

Spreadsheet Formulas for the Wilcoxon Rank Sum Test and Power Calculation

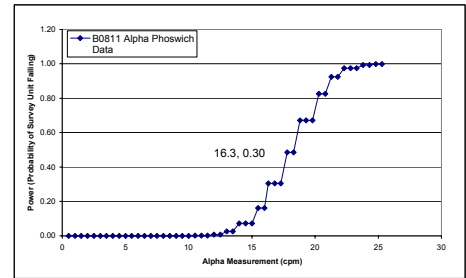
Wilcoxon Rank Sum Test, per NUREG-1506  
 LBGR (For this calculation, LBGR = 3w for 2002 Igloo Background)  
 LBGR (Reference Dataset - 2002 Igloo Alpha Phoswich)

DATA	AREA	ADJUSTED DATA	RANKS	SURVEY AREA RANKS	
13	R	13	166.5	0	
17	R	17	117.5	0	
12	R	12	164.0	0	
4	R	4	133.0	0	
18	R	18	176.0	0	
9	R	9	159.0	0	
8	R	8	156.0	0	
16	R	16	173.5	0	
4	R	4	133.0	0	
7	R	7	153.5	0	
4	R	4	133.0	0	
9	R	9	159.0	0	
14	R	14	168.5	0	
5	R	5	143.5	0	
14	R	14	168.5	0	
12	R	12	164.0	0	
16	R	16	173.5	0	
11	R	11	161.5	0	
15	R	15	171.0	0	
6	R	6	151.0	0	
5	R	5	143.5	0	
4	R	4	133.0	0	
1	R	1	59.5	0	
9	R	9	159.0	0	
12	R	12	164.0	0	
15	R	15	171.0	0	
15	R	15	171.0	0	
6	R	6	151.0	0	
111	R	111	190.0	0	
8	R	8	156.0	0	
3	R	3	114.5	0	
3	R	3	114.5	0	
3	R	3	114.5	0	
4	R	4	133.0	0	
6	R	6	151.0	0	
11	R	11	161.5	0	
5	R	5	143.5	0	
5	R	5	143.5	0	
3	R	3	114.5	0	
2	R	2	86.0	0	
3	R	3	114.5	0	
4	R	4	133.0	0	
4	R	4	133.0	0	
5	R	5	143.5	0	
3	R	3	114.5	0	
5	R	5	143.5	0	
2	R	2	86.0	0	
2	R	2	86.0	0	
1	R	1	59.5	0	
3	R	3	114.5	0	
5	R	5	143.5	0	
1	R	1	59.5	0	
2	R	2	86.0	0	
0	R	0	38.5	0	
0	R	0	38.5	0	
2	R	2	86.0	0	
1	R	1	59.5	0	
2	R	2	86.0	0	
3	R	3	114.5	0	
1	R	1	59.5	0	
0	R	0	38.5	0	
0	R	0	38.5	0	
2	R	2	86.0	0	
0	R	0	38.5	0	
0	R	0	38.5	0	
1	R	1	59.5	0	
0	R	0	38.5	0	
0	R	0	38.5	0	
1	R	1	59.5	0	
0	R	0	38.5	0	
0	R	0	38.5	0	
3	R	3	114.5	0	
3	R	3	114.5	0	
2	R	2	86.0	0	
1	R	1	59.5	0	
2	R	2	86.0	0	
1	R	1	59.5	0	
13	R	13	166.5	0	
3	R	3	114.5	0	
2	R	2	86.0	0	
1	R	1	59.5	0	
2	R	2	86.0	0	

Survey Unit Stats	Count	SD	Median	Reference Stats	Count	SD	Median	Critical Value	Bkgd Median plus LBGR
Measurement	30 m	6.5	1.0	150 n	2.5	12.0	3.0	3225.6	16.3
(C-LBGR)/SD									
Rounded									
p1									
p2									
E(Wmw)									
Var(Wmw)									
SD(Wmw)									
z									
Power									

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

p1 and p2 pull data from Table 10-3 sheet



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 (16.3) will have a 0.30 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).

