

Spreadsheet Formulas for the Wilcoxon Rank Sum Test and Power Calculation*

Wilcoxon Rank Sum Test, per NUREG-1505

LBGR 2.1 (For this calculation, LBGR = 3w for Building 722 Background)

(Reference Dataset - Building 722 Alpha Phoswich)

DATA	AREA	ADJUSTED DATA	RANKS	SURVEY AREA RANKS	
1	R		1	35.5	0
3	R		3	68.5	0
3	R		3	68.5	0
1	R		1	35.5	0
4	R		4	88.5	0
4	R		4	88.5	0
1	R		1	35.5	0
4	R		4	88.5	0
4	R		4	88.5	0
9	R		9	125.5	0
7	R		7	120	0
2	R		2	49	0
2	R		2	49	0
4	R		4	88.5	0
3	R		3	68.5	0
1	R		1	35.5	0
6	R		6	111	0
3	R		3	68.5	0
3	R		3	68.5	0
2	R		2	49	0
1	R		1	35.5	0
2	R		2	49	0
4	R		4	88.5	0
4	R		4	88.5	0
7	R		7	120	0
3	R		3	68.5	0
3	R		3	68.5	0
7	R		7	120	0
5	R		5	101.5	0
2	R		2	49	0
2	R		2	49	0
4	R		4	88.5	0
3	R		3	68.5	0
6	R		6	111	0
0	R		0	28.5	0
6	R		6	111	0
14	R		14	128	0
2	R		2	49	0
6	R		6	111	0
6	R		6	111	0
7	R		7	120	0
4	R		4	88.5	0
0	R		0	28.5	0
4	R		4	88.5	0
2	R		2	49	0
3	R		3	68.5	0
3	R		3	68.5	0
3	R		3	68.5	0
3	R		3	68.5	0
2	R		2	49	0
2	R		2	49	0
4	R		4	88.5	0
6	R		6	111	0
10	R		10	127	0
5	R		5	101.5	0
8	R		8	124	0
3	R		3	68.5	0
2	R		2	49	0
0	R		0	28.5	0
3	R		3	68.5	0
4	R		4	88.5	0
2	R		2	49	0
5	R		5	101.5	0
5	R		5	101.5	0
3	R		3	68.5	0
6	R		6	111	0
7	R		7	120	0

Survey Unit Stats
Count 28 n
SD 1.0
Median 1
Reference Stats
Count 100 n
SD 2.3
Median 3

Critical Value 2146.0

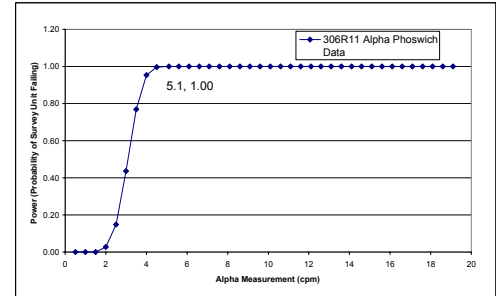
Bkgd Med plus LBGR 5.1

Retrospective Power Curve Calculation

From Example in Section 10.5 of NUREG-1505

p1 and p2 pull data from Table 10-3 sheet

C	Measuremen	(C-LBGR)/SD	Rounded	p1	p2	E(Wmw)	Var(Wmw)	SD(Wmw)	z	Power
0.5	-0.685	-0.700	0.310309	0.164691	868.8652	25496.6	159.6766	5.452786	0.00	0.00
1	-0.471	-0.500	0.361837	0.206266	1013.144	28070.31	167.542	4.335653	0.00	0.00
1.5	-0.2567	-0.300	0.416002	0.253419	1164.806	29931.77	173.008	3.322053	0.00	0.00
2	-0.0428	0.000	0.5	0.333333	1400	31033.21	176.1625	1.927467	0.03	0.15
2.5	0.1712	0.200	0.556231	0.391392	1557.447	30538.81	174.7536	1.042042	0.15	0.44
3	0.3851	0.400	0.611351	0.451875	1711.783	29102.77	170.5953	0.162751	0.44	0.77
3.5	0.5990	0.600	0.664313	0.513387	1860.076	26859.79	163.8896	-0.73543	0.77	0.95
4	0.8130	0.800	0.714196	0.574469	1999.749	24010.61	154.9536	-1.67922	0.95	1.00
4.5	1.0269	1.000	0.76025	0.633702	2128.7	20793.14	144.1983	-2.69873	1.00	1.00
5	1.2836	1.300	0.821015	0.716331	2298.842	15796.05	126.6823	-4.45607	1.00	1.00
5.5	1.4976	1.500	0.836901	0.741698	2349.923	14189.7	119.1205	-5.11562	1.00	1.00
6	1.7115	1.700	0.87105	0.788602	2438.94	11188.6	105.7762	-6.61201	1.00	1.00
6.6	1.9254	1.900	0.898454	0.830022	2515.671	8555.534	92.49613	-8.39088	1.00	1.00
7	2.1394	2.100	0.92135	0.865767	2579.78	6347.648	79.67213	-10.5461	1.00	1.00
7.6	2.3533	2.400	0.948062	0.908982	2654.574	3836.275	61.93767	-14.7733	1.00	1.00
8	2.5673	2.600	0.96145	0.931365	2692.06	2644.098	51.42079	-18.5239	1.00	1.00
8.6	2.7812	2.800	0.971881	0.949208	2721.267	1771.056	42.08392	-23.3277	1.00	1.00
9	2.9951	3.000	0.979848	0.963118	2743.574	1153.075	33.95696	-29.5676	1.00	1.00
9.6	3.2091	3.200	0.985811	0.973725	2760.271	731.3742	27.04393	-37.7432	1.00	1.00
10	3.4230	3.400	0.990188	0.981636	2772.526	450.7998	21.23205	-48.6519	1.00	1.00
10.6	3.6370	3.600	0.993336	0.98741	2781.341	271.002	16.46214	-63.2842	1.00	1.00
11	3.8509	3.900	0.993336	0.98741	2781.341	271.002	16.46214	-63.2842	1.00	1.00
11.6	4.0648	4.100	0.997661	0.995497	2793.451	68.24247	8.2609	-127.577	1.00	1.00
12	4.2788	4.300	0.997661	0.995497	2793.451	68.24247	8.2609	-127.577	1.00	1.00
12.6	4.4927	4.500	0.997661	0.995497	2793.451	68.24247	8.2609	-127.577	1.00	1.00
13	4.7067	4.700	0.997661	0.995497	2793.451	68.24247	8.2609	-127.577	1.00	1.00
13.6	4.9206	4.900	0.997661	0.995497	2793.451	68.24247	8.2609	-127.577	1.00	1.00
14	5.1345	5.100	0.999796	0.999599	2799.429	3.103935	1.761799	-601.591	1.00	1.00
14.6	5.3485	5.300	0.999796	0.999599	2799.429	3.103935	1.761799	-601.591	1.00	1.00
15	5.5624	5.600	0.999796	0.999599	2799.429	3.103935	1.761799	-601.591	1.00	1.00
15.6	5.7763	5.800	0.999796	0.999599	2799.429	3.103935	1.761799	-601.591	1.00	1.00
16	5.9903	6.000	0.999989	0.999978	2799.969	0.030756	0.175373	-6046.67	1.00	1.00
16.6	6.2042	6.200	0.999989	0.999978	2799.969	0.030756	0.175373	-6046.67	1.00	1.00
17	6.4182	6.400	0.999989	0.999978	2799.969	0.030756	0.175373	-6046.67	1.00	1.00
17.6	6.6321	6.600	0.999989	0.999978	2799.969	0.030756	0.175373	-6046.67	1.00	1.00
18	6.8460	6.800	0.999989	0.999978	2799.969	0.030756	0.175373	-6046.67	1	1
18.6	7.0600	7.100	0.999989	0.999978	2799.969	0.030756	0.175373	-6046.67	1	1
19	7.2739	7.300	0.999989	0.999978	2799.969	0.030756	0.175373	-6046.67	1	1



