

Blog Entry © Sunday, November 17, 2024, by James Pate Williams, Jr. Three Methods of Solving the Exterior Ballistics Problem for the Fast Battleship USS Iowa (BB-61) 16-Inch/50 Caliber Rifles

References:

1. ***Elementary Numerical Analysis an Algorithmic Approach*** © 1980 by S. D. Conte and Carl de Boor
2. ***Exterior ballistics, 1935*** © 1935 by LCDR Ernest Edward Herrmann U. S. Navy
3. ***A Numerical Library in C for Scientists and Engineers*** © 1995 by H. T. Lau, PhD
4. ***Ordnance Pamphlet 770*** U. S. Navy Online Document

Using Conte and de Boor 5th Order Runge-Kutta formulas with no corrections and then with a curvature of the Earth correction:

Actual Angle	IV Ft / S	Actual Range	Theory Range	Percent Error
10	2502	17402	17760	2.06
15	2502	23642	24101	1.94
25	2500	32971	33816	2.56
45	2500	42643	43917	2.99
15	2478	23182	23709	2.27
20	2476	28110	28876	2.73
25	2481	32544	33395	2.61
30	2475	36539	36971	1.18
45	2475	43188	43170	0.04
15	2439	23028	23099	0.31

Actual Angle	IV Ft / S	Actual Range	Theory Range	Percent Error
10	2502	17402	17657	1.46
15	2502	23642	23983	1.44
25	2500	32971	33689	2.18
45	2500	42643	43809	2.74
15	2478	23182	23594	1.78
20	2476	28110	28755	2.30
25	2481	32544	33270	2.23
30	2475	36539	36847	0.84
45	2475	43188	43066	0.28
15	2439	23028	22989	0.17

Using Dr. H. T. Lau's 5th Order Runge-Kutta NUMAL function:

Actual Angle	IV Ft / S	Actual Range	Theory Range	Percent Error
10	2502	17402	17683	1.62
15	2502	23642	24030	1.64
25	2500	32971	33754	2.37
45	2500	42643	43890	2.92
15	2478	23182	23638	1.97
20	2476	28110	28810	2.49
25	2481	32544	33332	2.42
30	2475	36539	36912	1.02
45	2475	43188	43123	0.15
15	2439	23028	23029	0.01

Actual Angle	IV Ft / S	Actual Range	Theory Range	Percent Error
10	2502	17402	17580	1.02
15	2502	23642	23912	1.14
25	2500	32971	33626	1.99
45	2500	42643	43782	2.67
15	2478	23182	23524	1.47
20	2476	28110	28689	2.06
25	2481	32544	33208	2.04
30	2475	36539	36788	0.68
45	2475	43188	43019	0.39
15	2439	23028	22920	0.47

Using Conte and de Boor's Adams-Moulton formulas:

Actual Angle	IV Ft / S	Actual Range	Theory Range	Percent Error
10	2502	17402	18211	4.65
15	2502	23642	24653	4.28
25	2500	32971	34577	4.87
45	2500	42643	44889	5.27
15	2478	23182	24252	4.62
20	2476	28110	29531	5.05
25	2481	32544	34146	4.92
30	2475	36539	37773	3.38
45	2475	43188	44104	2.12
15	2439	23028	23629	2.61

Actual Angle	IV Ft / S	Actual Range	Theory Range	Percent Error
10	2502	17402	18104	4.03
15	2502	23642	24530	3.76
25	2500	32971	34444	4.47
45	2500	42643	44776	5.00
15	2478	23182	24133	4.10
20	2476	28110	29405	4.61
25	2481	32544	34016	4.52
30	2475	36539	37644	3.02
45	2475	43188	43995	1.87
15	2439	23028	23515	2.11