Spreadsheet Formulas for the Wilcoxon Rank Sum Test and Power Calculation

Wilcoxon Rank Sum Test, per NUREG-1505

LBGR 13.3 *(For this calculation, LBGR = 3w for 2002 Igloo Background)*

(Reference Dataset - 2002 Igloo Alpha Phoswich)

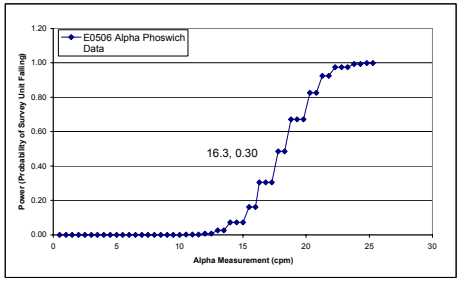
DATA	AREA	ADJUSTED DATA	RANKS	SURVEY AREA RANKS
13	R	13	167.5	0
17	R	17	176	0
12	R	12	165	0
4	R	4	134	0
18	R	18	177	0
9	R	9	160	0
8	R	8	157	0
16	R	16	174.5	0
4	R	4	134	0
7	R	7	154.5	0
4	R	4	134	0
9	R	9	160	0
14	R	14	169.5	0
5	R	5	144.5	0
14	R	14	169.5	0
12	R	12	165	0
16	R	16	174.5	0
11	R	11	162.5	0
15	R	15	172	0
6	R	6	152	0
5	R	5	144.5	0
4	R	4	134	0
1	R	1	60.5	0
9	R	9	160	0
12	R	12	165	0
15	R	15	172	0
15	R	15	172	0
6	R	6	152	0
111	R	111	180	0
8	R	8	157	0
3	R	3	115.5	0
3	R	3	115.5	0
3	R	3	115.5	0
4	R	4	134	0
6	R	6	152	0
11	R	11	162.5	0
5	R	5	144.5	0
5	R	5	144.5	0
3	R	3	115.5	0
2	R	2	87	0
3	R	3	115.5	0
4	R	4	134	0
4	R	4	134	0
5	R	5	144.5	0
3	R	3	115.5	0
5	R	5	144.5	0
2	R	2	87	0
2	R	2	87	0
5	R	5	144.5	0
2	R	2	87	0
5	R	5	144.5	0
5	R	5	144.5	0
3	R	3	115.5	0
2	R	2	87	0
5	R	5	144.5	0
8	R	8	157	0
2	R	2	87	0
3	R	3	115.5	0
86	R	86	179	0
2	R	2	87	0
1	R	1	60.5	0
5	R	5	144.5	0
3	R	3	115.5	0
1	R	1	60.5	0
2	R	2	87	0
0	R	0	39.5	0
0	R	0	39.5	0
2	R	2	87	0
1	R	1	60.5	0
2	R	2	87	0
3	R	3	115.5	0
1	R	1	60.5	0
0	R	0	39.5	0
0	R	0	39.5	0
2	R	2	87	0
0	R	0	39.5	0
0	R	0	39.5	0
1	R	1	60.5	0
0	R	0	39.5	0
1	R	1	60.5	0
0	R	0	39.5	0
0	R	0	39.5	0
3	R	3	115.5	0
3	R	3	115.5	0
1	R	1	60.5	0
2	R	2	87	0
1	R	1	60.5	0
3	R	3	115.5	0
13	R	13	167.5	0
3	R	3	115.5	0
2	R	2	87	0
1	R	1	60.5	0
2	R	2	87	0

	Survey Unit Stats	
Count	30	*m*
SD	1.6	
Median	1.0	
	Reference Stats	
Count	150	*n*
SD	12.0	
Median	3.0	
Critical Value	3225.6	
Bkgd Median plus LBGR	16.3	

Retrospective Power Curve Calculation *p1* and *p2* pull data from Table 10-3 sheet

