APPENDIX G

RADGUNS MODEL DEFICIENCY REPORTS

SMART

Credible Models for Credible Analysis…

MODEL DEFICIENCY REPORT

REPORTING ACTIVITY:	MDR NUMBER:	DATE:
ASI-SI T. McCormick	95-01	6/27/95

MODEL AND VERSION:

RADGUNS v.1.9

DESCRIPTION OF ANOMALY:

The S/I value passed to subroutine PDET is the maximum for the scan. PDET should use the average S/I for the number of pulses integrated (not the number of pulses in a scan).

POSSIBLE IMPACTS:

Passing a maximum S/I value instead of an average S/I value will lead to earlier detections

SUGGESTED CORRECTIVE ACTION:

Examine the current interface between S/N, NPI, and the PDET model. Either update the current PDET model using Meyer and Mayer's Radar Target Detection Handbook, or replace the detection model completely with previously verified code (i.e., ALARM).

ESTIMATED COST TO CORRECT:

2 weeks

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MODEL DEFICIENCY REPORT

REPORTING ACTIVITY:	MDR NUMBER:	DATE:
ASI-SI T. McCormick	95-02	6/27/95

MODEL AND VERSION:

RADGUNS v.1.9

DESCRIPTION OF ANOMALY:

The Methodology and Design Manual does not contain a description of the probability of detection model.

POSSIBLE IMPACTS:

The user cannot quantify detection results with this model option.

SUGGESTED CORRECTIVE ACTION:

Revise ASP-II Threshold section and insert it in the Methodology and Design Manual under Section 3.3.

ESTIMATED COST TO CORRECT:

None.

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Credible Models for Credible Analysis…

MODEL DEFICIENCY REPORT

REPORTING ACTIVITY:	MDR NUMBER:	DATE:
ASI-SI T. McCormick	95-03	6/27/95

MODEL AND VERSION:

RADGUNS v.1.9

DESCRIPTION OF ANOMALY:

The clutter patch surface area calculation is wrong for both the pulse-length limited and beamwidth-limited cases. Variables PHIB and ELBW are incorrectly divided by two.

POSSIBLE IMPACTS:

The clutter patch area (and thus the power returned from this area) is approximately half of its correct value for the pulse-limited case, and one-fourth of its correct value for the beamwidth-limited case.

SUGGESTED CORRECTIVE ACTION:

Where variable AREA is calculated in function CLUTG, change PHIB/2.0 to PHIB, and ELBW/2.0 to ELBW.

ESTIMATED COST TO CORRECT:

None.

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Credible Models for Credible Analysis…

MODEL DEFICIENCY REPORT

REPORTING ACTIVITY:	MDR NUMBER:	DATE:
ASI-SI T. McCormick	95-04	6/27/95

MODEL AND VERSION:
RADGUNS v.1.9

DESCRIPTION OF ANOMALY:
The "numerical" clutter model does not include the beamwidth-limited case. The half-power azimuth beamwidth should be multiplied by 0.75 to yield the three-fourths conventional 3-dB one-way beamwidth cited by Blake.

POSSIBLE IMPACTS:
Incorrect returns from clutter patches at large grazing angles.

SUGGESTED CORRECTIVE ACTION:
The clutter models (numerical and descriptive) should differ only in their determination of the back-scatter coefficient. Calculate s_0 first, based on clutter model, then calculate clutter area and power returned for either model using the existing code under the descriptive model.

ESTIMATED COST TO CORRECT:
None.

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Credible Models for Credible Analysis…

MODEL DEFICIENCY REPORT

REPORTING ACTIVITY:	MDR NUMBER:	DATE:
ASI-SI T. McCormick	95-05	6/27/95

MODEL AND VERSION:
RADGUNS v.1.9

DESCRIPTION OF ANOMALY:
Variable CLUTG is specified as the elevation angle of the ground clutter patch under Item 9 of the function CLUTG description in the Methodology and Design Manual. The correct variable name is CLEL.

POSSIBLE IMPACTS:
User confusion.

SUGGESTED CORRECTIVE ACTION:
Change CLUTG to CLEL in description.

ESTIMATED COST TO CORRECT:
None.

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Credible Models for Credible Analysis…

MODEL DEFICIENCY REPORT

REPORTING ACTIVITY:	MDR NUMBER:	DATE:
ASI-SI T. McCormick	95-06	6/27/95

MODEL AND VERSION:

RADGUNS v.1.9

DESCRIPTION OF ANOMALY:

No reference to modeling glint as a sinusoidal process can be found. The effects of modeling glint as a sinusoidal rather than a random process should be examined and documented.

POSSIBLE IMPACTS:

An unrealistic glint model will result in unrealistic tracking and shooting performance

SUGGESTED CORRECTIVE ACTION:

Action should be based on the results of the testing described above. If the tracking and shooting performance of the system is significantly affected by modeling glint as sinusoidal rather than random, a machine-independent random number generator should be implemented.

ESTIMATED COST TO CORRECT:

Will depend on results of testing (~0 to 2 weeks)

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Credible Models for Credible Analysis…

MODEL DEFICIENCY REPORT

REPORTING ACTIVITY:	MDR NUMBER:	DATE:
ASI-SI V. Ross	95-07	8/8/95

MODEL AND VERSION:
RADGUNS v.1.9

DESCRIPTION OF ANOMALY:
Due to changes made to the integration function, perfect cuing (PERC) does not yield the longest detection range when using the probability of detection (PDET) option for type of target detection. During sensitivity analysis, it was discovered that sector (SECT) achieved consistently earlier detection than PERC for given P_d, P_{fa}, and Swerling case. However, when using threshold (THRS), PERC achieved the earliest detections.

POSSIBLE IMPACTS:
When using PDET, PERC does not yield the earliest detection.

SUGGESTED CORRECTIVE ACTION:
According to the developers, a nominal code change can provide full PERC capability when using PDET.

ESTIMATED COST TO CORRECT:

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Credible Models for Credible Analysis…

MODEL DEFICIENCY REPORT

REPORTING ACTIVITY:	MDR NUMBER:	DATE:
ASI-SI J. Garcia	95-08	8/17/95

MODEL AND VERSION:

RADGUNS v.1.9

DESCRIPTION OF ANOMALY:

RADGUNS produces a radar antenna pattern for RAD1 with the first null at 1.6 degrees off-boresight, and the second null at 2.9 degrees off-boresight. These angles do not match the data in the IDIP (pp. M-5 through M-8), which exhibit nulls between 2.2 and 2.4 degrees and between 3.6 and 3.8 degrees, depending on the conical scanner's position and earth axis measurement cut.

POSSIBLE IMPACTS:

This anomaly causes the half-power beamwidth in *RADGUNS* to be 18.6 percent narrower than that shown in ASP-II, Section 3.20, when main lobe width is decreased, the magnitude of the tracking errors is reduced, and tracking error frequency is increased. From this, better shooting performance and a higher number of expected target hits will result.

SUGGESTED CORRECTIVE ACTION:

Function ANTTRK should be modified to mathematically produce an antenna pattern which more closely resembles the antenna pattern plots shown in the IDIP, or the IDIP data could be used to generate tables of antenna gain as a function of scanner position. A table lookup algorithm could then be incorporated to determine antenna gain.

ESTIMATED COST TO CORRECT:

The table lookup method suggested above has been implemented in *RADGUNS* v.2.0.

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Credible Models for Credible Analysis…

MODEL DEFICIENCY REPORT

REPORTING ACTIVITY:	MDR NUMBER:	DATE:
ASI-SI T. McCormick	95-09	9/13/95

MODEL AND VERSION:

RADGUNS v.1.9

DESCRIPTION OF ANOMALY:

The attached pages from the US Standard Atmospheric Table (1976) give velocity of sound as a function of altitude. *RADGUNS* models velocity of sound in function BALIST with the following equation which is an empirical fit to atmospheric data.

$$V_s = V_s e^{-ky} \quad [1]$$

where the velocity of sound at standard temperature and pressure, V_s, is equal to 340.34 m/s, and the empirically derived constant k is equal to 0.000009867 m^{-1}. The attached figure show velocity of sound as a function of altitude. The curve labeled US Std Atm is data plotted from the 1976 US Standard Atmospheric Table. The velocity obtained with Equation 1 above and implemented in *RADGUNS* v.1.9 is shown by the curve labeled RADGUNS. The velocity of sound obtained in the model diverges with increasing altitude from that shown in the table.