Based on the number of measurements and the observed standard deviation, a survey unit with a median measurement equal to the background median plus the LBGR (5.1) will have a 1.0 probability that the survey unit will **correctly** fail (i.e., the null hypothesis that the difference between the survey unit median and the background median is less than the LBGR [i.e., the survey unit is indistinguishable from background] is rejected).

1	R	1	35.5	0
1	R	1	35.5	0
5	R	5	101.5	0
6	R	6	111	0
2	R	2	49	0
4	R	4	88.5	0
2	R	2	49	0
1	R	1	35.5	0
6	R	6	111	0
4	R	4	88.5	0
2	R	2	49	0
2	R	2	49	0
3	R	3	68.5	0
3	R	3	68.5	0
0	S	-2.1	5.5	5.5
1	S	-1.1	16.5	16.5
0	S	-2.1	5.5	5.5
1	S	-1.1	16.5	16.5
1	S	-1.1	16.5	16.5
0	S	-2.1	5.5	5.5
2	S	-0.1	24.5	24.5
1	S	-1.1	16.5	16.5
0	S	-2.1	5.5	5.5
4	S	1.9	40	40
1	S	-1.1	16.5	16.5
0	S	-2.1	5.5	5.5
1	S	-1.1	16.5	16.5
1	S	-1.1	16.5	16.5
1	S	-1.1	16.5	16.5
1	S	-1.1	16.5	16.5
0	S	-2.1	5.5	5.5
1	S	-1.1	16.5	16.5
0	S	-2.1	5.5	5.5
0	S	-2.1	5.5	5.5
3	S	0.9	31	31
1	S	-1.1	16.5	16.5
2	S	-0.1	24.5	24.5
2	S	-0.1	24.5	24.5
2	S	-0.1	24.5	24.5
0	S	-2.1	5.5	5.5
1	S	-1.1	16.5	16.5
0	S	-2.1	5.5	5.5
Sum =			8256	422

* This spreadsheet is originally designed to work with a set of twenty measurements, 10 from the survey unit (S) and 10 from the background reference area (R). If a different number of measurements have been performed, it is necessary to modify the spreadsheet to account for the change in the number of measurements.

of R: 100 n
of S: 28 m
Avg Rank R: 78
Avg Rank S: 15

For m or n greater than 20, the critical value (k) can be calculated for Scenario B from

$$\frac{m(n+m+1)}{2} + z \sqrt{\frac{nm(n+m+1)}{12}}$$

z = 97.5% percentile of standard normal distribution = 1.960

k = 2146.0

Since the sum of survey unit ranks is less than the critical value, the null hypothesis that the difference between the survey unit median and the background median is less than the LBGR (i.e., the survey unit is indistinguishable from background) is accepted and the survey unit passes Scenario B

Spreadsheet Formulas for the Wilcoxon Rank Sum Test and Power Calculation*

Wilcoxon Rank Sum Test, per NUREG-1505

LBGR 417.6 (For this calculation, LBGR = 3w for Building 722 Background)
(Reference Dataset - Building 722 Beta Phoswich)

DATA	AREA	ADJUSTED DATA	RANKS	SURVEY AREA RANKS
211	R	211	42	0
358	R	358	88	0
278	R	278	71	0
275	R	275	69	0
234	R	234	53	0
209	R	209	41	0
429	R	429	100	0
327	R	327	82.5	0
237	R	237	55	0
258	R	258	61	0
370	R	370	90	0
497	R	497	110	0
448	R	448	103	0
401	R	401	93	0
423	R	423	99	0
368	R	368	89	0
432	R	432	101	0
485	R	485	108	0
418	R	418	97	0
337	R	337	85	0
498	R	498	111.5	0
496	R	496	109	0
617	R	617	122	0
511	R	511	115.5	0
463	R	463	105	0
480	R	480	106	0
411	R	411	95	0
457	R	457	104	0
437	R	437	102	0
484	R	484	107	0
541	R	541	120	0
498	R	498	111.5	0
529	R	529	117	0
511	R	511	115.5	0
405	R	405	94	0
537	R	537	119	0
420	R	420	98	0
297	R	297	76	0
533	R	533	118	0
501	R	501	114	0
239	R	239	57	0
327	R	327	82.5	0
342	R	342	86	0
271	R	271	66.5	0
274	R	274	68	0
371	R	371	91	0
376	R	376	92	0
238	R	238	56	0
243	R	243	58	0
281	R	281	73.5	0
295	R	295	75	0
316	R	316	80	0
271	R	271	66.5	0
306	R	306	79	0
597	R	597	121	0
717	R	717	123	0
225	R	225	48	0
276	R	276	70	0
301	R	301	78	0
500	R	500	113	0
232	R	232	52	0
201	R	201	37.5	0
183	R	183	34	0
250	R	250	60	0
223	R	223	46.5	0
201	R	201	37.5	0
205	R	205	39	0
280	R	280	72	0
270	R	270	65	0
319	R	319	81	0
328	R	328	84	0
923	R	923	125	0
281	R	281	73.5	0
285	R	285	62	0
1187	R	1187	128	0
779	R	779	124	0
1026	R	1026	127	0
935	R	935	126	0
353	R	353	87	0
412	R	412	96	0
160	R	160	29	0
170	R	170	31	0
173	R	173	33	0
236	R	236	54	0
221	R	221	44.5	0
219	R	219	43	0