From Example in Section 10.5 of NUREG-1505

C Measurement	(C-LBGR)/SD	Rounded	p1	p2	E(Wmw)	Var(Wmw)	SD(Wmw)	z	Power
0.5	-1.071	-1.100	0.198072	0.085944	891.324	38971.48	197.412	9.466557	0.00
1	-1.029	-1.000	0.218338	0.098892	982.521	42717.6	206.6824	8.600707	0.00
1.5	-0.987	-1.000	0.218338	0.098892	982.521	42717.6	206.6824	8.600707	0.00
2	-0.945	-0.900	0.23975	0.113202	1078.875	46456.48	215.5377	7.80031	0.00
2.5	-0.904	-0.900	0.23975	0.113202	1078.875	46456.48	215.5377	7.80031	0.00
3	-0.862	-0.900	0.23975	0.113202	1078.875	46456.48	215.5377	7.80031	0.00
3.5	-0.820	-0.800	0.262259	0.12892	1180.166	50125.49	223.8872	7.05699	0.00
4	-0.778	-0.800	0.262259	0.12892	1180.166	50125.49	223.8872	7.05699	0.00
4.5	-0.736	-0.700	0.310309	0.164691	1396.391	56982.12	238.7093	5.712995	0.00
5	-0.694	-0.700	0.310309	0.164691	1396.391	56982.12	238.7093	5.712995	0.00
5.5	-0.653	-0.700	0.310309	0.164691	1396.391	56982.12	238.7093	5.712995	0.00
6	-0.611	-0.600	0.335687	0.18476	1510.592	60032.31	245.0149	5.099869	0.00
6.5	-0.569	-0.600	0.335687	0.18476	1510.592	60032.31	245.0149	5.099869	0.00
7	-0.527	-0.500	0.361837	0.206266	1628.267	62742.55	250.4846	4.518716	0.00
7.5	-0.485	-0.500	0.361837	0.206266	1628.267	62742.55	250.4846	4.518716	0.00
8	-0.443	-0.400	0.388649	0.229172	1748.921	65052.72	255.0544	3.964704	0.00
8.5	-0.402	-0.400	0.388649	0.229172	1748.921	65052.72	255.0544	3.964704	0.00
9	-0.360	-0.400	0.388649	0.229172	1748.921	65052.72	255.0544	3.964704	0.00
9.5	-0.318	-0.300	0.416002	0.253419	1872.009	66909.18	258.6681	3.43346	0.00
10	-0.276	-0.300	0.416002	0.253419	1872.009	66909.18	258.6681	3.43346	0.00
10.5	-0.234	-0.200	0.443769	0.27893	1996.961	68268.01	261.2815	2.920892	0.00
11	-0.192	-0.200	0.443769	0.27893	1996.961	68268.01	261.2815	2.920892	0.00
11.5	-0.151	-0.200	0.443769	0.27893	1996.961	68268.01	261.2815	2.920892	0.00
12	-0.109	-0.100	0.471814	0.305606	2123.163	69096.42	262.862	2.42322	0.01
12.5	-0.067	-0.100	0.471814	0.305606	2123.163	69096.42	262.862	2.42322	0.01
13	-0.025	0.000	0.5	0.333333	2250	69374.73	263.3908	1.936801	0.03
13.5	0.017	0.000	0.5	0.333333	2250	69374.73	263.3908	1.936801	0.03
14	0.059	0.100	0.528186	0.361978	2376.837	69096.42	262.862	1.458174	0.07
14.5	0.100	0.100	0.528186	0.361978	2376.837	69096.42	262.862	1.458174	0.07
15	0.142	0.100	0.528186	0.361978	2376.837	69096.42	262.862	1.458174	0.07
15.5	0.184	0.200	0.556231	0.391392	2503.04	68268.01	261.2815	0.983981	0.16
16	0.226	0.200	0.556231	0.391392	2503.04	68268.01	261.2815	0.983981	0.16
16.3	**0.251**	**0.300**	**0.583998**	**0.421415**	**2627.991**	**66909.18**	**258.6681**	**0.510865**	**0.30**
16.8	0.293	0.300	0.583998	0.421415	2627.991	66909.18	258.6681	0.510865	0.30
17.3	0.335	0.300	0.583998	0.421415	2627.991	66909.18	258.6681	0.510865	0.30
17.8	0.376	0.400	0.611351	0.451875	2751.08	65053.54	255.056	0.035506	0.49
18.3	0.418	0.400	0.611351	0.451875	2751.08	65053.54	255.056	0.035506	0.49
18.8	0.460	0.500	0.638163	0.482593	2871.734	62743.37	250.4863	-0.44553	0.67
19.3	0.502	0.500	0.638163	0.482593	2871.734	62743.37	250.4863	-0.44553	0.67
