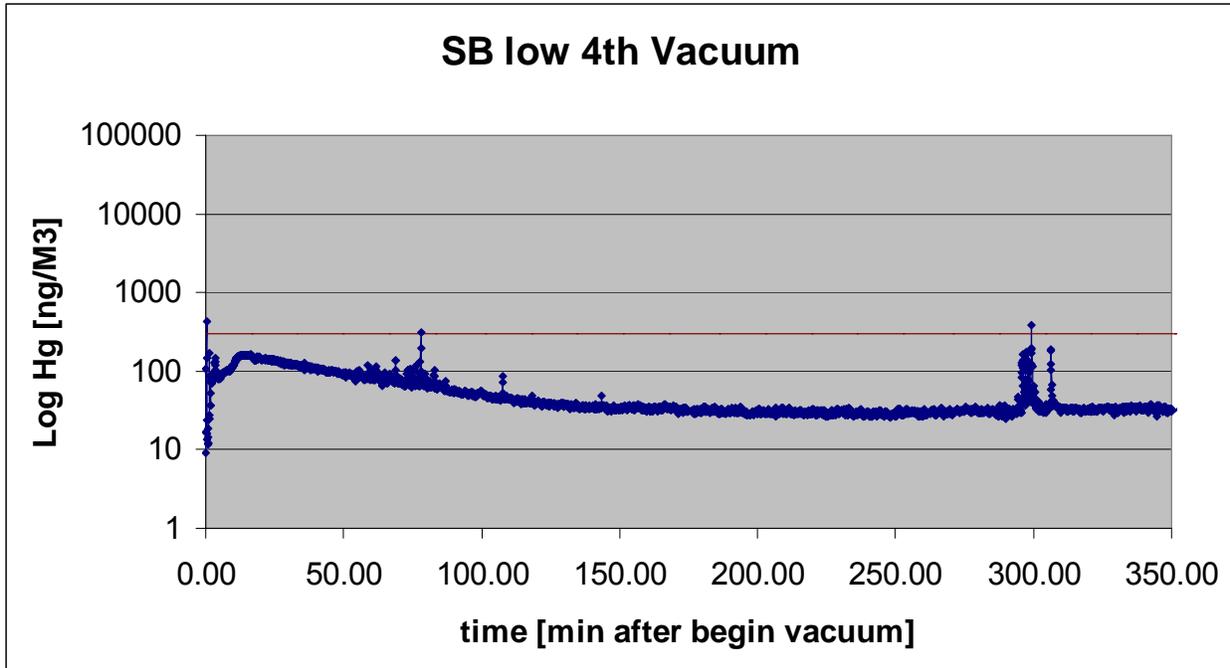


Figure A-87. Scenario “SB Vacuum” at One-Foot Height (7/10/07)

See Table A-18 below for measurements taken near the vacuum over time after this scenario.

Table A-18

Hoover Spectrum 850, canister style, Model #S3585, Serial # 089000014844, approx. 20 yrs. old

Date of Lamp Breakage	Date of Vacuuming	Date of Measurement	Vacuum Cleaner Part						
			Beaters			Plastic hose	Inside vac	Metal wand	Bag
			hot	cold	cold agitated	cold	cold	cold	cold
		6/28/2007	160	<20					
		7/2/2007		95	711				
		7/3/07 before cleaning		24	347	<20	<20		
		7/3/07 after cleaning		<20	22				
6/12/2007	7/3/2007	7/3/2007 Right after vacuuming	>50,000						
		7/3/07 after cleaning again		188	534	4,657		259	
		7/5/2007		75	990	17,540		142	
		7/6/2007 after cleaning again		<20	97	801		110	
	7/6/2007	7/6/07 after this vacuuming and before cleaning		137	537	14,670		943	972
		7/6/07 after cleaning		<20	296				
		7/6/07 PM		36	559	1,280	26	66	
		7/9/2007 after cleaning		64	125	550		<20	
	7/9/2007	7/9/07 after this vacuuming and before cleaning		75	81	666		1,553	417
		7/9/07 after cleaning again		81					
		7/10/2007		<20	22	528		26	<20
	7/10/2007	7/10/07 after 4th vacuum		87	74	1,319		193	188
		7/11/2007		20	43	214	29	25	

New vac bag before 3rd vac

Vacuum measurements with 3rd Lumex when room levels of mercury are low

Vacuum ran for approx 10 min. to get warm vac or "hot" numbers

Measurements are ng/m³

Wet wipes used frequently on vacuum

Scenario L: “Brand B” 100 Watt Eq., Short Nap Carpet, No Venting, Vacuuming Four Different Times.

This was meant to be a worst case scenario. On 7/19/07 the “Brand B” lamp was thoroughly broken on short nap carpet, the big pieces of debris were picked up and put in an open trash can in the study room, and the rest of the debris was vacuumed with the Hoover 850. The window was left closed, and the vacuum bag was left in the vacuum and in the study room. The vacuum was not wiped down with a wet wipe.

The third Lumex was used to monitor the air outside of the study room that was contaminated from the mercury coming out from under the door. At about an hour after the first vacuuming, measurements were taken near the floor near the study room and at the five foot breathing zone. Along the floor two feet from the door the Lumex read 5,000 ng/m³, fifteen feet from the door read approximately 1,150 ng/m³ and 25 feet from the door read approximately 700 ng/m³. In the five foot breathing zone the Lumex read over 2,000 ng/m³ four feet from the door, approximately 1,000 ng/m³ ten feet from the door, approximately 300 ng/m³ twenty-five feet from the door, and approximately 40 ng/m³ thirty feet from the door.

Figures A-88 & A-89 for the first vacuuming event for this scenario show mercury peaking to 23,720 ng/m³ at the five foot height, and 133,955 ng/m³ at the one foot height.³⁹ Mercury was still over 300 ng/m³ after 1500 minutes at both heights.

During this scenario researchers observed that the overhead garage door located outside the study room had a direct effect on the concentrations of mercury in the study room depending on whether it was opened or closed. The more dramatic decreases of mercury on the graphs below are associated with the overhead door being closed. This had the effect of reducing mercury concentrations in the study room sooner, and venting into adjacent rooms.

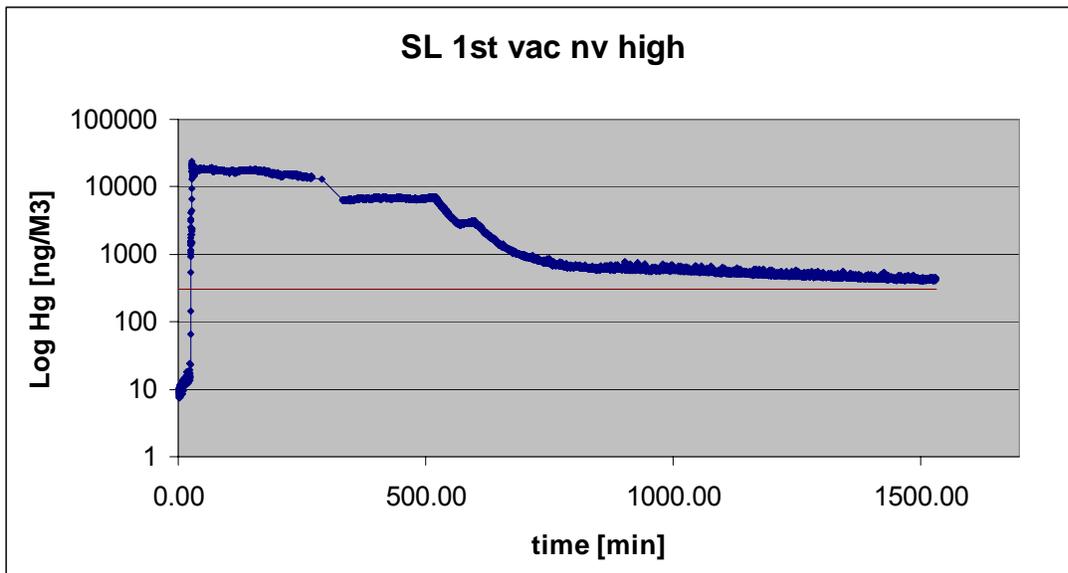


Figure A-88. Scenario L first vacuum at Five-Foot Height (7/19/07)

³⁹ Lumex RA-915+ calibration is out of range above 50,000 ng/m³. This number is therefore a relative number.

