

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

Wilcoxon Rank Sum Test, per NUREG-1505

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	36.5
3	R		3	68.5
3	R		3	68.5
1	R		1	36.5
4	R		4	88.5
4	R		4	88.5
1	R		1	36.5
4	R		4	88.5
4	R		4	88.5
9	R		9	125.5
7	R		7	120
2	R		2	49
2	R		2	49
4	R		4	88.5
3	R		3	68.5
1	R		1	36.5
6	R		6	111
3	R		3	68.5
3	R		3	68.5
2	R		2	49
1	R		1	36.5
2	R		2	49
4	R		4	88.5
4	R		4	88.5
7	R		7	120
3	R		3	68.5
3	R		3	68.5
3	R		3	68.5
7	R		7	120
5	R		5	101.5
2	R		2	49
2	R		2	49
4	R		4	88.5
3	R		3	68.5
6	R		6	111
0	R		0	28.5
6	R		6	111
3	R		3	68.5
3	R		3	68.5
4	R		4	88.5
5	R		5	101.5
6	R		6	111
14	R		14	128
2	R		2	49
6	R		6	111
6	R		6	111
7	R		7	120
4	R		4	88.5
0	R		0	28.5
4	R		4	88.5
2	R		2	49
3	R		3	68.5
3	R		3	68.5
3	R		3	68.5
3	R		3	68.5
2	R		2	49
2	R		2	49
4	R		4	88.5
6	R		6	111
10	R		10	127
5	R		5	101.5
8	R		8	124
3	R		3	68.5
2	R		2	49
0	R		0	28.5
3	R		3	68.5
4	R		4	88.5
2	R		2	49
5	R		5	101.5
5	R		5	101.5
3	R		3	68.5
6	R		6	111
7	R		7	120

Survey Unit Stats
 Count 28 n
 SD 0.9
 Median 1
 Reference Stats
 Count 100 n
 SD 2.3
 Median 3

Critical Value 2146.0

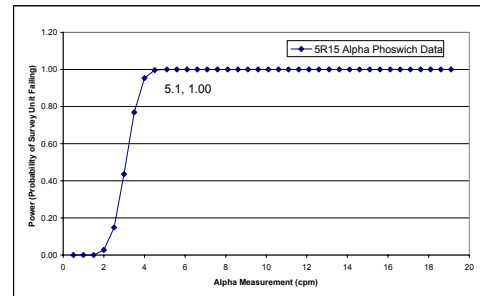
Bkgd Med plus LBGR 5.1

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	0.03
2.5	0.1712	0.200	0.556231	0.391392	1557.447	30538.81	174.7536	1.042042	0.15	0.15
3	0.3851	0.400	0.611351	0.451875	1711.783	29102.77	170.5953	0.162751	0.44	0.44
3.5	0.5990	0.600	0.664313	0.513387	1860.076	26859.79	163.8896	-0.73543	0.77	0.77
4	0.8130	0.800	0.714196	0.574469	1999.749	24010.61	154.9536	-1.67922	0.95	0.95
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
7.1	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
8.1	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
9.1	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
10.1	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
11.1	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
12.1	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
13.1	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
14.1	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
15.1	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
16.1	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
17.1	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
18.1	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
19.1	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	36.5	0
1	R	1	36.5	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	36.5	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
2	S	-0.1	22	22
1	S	-1.1	13	13
1	S	-1.1	13	13
0	S	-2.1	4.5	4.5
2	S	-0.1	22	22
0	S	-2.1	4.5	4.5
1	S	-1.1	13	13
3	S	0.9	31.5	31.5
2	S	-0.1	22	22
1	S	-1.1	13	13
1	S	-1.1	13	13
3	S	0.9	31.5	31.5
2	S	-0.1	22	22
2	S	-0.1	22	22
2	S	-0.1	22	22
0	S	-2.1	4.5	4.5
2	S	-0.1	22	22
2	S	-0.1	22	22
1	S	-1.1	13	13
2	S	-0.1	22	22
0	S	-2.1	4.5	4.5
1	S	-1.1	13	13
1	S	-1.1	13	13
0	S	-2.1	4.5	4.5
1	S	-1.1	13	13
0	S	-2.1	4.5	4.5
0	S	-2.1	4.5	4.5
Sum =			8256	414