Survey Unit Stats
Count 28 m
SD 20
Median 155
Reference Stats
Count 100 n
SD 186
Median 304

Critical Value 2148.0

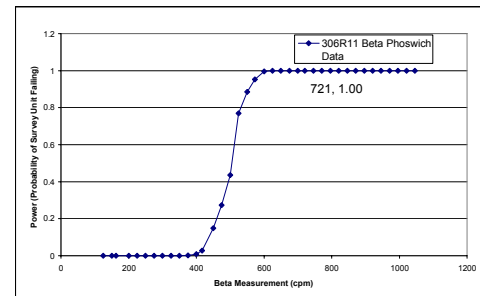
Bkgd Med plus LBGR

Retrospective Power Curve Calculation

From Example in Section 10.5 of NUREG-1505

p1 and p2 pull data from Table 10-3 sheet

C	Measurement	(C-LBGR)/SD	Rounded	p1	p2	E(Wmw)	Var(Wmw)	SD(Wmw)	z	Power
125	-1.570	-1.600	0.12895	0.046501	361.06	11188.24	105.7745	13.03233	0	0.00
150	-1.436	-1.400	0.161099	0.063897	451.0772	14190.07	119.1221	10.81638	0.00	0.00
163	-1.3661	-1.400	0.161099	0.063897	451.0772	14190.07	119.1221	10.81638	0.00	0.00
200	-1.1676	-1.200	0.198072	0.085944	554.8016	17447.73	132.0899	8.970755	0.00	0.00
225	-1.0334	-1.000	0.218336	0.098892	611.3464	19122.13	138.2828	8.158649	0.00	0.00
250	-0.8993	-0.900	0.23975	0.113202	671.3	20793.14	144.1983	7.408184	0.00	0.00
275	-0.7652	-0.800	0.262259	0.12892	734.3252	22432.78	149.7758	6.711513	0.00	0.00
300	-0.6310	-0.600	0.335687	0.18476	939.9236	26859.43	163.8885	4.879073	0.00	0.00
325	-0.4969	-0.500	0.361837	0.206266	1013.144	28070.31	167.542	4.335653	0.00	0.00
350	-0.3627	-0.400	0.388649	0.229172	1088.217	29102.77	170.5953	3.818007	0.00	0.00
375	-0.2286	-0.200	0.443769	0.27693	1242.553	30538.81	174.7536	2.843971	0.00	0.00
400	-0.0944	-0.100	0.471814	0.305606	1321.079	30908.88	175.8092	2.38024	0.01	0.01
417	-0.0032	0.000	0.5	0.333333	1400	31033.21	176.1625	1.927467	0.03	0.03
450	0.1739	0.200	0.556231	0.391392	1557.447	30538.81	174.7536	1.042042	0.15	0.15
475	0.3080	0.300	0.583998	0.421415	1635.194	29931.77	173.008	0.603168	0.27	0.27
500	0.4421	0.400	0.611351	0.451875	1711.783	29102.77	170.5953	0.162751	0.44	0.44
525	0.5763	0.600	0.664313	0.513387	1860.076	26859.79	163.8896	-0.73543	0.77	0.77
550	0.7104	0.700	0.689691	0.544073	1931.135	25496.6	159.6766	-1.19985	0.88	0.88
572.6	0.8317	0.800	0.714196	0.574469	1999.749	24010.61	154.9536	-1.67922	0.95	0.95
600	0.9787	1.000	0.76025	0.633702	2128.7	20793.14	144.1983	-2.69873	1.00	1.00
625	1.1129	1.100	0.781662	0.662216	2188.654	19122.13	138.2828	-3.24774	1.00	1.00
650	1.2470	1.200	0.801928	0.6898	2245.398	17447.73	132.0899	-3.8296	1.00	1.00
675	1.3811	1.400	0.821015	0.716331	2298.842	15796.05	125.6823	-4.45007	1.00	1.00
700	1.5153	1.500	0.838901	0.741698	2348.923	14189.7	119.1205	-5.11562	1.00	1.00
721	1.6280	1.600	0.855578	0.765812	2395.618	12648.56	112.4658	-5.83352	1.00	1.00
746	1.7621	1.800	0.885334	0.810016	2478.935	9820.943	99.10067	-7.46098	1	1
771	1.8963	1.900	0.898454	0.830022	2515.671	8555.534	92.49613	-8.39088	1	1
796	2.0304	2.000	0.910445	0.848605	2549.246	7397.242	86.00722	-9.41431	1	1
821	2.1645	2.200	0.931218	0.881527	2607.41	5406.396	73.5282	-11.8031	1	1
846	2.2987	2.300	0.940103	0.895917	2632.288	4570.565	67.60596	-13.2051	1	1
871	2.4328	2.400	0.948062	0.908982	2654.574	3836.275	61.93767	-14.7733	1	1
896	2.5670	2.600	0.96145	0.931365	2692.06	2644.098	51.42079	-18.5239	1	1
921	2.7011	2.700	0.967004	0.940817	2707.611	2171.516	46.59953	-20.7741	1	1
946	2.8353	2.800	0.971881	0.949208	2721.267	1771.056	42.08392	-23.3277	1	1
971	2.9694	3.000	0.979848	0.963118	2743.574	1153.075	33.95696	-29.5676	1	1
996	3.1036	3.100	0.983053	0.968795	2752.548	920.9023	30.34637	-33.3813	1	1
1021	3.2377	3.200	0.985811	0.973725	2760.271	731.3742	27.04393	-37.7432	1	1
1046	3.3718	3.400	0.990188	0.981636	2772.526	450.7998	21.23205	-48.6519	1	1



Based on the number of measurements and the observed standard deviation, a survey unit with a median measurement equal to the background median plus the LBGR (721) will have a 1.0 probability that the survey unit will **correctly** fail (i.e., the null hypothesis that the difference between the survey unit median and the background median is less than the LBGR [i.e., the survey unit is indistinguishable from background] is rejected).

