OAK RIDGE NATIONAL LABORATORY LIBRARIES
3 4456 0548659 6

CENTRAL RESEARCH LIBRARY
DOCUMENT COLLECTION

ORNL-3649, Vol. 2
UC-37 – Instruments
TID-4500 (37th ed.)
Section 2.5

SMOOTHED THERMOCOUPLE TABLES OF EXTENDED SIGNIFICANCE (°C)

Volume 2

Section 2.5 Copper-Constantan Thermocouples

R. K. Adams
E. G. Davisson

OAK RIDGE NATIONAL LABORATORY
operated by
UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION

CENTRAL RESEARCH LIBRARY
DOCUMENT COLLECTION
LIBRARY LOAN COPY
DO NOT TRANSFER TO ANOTHER PERSON
If you wish someone else to see this document, send in name with document and the library will arrange a loan.

Printed in USA. Price $2.00. Available from the Clearinghouse for Federal Scientific and Technical Information, National Bureau of Standards, U.S. Department of Commerce, Springfield, Virginia

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

ORNL-3649
Vol. 2, Sect. 2.5

Contract No. W-7405-eng-26

INSTRUMENTATION AND CONTROLS DIVISION

SMOOTHED THERMOCOUPLE TABLES OF EXTENDED SIGNIFICANCE (°C)

R. K. Adams and E. G. Davisson

Volume 2

SECTION 2.5 COPPER-CONSTANTAN THERMOCOUPLES

MARCH 1965

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee
operated by
UNION CARBIDE CORPORATION
for the
U. S. ATOMIC ENERGY COMMISSION

OAK RIDGE NATIONAL LABORATORY LIBRARIES

3 4456 0548659 6

SMOOTHED THERMOCOUPLE TABLES OF EXTENDED SIGNIFICANCE (°C)

R. K. Adams E. G. Davisson

Volume 2

SECTION 2.5 COPPER-CONSTANTAN THERMOCOUPLES

This section contains tables of emf (in absolute millivolts) vs temperature (in degrees Celsius on the International Temperature Scale of 1948) for copper-constantan thermocouples. The values in these tables, derived from those given in National Bureau of Standards Circular 561, Table 10,[1] are computed to more significant digits, that is, to the nearest 0.001 μv. The techniques of computation are described in Vol. 1 of this report.

Figure 1, a plot of the difference in microvolts between the values in the smoothed table and those in the original table vs temperature, illustrates how the values in the smoothed table compare with those in the original table.

In Table 5 a smoothed emf value is tabulated in absolute millivolts for every degree Celsius in the range of the table.

In Table 5A the first two columns contain the same information as given in Table 5. To the right of these two columns is a difference table of the millivolt values in column 2. The difference table is expressed in thousandths of microvolts and contains orders 0 through 5. This difference table gives a convenient tabulation of differences for those engaged in temperature difference work.

Although these tables are expressed to the nearest 0.001 μv, which is roughly equivalent to 0.00002°C, this in no way implies that temperature measurements to this accuracy are possible. The user of these tables is reminded of the accuracy tolerances on thermocouples published by the American Society for Testing and Materials[2] and the Instrument Society of America,[3] which state limits of error equivalent to about ±0.8°C from −60 to 93°C, ±0.75% of reading from 93 to 370°C for "standard" materials, and one-half these limits for "special" materials. Individual calibration of copper-constantan thermocouples in the ORNL Standards Laboratory can improve their accuracy to better than ±0.5°C in the range of −190 to 1100°C, and the reproducibility will be better than ±0.25°C.

After a thermocouple has been used in the field to measure temperature, the reproducibility of the characteristic calibration curve for that thermocouple, previously standardized in the ORNL Standards Laboratory, depends on such factors as the temperatures to which the thermocouple had been exposed, the length of exposure to elevated or depressed temperatures, and the conditions of exposure.[4]

---

[1] H. Shenker *et al.*, "Reference Tables for Thermocouples," *Nat. Bur. Std. (U.S.) Circ. 561*, GPO, Washington, 1955.

[2] "Temperature Electromotive Force (EMF) Tables for Thermocouples, ASTM E 230–63," *Am. Soc. Testing Mater., ASTM Std. 1964*, Pt. 30, pp. 646–704; see Table XIII, p. 700.

[3] "Thermocouples and Thermocouple Extension Wires — Terminology, Limits of Error, and Wire Sizes," *Recommended Practice RP 1.3*, Instrument Society of America, Pittsburgh, Pa., 1959.

[4] "Temperature Electromotive Force (EMF) Tables for Thermocouples, ASTM E 230–63," *Am. Soc. Testing Mater., ASTM Std. 1964*, Pt. 30, pp. 646–704; see Note 3 to Table XIII, p. 700.

