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Report No. SA-TR20-2818

FORTRAN PROGRAM FOR CALCULATING PROBABILITY OF A HIT ON A SQUARE TARGET

Technical Report

Hazel E. Luney

Date 15 September 1966

SPRINGFIELD ARMORY
SPRINGFIELD, MASSACHUSETTS

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FORTRAN PROGRAM FOR CALCULATING PROBABILITY OF A HIT ON A SQUARE TARGET

Technical Report

Hazel E. Lundy

DA PROJECT TITLE: Investigation of Gun Type Aerial Weapons

DA PROJECT: 1X120301D02503

ABSTRACT

Probability of a hit by a single shot or by a ten-shot burst at direct or angular approach to a square target is calculated. Parameters include dispersion in mils, distance from the target in meters, and size of the target in feet. A normal distribution is assumed. Solution by linear interpolation of normal curve areas from standard tables was accurate to 0.0002 when contrasted with integration of the normal curve by Simpson's 1/3 Rule in sample problems.

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FORTRAN PROGRAM FOR CALCULATING PROBABILITY OF A HIT ON A SQUARE TARGET

1. PURPOSE

To record three variations of a computer program in FORTRAN which have been used for calculating the probability of a hit on a square upright target based on assumption of a normal distribution in both the horizontal and vertical directions.

2. DISCUSSION

a. Calculations described below may be performed by use of these FORTRAN programs:

(1) P_{HIT} on a square target - detailed calculations for single-shot hit probability based on normal curve areas (Program R453R).

(2) P_{HIT} on a square target - single shot and ten-shot bursts at direct approach and at any two angular approaches with provision for regular incrementation of radial standard deviation in mils, distance from the target in meters, and size of the target in feet.

(a) Calculated by linear interpolation of normal curve areas from standard tables (Program R454R).

(b) Calculated by integration of the normal curve by Simpson's 1/3 Rule (Program R455R).

b. Sample calculations in this report show the same problem solved in the following ways:

(1) By use of Program R455R with 101 incremental areas,

(2) By use of Program R455R with 11 incremental areas,

(3) By use of Program R454R.

c. Values of P_{HIT} for the sample problem, rounded to four decimal places, varied at most by .0002 whether calculated by Program R455R with 101 or with 11 incremental areas of integration or by the linear interpolation method of Program R454R. However, calculation by (1) involving the 101 incremental areas required approximately 3-1/2 times longer than calculations by (2) and (3). This calculation required 7 minutes on the Springfield Armory 8K computer as compared with 2 minutes each for (2) and (3).

3. PROGRAM R453R

a. DESCRIPTION

This program gives detailed calculations for probability of a hit by a single shot based on conversion of a projected radial standard deviation in mils to linear standard deviation in feet and linear interpolation of 400 stored values of area of the normal curve. Range (distance from the target) is given in meters. Load limits equal 2074(DECIMAL) words.

b. OUTPUT AND SAMPLE CALCULATIONS

(1) Values of the normal curve as read in from cards are printed as the first page of output.

(2) Second and subsequent pages include columns described below. The sample calculations for one line of output are based on a 6.5-mil radial standard deviation delivered at 1500 meters to a 50-foot square target.

Column 1. Radial Standard Deviation

$$RSD = \sqrt{\sigma_x^2 + \sigma_y^2} = 6.5, \text{ where } \sigma_x = \sigma_y$$

Column 2. Linear Standard Deviation

Conversion Factor for RSD in mils to LSD in feet

$$\frac{1.5 \times 3.280833}{1.414214} = 3.47984$$

$$LSD = 6.5 \times 3.47984 = 22.6190 \text{ feet}$$

Column 3. Z

$$Z = \frac{X}{\sigma} = \frac{25}{22.61896} = 1.1053$$

3. PROGRAM R453R - Continued

b. OUTPUT AND SAMPLE CALCULATIONS

Column 4. Difference

Difference between values of normal curve area adjacent to 1.1053

Z	Normal Curve Area
1.11	.3665
1.10	.3643
Difference	.0022

Column 5. Interpolation

$.0022 \times (1.1053 - 1.10) \times 100 = .0012$

Column 6. Area of Normal Curve

The low adjacent value of Z = .3643

Column 7. PHX on Half of Target

Probability of a hit on half of the target in the X direction equals .3643 plus .0012 = .3655

