APPENDIX D

SONAR CALCULATIONS

Summary

Sonar calculations were completed for two sonar systems, a SQS-56 hull-mounted sonar and a Active Towed Array Sonar (ATAS). Using a Microsoft Excel V5.0 spreadsheet, parameters for frequency, power output, sound speed, depth, and pulse width were used to calculate the detection range for a submarine with a target strength of 15dB, at a depth of 150 meters in water 2000 meters deep. Assumptions included a 50% probability of detection and straight ray path propagation.

Page D-3&4 contains the range calculations for the SQS-56 sonar

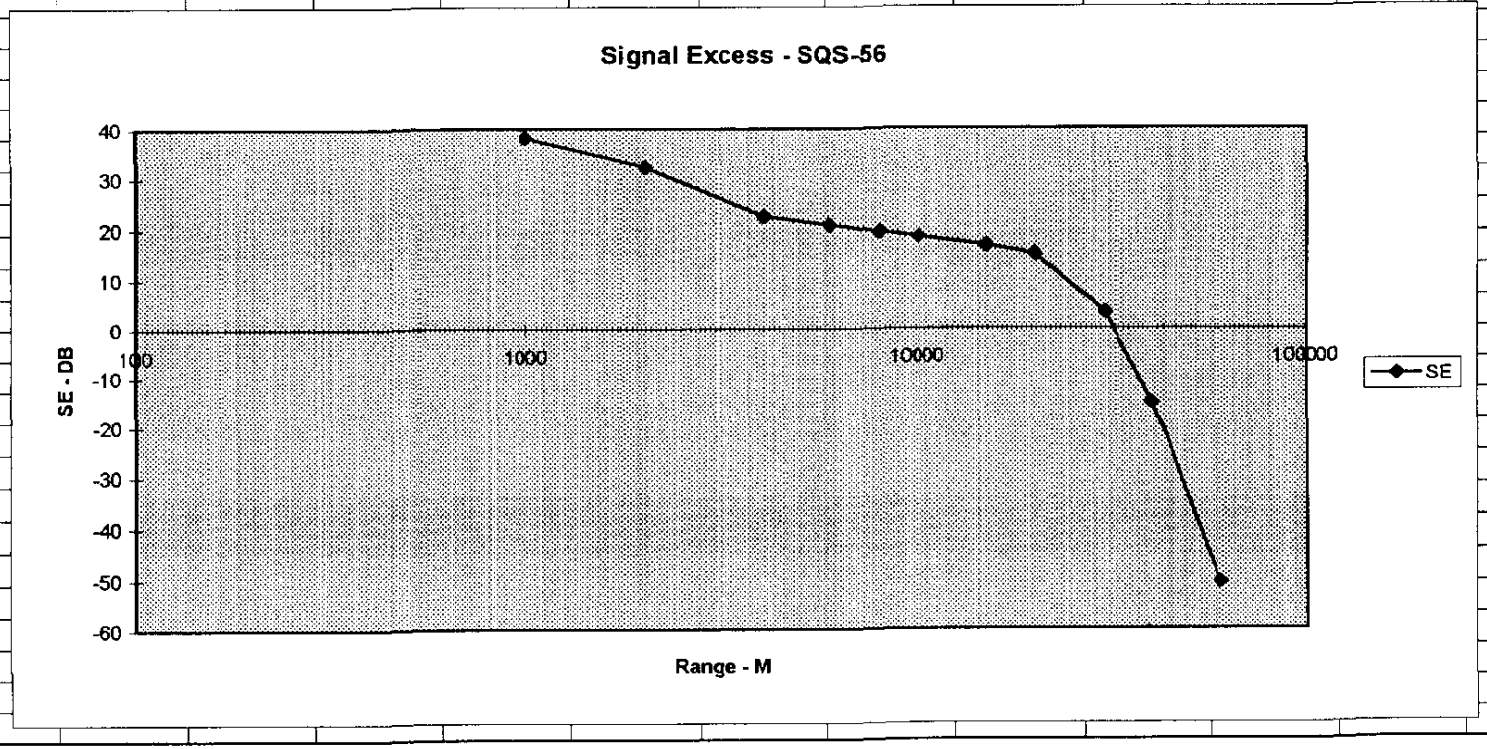
Page D-5&6 contains the range calculations for the ATAS