3	R	3	114.5	0
3	R	3	114.5	0
3	R	3	114.5	0
2	R	2	86	0
0	R	0	38.5	0
2	R	2	86	0
2	R	2	86	0
1	R	1	59.5	0
0	R	0	38.5	0
3	R	3	114.5	0
1	R	1	59.5	0
1	R	1	59.5	0
0	R	0	38.5	0
1	R	1	59.5	0
2	R	2	86	0
3	R	3	114.5	0
2	R	2	86	0
1	R	1	59.5	0
2	R	2	86	0
3	R	3	114.5	0
4	R	4	133	0
3	R	3	114.5	0
1	R	1	59.5	0
3	R	3	114.5	0
5	R	5	143.5	0
3	R	3	114.5	0
3	R	3	114.5	0
1	R	1	59.5	0
2	R	2	86	0
2	R	2	86	0
3	R	3	114.5	0
1	R	1	59.5	0
2	R	2	86	0
4	R	4	133	0
2	R	2	86	0
2	R	2	86	0
2	R	2	86	0
1	R	1	59.5	0
0	R	0	38.5	0
1	R	1	59.5	0
3	R	3	114.5	0
1	R	1	59.5	0
7	R	7	153.5	0
0	R	0	38.5	0
2	R	2	86	0
1	R	1	59.5	0
2	R	2	86	0
0	R	0	38.5	0
0	R	0	38.5	0
1	R	1	59.5	0
2	R	2	86	0
1	R	1	59.5	0
0	R	0	38.5	0
0	R	0	38.5	0
34	R	34	178	0
3	R	3	114.5	0
1	S	-12.3	16.5	16.5
0	S	-13.3	6.5	6.5
4	S	-9.3	28	28
2	S	-11.3	22.5	22.5
3	S	-10.3	25.5	25.5
0	S	-13.3	6.5	6.5
0	S	-13.3	6.5	6.5
0	S	-13.3	6.5	6.5
0	S	-13.3	6.5	6.5
0	S	-13.3	6.5	6.5
2	S	-11.3	22.5	22.5
1	S	-12.3	16.5	16.5
0	S	-13.3	6.5	6.5
1	S	-12.3	16.5	16.5
4	S	-9.3	28	28
1	S	-12.3	16.5	16.5
0	S	-13.3	6.5	6.5
1	S	-12.3	16.5	16.5
2	S	-11.3	22.5	22.5
1	S	-12.3	16.5	16.5
0	S	-13.3	6.5	6.5
0	S	-13.3	6.5	6.5
4	S	-9.3	28	28
3	S	-10.3	25.5	25.5
1	S	-12.3	16.5	16.5
2	S	-11.3	22.5	22.5
1	S	-12.3	16.5	16.5
36	S	22.7	177	177
0	S	-13.3	6.5	6.5
Sum =				612

\* 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: 150 n  
 # of S: 30 m  
 Avg Rank R: 105  
 Avg Rank S: 20

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

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

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

$$k = 3225.6$$

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 LSCR (i.e., the survey unit is indistinguishable from background) is accepted and the survey unit passes Scenario B



317	R	317	174	0
337	R	337	176	0
291	R	281	169	0
222	R	222	109	0
199	R	199	71.5	0
187	R	187	52.5	0
232	R	232	129	0
188	R	188	54.5	0
246	R	246	144	0
204	R	204	82	0
286	R	286	171.5	0
189	R	189	57	0
264	R	264	162	0
206	R	206	87	0
204	R	204	82	0
202	R	202	78	0
188	R	188	54.5	0
280	R	280	168	0
226	R	226	115.5	0
196	R	196	64.5	0
259	R	259	156	0
234	R	234	132.5	0
183	R	183	49.5	0
272	R	272	163.5	0
369	R	369	177	0
286	R	286	171.5	0
223	R	223	111.5	0
206	R	206	87	0
206	R	206	87	0
251	R	251	150	0
111	R	111	3	0
253	R	253	152.5	0
222	R	222	109	0
230	R	230	123	0
276	R	276	166	0
246	R	246	144	0
260	R	260	160	0
228	R	228	119	0
236	R	236	135	0
164	R	164	26	0
223	R	223	111.5	0
179	R	179	42.5	0
218	R	218	104	0
189	R	189	57	0
200	R	200	74.5	0
172	R	172	37.5	0
156	R	156	21	0
243	R	243	141	0
257	R	257	157	0
214	R	214	96.5	0
250	R	250	149	0
231	R	231	125.5	0
219	R	219	105	0
206	R	206	87	0
180	R	180	44	0
299	R	299	173	0
129	R	129	8	0
165	S	124.5	6	6
139	S	98.5	2	2
180	S	139.5	13	13
194	S	153.5	18	18
234	S	193.5	61.5	61.5
160	S	119.5	4	4
268	S	227.5	117	117
219	S	178.5	41	41
167	S	146.5	15	15
257	S	216.5	103	103
171	S	130.5	9	9
234	S	193.5	61.5	61.5
281	S	240.5	138	138
189	S	148.5	16	16
165	S	124.5	6	6
250	S	209.5	91	91
165	S	124.5	6	6
221	S	180.5	45	45
177	S	136.5	11	11
186	S	145.5	14	14
242	S	201.5	76	76
231	S	190.5	59	59
205	S	164.5	27	27
236	S	195.5	63	63
213	S	172.5	39	39
191	S	150.5	17	17
272	S	231.5	128	128
196	S	155.5	20	20
295	S	254.5	154	154
131	S	90.5	1	1
Sum =				1362

\* 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: 150 n  
 # of S: 30 m  
 Avg Rank R: 100  
 Avg Rank S: 45

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

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

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

$$k = 3225.6$$

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 LSCR (i.e. the survey unit is indistinguishable from background) is accepted and the survey unit passes Scenario B

B0811 Alpha-Beta Ph Quantile

**Quantile Test**

per Section 7 of NUREG-1505  
 n (Survey) 30  
 m (Ref) 150  
 alpha/2 0.025

From Table A.7  
 r 6  
 k 4  
 alpha 0.025

If  $k$  of the  $r$  largest ranks are from the survey unit, the null hypott  
 (30,100) in Table A.7

