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Fit Factor for ASABE X613 Cabin Filtration

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To ASABE X613 Committee Members:

As part four of the standard is an extension of part 3, it is imperative that we address the problems in part 3 before proceeding with part 4.

Fit Test

NIOSH utilizes a “fit test” @ $0.3\mu\text{m}$ for respirator usage.¹ This is done prior to vapor filter recommendations. The correlation of a $0.3\mu\text{m}$ particulate fit test for vapor cartridge usage is another critical point being overlooked by the committee. The committee does **not** have data to validate a $0.3 - 1.0\mu\text{m}$ particulate fit test.

An adequate particulate fit test is critical because vapor penetration is higher than particulate penetration through a given leak, due to size. “Perhaps the most interesting observation is the finding that the mean penetration values measured with a vapor, for all leak sizes, were larger than those mean penetration values measured with any of the different size PSL aerosols.”² This is another reason why MERV 16, $0.3\mu\text{m} - 1.0\mu\text{m}$, cannot be used.

CAF has data showing vapor integrity testing to be 1.5 times more critical than $0.3\mu\text{m}$ particulate integrity testing.³ In addition, NIOSH has data stating, “For the larger leak sizes (0.3 mm, 0.33mm, and 0.51mm) the penetration for acetone vapor was 1.6 to 3.4 times higher than the penetration calculated by particle size range data.”²

- The same size leak is amplified when vapors are used vs. particulates.
- We do not have data up to $1.0\mu\text{m}$.

The cab needs to have less than 2% leakage @ $0.3\mu\text{m}$

- NIOSH Respirator Logic is based on $0.3\mu\text{m}$ ¹
- $0.3\mu\text{m}$ is within the most penetrating particle size range for the lungs
- CAF field testing shows that the majority of the particulate exposure is in this size range.⁴
- Multiple/Affordable instrumentation available to measure at $0.3\mu\text{m}$
- Repeatable, non-destructive field test
- realistic (CAF has tested multiple OEM cabs with less than 2% leakage)

By using the OPC, Optical Particle Counter, @ $0.3\mu\text{m}$ Methodology, OEM’s, field technicians, regulators and end users, with or without managed programs, can check the real world Protection Levels of their cabs. Any Protection Factor below the minimum of 95% @ $0.3\mu\text{m}$ would prompt investigation into cab/filter issues. Installing a HEPA filter would determine cab leakage.

Equation $100\% - 2\%$ (cab leakage) -2% (98% filter) = 96% = Powered Respirator Level

In Regards to Vapor Filters

Another specific point we need to revisit is the fact that the vapor test has been changed from 1,000 ppm to 1150 ppm. This deviates from our previous position established by Gary Nelson, Miller-Nelson Laboratories. We need to review the data, reasoning and equipment used to substantiate this change.

CAF recommends using cyclohexane as the test agent, in concurrence with NIOSH⁵, EN15695⁶ part 4.

REFERENCES

¹ NIOSH Respirator Decision Logic, U.S. Department of Health and Human Services, Public Health Services, Centers for Disease Control, National Institute for Occupational Safety and Health, Division of Standards Development and Technology Transfer, May 1987, DHHS (NIOSH) Publication No. 87-108.

<https://www.cdc.gov/niosh/docs/87-108/pdfs/87-108.pdf>

² Effect of Particle Size On Respirator Facesal Leakage, Warren R. Myers PhD, Hyunwook Kim PhD, Nani Kadrichu PhD, West Virginia University, Department of Industrial Engineering, Morgantown, WV, December 1990

<http://www.dtic.mil/dtic/tr/fulltext/u2/a235439.pdf>

³ CAF Cab Vapor and Particulate Test, October 2015, Manusad Shipyard, Marseille France, CAT950G

⁴ CAF Outside Raw Data Averages from testing: October 15 2015 Marseille France, October 20 2015 Champagne France, October 21 2015 Paris France, July 26 2016 Test #26 Oskaloosa Iowa, July 26 2016 Test# 27 Oskaloosa Iowa.

