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Aerodynamics Research Report 85

STATIC STABILITY AND DRAG OF THE HOPI WEAPON

Prepared by:

C. J. Carroll

ABSTRACT: This report presents the results of an investigation in the NOL Supersonic Tunnel No. 1 to measure the normal force, axial force, and pitching moment of the Hopi Weapon. These data were obtained at Mach numbers of 0.75, 0.90, 1.57, 2.17, and 3.25.

U. S. NAVAL ORDNANCE LABORATORY
White Oak, Maryland

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26 January 1960

The purpose of this investigation was to obtain normal force, axial force, and pitching moment on the Hopi Weapon. The wind-tunnel test was performed at the request of the U. S. Naval Ordnance Test Station (reference (a)), under task number NOL 415.

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JOHN A. QUENSE', Acting
Captain, USN
Commander

R. KENNETH LOBB
By direction

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ILLUSTRATIONS

Figure 1	Hopi Weapon Configuration
Figure 2	Hopi Weapon Fin Dimensions
Table I	Model Configuration and Test Information

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STATIC STABILITY AND DRAG OF THE HOPI WEAPON

INTRODUCTION

1. The Hopi Weapon is an air to surface, rocket assisted bomb being developed by the U. S. Naval Ordnance Test Station for the U. S. Navy.
2. This report gives the results of a wind-tunnel investigation performed to determine the normal force, axial force, and pitching moment at Mach numbers of 0.75, 0.90, 1.57, 2.17, and 3.25.

SYMBOLS

A	reference area ($\pi d^2/4$)
C	fin root chord length (in) (see Figures 1 and 2)
c.g.	center of gravity located at L/2
C_A	axial force coefficient (F_A/qA)
C_N	normal force coefficient (F_N/qA)
C_O	pitching moment coefficient (M_O/qAd)
d	reference diameter (0.978 in)
L	model length (in) (see Figure 1)
F_A	axial force (lbs)
F_N	normal force (lbs)
M	Mach number
M_O	pitching moment (in-lbs)
q	dynamic pressure (psi)
R_1	nose ogive radius (in)
R_2	nose tip radius (in)
Re/ft	Reynolds number per foot
S	fin span (in) (see Figures 1 and 2)
Θ	angle of pitch in vertical tunnel center plane (deg)
ϕ	angle of roll (deg)

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MODEL NOMENCLATURE

3. A drawing of the Hopi weapon configuration is shown as Figure 1. Two body configurations (B_1 and B_2) were tested. These varied in length only, being 9.914 and 14.670 inches, respectively. There were 10 tail sections used in the test, one without fins and nine with different fin configurations, labeled F_1 through F_9 (see Figure 2).

TEST TECHNIQUES AND DATA REDUCTION

4. The data were obtained using a six-component internal strain-gage balance (reference (b)). These data were recorded on IBM cards using the automatic data recording system explained in reference (c). IBM 650 machines were used to reduce the wind-tunnel data to coefficient form using the equations given in reference (b). A correction was made to the data for the elastic deflection of the sting due to the aerodynamic loading.

5. The model was placed in the wind tunnel at 0° yaw and swept through an angle of pitch range from -6° to $+12^\circ$ in 2° increments. The roll attitudes tested were 0° and 45° .

TABULATED DATA

1. Model configurations tested and test information are listed in Table I.
2. Tabulated data follow Table I in sequence.
3. The symbols used in the column headings are defined on Page 1.
4. Runs are tabulated in sequence by Run Number.
5. Column headings are shown on Run 1 of the tabulated data and are the same for all runs.

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REFERENCES

- (a) Naval Ordnance Test Station Wind-Tunnel Request 481, Conf., 1958
- (b) Shantz, I., Gilbert, B. D., and White, C. E., "NOL Wind-Tunnel Internal Strain-Gage Balance System," NAVORD Report 2972, Unclass., 1953
- (c) Gilbert, B. D., "Automatic Data Processing System (ADAPS) for the Supersonic Wind Tunnels," NAVORD Report 2813, Unclass., 1953

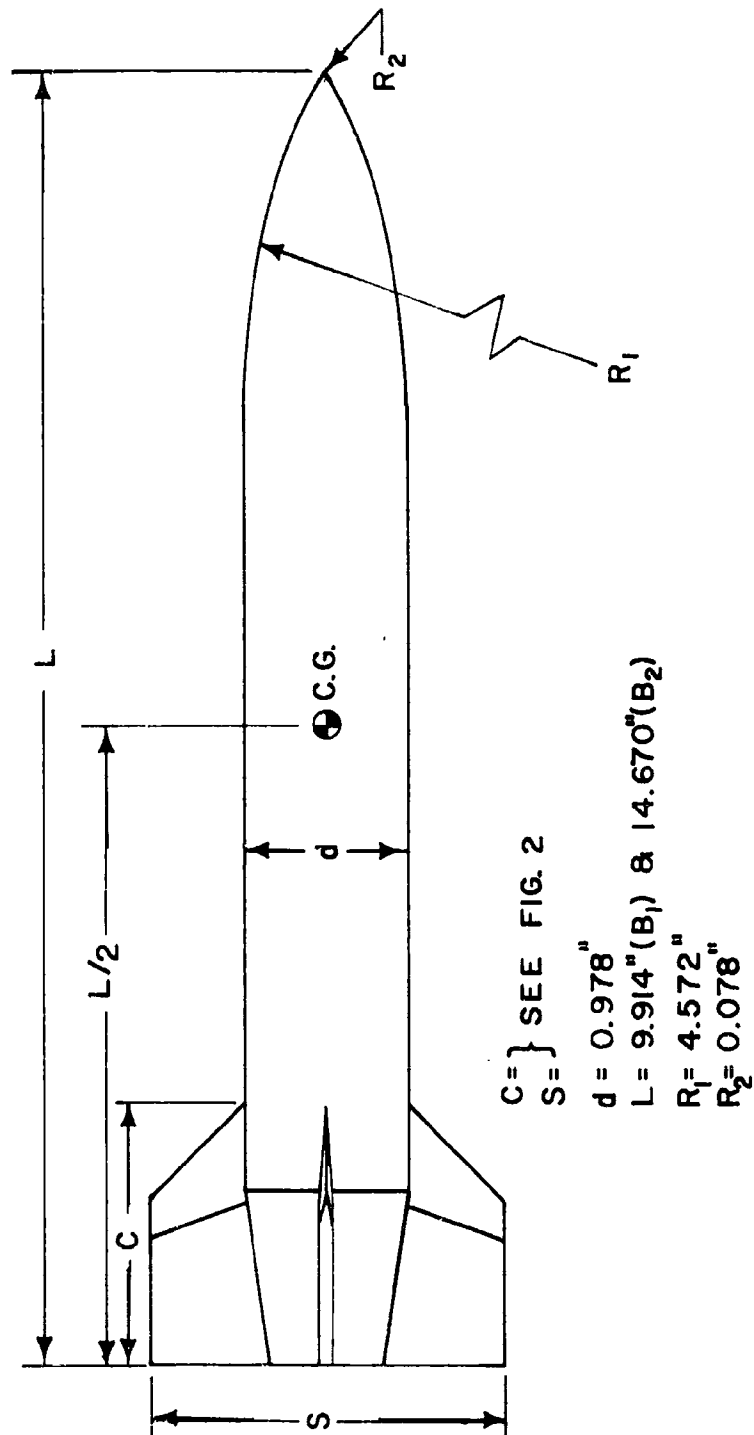
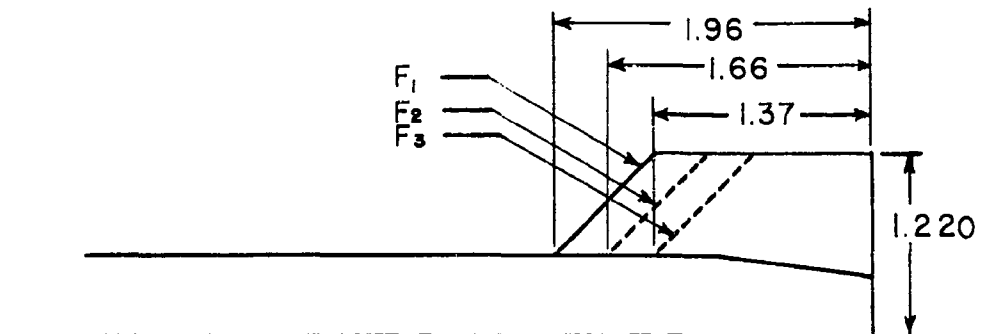