POSSIBLE IMPACTS:

A value for the velocity of sound that is too high will cause a Mach number value that is too low, which will in turn affect the drag coefficient that goes into the computation of projectile acceleration. The drag coefficient is usually only highly sensitive to Mach number as a projectile passes through Mach one. Ballistic trajectories produced with *RADGUNS*, however, closely matched those obtained through live fire; therefore, the impact of the higher velocity of sound value in the model is not significant.

SUGGESTED CORRECTIVE ACTION:

The value of V_s should be changed to 340.29 m/s, and the value of k should be changed to 0.0000125 m^{-1}. These values produce the curve labeled RADGUNS MDR shown on the attached plot.

ESTIMATED COST TO CORRECT:

None

U.S. STANDARD ATMOSPHERE (1976)

From, "U.S. Standard Atmosphere, 1976", National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration and the United States Air Force, 1976. The above referenced book is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The book contains considerably more extensive tables than those presented below plus the development of the equations used in the calculations of the tables as well as a discussion of the bases for selection of constants used in the equations.

The U.S. Standard Atmosphere, 1976 is an idealized, steady-state representation of the earth's atmosphere from the surface to 1000 km, as it is assumed to exist in a period of moderate solar activity. The air is assumed to be dry, and at heights sufficiently below 86 km, the atmosphere is assumed to be homogeneously mixed with a relative-volume composition leading to a mean molecular weight M. The molecular weights and assumed fractional-volume composition of sea-level dry air were

Gas species	Molecular weight M_i (kg/kmol)	Fractional volume F_i (dimensionless)
N_2	28.0134	0.78084
O_2	31.9988	0.209476
Ar	39.948	0.00934
CO_2	44.00995	0.000314
Ne	20.183	0.00001818
He	4.0026	0.00000524
Kr	83.80	0.00000114
Xe	131.30	0.000000087
CH_4	16.04303	0.000002
H_2	2.01594	0.0000005

SYMBOLS, ABBREVIATIONS, AND UNITS RELATING TO FOLLOWING TABLE

- C_s Speed of sound expressed as meters per second.
- g Acceleration due to gravity expressed as meters per second.
- H Geopotential altitude expressed in meters. The unit of measurement of geopotential is the standard geopotential meter (m') which represents the work done by lifting a unit mass 1 geometric meter, through a region in hich the acceleration of gravity is uniformly 9.80665 m/s^2. The geopotential at any point with respect to sea level (assumed zero potential), expressed in geopotential meters, is called geopotential altitude.
- H_p Pressure scale height. The quantity, $H_p RT/(g \cdot m)$, which has the dimensions of length, is the quantity commonly associated with the concept of scale height, and is the defining form of pressure scale height used in this model.
- K Kelvin, the thermodynamic temperature.
- L Mean free path. This is the mean value of the distances traveled by each of the neutral particles in a selected volume between successive collisions with other particles in the volume.
- m Meter, the unit of length.
- M Molecular weight expressed as kg/kmol or lb/lbmol.
- n The number of neutral atmospheric gas particles per cubic meter of the atmosphere at the geometric height Z or the geopotential height H.
- N Newton, a force having the units $kg \cdot m/s^2$.
- P Pressure, expressed as millibars ($100 N/m^2$).
- R The gas constant, $R = 8.31432 \times 10^3 N \cdot m/(kmol \cdot K)$.
- s Seconds, time.
- T Temperature, degrees Kelvin.
- V Mean air particle speed, expressed as meters per second, is the arithmetic average of the speeds of all air particles in the volume element being considered.
- Z Geometric altitude expressed in kilometers.
- η Kinematic viscosity in the units m^2/s.
- κ Thermal conductivity in the units $J/m \cdot s \cdot K$.
- μ Dynamic viscosity in the units $N \cdot s/m^2$.
- ν Mean collision frequency. Average speed of air particles within a selected volume divided by the mean free path of the particles in that volume. Thus $\nu = V/L$.
- ϱ Density expressed as kg/m^3.
- r Mean radius of earth at equator, 6,370,949 m.

Some equations useful for computing certain values of the Standard Atmosphere are:

$-1{,}524 \leq H < 11{,}000$ m

$T = 288.15 - 0.006500\,H$

$P = 1013.25(288.15/T)^{-5.255877}$

$H = 44{,}331.514 - 11{,}880.516\,P^{0.1902632}$

$11{,}000 \leq H < 20{,}000$ m

$T = 216.650$

$P = 226.32\,e^{-0.00015768832(H - 11{,}000.0)}$

$H = 45{,}383.967 - 6{,}341.6237 \ln P$

$20{,}000 \leq H < 32{,}000$ m

$T = 216.650 + 0.00100(H - 19{,}999.997)$

$P = 54.7487\,(216.650/T)^{34.16319}$

$H = -196{,}650.0 + 243{,}580.85/P^{0.0292713}$

$-1{,}524 \leq H < 32{,}000$ m

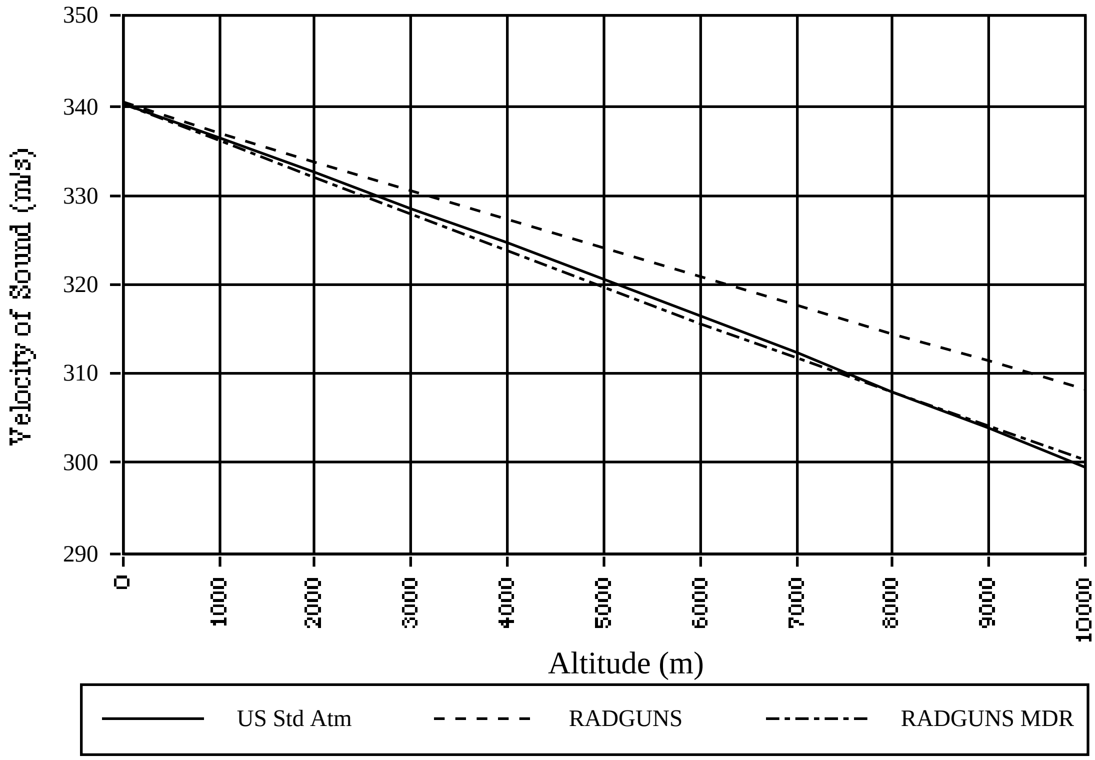
$\varrho = 0.3483677\,(P/T)$

$H = rZ/(r + Z)$

$Z = rH/(r - H)$

F-150

Altitude		Acceleration due to gravity	Pressure scale height	Number density	Particle speed	Collision frequency	Mean free path	Molecular weight	Temperature	Pressure	Density	Sound speed	Dynamic viscosity	Kinematic viscosity	Thermal conductivity
Z(m)	H(m)	g(m/s²)	H_p (m)	n (m⁻³)	V (m/s)	ν (s⁻¹)	L (m)	M (kg/kmol)	T(K)	P(mb)	ρ(kg/m³)	C_s(m/s)	μ (N·s/m²)	η (m²/s)	(J/m·s·K)
−5000	−5004	9.8221	9371.8	4.0151(+25)	484.15	1.1506(+10)	4.2078(−8)	28.964	320.676	1.7776(+3)	1.9311(+0)	358.99	1.9422(−5)	1.0058(−5)	2.7882(−5)
−4500	−4503	9.8295	9278.2	3.8445(+25)	481.69	1.0961(+10)	4.3945(−8)	28.964	317.421	1.6848(+3)	1.8491(+0)	357.16	1.9273(−5)	1.0423(−5)	2.7634(−5)
−4000	−4003	9.8190	9184.5	3.6795(+25)	479.22	1.0417(+10)	4.5915(−8)	28.964	314.166	1.5959(+3)	1.7697(+0)	355.32	1.9123(−5)	1.0806(−5)	2.7384(−5)
−3500	−3502	9.8175	9090.8	3.5201(+25)	476.73	9.9328(+9)	4.7995(−8)	28.964	310.913	1.5109(+3)	1.6930(+0)	353.48	1.8972(−5)	1.1206(−5)	2.7134(−5)
−3000	−3001	9.8159	8997.1	3.3660(+25)	474.23	9.4481(+9)	5.0193(−8)	28.964	307.659	1.4297(+3)	1.6189(+0)	351.63	1.8820(−5)	1.1625(−5)	2.6884(−5)
−2500	−2501	9.8144	8903.4	3.2171(+25)	471.71	8.9824(+9)	5.2515(−8)	28.964	304.406	1.3520(+3)	1.5473(+0)	349.76	1.8668(−5)	1.2065(−5)	2.6632(−5)
−2000	−2001	9.8128	8809.6	3.1017(+25)	469.69	8.6231(+9)	5.4469(−8)	28.964	301.154	1.2778(+3)	1.4782(+0)	347.89	1.8515(−5)	1.2525(−5)	2.6380(−5)
−1500	−1500	9.8113	8715.9	2.9346(+25)	466.65	8.1056(+9)	5.7571(−8)	28.964	297.902	1.2069(+3)	1.4114(+0)	346.00	1.8361(−5)	1.3009(−5)	2.6126(−5)
−1000	−1000	9.8097	8622.1	2.8007(+25)	464.09	7.6934(+9)	6.0324(−8)	28.964	294.651	1.1393(+3)	1.3470(+0)	344.11	1.8206(−5)	1.3516(−5)	2.5872(−5)
−500	−500	9.8082	8528.3	2.6715(+25)	461.53	7.2980(+9)	6.3240(−8)	28.964	291.400	1.0747(+3)	1.2849(+0)	342.21	1.8050(−5)	1.4048(−5)	2.5618(−5)
0	0	9.8066	8434.5	2.5470(+25)	458.94	6.9189(+9)	6.6332(−8)	28.964	288.150	1.01325(+3)	1.2250(+0)	340.29	1.7894(−5)	1.4607(−5)	2.5326(−5)
500	500	9.8051	8340.7	2.4269(+25)	456.35	6.5555(+9)	6.9613(−8)	28.964	284.900	9.5461(+2)	1.1673(+0)	338.37	1.7737(−5)	1.5195(−5)	2.5106(−5)
1000	1000	9.8036	8246.9	2.3113(+25)	453.74	6.2075(+9)	7.3095(−8)	28.964	281.651	8.9876(+2)	1.1117(+0)	336.43	1.7579(−5)	1.5813(−5)	2.4849(−5)
1500	1500	9.8020	8153.0	2.2000(+25)	451.12	5.8743(+9)	7.6795(−8)	28.964	278.402	8.4559(+2)	1.0581(+0)	334.49	1.7420(−5)	1.6463(−5)	2.4591(−5)
2000	1999	9.8005	8059.2	2.0928(+25)	448.48	5.5554(+9)	8.0728(−8)	28.964	275.154	7.9501(+2)	1.0066(+0)	332.53	1.7260(−5)	1.7147(−5)	2.4333(−5)
2500	2499	9.7989	7965.3	1.9897(+25)	445.82	5.2504(+9)	8.4912(−8)	28.964	271.906	7.4691(+2)	9.5695(−1)	330.56	1.7099(−5)	1.7868(−5)	2.4073(−5)
3000	2999	9.7974	7871.4	1.8905(+25)	443.15	4.9588(+9)	8.9367(−8)	28.964	268.659	7.0121(+2)	9.0925(−1)	328.58	1.6938(−5)	1.8628(−5)	2.3813(−5)
3500	3498	9.7959	7777.5	1.7952(+25)	440.47	4.6802(+9)	9.4113(−8)	28.964	265.413	6.5780(+2)	8.6340(−1)	326.59	1.6775(−5)	1.9429(−5)	2.3552(−5)
4000	3997	9.7943	7683.6	1.7036(+25)	437.76	4.4141(+9)	9.9173(−8)	28.964	262.166	6.1660(+2)	8.1935(−1)	324.59	1.6612(−5)	2.0275(−5)	2.3290(−5)
4500	4497	9.7928	7589.7	1.6156(+25)	435.05	4.1602(+9)	1.0457(−7)	28.964	258.921	5.7752(+2)	7.7704(−1)	322.57	1.6448(−5)	2.1167(−5)	2.3028(−5)
5000	4996	9.7912	7495.7	1.5312(+25)	432.31	3.9180(+9)	1.1034(−7)	28.964	255.676	5.4048(+2)	7.3643(−1)	320.55	1.6282(−5)	2.2110(−5)	2.2765(−5)
5500	5495	9.7897	7401.8	1.4502(+25)	429.56	3.6871(+9)	1.1650(−7)	28.964	252.431	5.0539(+2)	6.9747(−1)	318.50	1.6116(−5)	2.3107(−5)	2.2500(−5)
6000	5994	9.7882	7307.8	1.3725(+25)	426.79	3.4671(+9)	1.2310(−7)	28.964	249.187	4.7217(+2)	6.6011(−1)	316.45	1.5949(−5)	2.4161(−5)	2.2236(−5)
6500	6493	9.7866	7213.8	1.2980(+25)	424.00	3.2577(+9)	1.3016(−7)	28.964	245.943	4.4075(+2)	6.6431(−1)	314.39	1.5781(−5)	2.5278(−5)	2.1970(−5)
7000	6992	9.7851	7119.8	1.2267(+25)	421.20	3.0584(+9)	1.3772(−7)	28.964	242.700	4.1105(+2)	5.9002(−1)	312.31	1.5612(−5)	2.6461(−5)	2.1703(−5)
7500	7491	9.7836	7025.8	1.1585(+25)	418.37	2.8689(+9)	1.4583(−7)	28.964	239.457	3.8299(+2)	5.5719(−1)	310.21	1.5442(−5)	2.7714(−5)	2.1436(−5)
8000	7990	9.7820	6931.7	1.0932(+25)	415.53	2.6888(+9)	1.5454(−7)	28.964	236.215	3.5651(+2)	5.2579(−1)	308.11	1.5271(−5)	2.9044(−5)	2.1168(−5)
8500	8489	9.7805	6837.7	1.0308(+25)	412.67	2.5178(+9)	1.6390(−7)	28.964	232.974	3.3154(+2)	4.9576(−1)	305.98	1.5099(−5)	3.0457(−5)	2.0899(−5)
9000	8987	9.7789	6743.6	9.7110(+24)	409.79	2.3555(+9)	1.7397(−7)	28.964	229.733	3.0800(+2)	4.6706(−1)	303.85	1.4926(−5)	3.1957(−5)	2.0630(−5)
9500	9486	9.7774	6649.5	9.1413(+24)	406.89	2.2016(+9)	1.8482(−7)	28.964	226.492	2.8584(+2)	4.3966(−1)	301.70	1.4752(−5)	3.3553(−5)	2.0359(−5)
10000	9984	9.7759	6555.4	8.5976(+24)	403.97	2.0558(+9)	1.9651(−7)	28.964	223.252	2.6499(+2)	4.1351(−1)	299.53	1.4577(−5)	3.5251(−5)	2.0088(−5)
10500	10483	9.7743	6461.3	8.0790(+24)	401.03	1.9177(+9)	2.0912(−7)	28.964	220.013	2.4540(+2)	3.8857(−1)	297.35	1.4400(−5)	3.7060(−5)	1.9816(−5)
11000	10981	9.7728	6367.2	7.5854(+24)	398.07	1.7871(+9)	2.2274(−7)	28.964	216.774	2.2699(+2)	3.6480(−1)	295.15	1.4223(−5)	3.8988(−5)	1.9543(−5)
11500	11479	9.7713	6364.6	7.0157(+24)	397.95	1.6525(+9)	2.4081(−7)	28.964	216.650	2.0984(+2)	3.3743(−1)	295.07	1.4216(−5)	4.2131(−5)	1.9533(−5)
12000	11977	9.7697	6365.6	6.4857(+24)	397.95	1.5277(+9)	2.6049(−7)	28.964	216.650	1.9399(+2)	3.1194(−1)	295.07	1.4216(−5)	4.5574(−5)	1.9533(−5)
12500	12475	9.7682	6366.6	5.9958(+24)	397.95	1.4123(+9)	2.8178(−7)	28.964	216.650	1.7934(+2)	2.8838(−1)	295.07	1.4216(−5)	4.9297(−5)	1.9533(−5)
13000	12973	9.7667	6367.6	5.5430(+24)	397.95	1.3056(+9)	3.0479(−7)	28.964	216.650	1.6579(+2)	2.6660(−1)	295.07	1.4216(−5	5.3325(−5)	1.9533(−5)
13500	13471	9.7651	6368.6	5.1244(+24)	397.95	1.2070(+9)	3.2969(−7)	28.964	216.650	1.5327(+2)	2.4646(−1)	295.07	1.4216(−5)	5.7680(−5)	1.9533(−5)
14000	13969	9.7636	6369.6	4.7375(+24)	397.95	1.1159(+9)	3.5662(−7)	28.964	216.650	1.4170(+2)	2.2786(−1)	295.07	1.4216(−5)	6.2391(−5)	1.9533(−5)
14500	14467	9.7621	6370.6	4.3799(+24)	397.95	1.0317(+9)	3.8574(−7)	28.964	216.650	1.3100(+2)	2.1066(−1)	295.07	1.4216(−5)	6.7485(−5)	1.9533(−5)
15000	14965	9.7605	6371.6	4.0493(+24)	397.95	9.5380(+8)	4.1723(−7)	28.964	216.650	1.2111(+2)	1.9476(−1)	295.07	1.4216(−5)	7.2995(−5)	1.9533(−5)
16000	15960	9.7575	6373.6	3.4612(+24)	397.95	8.1528(+8)	4.8812(−7)	28.964	216.650	1.0352(+2)	1.6647(−1)	295.07	1.4216(−5)	8.5397(−5)	1.9533(−5)
17000	16955	9.7544	6375.6	2.9587(+24)	397.95	6.9691(+8)	5.7102(−7)	28.964	216.650	8.8497(+1)	1.4230(−1)	295.07	1.4216(−5)	9.9901(−5)	1.9533(−5)
18000	17949	9.7513	6377.6	2.5292(+24)	397.95	5.9576(+8)	6.6797(−7)	28.964	216.650	7.5652(+1)	1.2165(−1)	295.07	1.4216(−5)	1.1686(−4)	1.9533(−5)
19000	18943	9.7483	6379.6	2.1622(+24)	397.95	5.0931(+8)	7.8135(−7)	28.964	216.650	6.4674(+1)	1.0400(−1)	295.07	1.4216(−5)	1.3670(−4)	1.9533(−5)
20000	19937	9.7452	6381.6	1.8486(+24)	397.95	4.3543(+8)	9.1393(−7)	28.964	216.650	5.5293(+1)	8.8910(−2)	295.07	1.4216(−5)	1.5989(−4)	1.9533(−5)
21000	20931	9.7422	6411.0	1.5742(+24)	398.81	3.7161(+8)	1.0732(−6)	28.964	217.581	4.7289(+1)	7.5715(−2)	295.07	1.4267(−5)	1.8843(−4)	1.9611(−5)
22000	21924	9.7391	6442.3	1.3413(+24)	399.72	3.1733(+8)	1.2596(−6)	28.964	218.574	4.0475(+1)	6.4510(−2)	296.38	1.4322(−5)	2.2201(−4)	1.9695(−5)
23000	22917	9.7361	6473.6	1.1437(+24)	400.62	2.7119(+8)	1.4772(−6)	28.964	219.567	3.4668(+1)	5.5006(−2)	297.05	1.4376(−5)	2.6135(−4)	1.9778(−5)
24000	23910	9.7330	6504.9	9.7591(+23)	401.53	2.3194(+8)	1.7312(−6)	28.964	220.560	2.9717(+1)	4.6938(−2)	297.72	1.4430(−5)	3.0743(−4)	1.9862(−5)
25000	24902	9.7300	6536.2	8.3341(+23)	402.43	1.9852(+8)	2.0272(−6)	28.964	221.552	2.5492(+1)	4.0084(−2)	298.39	1.4484(−5)	3.6135(−4)	1.9945(−5)
26000	25894	9.7269	6567.5	7.1225(+23)	403.33	1.7004(+8)	2.3720(−6)	28.964	222.544	2.1883(+1)	3.4257(−2)	299.06	1.4538(−5)	4.2439(−4)	2.0029(−5)
27000	26886	9.7239	6598.9	6.0916(+23)	404.23	1.4575(+8)	2.7734(−6)	28.964	223.536	1.8799(+1)	2.9298(−2)	299.72	1.4592(−5)	4.9805(−4)	2.0112(−5)
28000	27877	9.7208	6630.2	5.2138(+23)	405.12	1.2502(+8)	3.2404(−6)	28.964	224.527	1.6161(+1)	2.5076(−2)	300.39	1.4646(−5)	5.8405(−4)	2.0195(−5)
29000	28868	9.7178	6661.6	4.4657(+23)	406.01	1.0732(+8)	3.7832(−6)	28.964	225.518	1.3904(+1)	2.1478(−2)	301.05	1.4699(−5)	6.8437(−4)	2.0278(−5)
30000	29859	9.7147	6692.0	3.8278(+23)	406.91	9.2192(+8)	4.4137(−6)	28.964	226.509	1.1970(+1)	1.8410(−2)	301.71	1.4753(−5)	8.0134(−4)	2.0361(−5)