⁵ Determination of CBRN Organic Vapor (Cyclohexane) Service Life Test, Loose-Fitting Powered Air Purifying Respirators (PAPR) Standard Test Procedure (STP), National Institute for Occupational Safety and Health, Procedure No. TEB-APR-STP-0511-CBRN, Revision 0.1, 9 February 2009

<http://www.cdc.gov/niosh/npptl/stps/pdfs/TEB-APR-STP-0511-CBRN.pdf>

⁶ EN15695-2:2009 Test Standard, 3.4.2 Test procedure

Test A - Outside TSI Raw Data

Time	Particle Count (particles/m3)														
	>20.0 µm	>15.0 µm	>10.0 µm	>7.5 µm	>5.0 µm	>4.0 µm	>3.0 µm	>2.0 µm	>1.6 µm	>1.0 µm	>0.80 µm	>0.65 µm	>0.50 µm	>0.40 µm	>0.30 µm
10/20/15 06:20 AM			0	6	7	14	27	91	137	204	821	1431	17931	44447	161961
10/20/15 06:21 AM			2	3	13	7	21	91	130	199	692	1310	16356	41078	150929
10/20/15 06:22 AM			1	4	18	6	16	65	121	215	736	1239	15146	37786	143385
10/20/15 06:23 AM			1	1	16	11	16	76	115	173	626	1196	14039	36052	137617
10/20/15 06:24 AM			2	1	11	16	16	58	114	168	644	1182	14929	38569	142251
10/20/15 06:25 AM			1	5	9	18	24	73	109	191	657	1158	14438	36880	137952
10/20/15 06:26 AM			0	0	8	11	24	71	114	160	649	1203	14643	37277	139200
10/20/15 06:27 AM			0	2	3	10	18	62	107	201	578	1057	13003	33646	129398
10/20/15 06:28 AM			1	2	11	7	19	79	106	171	606	1046	13057	33756	130329
10/20/15 06:29 AM			2	7	14	9	26	68	115	145	551	1010	11868	31129	121647
10/20/15 06:30 AM			2	2	9	12	17	74	104	149	546	958	12057	31507	126019
10/20/15 06:31 AM			1	4	12	7	18	79	91	175	574	892	11664	30862	123998
10/20/15 06:32 AM			0	5	17	13	23	79	119	157	601	1080	12449	34075	140118
10/20/15 06:33 AM			2	4	11	15	24	71	85	150	532	849	10569	28102	114441
10/20/15 06:34 AM			0	2	15	5	12	54	82	125	502	809	10227	27860	114872
10/20/15 06:35 AM			0	2	5	11	16	56	86	135	447	781	9871	26873	112097
10/20/15 06:36 AM			0	3	7	7	15	61	96	142	454	737	9463	25931	109562
10/20/15 06:37 AM			0	4	14	10	25	72	97	152	505	766	9371	25941	111065
10/20/15 06:38 AM			0	4	8	9	16	57	83	159	425	754	9100	25602	109233
10/20/15 06:39 AM			1	1	12	14	21	65	81	127	486	706	9257	25465	109912
										3298	11632	20164	249438	652838	2565986
										Total Counts 0.30-1.0	3503356	100.00%			
										Total Counts 0.65-1.0	35094	1.00%			
										Total Counts 0.30-0.50	3468262	99.00%			

