

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	14.5	0
3	R	3	46.5	0
3	R	3	46.5	0
1	R	1	14.5	0
4	R	4	66.5	0
4	R	4	66.5	0
1	R	1	14.5	0
4	R	4	66.5	0
4	R	4	66.5	0
9	R	9	103.5	0
7	R	7	98	0
2	R	2	27	0
2	R	2	27	0
4	R	4	66.5	0
3	R	3	46.5	0
1	R	1	14.5	0
6	R	6	89	0
3	R	3	46.5	0
3	R	3	46.5	0
2	R	2	27	0
1	R	1	14.5	0
2	R	2	27	0
4	R	4	66.5	0
4	R	4	66.5	0
7	R	7	98	0
3	R	3	46.5	0
3	R	3	46.5	0
7	R	7	98	0
5	R	5	79.5	0
2	R	2	27	0
2	R	2	27	0
4	R	4	66.5	0
3	R	3	46.5	0
6	R	6	89	0
0	R	0	7.5	0
6	R	6	89	0
14	R	14	106	0
2	R	2	27	0
6	R	6	89	0
6	R	6	89	0
7	R	7	98	0
4	R	4	66.5	0
0	R	0	7.5	0
4	R	4	66.5	0
2	R	2	27	0
3	R	3	46.5	0
3	R	3	46.5	0
3	R	3	46.5	0
2	R	2	27	0
2	R	2	27	0
4	R	4	66.5	0
6	R	6	89	0
10	R	10	105	0
5	R	5	79.5	0
8	R	8	102	0
3	R	3	46.5	0
2	R	2	27	0
0	R	0	7.5	0
3	R	3	46.5	0
4	R	4	66.5	0
2	R	2	27	0
5	R	5	79.5	0
5	R	5	79.5	0
3	R	3	46.5	0
6	R	6	89	0
7	R	7	98	0

Survey Unit Stats
 Count 6 m
 SD 1.1
 Median 1
 Reference Stats
 Count 100 n
 SD 2.3
 Median 3

