Spreadsheet Formulas for the Wilcoxon Rank Sum Test and Power Calculation

Wilcoxon Rank Sum Test, per NUREG-1505

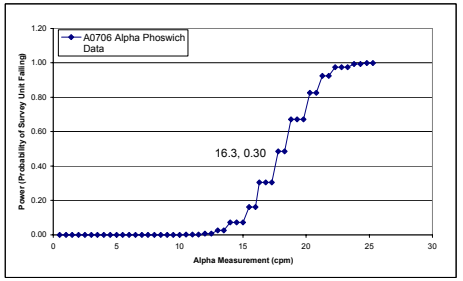
LBGR 13.3 *(For this calculation, LBGR = 3w for 2002 Igloo Background)*
(Reference Dataset - 2002 Igloo Alpha Phoswich)

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	133	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	133	0
7	R	7	154.5	0
4	R	4	133	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	133	0
1	R	1	59.5	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	114.5	0
3	R	3	114.5	0
3	R	3	114.5	0
4	R	4	133	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	114.5	0
2	R	2	86	0
3	R	3	114.5	0
4	R	4	133	0
4	R	4	133	0
5	R	5	144.5	0
3	R	3	114.5	0
5	R	5	144.5	0
2	R	2	86	0
2	R	2	86	0
5	R	5	144.5	0
2	R	2	86	0
5	R	5	144.5	0
5	R	5	144.5	0
3	R	3	114.5	0
2	R	2	86	0
5	R	5	144.5	0
8	R	8	157	0
2	R	2	86	0
3	R	3	114.5	0
86	R	86	179	0
2	R	2	86	0
1	R	1	59.5	0
5	R	5	144.5	0
3	R	3	114.5	0
1	R	1	59.5	0
2	R	2	86	0
0	R	0	38.5	0
0	R	0	38.5	0
2	R	2	86	0
1	R	1	59.5	0
2	R	2	86	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	R	0	38.5	0
0	R	0	38.5	0
1	R	1	59.5	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
1	R	1	59.5	0
2	R	2	86	0
1	R	1	59.5	0
3	R	3	114.5	0
13	R	13	167.5	0
3	R	3	114.5	0
2	R	2	86	0
1	R	1	59.5	0
2	R	2	86	0

Survey Unit Stats		
Count	30	*m*
SD	3	
Median	4	
Reference Stats		
Count	150	*n*
SD	12	
Median	3	
Critical Value	3225.6	
Bkgd Median plus LBGR	16.3	