194	R	194	36	0
162	R	162	30	0
245	R	245	59	0
172	R	172	32	0
226	R	226	49.5	0
223	R	223	46.5	0
266	R	266	63	0
299	R	299	77	0
227	R	227	51	0
206	R	206	40	0
226	R	226	49.5	0
269	R	269	64	0
221	R	221	44.5	0
193	R	193	35	0
148	S	-269.6	11	11
161	S	-256.6	17	17
139	S	-278.6	9	9
162	S	-255.6	18.5	18.5
159	S	-258.6	16	16
151	S	-266.6	12.5	12.5
137	S	-280.6	6	6
167	S	-250.6	21.5	21.5
169	S	-248.6	24	24
126	S	-291.6	5	5
168	S	-249.6	23	23
151	S	-266.6	12.5	12.5
162	S	-255.6	18.5	18.5
140	S	-277.6	10	10
138	S	-279.6	7.5	7.5
177	S	-240.6	26.5	26.5
112	S	-305.6	1	1
122	S	-295.6	4	4
115	S	-302.6	2	2
117	S	-300.6	3	3
163	S	-254.6	20	20
167	S	-250.6	21.5	21.5
153	S	-264.6	14	14
157	S	-260.6	15	15
170	S	-247.6	25	25
181	S	-236.6	28	28
138	S	-279.6	7.5	7.5
177	S	-240.6	26.5	26.5
Sum =			8256	406

* This spreadsheet is originally designed to work with a set of twenty measurements, 10 from the survey unit (S) and 10 from the background reference area (R).
If a different number of measurements have been performed, it is necessary to modify the spreadsheet to account for the change in the number of measurements.

of R: 100 *n*
of S: 28 *m*
Avg Rank R: 79
Avg Rank S: 15

For *m* or *n* greater than 20, the critical value (*k*) can be calculated for Scenario B from

$$\frac{m(n+m+1)}{2} + z \sqrt{\frac{nm(n+m+1)}{12}}$$

z = 97.5% percentile of standard normal distribution = 1.960

k = 2146.0

Since the sum of survey unit ranks is less than the critical value, the null hypothesis that the difference between the survey unit median and the background median is less than the LBGR (i.e., the survey unit is indistinguishable from background) is accepted and the survey unit passes Scenario B

Spreadsheet Formulas for the Wilcoxon Rank Sum Test and Power Calculation*
Wilcoxon Rank Sum Test, per NUREG-1505

LBGR 0 (For this calculation, LBGR is set to zero)
 (Reference Dataset - Building 722 Alpha Floor Monitor)

DATA	AREA	ADJUSTED DATA	RANKS	SURVEY AREA RANKS
4	R	4	12.5	0
1	R	1	2.5	0
0	R	0	1	0
6	R	6	23.5	0
6	R	6	23.5	0
4	R	4	12.5	0
2	R	2	4.5	0
3	R	3	8	0
2	R	2	4.5	0
4	R	4	12.5	0
6	R	6	23.5	0
1	R	1	2.5	0
3	R	3	8	0
7	R	7	27	0
8	R	8	28.5	0
12	S	12	33	33
3	S	3	8	8
6	S	6	23.5	23.5
5	S	5	17.5	17.5
5	S	5	17.5	17.5
8	S	8	28.5	28.5
9	S	9	30	30
10	S	10	31.5	31.5
5	S	5	17.5	17.5
3	S	3	8	8
3	S	3	8	8
5	S	5	17.5	17.5
5	S	5	17.5	17.5
10	S	10	31.5	31.5
6	S	6	23.5	23.5
6	S	6	23.5	23.5
5	S	5	17.5	17.5
4	S	4	12.5	12.5
Sum =			561	366.5

* This spreadsheet is originally designed to work with a set of twenty measurements, 10 from the survey unit (S) and 10 from the background reference area (R). If a different number of measurements have been performed, it is necessary to modify the spreadsheet to account for the change in the number of measurements.

of R: 15 n
 # of S: 18 m
 Avg Rank R: 12.9666667
 Avg Rank S: 20.4

For m or n greater than 20, the critical value (k) can be calculated for Scenario B from

$$\frac{m(n+m+1)}{2} + z \sqrt{\frac{nm(n+m+1)}{12}}$$

z = 97.5% percentile of standard normal distribution = 1.960

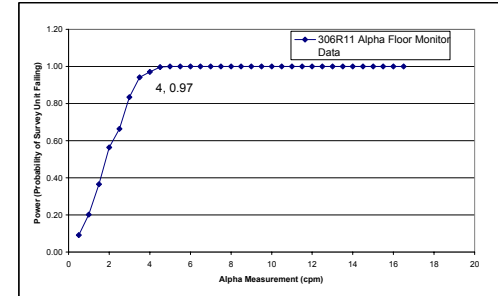
$$k = 360.2$$

Since the sum of survey unit ranks is greater than the critical value, that the difference between the survey unit median and the background median is less than the LBGR (i.e., the survey unit is indistinguishable from background) is rejected and the survey unit fails. *Scenario B*

Retrospective Power Curve Calculation
 From Example in Section 10.5 of NUREG-1505