Critical Value 464.4

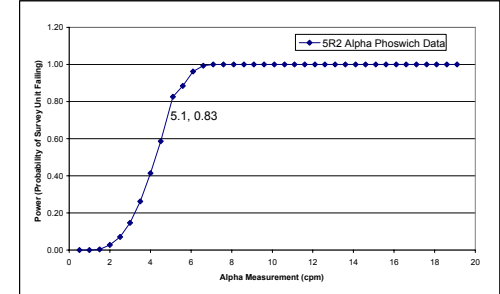
Bkgd Med plus LBGR 5.1

Retrospective Power Curve Calculation

From Example in Section 10.5 of NUREG-1505

p1 and p2 pull data from Table 10-3 sheet

C Measurement: (C-LBGR)/SD	Rounded	p1	p2	E(Wmw)	Var(Wmw)	SD(Wmw)	z	Power
0.5	-0.685	-0.700	0.310309	0.164691	186.1854	4560.687	67.53286	3.800761
1	-0.471	-0.500	0.361837	0.206266	217.1022	5020.578	70.85603	3.186171
1.5	-0.2567	-0.300	0.416002	0.253419	249.6012	5353.181	73.16544	2.641417
2	-0.0428	0.000	0.5	0.333333	300	5549.978	74.49818	1.917853
2.5	0.1712	0.200	0.556231	0.391392	333.7386	5461.643	73.90293	1.476573
3	0.3851	0.400	0.611351	0.451875	366.8106	5205.058	72.14609	1.054126
3.5	0.5990	0.600	0.664313	0.513387	398.5878	4804.276	69.31289	0.638753
4	0.8130	0.800	0.714196	0.574469	428.5176	4295.143	65.53734	0.218868
4.5	1.0269	1.000	0.76025	0.633702	456.15	3720.144	60.99298	-0.21787
5.1	1.2836	1.300	0.821015	0.716331	492.809	2826.966	53.16922	-0.93564
5.5	1.4976	1.500	0.836901	0.741698	503.3406	2539.801	50.39644	-1.20006
6.1	1.7115	1.700	0.87105	0.788602	522.63	2003.222	44.75736	-1.78224
6.6	1.9254	1.900	0.898454	0.830022	539.0724	1532.337	39.14507	-2.4578
7.1	2.1394	2.100	0.92135	0.865767	552.81	1137.379	33.72505	-3.26014
7.6	2.3533	2.400	0.948062	0.908982	568.8372	687.941	26.22863	-4.80298
8.1	2.5673	2.600	0.96145	0.931365	576.87	474.4709	21.78235	-6.15215
8.6	2.7812	2.800	0.971881	0.949208	583.1286	318.0618	17.83429	-7.86502
9.1	2.9951	3.000	0.979848	0.963118	587.9088	207.2777	14.39714	-10.0747
9.6	3.2091	3.200	0.985811	0.973725	591.4866	131.621	11.47262	-12.9548
10.1	3.4230	3.400	0.990188	0.981636	594.1128	81.23879	9.013256	-16.781
10.6	3.6370	3.600	0.993336	0.98741	596.0016	48.91646	6.99403	-21.8958
11.1	3.8509	3.900	0.993336	0.98741	596.0016	48.91646	6.99403	-21.8958
11.6	4.0648	4.100	0.997661	0.995497	598.5966	12.3856	3.519318	-44.2515
12.1	4.2788	4.300	0.997661	0.995497	598.5966	12.3856	3.519318	-44.2515
12.6	4.4927	4.500	0.997661	0.995497	598.5966	12.3856	3.519318	-44.2515
13.1	4.7067	4.700	0.997661	0.995497	598.5966	12.3856	3.519318	-44.2515
13.6	4.9206	4.900	0.997661	0.995497	598.5966	12.3856	3.519318	-44.2515
14.1	5.1345	5.100	0.999796	0.999599	599.8776	0.573278	0.757151	-207.377
14.6	5.3485	5.300	0.999796	0.999599	599.8776	0.573278	0.757151	-207.377
15.1	5.5624	5.600	0.999796	0.999599	599.8776	0.573278	0.757151	-207.377
15.6	5.7763	5.800	0.999796	0.999599	599.8776	0.573278	0.757151	-207.377
16.1	5.9903	6.000	0.999989	0.999978	599.9934	0.006592	0.081192	-1935.32
16.6	6.2042	6.200	0.999989	0.999978	599.9934	0.006592	0.081192	-1935.32
17.1	6.4182	6.400	0.999989	0.999978	599.9934	0.006592	0.081192	-1935.32
17.6	6.6321	6.600	0.999989	0.999978	599.9934	0.006592	0.081192	-1935.32
18.1	6.8460	6.800	0.999989	0.999978	599.9934	0.006592	0.081192	-1935.32
18.6	7.0600	7.100	0.999989	0.999978	599.9934	0.006592	0.081192	-1935.32
19.1	7.2739	7.300	0.999989	0.999978	599.9934	0.006592	0.081192	-1935.32



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 0.83 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	14.5	0
1	R	1	14.5	0
5	R	5	79.5	0
6	R	6	89	0
2	R	2	27	0
4	R	4	66.5	0
2	R	2	27	0
1	R	1	14.5	0
6	R	6	89	0
4	R	4	66.5	0
2	R	2	27	0
2	R	2	27	0
3	R	3	46.5	0
3	R	3	46.5	0
1	S	-1.1	4	4
3	S	0.9	10	10
1	S	-1.1	4	4
1	S	-1.1	4	4
0	S	-2.1	1.5	1.5
0	S	-2.1	1.5	1.5
Sum =			5671	25

* 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: 6 m
Avg Rank R: 56
Avg Rank S: 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 = 464.4

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)