FIG. 1 HOPI WEAPON CONFIGURATION

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NOTE

ALL DIMENSIONS IN INCHES
FIN SPAN DIMENSIONS SHOWN
ARE EQUAL TO S/2

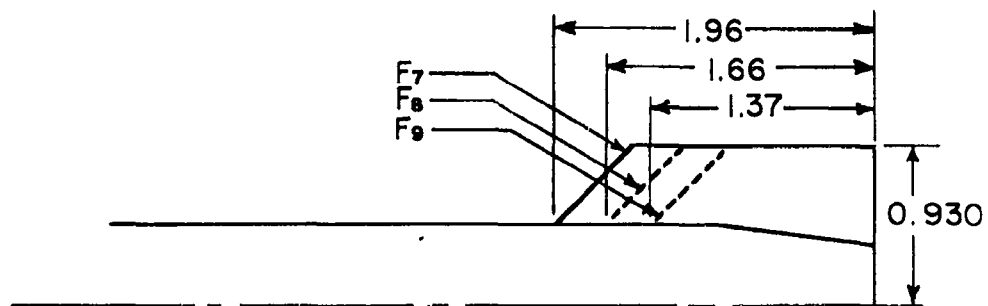
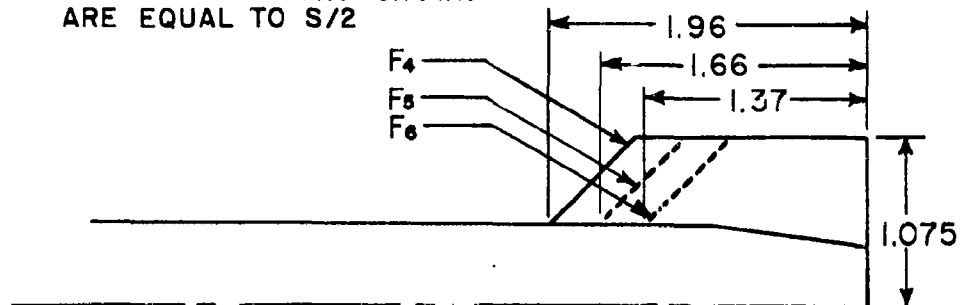


FIG. 2 HOPI WEAPON FIN DIMENSIONS

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TABLE I
MODEL CONFIGURATION AND TEST INFORMATION

Run	M	Config.	ϕ°	q(psi)	(Re/Ft) $\times 10^{-6}$
1	3.25	B ₁	0	2.01	2.1
2	3.25	B ₁ F ₂	0	2.01	2.1
3	3.25	B ₁ F ₂	-45	2.01	2.1
4	3.25	B ₁ F ₁	-45	2.01	2.1
5	3.25	B ₁ F ₃	-45	2.01	2.1
6	3.25	B ₁ F ₄	-45	2.01	2.1
7	3.25	B ₁ F ₆	-45	2.01	2.1
8	3.25	B ₁ F ₇	-45	2.01	2.1
9	3.25	B ₁ F ₉	-45	2.01	2.1
10	3.25	B ₁ F ₅	-45	2.01	2.1
11	3.25	B ₁ F ₅	0	2.01	2.1
12	3.25	B ₁ F ₈	0	2.01	2.1
13	3.25	B ₁ F ₈	-45	2.01	2.1
14	3.25	B ₂ F ₂	-45	2.03	2.1
15	3.25	B ₂ F ₈	-45	2.03	2.1
16	3.25	B ₂ F ₅	-45	2.03	2.1
17	3.25	B ₂ F ₅	0	2.03	2.1
18	3.25	B ₂	0	2.03	2.1
19	1.57	B ₂	0	5.97	4.2
20	1.57	B ₂ F ₅	0	5.97	4.2
21	1.57	B ₂ F ₅	-45	5.97	4.2
22	1.57	B ₂ F ₈	-45	5.97	4.2
23	1.57	B ₂ F ₂	-45	6.01	4.3
24	1.57	B ₁ F ₈	-45	6.01	4.3
25	1.57	B ₁ F ₈	0	6.01	4.3
26	1.57	B ₁ F ₅	0	6.01	4.3
27	1.57	B ₁ F ₅	-45	6.01	4.3
28	1.57	B ₁ F ₉	-45	6.01	4.3

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TABLE I (Cont.)

Run	M	Config.	ϕ°	q(psi)	(Re/Ft) $\times 10^{-6}$
29	1.57	B ₁ F ₇	-45	6.01	4.3
30	1.57	B ₁ F ₆	-45	6.01	4.3
31	1.57	B ₁ F ₄	-45	6.01	4.3
32	1.57	B ₁ F ₃	-45	6.01	4.3
33	1.57	B ₁ F ₂	-45	6.01	4.3
34	1.57	B ₁ F ₂	-45	6.01	4.3
35	1.57	B ₁ F ₂	0	6.01	4.3
36	1.57	B ₁ F ₁	-45	6.01	4.3
37	1.57	B ₁	0	6.01	4.3
38	0.90	B ₁	0	4.72	4.3
39	0.90	B ₁ F ₂	0	4.72	4.3
40	0.90	B ₁ F ₂	-45	4.72	4.3
41	0.90	B ₁ F ₁	-45	4.72	4.3
42	0.90	B ₁ F ₃	-45	4.72	4.3
43	0.90	B ₁ F ₄	-45	4.72	4.3
44	0.90	B ₁ F ₂	-45	4.78	4.3
45	0.90	B ₁ F ₇	-45	4.78	4.3
46	0.90	B ₁ F ₉	-45	4.78	4.3
47	0.90	B ₁ F ₅	-45	4.78	4.3
48	0.90	B ₁ F ₅	0	4.78	4.3
49	0.90	B ₁ F ₈	0	4.78	4.3
50	0.90	B ₁ F ₈	-45	4.78	4.3
51	0.75	B ₁	0	3.83	4.0
52	0.75	B ₁ F ₅	0	3.83	4.0
53	0.75	B ₁ F ₅	-45	3.83	4.0
54	0.75	B ₁ F ₄	-45	3.83	4.0
55	0.75	B ₁ F ₆	-45	3.83	4.0
56	2.17	B ₁ F ₆	-45	4.65	3.5
57	2.17	B ₁ F ₄	-45	4.65	3.5

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TABLE I (Cont.)