Column 8. PHX on Full Target

$2 \times .3655 = .7310$

Column 9. P_{HIT} on Full Target, X and Y Directions

$.7310 \times .7310 = .5342$

Column 10. Percentage

$100 \times .5342 = 53.42$ Per Cent

3. PROGRAM R453R - Continued

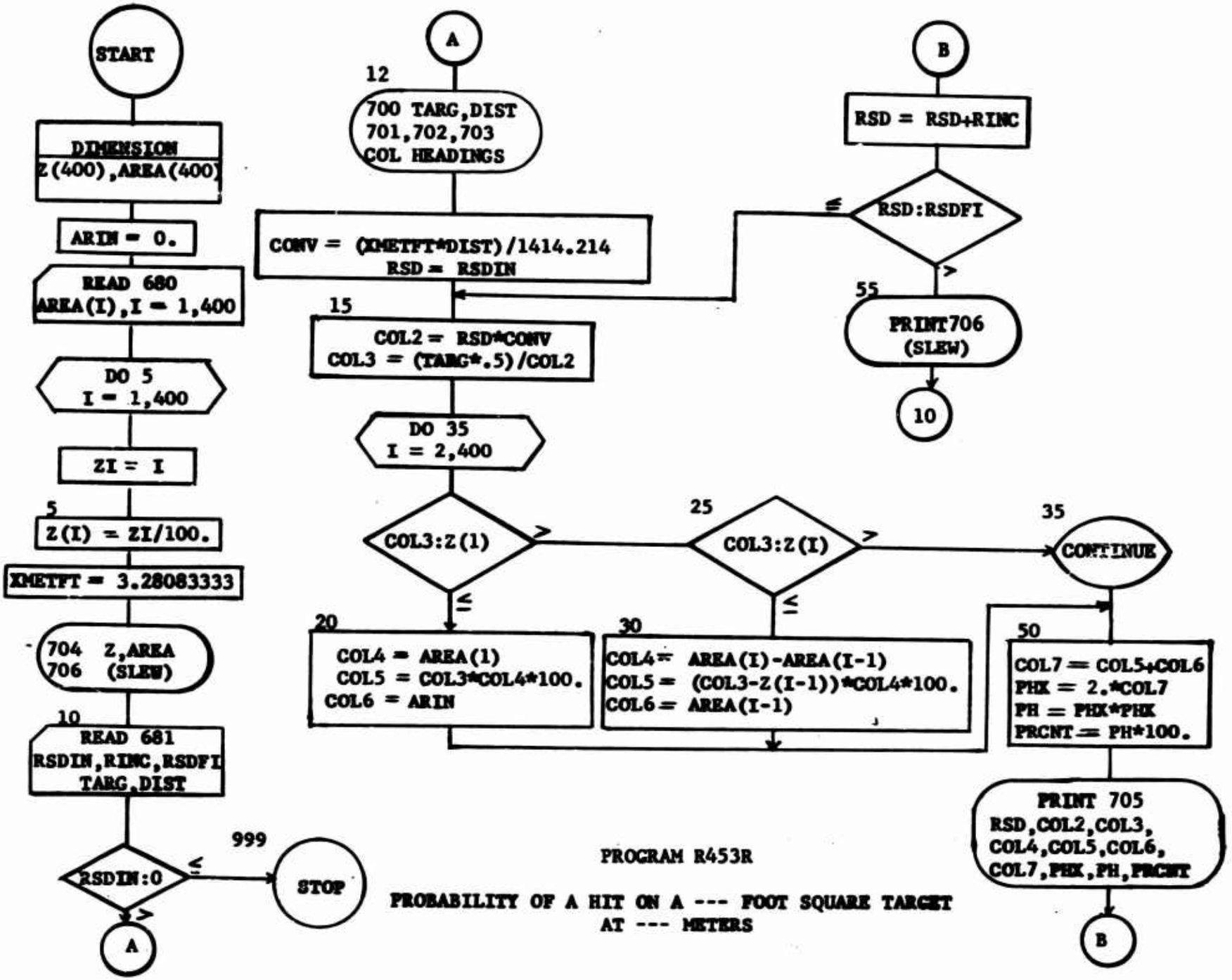
c. INPUT

(1) Set of 50 cards with values of the normal curve area from standard tables, 8 values per card, total of 400 values.

	Column		Column	
First Card.	1-4	0040	41-44	0199
	11-14	0080	51-54	0239
	21-24	0120	61-64	0279
	31-34	0160	71-74	0319
Fiftieth Card.	1-4	5000	41-44	5000
	11-14	5000	51-54	5000
	21-24	5000	61-64	5000
	31-34	5000	71-74	5000

(2) Followed by Data Cards

Column	Variable Name	Description
1-10	RSDIN	Initial radial std. dev. - mils
11-20	RINC	Increments of RSD
21-30	RSDFI	Final RSD - mils
31-40	TARG	Length and width of target - feet
41-50	DIST	Range - meters