Active sonar range prediction

SQS-56 sonar

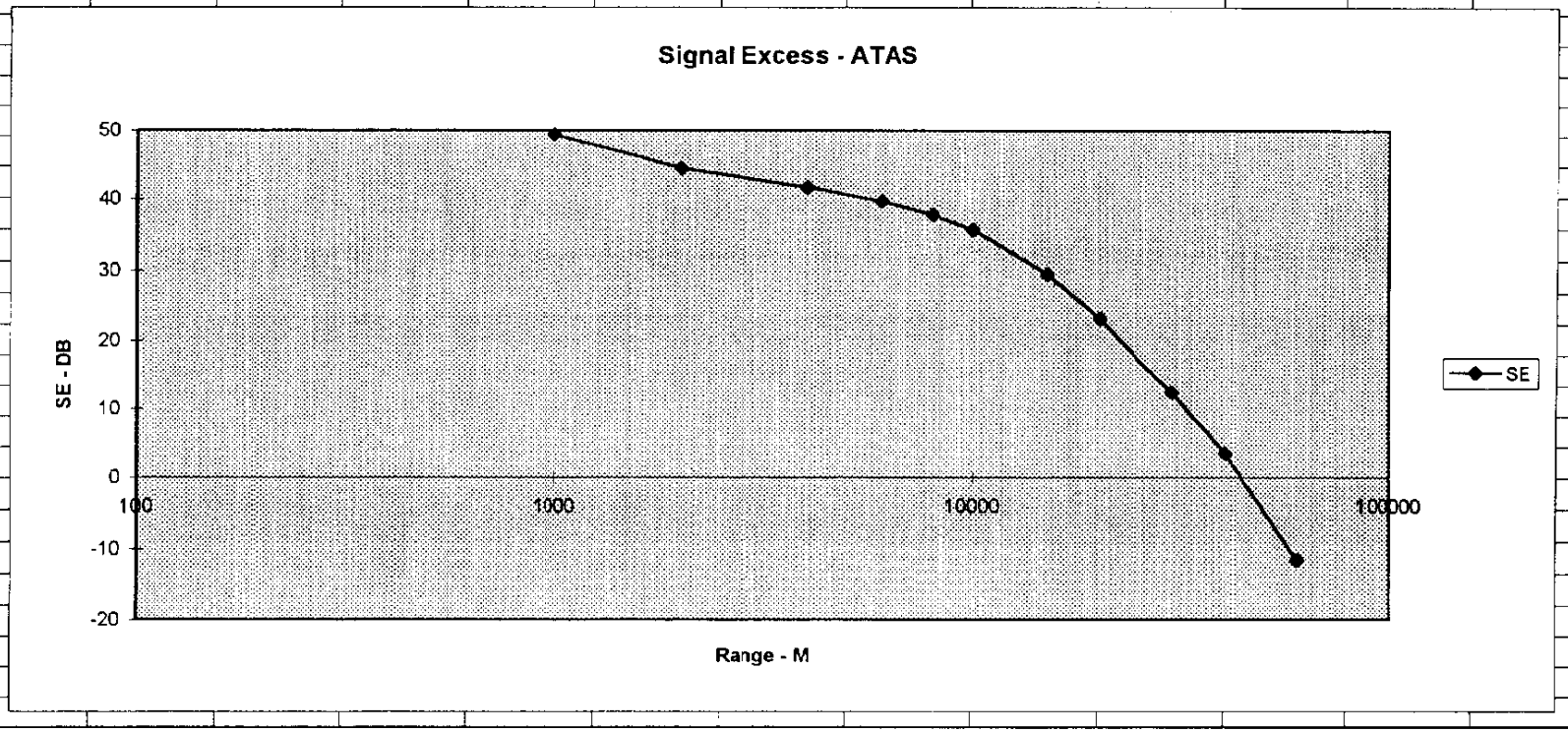
Constants												
c=	1500		f=	7500		depth=	4		W=	125		
diameter=	1.2		h=	1.2		Power=	3600					
DT=	0		alpha=	0.000704		T=	0.1					
Calculated parameters												
BWh=	9.75205		BWv=	8.468383		AG=	26.98954					
SLt=	233.5526		DT=	-2.49877								
Target parameters												
depth=	150		TS=	15		depth b=	2000					
Level Calculations												
Range	Spreading	Atten	2TL	PHIt	2ARt	SLr	Vol	RSv	2EARv	RLv		
1000	120	1.408	121.408	8.395191	-1.5	125.6446	86.74975	-73	-22.4279	103.4665		
2000	132.0412	2.816	134.8572	4.186316	-0.5	113.1954	92.75301	-73	-22.4517	95.99668		
4000	144.0824	5.632	149.7144	2.091761	0	98.83817	95.76331	-73	-15.6634	90.93809		
6000	151.1261	8.448	159.5741	1.394335	0	88.97852	97.52422	-73	-15.6634	82.83935		
8000	156.1236	11.264	167.3876	1.045706	0	81.16497	98.77361	-73	-15.6634	76.27519		
10000	160	14.08	174.08	0.836548	0	74.47257	99.74271	-73	-15.6634	70.55189		
15000	167.0437	21.12	188.1637	0.557688	0	60.38892	101.5036	-73	-15.6634	58.22915		
20000	172.0412	28.16	200.2012	0.418263	0	48.35137	102.753	-73	-15.6634	47.44099		
30000	179.0849	42.24	221.3249	0.278841	0	27.22772	104.5139	-73	-15.6634	28.07825		
40000	184.0824	56.32	240.4024	0.20913	0	8.150167	105.7633	-73	-15.6634	10.25009		
60000	191.1261	84.48	275.6061	0.13942	0	-27.0535	107.5242	-73	-15.6634	-23.1926		