Test B - Outside TSI Raw Data

Time	Particle Count (particles/m3)												>0.40 µm	>0.30 µm		
	>20.0 µm	>15.0 µm	>10.0 µm	>7.5 µm	>5.0 µm	>4.0 µm	>3.0 µm	>2.0 µm	>1.6 µm	>1.0 µm	>0.80 µm	>0.65 µm			>0.50 µm	
10/21/15 01:30 AM			7	20	50	52	124	372	465	539	1063	1114	9457	24148	120886	
10/21/15 01:31 AM			3	11	56	50	91	353	510	586	1066	1163	9425	23608	115525	
10/21/15 01:32 AM			5	17	66	55	94	391	516	583	1218	1222	10361	24949	119980	
10/21/15 01:33 AM			6	18	69	63	122	400	531	549	1236	1236	10289	25714	115074	
10/21/15 01:34 AM			9	29	60	69	125	385	471	580	1100	1124	10279	26688	123810	
10/21/15 01:35 AM			6	19	75	70	104	440	506	529	1056	1174	9976	26169	115498	
10/21/15 01:36 AM			10	8	66	44	90	410	490	598	1179	1323	10416	25532	124396	
10/21/15 01:37 AM			8	14	51	54	97	399	499	492	981	1133	9464	22780	107557	
10/21/15 01:38 AM			3	20	60	41	97	390	444	475	917	994	8654	21913	105627	
10/21/15 01:39 AM			7	20	53	61	87	367	459	467	928	1048	8767	21908	102499	
10/21/15 01:40 AM			7	16	47	55	105	379	435	465	856	921	8137	21203	101460	
10/21/15 01:41 AM			12	17	63	58	95	388	535	509	1048	1117	9098	23232	115898	
10/21/15 01:42 AM			9	15	67	40	98	331	474	459	980	916	8391	20654	103647	
10/21/15 01:43 AM			3	18	57	54	78	400	464	470	994	1039	8738	22074	114627	
10/21/15 01:44 AM			7	13	49	54	88	371	474	455	946	1035	8714	21785	112869	
10/21/15 01:45 AM			11	15	51	56	122	460	593	605	1209	1134	9039	22629	112422	
10/21/15 01:46 AM			2	9	59	59	100	371	440	482	896	996	8383	21164	104082	
10/21/15 01:47 AM			8	18	46	47	96	345	436	468	793	926	8438	21312	99065	
10/21/15 01:48 AM			14	21	93	65	150	682	759	867	1486	1370	10354	24715	114505	
10/21/15 01:49 AM			11	19	61	57	123	587	639	761	1311	1353	9818	23693	108889	
											10939	21263	22338	186198	465870	2238316
											Total Counts 0.30-1.0		2944924	100.00%		
											Total Counts 0.65-1.0		54540	1.85%		
											Total Counts 0.30-0.50		2890384	98.15%		

Test A - Outside TSI Raw Data

Time	Particle Count (particles/m3)														
	>20.0 µm	>15.0 µm	>10.0 µm	>7.5 µm	>5.0 µm	>4.0 µm	>3.0 µm	>2.0 µm	>1.6 µm	>1.0 µm	>0.80 µm	>0.65 µm	>0.50 µm	>0.40 µm	>0.30 µm
7/26/16 01:53 PM			2	6	27	28	55	157	111	117	194	170	1376	5305	32464
7/26/16 01:54 PM			8	15	28	43	73	192	137	176	390	408	2885	8411	40639
7/26/16 01:55 PM			7	26	66	42	93	225	151	170	249	250	1697	6097	34373
7/26/16 01:56 PM			52	120	265	232	388	648	395	350	440	347	2177	6807	36133
7/26/16 01:57 PM			17	37	79	90	143	357	223	186	289	203	1459	5529	32431
7/26/16 01:58 PM			7	18	71	55	107	272	182	161	201	132	964	4560	30654
7/26/16 01:59 PM			9	26	44	44	95	193	165	129	154	79	905	4673	30897
7/26/16 02:00 PM			8	23	55	65	110	226	150	111	158	99	943	4668	30702
7/26/16 02:01 PM			11	15	55	45	80	190	139	120	163	89	850	4418	30281
7/26/16 02:02 PM			21	33	63	46	105	210	127	120	189	126	1034	4803	30963
7/26/16 02:03 PM			31	37	107	67	138	264	190	143	226	187	1467	5524	33336
7/26/16 02:04 PM			10	22	63	55	108	230	195	197	287	246	1872	6413	35579
7/26/16 02:05 PM			39	85	208	131	223	439	254	229	284	161	1267	5250	31612
7/26/16 02:06 PM			14	18	52	49	76	195	142	140	186	161	1171	5162	31784
7/26/16 02:07 PM			4	8	48	43	89	190	148	164	251	204	1620	5983	33558
7/26/16 02:08 PM			5	16	34	44	77	226	163	156	325	333	2403	7501	38205
7/26/16 02:09 PM			14	28	42	33	88	228	152	134	231	172	1505	5613	32990
7/26/16 02:10 PM			2	21	48	66	97	193	125	112	148	113	909	4618	30476
7/26/16 02:11 PM			76	149	357	295	536	1101	629	579	624	284	1224	4900	30925
7/26/16 02:12 PM			54	73	188	127	225	489	265	233	275	127	997	4586	30622
										3727	5264	3891	28725	110821	658624