19.8	0.544	0.500	0.638163	0.482593	2871.734	62743.37	250.4863	-0.44553	0.67
20.3	0.586	0.600	0.664313	0.513387	2989.409	60033.13	245.0166	-0.93574	0.83
20.8	0.627	0.600	0.664313	0.513387	2989.409	60033.13	245.0166	-0.93574	0.83
21.3	0.669	0.700	0.689691	0.544073	3103.61	56982.12	238.7093	-1.43888	0.92
21.8	0.711	0.700	0.689691	0.544073	3103.61	56982.12	238.7093	-1.43888	0.92
22.3	0.753	0.800	0.714196	0.574469	3213.882	53656.47	231.6387	-1.95885	0.97
22.8	0.795	0.800	0.714196	0.574469	3213.882	53656.47	231.6387	-1.95885	0.97
23.3	0.837	0.800	0.714196	0.574469	3213.882	53656.47	231.6387	-1.95885	0.97
23.8	0.878	0.900	0.737741	0.604402	3319.835	50125.49	223.8872	-2.49991	0.99
24.3	0.920	0.900	0.737741	0.604402	3319.835	50125.49	223.8872	-2.49991	0.99
24.8	0.962	1.000	0.76025	0.633702	3421.125	46456.48	215.5377	-3.0667	1.00
25.3	1.004	1.000	0.76025	0.633702	3421.125	46456.48	215.5377	-3.0667	1.00
25.8	1.046	1.000	0.76025	0.633702	3421.125	46456.48	215.5377	-3.0667	1.00
26.3	1.088	1.100	0.781662	0.662216	3517.479	42717.6	206.6824	-3.66429	1.00
26.8	1.129	1.100	0.781662	0.662216	3517.479	42717.6	206.6824	-3.66429	1.00
27.3	1.171	1.200	0.801928	0.6898	3608.676	38971.48	197.412	-4.29832	1.00
27.8	1.213	1.200	0.801928	0.6898	3608.676	38971.48	197.412	-4.29832	1.00
28.3	1.255	1.300	0.821015	0.716331	3694.568	35276.61	187.8207	-4.97513	1.00
28.8	1.297	1.300	0.821015	0.716331	3694.568	35276.61	187.8207	-4.97513	1.00
29.3	1.339	1.300	0.821015	0.716331	3694.568	35276.61	187.8207	-4.97513	1.00
29.8	1.380	1.400	0.821015	0.716331	3694.568	35276.61	187.8207	-4.97513	1.00
30.3	1.422	1.400	0.821015	0.716331	3694.568	35276.61	187.8207	-4.97513	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 (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	115.5	0
3	R	3	115.5	0
3	R	3	115.5	0
3	R	3	115.5	0
2	R	2	87	0
0	R	0	39.5	0
2	R	2	87	0
2	R	2	87	0
1	R	1	60.5	0
0	R	0	39.5	0
3	R	3	115.5	0
1	R	1	60.5	0
1	R	1	60.5	0
0	R	0	39.5	0
1	R	1	60.5	0
2	R	2	87	0
3	R	3	115.5	0
2	R	2	87	0
1	R	1	60.5	0
2	R	2	87	0
3	R	3	115.5	0
4	R	4	134	0
3	R	3	115.5	0
1	R	1	60.5	0
3	R	3	115.5	0
5	R	5	144.5	0
3	R	3	115.5	0
3	R	3	115.5	0
1	R	1	60.5	0
2	R	2	87	0
2	R	2	87	0
3	R	3	115.5	0
1	R	1	60.5	0
2	R	2	87	0
4	R	4	134	0
2	R	2	87	0
2	R	2	87	0
2	R	2	87	0
1	R	1	60.5	0
0	R	0	39.5	0
1	R	1	60.5	0
3	R	3	115.5	0
1	R	1	60.5	0
7	R	7	154.5	0
0	R	0	39.5	0
2	R	2	87	0
1	R	1	60.5	0
2	R	2	87	0
0	R	0	39.5	0
0	R	0	39.5	0
1	R	1	60.5	0
2	R	2	87	0
1	R	1	60.5	0
0	R	0	39.5	0
0	R	0	39.5	0
34	R	34	178	0
3	R	3	115.5	0
3	S	-10.3	26	26
0	S	-13.3	4	4
1	S	-12.3	13.5	13.5
6	S	-7.3	29.5	29.5
0	S	-13.3	4	4
2	S	-11.3	22	22
0	S	-13.3	4	4
3	S	-10.3	26	26
0	S	-13.3	4	4
1	S	-12.3	13.5	13.5
0	S	-13.3	4	4
2	S	-11.3	22	22
1	S	-12.3	13.5	13.5
1	S	-12.3	13.5	13.5
2	S	-11.3	22	22
1	S	-12.3	13.5	13.5
1	S	-12.3	13.5	13.5
1	S	-12.3	13.5	13.5
1	S	-12.3	13.5	13.5
0	S	-13.3	4	4
1	S	-12.3	13.5	13.5
2	S	-11.3	22	22
2	S	-11.3	22	22
1	S	-12.3	13.5	13.5
1	S	-12.3	13.5	13.5
1	S	-12.3	13.5	13.5
3	S	-10.3	26	26
0	S	-13.3	4	4
6	S	-7.3	29.5	29.5
4	S	-9.3	28	28
		Sum =	16290	465