Retrospective Power Curve Calculator *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
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	-0.9872	-1.000	0.218338	0.098892	982.521	42717.6	206.6824	8.600707	0.00
2	-0.9454	-0.900	0.23975	0.113202	1078.875	46456.48	215.5377	7.80031	0.00
2.5	-0.9036	-0.900	0.23975	0.113202	1078.875	46456.48	215.5377	7.80031	0.00
3	-0.8617	-0.900	0.23975	0.113202	1078.875	46456.48	215.5377	7.80031	0.00
3.5	-0.8199	-0.800	0.262259	0.12892	1180.166	50125.49	223.8872	7.05699	0.00
4	-0.7781	-0.800	0.262259	0.12892	1180.166	50125.49	223.8872	7.05699	0.00
4.5	-0.7362	-0.700	0.310309	0.164691	1396.391	56982.12	238.7093	5.712995	0.00
5	-0.6944	-0.700	0.310309	0.164691	1396.391	56982.12	238.7093	5.712995	0.00
5.5	-0.6526	-0.700	0.310309	0.164691	1396.391	56982.12	238.7093	5.712995	0.00
6	-0.6107	-0.600	0.335687	0.18476	1510.592	60032.31	245.0149	5.099869	0.00
6.5	-0.5689	-0.600	0.335687	0.18476	1510.592	60032.31	245.0149	5.099869	0.00
7	-0.5271	-0.500	0.361837	0.206266	1628.267	62742.55	250.4846	4.518716	0.00
7.5	-0.4852	-0.500	0.361837	0.206266	1628.267	62742.55	250.4846	4.518716	0.00
8	-0.4434	-0.400	0.388649	0.229172	1748.921	65052.72	255.0544	3.964704	0.00
8.5	-0.4016	-0.400	0.388649	0.229172	1748.921	65052.72	255.0544	3.964704	0.00
9	-0.3598	-0.400	0.388649	0.229172	1748.921	65052.72	255.0544	3.964704	0.00
9.5	-0.3179	-0.300	0.416002	0.253419	1872.009	66909.18	258.6681	3.43346	0.00
10	-0.2761	-0.300	0.416002	0.253419	1872.009	66909.18	258.6681	3.43346	0.00
10.5	-0.2343	-0.200	0.443769	0.27893	1996.961	68268.01	261.2815	2.920892	0.00
11	-0.1924	-0.200	0.443769	0.27893	1996.961	68268.01	261.2815	2.920892	0.00
11.5	-0.1506	-0.200	0.443769	0.27893	1996.961	68268.01	261.2815	2.920892	0.00
12	-0.1088	-0.100	0.471814	0.305606	2123.163	69096.42	262.862	2.42322	0.01
12.5	-0.0669	-0.100	0.471814	0.305606	2123.163	69096.42	262.862	2.42322	0.01
13	-0.0251	0.000	0.5	0.333333	2250	69374.73	263.3908	1.936801	0.03
13.5	0.0167	0.000	0.5	0.333333	2250	69374.73	263.3908	1.936801	0.03
14	0.0586	0.100	0.528186	0.361978	2376.837	69096.42	262.862	1.458174	0.07
14.5	0.1004	0.100	0.528186	0.361978	2376.837	69096.42	262.862	1.458174	0.07
15	0.1422	0.100	0.528186	0.361978	2376.837	69096.42	262.862	1.458174	0.07
15.5	0.1841	0.200	0.556231	0.391392	2503.04	68268.01	261.2815	0.983981	0.16
16	0.2259	0.200	0.556231	0.391392	2503.04	68268.01	261.2815	0.983981	0.16
16.3	**0.2510**	**0.300**	**0.583998**	**0.421415**	**2627.991**	**66909.18**	**258.6681**	**0.510865**	**0.30**
16.8	0.2928	0.300	0.583998	0.421415	2627.991	66909.18	258.6681	0.510865	0.30
17.3	0.3347	0.300	0.583998	0.421415	2627.991	66909.18	258.6681	0.510865	0.30
17.8	0.3765	0.400	0.611351	0.451875	2751.08	65053.54	255.056	0.035506	0.49
18.3	0.4183	0.400	0.611351	0.451875	2751.08	65053.54	255.056	0.035506	0.49
18.8	0.4601	0.500	0.638163	0.482593	2871.734	62743.37	250.4863	-0.44553	0.67
19.3	0.5020	0.500	0.638163	0.482593	2871.734	62743.37	250.4863	-0.44553	0.67
19.8	0.5438	0.500	0.638163	0.482593	2871.734	62743.37	250.4863	-0.44553	0.67
20.3	0.5856	0.600	0.664313	0.513387	2989.409	60033.13	245.0166	-0.93574	0.83
20.8	0.6275	0.600	0.664313	0.513387	2989.409	60033.13	245.0166	-0.93574	0.83
21.3	0.6693	0.700	0.689691	0.544073	3103.61	56982.12	238.7093	-1.43888	0.92
21.8	0.7111	0.700	0.689691	0.544073	3103.61	56982.12	238.7093	-1.43888	0.92
22.3	0.7530	0.800	0.714196	0.574469	3213.882	53656.47	231.6387	-1.95885	0.97
22.8	0.7948	0.800	0.714196	0.574469	3213.882	53656.47	231.6387	-1.95885	0.97
23.3	0.8366	0.800	0.714196	0.574469	3213.882	53656.47	231.6387	-1.95885	0.97
23.8	0.8785	0.900	0.737741	0.604402	3319.835	50125.49	223.8872	-2.49991	0.99
24.3	0.9203	0.900	0.737741	0.604402	3319.835	50125.49	223.8872	-2.49991	0.99
24.8	0.9621	1.000	0.76025	0.633702	3421.125	46456.48	215.5377	-3.0667	1.00
25.3	1.0040	1.000	0.76025	0.633702	3421.125	46456.48	215.5377	-3.0667	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	114.5	0
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	144.5	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	154.5	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
5	S	-8.3	21.5	21.5
8	S	-5.3	28.5	28.5
1	S	-12.3	1.5	1.5
3	S	-10.3	9	9
5	S	-8.3	21.5	21.5
4	S	-9.3	15.5	15.5
5	S	-8.3	21.5	21.5
3	S	-10.3	9	9
2	S	-11.3	4	4
4	S	-9.3	15.5	15.5
5	S	-8.3	21.5	21.5
3	S	-10.3	9	9
3	S	-10.3	9	9
3	S	-10.3	9	9
5	S	-8.3	21.5	21.5
3	S	-10.3	9	9
4	S	-9.3	15.5	15.5
1	S	-12.3	1.5	1.5
3	S	-10.3	9	9
7	S	-6.3	26.5	26.5
4	S	-9.3	15.5	15.5
4	S	-9.3	15.5	15.5
5	S	-8.3	21.5	21.5
7	S	-6.3	26.5	26.5
6	S	-7.3	25	25
8	S	-5.3	28.5	28.5
4	S	-9.3	15.5	15.5
2	S	-11.3	4	4
18	S	4.7	138	138
2	S	-11.3	4	4
		Sum =	16290	573