350
340
330
320
310
300
290
Velocity of Sound (m/s)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
Altitude (m)
US Std Atm
RADGUNS
RADGUNS MDR

SMART

Credible Models for Credible Analysis…

MODEL DEFICIENCY REPORT

REPORTING ACTIVITY:	MDR NUMBER:	DATE:
ASI-SI T. McCormick	95-10	9/20/95

MODEL AND VERSION:

RADGUNS v.1.9

DESCRIPTION OF ANOMALY:

An engagement between a RAD1 system and a 1 sm target flying along a linear flight path at an offset of 500 m was simulated. The engagement was repeated with the target carrying a 5 sm passive reflector (the SOJ option was used with a (0, 0, 0) offset). The increase in RCS due to the reflector should not significantly affect tracking and shooting performance if the jammer signal at the radar receiver is being computed properly and the AGC model is operating as expected. The increase in RCS at the target location, however, resulted in a significant degradation of system performance.

POSSIBLE IMPACTS:

The attached table shows the tracking and shooting performance of the two engagements.

SUGGESTED CORRECTIVE ACTION:

The problem was discussed directly with the model developer who later concluded that the calculation of antenna gain on incoming jammer signals did not include the effects of beam nutation in a conical scan about the antenna boresight. Subsequent inclusion of beam nutation corrected the anomaly. (Several changes were made to Subroutine SIGJAM in RAD1.F.)

ESTIMATED COST TO CORRECT:

None

	1 sm target	**1 sm target w/ 5 sm reflector**
Avg Azimuth Error (mrad)	1.22	10.37
Avg Elevation Error (mrad)	0.49	2.94
Avg Range Error (m)	0.21	0.61
# Breaklocks	0	1
# Rounds Fired	618	498
Avg Miss Distance (m)	4.23	20.60
Cumulative Phit	0.93	0.16

SMART

Credible Models for Credible Analysis…

MODEL DEFICIENCY REPORT

REPORTING ACTIVITY:	MDR NUMBER:	DATE:
ASI-SI T. McCormick	95-11	10/25/95

MODEL AND VERSION:

RADGUNS v.1.9

DESCRIPTION OF ANOMALY:

Drag coefficient as a function of Mach number as generated by function KD in GUN57.F does not match the data shown on page 27 of BRL Report No. 2626, *Exterior Ballistic Data for Foreign 23mm and 57mm Antiaircraft Systems—HITVAL I.*

POSSIBLE IMPACTS:

The difference in KD values significantly affects the projectile's trajectory. The attached table shows the difference in downrange and altitude values when fired at an elevation angle of 33.75 deg for five times-of-flight.