* 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:	106	
Avg Rank S:	16	

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

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

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 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 40.5 *(For this calculation, LBGR = 3w for 2002 Igloo Background)*
(Reference Dataset - 2002 Igloo Beta Phoswich)

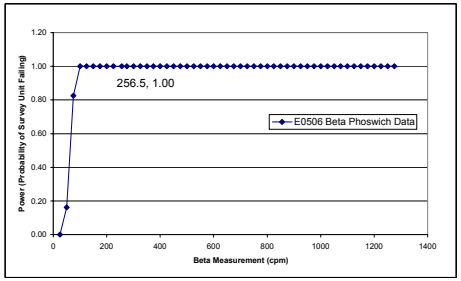
DATA	AREA	ADJUSTED DATA	RANKS	SURVEY AREA RANKS
234	R	234	130.5	0
255	R	255	153	0
272	R	272	162.5	0
206	R	206	81	0
283	R	283	169	0
199	R	199	65.5	0
235	R	235	132	0
202	R	202	71	0
220	R	220	105.5	0
215	R	215	97.5	0
183	R	183	45.5	0
225	R	225	114	0
213	R	213	92	0
243	R	243	139	0
203	R	203	73	0
252	R	252	150	0
197	R	197	60	0
226	R	226	115.5	0
220	R	220	105.5	0
181	R	181	41.5	0
222	R	222	108	0
231	R	231	124.5	0
241	R	241	137	0
228	R	228	118	0
277	R	277	166	0
260	R	260	158	0
387	R	387	178	0
216	R	216	100	0
596	R	596	180	0
163	R	163	21	0
155	R	155	15	0
171	R	171	31.5	0
228	R	228	118	0
196	R	196	57.5	0
237	R	237	134	0
172	R	172	33.5	0
253	R	253	151.5	0
216	R	216	100	0
191	R	191	56	0
231	R	231	124.5	0
204	R	204	75	0
231	R	231	124.5	0
162	R	162	18.5	0
171	R	171	31.5	0
197	R	197	60	0
246	R	246	142	0
166	R	166	23	0
198	R	198	62	0
169	R	169	28.5	0
162	R	162	18.5	0
256	R	256	154	0
233	R	233	128.5	0
179	R	179	38.5	0
260	R	260	158	0
248	R	248	145.5	0
212	R	212	90	0
211	R	211	89	0
229	R	229	120.5	0
430	R	430	179	0
134	R	134	9	0
334	R	334	175	0
168	R	168	26	0
205	R	205	77	0
170	R	170	30	0
210	R	210	86	0
274	R	274	164	0
243	R	243	139	0
229	R	229	120.5	0
159	R	159	17	0
187	R	187	49.5	0
202	R	202	71	0
224	R	224	113	0
168	R	168	26	0
185	R	185	48	0
173	R	173	36	0
233	R	233	128.5	0
169	R	169	28.5	0
182	R	182	44	0
200	R	200	68.5	0
168	R	168	26	0
240	R	240	136	0
215	R	215	97.5	0
181	R	181	41.5	0
197	R	197	60	0
214	R	214	95.5	0
216	R	216	100	0
199	R	199	65.5	0
249	R	249	147	0
209	R	209	85	0
138	R	138	11	0
199	R	199	65.5	0
189	R	189	54	0
248	R	248	145.5	0