Range	Area	PHIs	2EARs	RSs	RLs	PHIb	2EARb	RSb	RLb	NLr	NL	SE
1000	41.06035	0.229184	-15.6721	-60	77.53285	0				37.97956	103.4775	38.15536
2000	44.07065	0.114592	-15.6721	-60	67.09395	0				37.97956	96.00227	32.18141
4000	47.08095	0.057296	-15.6721	-60	55.24705	60.06614	-45.6721	-18	67.24705	37.97956	90.93928	22.3872
6000	48.84186	0.038197	-15.6721	-60	47.14831	70.56929	-45.6721	-13	64.14831	37.97956	82.84066	20.62617
8000	50.09125	0.028648	-15.6721	-60	40.58415	75.55207	-45.6721	-11	59.58415	37.97956	76.277	19.37628
10000	51.06035	0.022918	-15.6721	-60	34.86085	78.48643	-45.6721	-10	54.86085	37.97956	70.55546	18.40542
15000	52.82126	0.015279	-15.6721	-60	22.53811	82.35316	-45.6721	-9	43.53811	37.97956	58.27112	16.60611
20000	54.07065	0.011459	-15.6721	-60	11.74995	84.27235	-45.6721	-8	33.74995	37.97956	47.90778	14.9319
30000	55.83156	0.007639	-15.6721	-60	-7.61279	86.1851	-45.6721	-8	14.38721	37.97956	38.40266	3.313372
40000	57.08095	0.00573	-15.6721	-60	-25.441	87.13975	-45.6721	-9	-4.44095	37.97956	37.98688	-15.3484
60000	58.84186	0.00382	-15.6721	-60	-58.8837	88.09361	-45.6721	-9	-37.8837	37.97956	37.97956	-50.5447