PROGRAM R453R

PROBABILITY OF A HIT ON A --- FOOT SQUARE TARGET AT --- METERS

```
C     PROBABILITY OF A HIT ON A --- FOOT SQUARE TARGET AT ---- METERS
C     PROGRAM NO. R453R   CHARGE TO R701R          BY H. LUNDY
      DIMENSION Z(400), AREA(400)
      ARIN = 0.
      READ 680,(AREA(I),I = 1,400)
      DO 5 I = 1,400
      ZI = I
    5 Z(I) = ZI/100.
      XMETFT = 3.28083333
      PRINT 704,(Z(I),AREA(I),I = 1,400)
      PRINT 706
   10 READ 681, RSDIN,RINC,RSDFI,TARG,DIST
      IF(RSDIN) 999,999,12
   12 PRINT 700,TARG,DIST
      PRINT 701
      PRINT 702
      PRINT 703
      CONV = (XMETFT * DIST) / 1414.214
      RSD = RSDIN
   15 COL2 = RSD * CONV
      COL3 = (TARG * .5) / COL2
      DO 35 I = 2,400
      IF(COL3-Z(1)) 20,20,25
   20 COL4 = AREA(1)
      COL5 = COL3 * COL4 * 100.
      COL6 = ARIN
      GO TO 50
   25 IF(COL3 - Z(I)) 30,30,35
   30 COL4 = AREA(I) - AREA(I-1)
      COL5 = (COL3 - Z(I-1))* COL4 * 100.
      COL6 = AREA(I-1)
      GO TO 50
   35 CONTINUE
   50 COL7 = COL5 + COL6
      PHX = 2.*COL7
      PH = PHX * PHX
      PRCNT = PH * 100.
```

```
      PRINT 705, RSD,COL2,COL3,COL4,COL5,COL6,COL7,PHX,PH,PRCNT
      RSD = RSD + RINC
      IF(RSD - RSDF) 15,15,55
   55 PRINT 706
      GO TO 10
  999 STOP
  680 FORMAT (8(F4.4,6X))
  681 FORMAT (5F10.0)
  700 FORMAT ( 8X,25HPROBABILITY OF A HIT ON A, F6.2,23H  FOOT SQUARE TA
     1RGET AT,F6.0,8H  METERS//)
  701 FORMAT (74H RADIAL    LINEAR                        INTER-  AREA OF
     1PHX      PHX       PH)
  702 FORMAT (82H STD DEV   STD DEV                        POLA-  NORMAL  ON
     1 HALF  FULL   FULL TGT  PER)
  703 FORMAT (83H  -MILS     -FEET       Z     DIFF    TION    CURVE  OF
     1 TGT  TARGET  X AND Y   CENT/)
  704 FORMAT(10(F5.2,F7.4))
  705 FORMAT (F7.1,F12.4,7F8.4,F9.2)
  706 FORMAT (1H1)
      END
```