	Survey Unit Stats	
Count	30	*m*
SD	52	
Median	223.5	
	Reference Stats	
Count	150	*n*
SD	56	
Median	216	
Critical Value	3225.6	
Bkgd Median plus LBGR	256.5	

Retrospective Power Curve Calculatior *p1* and *p2* pull data from Table 10-3 shee

From Example in Section 10.5 of NUREG-1505

C Measurement	(C-LBGR)/SD	Rounded	p1	p2	E(Wmw)	Var(Wmw)	SD(Wmw)	z	Power
25	-0.279	-0.300	0.416002	0.253419	1872.009	66909.18	258.6681	3.43346	0.00
50	0.171	0.200	0.556231	0.391392	2503.04	68268.01	261.2815	0.983981	0.16
75	0.621	0.600	0.664313	0.513387	2989.409	60033.13	245.0166	-0.93574	0.83
100	1.072	1.100	0.781662	0.662216	3517.479	42717.6	206.6824	-3.66429	1.00
125	1.522	1.500	0.838901	0.741698	3775.055	31683.57	177.9988	-5.70183	1.00
150	1.972	2.000	0.910445	0.848605	4097.003	16497.03	128.4408	-10.4084	1.00
175	2.422	2.400	0.948062	0.908982	4266.279	8542.986	92.42827	-16.2953	1.00
200	2.873	2.900	0.976143	0.956616	4392.644	3184.926	56.43515	-28.9271	1.00
225	3.323	3.300	0.988174	0.977981	4446.783	1275.474	35.71378	-47.2268	1.00
256.5	**3.890**	**3.900**	**0.993336**	**0.98741**	**4470.012**	**597.8393**	**24.45075**	**-69.9314**	**1.00**
275	4.223	4.200	0.997661	0.995497	4489.475	149.3452	12.22069	-141.509	1.00
300	4.674	4.700	0.997661	0.995497	4489.475	149.3452	12.22069	-141.509	1.00
325	5.124	5.100	0.999796	0.999599	4499.082	6.616729	2.5723	-676.028	1.00
350	5.574	5.600	0.999796	0.999599	4499.082	6.616729	2.5723	-676.028	1.00
375	6.024	6.000	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
400	6.474	6.500	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
425	6.925	6.900	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
450	7.375	7.400	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
475	7.825	7.800	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
500	8.275	8.300	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
525	8.726	8.700	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
550	9.176	9.200	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
575	9.626	9.600	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
600	10.076	10.100	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
625	10.527	10.500	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
650	10.977	11.000	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
675	11.427	11.400	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
700	11.877	11.900	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
725	12.328	12.300	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
750	12.778	12.800	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
775	13.228	13.200	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
800	13.678	13.700	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
825	14.129	14.100	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
850	14.579	14.600	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
875	15.029	15.000	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
900	15.479	15.500	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
925	15.930	15.900	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
950	16.380	16.400	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
975	16.830	16.800	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
1000	17.280	17.300	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
1025	17.731	17.700	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
1050	18.181	18.200	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
1075	18.631	18.600	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
1100	19.081	19.100	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
1125	19.532	19.500	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
1150	19.982	20.000	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
1175	20.432	20.400	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
1200	20.882	20.900	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
1225	21.332	21.300	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
1250	21.783	21.800	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
1275	22.233	22.200	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	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 (256.5) 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).

