

file copy

76717

BRL



TECHNICAL NOTE No. 1041

A Drag Coefficient, K_D , Based On The 8-Inch Howitzer Shell, HE, M106

C. T. ODOM

DEPARTMENT OF THE ARMY PROJECT No. 5B0307003
ORDNANCE RESEARCH AND DEVELOPMENT PROJECT No. TB3-0430

BALLISTIC RESEARCH LABORATORIES



ABERDEEN PROVING GROUND, MARYLAND

**Destroy when no longer
needed. DO NOT RETURN**

BALLISTIC RESEARCH LABORATORIES

TECHNICAL NOTE NO. 1041

October 1955

A DRAG COEFFICIENT, K_D , BASED on the 8-INCH HOWITZER
SHELL, HE, M106

C. T. Odom

Department of the Army Project No. 5B0307003
Ordnance Research and Development Project No. TB3-0430

ABERDEEN PROVING GROUND, MARYLAND

A Drag Coefficient, K_D , Based on the
8-Inch Howitzer Shell, HE, M106

During December 1949 and January 1950, twelve rounds of 8-Inch Howitzer Shell, HE, M106 (See Figure 1.) were fired at high angles of elevation to determine the mean drag of the round. Radio doppler measurements of radial velocity along each trajectory were made with the Model 10 Velocimeter. To cover a large portion of the velocity history of each round, high angles of elevation were fired. The doppler records were measured and reduced by R. B. Patton.*

The first fit of the mean drag data of the twelve rounds was made informally by the Surveillance Laboratory (now the Surveillance Branch) with two hyperbolas. Application of this fit to full scale range firing data indicated that improvement could be made by joining the two hyperbolas in the transonic region with a cubic polynomial and by replacing the subsonic portion of the function with a constant.

Finally the improved fit was adjusted by a constant to produce a weighted-mean over-all form factor of unity with respect to the full scale range firing data. This adjusted fit will be used for firing table computations unless the results of additional range firings now being planned indicate that further modifications and adjustments are desirable.

The fitting expressions, which at each juncture point give similar values of the K_D 's and their first derivatives, are tabulated below:

In the Interval	K_D is given by
$0 \leq M \leq 0.71627$	0.0509362061
$0.71627 \leq M \leq 0.76104$	$4.521434552M^3 - 10.42261884M^2 + 7.971751250M - 1.973265092$
$0.76104 \leq M \leq 0.93116$	$-0.5675865634 + 0.6627785038M$ $+ \sqrt{0.4955008785M^2 - 0.9122953214M + 0.4201021171}$
$0.93116 \leq M \leq 0.94906$	$191.81088075M^3 - 532.70702879M^2 + 494.13979376M - 153.03230004$
$0.94906 \leq M \leq 3$	$-0.4953449066 + 0.6585549046M$ $- \sqrt{0.5014967518M^2 - 1.0090404772M + 0.5079263485}$

*Patton, R. B., "Determination of Drag Functions for 8" Howitzer Shell HE, M106" BRL Technical Note No. 392, March 1951.