* 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

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
410	R	410	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

Count	28	m
SD	66	
Median	213	
Reference Stats	100	n
Count	186	
SD	304	
Median	304	

Critical Value 2146.0

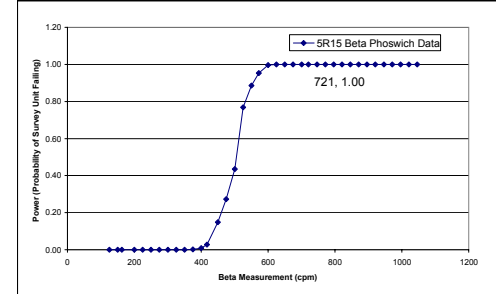
Bkgd Med plus LBGR 721

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	0.00	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	170.5943	3.818007	0.00	0.00
375	-0.2286	-0.200	0.443769	0.27893	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	170.5943	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	1.00	1.00
771	1.8963	1.900	0.898454	0.830022	2515.671	8555.534	92.49613	-8.39088	1.00	1.00
796	2.0304	2.000	0.910445	0.848605	2549.246	7397.242	86.00722	-9.41431	1.00	1.00
821	2.1645	2.200	0.931218	0.881527	2607.41	5406.396	73.5282	-11.8031	1.00	1.00
846	2.2987	2.300	0.940103	0.895917	2632.288	4570.565	67.60596	-13.2051	1.00	1.00
871	2.4328	2.400	0.948062	0.908982	2654.574	3836.275	61.93767	-14.7733	1.00	1.00
896	2.5670	2.600	0.96145	0.931365	2692.06	2644.098	51.42079	-18.5239	1.00	1.00
921	2.7011	2.700	0.967004	0.940817	2707.611	2171.516	46.59953	-20.7741	1.00	1.00
946	2.8353	2.800	0.971881	0.949208	2721.267	1771.056	42.08392	-23.3277	1.00	1.00
971	2.9694	3.000	0.979848	0.963118	2743.574	1153.075	33.95696	-29.5676	1.00	1.00
996	3.1036	3.100	0.983053	0.968795	2752.548	920.9023	30.34637	-33.3813	1.00	1.00
1021	3.2377	3.200	0.985811	0.973725	2760.271	731.3742	27.04393	-37.7432	1.00	1.00
1046	3.3718	3.400	0.990188	0.981636	2772.526	450.7998	21.23205	-48.6519	1.00	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 (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
218	S	-199.6	16.5	16.5
202	S	-215.6	12	12
197	S	-220.6	10	10
158	S	-259.6	2	2
210	S	-207.6	14	14
375	S	-42.6	27	27
444	S	26.4	28	28
321	S	-96.6	26	26
167	S	-250.6	3	3
316	S	-101.6	25	25
216	S	-201.6	15	15
201	S	-216.6	11	11
153	S	-264.6	1	1
193	S	-224.6	8	8
182	S	-235.6	5	5
218	S	-199.6	16.5	16.5
268	S	-149.6	23	23
236	S	-181.6	21	21
204	S	-213.6	13	13
192	S	-225.6	7	7
196	S	-221.6	9	9
294	S	-123.6	24	24
228	S	-189.6	19	19
229	S	-188.6	20	20
222	S	-195.6	18	18
186	S	-231.6	6	6
176	S	-241.6	4	4
245	S	-172.6	22	22
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