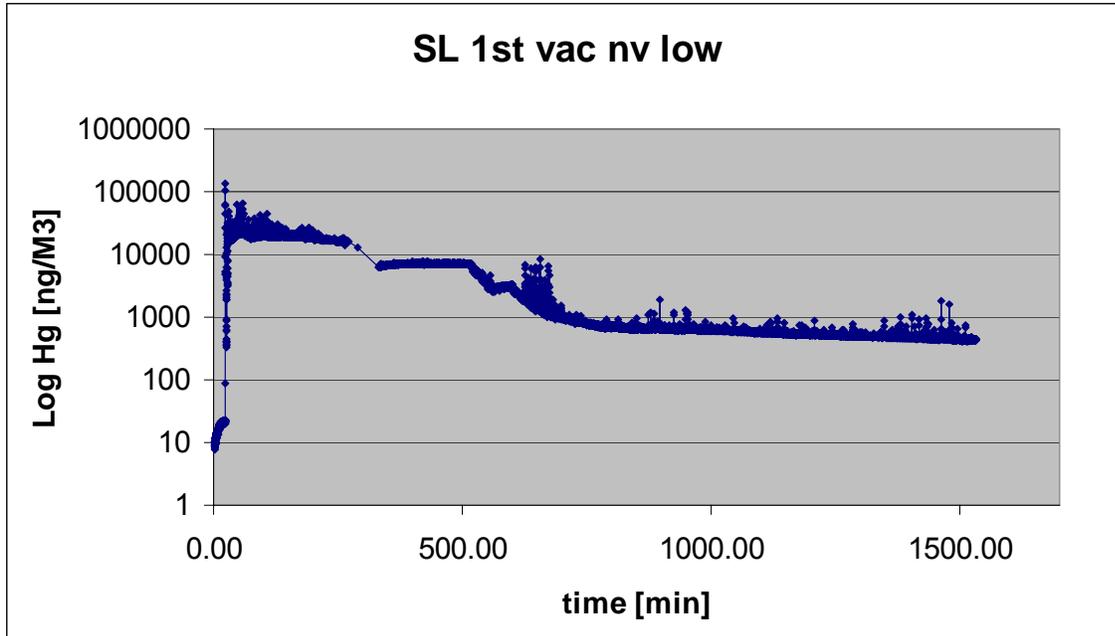


Figure A-89. Scenario L first vacuum at One-Foot Height (7/19/07)

On 7/23/2007, without trying to decontaminate the vacuum, the carpet was vacuumed again, with the window closed. The overhead garage door outside the study room had been closed over the weekend. Before this second vacuuming, the room had approximately 300-400 ng/m³ of mercury in the air. The garage door was opened for the first eight hours of this run (approximately 480 minutes).

The graphs for the second vacuuming event for this scenario below show mercury peaking to 3,135 ng/m³ at the five foot height, and 36,397 ng/m³ at the one foot height. Mercury was less than 300 ng/m³ after 530.75 minutes at the five foot height and was still over 300 ng/m³ after 1200 minutes at the one foot height.

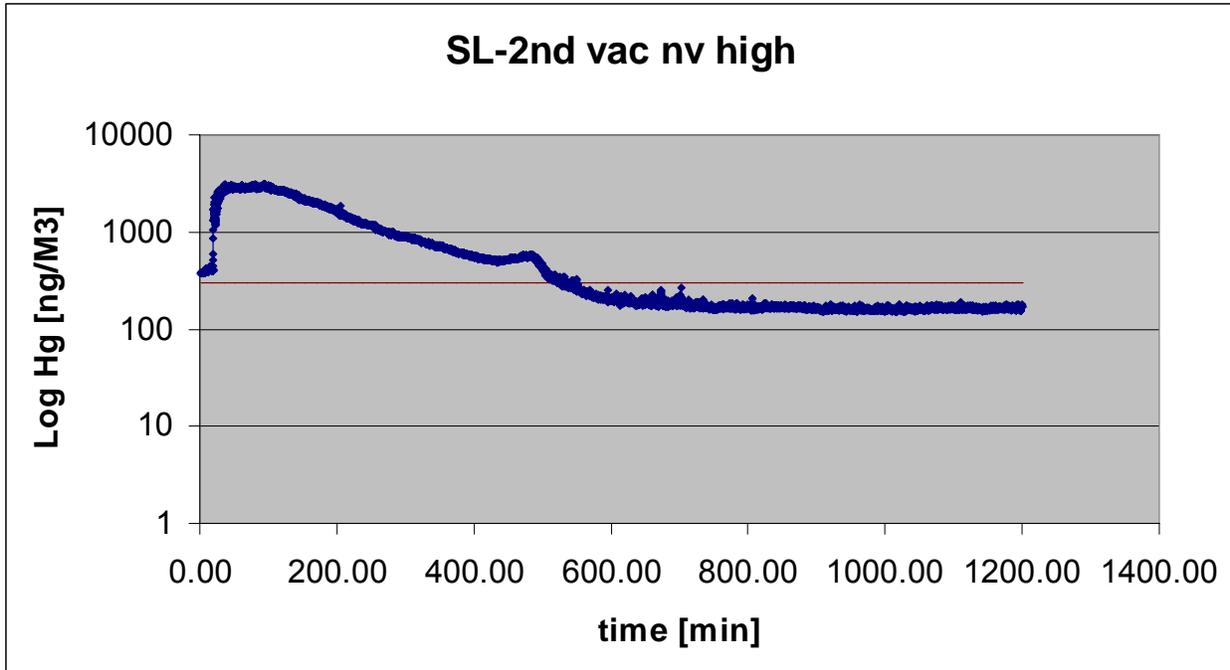


Figure A-90. Scenario L second vacuum at Five-Foot Height (7/23/07)

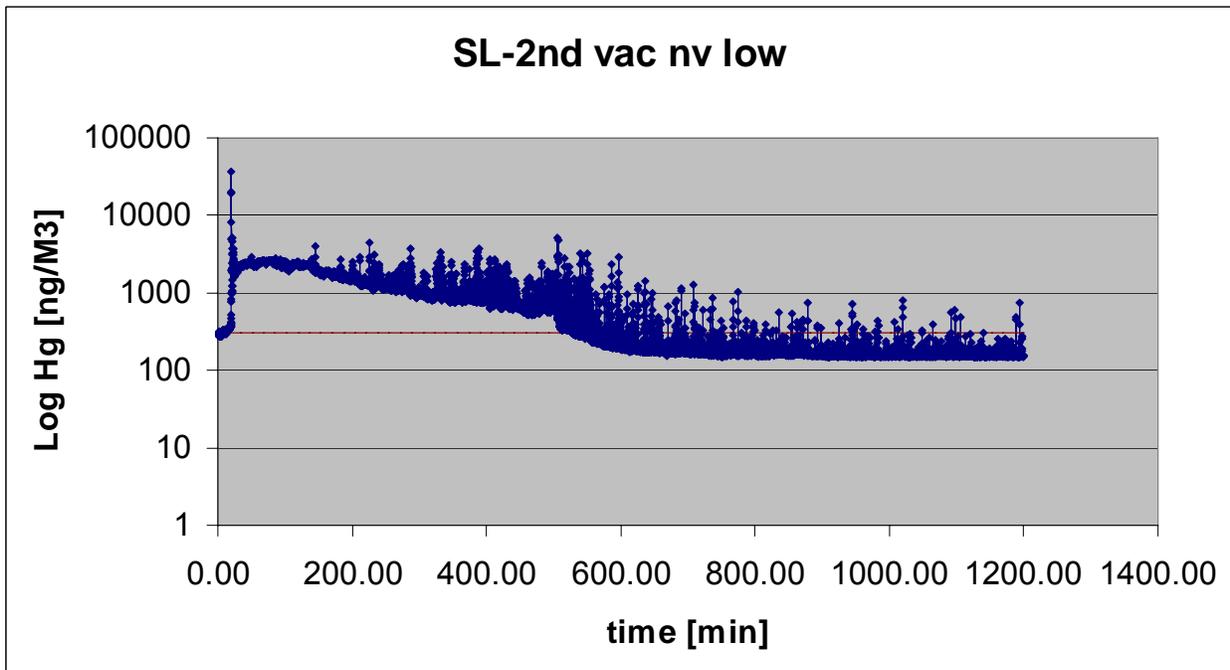


Figure A-91. Scenario L second vacuum at One-Foot Height (7/23/07)

On 7/24/2007 the garage door was opened again at 7:15 AM. Mercury concentrations in the study room were in the range of approximately 200 to 600 ng/m³. This carpet was vacuumed for a third time. After about eight hours and 20 minutes, the garage door was closed again for the night (approx. 500 minutes). The concentration of mercury in the air decreased much more rapidly when the garage door was closed as can be seen in Figures A-92 & A-93.