Charles T. Odom
Charles T. Odom

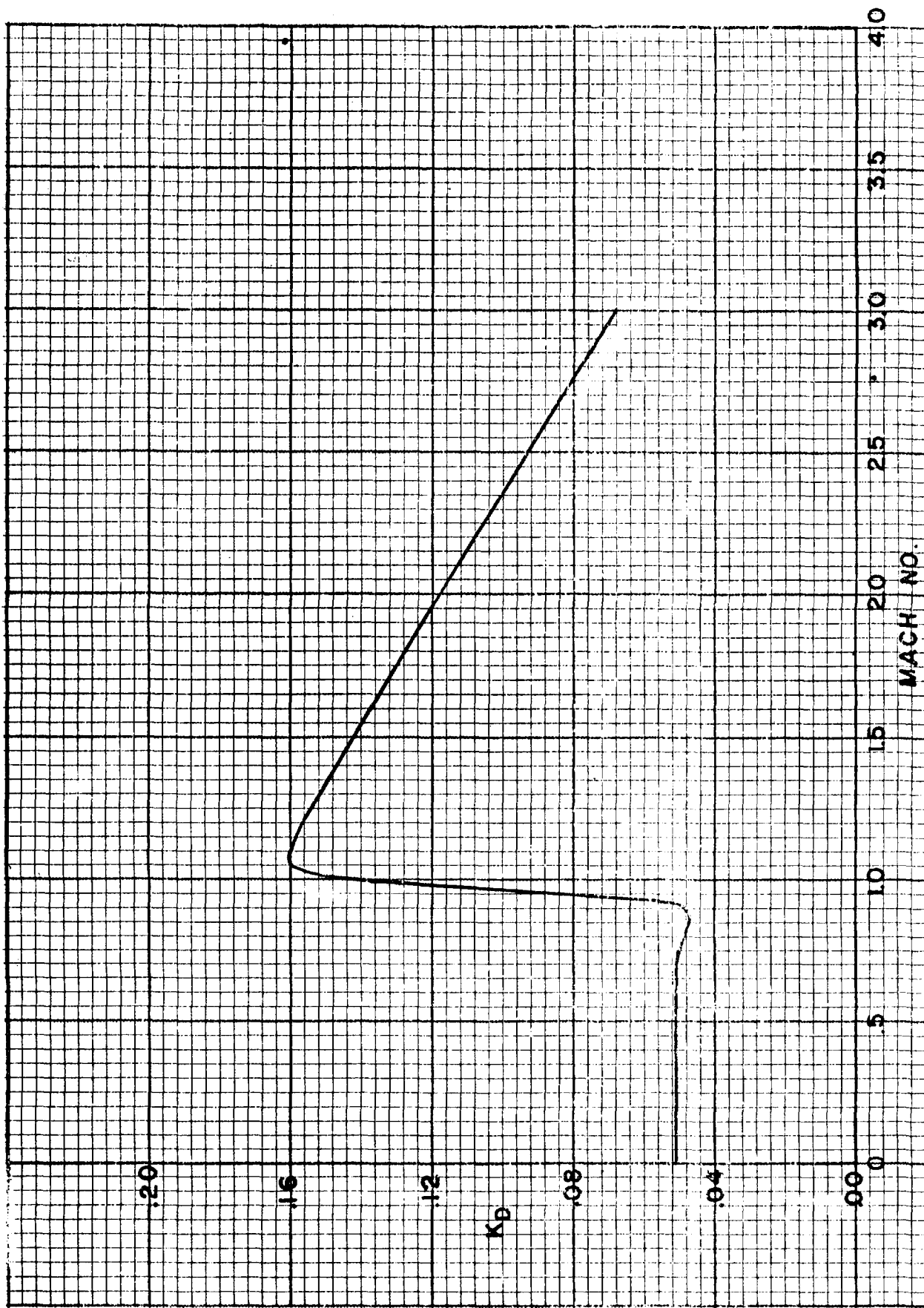


FIG. 2. DRAG COEFFICIENT, 8-INCH SHELL HE, M106

TABLE
of
DRAG COEFFICIENTS

Drag Coefficient 8-Inch, HE, M106

M	K _D	M	K _D	M	K _D	M	K _D
3.000	.068132	2.600	.087943	2.200	.107733	1.800	.127468
2.990	.068627	2.590	.088438	2.190	.108227	1.790	.127960
2.980	.069122	2.580	.088933	2.180	.108721	1.780	.128452
2.970	.069618	2.570	.089428	2.170	.109215	1.770	.128944
2.960	.070113	2.560	.089923	2.160	.109710	1.760	.129435
2.950	.070609	2.550	.090418	2.150	.110204	1.750	.129927
2.940	.071104	2.540	.090913	2.140	.110698	1.740	.130418
2.930	.071600	2.530	.091408	2.130	.111192	1.730	.130909
2.920	.072095	2.520	.091903	2.120	.111686	1.720	.131400
2.910	.072590	2.510	.092398	2.110	.112180	1.710	.131891
2.900	.073086	2.500	.092893	2.100	.112674	1.700	.132382
2.890	.073581	2.490	.093388	2.090	.113168	1.690	.132873
2.880	.074076	2.480	.093883	2.080	.113662	1.680	.133363
2.870	.074572	2.470	.094378	2.070	.114156	1.670	.133854
2.860	.075067	2.460	.094873	2.060	.114649	1.660	.134344
2.850	.075562	2.450	.095368	2.050	.115143	1.650	.134834
2.840	.076058	2.440	.095862	2.040	.115637	1.640	.135324
2.830	.076553	2.430	.096357	2.030	.116131	1.630	.135813
2.820	.077048	2.420	.096852	2.020	.116624	1.620	.136303
2.810	.077544	2.410	.097347	2.010	.117118	1.610	.136792
2.800	.078039	2.400	.097842	2.000	.117611	1.600	.137281
2.790	.078534	2.390	.098336	1.990	.118105	1.590	.137770
2.780	.079030	2.380	.098831	1.980	.118598	1.580	.138258
2.770	.079525	2.370	.099326	1.970	.119091	1.570	.138746
2.760	.080020	2.360	.099821	1.960	.119585	1.560	.139234
2.750	.080515	2.350	.100315	1.950	.120078	1.550	.139722
2.740	.081011	2.340	.100810	1.940	.120571	1.540	.140209
2.730	.081506	2.330	.101305	1.930	.121064	1.530	.140696
2.720	.082001	2.320	.101799	1.920	.121557	1.520	.141182
2.710	.082496	2.310	.102294	1.910	.122050	1.510	.141669
2.700	.082992	2.300	.102788	1.900	.122543	1.500	.142154
2.690	.083487	2.290	.103283	1.890	.123036	1.490	.142640
2.680	.083982	2.280	.103777	1.880	.123529	1.480	.143125
2.670	.084477	2.270	.104272	1.870	.124022	1.470	.143609
2.660	.084972	2.260	.104766	1.860	.124514	1.460	.144093
2.650	.085467	2.250	.105261	1.850	.125007	1.450	.144576
2.640	.085963	2.240	.105755	1.840	.125499	1.440	.145059
2.630	.086458	2.230	.106250	1.830	.125991	1.430	.145541
2.620	.086953	2.220	.106744	1.820	.126484	1.420	.146023
2.610	.087448	2.210	.107238	1.810	.126976	1.410	.146503
2.600	.087943	2.200	.107733	1.800	.127468	1.400	.146983