DATA	AREA	ADJUSTED DATA	RANKS	SURVEY AREA RANKS
211	R	211	20	0
358	R	358	66	0
278	R	278	49	0
275	R	275	47	0
234	R	234	31	0
209	R	209	19	0
429	R	429	78	0
327	R	327	60.5	0
237	R	237	33	0
258	R	258	39	0
370	R	370	68	0
497	R	497	88	0
448	R	448	81	0
401	R	401	71	0
423	R	423	77	0
368	R	368	67	0
432	R	432	79	0
485	R	485	86	0
418	R	418	75	0
337	R	337	63	0
498	R	498	89.5	0
496	R	496	87	0
617	R	617	100	0
511	R	511	93.5	0
463	R	463	83	0
480	R	480	84	0
411	R	411	73	0
457	R	457	82	0
437	R	437	80	0
484	R	484	85	0
541	R	541	98	0
498	R	498	89.5	0
529	R	529	95	0
511	R	511	93.5	0
405	R	405	72	0
537	R	537	97	0
420	R	420	76	0
297	R	297	54	0
533	R	533	96	0
501	R	501	92	0
239	R	239	35	0
327	R	327	60.5	0
342	R	342	64	0
271	R	271	44.5	0
274	R	274	46	0
371	R	371	69	0
376	R	376	70	0
238	R	238	34	0
243	R	243	36	0
281	R	281	51.5	0
295	R	295	53	0
316	R	316	58	0
271	R	271	44.5	0
306	R	306	57	0
597	R	597	99	0
717	R	717	101	0
225	R	225	26	0
276	R	276	48	0
301	R	301	56	0
500	R	500	91	0
232	R	232	30	0
201	R	201	15.5	0
183	R	183	12	0
250	R	250	38	0
223	R	223	24.5	0
201	R	201	15.5	0
205	R	205	17	0
280	R	280	50	0
270	R	270	43	0
319	R	319	59	0
328	R	328	62	0
923	R	923	103	0
281	R	281	51.5	0
285	R	285	40	0
1187	R	1187	106	0
779	R	779	102	0
1026	R	1026	105	0
935	R	935	104	0
353	R	353	65	0
412	R	412	74	0
160	R	160	7	0
170	R	170	9	0
173	R	173	11	0
236	R	236	32	0
221	R	221	22.5	0
219	R	219	21	0

Survey Unit Stats
 Count 6 m
 SD 35
 Median 183
 Reference Stats
 Count 100 n
 SD 186
 Median 304

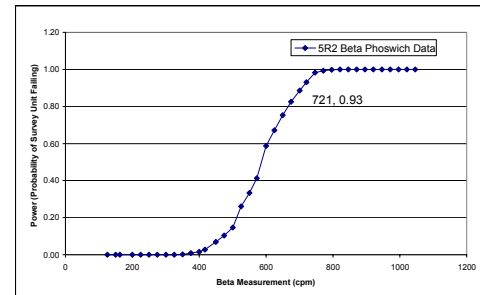
Critical Value 464.4
 Bkgd Med plus LBGR 721