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	9	0
1	R		1	2.5	0
0	R		0	1	0
6	R		6	14	0
6	R		6	14	0
4	R		4	9	0
2	R		2	4.5	0
3	R		3	6.5	0
2	R		2	4.5	0
4	R		4	9	0
6	R		6	14	0
1	R		1	2.5	0
3	R		3	6.5	0
7	R		7	16	0
8	R		8	17	0
5	S		5	11.5	11.5
5	S		5	11.5	11.5
Sum =				153	23

* 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: 2 m
Avg Rank R: 8.7
Avg Rank S: 11.5

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

$k = 31.1$

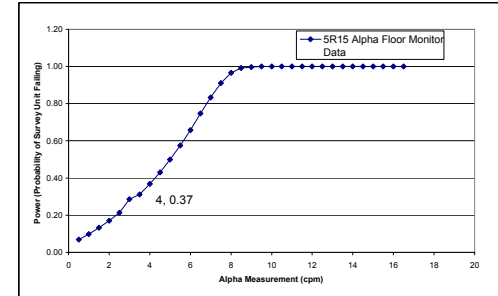
Since the sum of survey unit ranks is less than the critical value, the null hypothesis that the difference between the survey unit median and the background median is less than the LBGR (i.e., the survey unit is indistinguishable from background) is accepted and the survey unit passes Scenario B

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	Measuremen	(C-LBGR)/SD	Rounded	p1	p2	E(Wmw)	Var(Wmw)	SD(Wmw)	z	Power
Count	2 m	0.5	0.209	0.200	0.556231	0.391392	16.68693	54.14461	7.358302	1.48963	0.07
SD	0.00	1	0.417	0.400	0.611351	0.451875	18.34053	51.65925	7.187437	1.294975	0.10
Median	5	1.5	0.626	0.600	0.664313	0.513387	19.92939	47.77292	6.911796	1.116742	0.13
Reference Stats		2	0.835	0.800	0.714196	0.574469	21.42588	42.82765	6.544284	0.950784	0.17
Count	15 n	2.5	1.043	1.000	0.780225	0.633702	22.8075	37.2296	6.101607	0.793329	0.21
SD		3	1.252	1.300	0.821015	0.716331	24.63045	28.49974	5.338515	0.565256	0.29
Median	4	3.5	1.461	1.500	0.838901	0.741698	25.16703	25.68196	5.067737	0.489577	0.31
		4	1.669	1.700	0.871005	0.788602	26.1315	20.39778	4.51639	0.335795	0.37
		4.5	1.878	1.900	0.898454	0.830022	26.95362	15.73441	3.966662	0.175074	0.43
		5	2.086	2.100	0.92135	0.865767	27.6405	11.7962	3.434559	0.002207	0.50
		5.5	2.295	2.300	0.940103	0.895917	28.20309	8.59959	2.932506	-0.18926	0.58
Critical Value	31.1	6	2.504	2.500	0.955157	0.920777	28.65471	6.102663	2.470357	-0.40748	0.66
		6.5	2.712	2.700	0.967004	0.940817	29.01012	4.217768	2.053721	-0.66321	0.75
Bkgd Med plus LBGR	4	7	2.921	2.900	0.976143	0.956616	29.28429	2.842316	1.685917	-0.97052	0.83
		7.5	3.130	3.100	0.983053	0.968795	29.49159	1.86882	1.367048	-1.34853	0.91
		8	3.338	3.300	0.988174	0.977981	29.64522	1.201677	1.09621	-1.62186	0.97
		8.5	3.547	3.500	0.991895	0.984758	29.75685	0.755495	0.869192	-2.42613	0.99
		9	3.756	3.800	0.993336	0.98741	29.80008	0.593935	0.770672	-2.79237	1.00
		9.5	3.964	4.000	0.997661	0.995497	29.92983	0.166637	0.408213	-5.58961	1.00
		10	4.173	4.200	0.997661	0.995497	29.92983	0.166637	0.408213	-5.58961	1.00
		10.5	4.382	4.400	0.997661	0.995497	29.92983	0.166637	0.408213	-5.58961	1.00
		11	4.590	4.600	0.997661	0.995497	29.92983	0.166637	0.408213	-5.58961	1
		11.5	4.799	4.800	0.997661	0.995497	29.92983	0.166637	0.408213	-5.58961	1
		12	5.007	5.000	0.999796	0.999599	29.99388	0.010085	0.100424	-23.3589	1
		12.5	5.216	5.200	0.999796	0.999599	29.99388	0.010085	0.100424	-23.3589	1
		13	5.425	5.400	0.999796	0.999599	29.99388	0.010085	0.100424	-23.3589	1
		13.5	5.633	5.600	0.999796	0.999599	29.99388	0.010085	0.100424	-23.3589	1
		14	5.842	5.800	0.999796	0.999599	29.99388	0.010085	0.100424	-23.3589	1
		14.5	6.051	6.100	0.999989	0.999978	29.99967	0.00033	0.018164	-129.465	1
		15	6.259	6.300	0.999989	0.999978	29.99967	0.00033	0.018164	-129.465	1
		15.5	6.468	6.500	0.999989	0.999978	29.99967	0.00033	0.018164	-129.465	1
		16	6.677	6.700	0.999989	0.999978	29.99967	0.00033	0.018164	-129.465	1
		16.5	6.885	6.900	0.999989	0.999978	29.99967	0.00033	0.018164	-129.465	1
			0.000								