0.01	0.0040	0.02	0.0080	0.03	0.0120	0.04	0.0160	0.05	0.0199	0.06	0.0239	0.07	0.0279	0.08	0.0319	0.09	0.0359	0.10	0.0398
0.11	0.0438	0.12	0.0478	0.13	0.0517	0.14	0.0557	0.15	0.0596	0.16	0.0636	0.17	0.0675	0.18	0.0714	0.19	0.0753	0.20	0.0793
0.21	0.0832	0.22	0.0871	0.23	0.0910	0.24	0.0948	0.25	0.0987	0.26	0.1026	0.27	0.1064	0.28	0.1103	0.29	0.1141	0.30	0.1179
0.31	0.1217	0.32	0.1255	0.33	0.1293	0.34	0.1331	0.35	0.1368	0.36	0.1406	0.37	0.1443	0.38	0.1480	0.39	0.1517	0.40	0.1554
0.41	0.1591	0.42	0.1628	0.43	0.1664	0.44	0.1700	0.45	0.1736	0.46	0.1772	0.47	0.1808	0.48	0.1844	0.49	0.1879	0.50	0.1915
0.51	0.1950	0.52	0.1985	0.53	0.2019	0.54	0.2054	0.55	0.2088	0.56	0.2123	0.57	0.2157	0.58	0.2190	0.59	0.2224	0.60	0.2257
0.61	0.2291	0.62	0.2324	0.63	0.2357	0.64	0.2389	0.65	0.2422	0.66	0.2454	0.67	0.2486	0.68	0.2517	0.69	0.2549	0.70	0.2580
0.71	0.2611	0.72	0.2642	0.73	0.2673	0.74	0.2704	0.75	0.2734	0.76	0.2764	0.77	0.2794	0.78	0.2823	0.79	0.2852	0.80	0.2881
0.81	0.2910	0.82	0.2939	0.83	0.2967	0.84	0.2995	0.85	0.3023	0.86	0.3051	0.87	0.3078	0.88	0.3106	0.89	0.3133	0.90	0.3159
0.91	0.3186	0.92	0.3212	0.93	0.3238	0.94	0.3264	0.95	0.3289	0.96	0.3315	0.97	0.3340	0.98	0.3365	0.99	0.3389	1.00	0.3413
1.01	0.3438	1.02	0.3461	1.03	0.3485	1.04	0.3508	1.05	0.3531	1.06	0.3554	1.07	0.3577	1.08	0.3599	1.09	0.3621	1.10	0.3643
1.11	0.3665	1.12	0.3686	1.13	0.3708	1.14	0.3729	1.15	0.3749	1.16	0.3770	1.17	0.3790	1.18	0.3810	1.19	0.3830	1.20	0.3849
1.21	0.3869	1.22	0.3888	1.23	0.3907	1.24	0.3925	1.25	0.3944	1.26	0.3962	1.27	0.3980	1.28	0.3997	1.29	0.4015	1.30	0.4032
1.31	0.4049	1.32	0.4066	1.33	0.4082	1.34	0.4099	1.35	0.4115	1.36	0.4131	1.37	0.4147	1.38	0.4162	1.39	0.4177	1.40	0.4192
1.41	0.4207	1.42	0.4222	1.43	0.4236	1.44	0.4251	1.45	0.4265	1.46	0.4279	1.47	0.4292	1.48	0.4306	1.49	0.4319	1.50	0.4332
1.51	0.4345	1.52	0.4357	1.53	0.4370	1.54	0.4382	1.55	0.4394	1.56	0.4406	1.57	0.4418	1.58	0.4429	1.59	0.4441	1.60	0.4452
1.61	0.4463	1.62	0.4474	1.63	0.4484	1.64	0.4495	1.65	0.4505	1.66	0.4515	1.67	0.4525	1.68	0.4535	1.69	0.4545	1.70	0.4554
1.71	0.4564	1.72	0.4573	1.73	0.4582	1.74	0.4591	1.75	0.4599	1.76	0.4608	1.77	0.4616	1.78	0.4625	1.79	0.4633	1.80	0.4641
1.81	0.4649	1.82	0.4656	1.83	0.4664	1.84	0.4671	1.85	0.4678	1.86	0.4686	1.87	0.4693	1.88	0.4699	1.89	0.4706	1.90	0.4713
1.91	0.4719	1.92	0.4726	1.93	0.4732	1.94	0.4738	1.95	0.4744	1.96	0.4750	1.97	0.4756	1.98	0.4761	1.99	0.4767	2.00	0.4772
2.01	0.4778	2.02	0.4783	2.03	0.4788	2.04	0.4793	2.05	0.4798	2.06	0.4803	2.07	0.4808	2.08	0.4812	2.09	0.4817	2.10	0.4821
2.11	0.4826	2.12	0.4830	2.13	0.4834	2.14	0.4838	2.15	0.4842	2.16	0.4846	2.17	0.4850	2.18	0.4854	2.19	0.4857	2.20	0.4861
2.21	0.4864	2.22	0.4868	2.23	0.4871	2.24	0.4875	2.25	0.4878	2.26	0.4881	2.27	0.4884	2.28	0.4887	2.29	0.4890	2.30	0.4893
2.31	0.4896	2.32	0.4898	2.33	0.4901	2.34	0.4904	2.35	0.4906	2.36	0.4909	2.37	0.4911	2.38	0.4913	2.39	0.4916	2.40	0.4918
2.41	0.4920	2.42	0.4922	2.43	0.4925	2.44	0.4927	2.45	0.4929	2.46	0.4931	2.47	0.4932	2.48	0.4934	2.49	0.4936	2.50	0.4938
2.51	0.4940	2.52	0.4941	2.53	0.4943	2.54	0.4945	2.55	0.4946	2.56	0.4948	2.57	0.4949	2.58	0.4951	2.59	0.4952	2.60	0.4953
2.61	0.4955	2.62	0.4956	2.63	0.4957	2.64	0.4959	2.65	0.4960	2.66	0.4961	2.67	0.4962	2.68	0.4963	2.69	0.4964	2.70	0.4965
2.71	0.4966	2.72	0.4967	2.73	0.4968	2.74	0.4969	2.75	0.4970	2.76	0.4971	2.77	0.4972	2.78	0.4973	2.79	0.4974	2.80	0.4974
2.81	0.4975	2.82	0.4976	2.83	0.4977	2.84	0.4977	2.85	0.4978	2.86	0.4979	2.87	0.4979	2.88	0.4980	2.89	0.4981	2.90	0.4981
2.91	0.4982	2.92	0.4982	2.93	0.4983	2.94	0.4984	2.95	0.4984	2.96	0.4985	2.97	0.4985	2.98	0.4986	2.99	0.4986	3.00	0.4987
3.01	0.4987	3.02	0.4987	3.03	0.4988	3.04	0.4988	3.05	0.4989	3.06	0.4989	3.07	0.4989	3.08	0.4990	3.09	0.4990	3.10	0.4990
3.11	0.4991	3.12	0.4991	3.13	0.4991	3.14	0.4992	3.15	0.4992	3.16	0.4992	3.17	0.4992	3.18	0.4993	3.19	0.4993	3.20	0.4993
3.21	0.4993	3.22	0.4994	3.23	0.4994	3.24	0.4994	3.25	0.4994	3.26	0.4994	3.27	0.4995	3.28	0.4995	3.29	0.4995	3.30	0.4995
3.31	0.4995	3.32	0.4995	3.33	0.4996	3.34	0.4996	3.35	0.4996	3.36	0.4996	3.37	0.4996	3.38	0.4996	3.39	0.4997	3.40	0.4997
3.41	0.4997	3.42	0.4997	3.43	0.4997	3.44	0.4997	3.45	0.4997	3.46	0.4997	3.47	0.4997	3.48	0.4997	3.49	0.4998	3.50	0.4998
3.51	0.4998	3.52	0.4998	3.53	0.4998	3.54	0.4998	3.55	0.4998	3.56	0.4998	3.57	0.4998	3.58	0.4998	3.59	0.4998	3.60	0.4998
3.61	0.4998	3.62	0.4999	3.63	0.4999	3.64	0.4999	3.65	0.4999	3.66	0.4999	3.67	0.4999	3.68	0.4999	3.69	0.4999	3.70	0.4999
3.71	0.4999	3.72	0.4999	3.73	0.4999	3.74	0.4999	3.75	0.4999	3.76	0.4999	3.77	0.4999	3.78	0.4999	3.79	0.4999	3.80	0.4999
3.81	0.4999	3.82	0.4999	3.83	0.4999	3.84	0.4999	3.85	0.4999	3.86	0.4999	3.87	0.4999	3.88	0.4999	3.89	0.4999	3.90	0.5000
3.91	0.5000	3.92	0.5000	3.93	0.5000	3.94	0.5000	3.95	0.5000	3.96	0.5000	3.97	0.5000	3.98	0.5000	3.99	0.5000	4.00	0.5000