Alpha Phoswich Ranks		Beta Phoswich Ranks	
Sorted Ranks	Location	Sorted Ranks	Location
6.5	S	1	S
6.5	S	2	S
6.5	S	3	R
6.5	S	4	S
6.5	S	6	S
6.5	S	6	S
6.5	S	6	S
6.5	S	8	R
6.5	S	9	S
6.5	S	10	R
6.5	S	11	S
6.5	S	12	R
16.5	S	13	S
16.5	S	14	S
16.5	S	15	S
16.5	S	16	S
16.5	S	17	S
16.5	S	18	S
16.5	S	19	R
16.5	S	20	S
22.5	S	21	R
22.5	S	22	R
22.5	S	23.5	R
22.5	S	23.5	R
25.5	S	25	R
25.5	S	26	R
28	S	27	S
28	S	28	R
28	S	30	R
38.5	R	30	R
38.5	R	30	R
38.5	R	32.5	R
38.5	R	32.5	R
38.5	R	34	R
38.5	R	35.5	R
38.5	R	35.5	R
38.5	R	37.5	R
38.5	R	37.5	R
38.5	R	39	S
38.5	R	40	R
38.5	R	41	S
38.5	R	42.5	R
38.5	R	42.5	R
38.5	R	44	R
38.5	R	45	S
38.5	R	46.5	R
38.5	R	46.5	R
59.5	R	48	R
59.5	R	49.5	R
59.5	R	49.5	R
59.5	R	51	R
59.5	R	52.5	R
59.5	R	52.5	R
59.5	R	54.5	R
59.5	R	54.5	R
59.5	R	57	R
59.5	R	57	R

B0811 Alpha-Beta Ph Quantile

59.5	R	57	R
59.5	R	59	S
59.5	R	60	R
59.5	R	61.5	S
59.5	R	61.5	S
59.5	R	63	S
59.5	R	64.5	R
59.5	R	64.5	R
59.5	R	67	R
59.5	R	67	R
59.5	R	67	R
59.5	R	69	R
59.5	R	71.5	R
59.5	R	71.5	R
86	R	71.5	R
86	R	71.5	R
86	R	74.5	R
86	R	74.5	R
86	R	76	S
86	R	78	R
86	R	78	R
86	R	78	R
86	R	80	R
86	R	82	R
86	R	82	R
86	R	82	R
86	R	84	R
86	R	87	R
86	R	87	R
86	R	87	R
86	R	87	R
86	R	87	R
86	R	87	R
86	R	87	R
86	R	90	R
86	R	91	S
86	R	92	R
86	R	93	R
86	R	94	R
86	R	95	R
86	R	96.5	R
86	R	96.5	R
86	R	98.5	R
86	R	98.5	R
86	R	101	R
114.5	R	101	R
114.5	R	101	R
114.5	R	103	S
114.5	R	104	R
114.5	R	105	R
114.5	R	106.5	R
114.5	R	106.5	R
114.5	R	109	R
114.5	R	109	R
114.5	R	109	R
114.5	R	111.5	R
114.5	R	111.5	R
114.5	R	113	R
114.5	R	114	R
114.5	R	115.5	R
114.5	R	115.5	R
114.5	R	117	S
114.5	R	119	R
114.5	R	119	R
114.5	R	119	R
114.5	R	121.5	R



B0811 Alpha-Beta Ph Quantile

114.5	R	121.5	R
114.5	R	123	R
114.5	R	125.5	R
114.5	R	125.5	R
114.5	R	125.5	R
114.5	R	125.5	R
114.5	R	128	S
133	R	129	R
133	R	130.5	R
133	R	130.5	R
133	R	132.5	R
133	R	132.5	R
133	R	134	R
133	R	135	R
133	R	136	R
133	R	137	R
143.5	R	138	S
143.5	R	139	R
143.5	R	141	R
143.5	R	141	R
143.5	R	141	R
143.5	R	144	R
143.5	R	144	R
143.5	R	144	R
143.5	R	144	R
143.5	R	146.5	R
143.5	R	146.5	R
143.5	R	148	R
143.5	R	149	R
151	R	150	R
151	R	151	R
151	R	152.5	R
153.5	R	152.5	R
153.5	R	154	S
156	R	155	R
156	R	156	R
156	R	157	R
159	R	158	R
159	R	160	R
159	R	160	R
161.5	R	160	R
161.5	R	162	R
164	R	163.5	R
164	R	163.5	R
164	R	165	R
166.5	R	166	R
166.5	R	167	R
168.5	R	168	R
168.5	R	169	R
171	R	170	R
171	R	171.5	R
171	R	171.5	R
173.5	R	173	R
173.5	R	174	R

175	R	175	R
176	R	176	R
177	S	177	R
178	R	178	R
179	R	179	R
180	R	180	R

1 of top 6 from S

0 of top 6 from S

thesis is rejected.





Reproduction 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