SUGGESTED CORRECTIVE ACTION:

Modify function KD so that it produces a curve similar to the one shown in the reference, if no other source is available.

ESTIMATED COST TO CORRECT:

8 hours

TOF	Δ Downrange (m)	Δ Altitude (m)
2	21.77	14.25
4	66.60	43.07
6	118.43	75.72
8	168.94	106.98
10	209.78	132.85

SMART

Credible Models for Credible Analysis…

MODEL DEFICIENCY REPORT

REPORTING ACTIVITY:	MDR NUMBER:	DATE:
ASI-SI Dianne Rindt	96-01	4/3/96

MODEL AND VERSION:

RADGUNS v.1.9

DESCRIPTION OF ANOMALY:

In updating the position and velocity of an expendable jammer in subroutine MOVJAM, the horizontal deceleration is used to update both the x and y components of jammer velocity.

POSSIBLE IMPACTS:

Incorrect trajectory for expendable jammer. Since the horizontal projection of the trajectory is defined using a single deceleration value, the trajectory should continue in the same direction as the expendable is launched. The current coding will cause the trajectory to curve at some launch angles.

SUGGESTED CORRECTIVE ACTION:

The horizontal deceleration should be decomposed into x and y components, using the direction of the current horizontal velocity vector, and these components should be applied to the current x and y velocity values, respectively.

ESTIMATED COST TO CORRECT:

Minimal

a. Compute the magnitude of the current velocity vector:

$$M = \sqrt{v_x^2 + v_y^2}$$

b. If M ≤ dhDt, set vx(new) = vy(new) = 0.

c. If M > dhDt, compute the components of the horizontal deceleration:

$$d_x = \frac{d_h v_x}{M}$$
$$d_y = \frac{d_h v_y}{M}$$

d. Update velocity components:

$$v_x(\text{new}) = v_x - d_x \Delta t$$
$$v_y(\text{new}) = v_y - d_y \Delta t$$

The equations in c can be substituted into the equations in d to form a single-step:

$$v_x(\text{new}) = v_x - \frac{d_h v_x \Delta t}{M} = v_x\left(1 - \frac{d_h \Delta t}{M}\right)$$
$$v_y(\text{new}) = v_y - \frac{d_h v_y \Delta t}{M} = v_y\left(1 - \frac{d_h \Delta t}{M}\right)$$

This shows that vx and vy are both multiplied by the same quantity, preserving the horizontal direction of the velocity vector (except for a 180-deg shift). These equations also show the reason for the test in part b being more restrictive than testing for M = 0. Ensuring that the multiplier is positive will preserve the sign of each component.

RADGUNS PROBLEM/SUGGESTION REPORT

9 August 1994

1. Reported by: MAJ Steve Satchwell
Organization: AF/XOFE
Address: Rm 4B879 Pentagon
Washington, DC 20330-5054

2. Version No: Version 1.9β

3. Function or subroutine affected (if applicable): Subroutine INPJAM

4. Problem Description: The current support jammer implementation is too restrictive. It only allows for a "welded" wingman to act as the support jamming platform. It does not allow for independent support jammer flight paths. It also does not model the support jammer's RCS.

5. Suggested Solution

   a. Modify subroutine INPJAM to accept separate user-identified support jammer flight paths.

   b. Require the user to specify the support jammer platform type so the proper support jammer RCS file can be referenced.

   c. Modify subroutine JAMMER to determine and return the support jammer's RCS signal return (as a function of time) to the weapon system receiver.

6. Comments: Subroutine MOVJAM already has the variable independence to move a support jammer around. However, it may be better to modify subroutine MOVTAR to give it similar variable independence (aka, make TARGET a local variable array instead of a COMMON variable array) to allow the use of existing flight path options.

The support jammer RCS signal return is needed because it provides a "real" signal return if the weapon system receiver goes into a track-on-jam/home-on-jam mode. Absence of a "target" return could allow the weapon system to recognize that it isn't tracking a "real" target.

Suggest adding two new flight paths: "RACETRACK" and "Figure 8". These are common support jammer flight paths. The names aptly describe what each flight path should look like.

<u>*RADGUNS* PROBLEM/SUGGESTION REPORT</u>

9 August 1994

1. Reported by: MAJ Steve Satchwell
   Organization: AF/XOFE
   Address: Rm 4B879 Pentagon
   Washington, DC 20330-5054

2. Version No: Version 1.9β

3. Function or subroutine affected (if applicable): Subroutine INPJAM & RGWO

4. Problem Description: Subroutine RGWO contains several false assumptions. First, it assumes that the minimu jammer pulse delay (AMINDL) is as large or larger than the simulation time step. This is an incorrect assumption as the minimum jammer pulse delay time may be up to 1-2 orders of magnitude smaller than the simulation step time. Second, RGWO assumes that the RGWO pulse width is the same size as the simulation step time. This would allow the victim radar to “leading-edge track” the target and disregard the RGWO. Third, the maximum jammer pulse delay (AMAXDL) implicitly assumes that the user knows that this time is the length of the walk-off region plus the pulse width of the RGWO pulse. Finally, RGWO assumes that the jammer frequency is the same as the victim radar’s frequency.

5. Suggested Solution

   a. Require a new RGWO input variable: Walk-off pulse width.

   b. Adjust AMAXDL to equal the input value of AMAXDL plus walk-off pulse width (or make this a jammer file “constant”). Also decrease the RGWO “off” time by the walk-off pulse width.

   c. Allow the user to specify frequency set-on RGWO or to specify the RGWO center frequency and signal bandwidth. If the user specifies the RGWO frequency, adjust the victim radar’s perceived jammer power.

SEE ATTACHED PSEUDO-CODE FOR HIGH-LEVEL REWRITE & EXPANSION OF ENTIRE RGWO SUBROUTINE

6. Comments: A review of actual USAF EA jammers indicates that they use a fixed value of RGWO pulse width and walk-off pull period. User-specified parameters for a basic RGWO (without hook or cover pulse) are program time (or pull-off g-radte), delay (aka hold or dwell) time, wobbulation option, minimum and maximum wobbulation frequencies, and wobbulation period. Some jammers also require the user to set the jammer’s center frequency.

RGWO PSEUDO CODE

Given:
Jammer_Rx_Ant_Gain
RGWO_Internal_Gain
RGPO_Program_Time XOR RGWO_Acceleration_Rate
Pull_Type
Pull_Direction
Max_Pull_Time (jammer system constant)
RGWO_PW (jammer system constant)
RGWO_Minimum_Delay_Time (jammer system constant, see assumptions)
RGWO_Dwell_Time
RGWO_Off_Time (jammer system constant)
Wobb_Flag
Wobb_Min_Freq
Wobb_Max_Freq
Wobb_Period
Hook_Flag
Num_Hooks
Hook_PW
Hook_Region
Hook_Wobb_Flag
Hook_Min_Wobb_Freq
Hook_Max_Wobb_Freq
Hook_Wobb_Period
Cover_Pulse_Flag
Cover_Pulse_Start_Delay
Cover_Pulse_Max_Peg (EA jammer system constant)
Jammer_Technique_Number (RGWO_Technique_Num = lowest, last Hook_Pulse = RGWO_Technique_Num + Num_Hooks)
SIGENV(100,5) [Expanded signal environment array]