Drag Coefficient 8-Inch, HE, M106

M	K _D	M	K _D	M	K _D	M	K _D
1.400	.146983	1.180	.157080	1.140	.158633	1.100	.159835
1.390	.147463	1.179	.157121	1.139	.158668	1.099	.159857
1.380	.147941	1.178	.157162	1.138	.158704	1.098	.159878
1.370	.148418	1.177	.157203	1.137	.158739	1.097	.159899
1.360	.148894	1.176	.157244	1.136	.158774	1.096	.159919
1.350	.149369	1.175	.157285	1.135	.158809	1.095	.159938
1.340	.149843	1.174	.157325	1.134	.158843	1.094	.159957
1.330	.150316	1.173	.157366	1.133	.158877	1.093	.159975
1.320	.150787	1.172	.157407	1.132	.158911	1.092	.159993
1.310	.151256	1.171	.157447	1.131	.158945	1.091	.160010
1.300	.151723	1.170	.157487	1.130	.158979	1.090	.160026
1.290	.152189	1.169	.157527	1.129	.159012	1.089	.160041
1.280	.152652	1.168	.157567	1.128	.159045	1.088	.160056
1.270	.153113	1.167	.157607	1.127	.159078	1.087	.160069
1.260	.153571	1.166	.157647	1.126	.159111	1.086	.160082
1.250	.154026	1.165	.157687	1.125	.159143	1.085	.160094
1.240	.154477	1.164	.157727	1.124	.159175	1.084	.160106
1.230	.154925	1.163	.157766	1.123	.159206	1.083	.160116
1.220	.155368	1.162	.157805	1.122	.159238	1.082	.160125
1.210	.155806	1.161	.157845	1.121	.159269	1.081	.160134
1.200	.156238	1.160	.157884	1.120	.159300	1.080	.160141
1.199	.156280	1.159	.157923	1.119	.159330	1.079	.160147
1.198	.156323	1.158	.157961	1.118	.159360	1.078	.160152
1.197	.156366	1.157	.158000	1.117	.159390	1.077	.160156
1.196	.156408	1.156	.158038	1.116	.159419	1.076	.160159
1.195	.156451	1.155	.158077	1.115	.159448	1.075	.160161
1.194	.156493	1.154	.158115	1.114	.159477	1.074	.160161
1.193	.156536	1.153	.158153	1.113	.159505	1.073	.160160
1.192	.156578	1.152	.158191	1.112	.159533	1.072	.160158
1.191	.156620	1.151	.158229	1.111	.159561	1.071	.160154
1.190	.156663	1.150	.158266	1.110	.159588	1.070	.160149
1.189	.156705	1.149	.158304	1.109	.159615	1.069	.160142
1.188	.156747	1.148	.158341	1.108	.159641	1.068	.160134
1.187	.156789	1.147	.158378	1.107	.159667	1.067	.160124
1.186	.156830	1.146	.158415	1.106	.159692	1.066	.160112
1.185	.156872	1.145	.158452	1.105	.159717	1.065	.160099
1.184	.156914	1.144	.158488	1.104	.159742	1.064	.160083
1.183	.156955	1.143	.158525	1.103	.159766	1.063	.160066
1.182	.156997	1.142	.158561	1.102	.159789	1.062	.160046
1.181	.157038	1.141	.158597	1.101	.159812	1.061	.160025
1.180	.157080	1.140	.158633	1.100	.159835	1.060	.160001