PROBABILITY OF A HIT ON A 50.00 FOOT SQUARE TARGET AT 1500. METERS

RADIAL STD DEV -MILS	LINEAR STD DEV -FEET	Z	DIFF	INTER-POLATION	AREA OF NORMAL CURVE	PHX ON HALF OF TGT	PHX FULL TARGET	PH FULL TGT X AND Y	PER CENT
6.5	22.6190	1.1053	0.0022	0.0012	0.3643	0.3655	0.7309	0.5342	53.42
7.0	24.3589	1.0263	0.0024	0.0015	0.3461	0.3476	0.6952	0.4833	48.33
7.5	26.0989	0.9579	0.0026	0.0021	0.3289	0.3310	0.6619	0.4381	43.81
8.0	27.8388	0.8980	0.0026	0.0021	0.3133	0.3154	0.6308	0.3979	39.79
8.5	29.5787	0.8452	0.0028	0.0015	0.2995	0.3010	0.6019	0.3623	36.23
9.0	31.3186	0.7982	0.0029	0.0024	0.2852	0.2876	0.5752	0.3308	33.08
9.5	33.0586	0.7562	0.0030	0.0019	0.2734	0.2753	0.5505	0.3031	30.31
10.0	34.7985	0.7184	0.0031	0.0026	0.2611	0.2637	0.5274	0.2782	27.82
10.5	36.5384	0.6842	0.0032	0.0013	0.2517	0.2530	0.5061	0.2561	25.61
11.0	38.2783	0.6531	0.0032	0.0010	0.2422	0.2432	0.4864	0.2366	23.66
11.5	40.0183	0.6247	0.0033	0.0016	0.2324	0.2340	0.4679	0.2189	21.89
12.0	41.7582	0.5987	0.0033	0.0029	0.2224	0.2253	0.4505	0.2030	20.30
12.5	43.4981	0.5747	0.0033	0.0016	0.2157	0.2173	0.4345	0.1888	18.88
13.0	45.2380	0.5526	0.0035	0.0009	0.2088	0.2097	0.4194	0.1759	17.59
13.5	46.9780	0.5322	0.0035	0.0008	0.2019	0.2027	0.4053	0.1643	16.43
14.0	48.7179	0.5132	0.0035	0.0011	0.1950	0.1961	0.3922	0.1538	15.38
14.5	50.4578	0.4955	0.0036	0.0020	0.1879	0.1899	0.3797	0.1442	14.42
15.0	52.1977	0.4789	0.0036	0.0032	0.1808	0.1840	0.3680	0.1355	13.55
15.5	53.9376	0.4635	0.0036	0.0013	0.1772	0.1785	0.3569	0.1274	12.74
16.0	55.6776	0.4490	0.0036	0.0032	0.1700	0.1732	0.3465	0.1201	12.01
16.5	57.4175	0.4354	0.0036	0.0019	0.1664	0.1683	0.3367	0.1134	11.34
17.0	59.1574	0.4226	0.0036	0.0009	0.1628	0.1637	0.3275	0.1072	10.72
17.5	60.8973	0.4105	0.0037	0.0002	0.1591	0.1593	0.3186	0.1015	10.15
18.0	62.6373	0.3991	0.0037	0.0034	0.1517	0.1551	0.3102	0.0962	9.62
18.5	64.3772	0.3883	0.0037	0.0031	0.1480	0.1511	0.3022	0.0913	9.13
19.0	66.1171	0.3781	0.0037	0.0030	0.1443	0.1473	0.2946	0.0868	8.68
19.5	67.8570	0.3684	0.0037	0.0031	0.1406	0.1437	0.2874	0.0826	8.26
20.0	69.5970	0.3592	0.0038	0.0035	0.1368	0.1403	0.2806	0.0787	7.87
20.5	71.3369	0.3504	0.0038	0.0002	0.1368	0.1370	0.2739	0.0750	7.50
21.0	73.0768	0.3421	0.0037	0.0008	0.1331	0.1339	0.2678	0.0717	7.17
21.5	74.8167	0.3341	0.0038	0.0016	0.1293	0.1309	0.2618	0.0685	6.85
22.0	76.5567	0.3266	0.0038	0.0025	0.1255	0.1280	0.2560	0.0655	6.55
22.5	78.2966	0.3193	0.0038	0.0035	0.1217	0.1252	0.2505	0.0627	6.27
23.0	80.0365	0.3124	0.0038	0.0009	0.1217	0.1226	0.2452	0.0601	6.01
23.5	81.7764	0.3057	0.0038	0.0022	0.1179	0.1201	0.2401	0.0577	5.77
24.0	83.5164	0.2993	0.0038	0.0036	0.1141	0.1177	0.2353	0.0554	5.54
24.5	85.2563	0.2932	0.0038	0.0012	0.1141	0.1153	0.2307	0.0532	5.32
25.0	86.9962	0.2874	0.0038	0.0028	0.1103	0.1131	0.2262	0.0512	5.12
25.5	88.7361	0.2817	0.0038	0.0007	0.1103	0.1110	0.2219	0.0492	4.92
26.0	90.4761	0.2763	0.0039	0.0025	0.1064	0.1089	0.2177	0.0474	4.74