* 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:	19	

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 =	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)

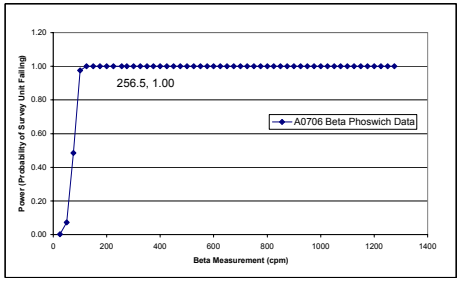
DATA	AREA	ADJUSTED DATA	RANKS	SURVEY AREA RANKS
234	R	234	131.5	0
255	R	255	153	0
272	R	272	161.5	0
206	R	206	83	0
283	R	283	169	0
199	R	199	68.5	0
235	R	235	133	0
202	R	202	74	0
220	R	220	103.5	0
215	R	215	95.5	0
183	R	183	44.5	0
225	R	225	113	0
213	R	213	92	0
243	R	243	139	0
203	R	203	76	0
252	R	252	149	0
197	R	197	64	0
226	R	226	114.5	0
220	R	220	103.5	0
181	R	181	40.5	0
222	R	222	107	0
231	R	231	125.5	0
241	R	241	137	0
228	R	228	119	0
277	R	277	165	0
260	R	260	158	0
387	R	387	177	0
216	R	216	98	0
596	R	596	180	0
163	R	163	19	0
155	R	155	11	0
171	R	171	29.5	0
228	R	228	119	0
196	R	196	60.5	0
237	R	237	135	0
172	R	172	31.5	0
253	R	253	151.5	0
216	R	216	98	0
191	R	191	58	0
231	R	231	125.5	0
204	R	204	78	0
231	R	231	125.5	0
162	R	162	16.5	0
171	R	171	29.5	0
197	R	197	64	0
246	R	246	142	0
166	R	166	21	0
198	R	198	66	0
169	R	169	26.5	0
162	R	162	16.5	0
256	R	256	154	0
233	R	233	129.5	0
179	R	179	36.5	0
260	R	260	158	0
248	R	248	144.5	0
212	R	212	91	0
211	R	211	90	0
229	R	229	121.5	0
430	R	430	178	0
134	R	134	5	0
334	R	334	174	0
168	R	168	24	0
205	R	205	80	0
170	R	170	28	0
210	R	210	88	0
274	R	274	163	0
243	R	243	139	0
229	R	229	121.5	0
159	R	159	15	0
187	R	187	50.5	0
202	R	202	74	0
224	R	224	112	0
168	R	168	24	0
185	R	185	48	0
173	R	173	33	0
233	R	233	129.5	0
169	R	169	26.5	0
182	R	182	42	0
200	R	200	71.5	0
168	R	168	24	0
240	R	240	136	0
215	R	215	95.5	0
181	R	181	40.5	0
197	R	197	64	0
214	R	214	93.5	0
216	R	216	98	0
199	R	199	68.5	0
249	R	249	146	0
209	R	209	87	0
138	R	138	6	0
199	R	199	68.5	0
189	R	189	56	0
248	R	248	144.5	0

Survey Unit Stats	
Count	30 *m*
SD	79
Median	225
Reference Stats	
Count	150 *n*
SD	56
Median	216
Critical Value	3225.6
Bkgd Median plus LBGR	256.5