p1 and p2 pull data from Table 10-3 sheet

Survey Unit Stats	C	Measurement: (C-LBGR)/SD	Rounded	p1	p2	E(Wmw)	Var(Wmw)	SD(Wmw)	z	Power
Count	18 m	0.5	0.190	0.200	0.556231	0.391392	150.1824	841.5375	29.00927	1.328146
SD	2.6	1	0.380	0.400	0.611351	0.451875	165.0648	802.4331	28.32725	0.834749
Median	5	1.5	0.570	0.600	0.664313	0.513387	179.3645	741.3213	27.22722	0.343275
		2	0.760	0.800	0.714196	0.574469	192.8329	663.627	25.76096	-0.16001
Reference Stats	15 n	2.5	0.950	0.900	0.737741	0.604402	199.1901	620.5644	24.91113	-0.42066
Count	2.4	3	1.140	1.100	0.781662	0.662216	211.0487	530.1139	23.0242	-0.97019
SD	4	3.5	1.330	1.300	0.821015	0.716331	221.6741	439.0841	20.95433	-1.57309
Median		4	1.520	1.500	0.838901	0.741698	226.5033	395.0519	19.87591	-1.90141
		4.5	1.710	1.700	0.87105	0.788602	235.1835	312.6352	17.68149	-2.62832
		5	1.900	1.900	0.898454	0.830022	242.5826	240.1161	15.49568	-3.47656
		5.5	2.090	2.100	0.92135	0.865767	248.7845	179.0925	13.38254	-4.48746
Critical Value	360.2	6	2.280	2.300	0.940103	0.895917	253.8278	129.7692	11.39163	-5.71621
		6.5	2.469	2.500	0.955157	0.920777	257.8924	91.43706	9.562273	-7.23484
Bkgd Med plus LBGR	4	7	2.659	2.700	0.967004	0.940817	261.0911	62.67146	7.916531	-9.14291
		7.5	2.849	2.800	0.971881	0.949208	262.4079	51.37144	7.167387	-10.2823
		8	3.039	3.000	0.979848	0.963118	264.559	33.83162	5.816495	-13.0402
		8.5	3.229	3.200	0.985811	0.973725	266.169	21.74747	4.663419	-16.6097
		9	3.419	3.400	0.990188	0.981636	267.3508	13.62044	3.690589	-21.3082
		9.5	3.609	3.600	0.993336	0.98741	268.2007	8.341726	2.888205	-27.5222
		10	3.799	3.800	0.993336	0.98741	268.2007	8.341726	2.888205	-27.5222
		10.5	3.989	4.000	0.997661	0.995497	269.3685	2.232103	1.494022	-53.9868
		11	4.179	4.200	0.997661	0.995497	269.3685	2.232103	1.494022	-53.9868
		11.5	4.369	4.400	0.997661	0.995497	269.3685	2.232103	1.494022	-53.9868
		12	4.559	4.600	0.997661	0.995497	269.3685	2.232103	1.494022	-53.9868
		12.5	4.749	4.700	0.997661	0.995497	269.3685	2.232103	1.494022	-53.9868
		13	4.939	4.900	0.997661	0.995497	269.3685	2.232103	1.494022	-53.9868
		13.5	5.129	5.100	0.999796	0.999599	269.9449	0.120825	0.3476	-233.7
		14	5.319	5.300	0.999796	0.999599	269.9449	0.120825	0.3476	-233.7
		14.5	5.509	5.500	0.999796	0.999599	269.9449	0.120825	0.3476	-233.7
		15	5.699	5.700	0.999796	0.999599	269.9449	0.120825	0.3476	-233.7
		15.5	5.889	5.900	0.999796	0.999599	269.9449	0.120825	0.3476	-233.7
		16	6.079	6.100	0.999989	0.999978	269.997	0.002969	0.054487	-1491.85
		16.5	6.269	6.300	0.999989	0.999978	269.997	0.002969	0.054487	-1491.85



Based on the number of measurements and the observed standard deviation, a survey unit with a median measurement equal to the background median plus the LBGR (4) will have a 0.97 probability that the survey unit will **correctly** fail (i.e., the null hypothesis that the difference between the survey unit median and the background median is less than the LBGR [i.e., the survey unit is indistinguishable from background] is rejected).

Spreadsheet Formulas for the Wilcoxon Rank Sum Test and Power Calculation*

Wilcoxon Rank Sum Test, per NUREG-1505

LBGR 6757 (For this calculation, LBGR is equal to 3w (zero) plus the DCGLw)

(Reference Dataset - Building 722 Alpha Floor Monitor)

DATA	AREA	ADJUSTED DATA	RANKS	SURVEY AREA RANKS
4	R		4	27
1	R		1	20.5
0	R		0	19
0	R		6	30
6	R		6	30
4	R		4	27
2	R		2	22.5
3	R		3	24.5
2	R		2	22.5
4	R		4	27
6	R		6	30
1	R		1	20.5
3	R		3	24.5
7	R		7	32
8	R		8	33
12	S	-6745	18	18
3	S	-6754	2	2
6	S	-6751	12	12
5	S	-6752	7.5	7.5
5	S	-6752	7.5	7.5
8	S	-6749	14	14
9	S	-6748	15	15
10	S	-6747	16.5	16.5
5	S	-6752	7.5	7.5
3	S	-6754	2	2
3	S	-6754	2	2
5	S	-6752	7.5	7.5
6	S	-6752	7.5	7.5
10	S	-6747	16.5	16.5
6	S	-6751	12	12
6	S	-6751	12	12
5	S	-6752	7.5	7.5
4	S	-6753	4	4
Sum =			561	171

* This spreadsheet is originally designed to work with a set of twenty measurements, 10 from the survey unit (S) and 10 from the background reference area (R). If a different number of measurements have been performed, it is necessary to modify the spreadsheet to account for the change in the number of measurements.

of R: 15
of S: 18
Avg Rank R: 26
Avg Rank S: 9.5

For m or n greater than 20, the critical value (k) can be calculated for Scenario B from

$$\frac{m(n+m+1)}{2} + z \sqrt{\frac{nm(n+m+1)}{12}}$$

$z = 97.5\%$ percentile of standard normal distribution = 1.960

$k = 360.2$

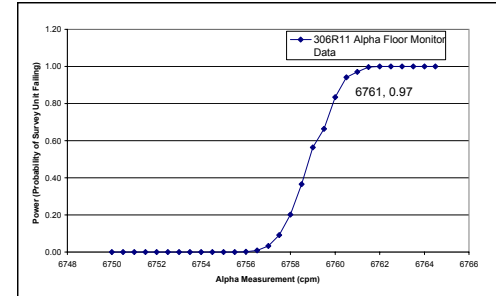
Since the sum of survey unit ranks is less than the critical value, the null hypothesis that the difference between the survey unit median and the background median is less than the LBGR plus the DCGLw (i.e., the survey unit does not exceed the DCGLw) is accepted and the survey unit passes Scenario B