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	77.37	2003.157	44.75664	8.166199	0.00
150	-1.436	-1.400	0.161099	0.063897	96.6594	2539.866	50.39708	6.869489	0.00
163	-1.3661	-1.400	0.161099	0.063897	96.6594	2539.866	50.39708	6.869489	0.00
200	-1.1676	-1.200	0.199072	0.085944	118.8432	3122.208	55.87672	5.798809	0.00
225	-1.0334	-1.000	0.218338	0.098892	131.0028	3421.489	58.4935	5.531513	0.00
250	-0.8993	-0.900	0.23975	0.113202	143.85	3720.144	60.99298	4.902394	0.00
275	-0.7652	-0.800	0.262259	0.12892	157.3554	4013.174	63.34961	4.506835	0.00
300	-0.6310	-0.600	0.335687	0.18476	201.4122	4804.211	69.31242	3.483495	0.00
325	-0.4969	-0.500	0.361837	0.206266	217.1022	5020.578	70.85603	3.186171	0.00
350	-0.3627	-0.400	0.388649	0.229172	233.1894	5204.993	72.14564	2.906236	0.00
375	-0.2286	-0.200	0.443769	0.27893	266.2614	5461.643	73.90293	2.389624	0.01
400	-0.0944	-0.100	0.471814	0.305606	283.0884	5527.765	74.34894	2.148965	0.02
417	-0.0032	0.000	0.5	0.333333	300	5549.978	74.49818	1.917653	0.03
450	0.1739	0.200	0.556231	0.391392	333.7386	5461.643	73.90293	1.476573	0.07
475	0.3080	0.300	0.583998	0.421415	350.3988	5353.181	73.16544	1.26375	0.10
500	0.4421	0.400	0.611351	0.451875	366.8106	5205.058	72.14609	1.054126	0.15
525	0.5763	0.600	0.664313	0.513387	398.5878	4804.276	69.31289	0.638753	0.26
550	0.7104	0.700	0.689691	0.544073	413.8146	4560.687	67.53286	0.430117	0.33
572.6	0.8317	0.800	0.714196	0.574469	428.5176	4295.143	65.53734	0.218868	0.41
600	0.9787	1.000	0.76025	0.633702	456.15	3720.144	60.99298	-0.21787	0.59
625	1.1129	1.100	0.781662	0.662216	468.9972	3421.489	58.4935	-0.44681	0.67
650	1.2470	1.200	0.801928	0.6898	481.1568	3122.208	55.87672	-0.68535	0.75
675	1.3811	1.400	0.821015	0.716331	492.609	2826.966	53.16922	-0.93564	0.83
700	1.5153	1.500	0.838901	0.741698	503.3406	2539.801	50.39644	-1.20006	0.88
721	1.6280	1.600	0.855578	0.765812	513.3468	2264.267	47.58432	-1.48127	0.93
746	1.7621	1.800	0.885334	0.810016	531.2004	1758.652	41.93628	-2.1065	0.98
771	1.8963	1.900	0.898454	0.830022	539.0724	1532.337	39.14507	-2.4578	0.99
796	2.0304	2.000	0.910445	0.848605	546.267	1325.151	36.40262	-2.8406	1.00
821	2.1645	2.200	0.931218	0.881527	558.7308	968.961	31.12814	-3.72233	1.00
846	2.2987	2.300	0.940103	0.895917	564.0618	819.3787	28.62479	-4.2341	1.00
871	2.4328	2.400	0.948062	0.908982	568.8372	687.941	26.22863	-4.80298	1.00
896	2.5670	2.600	0.96145	0.931365	576.87	474.4709	21.78235	-6.15215	1.00
921	2.7011	2.700	0.967004	0.940817	580.2024	389.8175	19.7438	-6.95615	1.00
946	2.8353	2.800	0.971881	0.949208	583.1286	318.0618	17.83429	-7.86502	1.00
971	2.9694	3.000	0.979848	0.963118	587.9088	207.2777	14.39714	-10.0747	1.00
996	3.1036	3.100	0.983053	0.968795	589.8318	165.6325	12.86983	-11.4197	1.00
1021	3.2377	3.200	0.985811	0.973725	591.4866	131.621	11.47262	-12.9548	1.00
1046	3.3718	3.400	0.990188	0.981636	594.1128	81.23879	9.013256	-16.781	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 0.93 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	14	0
162	R	162	8	0
245	R	245	37	0
172	R	172	10	0
226	R	226	27.5	0
223	R	223	24.5	0
266	R	266	41	0
299	R	299	55	0
227	R	227	29	0
206	R	206	18	0
226	R	226	27.5	0
269	R	269	42	0
221	R	221	22.5	0
193	R	193	13	0
212	S	-205.6	6	6
205	S	-212.6	5	5
181	S	-236.6	3	3
185	S	-232.6	4	4
137	S	-280.6	2	2
129	S	-288.6	1	1
Sum =		5671	21	21