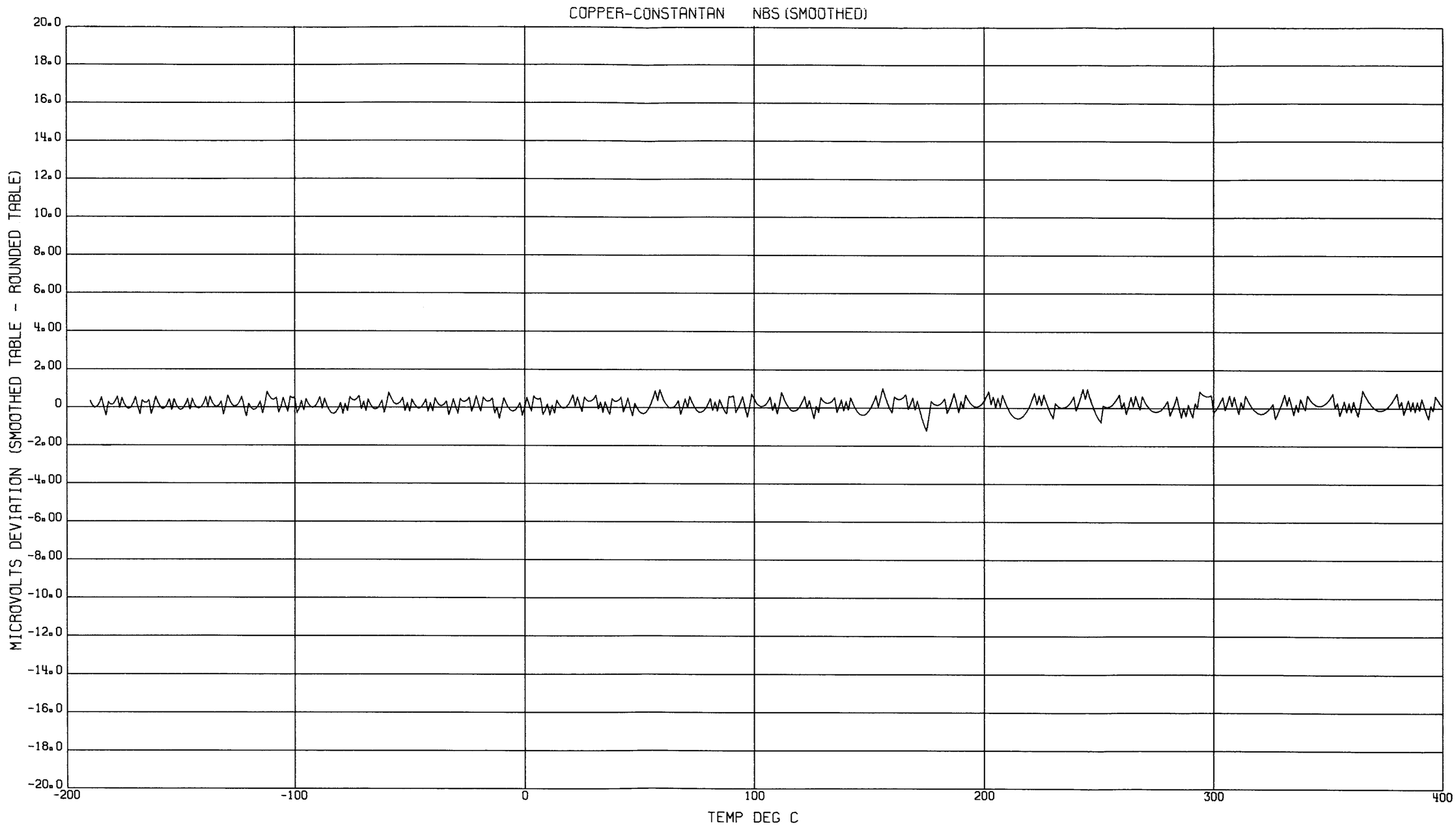

Fig. 1. Deviation of Original Table from Smoothed Table.

COPPER-CONSTANTAN NBS(SMOOTHED)
TABLE NO. 5

TEMP=DEG C (INT.1948)
VOLTAGE=MILLIVOLT ABSOLUTE

TEMP	0	1	2	3	4	5	6	7	8	9
					MILLIVOLTS					
-190	-5.378682									
-180	-5.204853	-5.222851	-5.240713	-5.258439	-5.276029	-5.293482	-5.310797	-5.327975	-5.345015	-5.361918
-170	-5.017457	-5.036799	-5.056008	-5.075083	-5.094025	-5.112833	-5.131506	-5.150045	-5.168450	-5.186719
-160	-4.816790	-4.837445	-4.857970	-4.878365	-4.898630	-4.918763	-4.938766	-4.958637	-4.978376	-4.997983
-150	-4.603147	-4.625087	-4.646900	-4.668586	-4.690143	-4.711573	-4.732874	-4.754047	-4.775090	-4.796005
-140	-4.376791	-4.399992	-4.423068	-4.446019	-4.468844	-4.491543	-4.514116	-4.536564	-4.558885	-4.581079
-130	-4.137949	-4.162390	-4.186707	-4.210901	-4.234972	-4.258919	-4.282742	-4.306441	-4.330015	-4.353466
-120	-3.886817	-3.912478	-3.938018	-3.963436	-3.988733	-4.013908	-4.038961	-4.063892	-4.088700	-4.113386
-110	-3.623585	-3.650447	-3.677190	-3.703813	-3.730317	-3.756701	-3.782965	-3.809109	-3.835133	-3.861035
-100	-3.348475	-3.376513	-3.404435	-3.432240	-3.459928	-3.487499	-3.514952	-3.542288	-3.569505	-3.596605
-90	-3.061766	-3.090950	-3.120021	-3.148978	-3.177822	-3.206551	-3.235166	-3.263666	-3.292051	-3.320321
-80	-2.763758	-2.794060	-2.824251	-2.854330	-2.884299	-2.914157	-2.943903	-2.973537	-3.003059	-3.032469
-70	-2.454706	-2.486102	-2.517390	-2.548569	-2.579639	-2.610600	-2.641451	-2.672193	-2.702825	-2.733347
-60	-2.134798	-2.167272	-2.199639	-2.231899	-2.264052	-2.296098	-2.328035	-2.359865	-2.391587	-2.423200
-50	-1.804220	-1.837752	-1.871179	-1.904501	-1.937718	-1.970829	-2.003835	-2.036735	-2.069529	-2.102217
-40	-1.463197	-1.497762	-1.532225	-1.566586	-1.600844	-1.634999	-1.669050	-1.702999	-1.736843	-1.770584
-30	-1.111983	-1.147556	-1.183028	-1.218402	-1.253675	-1.288847	-1.323920	-1.358891	-1.393761	-1.428530
-20	-.750848	-.787400	-.823855	-.860213	-.896475	-.932638	-.968704	-1.004672	-1.040541	-1.076311
-10	-.380087	-.417587	-.454994	-.492308	-.529527	-.566651	-.603681	-.640616	-.677456	-.714200
0	0	-.038421	-.076751	-.114990	-.153137	-.191192	-.229156	-.267028	-.304807	-.342493
0	0	.038512	.077114	.115808	.154591	.193465	.232429	.271483	.310628	.349862
10	.389186	.428599	.468103	.507696	.547379	.587151	.627013	.666964	.707005	.747135
20	.787355	.827664	.868061	.908548	.949124	.989789	1.030542	1.071384	1.112315	1.153334
30	1.194441	1.235636	1.276919	1.318290	1.359748	1.401293	1.442925	1.484645	1.526450	1.568342
40	1.610320	1.652384	1.694534	1.736769	1.779089	1.821494	1.863984	1.906558	1.949216	1.991958
50	2.034783	2.077692	2.120684	2.163758	2.206916	2.250155	2.293477	2.336880	2.380365	2.423931
60	2.467578	2.511306	2.555114	2.599003	2.642972	2.687021	2.731150	2.775357	2.819644	2.864010
70	2.908455	2.952978	2.997579	3.042259	3.087016	3.131851	3.176763	3.221753	3.266819	3.311963
80	3.357183	3.402479	3.447852	3.493301	3.538826	3.584427	3.630104	3.675857	3.721684	3.767587
90	3.813566	3.859619	3.905747	3.951950	3.998228	4.044580	4.091006	4.137507	4.184081	4.230730
100	4.277452	4.324247	4.371116	4.418059	4.465074	4.512162	4.559323	4.606556	4.653861	4.701239
110	4.748688	4.796209	4.843801	4.891464	4.939198	4.987003	5.034878	5.082823	5.130838	5.178922
120	5.227076	5.275299	5.323590	5.371950	5.420378	5.468875	5.517439	5.566070	5.614769	5.663535
130	5.712368	5.761268	5.810234	5.859266	5.908365	5.957530	6.006761	6.056057	6.105420	6.154847
140	6.204340	6.253899	6.303522	6.353210	6.402964	6.452782	6.502664	6.552612	6.602623	6.652699
150	6.702839	6.753043	6.803312	6.853644	6.904039	6.954499	7.005022	7.055608	7.106257	7.156969
160	7.207744	7.258581	7.309481	7.360444	7.411468	7.462554	7.513702	7.564911	7.616182	7.667513
170	7.718906	7.770359	7.821873	7.873447	7.925082	7.976777	8.028531	8.080346	8.132221	8.184155
180	8.236148	8.288202	8.340314	8.392486	8.444717	8.497008	8.549357	8.601765	8.654232	8.706757
190	8.759341	8.811983	8.864684	8.917443	8.970259	9.023134	9.076066	9.129056	9.182103	9.235207