Run	M	Config.	θ°	q(psi)	(Re/Ft) $\times 10^{-6}$
58	2.17	B ₁ F ₅	-45	4.65	3.5
59	2.17	B ₁ F ₅	0	4.65	3.5
60	2.17	B ₁	0	4.65	3.5
61	2.17	B ₂	0	4.65	3.5
62	2.17	B ₂ F ₅	0	4.65	3.5
63	2.17	B ₂ F ₅	-45	4.65	3.5

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WTR RUN

481 θ	C_N	C_θ	C_A
4.02-	.1810-	1.0116-	.3027
4.02-	.2636-	.6599-	.2833
6.03-	.3949-	1.0706-	.2660
2.01-	.1595-	.1857-	.2623
.00	.0089-	.0058-	.2774
2.01	.1412	.2549	.2627
4.02	.3093	.4860	.2732
6.03	.4050	.8744	.2937
6.03	.4317	.8918	.2935
8.05	.6709	1.1704	.3020
10.06	.9823	1.5340	.3100
12.00	1.2764	1.4050	.3245
2.01-	.1132-	.4395-	.1954

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2

6.03-	.8894-	.9938	.3653
6.02-	.9711-	1.2291	.3866
4.02-	.6109-	.6946	.3823
2.01-	.2696-	.3100	.3541
2.00	.0086-	.0462-	.3512
2.01	.2690	.2292-	.3264
4.02	.5396	.7008-	.3474
6.03	.8079	.8088-	.3632
8.04	1.2569	1.2851-	.3777
10.05	1.6881	1.7720-	.3982
12.07	2.0724	1.8862-	.3843
2.01	.2871	.2580-	.3121

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3

6.02-	.7934-	.8530	.3297
4.02-	.5520-	.4385	.3974
4.02-	.5722-	.4825	.3813
2.02-	.2160-	.0286	.3453
.00	.0125	.0946	.3396
2.01	.2418	.3854-	.3395
2.01	.3293	.4144-	.3269
4.02	.6160	.7703-	.3225
6.02	.9274	.9373-	.3377
8.04	1.2337	1.3086-	.3346
10.06	1.6492	1.4931-	.2968
12.08	2.1263	1.5777-	.3231
12.08	2.0254	1.5885-	.3271
10.06	1.6622	1.3115-	.3338
6.02-	.8253-	.9184	.3400
4.02-	.5507-	.5548	.3787

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4

4.02-	.5449-	.5010	.2780
6.02-	.9219-	1.0557	.4061
2.01-	.2488-	.2368	.3517
.00	.0438	.1153-	.3484
2.01	.2990	.5489-	.3232
4.02	.5893	.9319-	.3368
6.02	.9928	1.1827-	.3514
8.04	1.3753	1.6177-	.3087
10.06	1.7760	1.8104-	.3355
12.08	2.2505	2.2144-	.3297
4.02	.6393	.8113-	.3357

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.4.02-	.4475-	.3644	.3283
.4.02-	.6961-	.3998	.3748
.2.02-	.2341-	.1606	.3413
.00	.0776-	.1501	.3147
.2.02	.3766	.4405-	.3055
.4.02	.4851	.6563-	.3379
.6.02	.8209	.4608-	.3315
.8.04	1.1561	.9864-	.3249
10.86	1.3580	1.0357-	.3157
12.08	1.8410	.9616-	.3006
4.02	.4549	.5319-	.3069
2.01	.1598	.0366-	.2998
3.02	.3846	.2330-	.3128
5.02	.6489	.6045-	.3205

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6

4.07-	.5027-	.3843	.3222
6.02-	.8071-	.5272	.3792
2.02-	.2076-	.1210	.3245
.00	.0002-	.1441-	.3239
2.01	.2494	.3515-	.3177
4.02	.5900	.4710-	.3210
6.02	.8829	.8802-	.3328
8.04	1.2080	1.0667-	.3300
10.06	1.5682	1.2979-	.3175
12.08	2.0017	1.6457-	.3208
2.01-	.2064-	.0059	.3280
1.00-	.1339-	.2279	.3111

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2.02-	.1875-	.0669-	.3017
4.02-	.3767-	.0083	.3390
6.02-	.7349-	.3174	.3659
8.00	.0063	.0042	.3009
2.01	.2531	.1619-	.3272
4.02	.4867	.4246-	.2924
6.02	.7581	.3883-	.3205
8.05	1.1436	.4463-	.2222
10.07	1.4803	.3952-	.3259
12.08	1.7931	.4746-	.3041
8.04	1.0298	.4651-	.3218
6.03	.7900	.2503-	.2890
4.02	.4550	.3012-	.3059
2.01-	.2544-	.3197	.2942
4.02-	.4359-	.1994	.3230
6.02-	.7529-	.5067	.3562
3.02-	.3615-	.3069	.3207

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2.02-	.2264-	.0800	.3195
4.02-	.4965-	.2448	.3294
6.02-	.6967-	.0830	.3676
.00	.0192	.0451-	.3105
2.02	.2587	.2310-	.2973
4.02	.4811	.2842-	.3166
6.03	.8019	.2142-	.3007
8.03	1.1765	.3972-	.3322
10.06	1.5226	.6049-	.3158
12.08	1.7831	.5516-	.3008
4.02-	.4613-	.2400	.3201
6.03-	.7956-	.1320	.3644

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9

2.02-	.1434-	.0959-	.2726
4.02-	.3725-	.1906-	.3415
6.02-	.5345-	.4132-	.3421
.01	.1002	.0764-	.3054
2.02	.1889	.0106	.3033
4.02	.3833	.1685	.2959
6.02	.7153	.0424-	.3356
8.04	1.0655	.2124-	.3029
10.07	1.3179	.0431	.3028
12.08	1.6361	.1108	.2839
2.02-	.1913-	.2142-	.2821
3.02-	.2878-	.0957	.2984
5.02-	.4731-	.0840-	.3043
6.02-	.6858-	.0251-	.3397
.01	.0741	.1362	.2970

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2.52-	.2748-	.0470	.2945
4.02-	.3681-	.0725	.3653
6.02-	.8066-	.5279	.3411
.00	.0246-	.0128	.3168
2.01	.2747	.3637-	.3220
4.02	.4722	.3756-	.2373
6.02	.8001	.6760-	.3275
8.04	1.0287	.3906-	.3161
10.07	1.6005	.7764-	.3283
12.08	1.8368	1.1365-	.3512
6.02-	.7662-	.3535	.3548
.00	.0178-	.2185	.3174
8.04	1.1571	.8991-	.3366
4.02	.5309	.3651-	.3328