The graphs in Figures A-92 and A-93 show mercury peaking at 3,708 ng/m³ at the five foot height, and 19,270 ng/m³ at the one foot height. Mercury was less than 300 ng/m³ after 539.33 minutes at the five foot height and was still over 300 ng/m³ after 1200 minutes at the one foot height.

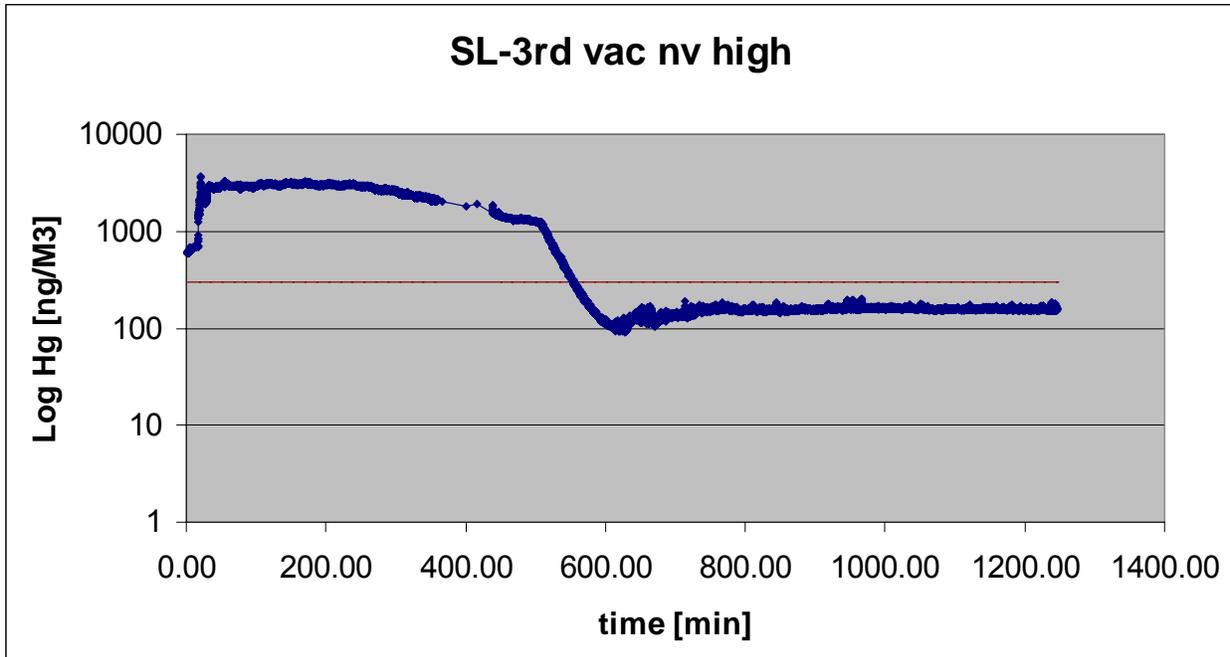


Figure A-92. Scenario L third vacuum at Five-Foot Height (7/24/07)

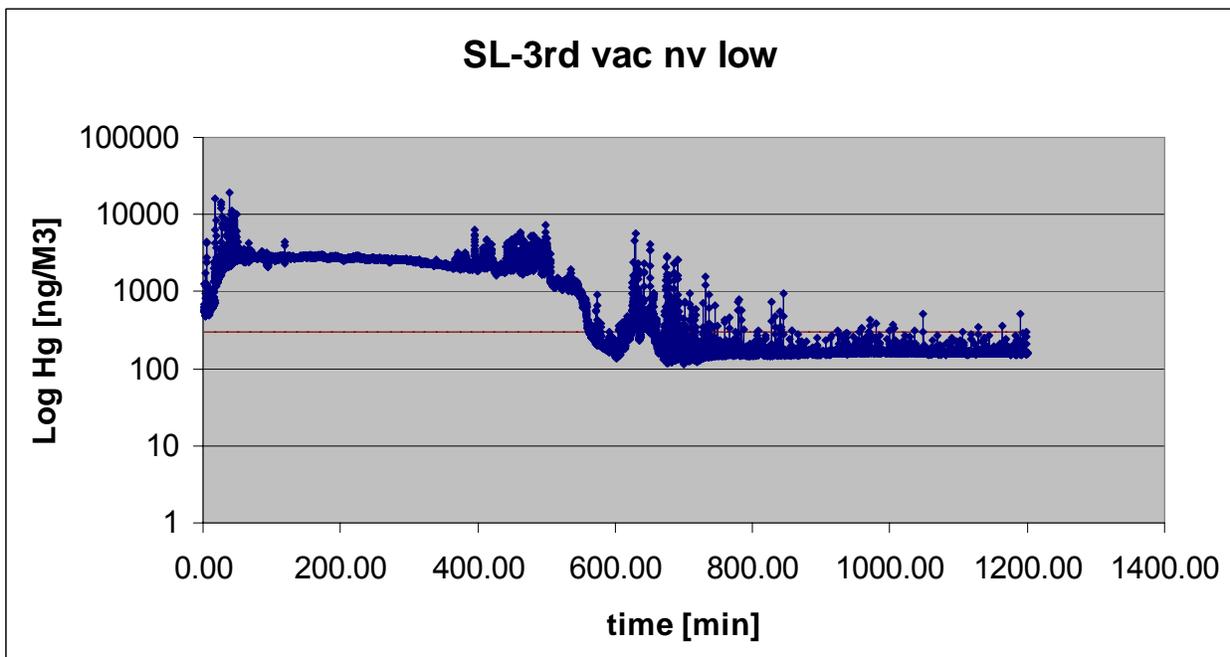


Figure A-93. Scenario L third vacuum at One-Foot Height (7/24/07)

The fourth vacuuming event for this scenario occurred 7/25/07. The graphs for the fourth vacuuming event below show mercury peaking at 3,288 ng/m³ at the five foot height, and

12,367 ng/m³ at the one foot height. Mercury was less than 300 ng/m³ after 523.75 minutes at the five foot height and continued to spike above 300 ng/m³ after 1200 minutes for the one foot height.

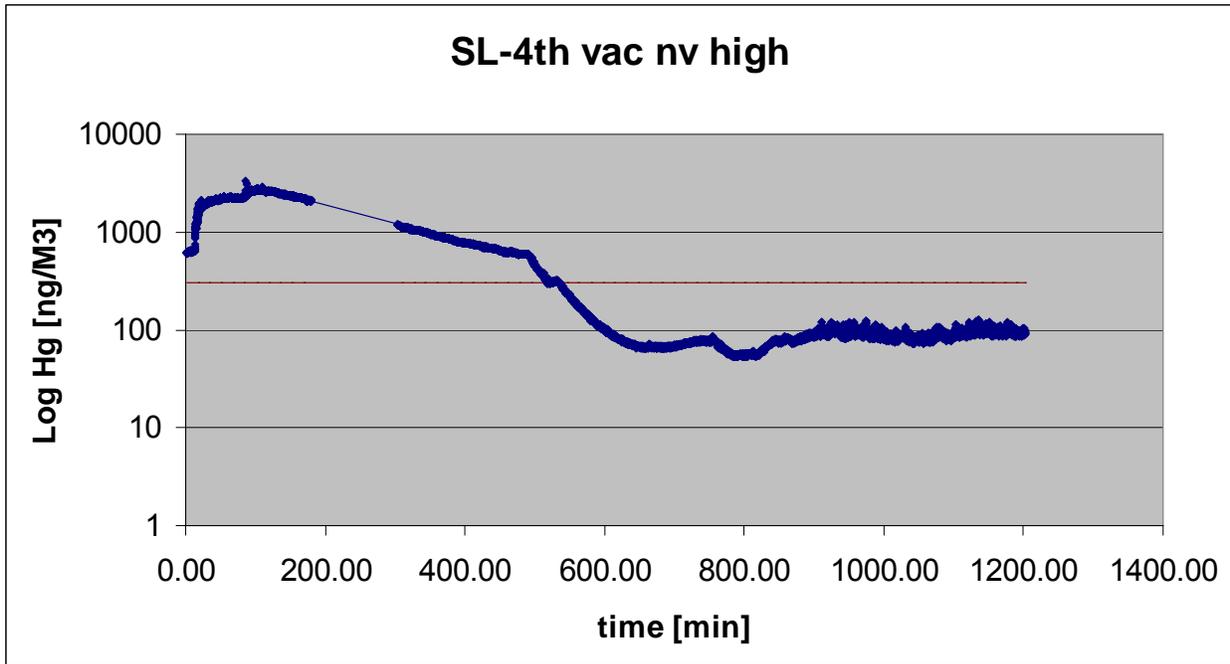


Figure A-94. Scenario L for the vacuum at Five-Foot Height (7/25/07)