Retrospective Power Curve Calculator *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	-0.197	-0.200	0.443769	0.27893	1996.961	68268.01	261.2815	2.920892	0.00
50	0.121	0.100	0.528186	0.361978	2376.837	69096.42	262.862	1.458174	0.07
75	0.438	0.400	0.611351	0.451875	2751.08	65053.54	255.056	0.035506	0.49
100	0.755	0.800	0.714196	0.574469	3213.882	53656.47	231.6387	-1.95885	0.97
125	1.072	1.100	0.781662	0.662216	3517.479	42717.6	206.6824	-3.66429	1.00
150	1.389	1.400	0.821015	0.716331	3694.568	35276.61	187.8207	-4.97513	1.00
175	1.707	1.700	0.87105	0.788602	3919.725	24972.17	158.0259	-7.33797	1.00
200	2.024	2.000	0.910445	0.848605	4097.003	16497.03	128.4408	-10.4084	1.00
225	2.341	2.300	0.940103	0.895917	4230.464	10182.42	100.908	-14.571	1.00
256.5	**2.741**	**2.700**	**0.967004**	**0.940817**	**4351.518**	**4828.479**	**69.48726**	**-22.9018**	**1.00**
275	2.976	3.000	0.979848	0.963118	4409.316	2558.876	50.58533	-32.6019	1.00
300	3.293	3.300	0.988174	0.977981	4446.783	1275.474	35.71378	-47.2268	1.00
325	3.610	3.600	0.993336	0.98741	4470.012	597.8393	24.45075	-69.9314	1.00
350	3.927	3.900	0.993336	0.98741	4470.012	597.8393	24.45075	-69.9314	1.00
375	4.244	4.200	0.997661	0.995497	4489.475	149.3452	12.22069	-141.509	1.00
400	4.562	4.600	0.997661	0.995497	4489.475	149.3452	12.22069	-141.509	1.00
425	4.879	4.900	0.997661	0.995497	4489.475	149.3452	12.22069	-141.509	1.00
450	5.196	5.200	0.999796	0.999599	4499.082	6.616729	2.5723	-676.028	1.00
475	5.513	5.500	0.999796	0.999599	4499.082	6.616729	2.5723	-676.028	1.00
500	5.831	5.800	0.999796	0.999599	4499.082	6.616729	2.5723	-676.028	1.00
525	6.148	6.100	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
550	6.465	6.500	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
575	6.782	6.800	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
600	7.099	7.100	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
625	7.417	7.400	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
650	7.734	7.700	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
675	8.051	8.100	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
700	8.368	8.400	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
725	8.686	8.700	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
750	9.003	9.000	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
775	9.320	9.300	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
800	9.637	9.600	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
825	9.955	10.000	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
850	10.272	10.300	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.00
875	10.589	10.600	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
900	10.906	10.900	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
925	11.223	11.200	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
950	11.541	11.500	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
975	11.858	11.900	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
1000	12.175	12.200	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
1025	12.492	12.500	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
1050	12.810	12.800	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
1075	13.127	13.100	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
1100	13.444	13.400	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
1125	13.761	13.800	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
1150	14.078	14.100	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
1175	14.396	14.400	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
1200	14.713	14.700	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
1225	15.030	15.000	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
1250	15.347	15.300	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000
1275	15.665	15.700	0.999989	0.999978	4499.951	0.0494	0.222262	-7827.77	1.000



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 (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	175	0
281	R		281	168	0
222	R		222	107	0
199	R		199	68.5	0
187	R		187	50.5	0
232	R		232	128	0
188	R		188	53.5	0
246	R		246	142	0
204	R		204	78	0
286	R		286	170.5	0
189	R		189	56	0
264	R		264	160	0
206	R		206	83	0
204	R		204	78	0
202	R		202	74	0
188	R		188	53.5	0
280	R		280	167	0
226	R		226	114.5	0
196	R		196	60.5	0
259	R		259	156	0
234	R		234	131.5	0
183	R		183	44.5	0
272	R		272	161.5	0
369	R		369	176	0
286	R		286	170.5	0
223	R		223	110.5	0
206	R		206	83	0
206	R		206	83	0
251	R		251	148	0
111	R		111	2	0
253	R		253	151.5	0
222	R		222	107	0
230	R		230	123	0
276	R		276	164	0
246	R		246	142	0
260	R		260	158	0
228	R		228	119	0
236	R		236	134	0
164	R		164	20	0
223	R		223	110.5	0
179	R		179	36.5	0
218	R		218	101	0
189	R		189	56	0
200	R		200	71.5	0
172	R		172	31.5	0
156	R		156	13	0
243	R		243	139	0
257	R		257	155	0
214	R		214	93.5	0
250	R		250	147	0
231	R		231	125.5	0
219	R		219	102	0
206	R		206	83	0
180	R		180	39	0
299	R		299	172	0
129	R		129	4	0
214	S		173.5	34	34
225	S		184.5	46.5	46.5
263	S		222.5	109	109
198	S		157.5	14	14
268	S		227.5	116.5	116.5
220	S		179.5	38	38
268	S		227.5	116.5	116.5
293	S		252.5	150	150
225	S		184.5	46.5	46.5
228	S		187.5	52	52
186	S		145.5	7	7
236	S		195.5	59	59
165	S		124.5	3	3
195	S		154.5	10	10
207	S		166.5	22	22
223	S		182.5	43	43
203	S		162.5	18	18
215	S		174.5	35	35
192	S		151.5	8	8
193	S		152.5	9	9
227	S		186.5	49	49
249	S		208.5	86	86
196	S		155.5	12	12
237	S		196.5	62	62
261	S		220.5	105	105
251	S		210.5	89	89
320	S		279.5	166	166
257	S		216.5	100	100
608	S		567.5	179	179
148	S		107.5	1	1
		Sum =		16290	1786