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2.01-	.1972-	.1546	.2597
3.02-	.7982-	.6935	.3533
4.02-	.5026-	.4010	.4214
5.02-	.0175	.0520	.3131
2.01-	.2696	.3100-	.2984
4.02-	.5685	.5621-	.3039
6.02-	.8296	.7972-	.3023
8.02-	1.1741	.8932-	.3325
10.02-	1.5655	1.2025-	.3460
12.07-	1.8728	1.3680-	.3410
2.01-	.1787	.0451	.3043
4.02-	.5198-	.3893	.3094
6.03-	.8244-	.5952	.2940

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2.01-	.1957-	.0877-	.2936
4.02-	.4284-	.0436	.2792
6.03-	.7330-	.2496	.3625
.00	.0183	.0691-	.3099
2.01	.2322	.0506-	.2925
4.02	.5018	.3606-	.2912
6.03	.7968	.3478-	.3472
8.04	1.0195	.4268-	.3075
10.06	1.4664	.5799-	.3303
12.07	1.7334	.4860-	.3458
6.03	.7515	.3591-	.3358
6.03-	.7340-	.4111	.3484

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12	13	14	15
2.02-	.0793-	.6002-	.3291
6.02-	.6381-	.1365-	.3384
4.02-	.4175-	.3067-	.3485
.00	.0645	.1589-	.2365
2.02	.1818	.0800-	.2825
4.02	.4501	.1893-	.2986
6.03	.7631	.0476	.3106
8.04	1.0933	.1936-	.2926
10.07	1.4141	.2093-	.2931
12.08	1.7750	.0857-	.2604
2.02	.2624	.0887	.2944
.00	.0026-	.0540	.2946
2.01-	.1102-	.2459-	.2546
4.02-	.4490-	.1041	.3520
5.02-	.5827-	.1855-	.3720

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7.02-	.2276-	.0368	.3509
4.03-	.4832-	.0009	.3707
6.05-	.8495-	.8984	.4008
.00	.0778-	.1973	.3647
2.02	.2178	.0625	.3521
4.03	.5708	.6718-	.3394
6.07	.8845	.6320-	.3236
8.08	1.4043	1.3184-	.3738
10.10	1.4524	.4370-	.3412
12.14	2.3588	2.0773-	.2559
12.13	1.7011	1.1927-	.2733
10.10	1.5376	.8464-	.3114
2.02-	.2329-	.2762	.2886
2.02-	.2332-	.2480	.3598

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2.02-	.1504-	.0718-	.2486
4.04-	.4520-	.6459-	.3518
6.06-	.7156-	.0958-	.3462
4.04-	.5752-	.0390-	.3486
.00	.0069-	.1248	.3115
2.02	.1415	.2582	.3507
4.03	.4048	.3991	.3159
6.07	.7251	.5722	.2698
8.09	1.0499	.6251	.3255
10.13	1.6835	.1769	.3368
12.16	2.1639	.2664	.3092
5.07	.7791	.3510	.3191
2.02-	.2009-	.0294	.3158

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2.01-	.1070-	.1905-	.3912
4.02-	.4499-	.0981	.3962
6.06-	.8231-	.3153	.4141
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2.02	.1883	.0972-	.3429
4.03	.4591	.0236-	.3403
6.07	.8512	.2686-	.3215
8.09	1.3365	.2443-	.2885
10.12	1.7266	.3430-	.3419
12.16	2.3376	.9588-	.3523
2.02-	.2285-	.3267	.3293
4.03-	.5711-	.4126	.3440

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487 17

2.02-	.2376-	.0588	.3403
4.03-	.5463-	.1049	.3774
6.03-	.8467-	.5315	.3714
.00	.1272	.6690-	.4174
2.02	.2469	.1533-	.3580
4.02	.5197	.2224-	.3690
6.03	.8882	.7460-	.3721
8.08	1.3419	1.0424-	.3875
10.12	1.8763	1.1269-	.3410
12.15	2.2809	.8973-	.4019
4.04	.6180	.4854-	.3243
.00	.0631	.2528-	.2576
.00	.0355	.0811-	.3505
.00	.0633	.2937-	.2975
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.00	.1257	.4249-	.2895
2.02-	.2282-	.0356-	.3320

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2.02	.1197	.5157	.2604
4.04	.3102	.9701	.7982
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2.02	.1451	.6816	.2747
4.04	.3081	1.2969	.2531
6.06	.5327	1.9044	.2714
8.09	.8279	2.4507	.2974
10.15	1.2098	3.1360	.2544
12.17	1.7228	3.9030	.2508
8.10	.9954	2.1340	.2782
4.04	.5251	1.3939	.2505

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481 19

5.14-	.3556-	1.5548-	.4196
6.14-	.3522-	1.6282-	.4278
7.09-	.2254-	1.6032-	.4216
2.04-	.1104-	.4023-	.4119
4.01-	.0111-	.3445	.4213
2.55-	.5364	.9592	.4169
4.10-	.2047	1.4573	.3518
6.15-	.3282	1.9805	.3820
8.20-	.4709	2.5934	.3935
6.14-	.3645-	1.5557-	.4204
6.14-	.3492-	1.6325-	.4183
4.09-	.2071-	1.0843-	.4091
2.04-	.0954-	.4239-	.4073
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2.05	.0831	.9618	.3955
4.10	.1833	1.5366	.3866
6.15	.3291	1.9900	.3769
8.20	.4856	2.6133	.3921
10.28	.6763	3.4749	.4080
12.37	.9332	4.3079	.4024
12.37	.9383	4.3157	.4064

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491 20

4.08-	.7409-	2.5456	.5331
2.03-	.4078-	1.5457	.5203
2.05-	.2725	.3377-	.5150
4.08	.6209	1.4145-	.5035
6.12	1.0237	2.6382-	.5054
8.15	1.4627	3.9550-	.5063
10.23	1.9659	5.0768-	.5129
6.11-	1.1612-	3.7261	.5174
6.11-	1.1673-	3.7486	.5220
6.11-	1.1735-	3.7848	.5396
.01	.0507-	.5112	.5238
12.31	2.4177	5.5903-	.5085
12.31	2.4426	5.7173-	.5110
12.30	2.4153	5.6832-	.5211
12.31	2.4394	5.7315-	.5177
10.23	1.9448	5.0323-	.5166
11.26	2.1758	5.1929-	.5195
13.26	2.7079	5.9130-	.5012

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21

6.10-	1.0539-	3.2956	.5284
4.08-	.7406-	2.4291	.5410
2.02-	.3793-	1.4950	.5164
.01	.0388-	.5218	.5206
2.05	.2632	.2888-	.5027
4.08	.6164	1.3088-	.4722
2.12	.9896	2.4060-	.4733
8.16	1.3638	3.4371-	.4763
10.23	1.8363	4.3744-	.4777
12.32	2.3001	4.9210-	.4700
12.32	2.3026	4.9366-	.4770