COPPER-CONSTANTAN NBS(SMOOTHED)
TABLE NO. 5

TEMP=DEG C (INT.1948)
VOLTAGE=MILLIVOLT ABSOLUTE

TEMP	0	1	2	3	4	5	6	7	8	9
					MILLIVOLTS					
200	9.288368	9.341585	9.394859	9.448190	9.501576	9.555018	9.608515	9.662067	9.715674	9.769336
210	9.823052	9.876822	9.930646	9.984523	10.038454	10.092437	10.146473	10.200562	10.254703	10.308897
220	10.363142	10.417440	10.471789	10.526190	10.580642	10.635146	10.689702	10.744308	10.798967	10.853676
230	10.908437	10.963249	11.018113	11.073027	11.127993	11.183011	11.238079	11.293199	11.348370	11.403592
240	11.458866	11.514190	11.569566	11.624994	11.680472	11.736001	11.791582	11.847213	11.902895	11.958628
250	12.014411	12.070245	12.126129	12.182063	12.238046	12.294079	12.350162	12.406293	12.462474	12.518703
260	12.574981	12.631306	12.687680	12.744102	12.800570	12.857086	12.913650	12.970259	13.026916	13.083619
270	13.140367	13.197162	13.254003	13.310889	13.367820	13.424797	13.481819	13.538886	13.595998	13.653155
280	13.710356	13.767602	13.824893	13.882229	13.939609	13.997034	14.054504	14.112018	14.169577	14.227181
290	14.284829	14.342522	14.400260	14.458043	14.515870	14.573742	14.631659	14.689620	14.747625	14.805675
300	14.863770	14.921909	14.980091	15.038318	15.096589	15.154903	15.213261	15.271662	15.330107	15.388594
310	15.447124	15.505696	15.564311	15.622967	15.681666	15.740406	15.799187	15.858009	15.916872	15.975775
320	16.034719	16.093703	16.152727	16.211791	16.270895	16.330038	16.389221	16.448443	16.507704	16.567005
330	16.626344	16.685723	16.745141	16.804599	16.864095	16.923630	16.983205	17.042819	17.102472	17.162165
340	17.221897	17.281668	17.341479	17.401329	17.461219	17.521148	17.581117	17.641125	17.701172	17.761260
350	17.821386	17.881552	17.941757	18.002001	18.062285	18.122607	18.182968	18.243368	18.303807	18.364284
360	18.424799	18.485352	18.545943	18.606571	18.667237	18.727940	18.788680	18.849457	18.910271	18.971120
370	19.032006	19.092927	19.153884	19.214876	19.275903	19.336965	19.398061	19.459192	19.520357	19.581555
380	19.642787	19.704053	19.765351	19.826683	19.888047	19.949443	20.010872	20.072333	20.133825	20.195349
390	20.256904	20.318490	20.380107	20.441754	20.503432	20.565140	20.626878	20.688645	20.750442	20.812268
400	20.874123									

TABLE 5A

COPPER-CONSTANTAN NBS(SMOOTHED)

TEMP	MV	0 TH	1 ST	2 ND	3 RD	4 TH	5 TH
			DIFFERENCE ORDER				
-190	-5.378682	-5378682					
			16764				
-189	-5.361918	-5361918		139			
			16903		-2		
-188	-5.345015	-5345015		137		3	
			17040		1		-5
-187	-5.327975	-5327975		138		-2	
			17178		-1		4
-186	-5.310797	-5310797		137		2	
			17315		1		-4
-185	-5.293482	-5293482		138		-2	
			17453		-1		2
-184	-5.276029	-5276029		137		0	
			17590		-1		1
-183	-5.258439	-5258439		136		1	
			17726		0		-1
-182	-5.240713	-5240713		136		0	
			17862		0		0
-181	-5.222851	-5222851		136		0	
			17998		0		-1
-180	-5.204853	-5204853		136		-1	
			18134		-1		3
-179	-5.186719	-5186719		135		2	
			18269		1		-5
-178	-5.168450	-5168450		136		-3	
			18405		-2		5
-177	-5.150045	-5150045		134		2	
			18539		0		-1
-176	-5.131506	-5131506		134		1	
			18673		1		-3
-175	-5.112833	-5112833		135		-2	
			18808		-1		2
-174	-5.094025	-5094025		134		0	
			18942		-1		2
-173	-5.075083	-5075083		133		2	
			19075		1		-4
-172	-5.056008	-5056008		134		-2	
			19209		-1		2
-171	-5.036799	-5036799		133		0	
			19342		-1		2
-170	-5.017457	-5017457		132		2	
			19474		1		-4
-169	-4.997983	-4997983		133		-2	
			19607		-1		3
-168	-4.978376	-4978376		132		1	
			19739		0		-1
-167	-4.958637	-4958637		132		0	
			19871		0		-2
-166	-4.938766	-4938766		132		-2	
			20003		-2		6
-165	-4.918763	-4918763		130		4	
			20133		2		-8
-164	-4.898630	-4898630		132		-4	
			20265		-2		6
-163	-4.878365	-4878365		130		2	
			20395		0		-2
-162	-4.857970	-4857970		130		0	
			20525		0		0
-161	-4.837445	-4837445		130		0	
			20655		0		0
-160	-4.816790	-4816790		130		0	
			20785		0		-2
-159	-4.796005	-4796005		130		-2	
			20915		-2		6
-158	-4.775090	-4775090		128		4	
			21043		2		-8
-157	-4.754047	-4754047		130		-4	
			21173		-2		7
-156	-4.732874	-4732874		128		3	
			21301		1		-6
-155	-4.711573	-4711573		129		-3	
			21430		-2		7
-154	-4.690143	-4690143		127		4	

-153	-4.668586	-4668586	21557	129	2	-8
-152	-4.646900	-4646900	21686	127	-2	6
-151	-4.625087	-4625087	21813	127	0	-1
-150	-4.603147	-4603147	21940	128	1	-4
-149	-4.581079	-4581079	22068	126	-2	6
-148	-4.558885	-4558885	22194	127	1	-4
-147	-4.536564	-4536564	22321	127	0	-1
-146	-4.514116	-4514116	22448	125	-2	5
-145	-4.491543	-4491543	22573	126	1	-4
-144	-4.468844	-4468844	22699	126	0	1
-143	-4.446019	-4446019	22825	126	0	-1
-142	-4.423068	-4423068	22951	125	-1	2
-141	-4.399992	-4399992	23076	125	0	-2
-140	-4.376791	-4376791	23201	124	-1	4
-139	-4.353466	-4353466	23325	126	2	-8
-138	-4.330015	-4330015	23451	123	-3	10
-137	-4.306441	-4306441	23574	125	2	-8
-136	-4.282742	-4282742	23699	124	-1	4
-135	-4.258919	-4258919	23823	124	0	-1
-134	-4.234972	-4234972	23947	124	0	-1
-133	-4.210901	-4210901	24071	123	-1	2
-132	-4.186707	-4186707	24194	123	0	0
-131	-4.162390	-4162390	24317	124	1	-4
-130	-4.137949	-4137949	24441	122	-2	6
-129	-4.113386	-4113386	24563	123	1	-5
-128	-4.088700	-4088700	24686	122	-1	4
-127	-4.063892	-4063892	24808	123	1	-4
-126	-4.038961	-4038961	24931	122	-1	3
-125	-4.013908	-4013908	25053	122	0	-1
-124	-3.988733	-3988733	25175	122	0	-1
-123	-3.963436	-3963436	25297	121	-1	3
-122	-3.938018	-3938018	25418	122	1	-4
-121	-3.912478	-3912478	25540	121	-1	3
-120	-3.886817	-3886817	25661	121	0	-2
-119	-3.861035	-3861035	25782	120	-1	4
-118	-3.835133	-3835133	25902	122	2	-7
-117	-3.809109	-3809109	26024	120	-2	6
-116	-3.782965	-3782965	26144	120	0	-2
-115	-3.756701	-3756701	26264	120	0	0
-114	-3.730317	-3730317	26384	120	0	-1
-113	-3.703813	-3703813	26504	119	-1	3