Drag Coefficient 8-Inch, HE, M106

M	K _D
1.060	.160001
1.059	.159975
1.058	.159946
1.057	.159915
1.056	.159881
1.055	.159844
1.054	.159805
1.053	.159762
1.052	.159716
1.051	.159667
1.050	.159614
1.049	.159557
1.048	.159496
1.047	.159431
1.046	.159362
1.045	.159288
1.044	.159210
1.043	.159126
1.042	.159037
1.041	.158942
1.040	.158842
1.039	.158735
1.038	.158621
1.037	.158500
1.036	.158372
1.035	.158236
1.034	.158092
1.033	.157939
1.032	.157776
1.031	.157604
1.030	.157421
1.029	.157228
1.028	.157023
1.027	.156805
1.026	.156575
1.025	.156331
1.024	.156073
1.023	.155799
1.022	.155510
1.021	.155204
1.020	.154880

M	K _D
1.020	.154880
1.019	.154538
1.018	.154177
1.017	.153796
1.016	.153394
1.015	.152970
1.014	.152524
1.013	.152054
1.012	.151561
1.011	.151043
1.010	.150500
1.009	.149932
1.008	.149338
1.007	.148718
1.006	.148072
1.005	.147400
1.004	.146701
1.003	.145976
1.002	.145226
1.001	.144450
1.000	.143649
.999	.142824
.998	.141975
.997	.141103
.996	.140208
.995	.139292
.994	.138355
.993	.137398
.992	.136422
.991	.135427
.990	.134415
.989	.133387
.988	.132342
.987	.131282
.986	.130208
.985	.129121
.984	.128020
.983	.126908
.982	.125783
.981	.124648
.980	.123503

M	K _D
.980	.123503
.979	.122348
.978	.121183
.977	.120010
.976	.118828
.975	.117639
.974	.116442
.973	.115238
.972	.114028
.971	.112811
.970	.111588
.969	.110360
.968	.109126
.967	.107887
.966	.106644
.965	.105396
.964	.104143
.963	.102886
.962	.101626
.961	.100361
.960	.099094
.959	.097822
.958	.096548
.957	.095270
.956	.093989
.955	.092706
.954	.091420
.953	.090131
.952	.088840
.951	.087547
.950	.086251
.949	.084954
.948	.083670
.947	.082412
.946	.081178
.945	.079967
.944	.078779
.943	.077612
.942	.076464
.941	.075335
.940	.074224

M	K _D
.940	.074224
.939	.073129
.938	.072050
.937	.070984
.936	.069931
.935	.068891
.934	.067861
.933	.066840
.932	.065828
.931	.064823
.930	.063837
.929	.062877
.928	.061946
.927	.061044
.926	.060173
.925	.059336
.924	.058532
.923	.057763
.922	.057030
.921	.056334
.920	.055674
.919	.055051
.918	.054464
.917	.053913
.916	.053396
.915	.052914
.914	.052463
.913	.052044
.912	.051655
.911	.051293
.910	.050958
.909	.050647
.908	.050359
.907	.050093
.906	.049847
.905	.049619
.904	.049409
.903	.049214
.902	.049034
.901	.048868
.900	.048714