* 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	<i>n</i>
# of S:	6	<i>m</i>
Avg Rank R:	57	
Avg Rank S:	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

$$k = 464.4$$

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	15.5	0
1	R	1	2.5	0
0	R	0	1	0
6	R	6	22	0
6	R	6	22	0
4	R	4	15.5	0
2	R	2	5.5	0
3	R	3	10.5	0
2	R	2	5.5	0
4	R	4	15.5	0
6	R	6	22	0
1	R	1	2.5	0
3	R	3	10.5	0
7	R	7	24.5	0
8	R	8	26	0
3	S	3	10.5	10.5
9	S	9	27.5	27.5
5	S	5	19	19
9	S	9	27.5	27.5
7	S	7	24.5	24.5
2	S	2	5.5	5.5
11	S	11	29	29
5	S	5	19	19
4	S	4	15.5	15.5
3	S	3	10.5	10.5
5	S	5	19	19
2	S	2	5.5	5.5
3	S	3	10.5	10.5
3	S	3	10.5	10.5
Sum =			435	234

* 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: 14 m
Avg Rank R: 13.4
Avg Rank S: 16.7

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 = 254.9

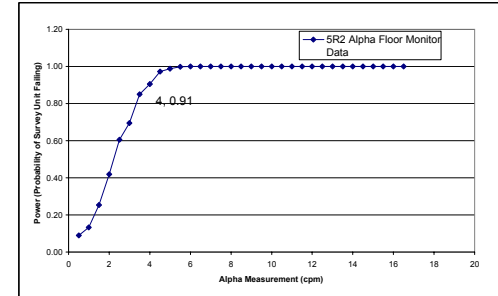
Since the sum of survey unit ranks is less than the critical value, the null hypothesis that the difference between the survey unit median and the background median is less than the LBGR (i.e., the survey unit is indistinguishable from background) is accepted and the survey unit passes Scenario B