Retrospective Power Curve Calculation

From Example in Section 10.5 of NUREG-1505

p_1 and p_2 pull data from Table 10-3 sheet

Survey Unit Stats	C	Measurement	(C-LBGR)/SD	Rounded	p_1	p_2	E(Wmw)	Var(Wmw)	SD(Wmw)	z	Power
Count 18 m		6750	-2.659	-2.700	0.016947	0.00269	4.57569	27.2046	5.215803	35.30334	0.00
SD 2.6		6750.5	-2.469	-2.500	0.03865	0.008465	10.4085	75.95783	8.715379	20.45837	0.00
Median 5		6751	-2.280	-2.300	0.03865	0.008465	10.4085	75.95783	8.715379	20.45837	0.00
Reference Stats		6751.5	-2.090	-2.100	0.03865	0.008465	10.4085	75.95783	8.715379	20.45837	0.00
Count 15 n		6752	-1.900	-1.900	0.089555	0.027714	24.17985	208.1218	14.42643	11.40484	0.00
SD 2.4		6752.5	-1.710	-1.700	0.114666	0.039348	30.95982	274.997	16.58303	9.512801	0.00
Median 4		6753	-1.520	-1.500	0.144422	0.054656	38.99394	352.7562	18.7818	7.971385	0.00
		6753.5	-1.330	-1.300	0.178985	0.074301	48.32595	439.0841	20.95433	6.699568	0.00
		6754	-1.140	-1.100	0.198072	0.085944	53.47944	484.3102	22.00705	6.144917	0.00
		6754.5	-0.950	-0.900	0.23975	0.113202	64.7325	575.7852	23.99552	5.166731	0.00
		6755	-0.760	-0.800	0.282259	0.12892	70.80993	620.5644	24.91113	4.732864	0.00
Critical Value 360.2		6755.5	-0.570	-0.600	0.335687	0.16476	80.93549	741.3119	27.22704	3.602133	0.00
		6756	-0.380	-0.400	0.388649	0.229172	104.9352	802.4236	28.32708	2.957442	0.00
		6756.5	-0.190	-0.200	0.443769	0.27893	119.8176	841.5375	29.00927	2.374872	0.01
Bkgd Med plus LBGR 6761		6757	0.000	0.000	0.5	0.333333	135	854.9969	29.24033	1.836878	0.03
		6757.5	0.190	0.200	0.556231	0.391392	150.1824	841.5375	29.00927	1.328146	0.09
		6758	0.380	0.400	0.611351	0.451875	165.0848	802.4331	28.32725	0.834749	0.20
		6758.5	0.570	0.600	0.664313	0.513387	179.3645	741.3213	27.22722	0.343275	0.37
		6759	0.760	0.800	0.714196	0.574469	192.8329	663.627	25.76096	-0.16001	0.56
		6759.5	0.950	0.900	0.737741	0.604402	199.1901	620.5644	24.91113	-0.42066	0.66
		6760	1.140	1.100	0.781662	0.662216	211.0487	530.1139	23.0242	-0.97019	0.83
		6760.5	1.330	1.300	0.821015	0.716331	221.6741	439.0841	20.95433	-1.57309	0.94
		6761	1.520	1.500	0.838991	0.741698	226.5833	395.0519	19.87591	-1.90141	0.97
		6761.5	1.710	1.700	0.87105	0.788602	235.1835	312.6352	17.68149	-2.62832	1.00
		6762	1.900	1.900	0.898454	0.830022	242.5826	240.1161	15.49568	-3.47656	1.00
		6762.5	2.090	2.100	0.92135	0.865767	248.7645	179.0925	13.38254	-4.48746	1.00
		6763	2.280	2.300	0.940103	0.895917	253.8278	129.7692	11.39163	-5.71621	1.00
		6763.5	2.469	2.500	0.955157	0.920777	257.8924	91.43706	9.562273	-7.23484	1.00
		6764	2.659	2.700	0.967004	0.940817	261.0911	62.67146	7.916531	-9.14291	1.00
		6764.5	2.849	2.800	0.971881	0.949208	262.4079	51.37144	7.167387	-10.2823	1.00



Based on the number of measurements and the observed standard deviation, a survey unit with a median measurement equal to the background median plus the DCGLw plus the LBGR (6761) will have a 0.97 probability that the survey unit will incorrectly fail (i.e., the null hypothesis that the difference between the survey unit median and the background median is less than the LBGR [i.e., the survey unit is indistinguishable from background] is rejected).

Spreadsheet Formulas for the Wilcoxon Rank Sum Test and Power Calculation*

Wilcoxon Rank Sum Test, per NUREG-1505

567.7 (For this calculation, LBGR = 3w for Building 722 Background)
(Reference Dataset - Building 722 Beta Floor Monitor)

DATA	AREA	ADJUSTED DATA	RANKS	SURVEY AREA RANKS
687	R	687	25	0
715	R	715	26	0
768	R	768	27	0
640	R	640	24	0
1435	R	1435	33	0
1420	R	1420	32	0
772	R	772	28	0
821	R	821	31	0
789	R	789	30	0
785	R	785	29	0
505	R	505	20	0
621	R	621	23	0
588	R	588	22	0
581	R	581	21	0
498	R	498	19	0
575	S	7.3	10.5	10.5
586	S	18.3	13	13
597	S	29.3	15	15
550	S	-17.7	5.5	5.5
578	S	10.3	12	12
655	S	87.3	16	16
566	S	-1.7	9	9
550	S	-17.7	5.5	5.5
596	S	28.3	14	14
551	S	-16.7	7	7
549	S	-18.7	4	4
575	S	7.3	10.5	10.5
908	S	340.3	17	17
1034	S	466.3	18	18
566	S	-11.7	8	8
539	S	-28.7	3	3
529	S	-38.7	2	2
436	S	-131.7	1	1
Sum =		561	171	

Survey Unit Stats
Count 18 *m*
SD 141
Median 570.5
Reference Stats
Count 15 *n*
SD 284
Median 715