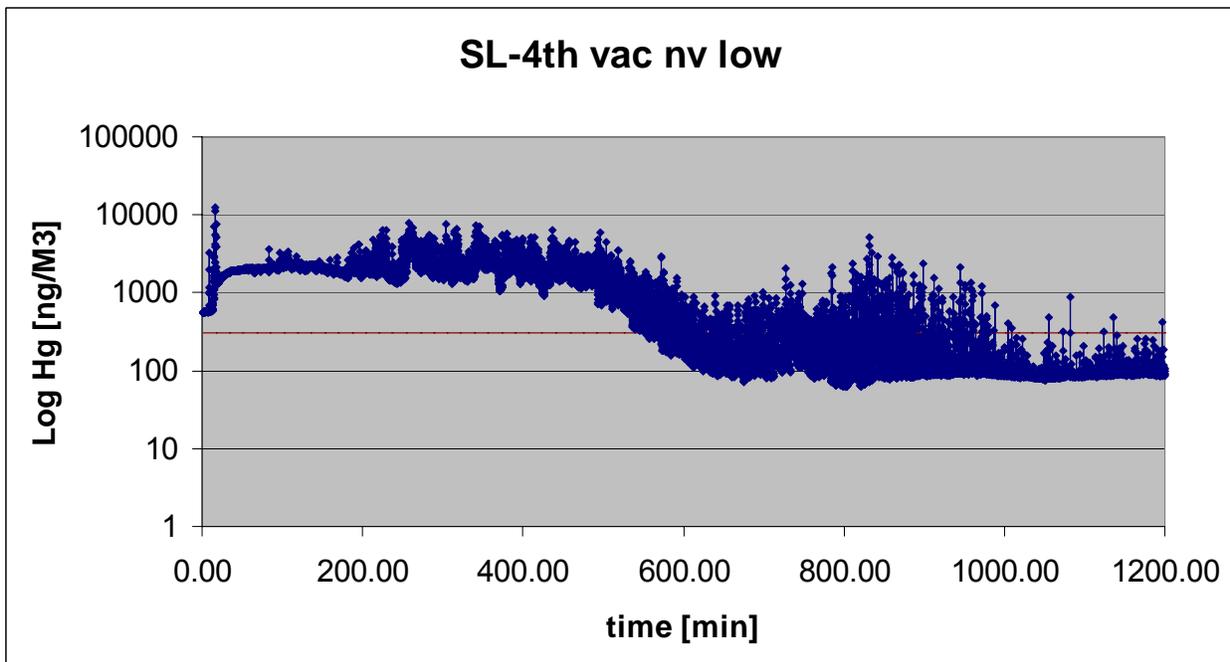


Figure A-95. Scenario L for the vacuum at One-Foot Height (7/25/07)

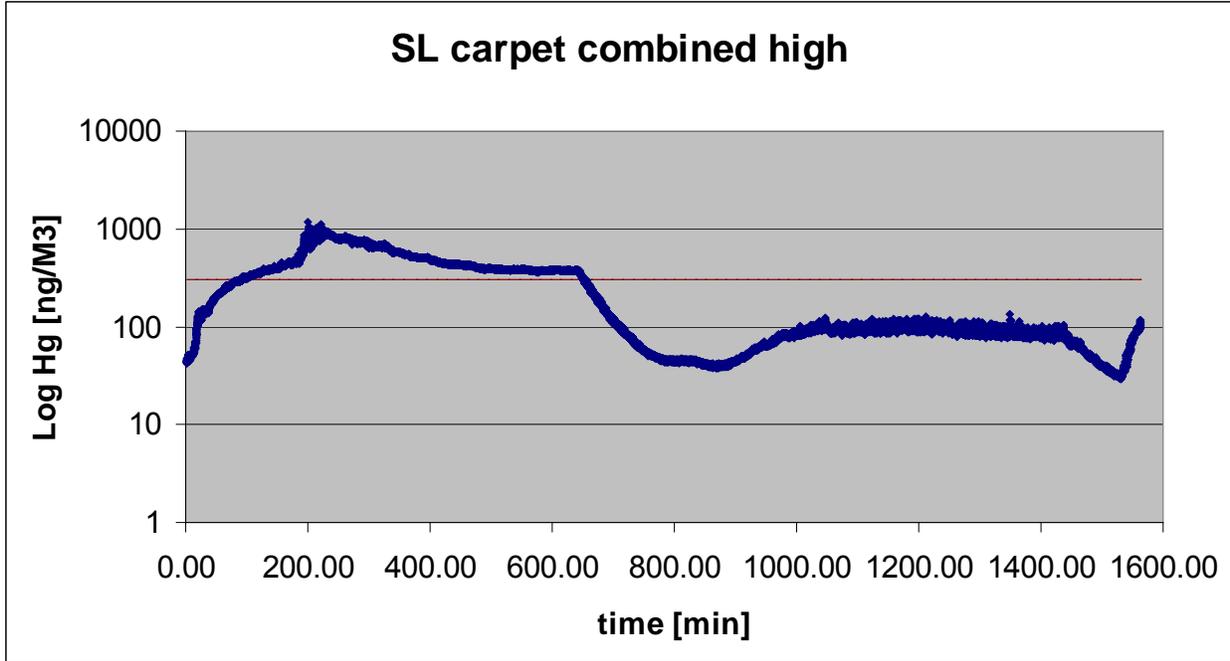


Figure A-96. Scenario L carpet only at Five-Foot Height on 7/26/07

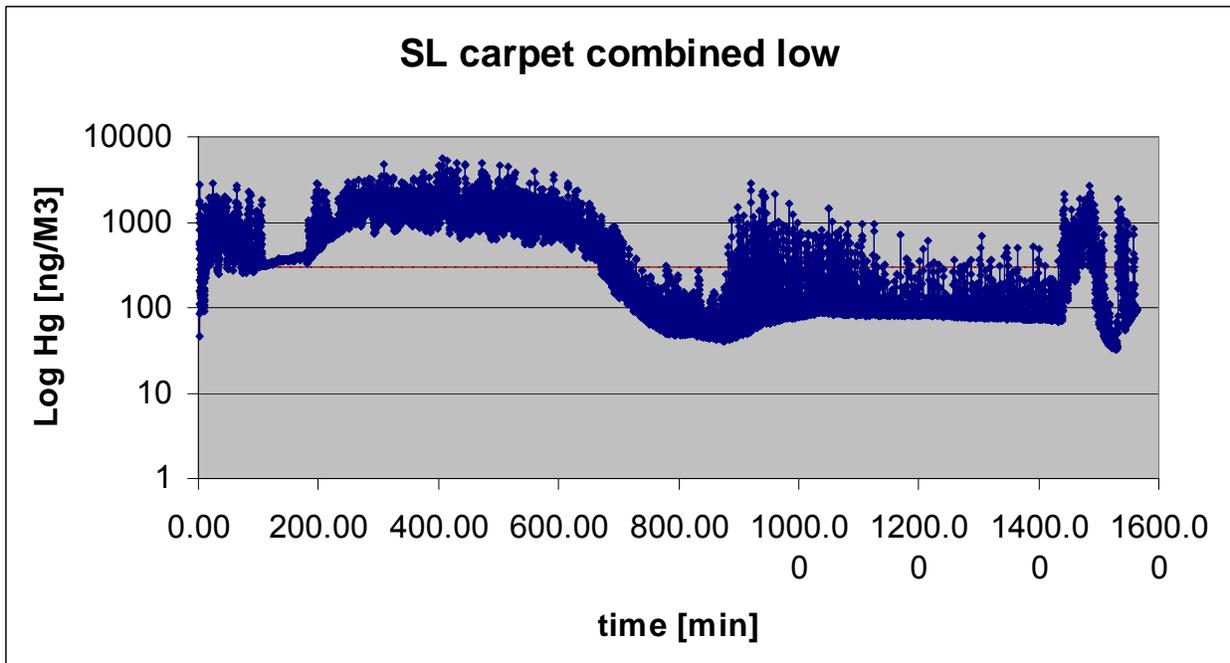


Figure A-97. Scenario L carpet only at One-Foot Height on 7/26/07

Table A-19. Flooring readings for Scenario L

Scenario	SL-"Brand B" 100vacnv	
Date of Breakage	7/19/2007	
Floor Type	short carpet	
Date Measured ↓	unagitated	agitated
7/19/2007 (vacuumed)		
7/23/2007 (vacuumed)		
7/24/2007 (vacuumed)	862	>50,000
7/25/2007 (vacuumed)	690	37,000
7/26/2007	990	13,200
7/27/2007	10,505	29,000
7/30/2007	392	7,795
7/31/2007	912	21,070
8/1/2007	310	16708
8/2/2007	2,116	12,170
8/3/2007	2,691	7,382
8/7/2007	2,033	14,536
8/9/2007	433	4,183
8/10/2007	551	7,456