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481 22

2.02-	.2378-	.7576	.5098
4.08-	.5612-	1.3470	.5019
6.12-	.9090-	1.8929	.5177
.01	.0426-	.4108	.5060
2.05	.8286	.0025	.4899
4.09	.5371	.6124-	.4826
6.12	.4847	1.0930-	.4645
8.16	1.0764	1.5979-	.4613
10.25	1.5554	2.3314-	.4610
12.32	1.9071	2.3724-	.4600
12.32	1.9043	2.4134-	.4583
11.28	1.7411	2.3644-	.4610
10.24	1.5144	2.2436-	.4581
4.08	.5029	.5638-	.4649
2.05	.2456	.0501-	.4739
6.12-	.8755-	1.8743	.5070
2.03-	.2681-	.7725	.4943
.01	.0407-	.3982	.5022
4.08-	.3751-	1.3762	.4837
4.08-	.5485-	1.2703	.4911
4.08-	.5677-	1.3174	.4896

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481 23

4.08-	.9401-	3.4079	.5535
2.01-	.4228-	1.9262	.5494
2.04	.3234	.7613-	.5257
4.08	.7325	2.2332-	.5014
6.11	1.1311	3.6425-	.4908
8.16	1.6553	5.3174-	.4786
10.22	2.1583	6.5517-	.4877
6.11-	1.3524-	4.9430	.5535
.01	.0579-	.5848	.5524
12.30	2.6493	7.3471-	.4890
6.12	1.1530	3.5386-	.4829
.02	.0295-	.4376	.5501
2.04	.2771	.5210-	.5261
4.09	.7777	2.2010-	.5002
4.06-	.0487-	3.3345	.5313
2.02-	.4883-	2.0869	.5453
.02	.0661-	.6827	.5407
.20	2.6943	7.6237-	.4829

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24

2.02-	.2593-	.2426	.4812
4.03-	.4602-	.6583	.4654
8.07-	.7838-	1.0497	.4657
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2.02	.2232	.1306-	.4511
4.03	.5054	.4634-	.4421
6.08	.8604	.9787-	.4304
8.12	1.1855	1.3594-	.4202
10.14	1.5367	1.8107-	.4097
12.17	1.9041	2.1540-	.4131
2.02	.2590	.2806-	.4419
2.02-	.2691-	.2549	.4607
6.08-	.7913-	.9193	.4567
4.03-	.5301-	.5728	.4575

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28

6.07-	.8465-	1.1158	.4857
4.05-	.5815-	.7869	.4760
2.03-	.2555-	.2536	.4692
.00	.0063	.0502-	.4674
2.02	.2866	.4370-	.4512
4.05	.5726	.7928-	.4558
6.08	.9071	1.2527-	.4451
8.10	1.2049	1.5726-	.4403
10.14	1.6487	2.3150-	.4322
12.18	1.9658	2.3924-	.4307
6.08	.9153	1.2874-	.4436
10.14	1.6120	2.1761-	.4358

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481 26

4.04-	.6984-	1.3215	.4829
2.02-	.3138-	.4871	.4804
6.06-	1.1351-	2.3393	.4757
.00	.0455-	.1060	.4747
2.02	.3298	.5567-	.4732
4.04	.6743	1.2630-	.4656
6.07	1.0884	2.0439-	.4665
8.10	1.3302	2.9360-	.4611
10.12	1.9592	3.6871-	.4891
12.16	2.4083	4.3295-	.4652
.00	.0368	.1524-	.4744
.00	.0278	.1448-	.4777

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481 27

6.07-	1.0017-	1.8591	.4822
4.04-	.6052-	1.0529	.4803
2.03-	.3601-	.4925	.4780
.00	.0063	.1307-	.4771
2.02	.3763	.6651-	.4658
4.04	.8710	1.2015-	.4548
6.08	1.0129	1.7548-	.4471
8.10	1.4104	2.4731-	.4338
10.12	1.8735	3.1770-	.4264
12.16	2.3142	3.9151-	.4196
4.03	.6678	1.0589-	.4485
6.07-	1.0068-	1.9422-	.4707
4.04-	.6191-	1.0454	.4799
2.02-	.2944-	.4885	.4342
2.02-	.3236-	.5365	.4818

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481 28

6.07-	.7688-	.9536	.4487
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2.02-	.1984-	.0027	.4532
.00	.0020	.0373-	.4565
2.02	.2701	.2730-	.4471
4.04	.5006	.5150-	.4382
8.08	.7642	.7836-	.4265
8.11	1.1181	1.1028-	.4144
10.14	1.4128	1.4498-	.4023
12.18	1.7630	1.6507-	.3999
2.02-	.2677-	.2651	.4408

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441 39

6.03-	.8428-	1.1163	.4719
4.05-	.5407-	.6043	.4714
2.02-	.2680-	.2203	.4786
.00	.0071	.0825-	.4733
2.02-	.2715-	.2332-	.4587
4.05-	.5690	.5368-	.4543
6.08	.8866	.9035-	.4438
8.12	1.2643	1.5293-	.4328
10.16	1.6596	1.9894-	.4235
12.18	2.0901	2.5512-	.4259
8.12	1.2550	1.5358-	.4259
6.08	.8794	.9471-	.4373
4.06	.5737	.5526-	.4506

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431 30

6.06-	.8857-	1.6275	.4750
4.03-	.5878-	1.0740	.4645
2.02-	.3177-	.4439	.4716
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2.02	.3347	.6734-	.4629
4.04	.6136	.9888-	.4508
6.08	.9802	1.6414-	.4416
8.10	1.3300	2.3471-	.4403
10.12	1.6872	2.6057-	.4278
12.16	2.1950	3.3968-	.4268
12.16	2.1590	3.1991-	.4197
8.10	1.3390	2.1449-	.4343
10.12	1.7172	2.7898-	.4324
2.02-	.3196-	.5295	.4643

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* 481 31

0.07-	1.0965-	1.9191	.5017
4.04-	.6972-	1.9092	.5055
2.02-	.3492-	.5775	.5000
.00	.0236	.1193-	.4978
2.02-	.3679	.6127-	.4806
4.04-	.7527	1.2529-	.4750
6.08	1.1275	1.8515-	.4684
8.12	1.5762	2.7001-	.4539
10.14	2.0290	3.5169-	.4368
12.16	2.5219	4.4130-	.4440
10.14	2.0553	3.7114-	.4432
10.14	2.0617	3.7168-	.4435
2.02	.3673	.6132-	.4804
6.07-	1.0670-	1.9596	.5028
4.05-	.6984-	1.1839	.5031

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32

6.05-	1.0691-	2.3632	.4824
4.03-	.6986-	1.5111	.4851
2.02-	.3546-	.7282	.4863
.00	.0110-	.0311	.4942
2.02	.3803	.7974-	.4788
4.04	.7403	1.5892-	.4651
6.07	1.0911	2.1940-	.4521
8.08	1.4204	2.6497-	.4353
10.12	1.8959	3.7982-	.4403
12.16	2.3347	4.1901-	.4322
10.11	1.9036	3.8223-	.4340
8.03	1.5159	2.9717-	.4345
12.16	2.3575	4.3879-	.4377
10.12	1.9247	3.7886-	.4385

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33

4.04-	.7598-	1.6920	.4918
6.07-	1.1900-	2.6686	.4942
2.02-	.3369-	.7106	.5078
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2.02	.4288	.8997-	.4939
4.04	.8953	1.8886-	.4799
6.08	1.2529	2.7227-	.4670
8.08	1.6784	3.6251-	.4527
10.12	2.1804	4.7177-	.4460
12.15	2.6768	5.8957-	.4488
8.08	1.7165	3.7540-	.4496
2.02	.4084	.9234-	.4873