4. PROGRAM R454R

a. DESCRIPTION

This program gives calculations for single-shot and ten-shot hit probabilities in a direct approach to the target. In addition, it gives single- and ten-shot hit probabilities for targets approached at two different angles from the horizontal where, for a 50-foot target at approach angle of 25 degrees,

$$x = 25$$

$$y = 25 \cos 25^{\circ}$$

Load limits equal 2586(DECIMAL) words.

b. OUTPUT

(1) First page - Values of the normal curve as read in from 80-column cards.

(2) Second and subsequent pages -

Column		
1	Radial Standard Deviation - mils	
2	Range - meters	
3	Target Size - feet	
4	Hit Probability, Single Shot -	0 Degree Approach
5	Hit Probability, Single Shot -	-- Degree Approach
6	Hit Probability, Single Shot -	-- Degree Approach
7	Hit Probability, Ten Shots -	0 Degree Approach
8	Hit Probability, Ten Shots -	-- Degree Approach
9	Hit Probability, Ten Shots -	-- Degree Approach

c. INPUT

(1) Set of 50 cards with values of the normal curve area as described under Program R453R.

(2) Followed by Data Cards.

Column	Variable Name	Description
1-5	RSDIN	Initial radial standard deviation - mils
6-10	RINC	Increments of RSD
11-15	RSDFI	Final RSD
16-20	DSTIN	Initial distance from target - meters
21-25	DINC	Increments of distance