			26623		1		-4
-112	-3.677190	-3677190		120		-2	
			26743		-1		2
-111	-3.650447	-3650447		119		0	
			26862		-1		3
-110	-3.623585	-3623585		118		3	
			26980		2		-8
-109	-3.596605	-3596605		120		-5	
			27100		-3		10
-108	-3.569505	-3569505		117		5	
			27217		2		-9
-107	-3.542288	-3542288		119		-4	
			27336		-2		7
-106	-3.514952	-3514952		117		3	
			27453		1		-5
-105	-3.487499	-3487499		118		-2	
			27571		-1		3
-104	-3.459928	-3459928		117		1	
			27688		0		-1
-103	-3.432240	-3432240		117		0	
			27805		0		-1
-102	-3.404435	-3404435		117		-1	
			27922		-1		2
-101	-3.376513	-3376513		116		1	
			28038		0		-1
-100	-3.348475	-3348475		116		0	
			28154		0		-1
-99	-3.320321	-3320321		116		-1	
			28270		-1		2
-98	-3.292051	-3292051		115		1	
			28385		0		-1
-97	-3.263666	-3263666		115		0	
			28500		0		-1
-96	-3.235166	-3235166		115		-1	
			28615		-1		3
-95	-3.206551	-3206551		114		2	
			28729		1		-5
-94	-3.177822	-3177822		115		-3	
			28844		-2		6
-93	-3.148978	-3148978		113		3	
			28957		1		-5
-92	-3.120021	-3120021		114		-2	
			29071		-1		3
-91	-3.090950	-3090950		113		1	
			29184		0		-1
-90	-3.061766	-3061766		113		0	
			29297		0		-1
-89	-3.032469	-3032469		113		-1	
			29410		-1		2
-88	-3.003059	-3003059		112		1	
			29522		0		-1
-87	-2.973537	-2973537		112		0	
			29634		0		0
-86	-2.943903	-2943903		112		0	
			29746		0		-1
-85	-2.914157	-2914157		112		-1	
			29858		-1		1
-84	-2.884299	-2884299		111		0	
			29969		-1		3
-83	-2.854330	-2854330		110		3	
			30079		2		-6
-82	-2.824251	-2824251		112		-3	
			30191		-1		2
-81	-2.794060	-2794060		111		-1	
			30302		-2		5
-80	-2.763758	-2763758		109		4	
			30411		2		-7
-79	-2.733347	-2733347		111		-3	
			30522		-1		4
-78	-2.702825	-2702825		110		1	
			30632		0		-2
-77	-2.672193	-2672193		110		-1	
			30742		-1		3
-76	-2.641451	-2641451		109		2	
			30851		1		-4
-75	-2.610600	-2610600		110		-2	
			30961		-1		3
-74	-2.579639	-2579639		109		1	
			31070		0		-1
-73	-2.548569	-2548569		109		0	
			31179		0		-1
-72	-2.517390	-2517390		109		-1	

			31288	-1		4
-71	-2.486102	-2486102	108		3	
			31396	2		-8
-70	-2.454706	-2454706	110		-5	
			31506	-3		10
-69	-2.423200	-2423200	107		5	
			31613	2		-8
-68	-2.391587	-2391587	109		-3	
			31722	-1		3
-67	-2.359865	-2359865	108		0	
			31830	-1		3
-66	-2.328035	-2328035	107		3	
			31937	2		-7
-65	-2.296098	-2296098	109		-4	
			32046	-2		6
-64	-2.264052	-2264052	107		2	
			32153	0		-2
-63	-2.231899	-2231899	107		0	
			32260	0		0
-62	-2.199639	-2199639	107		0	
			32367	0		0
-61	-2.167272	-2167272	107		0	
			32474	0		0
-60	-2.134798	-2134798	107		0	
			32581	0		-1
-59	-2.102217	-2102217	107		-1	
			32688	-1		2
-58	-2.069529	-2069529	106		1	
			32794	0		-1
-57	-2.036735	-2036735	106		0	
			32900	0		-1
-56	-2.003835	-2003835	106		-1	
			33006	-1		3
-55	-1.970829	-1970829	105		2	
			33111	1		-4
-54	-1.937718	-1937718	106		-2	
			33217	-1		3
-53	-1.904501	-1904501	105		1	
			33322	0		-1
-52	-1.871179	-1871179	105		0	
			33427	0		-1
-51	-1.837752	-1837752	105		-1	
			33532	-1		3
-50	-1.804220	-1804220	104		2	
			33636	1		-5
-49	-1.770584	-1770584	105		-3	
			33741	-2		7
-48	-1.736843	-1736843	103		4	
			33844	2		-9
-47	-1.702999	-1702999	105		-5	
			33949	-3		10
-46	-1.669050	-1669050	102		5	
			34051	2		-8
-45	-1.634999	-1634999	104		-3	
			34155	-1		4
-44	-1.600844	-1600844	103		1	
			34258	0		-2
-43	-1.566586	-1566586	103		-1	
			34361	-1		2
-42	-1.532225	-1532225	102		1	
			34463	0		-1
-41	-1.497762	-1497762	102		0	
			34565	0		0
-40	-1.463197	-1463197	102		0	
			34667	0		-1
-39	-1.428530	-1428530	102		-1	
			34769	-1		2
-38	-1.393761	-1393761	101		1	
			34870	0		0
-37	-1.358891	-1358891	101		1	
			34971	1		-5
-36	-1.323920	-1323920	102		-4	
			35073	-3		9
-35	-1.288847	-1288847	99		5	
			35172	2		-7
-34	-1.253675	-1253675	101		-2	
			35273	0		-1
-33	-1.218402	-1218402	101		-3	
			35374	-3		9
-32	-1.183028	-1183028	98		6	
			35472	3		-11
-31	-1.147556	-1147556	101		-5	

-30	-1.111983	-1111983	35573	99	-2	1	6
-29	-1.076311	-1076311	35672	98	-1	2	1
-28	-1.040541	-1040541	35770	99	1	-1	-3
-27	-1.004672	-1004672	35869	99	0	-1	0
-26	-.968704	-968704	35968	98	-1	0	1
-25	-.932638	-932638	36066	97	-1	3	3
-24	-.896475	-896475	36163	99	2	-5	-8
-23	-.860213	-860213	36262	96	-3	4	9
-22	-.823855	-823855	36358	97	1	-1	-5
-21	-.787400	-787400	36455	97	0	-1	0
-20	-.750848	-750848	36552	96	-1	1	2
-19	-.714200	-714200	36648	96	0	0	-1
-18	-.677456	-677456	36744	96	0	-1	-1
-17	-.640616	-640616	36840	95	-1	1	2
-16	-.603681	-603681	36935	95	0	-1	-2
-15	-.566651	-566651	37030	94	-1	2	3
-14	-.529527	-529527	37124	95	1	-1	-3
-13	-.492308	-492308	37219	95	0	-2	-1
-12	-.454994	-454994	37314	93	-2	2	4
-11	-.417587	-417587	37407	93	0	1	-1
-10	-.380087	-380087	37500	94	1	-3	-4
-9	-.342493	-342493	37594	92	-2	3	6
-8	-.304807	-304807	37686	93	1	-1	-4
-7	-.267028	-267028	37779	93	0	-1	0
-6	-.229156	-229156	37872	92	-1	0	1
-5	-.191192	-191192	37964	91	-1	2	2
-4	-.153137	-153137	38055	92	1	-1	-3
-3	-.114990	-114990	38147	92	0	-1	0
-2	-.076751	-76751	38239	91	-1	1	2
-1	-.038421	-38421	38330	91	0	0	-1
0	0	0	38421	91	0	-1	-1
1	.038512	38512	38512	90	-1	3	4
2	.077114	77114	38602	92	2	-5	-8
3	.115808	115808	38694	89	-3	5	10
4	.154591	154591	38783	91	2	-3	-8
5	.193465	193465	38874	90	-1	1	4
6	.232429	232429	38964	90	0	1	0
7	.271483	271483	39054	91	1	-3	-4
8	.310628	310628	39145	89	-2	3	6
9	.349862	349862	39234	90	1	-2	-5
10	.389186	389186	39324	89	-1	3	5