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	14 m	0.5	0.174	0.200	0.556231	0.391392	116.8085	585.65	24.20021	1.347126	0.09
SD	2.9	1	0.349	0.300	0.583998	0.421415	122.6396	574.1706	23.96186	1.117178	0.13
Median	4.5	1.5	0.523	0.500	0.638163	0.482593	134.0142	538.9611	23.21554	0.663134	0.25
Reference Stats	15 n	2	0.697	0.700	0.689691	0.544073	144.8351	490.2232	22.14099	0.206591	0.42
Count	2.4	2.5	0.872	0.900	0.737741	0.604402	154.9256	432.1434	20.78906	-0.26536	0.60
SD	4	3	1.046	1.000	0.76025	0.633702	159.6525	401.0265	20.02565	-0.51151	0.70
Median	4	3.5	1.220	1.200	0.801928	0.6898	168.4049	337.448	18.36976	-1.03407	0.85
Critical Value	254.9	4	1.395	1.400	0.821015	0.716331	172.4132	306.0069	17.49305	-1.31503	0.91
Bkgd Med plus LBGR	4	4.5	1.569	1.600	0.855578	0.765812	179.6714	245.9753	15.6836	-1.92954	0.97
		5	1.743	1.700	0.87105	0.788602	182.9205	219.0667	14.76708	-2.26932	0.99
		5.5	1.918	1.900	0.888454	0.830022	188.6753	167.6029	12.94615	-3.03303	1.00
		6	2.092	2.100	0.92135	0.865767	193.4835	125.1139	11.18543	-3.94033	1.00
		6.5	2.266	2.300	0.940103	0.895917	197.4216	90.74797	9.526173	-5.04005	1.00
		7	2.441	2.400	0.948062	0.908982	199.093	76.48498	8.745569	-5.68102	1.00
		7.5	2.615	2.600	0.96145	0.931365	201.9045	53.21604	7.294933	-7.19613	1.00
		8	2.789	2.800	0.971881	0.949208	204.095	36.04509	6.003757	-9.10859	1.00
		8.5	2.964	3.000	0.979848	0.963118	205.7681	23.78013	4.876487	-11.5573	1.00
		9	3.138	3.100	0.983053	0.968795	206.4411	19.13427	4.374274	-13.038	1
		9.5	3.312	3.300	0.988174	0.977981	207.5165	12.17447	3.489193	-16.6535	1
		10	3.487	3.500	0.991895	0.984758	208.298	7.562286	2.749961	-21.4144	1
		10.5	3.661	3.700	0.993336	0.98741	208.6006	5.905392	2.430101	-24.3576	1
		11	3.835	3.800	0.993336	0.98741	208.6006	5.905392	2.430101	-24.3576	1
		11.5	4.010	4.000	0.997661	0.995497	209.5088	1.593675	1.262409	-47.6071	1
		12	4.184	4.200	0.997661	0.995497	209.5088	1.593675	1.262409	-47.6071	1
		12.5	4.358	4.400	0.997661	0.995497	209.5088	1.593675	1.262409	-47.6071	1
		13	4.533	4.500	0.997661	0.995497	209.5088	1.593675	1.262409	-47.6071	1
		13.5	4.707	4.700	0.997661	0.995497	209.5088	1.593675	1.262409	-47.6071	1
		14	4.881	4.900	0.997661	0.995497	209.5088	1.593675	1.262409	-47.6071	1
		14.5	5.056	5.100	0.999796	0.999599	209.9572	0.08813	0.296868	-203.956	1
		15	5.230	5.200	0.999796	0.999599	209.9572	0.08813	0.296868	-203.956	1
		15.5	5.405	5.400	0.999796	0.999599	209.9572	0.08813	0.296868	-203.956	1
		16	5.579	5.600	0.999796	0.999599	209.9572	0.08813	0.296868	-203.956	1
		16.5	5.753	5.800	0.999796	0.999599	209.9572	0.08813	0.296868	-203.956	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 (4) will have a 0.91 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	21	0
715	R	715	22	0
768	R	768	23	0
640	R	640	20	0
1435	R	1435	29	0
1420	R	1420	28	0
772	R	772	24	0
821	R	821	27	0
789	R	789	26	0
785	R	785	25	0
505	R	505	15	0
621	R	621	19	0
588	R	588	18	0
581	R	581	17	0
498	R	498	14	0
768	S	200.3	12	12
741	S	173.3	11	11
674	S	106.3	6	6
668	S	100.3	5	5
774	S	206.3	13	13
1087	S	519.3	16	16
712	S	144.3	10	10
676	S	108.3	7	7
661	S	93.3	4	4
444	S	-123.7	1	1
543	S	-24.7	2	2
594	S	26.3	3	3
686	S	118.3	9	9
677	S	109.3	8	8
Sum =			435	107

* 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: 14
Avg Rank R: 22
Avg Rank S: 8

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

$k = 254.9$

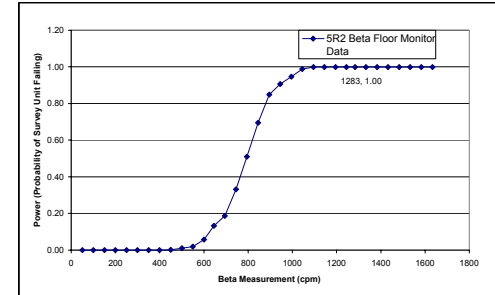
Since the sum of survey unit ranks is less than the critical value, the null hypothesis that the difference between the survey unit median and the background median is less than the LBGR (i.e., the survey unit is indistinguishable from background) is accepted and the survey unit passes Scenario B