Drag Coefficient 8-Inch, HE, M106

M	K _D	M	K _D	M	K _D	M	K _D
.900	.048714	.860	.047131	.820	.047966	.780	.049253
.899	.048572	.859	.047140	.819	.047995	.779	.049288
.898	.048441	.858	.047150	.818	.048024	.778	.049323
.897	.048319	.857	.047160	.817	.048053	.777	.049358
.896	.048207	.856	.047172	.816	.048083	.776	.049393
.895	.048103	.855	.047184	.815	.048113	.775	.049428
.894	.048008	.854	.047197	.814	.048143	.774	.049463
.893	.047919	.853	.047212	.813	.048173	.773	.049498
.892	.047838	.852	.047226	.812	.048203	.772	.049533
.891	.047763	.851	.047242	.811	.048234	.771	.049569
.890	.047694	.850	.047258	.810	.048264	.770	.049604
.889	.047630	.849	.047275	.809	.048295	.769	.049640
.888	.047571	.848	.047292	.808	.048326	.768	.049675
.887	.047517	.847	.047310	.807	.048357	.767	.049711
.886	.047468	.846	.047329	.806	.048389	.766	.049747
.885	.047423	.845	.047348	.805	.048420	.765	.049783
.884	.047382	.844	.047368	.804	.048452	.764	.049818
.883	.047344	.843	.047388	.803	.048484	.763	.049854
.882	.047310	.842	.047409	.802	.048516	.762	.049890
.881	.047279	.841	.047431	.801	.048548	.761	.049926
.880	.047251	.840	.047452	.800	.048581	.760	.049962
.879	.047227	.839	.047475	.799	.048613	.759	.049998
.878	.047204	.838	.047497	.798	.048646	.758	.050034
.877	.047185	.837	.047520	.797	.048678	.757	.050069
.876	.047167	.836	.047544	.796	.048711	.756	.050104
.875	.047152	.835	.047568	.795	.048744	.755	.050138
.874	.047139	.834	.047592	.794	.048777	.754	.050173
.873	.047128	.833	.047617	.793	.048811	.753	.050207
.872	.047120	.832	.047642	.792	.048844	.752	.050240
.871	.047112	.831	.047667	.791	.048878	.751	.050273
.870	.047107	.830	.047693	.790	.048911	.750	.050305
.869	.047103	.829	.047719	.789	.048945	.749	.050337
.868	.047101	.828	.047745	.788	.048979	.748	.050369
.867	.047100	.827	.047772	.787	.049013	.747	.050400
.866	.047101	.826	.047799	.786	.049047	.746	.050430
.865	.047103	.825	.047826	.785	.049081	.745	.050460
.864	.047106	.824	.047854	.784	.049115	.744	.050489
.863	.047111	.823	.047881	.783	.049149	.743	.050517
.862	.047116	.822	.047910	.782	.049184	.742	.050545
.861	.047123	.821	.047938	.781	.049218	.741	.050572
.860	.047131	.820	.047966	.780	.049253	.740	.050599

Drag Coefficient 8-Inch, HE, M106

M	K_D
.740	.050599
.739	.050624
.738	.050649
.737	.050673
.736	.050696
.735	.050718
.734	.050739
.733	.050760
.732	.050779
.731	.050797
.730	.050815
.729	.050831
.728	.050846
.727	.050860
.726	.050873
.725	.050885
.724	.050896
.723	.050906
.722	.050914
.721	.050921
.720	.050927
.719	.050931
.718	.050934
.717	.050936
.716	.050936
.	.
.	.
.	.
.001	.050936
.000	.050936

DISTRIBUTION LIST

<u>No. of Copies</u>	<u>Organization</u>	<u>No. of Copies</u>	<u>Organization</u>
	Chief of Ordnance Department of the Army Washington 25, D. C. Attn: ORDTB	5	Director Armed Services Technical Information Agency Documents Service Center Knott Building Dayton 2, Ohio Attn: DSC - SA
10	British Joint Services Mission 1800 K Street, N. W. Washington 6, D. C. Attn: Mr. John Izzard, Reports Officer	3	Commanding Officer Picatinny Arsenal Dover, New Jersey Attn: Samuel Feltman Ammunition Laboratories
4	Canadian Army Staff 2450 Massachusetts Avenue Washington 8, D. C.	3	Commanding General Frankford Arsenal Philadelphia 37, Penna. Attn: ORDBA-2B, J. J. Donnelly Fire Control Group, Paul Marasco Pitman-Dunn Lab David Walters
3	Chief, Bureau of Ordnance Department of the Navy Washington 25, D. C. Attn: Re3		
2	Commander Naval Proving Ground Dahlgren, Virginia	1	Commanding Officer Springfield Armory Springfield, Massachusetts Attn: E. N. Harvey
2	Commander Naval Ordnance Laboratory White Oak Silver Spring 19, Maryland	1	Midwest Research Institute 4049 Pennsylvania Kansas City 11, Missouri Attn: A. C. St. John
1	Commander Naval Ordnance Test Station China Lake, California Attn: Technical Library	1	Firestone Tire and Rubber Co. Defense Research Division Akron, Ohio Attn: C. M. Cox
1	Superintendent Naval Postgraduate School Monterey, California	1	Arthur D. Little, Inc. 30 Memorial Drive Cambridge 42, Massachusetts Attn: T. J. Nussdorfer
1	Director Air University Library Maxwell Air Force Base Alabama		