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 0.37 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 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	9	0
715	R	715	10	0
768	R	768	11	0
640	R	640	8	0
1435	R	1435	17	0
1420	R	1420	16	0
772	R	772	12	0
821	R	821	15	0
789	R	789	14	0
785	R	785	13	0
505	R	505	4	0
621	R	621	7	0
588	R	588	6	0
581	R	581	5	0
498	R	498	3	0
718	S	150.3	2	2
650	S	82.3	1	1
Sum =		153		3

* 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:	2	m
Avg Rank R:	10	
Avg Rank S:	2	

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 =	31.1
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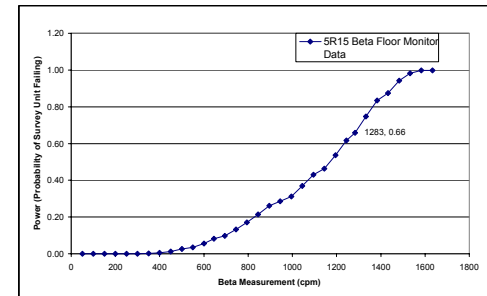
Since the sum of survey unit ranks is less than the critical value, the null hypothesis that the difference between the survey unit median and the background median is less than the LBGR (i.e., the survey unit is indistinguishable from background) is accepted and the survey unit passes Scenario B