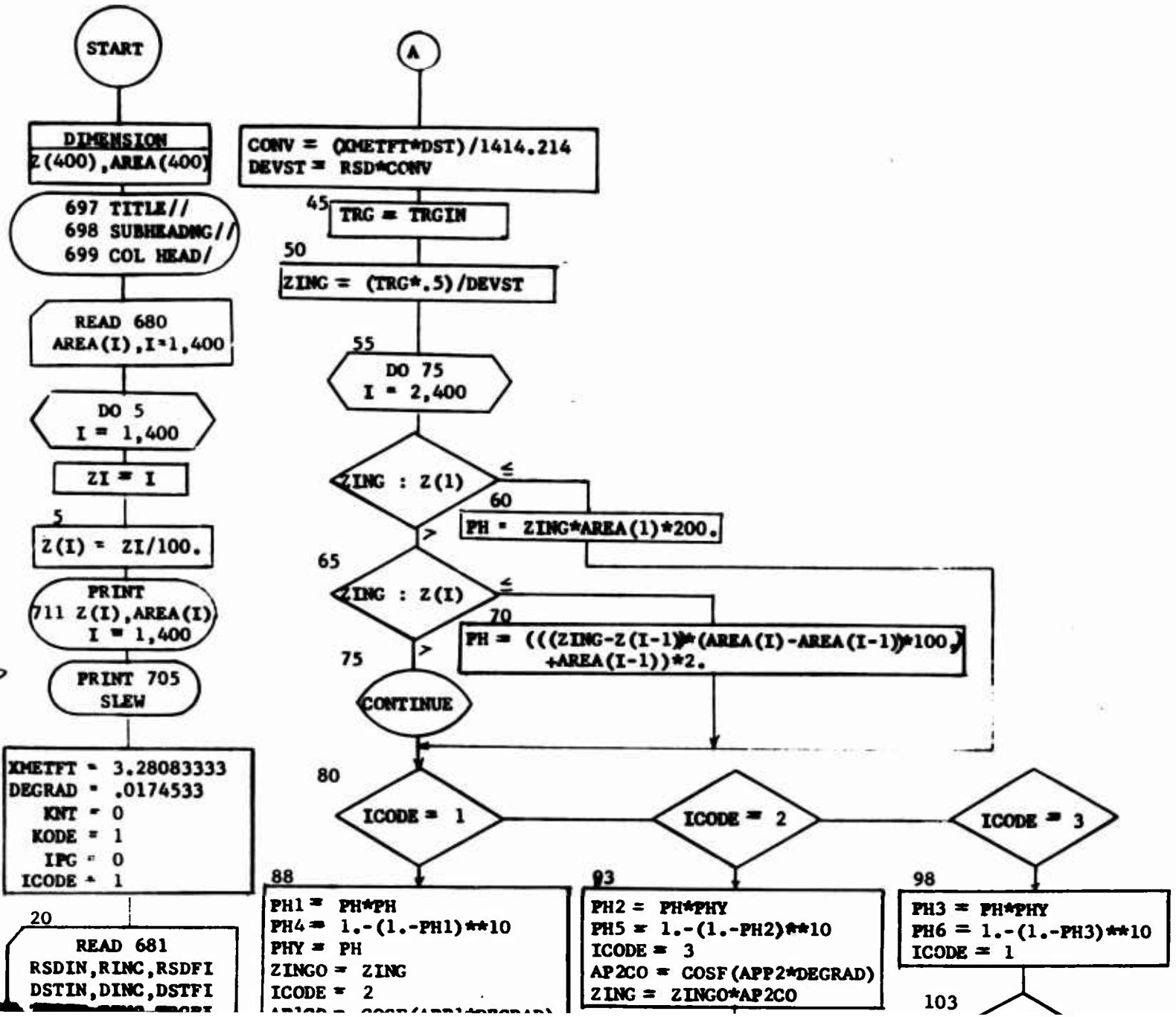
4. PROGRAM R454R - Continued

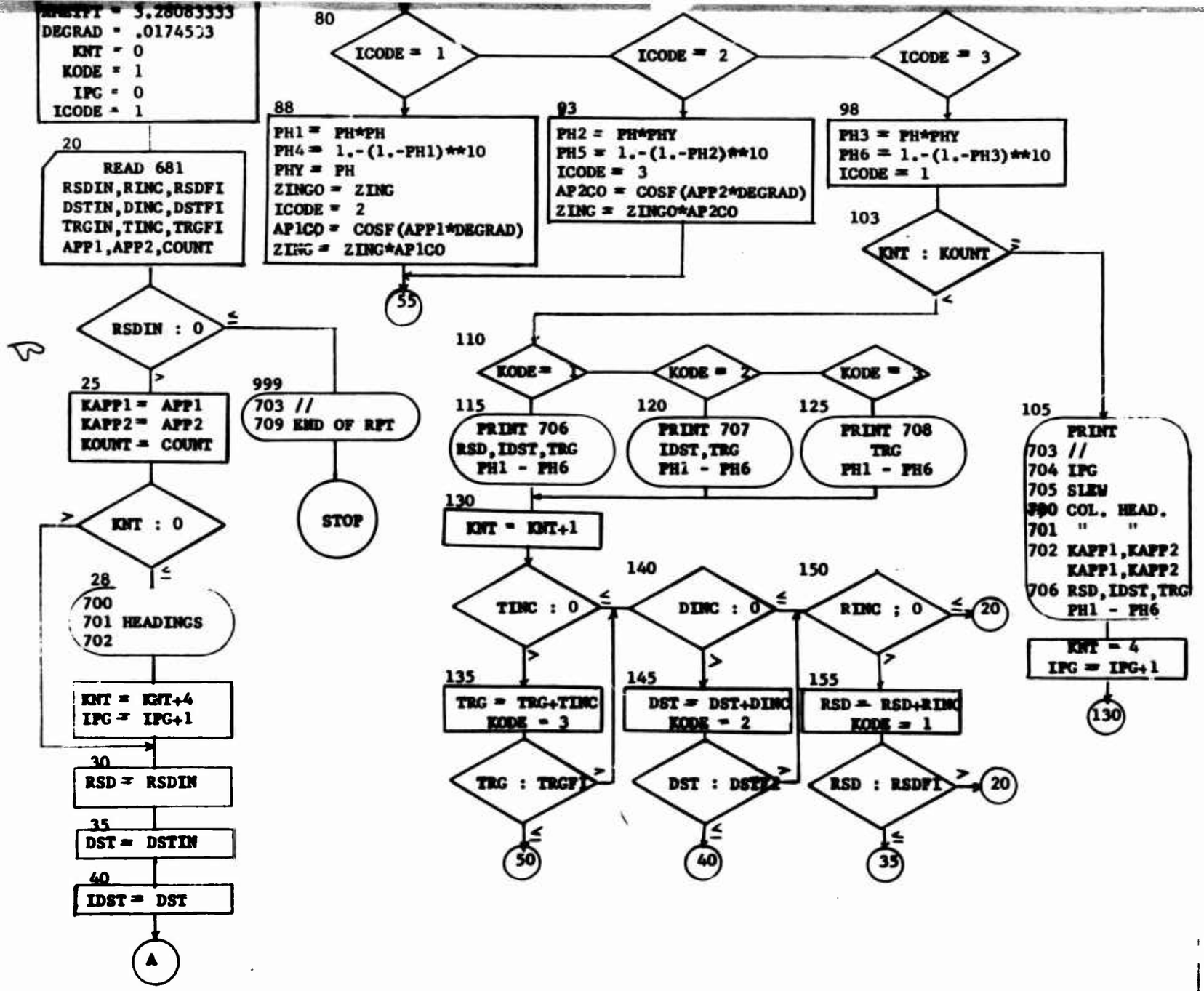
c. INPUT

Column	Variable Name	
26-30	DSTFI	Final distance from target
31-35	TRGIN	Initial length and width of target - feet
36-40	TINC	Increments of target edge
41-45	TRGFI	Final target edge
46-50	APP1	First approach angle
51-55	APP2	Second approach angle
56-60	COUNT	Line count per page

Line count of the sample problem was 44 lines, which includes a 4-line count for the heading and 40 printed lines of data. Title lines and page numbers are not included in the count.