317	R	317	173	0
337	R	337	176	0
281	R	281	168	0
222	R	222	108	0
199	R	199	65.5	0
187	R	187	49.5	0
232	R	232	127	0
188	R	188	51.5	0
246	R	246	142	0
204	R	204	75	0
286	R	286	170.5	0
189	R	189	54	0
264	R	264	160	0
206	R	206	81	0
204	R	204	75	0
202	R	202	71	0
188	R	188	51.5	0
280	R	280	167	0
226	R	226	115.5	0
196	R	196	57.5	0
259	R	259	156	0
234	R	234	130.5	0
183	R	183	45.5	0
272	R	272	162.5	0
369	R	369	177	0
286	R	286	170.5	0
223	R	223	110.5	0
206	R	206	81	0
206	R	206	81	0
251	R	251	149	0
111	R	111	3	0
253	R	253	151.5	0
222	R	222	108	0
230	R	230	122	0
276	R	276	165	0
246	R	246	142	0
260	R	260	158	0
228	R	228	118	0
236	R	236	133	0
164	R	164	22	0
223	R	223	110.5	0
179	R	179	38.5	0
218	R	218	103	0
189	R	189	54	0
200	R	200	68.5	0
172	R	172	33.5	0
156	R	156	16	0
243	R	243	139	0
257	R	257	155	0
214	R	214	95.5	0
250	R	250	148	0
231	R	231	124.5	0
219	R	219	104	0
206	R	206	81	0
180	R	180	40	0
299	R	299	172	0
129	R	129	7	0
215	S	174.5	37	37
175	S	134.5	10	10
254	S	213.5	93.5	93.5
180	S	139.5	12	12
247	S	206.5	84	84
361	S	320.5	174	174
288	S	247.5	144	144
310	S	269.5	161	161
193	S	152.5	14	14
254	S	213.5	93.5	93.5
170	S	129.5	8	8
253	S	212.5	91	91
167	S	126.5	5	5
132	S	91.5	1	1
163	S	122.5	4	4
225	S	184.5	47	47
207	S	166.5	24	24
222	S	181.5	43	43
192	S	151.5	13	13
168	S	127.5	6	6
251	S	210.5	87.5	87.5
246	S	205.5	78	78
203	S	162.5	20	20
239	S	198.5	63	63
264	S	223.5	112	112
257	S	216.5	102	102
280	S	239.5	135	135
213	S	172.5	35	35
251	S	210.5	87.5	87.5
141	S	100.5	2	2
		Sum =	16290	1787

* 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:	97	
Avg Rank S:	60	

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

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

z = 97.5% percentile of standard normal distribution = 1.960

k =	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 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		From Table A.7		If *k* of the *r* largest ranks are from the survey unit, the null hypoth
n (Survey)	30	*r*	6	*(30,100) in Table A.7*
m (Ref)	150	*k*	4	
alpha/2	0.025	*alpha*	0.025	