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
50	-1.823	-1.800	0.101546	0.033114	3.04638	15.73441	3.966662	6.202117	0.00
100	-1.647	-1.600	0.12895	0.046501	3.8685	20.39721	4.516327	5.265248	0.00
150	-1.470	-1.500	0.144422	0.054656	4.33266	22.97195	4.792906	4.864568	0.00
200	-1.294	-1.300	0.178985	0.074301	5.36955	28.49974	5.338515	4.173117	0.00
250	-1.118	-1.100	0.198072	0.085944	5.94216	31.39073	5.602743	3.874159	0.00
300	-0.942	-0.900	0.23975	0.113202	7.1925	37.2296	6.101607	3.352491	0.00
350	-0.766	-0.800	0.262259	0.12892	7.86777	40.0843	6.331216	3.124251	0.00
400	-0.590	-0.600	0.335687	0.18476	10.07061	47.77235	6.911755	2.543127	0.01
450	-0.414	-0.400	0.388649	0.229172	11.65947	51.65868	7.187398	2.224534	0.01
500	-0.238	-0.200	0.443769	0.27893	13.31307	54.14461	7.356302	1.948141	0.03
550	-0.062	-0.100	0.471814	0.305606	14.15442	54.78477	7.401673	1.823055	0.03
600	0.114	0.100	0.528186	0.361978	15.84558	54.78477	7.401673	1.594572	0.06
645	0.272	0.300	0.583998	0.421415	17.51994	53.09429	7.286583	1.389971	0.08
695	0.448	0.400	0.611351	0.451875	18.34053	51.65925	7.187437	1.294975	0.10
745	0.624	0.600	0.664313	0.513387	19.92939	47.77292	6.911796	1.116742	0.13
795	0.800	0.800	0.714196	0.574469	21.42588	42.82765	6.544284	0.950784	0.17
845	0.976	1.000	0.760225	0.633702	22.8075	37.2296	6.101607	0.793329	0.21
895	1.152	1.200	0.801928	0.6898	24.05784	31.39073	5.602743	0.6408	0.26
945	1.328	1.300	0.821015	0.716331	24.63045	28.49974	5.338515	0.565256	0.29
995	1.504	1.500	0.838901	0.741698	25.16703	25.68196	5.067737	0.489577	0.31
1045	1.680	1.700	0.87105	0.788602	26.1315	20.39778	4.51639	0.335795	0.37
1095	1.856	1.900	0.898454	0.830022	26.95362	15.73441	3.966662	0.175074	0.43
1145	2.032	2.000	0.910445	0.848605	27.31335	13.67214	3.697586	0.090527	0.46
1195	2.208	2.200	0.931218	0.881527	27.93854	10.10675	3.179112	-0.09074	0.54
1245	2.384	2.400	0.948062	0.908982	28.44186	7.28666	2.696046	-0.29442	0.62
1283	2.518	2.500	0.955167	0.920777	28.65471	6.102663	2.470357	-0.40748	0.66
1333	2.694	2.700	0.967004	0.940817	29.01012	4.217768	2.053721	-0.66321	0.75
1383	2.870	2.900	0.976143	0.956616	29.28429	2.842316	1.685917	-0.97052	0.83
1433	3.046	3.000	0.979848	0.963118	29.39544	2.311438	1.520341	-1.14932	0.87
1483	3.222	3.200	0.985811	0.973725	29.57433	1.503583	1.226207	-1.5709	0.94
1533	3.398	3.400	0.990188	0.981636	29.70564	0.954795	0.977136	-2.10571	0.98
1583	3.574	3.600	0.993336	0.98741	29.80008	0.593935	0.777067	-2.79237	1.00
1633	3.750	3.800	0.993336	0.98741	29.80008	0.593935	0.777067	-2.79237	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 0.66 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).

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

4.5 S

4.5 S

4.5 S

4.5 S

4.5 S

4.5 S

4.5 S

4.5 S

13 S

13 S

13 S

13 S

13 S

13 S

13 S

13 S

22 S

22 S

22 S

22 S

22 S

22 S

22 S

22 S

22 S

28.5 R

28.5 R

28.5 R

28.5 R

31.5 S

31.5 S

36.5 R

36.5 R

36.5 R

36.5 R

36.5 R

36.5 R

36.5 R

36.5 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

49 R

Beta Phoswich Ranks

Sorted Ranks Location

1 S

2 S

3 S

4 S

5 S

6 S

7 S

8 S

9 S

10 S

11 S

12 S

13 S

14 S

15 S

16.5 S

16.5 S

18 S

19 S

20 S

21 S

22 S

23 S

24 S

25 S

26 S

27 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

5R15 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

5R15 Alpha-Beta Ph Quantile

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	From Table A.7	If k of the r largest ranks are from the survey unit, the null hypott
n (Survey)	2	r
m (Ref)	15	k
$\alpha/2$	0.025	α

Since there were only 2 survey measurements, the Q test was not performed.

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