Critical Value 360.2

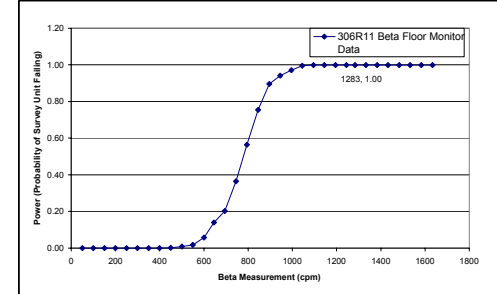
Bkgd Med plus LBGR 1283

Retrospective Power Curve Calculation

From Example in Section 10.5 of NUREG-1505

p1 and *p2* pull data from Table 10-3 sheet

C Measurement (C-LBGR)/SD	Rounded	<i>p1</i>	<i>p2</i>	E(Wmw)	Var(Wmw)	SD(Wmw)	<i>z</i>	Power
50	-1.823	-1.800	0.101546	0.033114	27.41742	240.1161	15.49568	0.00
100	-1.647	-1.600	0.12895	0.046501	34.8165	312.6258	17.68123	0.00
150	-1.470	-1.500	0.144422	0.054656	38.99394	352.7562	18.7818	0.00
200	-1.294	-1.300	0.178985	0.074301	48.32595	439.9841	20.95433	0.00
250	-1.118	-1.100	0.198072	0.085944	53.47944	484.3102	22.00705	0.00
300	-0.942	-0.900	0.23975	0.113202	64.7325	575.7852	23.96552	0.00
350	-0.766	-0.800	0.262259	0.12892	70.80993	620.5644	24.91113	0.00
400	-0.590	-0.600	0.335687	0.18476	90.63549	741.3119	27.22704	0.00
450	-0.414	-0.400	0.388649	0.229172	104.9352	802.4236	28.32708	0.00
500	-0.238	-0.200	0.443769	0.27893	119.8176	841.5375	29.00627	0.01
550	-0.062	-0.100	0.471814	0.305606	127.3898	851.6123	29.1824	0.02
600	0.114	0.100	0.528186	0.361978	142.6102	851.6123	29.1824	0.06
645	0.272	0.300	0.583998	0.421415	157.6795	825.0096	28.72298	0.14
695	0.448	0.400	0.611351	0.451875	165.0648	802.4331	28.32725	0.20
745	0.624	0.600	0.664313	0.513387	179.3645	741.3213	27.22722	0.37
795	0.800	0.800	0.714196	0.574469	192.8329	663.627	25.76096	0.56
845	0.976	1.000	0.760225	0.633702	205.2675	575.7852	23.96552	0.75
895	1.152	1.200	0.801928	0.6898	216.5206	484.3102	22.00705	0.90
945	1.328	1.300	0.821015	0.716331	221.6741	439.0841	20.95433	0.94
995	1.504	1.500	0.838901	0.741698	226.5033	395.0519	19.87591	0.97
1045	1.680	1.700	0.87105	0.788602	235.1835	312.6352	17.68149	1.00
1095	1.856	1.900	0.898454	0.830022	242.5826	240.1161	15.49568	1.00
1145	2.032	2.000	0.910445	0.849605	245.8202	208.1312	14.42675	1.00
1195	2.208	2.200	0.931218	0.881527	251.4289	152.9961	12.36916	1.00
1245	2.384	2.400	0.948062	0.908982	255.9767	109.3111	10.4552	1.00
1283	2.518	2.500	0.955157	0.920777	257.8924	91.43706	9.562273	1.00
1333	2.694	2.700	0.967004	0.940817	261.0911	62.67146	7.916531	1.00
1383	2.870	2.900	0.976143	0.956616	263.5586	41.82769	6.467433	1.00
1433	3.046	3.000	0.979648	0.963118	264.559	33.83162	5.816495	1.00
1483	3.222	3.200	0.985811	0.973725	266.169	21.74747	4.663419	1.00
1533	3.398	3.400	0.990188	0.981636	267.3508	13.62044	3.690589	1.00
1583	3.574	3.600	0.993336	0.98741	268.2007	8.341726	2.888205	1.00
1633	3.750	3.800	0.993336	0.98741	268.2007	8.341726	2.888205	1.00



Based on the number of measurements and the observed standard deviation, a survey unit with a median measurement equal to the background median plus the LBGR (1283) will have a 1.0 probability that the survey unit will **correctly** fail (i.e., the null hypothesis that the difference between the survey unit median and the background median is less than the LBGR [i.e., the survey unit is indistinguishable from background] is rejected).

* This spreadsheet is originally designed to work with a set of twenty measurements, 10 from the survey unit (S) and 10 from the background reference area (R). If a different number of measurements have been performed, it is necessary to modify the spreadsheet to account for the change in the number of measurements.

of R: 15 *n*
of S: 18 *m*
Avg Rank R: 26
Avg Rank S: 10

For *m* or *n* greater than 20, the critical value (*k*) can be calculated for Scenario B from

$$\frac{m(n+m+1)}{2} + z \sqrt{\frac{nm(n+m+1)}{12}}$$

z = 97.5% percentile of standard normal distribution = 1.960

k = 360.2 *k* = 360 From Table A.4 for *m*=18, *n*=15, alpha=0.02

Since the sum of survey unit ranks is less than the critical value, the null hypothesis that the difference between the survey unit median and the background median is less than the LBGR (i.e., the survey unit is indistinguishable from background) is accepted and the survey unit passes Scenario B

Quantile Test

per Section 7 of NUREG-1505

n (Survey) 28

m (Ref) 100

alpha/2 0.025

From Table A.7

 r 6 k 4 α 0.025If k of the r largest ranks are from the survey unit, the null hypothesis is rejected at the α level.