Alpha Phoswich Ranks		Beta Phoswich Ranks	
Sorted Ranks	Location	Sorted Ranks	Location
4	S	1	S
4	S	2	S
4	S	3	R
4	S	4	S
4	S	5	S
4	S	6	S
4	S	7	R
13.5	S	8	S
13.5	S	9	R
13.5	S	10	S
13.5	S	11	R
13.5	S	12	S
13.5	S	13	S
13.5	S	14	S
13.5	S	15	R
13.5	S	16	R
13.5	S	17	R
13.5	S	18.5	R
13.5	S	18.5	R
22	S	20	S
22	S	21	R
22	S	22	R
22	S	23	R
22	S	24	S
26	S	26	R
26	S	26	R
26	S	26	R
28	S	28.5	R
29.5	S	28.5	R
29.5	S	30	R
39.5	R	31.5	R
39.5	R	31.5	R
39.5	R	33.5	R
39.5	R	33.5	R
39.5	R	35	S
39.5	R	36	R
39.5	R	37	S
39.5	R	38.5	R
39.5	R	38.5	R
39.5	R	40	R
39.5	R	41.5	R
39.5	R	41.5	R
39.5	R	43	S
39.5	R	44	R
39.5	R	45.5	R
39.5	R	45.5	R
39.5	R	47	S
39.5	R	48	R
60.5	R	49.5	R
60.5	R	49.5	R
60.5	R	51.5	R
60.5	R	51.5	R
60.5	R	54	R
60.5	R	54	R
60.5	R	54	R
60.5	R	56	R
60.5	R	57.5	R

60.5	R	57.5	R
60.5	R	60	R
60.5	R	60	R
60.5	R	60	R
60.5	R	62	R
60.5	R	63	S
60.5	R	65.5	R
60.5	R	65.5	R
60.5	R	65.5	R
60.5	R	65.5	R
60.5	R	68.5	R
60.5	R	68.5	R
60.5	R	71	R
60.5	R	71	R
60.5	R	71	R
87	R	73	R
87	R	75	R
87	R	75	R
87	R	75	R
87	R	77	R
87	R	78	S
87	R	81	R
87	R	81	R
87	R	81	R
87	R	81	R
87	R	81	R
87	R	84	S
87	R	85	R
87	R	86	R
87	R	87.5	S
87	R	87.5	S
87	R	89	R
87	R	90	R
87	R	91	S
87	R	92	R
87	R	93.5	S
87	R	93.5	S
87	R	95.5	R
87	R	95.5	R
87	R	97.5	R
87	R	97.5	R
87	R	100	R
87	R	100	R
87	R	100	R
115.5	R	102	S
115.5	R	103	R
115.5	R	104	R
115.5	R	105.5	R
115.5	R	105.5	R
115.5	R	108	R
115.5	R	108	R
115.5	R	108	R
115.5	R	110.5	R
115.5	R	110.5	R
115.5	R	112	S
115.5	R	113	R
115.5	R	114	R
115.5	R	115.5	R
115.5	R	115.5	R
115.5	R	118	R
115.5	R	118	R
115.5	R	118	R
115.5	R	120.5	R
115.5	R	120.5	R

115.5	R	122	R
115.5	R	124.5	R
115.5	R	124.5	R
115.5	R	124.5	R
115.5	R	124.5	R
115.5	R	127	R
115.5	R	128.5	R
115.5	R	128.5	R
134	R	130.5	R
134	R	130.5	R
134	R	132	R
134	R	133	R
134	R	134	R
134	R	135	S
134	R	136	R
134	R	137	R
134	R	139	R
144.5	R	139	R
144.5	R	139	R
144.5	R	142	R
144.5	R	142	R
144.5	R	142	R
144.5	R	144	S
144.5	R	145.5	R
144.5	R	145.5	R
144.5	R	147	R
144.5	R	148	R
144.5	R	149	R
144.5	R	150	R
152	R	151.5	R
152	R	151.5	R
152	R	153	R
154.5	R	154	R
154.5	R	155	R
157	R	156	R
157	R	158	R
157	R	158	R
160	R	158	R
160	R	160	R
160	R	161	S
162.5	R	162.5	R
162.5	R	162.5	R
165	R	164	R
165	R	165	R
165	R	166	R
167.5	R	167	R
167.5	R	168	R
169.5	R	169	R
169.5	R	170.5	R
172	R	170.5	R
172	R	172	R
172	R	173	R
174.5	R	174	S
174.5	R	175	R
176	R	176	R
177	R	177	R
178	R	178	R
179	R	179	R
180	R	180	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=7
k=5
0 of top 7 from S

hesis 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