* 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

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

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	
n (Survey)	30	*r*	6
m (Ref)	150	*k*	4
alpha/2	0.025	*alpha*	0.025

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

Alpha Phoswich Ranks		Beta Phoswich Ranks	
Sorted Ranks	Location	Sorted Ranks	Location
1.5	S	1	S
1.5	S	2	R
4	S	3	S
4	S	4	R
4	S	5	R
9	S	6	R
9	S	7	S
9	S	8	S
9	S	9	S
9	S	10	S
9	S	11	R
9	S	12	S
15.5	S	13	R
15.5	S	14	S
15.5	S	15	R
15.5	S	16.5	R
15.5	S	16.5	R
15.5	S	18	S
21.5	S	19	R
21.5	S	20	R
21.5	S	21	R
21.5	S	22	S
21.5	S	24	R
21.5	S	24	R
25	S	24	R
26.5	S	26.5	R
26.5	S	26.5	R
28.5	S	28	R
28.5	S	29.5	R
38.5	R	29.5	R
38.5	R	31.5	R
38.5	R	31.5	R
38.5	R	33	R
38.5	R	34	S
38.5	R	35	S
38.5	R	36.5	R
38.5	R	36.5	R
38.5	R	38	S
38.5	R	39	R
38.5	R	40.5	R
38.5	R	40.5	R
38.5	R	42	R
38.5	R	43	S
38.5	R	44.5	R
38.5	R	44.5	R
38.5	R	46.5	S
38.5	R	46.5	S
59.5	R	48	R
59.5	R	49	S
59.5	R	50.5	R
59.5	R	50.5	R
59.5	R	52	S
59.5	R	53.5	R
59.5	R	53.5	R
59.5	R	56	R
59.5	R	56	R
59.5	R	56	R

59.5	R	58	R
59.5	R	59	S
59.5	R	60.5	R
59.5	R	60.5	R
59.5	R	62	S
59.5	R	64	R
59.5	R	64	R
59.5	R	64	R
59.5	R	66	R
59.5	R	68.5	R
59.5	R	68.5	R
59.5	R	68.5	R
59.5	R	68.5	R
59.5	R	71.5	R
86	R	71.5	R
86	R	74	R
86	R	74	R
86	R	74	R
86	R	76	R
86	R	78	R
86	R	78	R
86	R	78	R
86	R	80	R
86	R	83	R
86	R	83	R
86	R	83	R
86	R	83	R
86	R	83	R
86	R	86	S
86	R	87	R
86	R	88	R
86	R	89	S
86	R	90	R
86	R	91	R
86	R	92	R
86	R	93.5	R
86	R	93.5	R
86	R	95.5	R
86	R	95.5	R
86	R	98	R
86	R	98	R
86	R	98	R
86	R	100	S
114.5	R	101	R
114.5	R	102	R
114.5	R	103.5	R
114.5	R	103.5	R
114.5	R	105	S
114.5	R	107	R
114.5	R	107	R
114.5	R	107	R
114.5	R	109	S
114.5	R	110.5	R
114.5	R	110.5	R
114.5	R	112	R
114.5	R	113	R
114.5	R	114.5	R
114.5	R	114.5	R
114.5	R	116.5	S
114.5	R	116.5	S
114.5	R	119	R
114.5	R	119	R
114.5	R	119	R
114.5	R	121.5	R

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	R
133	R	129.5	R
133	R	129.5	R
133	R	131.5	R
133	R	131.5	R
133	R	133	R
133	R	134	R
133	R	135	R
133	R	136	R
133	R	137	R
138	S	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	144.5	R
144.5	R	144.5	R
144.5	R	146	R
144.5	R	147	R
144.5	R	148	R
144.5	R	149	R
144.5	R	150	S
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	161.5	R
162.5	R	161.5	R
162.5	R	163	R
165	R	164	R
165	R	165	R
165	R	166	S
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	R
174.5	R	175	R
176	R	176	R
177	R	177	R
178	R	178	R
179	R	179	S
180	R	180	R
0 of top 6 from S		**1 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

ɳesis 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