1. RGWO_Minimum_Delay_Time is 1-2 orders of magnitude smaller than the victim radar's PW (simulation step time). We'll include this term for grins, but let it be set to 0.0 as a jammer system constant. This allows the user to manually simulate a crude RGWO jammer.
2. RGWO_Pulse_Width is slightly too much larger than the victim radar's pulse width.
3. Cover_Pulse_Min_PW = Hook_PW.
4. Jammer technique effective radiated power will be calculated in a separate subroutine to properly share jammer transmitter power among all active techniques at every simulation time step.

```
If First
Initialize all dynamic variables
      If RGPO_Acceleration_Rate [This could be done in subr INPJAM for greater
      efficiency]
            RGWO _Program_Time = 7.825/SQRT(RGWO_Acceleration_Rate)
      Calculate Slope_of_RGWO_Pull based on Pull_Type
      If Pull_Type == LINEAR
            Slope_of_RGWO_Pull = Max_Pull_Time/RGWO_Program_Time
```

```
        ElseIf Pull_Type == PARABOLIC
                Slope_of_RGWO_Pull = Max_Pull_Time/SQR(RGWO_Program_Time)
        Else
                Error!
        EndIf Pull_Type
Calculate Wobbulation adjustment if required
        If Wobb_Flag == TRUE
                Mod_Adjust = (Wobb_Max_Freq – Wobb_Min_Freq)/Wobb_Period
Calculate Cover_Pulse_PW_Increment if required
        If Cover_Pulse = TRUE
                Cover_Pulse_PW_Increment = ((RGWO_PW * Cover_Pulse_Max_Peg) –
                  Hook_PW)/(Max_Pull_Time – Cover_Pulse_Start_Delay)
        Initialize RGWO_Cycle_Times
        RGWO_Cycle_Start_Time = Current_Simulation_Time
        Pull_Off_Start_Time = Current_Simulation_Time + RGWO_Dwell_Time
        Pull_Off_Off_Time = Current_Simulation_Time + Max_Pull_Time + RGWO_PW
        Next_Pull_Off_Start_Time = Current_Simulation_Time + Max_Pull_Time +
        RGWO_Off_Time
Establish Hook_Pulses as required
        If Hook_Flag is set
                Determine each Hook_Pulse's position in Hook_Region
                Hook_Pulse_Window = Hook_Region/Num_Hooks
                Prior_Hook_Start_Time = 0.0
                For K = 1, Num_Hooks
                        Hook_Time(k) = Current_Simulation_Time + Max_Pull_Time +
                        Prior_Hook_Start_Time
                        Prior_Hook_Start_Time = Hook_Time(K)
                EndFor
        EndIf Hook_Flag
EndIf First

Calculate RGWO_Signal_Levels and Associated Times seen at the victim's receiver
If Simulation_Time .EQ. Next_Pull_Off_Start_Time (Time to start a new cycle)
                Reset RGWO_Cycle_Start_Time = Current_Simulation_Time
                Reset Pull_Off_Start_Time = Current_Simulation_Time +
                  RGWO_Dwell_Time
                Reset Pull_Off_End_Time = Current_Simulation_Time + Max_Pull_Time +
                  RGWO_PW
                Reset Next_Pull_Off_Start_Time = Current_Simulation_Time +
                  Max_Pull_Time
                TDelay = Simulation_Time
ElseIf Simulation_Time .GT. Pull_Off_Off_Time (time for silence)
        RGWOSIG = 0.0
ElseIf Simulation_Time .GT. Pull_Off_Start_Time (We're walking...)
        If Pull_Type == LINEAR
                TDelay = (Simulation_Time – RGWO_Cycle_Start_Time) *
                  Slope_of_RGWO_Pull * RGWO_Min_Delay
        ElseIf Pull_Type = PARABOLIC
                TDelay = SQR(Simulation_Time – RGWO_Cycle_Start_Time) *
                  Slope_of_RGWO_Pull * RGWO_Min_Delay
```

```
        Else
                ERROR!
        EndIf Pull_Type
        RGWOSIG = Received_Radar_Signal * Jammer_Rx_Ant_Gain *
        RGWO_Internal_Gain
ElseIf Simulation_Time .EQ. RGWO_Cycle_Start_Time (We're in dwell period)
        RGWOSIG = Received_Radar_Signal * Jammer_Rx_Ant_Gain *
        RGWO_Internal_Gain
EndIf Simulation_Time

Adjust RGWOSIG if return is modulated
If Wobb_Flag == TRUE
        RGWOSIG = RGWOSIG * (1 + sin(2 * PI * Simulation_Time/Wobb_Adjust))

Determine Cover_Pulse signal return if required
If Cover_Pulse = TRUE
        If Simulation_Time .GE. RGWO_Cycle_Start_Time + Cover_Pulse_Start_Time
Adjust/limit maximum pulse width of cover pulse
        If (Cover_Pulse_End/RGWO_PW) .GT. Cover_Pulse_Max_Peg)
                Cover_Pulse_End = RGWO_PW * Cover_Pulse_Max_Peg
        Else
                Cover_Pulse_End = Cover_Pulse_End + Cover_Pulse_PW_Increment
        EndIf (Cover_Pulse_End/RGWO_PW)

        If SIGENV(0,2) .LE. Cover_Pulse_End
                If Wobb_Flag == TRUE
                        Cover_Pulse_Sig = Jammer_Rx_Ant_Gain * RGWO_Internal_Gain *
                        Received_Radar_Signal * sin(Circle(2 * PI * Simulation_Time/
                        Mod_Adjust))
                Else
                        Cover_Pulse_Sig = Jammer_Rx_Gain * RGWO_Internal_Gain *
                        Received_Radar_Signal
                EndIf Wobb_Flag
        Else
                Cover_Pulse_Sig = 0.0
        EndIf (SIGENV(0,2)

Set cover pulse variables in SIGENV
                SIGENV(Jammer_Technique_Number * 10, 1) = Cover_Pulse_Sig
                SIGENV(Jammer_Technique_Number * 10, 5) = Cover_Pulse_End
        EndIf Simulation_Time
EndIf Cover_Pulse

Determine Hook_Pulse signal returns if required
        If Hook_Wobb_Flag == TRUE
                Hook_Pulse_Sig = Jammer_Rx_Ant_Gain * RGWO_Internal_Gain *
                   Received_Radar_Signal * sin(Circle(2 * PI * Simulation_Time/
                   Mod_Adjust))
        Else
```

```
            Cover_Pulse_Sig = Jammer_Rx_Gain * RGWO_Internal_Gain *
              Received_Radar_Signal
      EndIf Hook_Wobb_Flag
Place Hook pulses in appropriate range-time positions
      For K = 1, Num_Hooks
            SIGENV(Jammer_Technique_Number * 10+K, 1) = Jammer_Rx_Gain *
              RGWO_Internal_Gain * Received_Radar_Signal
      EndFor
EndIf Hook_Flag
```

RADGUNS PROBLEM/SUGGESTION REPORT

9 August 1994

1. Reported by: MAJ Steve Satchwell
   Organization: AF/XOFE
   Address: 1480 Air Force Pentagon
   Washington, DC 20330-1480

2. Version No: Version 1.9β

3. Function or subroutine affected (if applicable): Subroutine INPJAM and RGWO.

4. Problem Description: The existing RGWO routine requires hook pulse and cover pulse options. Modern (real-world) EA jammers cannot be accurately simulated without this option. Requiring the user to use a straight-through repeater technique at a fixed delay (with reference to the actual radar pulse) is unacceptable because it is 1) user-unfriendly, 2) inaccurate, and 3) overly simplistic. Real-world jammer implementations also allow for separate and independent hook pulse modulations and pulse widths (with respect to the RGWO pulse). Some hook pulse implementations actually consist of multiple hook pulses that "move" as a function of time within a "small" time period.

5. Suggested Solution: Expand the array SIGENV to have places to store cover pulse and hook pulse signal return info. Modify the existing subroutine RGWO to include code that implements a cover pulse option and a hook pulse option.

See Pseudo Code Attached to Problem Report 68 (RGWO False Assumptions) for Suggested Pseudo Code Implementation Approach

6. Comments: Real-world EA jammers implement cover pulse and hook pulse with characteristics that differ from that of the RGWO pull-off pulse. The cover pulse may have a variable pulse width that is dependent on the status of the pull-off function. Many modern EA jammers use multiple hook pulses rather than a single hook pulse. These pulses have a shorter pulse width than the pull-off pulse and may be subject to different AM modulation rates than the pull-off pulse. Finally, these hook pulses may "move" within their hook pulse region. Failure to allow for multiple hook pulses leaves RADGUNS open to criticism as inadequate for acquisition of modern weapon systems because the EA jamming does not represent real-world EA jammers. I strongly recommend expanding the size of SIGENV to allow for multiple hook pulses (and a cover pulse). One possible SIGENV subscript addressing scheme might be:

SIGENV(0,x):	True target signal return
SIGENV(1,x) – SIGENV(8,x):	Jammer technique signal returns
SIGENV(K*10,x):	Cover pulse signal return
SIGENV(K*10+1,x) – SIGENV(K*10+9,x):	RGWO hook pulse signal returns

NOTE: K represents technique number and x represents the pointer to the rest of that technique's characteristics.