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
Count	50	-1.823	-1.800	0.101546	0.033114	21.32466	167.6029	12.94615	9.893639	0.00
SD	100	-1.647	-1.600	0.12895	0.046501	27.0795	218.0602	14.76686	8.284073	0.00
Median	150	-1.470	-1.500	0.144422	0.054656	30.32862	245.9753	15.6836	7.592684	0.00
	200	-1.294	-1.300	0.178985	0.074301	37.58685	306.0069	17.49305	6.392368	0.00
	250	-1.118	-1.100	0.198072	0.085944	41.59512	337.448	18.36976	5.869109	0.00
Count	300	-0.942	-0.900	0.23975	0.113202	50.3475	401.0265	20.02565	4.946744	0.00
SD	350	-0.766	-0.800	0.262259	0.12892	55.07439	432.1434	20.78806	4.537934	0.00
Median	400	-0.590	-0.600	0.335687	0.18476	70.49427	516.0335	22.71637	3.473925	0.00
	450	-0.414	-0.400	0.388649	0.229172	81.61629	558.4831	23.63225	2.868663	0.00
	500	-0.238	-0.200	0.443769	0.27893	93.19149	585.65	24.20021	2.32028	0.01
	550	-0.062	-0.100	0.471814	0.305606	99.08094	592.6472	24.34435	2.067351	0.02
Critical Value	600	0.114	0.100	0.528186	0.361978	110.9191	592.6472	24.34435	1.581073	0.06
Bkgd Med plus LBGR	645	0.272	0.300	0.583998	0.421415	122.6396	574.1706	23.96186	1.117178	0.13
	695	0.448	0.400	0.611351	0.451875	128.3837	558.4897	23.63239	0.889691	0.19
	745	0.624	0.600	0.664313	0.513387	139.5057	516.0401	22.71652	0.435961	0.33
	795	0.800	0.800	0.714196	0.574469	149.9812	462.0641	21.49568	-0.02661	0.51
	845	0.976	1.000	0.760225	0.633702	159.6525	401.0265	20.02565	-0.51151	0.70
	895	1.152	1.200	0.801928	0.6898	168.4049	337.448	18.36976	-1.03407	0.85
	945	1.328	1.300	0.821015	0.716331	172.4132	306.0069	17.49305	-1.31503	0.91
	995	1.504	1.500	0.838901	0.741698	176.1692	275.3903	16.59489	-1.61254	0.95
	1045	1.680	1.700	0.87105	0.788602	182.9205	218.0667	14.76708	-2.26932	0.99
	1095	1.856	1.900	0.898454	0.830022	188.6753	167.6029	12.94615	-3.03303	1.00
	1145	2.032	2.000	0.910445	0.848605	191.1935	145.3361	12.05554	-3.46597	1.00
	1195	2.208	2.200	0.931218	0.881527	195.5558	106.9346	10.34092	-4.46252	1.00
	1245	2.384	2.400	0.948062	0.908982	199.093	76.48498	8.745569	-5.68102	1.00
	1283	2.518	2.500	0.955167	0.920777	200.583	64.01795	8.001122	-6.39582	1.00
	1333	2.694	2.700	0.967004	0.940817	203.0708	43.93944	6.628683	-8.09536	1.00
	1383	2.870	2.900	0.976143	0.956616	204.99	29.37354	5.419736	-10.2553	1.00
	1433	3.046	3.000	0.979648	0.963118	205.7681	23.78013	4.876487	-11.5573	1.00
	1483	3.222	3.200	0.985811	0.973725	207.0203	15.3173	3.913732	-14.7202	1.00
	1533	3.398	3.400	0.990188	0.981636	207.9395	9.61615	3.100992	-18.8747	1.00
	1583	3.574	3.600	0.993336	0.98741	208.6006	5.905392	2.430101	-24.3576	1.00
	1633	3.750	3.800	0.993336	0.98741	208.6006	5.905392	2.430101	-24.3576	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).