Total Counts 0.30-1.0 811052 100.00%
 Total Counts 0.65-1.0 12882 1.59%
 Total Counts 0.30-0.50 798170 98.41%

Test A - Outside TSI Raw Data

Time	Particle Count (particles/m3)													>0.30 μ m	
	>20.0 μ m	>15.0 μ m	>10.0 μ m	>7.5 μ m	>5.0 μ m	>4.0 μ m	>3.0 μ m	>2.0 μ m	>1.6 μ m	>1.0 μ m	>0.80 μ m	>0.65 μ m	>0.50 μ m		>0.40 μ m
7/26/16 02:39 PM			10	20	34	49	87	204	135	110	135	92	851	4529	30234
7/26/16 02:40 PM			11	24	72	54	97	256	160	158	186	125	1045	4757	30880
7/26/16 02:41 PM			4	11	32	31	69	171	121	107	143	106	1006	4959	30906
7/26/16 02:42 PM			6	16	36	30	77	204	100	116	167	148	1187	5299	31879
7/26/16 02:43 PM			5	16	46	35	86	225	154	130	214	168	1321	5496	32214
7/26/16 02:44 PM			12	16	54	41	105	223	137	119	140	133	929	4555	29869
7/26/16 02:45 PM			3	9	28	33	79	192	116	117	173	154	1291	5235	32035
7/26/16 02:46 PM			9	31	65	54	101	256	159	167	294	255	1892	6300	35345
7/26/16 02:47 PM			6	24	37	45	95	229	162	118	172	119	1007	4732	30296
7/26/16 02:48 PM			8	21	51	54	78	233	159	125	153	107	865	4332	28953
7/26/16 02:49 PM			7	19	53	50	93	210	173	143	192	161	1213	5144	30566
7/26/16 02:50 PM			4	13	47	46	73	174	129	123	200	160	1303	5361	31423
7/26/16 02:51 PM			27	37	69	72	123	220	155	143	219	147	1102	4984	30548
7/26/16 02:52 PM			24	44	82	68	106	257	135	138	263	163	1237	5180	30610
7/26/16 02:53 PM			16	45	96	79	146	291	165	156	212	145	1073	4755	29724
7/26/16 02:54 PM			2	20	57	58	95	222	122	133	170	129	1030	4558	29777
7/26/16 02:55 PM			8	21	47	41	103	211	154	121	155	123	910	4551	29275
7/26/16 02:56 PM			2	15	50	42	72	180	133	137	231	206	1463	5707	32977
7/26/16 02:57 PM			7	18	42	45	79	208	142	112	177	136	1048	4809	30426
7/26/16 02:58 PM			5	9	50	39	82	229	159	143	204	153	1264	5218	32072
										2616	3800	2930	23037	100461	620009
											Total Counts 0.30-1.0	752853	100.00%		
											Total Counts 0.65-1.0	9346	1.24%		
											Total Counts 0.30-0.50	743507	98.76%		