RADGUNS PROBLEM/SUGGESTION REPORT

9 August 1994

1. Reported by: MAJ Steve Satchwell
   Organization: AF/XOFE
   Address: Rm 4B879 Pentagon
   Washington, DC 20330-5054

2. Version No: Version 1.9b

3. Function or subroutine affected (if applicable): Subroutine JAMMER, RCVRT (all versions).

4. Problem Description: The jammer signals are not being attenuated by the one-way signal loss. The receiver is also not seeing the one-way jammer multipath signal returns. An additional problem is that SIGENV needs to accumulate the different signals that occur at the same time.

5. Suggested Solution

   a. Call the appropriate multipath and signal propagation loss subroutines to determine the correct jammer technique signal propagation losses and delays immediately after calling each jamming technique.

   b. Add necessary code to accumulate multiple signal returns that simultaneously occur (new subroutine called from receiver?).

6. Comments: Probably have to modify the existing routines by adding a flag indicating if one-way or two-way losses/multipath signal values. Note that the jamming multipath time-of-arrival (TOA) is dependent on the type of jamming. Those jamming techniques (noise, inverse gain, reflector, cover pulse jamming, etc.) that do not act upon the weapon system receiver's range circuitry probably will have the same TOA as the target signal return. Pulse jamming techniques that act upon the range circuitry will have a different TOA than the target signal return.

<u>*RADGUNS* PROBLEM/SUGGESTION REPORT</u>

9 August 1994

1. Reported by: MAJ Steve Satchwell
   Organization: AF/XOFE
   Address: Rm 4B879 Pentagon
   Washington, DC 20330-5054

2. Version No: Version 1.9b

3. Function or subroutine affected (if applicable): Subroutine JAMMER, all technique subroutines, JXRTN (new subroutine).

4. Problem Description: The current jammer technique subroutines do not correctly distribute and limit total available jammer power among all active jamming techniques. What power distribution is done is user-hostile and confusing. The probably result is excessive and unrealistic jamming could be presented to the threat weapon system receiver.

5. Suggested Solution: Delete all power output calculations from each existing jamming technique subroutine. Instead, return that technique's signal level (prior to applying jammer transmit power and transmit antenna gain). Add a new subroutine that distributes and limits the total available jammer power among those active jamming techniques it is radiating at each time interval.

See Attached Pseudo-code for a High-level Outline of the New Subroutine

6. Comments: This is one of those items that cropped up when the code was expanded to allow simultaneous jamming. SIGENV can be used as a way of passing the jammer signal levels to the new subroutine, thus avoiding the need for an additional variable array.

JAMMER POWER DISTRIBUTION ROUTINE PSEUDO-CODE

Purpose: Distribute and apply jammer transmitter power and jammer transmit antenna gain to each individual jammer technique. Jammer transmitter power is assumed to be divided equally among all active jammer techniques. Jammer effective radiated power (as seen at the threat radar receiver) is attenuated to account for one-way signal loss.

Given:

```
    Jammer_Xmit_Ant_Gain (aka JTXAGN) for each jammer type
    Jammer_Power (aka JXPWR) for each jammer type
    Num_Techniques
    SIGENV array
    Jammer_Loc (jammer location array, aka JXLOC)
    Cover_Pulse_Flag
    Hook_Pulse_Flag
    Num_Hooks
    Signal_Loss    [one-way radar signal propagation loss calculation
    function/subroutine]
```

Assumptions:

1. This routine is called once for each jammer type (SPJ, SOJ, EXP, TOW) per time step
2. Multipath is handled from within Signal_Loss
3. Num_Techniques is number of techniques being transmitted by this jammer
4. Temp_Pwr is a local temporary variable

```
Determine the amount of power available for each jammer technique
    Ind_Jx_Pwr = Jammer_Power/Num_Techniques

Apply portion of power to each active technique
    For I = 1, Num_Jammers
        Temp_Pwr = SIGENV(I,1) * Ind_Jx_Pwr * Jammer_Xmit_Ant_Gain
Decrease to represent one-way signal propagation loss
    Call Signal_Loss(Temp_Pwr, Jammer_Location, Prop_Loss)
Determine final jammer signal as seen at receiver
        SIGENV(I,1) = Temp_Pwr * (1 – Prop_Loss)
        If JAMTYP(I) == RGW
Check for and adjust returns RGWO cover pulse & hook pulse options are specified
            If Cover_Pulse_Flag == TRUE
                Temp_Pwr = SIGENV(I * 10, 1) * Ind_Jx_Pwr *
                Jammer_Xmit_Ant_Gain
Decrease to represent one-way signal propagation loss
                Call Signal_Loss(Temp_Pwr, Jammer_Location, Prop_Loss)
Determine final jammer signal as seen at receiver
                SIGENV(I * 10, 1) = Temp_Pwr * (1 – Prop_Loss)
            EndIf Cover_Pulse_Flag
            If Hook_Flag == TRUE
                For J = 1, Num_Hooks
                    Temp_Pwr = SIGENV(I * 10 + J, 1) * Ind_Jx_Pwr *
                    Jammer_Xmit_Ant_Gain
```

```
Decrease to represent one-way signal propagation loss
                    Call Signal_Loss(Temp_Pwr, Jammer_Location, Prop_Loss)
Determine final jammer signal as seen at receiver
                    SIGENV(I * 10 + J, 1) = Temp_Pwr * (1 – Prop_Loss)
                Next J
            EndIf Hook_Flag
        EndIf JAMTYP
    Next I
    [End of Routine]
```

RADGUNS PROBLEM/SUGGESTION REPORT

9 August 1994

1. Reported by: MAJ Steve Satchwell
Organization: AF/XOFE
Address: Rm 4B879 Pentagon
Washington, DC 20330-5054

2. Version No: Version 1.9β

3. Function or subroutine affected (if applicable): Subroutine INPUT, JAMMER, Individual technique subroutines.

4. Problem Description: Subroutine INPUT requires jammer constant data to be entered in for every technique. This is user-unfriendly, increases the likelihood of operator error, and fails to properly (and dynamically) distribute jammer power to all active jamming techniques.

5. Suggested Solution: This problem requires a two-step solution. First, change subroutine INPUT to make jammer power, receive antenna gain, and transmit antenna gain a common input prior to individual technique parameter inputs. Second, delete all application of JTXAGN & JXPWR (or equivalent term) from all individual technique calculations. Write a new subroutine which divides the total jammer power up among all (active) jammer techniques. This power level is then applied along with the jammer transmit antenna gain and the result set in SIGENV(x,1).

See Attached Sheets for Typical POD Data Fields by Technique

6. Comments: SIGENV(x,1) can be used for temporary storage to pass the jammer signal to the new subroutine. Also, jammer pulse width entries seem to never be set, or am I missing something?

```
Pod 1
SRM  [Can have multiples]
AM   Duty Cycle (%):
Wobb (Hz):[min – max]
WobbPeriod (sec):
BN
BW (MHz):
# Boards:  (Not applicable to RADGUNS)
FSO (Y/N):
Type Noise:

RGPO
Walk Period (sec):
Hold Period (sec):
Type Pull:
Hooks (Y/N):
Hook AMDuty Cycle (%):
Wobb (Hz):[min – max]
Wobb Period (sec):
AM:  Duty Cycle (%):
Wobb (Hz):
Wobb Period (sec):
Backfill (Y/N):
(aka cover pulse)

Pod 2
FSO
Duty Cycle (%):
Modulation Type:
Modulation Freq (Hz):
Mod Freq Deviation (±%):
Wobb Rate (sec):
Open Loop Bandwidth (MHz):
Closed Loop Bandwidth (MHz):
[Closed loop tuning time (seconds)]:
fixed time constant

Pod 3
BAR
Freq Lower Limit (MHz):
Noise Width (MHz):

FSM
Initial Repeater Offset (MHz):
Sign of Offset (+, –, Neither, Both):
SRW Modulation Desired (Y/N):
If NO
     Offset Deviation (MHz):
     FM Sweep Rate (MHz):
     FM Sweep Rate Excursion (Hz):
     FM Sweep Waveform:
     Wobbulation Waveform
     Wobbulation Period (seconds):
ELSE
     [same entries as SRW]
ENDIF
```