Results recorded are the highest concentrations of mercury seen while scanning in ng/m³.
Readings for vacuuming days were recorded before the vacuuming.

Table A-20. Vacuum parts readings with Lumex

Hoover Spectrum 850, canister style, Model #S3585, Serial # 089000014844, approx. 20 yrs. old									
Date of Lamp Breakage	Date of Vacuuming	Date of Measurement	Vacuum Cleaner Parts						
			Beaters		Plastic hose	Inside vac	Metal wand	Bag	
			cold	cold agitated	cold	cold	cold	cold	
7/19/2007	7/19/2007								
	7/23/2007								
		7/24/2007 (ambient air = approx. 600)	1,043	1,755	>50,000				4,288
	7/24/2007								
		7/25/2007 before vac	763	1,421					
	7/25/2007								
		7/26/2007	419		38,600			2,524	1,750
		7/26/07 after wiping down with wet wipes	4,941	13,400	5,968	280		84	
		7/27/2007	87	567	3,807				
		7/30/2007	576	2,403	1,059				
		7/31/07(just removed from a container)	1,153	2,397	13,410				
		7/31/07 (after being out of container for 5 min.)	153	1,580	5,671				
		8/1/2007	42	563	4,739				
		8/2/2007	55	4,043	5,566				
		8/3/2007	254	1,793	16,009				
		8/7/2007	597	544	3,328				
		8/9/2007	3,144	3,138	886				
		8/10/2007	848	3,198	804				

This vacuum was used earlier in study

Vacuum measurements with 3rd Lumex when room levels of mercury are low

Measurements are ng/m³

Vacuum not cleaned with wet wipes between vacuuming events on this table

Container Study Additional Results

All mercury debris for the original study was contained in single re-sealable polyethylene storage bags and placed in 55 gallon hazardous waste drums. Mercury air concentration near the hazardous waste drums was measured while bags were deposited. After debris from the third CFL was placed in the drum, mercury concentrations were observed to be quite high (>50,000 ng/m³) near the open drum. This observation led researchers to consider whether or not re-sealable bags were appropriate for containing mercury contaminated debris.

Microsoft® Excel graphs with regression lines, graphing mercury vapor readings taken in phase one of the container study, are presented below.

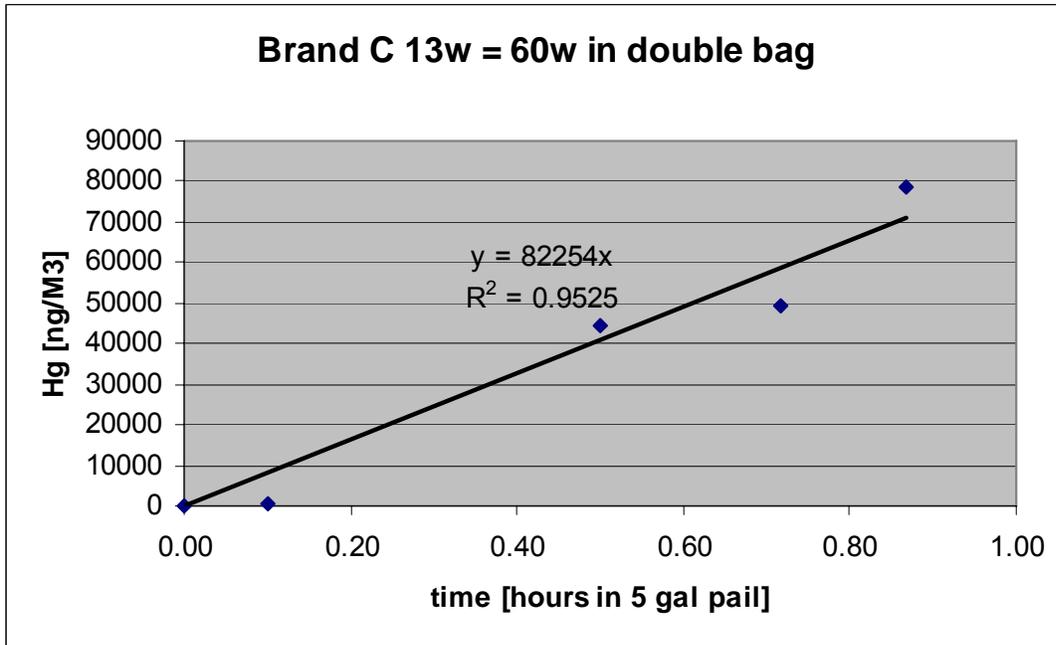


Figure A-98. Regression graph for “Brand C” 60 watt replacement CFL in double re-sealable plastic bags.

Glass jars with metal “gum seal” lids such as canning jars performed the best in waste pail trials. See Figure A-99.

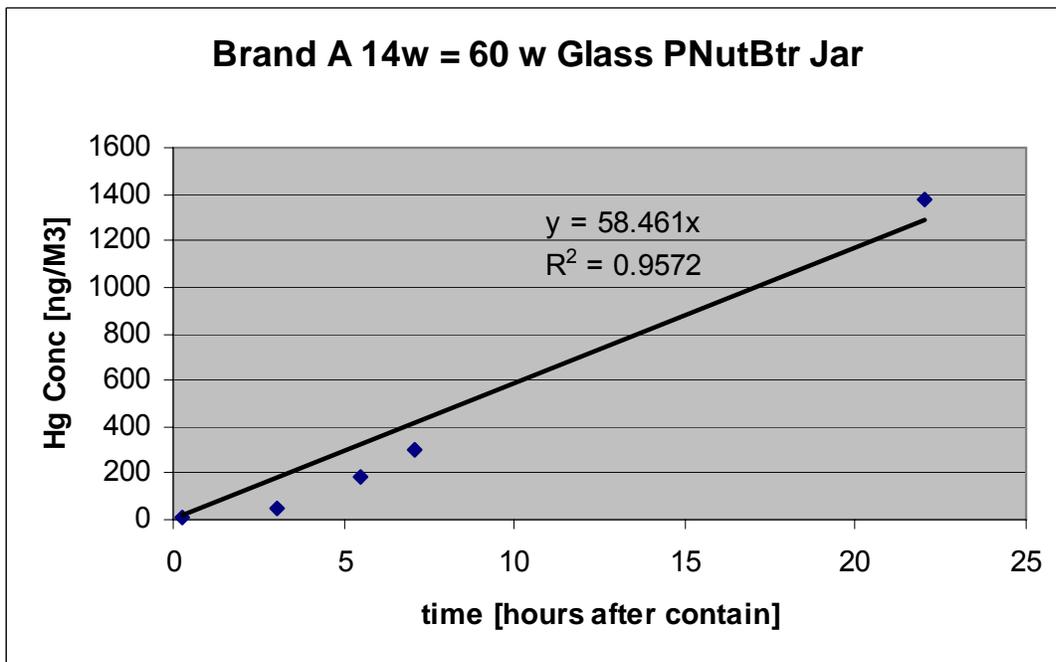


Figure A-99. Regression graph for “Brand A” 60 watt replacement CFL in glass jar/ metal lid.