Alpha Phoswich Ranks

Sorted Ranks Location

5.5 S

5.5 S

5.5 S

5.5 S

5.5 S

5.5 S

5.5 S

5.5 S

5.5 S

5.5 S

16.5 S

16.5 S

16.5 S

16.5 S

16.5 S

16.5 S

16.5 S

16.5 S

16.5 S

16.5 S

16.5 S

24.5 S

24.5 S

24.5 S

24.5 S

28.5 R

28.5 R

28.5 R

28.5 R

31 S

35.5 R

35.5 R

35.5 R

35.5 R

35.5 R

35.5 R

35.5 R

35.5 R

40 S

49 R

49 R

49 R

49 R

49 R

49 R

49 R

49 R

49 R

49 R

49 R

49 R

49 R

49 R

49 R

49 R

Beta Phoswich Ranks

Sorted Ranks Location

1 S

2 S

3 S

4 S

5 S

6 S

7.5 S

7.5 S

9 S

10 S

11 S

12.5 S

12.5 S

14 S

15 S

16 S

17 S

18.5 S

18.5 S

20 S

21.5 S

21.5 S

23 S

24 S

25 S

26.5 S

26.5 S

28 S

29 R

30 R

31 R

32 R

33 R

34 R

35 R

36 R

37.5 R

37.5 R

39 R

40 R

41 R

42 R

43 R

44.5 R

44.5 R

46.5 R

46.5 R

48 R

49.5 R

49.5 R

51 R

52 R

53 R

54 R

55 R

56 R

57 R

306R11 Alpha-Beta Ph Quantile

68.5	R	58	R
68.5	R	59	R
68.5	R	60	R
68.5	R	61	R
68.5	R	62	R
68.5	R	63	R
68.5	R	64	R
68.5	R	65	R
68.5	R	66.5	R
68.5	R	66.5	R
68.5	R	68	R
68.5	R	69	R
68.5	R	70	R
68.5	R	71	R
68.5	R	72	R
68.5	R	73.5	R
68.5	R	73.5	R
68.5	R	75	R
68.5	R	76	R
68.5	R	77	R
68.5	R	78	R
68.5	R	79	R
88.5	R	80	R
88.5	R	81	R
88.5	R	82.5	R
88.5	R	82.5	R
88.5	R	84	R
88.5	R	85	R
88.5	R	86	R
88.5	R	87	R
88.5	R	88	R
88.5	R	89	R
88.5	R	90	R
88.5	R	91	R
88.5	R	92	R
88.5	R	93	R
88.5	R	94	R
88.5	R	95	R
88.5	R	96	R
88.5	R	97	R
101.5	R	98	R
101.5	R	99	R
101.5	R	100	R
101.5	R	101	R
101.5	R	102	R
101.5	R	103	R
101.5	R	104	R
101.5	R	105	R
111	R	106	R
111	R	107	R
111	R	108	R
111	R	109	R
111	R	110	R
111	R	111.5	R
111	R	111.5	R
111	R	113	R
111	R	114	R
111	R	115.5	R
111	R	115.5	R
120	R	117	R
120	R	118	R
120	R	119	R
120	R	120	R
120	R	121	R

120	R	122	R
120	R	123	R
124	R	124	R
125.5	R	125	R
125.5	R	126	R
127	R	127	R
128	R	128	R

0 of top 6 from S

0 of top 6 from S

If the r -th largest measurement is among a group of tied (equal-in-value) measurements, increase r to include the tied measurements. Also increase k by the same amount (EPA 230-R-94-004).

r=12

k=10

0 of top 12 from S

thesis is rejected.

Quantile Test

per Section 7 of NUREG-1505

n (Survey) 18

m (Ref) 15

alpha/2 0.025

From Table A.7

 r 6 k 6 α 0.024If k of the r largest ranks are from the survey unit, the null hypott
(20,15) in Table A.7

Alpha FM Ranks Bkgd		Alpha FM Ranks DCGL		Beta FM Ranks	
Sorted Ranks	Location	Sorted Ranks	Location	Sorted Ranks	Location
1 R		2 S		1 S	
2.5 R		2 S		2 S	
2.5 R		2 S		3 S	
4.5 R		4 S		4 S	
4.5 R		7.5 S		5.5 S	
8 R		7.5 S		5.5 S	
8 R		7.5 S		7 S	
8 S		7.5 S		8 S	
8 S		7.5 S		9 S	
8 S		7.5 S		10.5 S	
12.5 R		12 S		10.5 S	
12.5 R		12 S		12 S	
12.5 R		12 S		13 S	
12.5 S		14 S		14 S	
17.5 S		15 S		15 S	
17.5 S		16.5 S		16 S	
17.5 S		16.5 S		17 S	
17.5 S		18 S		18 S	
17.5 S		19 R		19 R	
17.5 S		20.5 R		20 R	
23.5 R		20.5 R		21 R	
23.5 R		22.5 R		22 R	
23.5 R		22.5 R		23 R	
23.5 S		24.5 R		24 R	
23.5 S		24.5 R		25 R	
23.5 S		27 R		26 R	
27 R		27 R		27 R	
28.5 R		27 R		28 R	
28.5 S		30 R		29 R	
30 S		30 R		30 R	
31.5 S		30 R		31 R	
31.5 S		32 R		32 R	
33 S		33 R		33 R	

5 of top 6 from S

0 of top 6 from S

0 of top 6 from S

If the r -th largest measurement is among a group of tied (equal-in-value) measurements, increase r to include the tied measurements. Also increase k by the same amount (EPA 230-R-94-004).

 $r=8$ $k=8$

0 of top 8 from S

thesis is rejected.

Recreation of Table 10-3 from NUREG-1505

(C-LBGR)/SD	p1	p2
-6.0	0.00001	0
-5.0	0.000204	0.00001
-4.0	0.002339	0.000174
-3.5	0.006664	0.000738
-3.0	0.016947	0.00269
-2.5	0.03855	0.008465
-2.0	0.07865	0.023066
-1.9	0.089555	0.027714
-1.8	0.101546	0.033114
-1.7	0.114666	0.039348
-1.6	0.12895	0.046501
-1.5	0.144422	0.054656
-1.4	0.161099	0.063897
-1.3	0.178985	0.074301
-1.2	0.198072	0.085944
-1.1	0.218338	0.098892
-1.0	0.23975	0.113202
-0.9	0.262259	0.12892
-0.8	0.285804	0.146077
-0.7	0.310309	0.164691
-0.6	0.335687	0.18476
-0.5	0.361837	0.206266
-0.4	0.388649	0.229172
-0.3	0.416002	0.253419
-0.2	0.443769	0.27893
-0.1	0.471814	0.305606
0.0	0.5	0.333333
0.1	0.528186	0.361978
0.2	0.556231	0.391392
0.3	0.583998	0.421415
0.4	0.611351	0.451875
0.5	0.638163	0.482593
0.6	0.664313	0.513387
0.7	0.689691	0.544073
0.8	0.714196	0.574469
0.9	0.737741	0.604402
1.0	0.76025	0.633702
1.1	0.781662	0.662216
1.2	0.801928	0.6898
1.3	0.821015	0.716331
1.4	0.838901	0.741698
1.5	0.855578	0.765812
1.6	0.87105	0.788602
1.7	0.885334	0.810016
1.8	0.898454	0.830022
1.9	0.910445	0.848605
2.0	0.92135	0.865767
2.1	0.931218	0.881527
2.2	0.940103	0.895917
2.3	0.948062	0.908982
2.4	0.955157	0.920777
2.5	0.96145	0.931365
2.6	0.967004	0.940817
2.7	0.971881	0.949208
2.8	0.976143	0.956616
2.9	0.979848	0.963118
3.0	0.983053	0.968795
3.1	0.985811	0.973725
3.2	0.988174	0.977981
3.3	0.990188	0.981636
3.4	0.991895	0.984758
3.5	0.993336	0.98741
4.0	0.997661	0.995497
5.0	0.999796	0.999599
6.0	0.999989	0.999978