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NIP
```
Number of pulses:
For 1 to number of pulses
     Time Delay from Start (nanoseconds);
     Pulse Width (nanoseconds):
Center Frequency (GHz):
SRW Modulation Desired?  (Y/N):
IF YES
     [same entries as SRW]
ENDIF
```

RGPO
```
Walk-off Acceleration Rate (g):
Hold Time (seconds):
```
suggest not implementing
```
Boost Start (specified as % of walk time):
Boost Stop (specified as % of walk time):
```
```
Center Frequency (GHz):
Hook Movement?  (Y/N):
SRW Modulation?  (Y/N):
IF YES
     [same entries as SRW]
ENDIF
Backfill?  (Enable/Disable):
```
suggest not implementing now
```
DRR Freq OFF Duration (milliseconds):
DRR Freq ON+OFF Duration (milliseconds):
DRR' Freq OFF Duration (milliseconds):
DRR' Freq ON+OFF Duration (milliseconds):
Number of AID Regions:
For 1 to NumAID
     Start %:
     Stop %:
DRR' End Region (specified as % of cycle time):
```

SRW
```
Number Sweep Levels (different modulation frequencies):
Modulation Frequency (Hz):
Excursion (Hz):
Wobb Waveform:
Wobb Period (seconds):
```

SSW
```
Modulation Frequency (Hz):
Excursion (Hz):
Wobb Waveform:
Wobb Period (seconds):
```


DRAFT

RADGUNS PROBLEM/SUGGESTION REPORT

27 July 1994

1. Reported by: MAJ Steve Satchwell
   Organization: AF/XOFE
   Address: 1480 Air Force Pentagon
   Washington, DC 20330-1480

2. Version No: Version 1.9β

3. Function or subroutine affected (if applicable): Subroutine SWEPTA.

4. Problem Description: DELTON calculation appears incorrectly implemented. The conversion from frequency to wavelength (expressed in meters) is missin π. The correct formula is:

$$t = \frac{1}{2\pi f}$$

5. Suggested Solution: Two lines of code need changing.

Change line RGE18130 from:
```
DELTON(II) = 1.0/(2.0 * SWEEPF(II,1)
```
to:
```
DELTON(II) = 1.0/(2.0 * PI * SWEEPF(II,1)
```

Change line RGE18270 from:
```
DELTON(II) = 1.0/(2.0 * (SWEEPF(II,1) + T–TLAST(II) * SLOPE(II))
```
to:
```
DELTON(II) = 1.0/(2.0 * PI * (SWEEPF(II,1) + T–TLAST(II) * SLOPE(II))
```

6. Comments: The existing line RGE18270 should undergo a units of measure check and arithmetic operator precedence check. The suggested fix for RGE18270 includes additional sets of parentheses to explicitly ensure that it is analytically correct. The constant PI is already a declared common variable despite not being used in the existing subroutine.

```
FIXES TO RADGUNS FILES - Version 2.0, Released February 1996.
    Note that this listing is cumulative & in chronological order.

=================================================================
==FIX #1   3/01/96 ==============================================
File:  RGIO.FORTRAN, Subroutine VAREAD
Add the 4 lines marked”(add)” below.
Some preceding lines are included to aid in locating the appropriate
location.

....
....
  202 CONTINUE
      VASUM(1,2) = VASUM(1,2) * PROP2 + VASUM2(1,2) * PROP1
      VASUM(1,3) = VASUM(1,3) * PROP2 + VASUM2(1,3) * PROP1
      VASUM(1,4) = VASUM(1,4) * PROP2 + VASUM2(1,4) * PROP1
      VASUM(1,5) = VASUM(1,5) * PROP2 + VASUM2(1,5) * PROP1
(add) VASUM(2,2) = VASUM(2,2) * PROP2 + VASUM2(2,2) * PROP1
(add) VASUM(2,3) = VASUM(2,3) * PROP2 + VASUM2(2,3) * PROP1
(add) VASUM(2,4) = VASUM(2,4) * PROP2 + VASUM2(2,4) * PROP1
(add) VASUM(2,5) = VASUM(2,5) * PROP2 + VASUM2(2,5) * PROP1

=================================================================
==FIX #2   3/07/96 ==============================================
File:  RGINP20.FORTRAN, Subroutine INP01
Remove all references to SCANT in the subroutine.
A preceding line is included to aid in locating the appropriate location.

....
....
         READ (4,*) PTIME
change:  PTIME(1) = PTIME(1) - SCANT
to:      PTIME(1) = PTIME(1)
change:  PTIME(3) = PTIME(3) - SCANT
to:      PTIME(3) = PTIME(3)

=================================================================
==FIX #3   3/07/96 ==============================================
File:  RGINP20.FORTRAN, Subroutine MOVTAR
Change VX to TARGET(1,2) as shown below (don’t go beyond column 72).  Some
preceding and following lines are included to aid in locating the
appropriate location.

....
....

    ELSE IF (MOVTYP .EQ. ‘SINUSO’) THEN
         TARGET(2,2) = -TARGET(1,2) * DYDX
         TARGET(3,2) = -TARGET(1,2) * DZDX
C
C
change:  TARGET(1,3) = VX * SP*(AMY**2 + AMZ**2)*
         &  (TWOPI/WAVLNG)**3 *
to:         TARGET(1,3) = TARGET(1,2) * SP*(AMY**2 + AMZ**2)
         &        * (TWOPI/WAVLNG)**3 *
         &        COS(TWOPI * XINC/WAVLNG) *
         &        SIN(TWOPI * XINC/WAVLNG) / (1.0 +
         &        (AMY**2 + AMZ**2) * (TWOPI/
         &        WAVLNG)**2 * COS(TWOPI *
```

```
        &       XINC/WAVLNG)**2)**1.5
           D2YDX = -AMY * (TWOPI/WAVLNG)**2 * SIN(TWOPI *
        &       XINC/WAVLNG)

==============================================================
==FIX #4   3/07/96 ===========================================
File:  RGUTIL.FORTRAN, Program AAASIM
Put variable ENDTYP in COMMON (i.e., COMMON /ENDTYP/ ENDTYP)
Delete 1 line (marked "(del)") and add the 4 lines marked "(add)" below.
Some preceding and following lines are included to aid in locating the
appropriate location.

....
....
         DO 110 I = 1, 999
            TESTT = I
            TESTRG = HYPOT(TARGET(1,1),TARGET(2,1),
        &           TARGET(3,1))
(del)       IF (TESTRG .LE. RGMAX) INRG = .TRUE.
(add)       IF (TESTRG .LE. RGMAX) THEN
(add)                INRG = .TRUE.
(add)                GOTO 200
(add)       ENDIF
  110    CONTINUE

==============================================================
==FIX #5   3/07/96 ===========================================
File:  RGGUN.FORTRAN, Subroutine SHOOT1
Call FDRGEN with T+TIMEA instead of T+TP (as shown below).  Some preceding
and following lines are included to aid in locating the appropriate
location.

....
....

            IF (IVUON .AND. ((SBURST .OR. EBURST) .OR.
        &          (MOD(TOTFIR,RNDINC) .EQ. 0))) THEN
change:        CALL FDRGEN(21,MESSAG(1),T+TP,TARG1,TOTFIR)
to:            CALL FDRGEN(21,MESSAG(1),T+TIMEA,TARG1,TOTFIR)
change:        CALL FDRGEN(6,MESSAG(2),T+TP,SHELL,TOTFIR)
to:            CALL FDRGEN(6,MESSAG(2),T+TIMEA,SHELL,TOTFIR)
            ENDIF

==============================================================
==FIX #6   3/13/96 ===========================================
File:  RAD2.FORTRAN, Subroutine PLOT

change:        RMIN = 1.0E70
to:            RMIN = 1.0E35
```

Note: Mike Bennett reported a problem in running 2S6 A10A EX2 on a Sparc 10. It reports a NAN error, indicating something probably wasn't initialized. I haven't been able to replicate the error (even on a Sparc 10).