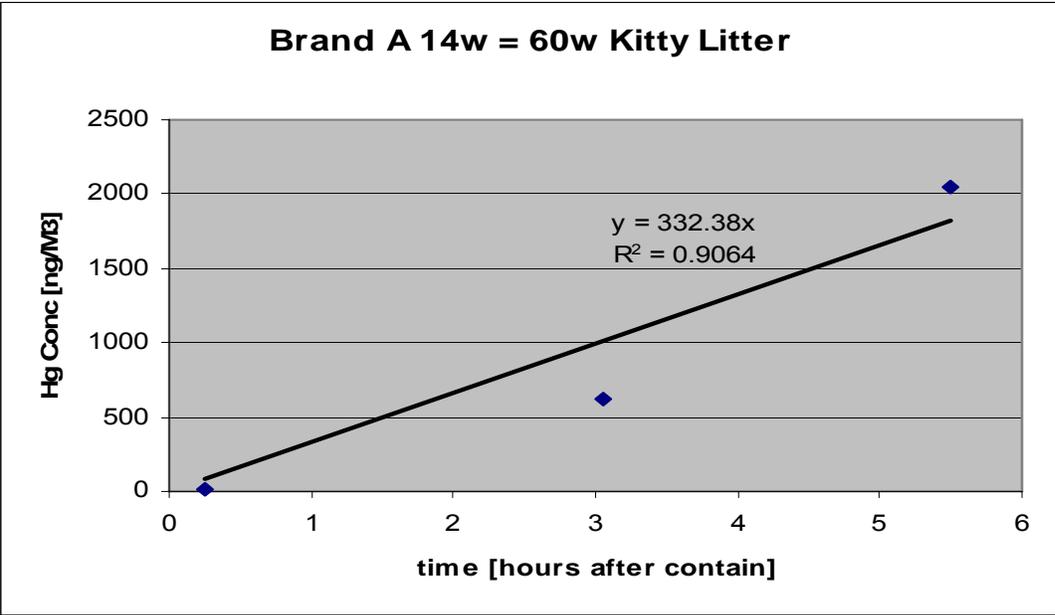


Figure A-100. Regression graph for “Brand A” 60 watt replacement CFL in HPDE Kitty Litter Jug.

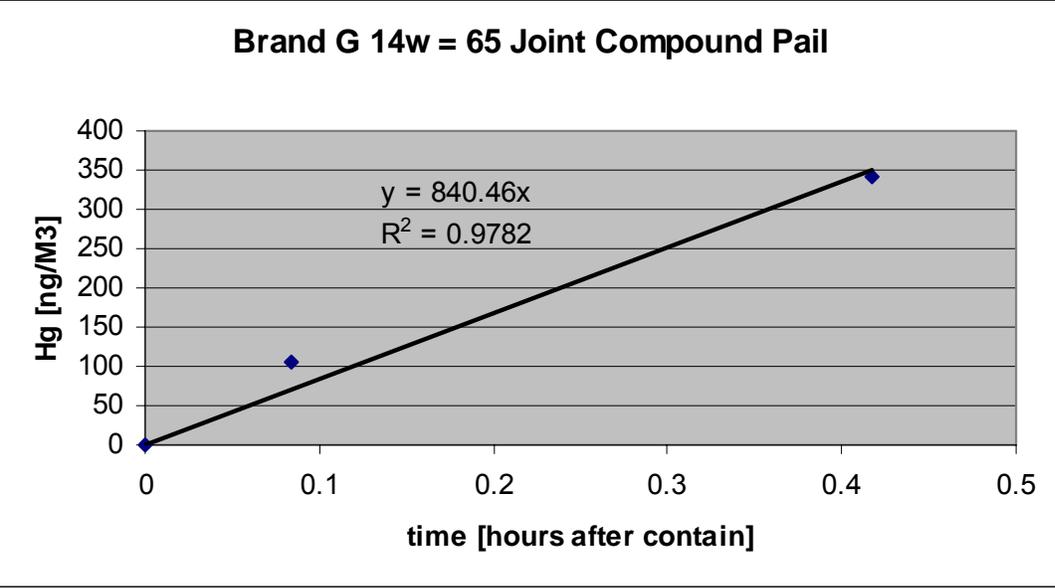


Figure A-101. Regression graph for Commercial Electric 65 watt replacement CFL in HPDE joint compound bucket.

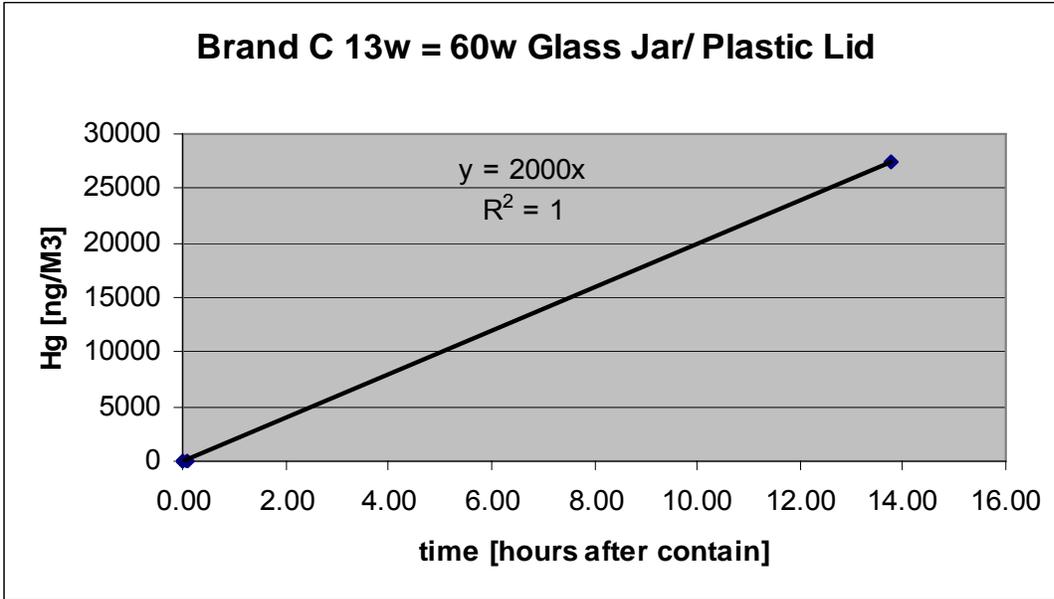


Figure A-102. Regression graph for “Brand C” 60 watt replacement CFL in glass with plastic lid.

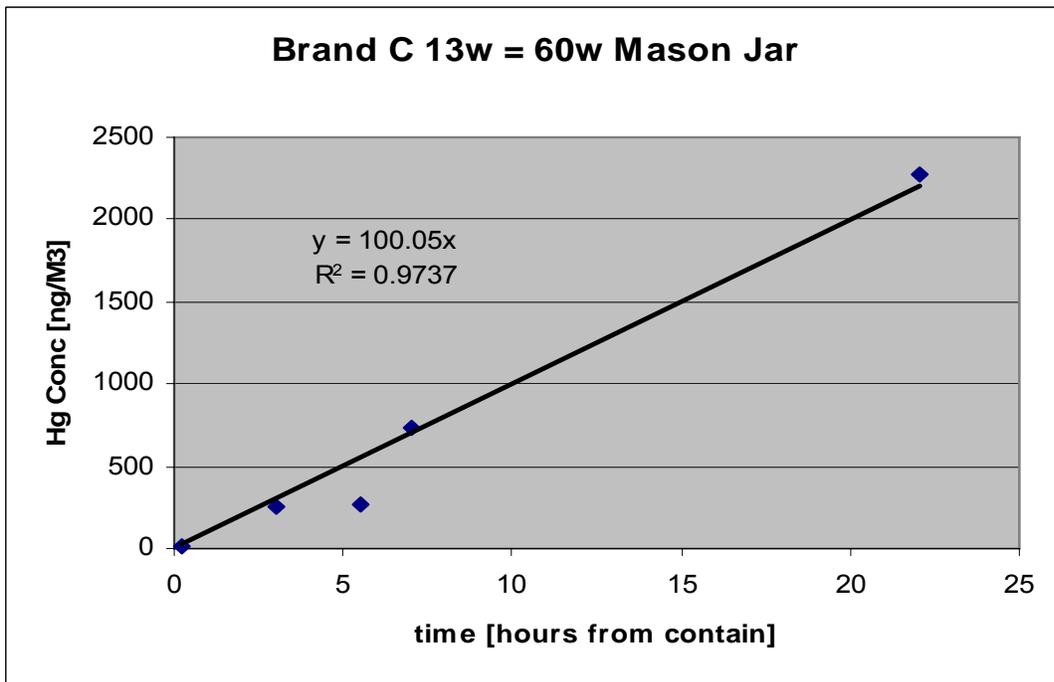


Figure A-103. Regression graph for “Brand C” 60 watt replacement CFL in glass jar/ metal lid.