11	.428599	428599	39413	91	2	-4	-7
12	.468103	468103	39504	89	-2	3	7
13	.507696	507696	39593	90	1	-2	-5
14	.547379	547379	39683	89	-1	2	4
15	.587151	587151	39772	90	1	-2	-4
16	.627013	627013	39862	89	-1	2	4
17	.666964	666964	39951	90	1	-2	-4
18	.707005	707005	40041	89	-1	2	4
19	.747135	747135	40130	90	1	-2	-4
20	.787355	787355	40220	89	-1	0	2
21	.827664	827664	40309	88	-1	3	3
22	.868061	868061	40397	90	2	-3	-6
23	.908548	908548	40487	89	-1	1	4
24	.949124	949124	40576	89	0	-1	-2
25	.989789	989789	40665	88	-1	2	3
26	1.030542	1030542	40753	89	1	-1	-3
27	1.071384	1071384	40842	89	0	-1	0
28	1.112315	1112315	40931	88	-1	1	2
29	1.153334	1153334	41019	88	0	0	-1
30	1.194441	1194441	41107	88	0	0	0
31	1.235636	1235636	41195	88	0	0	0
32	1.276919	1276919	41283	88	0	-1	-1
33	1.318290	1318290	41371	87	-1	1	2
34	1.359748	1359748	41458	87	0	0	-1
35	1.401293	1401293	41545	87	0	1	1
36	1.442925	1442925	41632	88	1	-4	-5
37	1.484645	1484645	41720	85	-3	5	9
38	1.526450	1526450	41805	87	2	-3	-8
39	1.568342	1568342	41892	86	-1	1	4
40	1.610320	1610320	41978	86	0	0	-1
41	1.652384	1652384	42064	86	0	-1	-1
42	1.694534	1694534	42150	85	-1	1	2
43	1.736769	1736769	42235	85	0	0	-1
44	1.779089	1779089	42320	85	0	0	0
45	1.821494	1821494	42405	85	0	-1	-1
46	1.863984	1863984	42490	84	-1	1	2
47	1.906558	1906558	42574	84	0	0	-1
48	1.949216	1949216	42658	84	0	-1	-1
49	1.991958	1991958	42742	83	-1	2	3
50	2.034783	2034783	42825	84	1	-2	-4
51	2.077692	2077692	42909	83	-1	0	2

52	2.120684	2120684	42992	82	-1	3	3
53	2.163758	2163758	43074	84	2	-5	-8
54	2.206916	2206916	43158	81	-3	5	10
55	2.250155	2250155	43239	83	2	-4	-9
56	2.293477	2293477	43322	81	-2	3	7
57	2.336880	2336880	43403	82	1	-2	-5
58	2.380365	2380365	43485	81	-1	1	3
59	2.423931	2423931	43566	81	0	0	-1
60	2.467578	2467578	43647	81	0	-1	-1
61	2.511306	2511306	43728	80	-1	2	3
62	2.555114	2555114	43808	81	1	-2	-4
63	2.599003	2599003	43889	80	-1	1	3
64	2.642972	2642972	43969	80	0	0	-1
65	2.687021	2687021	44049	80	0	-2	-2
66	2.731150	2731150	44129	78	-2	4	6
67	2.775357	2775357	44207	80	2	-3	-7
68	2.819644	2819644	44287	79	-1	1	4
69	2.864010	2864010	44366	79	0	-1	-2
70	2.908455	2908455	44445	78	-1	1	2
71	2.952978	2952978	44523	78	0	1	0
72	2.997579	2997579	44601	79	1	-3	-4
73	3.042259	3042259	44680	77	-2	3	6
74	3.087016	3087016	44757	78	1	-2	-5
75	3.131851	3131851	44835	77	-1	2	4
76	3.176763	3176763	44912	78	1	-3	-5
77	3.221753	3221753	44990	76	-2	4	7
78	3.266819	3266819	45066	78	2	-4	-8
79	3.311963	3311963	45144	76	-2	2	6
80	3.357183	3357183	45220	76	0	1	-1
81	3.402479	3402479	45296	77	1	-2	-3
82	3.447852	3447852	45373	76	-1	1	3
83	3.493301	3493301	45449	76	0	0	-1
84	3.538826	3538826	45525	76	0	0	0
85	3.584427	3584427	45601	76	0	0	0
86	3.630104	3630104	45677	76	0	-2	-2
87	3.675857	3675857	45753	74	-2	4	6
88	3.721684	3721684	45827	76	2	-2	-6
89	3.767587	3767587	45903	76	0	-2	0
90	3.813566	3813566	45979	74	-2	3	5
91	3.859619	3859619	46053	75	1	-1	-4
92	3.905747	3905747	46128	75	0	0	1
93	3.951950	3951950	46203	75	0	-1	-1

			46278		-1		2
94	3.998228	3998228		74		1	
			46352		0		0
95	4.044580	4044580		74		1	
			46426		1		-4
96	4.091006	4091006		75		-3	
			46501		-2		7
97	4.137507	4137507		73		4	
			46574		2		-8
98	4.184081	4184081		75		-4	
			46649		-2		6
99	4.230730	4230730		73		2	
			46722		0		-1
100	4.277452	4277452		73		1	
			46795		1		-2
101	4.324247	4324247		74		-1	
			46869		0		-1
102	4.371116	4371116		74		-2	
			46943		-2		5
103	4.418059	4418059		72		3	
			47015		1		-4
104	4.465074	4465074		73		-1	
			47088		0		0
105	4.512162	4512162		73		-1	
			47161		-1		2
106	4.559323	4559323		72		1	
			47233		0		0
107	4.606556	4606556		72		1	
			47305		1		-4
108	4.653861	4653861		73		-3	
			47378		-2		6
109	4.701239	4701239		71		3	
			47449		1		-5
110	4.748688	4748688		72		-2	
			47521		-1		3
111	4.796209	4796209		71		1	
			47592		0		-1
112	4.843801	4843801		71		0	
			47663		0		0
113	4.891464	4891464		71		0	
			47734		0		-1
114	4.939198	4939198		71		-1	
			47805		-1		2
115	4.987003	4987003		70		1	
			47875		0		-1
116	5.034878	5034878		70		0	
			47945		0		-1
117	5.082823	5082823		70		-1	
			48015		-1		3
118	5.130838	5130838		69		2	
			48084		1		-4
119	5.178922	5178922		70		-2	
			48154		-1		2
120	5.227076	5227076		69		0	
			48223		-1		2
121	5.275299	5275299		68		2	
			48291		1		-4
122	5.323590	5323590		69		-2	
			48360		-1		4
123	5.371950	5371950		68		2	
			48428		1		-5
124	5.420378	5420378		69		-3	
			48497		-2		5
125	5.468875	5468875		67		2	
			48564		0		-1
126	5.517439	5517439		67		1	
			48631		1		-3
127	5.566070	5566070		68		-2	
			48699		-1		3
128	5.614769	5614769		67		1	
			48766		0		-1
129	5.663535	5663535		67		0	
			48833		0		-1
130	5.712368	5712368		67		-1	
			48900		-1		2
131	5.761268	5761268		66		1	
			48966		0		0
132	5.810234	5810234		66		1	
			49032		1		-3
133	5.859266	5859266		67		-2	
			49099		-1		3
134	5.908365	5908365		66		1	