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481 34

6.05-	1.1620-	2.6581	.4987
4.05-	.7805-	1.7361	.4943
2.02-	.3805-	.7007	.4953
.00	.0138	.0967-	.5067
2.02	.4270	.9105-	.4917
4.04	.8211	1.7858-	.4737
6.07	1.2686	2.7506-	.4639
8.08	1.6976	3.7567-	.4433
10.12	2.2327	4.8273-	.4408
12.16	2.6717	5.4601-	.4411
12.15	2.7262	5.7131-	.4432
4.04	.8272	1.7722-	.4645
2.02-	.3577-	.6776	.4962

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4.04-	.7563-	1.6574	.4982
6.06-	1.2126-	2.7775	.4899
2.02-	.4054-	.6073	.5024
.00	.0034	.0657-	.5050
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6.06	1.3005	2.9915-	.4815
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10.11	2.1382	4.5885-	.4670
12.15	2.8202	6.1517-	.4755
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12.15	2.7922	5.9799-	.4740
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8.09	1.8034	4.0881-	.4738
6.06	1.3127	3.0243-	.4848
2.02-	.3691-	.7360	.4978
2.03-	.3745-	.6374	.5092

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481 36

6.07-	1.2752-	2.8622	.5144
4.04-	.8540-	1.8992	.5177
2.02-	.3947-	.8265	.5227
.00	.0243	.1284-	.5171
2.02	.4587	.9957-	.5053
4.05	.9150-	1.9834-	.4979
6.08	1.4244	3.1770-	.4870
8.09	1.9422	4.3460-	.4710
10.12	2.4269	5.4207-	.4649
12.16	3.0174	6.5602-	.4570

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37

2.03-	.0658-	.4506-	.3682
4.06-	.1005-	1.1117-	.3883
6.07-	.2841-	.8790-	.3771
.00	.0184	.0695-	.3841
2.03	.1083	.3427	.3811
4.06	.2404	.7145	.3659
6.09	.3418	1.2021	.3605
8.13	.4432	1.7032	.3542
10.16	.5750	2.1156	.3540
6.08-	.2853-	1.1670-	.3748
.00	.0895	.4439-	.3833
12.20	.8486	2.3085	.3654
10.16	.6419	1.9285	.3550
12.21	.8789	2.2333	.3667
6.09-	.2412-	1.5300-	.3778
4.05-	.1987-	.6872-	.3861
2.03-	.0316-	.6727-	.3856
2.03-	.1023-	.3523-	.3815
2.03-	.0392-	.5550-	.3797
4.06-	.2010-	.7974-	.3889
6.06-	.1389-	1.1777-	.3758
6.10-	.3523-	1.2775-	.3758
10.16	.6139	2.1003	.3607
12.26	.8241	2.4011	.3634
.01-	.0469-	.1194-	.3879
.01-	.0103-	.2513-	.3890
.00	.0088	.0194	.3858
2.03-	.0502-	.5626-	.3894
4.06-	.1183-	1.1234-	.3883
6.08-	.2698-	1.2500-	.3806
6.08-	.2761-	1.1997-	.3819
4.06-	.1893-	.7625-	.3870
2.03-	.0747-	.4700-	.3877

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6.06-	.1516-	1.2939-	.0810
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.00	.0198	.0935-	.0609
2.02	.0044-	.6896	.0858
4.03	.1140	.6287	.0743
6.05	.1678	1.1487	.0715
8.07	.3035	1.3588	.0757
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12.11	.5127	1.9807	.0511
12.12	.5041	2.1481	.0462
12.12	.5551	1.9046	.0479
10.10	.4193	1.7437	.0714
2.02	.0578	.4880	.0607
4.04	.1170	.7516	.0702

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39

8.04-	1.3045-	3.3861	.1977
4.03-	.7966-	1.9360	.2010
2.01-	.4019-	.9310	.1887
.00	.0194	.0565-	.1763
2.01	.4254	1.0368-	.1750
4.02	.8411	2.3569-	.1891
6.03	1.3919	3.9520-	.1946
8.04	1.9378	5.3773-	.1987
10.05	2.5506	7.1567-	.1604
12.07	3.0284	8.4296-	.2038
6.04	1.4328	3.8040-	.1932
6.03	1.4132	4.0233-	.1897
4.03	.8773	2.0562-	.1836
4.02	.8951	2.4600-	.1730
2.01	.4534	1.2609-	.1604

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48

6.03-	1.2519-	3.1452	.1908
4.02-	.8069-	2.1997-	.2008
2.02-	.3546-	.6275	.2003
.01	.0752	.1564-	.1793
2.02	.4016	1.0345-	.1742
4.02	.7918	1.8817-	.1975
6.04	1.3081	3.2290-	.1954
8.04	1.8561	4.9318-	.1450
10.06	2.3341	6.2198-	.1238-
12.08	3.0348	8.1129-	.1115
.00	.0376-	.0120	.1728
4.02-	.7218-	1.8365	.1946
6.04-	1.2389-	3.0190	.1843
4.02-	.7640-	1.7781	.1894
10.05	2.3174	6.4407-	.1331
10.08	2.4402	5.9662-	.1227

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41

3.04-	1.2854-	3.1581	.1978
4.03-	.8195-	1.9123	.1961
2.02-	.4453-	.9564	.1973
.00	.0380-	.1337	.1882
2.07	.3854	.8874-	.1835
4.02	.8534	1.9485-	.2003
6.04	1.3332	3.3338-	.1836
8.07	2.3330	4.7864-	.1636
10.08	2.4983	6.3897-	.1268
12.09	3.2148	8.7726-	.1300
12.10	3.2236	7.9373-	.1422
12.13	3.2353	8.1984-	.1643
8.08	1.9694	4.7471-	.1672
6.03	1.2732	2.8858-	.1804
4.02	.8590	2.1526-	.1831
4.02	.8365	2.0333-	.1886
.01-	.4098-	.1653-	.1757
.00	.0042-	.0026-	.1842
4.03-	.8329-	1.9521	.1862
4.02-	.7345-	1.6892	.1969
6.03-	1.2955-	3.0793	.1848
3.02-	.5112-	1.1441	.1808
3.04-	1.0930-	2.4108	.1911
4.03-	.8311-	1.6368	.1731
4.03-	.8612-	1.8965	.1930

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481 42

6.02-	1.1741-	3.0987	.1741
4.02-	.7532-	1.9077	.1742
2.02-	3.3856-	1.0690	.1778
.01	.0630-	.9355	.1732
2.02	.3949	1.0630-	.1477
4.02	.7711	2.1386-	.1815
6.03	1.1563	2.9533-	.1891
8.03	1.7223	4.3762-	.1411
10.07	2.3393	6.0940-	.1290
12.07	2.7539	7.4345-	.1244
.00	.0189	.0609	.1572
8.03	1.6502	4.2054-	.1321
10.06	2.3394	5.8005-	.1319
12.06	2.4468	7.5090-	.1162
12.06	2.7098	7.5018-	.1142
10.04	2.1860	6.2331-	.1186
8.02	1.6652	4.7672-	.1279
4.02-	.7514-	1.9581	.1713