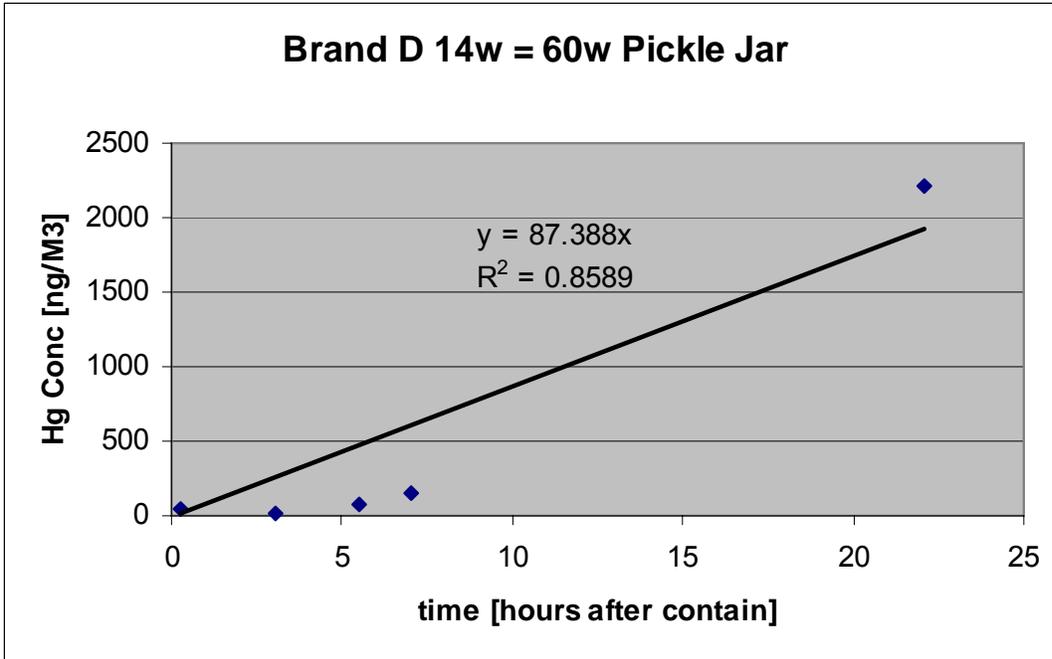


Figure A-104. Regression graph for “Brand D” 60 watt replacement CFL in glass jar/ metal lid.

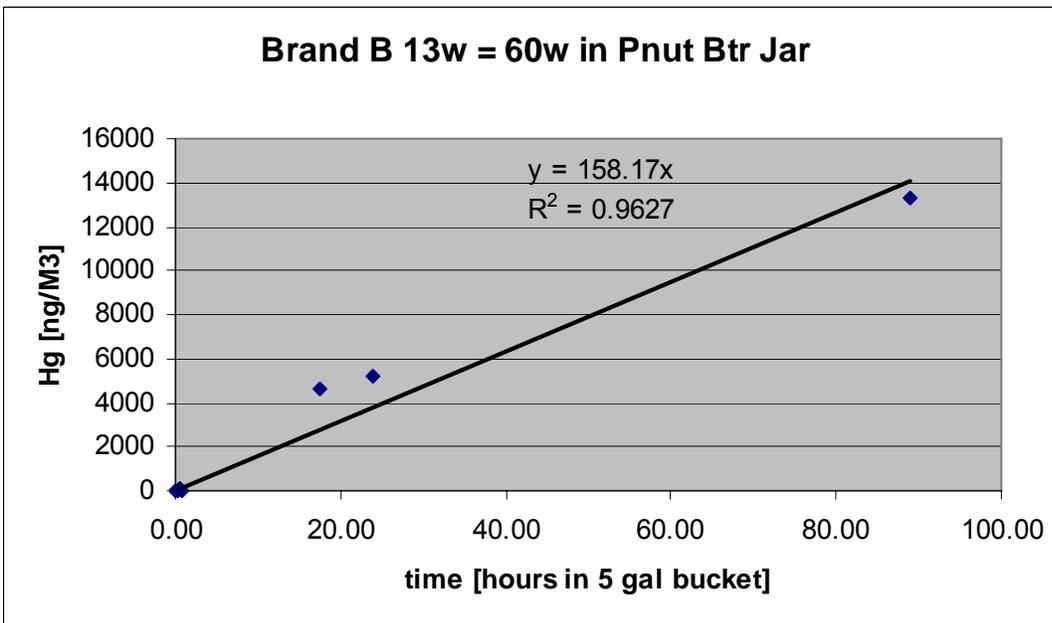


Figure A-105. Regression graph for “Brand B” 60 watt replacement CFL in glass jar/ metal lid.

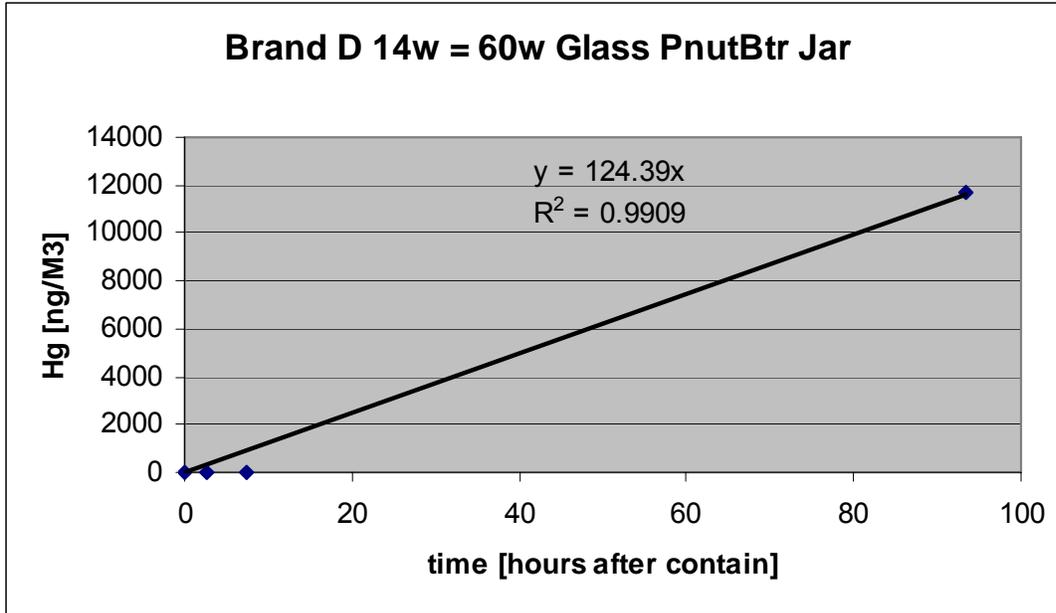


Figure A-106. Regression graph for “Brand D” 60 watt replacement CFL in glass jar/ metal lid.

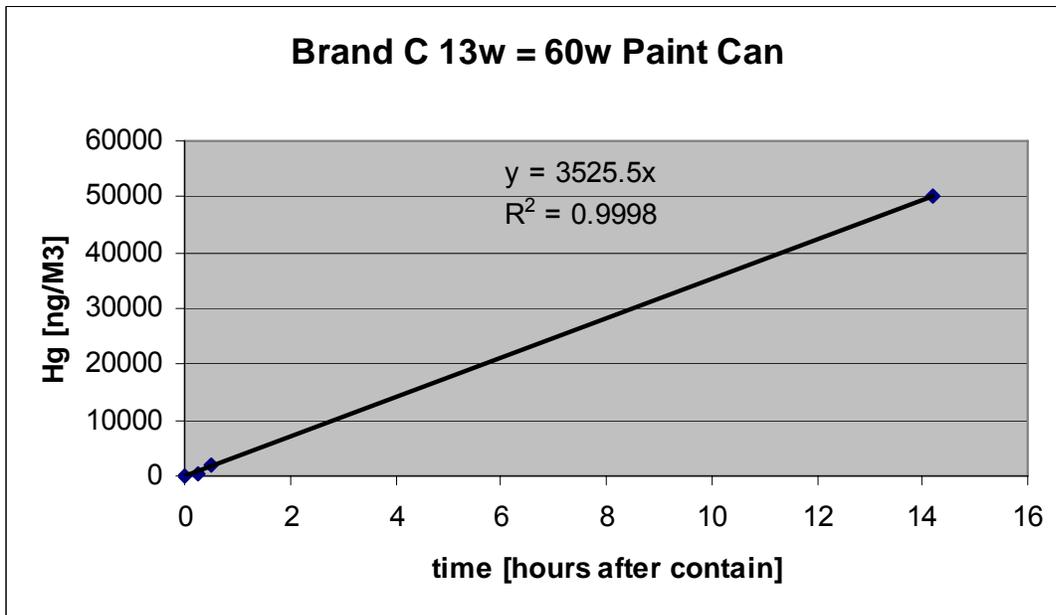


Figure A-107. Regression graph for “Brand C” 60 watt replacement CFL in paint can.