135	5.957530	5957530	49165	66	0	-2
136	6.006761	6006761	49231	65	-1	4
137	6.056057	6056057	49296	67	3	-8
138	6.105420	6105420	49363	64	2	10
139	6.154847	6154847	49427	66	-3	5
140	6.204340	6204340	49493	66	2	-7
141	6.253899	6253899	49559	64	0	0
142	6.303522	6303522	49623	65	-2	3
143	6.353210	6353210	49688	66	1	5
144	6.402964	6402964	49754	64	1	-3
145	6.452782	6452782	49818	64	-2	5
146	6.502664	6502664	49882	66	0	0
147	6.552612	6552612	49948	63	2	-7
148	6.602623	6602623	50011	65	-3	10
149	6.652699	6652699	50076	64	2	-8
150	6.702839	6702839	50140	64	-1	4
151	6.753043	6753043	50204	65	1	0
152	6.803312	6803312	50269	63	-3	-4
153	6.853644	6853644	50332	63	-2	5
154	6.904039	6904039	50395	65	0	0
155	6.954499	6954499	50460	63	2	-6
156	7.005022	7005022	50523	63	-2	6
157	7.055608	7055608	50586	63	0	-2
158	7.106257	7106257	50649	63	0	0
159	7.156969	7156969	50712	63	0	0
160	7.207744	7207744	50775	62	-1	-1
161	7.258581	7258581	50837	63	-1	3
162	7.309481	7309481	50900	63	1	-3
163	7.360444	7360444	50963	61	0	-1
164	7.411468	7411468	51024	62	-2	5
165	7.462554	7462554	51086	62	1	-4
166	7.513702	7513702	51148	61	0	0
167	7.564911	7564911	51209	62	-1	3
168	7.616182	7616182	51271	60	2	-3
169	7.667513	7667513	51331	62	-2	7
170	7.718906	7718906	51393	60	2	-4
171	7.770359	7770359	51453	61	1	3
172	7.821873	7821873	51514	60	-2	-5
173	7.873447	7873447	51574	61	-1	2
174	7.925082	7925082	51635	60	1	-4
175	7.976777	7976777	51695	59	-1	2
					3	3

176	8.028531	8028531	51754	61	2	-3	-6
177	8.080346	8080346	51815	60	-1	0	3
178	8.132221	8132221	51875	59	-1	1	1
179	8.184155	8184155	51934	59	0	2	1
180	8.236148	8236148	51993	61	2	-5	-7
181	8.288202	8288202	52054	58	-3	5	10
182	8.340314	8340314	52112	60	2	-3	-8
183	8.392486	8392486	52172	59	-1	2	5
184	8.444717	8444717	52231	60	1	-3	-5
185	8.497008	8497008	52291	58	-2	3	6
186	8.549357	8549357	52349	59	1	-1	-4
187	8.601765	8601765	52408	59	0	-1	0
188	8.654232	8654232	52467	58	-1	2	3
189	8.706757	8706757	52525	59	1	-2	-4
190	8.759341	8759341	52584	58	-1	2	4
191	8.811983	8811983	52642	59	1	-2	-4
192	8.864684	8864684	52701	58	-1	0	2
193	8.917443	8917443	52759	57	-1	3	3
194	8.970259	8970259	52816	59	2	-4	-7
195	9.023134	9023134	52875	57	-2	3	7
196	9.076066	9076066	52932	58	1	-2	-5
197	9.129056	9129056	52990	57	-1	1	3
198	9.182103	9182103	53047	57	0	0	-1
199	9.235207	9235207	53104	57	0	-1	-1
200	9.288368	9288368	53161	56	-1	2	3
201	9.341585	9341585	53217	57	1	-1	-3
202	9.394859	9394859	53274	57	0	-2	-1
203	9.448190	9448190	53331	55	-2	3	5
204	9.501576	9501576	53386	56	1	-2	-5
205	9.555018	9555018	53442	55	-1	1	3
206	9.608515	9608515	53497	55	0	0	-1
207	9.662067	9662067	53552	55	0	0	0
208	9.715674	9715674	53607	55	0	-1	-1
209	9.769336	9769336	53662	54	-1	1	2
210	9.823052	9823052	53716	54	0	0	-1
211	9.876822	9876822	53770	54	0	-1	-1
212	9.930646	9930646	53824	53	-1	2	3
213	9.984523	9984523	53877	54	1	-3	-5
214	10.038454	10038454	53931	52	-2	3	6
215	10.092437	10092437	53983	53	1	-1	-4
216	10.146473	10146473	54036	53	0	-1	0

217	10.200562	10200562	54089	52	-1	2	3
218	10.254703	10254703	54141	53	1	-3	-5
219	10.308897	10308897	54194	51	-2	4	7
220	10.363142	10363142	54245	53	2	-4	-8
221	10.417440	10417440	54298	51	-2	3	7
222	10.471789	10471789	54349	52	1	-2	-5
223	10.526190	10526190	54401	51	-1	2	4
224	10.580642	10580642	54452	52	1	-1	-3
225	10.635146	10635146	54504	52	0	-2	-1
226	10.689702	10689702	54556	50	-2	5	7
227	10.744308	10744308	54606	53	3	-6	-11
228	10.798967	10798967	54659	50	-3	5	11
229	10.853676	10853676	54709	52	2	-3	-8
230	10.908437	10908437	54761	51	-1	2	5
231	10.963249	10963249	54812	52	1	-3	-5
232	11.018113	11018113	54864	50	-2	4	7
233	11.073027	11073027	54914	52	2	-2	-6
234	11.127993	11127993	54966	52	0	-2	0
235	11.183011	11183011	55018	50	-2	4	6
236	11.238079	11238079	55068	52	2	-3	-7
237	11.293199	11293199	55120	51	-1	1	4
238	11.348370	11348370	55171	51	0	1	0
239	11.403592	11403592	55222	52	1	-3	-4
240	11.458866	11458866	55274	50	-2	4	7
241	11.514190	11514190	55324	52	2	-2	-6
242	11.569566	11569566	55376	52	0	-2	0
243	11.624994	11624994	55428	50	-2	3	5
244	11.680472	11680472	55478	51	1	0	-3
245	11.736001	11736001	55529	52	1	-3	-3
246	11.791582	11791582	55581	50	-2	3	6
247	11.847213	11847213	55631	51	1	-1	-4
248	11.902895	11902895	55682	51	0	-1	0
249	11.958628	11958628	55733	50	-1	2	3
250	12.014411	12014411	55783	51	1	-2	-4
251	12.070245	12070245	55834	50	-1	1	3
252	12.126129	12126129	55884	50	0	-1	-2
253	12.182063	12182063	55934	49	-1	2	3
254	12.238046	12238046	55983	50	1	-1	-3
255	12.294079	12294079	56033	50	0	-2	-1
256	12.350162	12350162	56083	48	-2	4	6