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481 43

6.06-	1.0626-	1.9942	.1742
4.02-	.5830-	1.1569	.1740
2.02-	.5009-	.5176	.1735
.01-	.0594-	.0459	.1601
2.03	.3658	.4370-	.1467
4.02	.6545	1.2675-	.1552
6.05	1.0044	1.9349-	.1706
8.07	1.5814	3.2785-	.1490
10.08	1.9819	4.1307-	.1177
12.12	2.7463	5.4951-	.1169
4.03	.6647	1.1307-	.1720
2.02	.3400	.5277-	.1524
8.07	1.4982	3.1510-	.1486
6.06	.9986	1.7926-	.1642
6.05	.9559	1.7475-	.1665
2.02	.2502	.3442-	.1588
4.04	.6698	1.0617-	.1678
4.03	.6574	1.1683-	.1529
6.04	1.0524	2.0975-	.1557
10.08	2.0178	4.1552-	.1182
10.08	1.9401	4.2433-	.1206
12.10	2.5250	5.6182-	.1117

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6.03-	.8340+	2.2749	.1511
4.02-	.5915-	1.0373	.1424
2.01-	.3332-	.84331	.1390
.08	.0535-	.1224-	.1426
2.01	.2000	.5216-	.1223
4.02	.5772	1.2661-	.1580
6.04	1.0081	2.2884-	.1341
8.06	1.3493	2.9834-	.1065
10.08	1.7042	4.0743+	.1178
12.08	2.2170	5.1588-	.0989
8.06	1.4338	3.3878-	.1152
6.03	1.0394	2.4378-	.1468
8.07	1.4874	3.1942-	.1279
.00	.0257-	.0681	.1338
4.02	.6326	1.3494-	.1853

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6.06	.8294-	1.1820	.1183
6.05	.5208-	.4780	.1405
2.02	.2601-	.1908	.1428
3.01	.0507-	.0336	.1257
4.02	.2437	.2869-	.1161
4.03	.5208	.7083-	.1381
6.04	.7960	.9623-	.1641
8.07	1.1208	1.7762-	.1370
10.10	1.5755	2.5297-	.1389
12.13	1.8987	3.3817-	.1089
8.07	1.1197	1.8871-	.1362
6.06	.0138	.0758-	.1342
6.06	.8464	1.1997-	.1458

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85

8.03-	.6830-	1.1577	.1152
4.02-	.6455-	.5773	.1146
2.02-	.2060-	.3114	.1343
.00	.0307-	.0326-	.1227
2.02	.2142	.2376-	.1252
4.02	.2009	.4733-	.1354
6.04	.7378	1.1616-	.1356
8.07	1.0241	1.5480-	.1448
10.08	1.4239	2.3631-	.1159
12.09	1.6515	3.1738-	.1192
12.09	1.7605	3.7584-	.1103
12.10	1.6836	2.6758-	.1141
6.04-	.6937-	1.0423	.1476
4.02-	.4846-	.7326	.1378
2.02-	.2518-	.3176	.1332
.01-	.0204-	.1301-	.1319
2.02	.4623	.2069-	.1351
4.02	.4356	.7036-	.1720
6.04	.6833	1.1224-	.1603

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481 47

6.04-	.9929-	1.9950	.1189
4.02-	.6452-	1.3048	.1634
2.02-	.2809-	.3470	.1665
.00	.0130	.1976-	.1597
2.02	.9502-	.6158-	.1702
4.02	.6516	1.4708-	.1990
6.03	.9893	2.2289-	.1755
8.07	1.4256	2.9929-	.1574
10.07	1.8298	4.2283-	.1551
12.10	2.3897	5.3582-	.1392
12.06	2.3893	5.5177-	.1409
10.08	1.8670	4.3251-	.1387
8.06	1.3911	3.0891-	.1610
6.04	1.0141	2.0541-	.1941
4.02	.5860	1.1379-	.1806
2.02	.2291	.5028-	.1639
.00	.0019	.0615	.1653

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481

48

2.01	.3094	.7715-	.1468
4.03	.6481	1.4213-	.1677
6.04	1.0573	2.5036-	.1627
8.05	1.6076	3.9206-	.1612
10.07	2.0552	5.1316-	.1516
12.09	2.6229	6.3320-	.1589
6.05-	1.0510-	2.1145	.1803
4.03-	.6322-	1.2779	.1737
2.02-	.3539-	.6740	.1543
.00	.0265-	.0839	.1433
4.03	.6277	1.1612-	.1619
4.03-	.7553-	1.7271	.1718

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481 49

6.04-	.8329-	1.5054	.1471
4.04-	.4765-	.4398	.1504
2.02-	.2426-	.3196	.1451
.00	.0662	.3668-	.1321
2.02	.2001	.1423-	.1255
4.03	.4619	.5177-	.1409
6.04	.7796	1.4035-	.1399
8.06	1.2031	2.3908-	.1304
10.08	1.5945	3.0403-	.1158
12.09	2.1273	4.6569-	.0966
2.01	.2014	.3466-	.1120
.00	.0155	.0753-	.1139
4.03	.5167	.8579-	.1405
6.05-	.7889-	1.0698	.1500

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481

50

6.03-	.7225-	1.2904	.1335
4.05-	.5679-	.4702	.1286
2.01-	.2031-	.4718	.1333
.00	.0543-	.1940	.1327
2.02	.2205	.3145-	.1267
4.02	.3785	.4756-	.1442
6.05	.6451	.6873-	.1469
8.05	.9606	1.7628-	.1157
10.08	1.3375	2.4118-	.1151
12.10	1.7447	2.8555-	.1057
12.09	1.7980	3.3159-	.0913
8.07	1.1193	1.9601-	.1175
4.03	.4856	.5748-	.1556
4.03	.4476	.5507-	.1444
6.03-	.7289-	1.4315	.1490
4.02-	.4465-	.6837	.1510
4.03-	.5113-	.7402	.1508
2.01-	.1646-	.3397	.1554
2.02-	.2470-	.3456	.1455
.00	.0053	.0207-	.1129

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481 51

6.04-	.1186-	1.2507-	.0533
4.03-	.1166-	.8441-	.0864
2.02-	.0919	1.1756-	.0529
.01	.0847	.0511-	.0758
2.01	.1810	.4358-	.0671
4.03	.0490	1.1410	.0575
6.04	.2616	.8965	.0503
8.06	.3020	1.1789	.0271
10.06	.4292	1.0917	.0102
12.09	.4846	1.9397	.0683
10.06	.4483	1.0402	.0239
10.06	.4967	.7548	.0259
10.07	.2735	1.9706	.0020-
12.07	.4505	1.4256	.0007-
2.02-	.1390	1.2097-	.0663
.00	.0150	.1395-	.0325
2.03	.1991-	1.8101	.0459
4.04	.1861-	2.2865	.0515