Data for the above graphs were originally recorded in study notebooks, and have been consolidated into the Excel file Containers.xls, available on request.

The four scenarios set up inside the study room were monitored to confirm previous findings in waste pail trials. Performance criterion for study room trials was whether or not study room mercury vapor concentrations exceeded the Maine Ambient Air Guideline (MAAG) of 300 ng/m³. Room door and window were closed for these trials. Study room air did not exceed the MAAG for scenarios where lamp debris was contained in glass jars. One scenario, with broken “Brand D” 60 lamp contained in a glass peanut butter jar was monitored for one week with the following results as listed in Table A-21.

Table A-21 “Brand D” 60 in Glass Peanut Butter Jar

Date	Time (military)	Hg (ng/M3)
7/11//07	10:05	35
7/11//07	10:15	20.3
7/11//07	12:10	<20
7/11//07	15:05	20.7
7/12/2007	16:00	<20
7/13/2007	10:30	<20
7/16/2007	6:30	<20
7/16/2007	15:00	<20
7/17/2007	8:00	<20
7/17/2007	9:10	<20
7/18/2007	6:30	<20

Mercury measurements taken from Study Room 5' intake.

An additional glass jar scenario was monitored using Lumex Air Monitoring software saving mercury air concentrations every 5 seconds. Study room trial graphs not included in the results section of the report are presented in figures A-108 & A-109). Six hour monitoring runs for study room scenarios with broken lamps contained in double re-sealable polyethylene storage bags exceed the MAAG in approximately one hour.

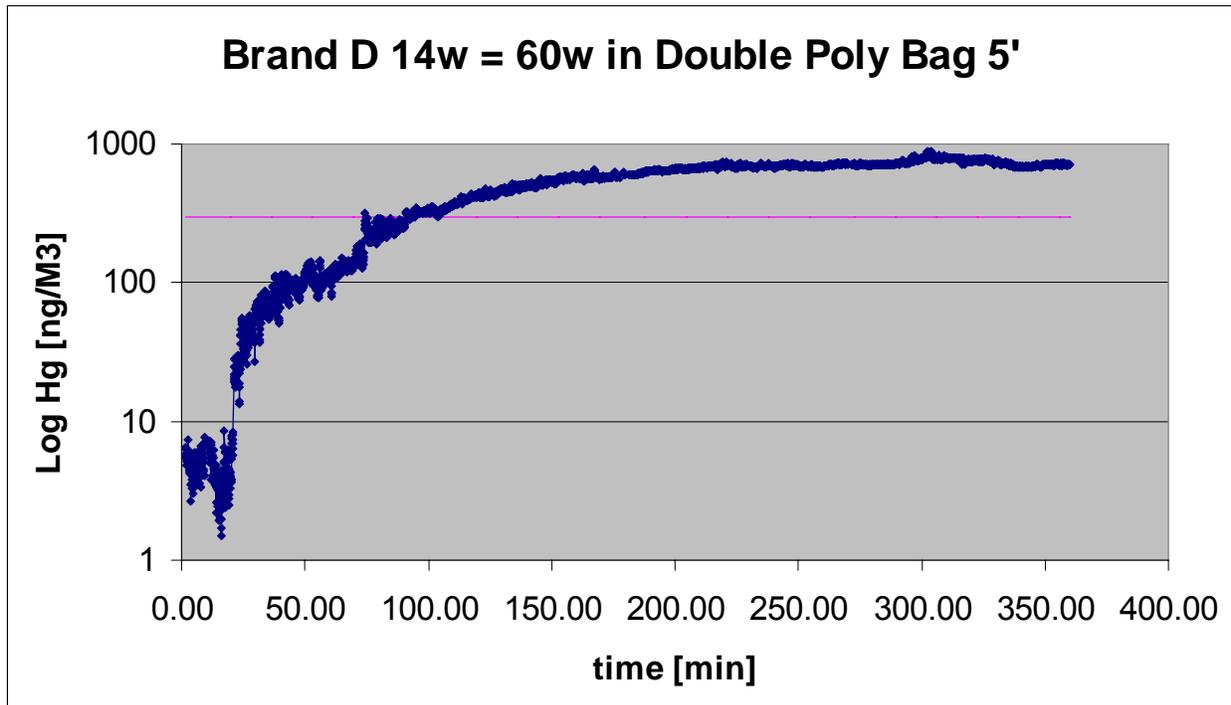


Figure A-108. Broken “Brand D” 60 watt replacement CFL in double re-sealable plastic bag at 5' (9/24/07)

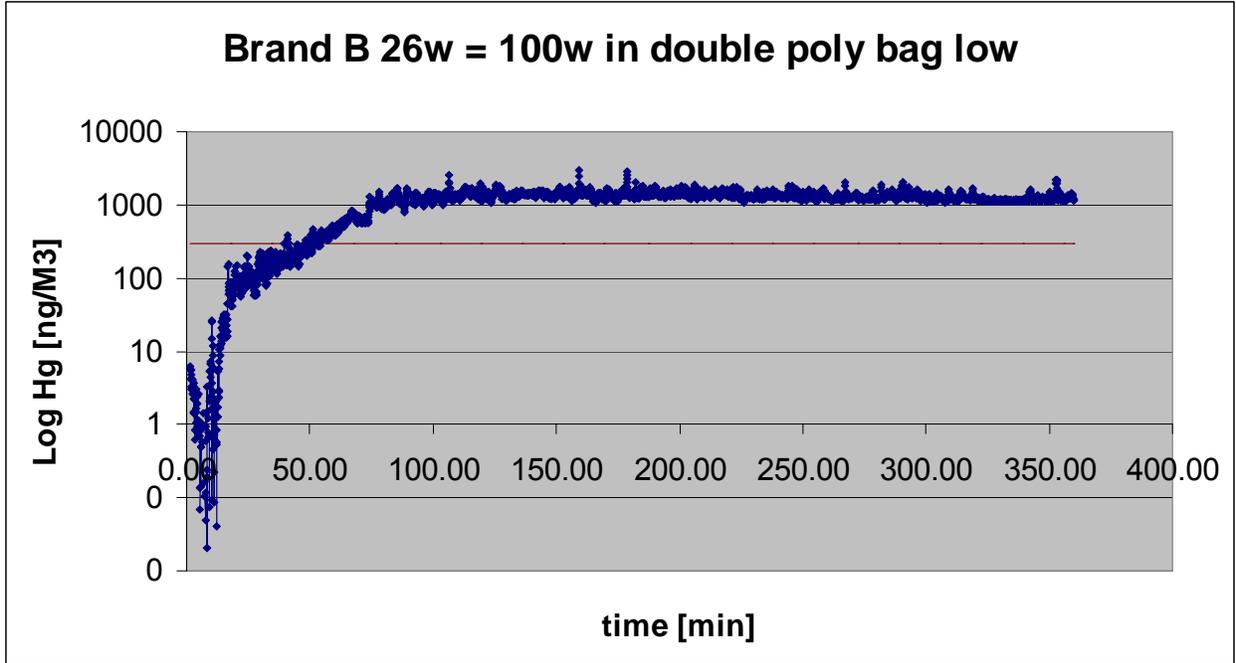


Figure A-111. Broken "Brand B" 100 watt replacement CFL in double re-sealable plastic bag at 1' (7/30/07)



Figure A-112.
Containers



Re-sealable Plastic Bags



Canning Jar