5R2 Alpha-Beta Ph Quantile

Quantile Test

per Section 7 of NUREG-1505

n (Survey) 6

m (Ref) 100

alpha/2 0.025

From Table A.7

r 3

k 2

α 0.023

If k of the r largest ranks are from the survey unit, the null hypothesis is rejected. See (5,45) in Table A.7

Alpha Phoswich Ranks

Sorted Ranks Location

1.5 S

1.5 S

4 S

4 S

4 S

7.5 R

7.5 R

7.5 R

7.5 R

10 S

14.5 R

14.5 R

14.5 R

14.5 R

14.5 R

14.5 R

14.5 R

14.5 R

27 R

27 R

27 R

27 R

27 R

27 R

27 R

27 R

27 R

27 R

27 R

27 R

27 R

27 R

27 R

27 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

46.5 R

Beta Phoswich Ranks

Sorted Ranks Location

1 S

2 S

3 S

4 S

5 S

6 S

7 R

8 R

9 R

10 R

11 R

12 R

13 R

14 R

15.5 R

15.5 R

17 R

18 R

19 R

20 R

21 R

22.5 R

22.5 R

24.5 R

24.5 R

26 R

27.5 R

27.5 R

29 R

30 R

31 R

32 R

33 R

34 R

35 R

36 R

37 R

38 R

39 R

40 R

41 R

42 R

43 R

44.5 R

44.5 R

46 R

47 R

48 R

49 R

50 R

51.5 R

51.5 R

53 R

54 R

55 R

56 R

57 R

5R2 Alpha-Beta Ph Quantile

66.5	R	58	R
66.5	R	59	R
66.5	R	60.5	R
66.5	R	60.5	R
66.5	R	62	R
66.5	R	63	R
66.5	R	64	R
66.5	R	65	R
66.5	R	66	R
66.5	R	67	R
66.5	R	68	R
66.5	R	69	R
66.5	R	70	R
66.5	R	71	R
66.5	R	72	R
66.5	R	73	R
66.5	R	74	R
66.5	R	75	R
79.5	R	76	R
79.5	R	77	R
79.5	R	78	R
79.5	R	79	R
79.5	R	80	R
79.5	R	81	R
79.5	R	82	R
79.5	R	83	R
89	R	84	R
89	R	85	R
89	R	86	R
89	R	87	R
89	R	88	R
89	R	89.5	R
89	R	89.5	R
89	R	91	R
89	R	92	R
89	R	93.5	R
89	R	93.5	R
98	R	95	R
98	R	96	R
98	R	97	R
98	R	98	R
98	R	99	R
98	R	100	R
98	R	101	R
102	R	102	R
103.5	R	103	R
103.5	R	104	R
105	R	105	R
106	R	106	R

0 of top 3 from S

0 of top 3 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).

$r=4$

$k=3$

0 of top 4 from S

thesis is rejected.

5R2 Alpha-Beta FM Quantile

Quantile Test

per Section 7 of NUREG-1505

n (Survey) 14

m (Ref) 15

alpha/2 0.025

From Table A.7

r 5

k 5

α 0.021

If k of the r largest ranks are from the survey unit, the null hypothesis is rejected. If k of the r largest ranks are from the survey unit, the null hypothesis is not rejected. (15,15) in Table A.7

Alpha FM Ranks Bkgd		Beta FM Ranks	
Sorted Ranks	Location	Sorted Ranks	Location
1	R	1	S
2.5	R	2	S
2.5	R	3	S
5.5	R	4	S
5.5	R	5	S
5.5	S	6	S
5.5	S	7	S
10.5	R	8	S
10.5	R	9	S
10.5	S	10	S
10.5	S	11	S
10.5	S	12	S
10.5	S	13	S
15.5	R	14	R
15.5	R	15	R
15.5	R	16	S
15.5	S	17	R
19	S	18	R
19	S	19	R
19	S	20	R
22	R	21	R
22	R	22	R
22	R	23	R
24.5	R	24	R
24.5	S	25	R
26	R	26	R
27.5	S	27	R
27.5	S	28	R
29	S	29	R

4 of top 5 from S

0 of top 5 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).

$r=6$

$k=6$

4 of top 6 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