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481 52

6.03-	1.0511-	2.2966	.1340
4.03-	.7974-	1.3490	.0850
2.01-	.1501-	.0082	.0730
.01-	.0208	.3275-	.1074
2.01	.0648	.1278	.0286
4.02	.6603	1.3159-	.0791
6.04	.9113	1.7058-	.0928
8.02	1.4973	3.8807-	.0671
10.05	1.9381	4.6153-	.0718
12.07	2.4276	5.6167-	.0463
12.07	2.3465	5.4139-	.0617
6.03	1.0325	2.3301-	.0938
8.03	1.4686	3.7929-	.0492
4.02	.6325	1.3767-	.0781
2.01	.2285	.5326-	.0931
2.01-	.2936-	.4473	.0752
2.01	.3055	.8447-	.0960
8.04	1.5631	3.9015-	.0794

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481 53

6.03-	.9201-	1.7019	.0951
4.02-	.5745-	1.2071	.0932
2.01-	.2260-	.3044	.1376
.01-	.0465	.0164	.1207
2.00	.2019	.5766-	.0736
4.02	.5898	1.0743-	.1223
6.03	.9057	1.0332-	.0547
8.03	1.3589	2.0536-	.0335
10.06	1.7451	3.0927-	.0322
12.08	2.1869	4.5511-	.0358
4.02	.5391	1.0785-	.0706
2.02-	.2671-	.3364	.1077
4.02-	.5641-	1.0470	.1250
4.02-	.6162-	1.0428	.0946

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481

54

6.08-	.9500-	1.4098	.1412
4.03-	.6253-	1.0217	.1354
2.02-	.2651-	.4743	.1305
.00	.0229	.1514-	.0994
2.01	.2695	.6381-	.1041
4.02	.6604	1.1487-	.0704
6.03	.9624	1.8863-	.0910
8.05	1.3921	2.9921-	.0371
10.06	1.9112	4.3573-	.0447
12.08	2.2802	4.8380-	.0433
10.06	1.8047	3.9747-	.0394
7.04	1.1488	2.4737-	.0529
7.04	1.1628	2.2376-	.0590
10.07	1.9490	4.1043-	.0542
10.08	1.8855	3.9808-	.0442
12.08	2.4579	5.4153-	.0380
9.06	1.6335	3.3013-	.0628
4.03	.6590	1.0131-	.0868
6.03-	1.0213-	2.2101	.1361

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481 55

6.03-	.9066-	2.0304	.1003
4.03-	.5836-	.8060	.0944
2.01-	.1733-	.2795	.1052
.01	.0128-	.2352	.0688
2.01	.3295-	.8540-	.1306
4.02	.6405-	1.5242-	.0639
6.02	.8804	2.0929-	.0861
8.02	1.2761	3.1293-	.0656
10.06	1.6216	3.5815-	.0660
12.08	2.0471	4.3578-	.0623
8.05	1.3336	2.7430-	.0745
.01-	.0084	.1452-	.1019
2.01	.2686	.6538-	.1291
4.02	.4722	1.0935-	.0527
4.01-	.5133-	1.0066	.0941
6.03-	.9056-	1.6674	.0826
6.02-	.8860-	1.8614	.0973

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481 56

6.08-	.7409-	.5537	.3764
6.06-	.6536-	.5819	.3789
4.03-	.4322-	.3729	.3621
2.02-	.2100-	.1974	.3401
.00	.0562	.0992-	.3305
2.02	.3247	.3324-	.3475
4.04	.5701	.5059-	.3459
6.08	.8939	.7895-	.3531
8.10	1.2240	.9310-	.3658
10.13	1.5492	1.1550-	.3716
12.19	2.0876	1.2040-	.3729
6.08	.0431	.7109-	.3513
6.07-	.7628-	.6400	.3598
4.03-	.4300-	.3005	.3554

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481 57

4.07-	.9074-	1.1354	.3835
4.03-	.5613-	.7618	.3717
2.02-	.2553-	.3168	.3585
.00	.0431	.0459-	.3434
2.02	.3555	.4742-	.3520
4.04	.6706	.8632-	.3540
6.08	1.0423	1.3142-	.3706
8.10	1.4614	1.7216-	.3668
10.14	1.9183	2.1033-	.3768
12.18	2.4505	2.4977-	.3750

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481 58

2.01-	.2148-	.3067	.3368
4.03-	.5252-	.6113	.3642
6.07-	.8467-	.9210	.3738
.00	.0285	.0433-	.3265
2.02	.2960	.3144-	.3485
4.05	.6491	.7400-	.3698
6.08	.9642	1.0669-	.3951
8.11	1.3365	1.3308-	.3717
10.14	1.7552	1.5388-	.3645
12.18	2.2632	1.8117-	.3664

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481

59

6.06-	.8880-	1.0352	.3856
6.06-	.9314-	1.1650	.3858
4.04-	.5527-	.5870	.3738
2.02-	.2723-	.2610	.3566
.00	.0119	.0449-	.3511
2.02	.2924	.3884-	.3511
4.04	.6042	.7817-	.3602
6.06	.9508	1.1874-	.3622
8.10	1.3672	1.6175-	.3775
10.13	1.8302	2.0700-	.3860
12.18	2.3699	2.4370-	.3692
4.04	.6116	.7242-	.3449

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481 60

6.07-	.3201-	1.3349-	.2989
4.05-	.1756-	.0589-	.2931
2.02-	.0864-	.0907-	.2838
.00	.0156	.0249-	.2608
2.02	.0937	.4657	.2520
4.05	.2146	.8966	.2995
6.08	.3982	1.2103	.2996
8.11	.6517	1.4644	.2932
10.15	.9676	1.6363	.3034
12.20	1.3371	1.8961	.3122
12.20	1.3488	1.8861	.3090
10.15	.9830	1.6454	.3128

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61

6.13-	.4260-	2.0233-	.3737
4.08-	.2703-	1.2982-	.3919
2.04-	.0792-	.7473-	.3544
.00	.0153	.0044-	.3437
2.04	.1095	.7916	.3359
4.08	.2547	1.3557	.3218
6.15	.5876	1.8081	.2967
8.21	.7880	2.6972	.3411
10.29	1.1262	3.5109	.3643
12.38	1.5068	4.2635	.3761

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481 62

4.07-	.5586-	.8573	.4079
2.03-	.2620-	.4126	.4074
6.12-	.9394-	1.3531	.4353
.00	.0396	.2329-	.4165
2.03	.3174	.7208-	.4148
4.07	.8323	1.0514-	.3999
6.12	.9984	1.6492-	.4026
6.12	1.0139	1.6891-	.3979
8.18	1.4941	2.2049-	.4162
10.27	2.0847	2.7041-	.4105
12.37	2.6763	2.7477-	.4137
12.36	2.6305	2.7521-	.4118
10.27	1.0768	2.6876-	.4021
6.11-	.9262-	1.4540	.4207
4.07-	.5461-	.6988	.4002

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83

5.19	.0187	1.1544	.4247
4.08	.5397	.7844	.3930
2.07	.2251	.2654	.4001
.60	.0360	.1961	.3911
2.04	.1450	.7307	.3902
4.08	.0335	1.0317	.3855
6.12	.4867	1.3491	.3920
8.20	1.4456	1.6072	.3971
10.29	1.7739	1.8038	.4173
12.37	2.4431	1.4403	.4078
14.45	2.4645	1.5419	.4078
16.53	.0814	1.3780	.4808