257	12.406293	12406293	56131	50	2	-4	-8
258	12.462474	12462474	56181	48	-2	3	7
259	12.518703	12518703	56229	49	1	-3	-6
260	12.574981	12574981	56278	47	-2	4	7
261	12.631306	12631306	56325	49	2	-3	-7
262	12.687680	12687680	56374	48	-1	-1	2
263	12.744102	12744102	56422	46	-2	4	5
264	12.800570	12800570	56468	48	2	-2	-6
265	12.857086	12857086	56516	48	0	-3	-1
266	12.913650	12913650	56564	45	-3	6	9
267	12.970259	12970259	56609	48	3	-5	-11
268	13.026916	13026916	56657	46	-2	1	6
269	13.083619	13083619	56703	45	-1	3	2
270	13.140367	13140367	56748	47	2	-3	-6
271	13.197162	13197162	56795	46	-1	0	3
272	13.254003	13254003	56841	45	-1	1	1
273	13.310889	13310889	56886	45	0	1	0
274	13.367820	13367820	56931	46	1	-2	-3
275	13.424797	13424797	56977	45	-1	1	3
276	13.481819	13481819	57022	45	0	0	-1
277	13.538886	13538886	57067	45	0	0	0
278	13.595998	13595998	57112	45	0	-1	-1
279	13.653155	13653155	57157	44	-1	2	3
280	13.710356	13710356	57201	45	1	-1	-3
281	13.767602	13767602	57246	45	0	0	1
282	13.824893	13824893	57291	45	0	-1	-1
283	13.882229	13882229	57336	44	-1	2	3
284	13.939609	13939609	57380	45	1	-1	-3
285	13.997034	13997034	57425	45	0	-1	0
286	14.054504	14054504	57470	44	-1	2	3
287	14.112018	14112018	57514	45	1	-1	-3
288	14.169577	14169577	57559	45	0	-1	0
289	14.227181	14227181	57604	44	-1	2	3
290	14.284829	14284829	57648	45	1	-1	-3
291	14.342522	14342522	57693	45	0	0	1
292	14.400260	14400260	57738	45	0	-1	-1
293	14.458043	14458043	57783	44	-1	2	3
294	14.515870	14515870	57827	45	1	-1	-3
295	14.573742	14573742	57872	45	0	-1	0
296	14.631659	14631659	57917	44	-1	1	2
297	14.689620	14689620	57961	44	0	1	0

298	14.747625	14747625	58005	45	1	-1	-2
299	14.805675	14805675	58050	45	0	-1	0
300	14.863770	14863770	58095	44	-1	0	1
301	14.921909	14921909	58139	43	-1	3	3
302	14.980091	14980091	58182	45	2	-3	-6
303	15.038318	15038318	58227	44	-1	0	3
304	15.096589	15096589	58271	43	-1	2	2
305	15.154903	15154903	58314	44	1	-2	-4
306	15.213261	15213261	58358	43	-1	2	4
307	15.271662	15271662	58401	44	1	-3	-5
308	15.330107	15330107	58445	42	-2	3	6
309	15.388594	15388594	58487	43	1	-2	-5
310	15.447124	15447124	58530	42	-1	2	4
311	15.505696	15505696	58572	43	1	-3	-5
312	15.564311	15564311	58615	41	-2	4	7
313	15.622967	15622967	58656	43	2	-4	-8
314	15.681666	15681666	58699	41	-2	2	6
315	15.740406	15740406	58740	41	0	0	-2
316	15.799187	15799187	58781	41	0	0	0
317	15.858009	15858009	58822	41	0	-1	-1
318	15.916872	15916872	58863	40	-1	2	3
319	15.975775	15975775	58903	41	1	-2	-4
320	16.034719	16034719	58944	40	-1	1	3
321	16.093703	16093703	58984	40	0	0	-1
322	16.152727	16152727	59024	40	0	0	0
323	16.211791	16211791	59064	40	0	-1	-1
324	16.270895	16270895	59104	39	-1	2	3
325	16.330038	16330038	59143	40	1	-2	-4
326	16.389221	16389221	59183	39	-1	1	3
327	16.448443	16448443	59222	39	0	1	0
328	16.507704	16507704	59261	40	1	-3	-4
329	16.567005	16567005	59301	38	-2	4	7
330	16.626344	16626344	59339	40	2	-3	-7
331	16.685723	16685723	59379	39	-1	2	5
332	16.745141	16745141	59418	40	1	-3	-5
333	16.804599	16804599	59458	38	-2	3	6
334	16.864095	16864095	59496	39	1	0	-3
335	16.923630	16923630	59535	40	1	-2	-2
336	16.983205	16983205	59575	39	-1	1	3
337	17.042819	17042819	59614	39	0	1	0
338	17.102472	17102472	59653	40	1	-2	-3

339	17.162165	17162165	59693	39	-1	1	3
340	17.221897	17221897	59732	39	0	1	0
341	17.281668	17281668	59771	40	1	-2	-3
342	17.341479	17341479	59811	39	-1	2	4
343	17.401329	17401329	59850	40	1	-2	-4
344	17.461219	17461219	59890	39	-1	2	4
345	17.521148	17521148	59929	40	1	-2	-4
346	17.581117	17581117	59969	39	-1	1	3
347	17.641125	17641125	60008	39	0	2	1
348	17.701172	17701172	60047	41	2	-5	-7
349	17.761260	17761260	60088	38	-3	5	10
350	17.821386	17821386	60126	40	2	-3	-8
351	17.881552	17881552	60166	39	-1	1	4
352	17.941757	17941757	60205	39	0	1	0
353	18.002001	18002001	60244	40	1	-3	-4
354	18.062285	18062285	60284	38	-2	3	6
355	18.122607	18122607	60322	39	1	-1	-4
356	18.182968	18182968	60361	39	0	0	1
357	18.243368	18243368	60400	39	0	-1	-1
358	18.303807	18303807	60439	38	-1	1	2
359	18.364284	18364284	60477	38	0	0	-1
360	18.424799	18424799	60515	38	0	0	0
361	18.485352	18485352	60553	38	0	-1	-1
362	18.545943	18545943	60591	37	-1	2	3
363	18.606571	18606571	60628	38	1	-2	-4
364	18.667237	18667237	60666	37	-1	1	3
365	18.727940	18727940	60703	37	0	0	-1
366	18.788680	18788680	60740	37	0	0	0
367	18.849457	18849457	60777	37	0	-2	-2
368	18.910271	18910271	60814	35	-2	4	6
369	18.971120	18971120	60849	37	2	-4	-8
370	19.032006	19032006	60886	35	-2	3	7
371	19.092927	19092927	60921	36	1	-2	-5
372	19.153884	19153884	60957	35	-1	1	3
373	19.214876	19214876	60992	35	0	0	-1
374	19.275903	19275903	61027	35	0	-1	-1
375	19.336965	19336965	61062	34	-1	2	3
376	19.398061	19398061	61096	35	1	-2	-4
377	19.459192	19459192	61131	34	-1	0	2
378	19.520357	19520357	61165	33	-1	2	2
379	19.581555	19581555	61198	34	1	-1	-3