Active sonar range prediction

ATAS sonar

Constants												
c=	1500		f=	3000		depth=	100		W=	125		
diameter=	0.3		h=	1.2		Power=	2500		depth b=	2000		
DT=	0		alpha=	0.0002		T=	0.1					
Calculated parameters												
BWh=	25		BWv=	21.27368		AGt=	18.9217		BWhr=	1.27		
SLt=	223.9011		DT=	-2.49877		AGr=	31.17162		BWvr=	25		
Target parameters												
depth=	150		TS=	15								
Level Calculations												
Range	Spreading	Atten	2TL	PHIt	2ARt	SLr	Vol	RSv	2EARv	RLv		
1000	120	0.4	120.4	2.865984	-0.5	118.0011	87.14634	-73	-30.0547	87.59279		
2000	132.0412	0.8	132.8412	1.432544	0	106.0599	92.75301	-73	-30.6222	80.19074		
4000	144.0824	1.6	145.6824	0.716216	0	93.2187	95.76331	-73	-30.9603	70.0217		
6000	151.1261	2.4	153.5261	0.47747	0	85.37505	97.52422	-73	-31.0831	63.81618		
8000	156.1236	3.2	159.3236	0.358101	0	79.5775	98.77361	-73	-31.1466	59.20452		
10000	160	4	164	0.28648	0	74.9011	99.74271	-73	-31.1854	55.45842		
15000	167.0437	6	173.0437	0.190986	0	65.85745	101.5036	-73	-31.238	48.12309		
20000	172.0412	8	180.0412	0.14324	0	58.8599	102.753	-73	-31.2647	42.34826		
30000	179.0849	12	191.0849	0.095493	0	47.81625	104.5139	-73	-31.2916	33.0386		
40000	184.0824	16	200.0824	0.07162	0	38.8187	105.7633	-73	-31.3051	25.27688		
60000	191.1261	24	215.1261	0.047746	0	23.77505	107.5242	-73	-31.3188	11.98052		

Range	Area	PHIs	2EARs	RSs	RLs	PHIb	2EARb	RSb	RLb	NLr	NL	SE
1000	45.14879	5.73917	-24.525	-50	74.1249	0				54.0474	87.78578	49.38571
2000	48.15909	2.865984	-24.525	-50	64.694	0				54.0474	80.32179	44.4085
4000	51.16939	1.432544	-24.525	-50	54.8631	61.64065	-54.525	-18	56.8631	54.0474	70.25734	41.63176
6000	52.9303	0.954974	-24.525	-50	48.78036	71.53854	-54.525	-13	55.78036	54.0474	64.37314	39.67231
8000	54.17969	0.716216	-24.525	-50	44.2322	76.26096	-54.525	-11	53.2322	54.0474	60.46524	37.78266
10000	55.14879	0.572967	-24.525	-50	40.5249	79.04722	-54.525	-10	50.5249	54.0474	57.90047	35.67102
15000	56.9097	0.381975	-24.525	-50	33.24216	82.72299	-54.525	-9	44.24216	54.0474	55.06457	29.46328
20000	58.15909	0.28648	-24.525	-50	27.494	84.54868	-54.525	-8	39.494	54.0474	54.34056	23.18974
30000	59.92	0.190986	-24.525	-50	18.21126	86.36884	-54.525	-8	30.21126	54.0474	54.08282	12.40383
40000	61.16939	0.14324	-24.525	-50	10.4631	87.27743	-54.525	-9	21.4631	54.0474	54.05335	3.435745
60000	62.9303	0.095493	-24.525	-50	-2.81964	88.18533	-54.525	-9	8.180361	54.0474	54.04768	-11.6022