			61232		0	-1
380	19.642787	19642787		34	-2	
			61266		-2	6
381	19.704053	19704053		32	4	
			61298		2	-8
382	19.765351	19765351		34	-4	
			61332		-2	6
383	19.826683	19826683		32	2	
			61364		0	-1
384	19.888047	19888047		32	1	
			61396		1	-3
385	19.949443	19949443		33	-2	
			61429		-1	2
386	20.010872	20010872		32	0	
			61461		-1	2
387	20.072333	20072333		31	2	
			61492		1	-4
388	20.133825	20133825		32	-2	
			61524		-1	3
389	20.195349	20195349		31	1	
			61555		0	-1
390	20.256904	20256904		31	0	
			61586		0	-1
391	20.318490	20318490		31	-1	
			61617		-1	3
392	20.380107	20380107		30	2	
			61647		1	-4
393	20.441754	20441754		31	-2	
			61678		-1	3
394	20.503432	20503432		30	1	
			61708		0	-2
395	20.565140	20565140		30	-1	
			61738		-1	3
396	20.626878	20626878		29	2	
			61767		1	-4
397	20.688645	20688645		30	-2	
			61797		-1	3
398	20.750442	20750442		29	1	
			61826		0	
399	20.812268	20812268		29		
			61855			
400	20.874123	20874123				

ORNL-3649, Vol. 2
UC-37 – Instruments
TID-4500 (37th ed.)

INTERNAL DISTRIBUTION

1. Biology Library
2–4. Central Research Library
5. Reactor Division Library
6–7. ORNL – Y-12 Technical Library
Document Reference Section
8–75. Laboratory Records Department
76. Laboratory Records, ORNL R.C.
77–86. R. K. Adams
87. E. T. Arakawa
88. J. A. Auxier
89. C. D. Baumann
90. T. V. Blalock
91. R. E. Biggers
92. R. D. Birkhoff
93. N. H. Briggs
94. R. D. Bundy
95. Charles T. Butler
96. T. A. Butler
97. R. M. Carroll
98. R. O. Chester
99. J. A. Conlin, Jr.
100. J. L. Cook
101–110. E. G. Davisson
111. C. W. Dollins
112. I. T. Dudley
113. J. R. Engel
114. R. B. Fitts
115. H. A. Friedman
116. E. L. Fuller
117. W. R. Gambill
118. Robert A. Gilbert
119. L. O. Gilpatrick
120. Glenn W. Greene
121. C. W. Hancher
122. R. W. Hendricks
123. N. E. Hinkle
124. D. O. Hobson
125. H. W. Hoffman
126. C. A. Horton
127. E. D. Hudson
128. Geo. Kidd
129. G. W. Keilholtz
130. Charles Klabunde
131. C. E. Larson
132. M. E. LaVerne
133. A. W. Longest
134. A. L. Lotts
135. H. G. MacPherson
136. H. E. McCoy
137. H. C. McCurdy
138. H. F. McDuffie
139. F. R. McQuilkin
140. A. P. Malinauskas
141. C. D. Martin
142. W. J. Martin
143. R. E. Minturn
144. J. G. Morgan
145. A. H. Narten
146. F. H. Neill
147. A. A. Palko
148–149. R. B. Parker
150. L. R. Phillips
151. J. C. Pigg
152. J. C. Posey
153. Paul E. Reagan
154. J. L. Redford
155. J. T. Stanley
156. S. T. Sekula
157. R. L. Senn
158. C. E. Sessions
159. W. J. Stelzner
160. Oscar Sisman
161. W. A. Sibley
162. M. J. Skinner
163. G. P. Smith
164. W. L. Stirling
165. O. E. Schow III
166. J. L. Scott
167. D. B. Trauger
168. R. W. Tucker
169. A. M. Weinberg
170. R. C. Weir
171. R. P. Wichner
172. J. M. Williams
173. Robin Williams
174. H. D. Wills
175. Richard E. Whitt
176. Henry Zeldes

EXTERNAL DISTRIBUTION

177. R. H. Cook, The Foxboro Company, Foxboro, Massachusetts
178. C. L. Guettel, Driver-Harris Company, Harrison, New Jersey
179. R. C. Stroud, Leeds & Northrup Company, Philadelphia, Pennsylvania
180. G. W. Burns, National Bureau of Standards, Washington, D.C.
181. F. S. Sibley, Hoskins Manufacturing Company, Detroit, Michigan
182. W. H. Schneider, Barber Column Company, Rockford, Illinois
183. W. J. Hammond, Claud S. Gordon Company, Richmond, Illinois
184. E. D. Zysk, Engelhard Industries Inc., Newark, New Jersey
185. A. I. Dahl, General Electric Company, Schenectady, New York
186. B. Brenner, Sigmund Cohn Corporation, Mount Vernon, New York
187. J. F. Carlson, Hoskins Manufacturing Company, Detroit, Michigan
188. R. H. Brice, Pyro Electric Inc., Walkerton, Indiana
189. J. J. Sullivan, QAO-U.S. Naval Weapons Plant, Washington, D.C.
190. R. A. Pustell, General Electric Company, Instrument Department, West Lynn, Massachusetts
191. R. P. Benedict, Westinghouse Electric Corp., Philadelphia, Pennyslvania
192. N. R. Corallo, Thermo Electric Company, Saddle Brook, New Jersey
193. J. D. Sine, Honeywell, Philadelphia, Pennsylvania
194. C. A. Vogelsang, SAMA (Honeywell), Philadelphia, Pennsylvania
195. A. Gottlieb, Wilbur B. Driver Company, Newark, New Jersey
196. J. A. Bard, J. Bishop & Company, Malvern, Pennsylvania
197. D. I. Finch, Leeds & Northrup Company, Philadelphia, Pennsylvania
198. W. H. Rector, Satec Corporation, Grove City, Pennsylvania
199. J. F. Swindells, National Bureau of Standards, Washington, D.C.
200. P. O. Johansson, The Kanthal Corporation, Stanford, Connecticut
201. T. J. Williams, Monsanto Chemical Company, St. Louis, Missouri
202. E. Y. Kung, Jones & Laughlin Steel, Pittsburgh, Pennsylvania
203. H. M. Paynter, Massachusetts Institute of Technology, Cambridge, Massachusetts
204. Fred Woods, Union Carbide Olefins Company, Charleston, West Virginia
205. Robert Gray, Union Carbide Corporation, New York, New York
206. J. L. Gabbard, Union Carbide Corporation, New York, New York
207. L. R. Turner, NASA Lewis Research Center, Cleveland, Ohio
208. A. S. Lough, Division of Biology and Medicine, AEC, Washington, D.C.
209. S. G. Nordlinger, Division of Reactor Development, AEC, Washington, D.C.
210. F. C. Legler, Division of Reactor Development, AEC, Washington, D.C.
211. J. Hitch, Office of Isotope Development, AEC, Washington, D.C.
212. Ohio State University (Professor of Naval Science)
213. R. Hofstadter, Stanford University
214. J. C. Nance, Consolidate-Vultee Aircraft Corporation
215. E. A. Rollor, ANP Project Office, Fort Worth
216. R. N. Keller, University of Colorado
217. L. J. Rogers, Union Carbide Olefins Company, South Charleston, West Virginia
218. Research and Development Division, AEC, ORO

219–863. Given distribution as shown in TID-4500 (37th ed.) under Instruments category (100 copies – CFSTI)