PROGRAM R454R P_{HIT} ON A SQUARE TARGET AT DIRECT AND TWO ANGULAR APPROACHES




PI = 3.28083333
DEGRAD = .0174533
KNT = 0
KODE = 1
IPG = 0
ICODE = 1
20
READ 681
RSDIN,RINC,RSDFI
DSTIN,DINC,DSTFI
TRGIN,TINC,TRGFI
APP1,APP2,COUNT
RSDIN : 0
25
KAPP1 = APP1
KAPP2 = APP2
KOUNT = COUNT
999
703 //
709 END OF RPT
STOP
KNT : 0
28
700
701 HEADINGS
702
KNT = KNT+4
IPG = IPG+1
30
RSD = RSDIN
35
DST = DSTIN
40
IDST = DST
A
80
ICODE = 1
ICODE = 2
ICODE = 3
88
PH1 = PH*PH
PH4 = 1.-(1.-PH1)**10
PHY = PH
ZINGO = ZING
ICODE = 2
AP1CO = COSF(APP1*DEGRAD)
ZING = ZING*AP1CO
55
93
PH2 = PH*PHY
PH5 = 1.-(1.-PH2)**10
ICODE = 3
AP2CO = COSF(APP2*DEGRAD)
ZING = ZINGO*AP2CO
98
PH3 = PH*PHY
PH6 = 1.-(1.-PH3)**10
ICODE = 1
103
KNT : KOUNT
110
KODE = 1
KODE = 2
KODE = 3
115
PRINT 706
RSD,IDST,TRG
PH1 - PH6
120
PRINT 707
IDST,TRG
PH1 - PH6
125
PRINT 708
TRG
PH1 - PH6
130
KNT = KNT+1
140
TINC : 0
150
DINC : 0
RINC ; 0
20
135
TRG = TRG+TINC
KODE = 3
145
DST = DST+DINC
KODE = 2
155
RSD = RSD+RINC
KODE = 1
TRG : TRGFI
DST : DSTFI
RSD : RSDFI
20
50
40
35
105
PRINT
703 //
704 IPG
705 SLEW
700 COL. HEAD.
701 " "
702 KAPP1,KAPP2
KAPP1,KAPP2
706 RSD,IDST,TRG
PH1 - PH6
KNT = 4
IPG = IPG+1
130

```
C      PROGRAM R454R   CHARGE TO R701R      BY H. LUNDY
C      PROBABILITY OF A HIT ON A SQUARE TARGET AT DIRECT AND 2 ANGULAR APPROACHES
C      INTERPOLATED FROM 400 VALUES OF THE NORMAL CURVE READ IN FROM CARDS
C      ICODE             - STORAGE CONTROL
C      IPG               - COUNT OF PAGES
C      KNT AND KOUNT     - COUNT OF PRINTED LINES
C      KODE              - FORMAT CONTROL
       DIMENSION Z(400),AREA(400)
       PRINT 697
       PRINT 698
       PRINT 699
       READ 680,(AREA(I),I = 1,400)
       DO 5 I = 1,400
       ZI = I
     5 Z(I) = ZI/100.
       PRINT 711,(Z(I),AREA(I),I = 1,400)
       PRINT 705
       XMETFT = 3.28083333
       DEGRAD = .0174533
       KNT = 0
       KODE = 1
       IPG = 0
       ICODE = 1
    20 READ 681,RSDIN,RINC,RSDFI,DSTIN,DINC,DSTFI, TRGIN,TINC,TRGFI, APP1
      1,APP2,COUNT
       IF(RSDIN) 999,999,25
    25 KAPP1 = APP1
       KAPP2 = APP2
       KOUNT = COUNT
       IF(KNT) 28,28,30
    28 PRINT 700
       PRINT 701
       PRINT 702,KAPP1,KAPP2,KAPP1,KAPP2
       KNT = KNT + 4
       IPG = IPG + 1
```

```
   30 RSD = RSDIN
   35 DST = DSTIN
   40 IDST = DST
      CONV = (XMETFT * DST) / 1414.214
      DEVST = RSD * CONV
   45 TRG = TRGIN
   50 ZING = (TRG * .5) / DEVST
   55 DO 75 I = 2,400
      IF(ZING - Z(1)) 60,60,65
   60 PH = (ZING * AREA(1) * 200.)
      GO TO 80
   65 IF(ZING - Z(I)) 70,70,75
   70 PH = (((ZING - Z(I-1)) * (AREA(I) - AREA(I-1)) * 100.) + AREA(I-1)
     1)*2.
      GO TO 80
   75 CONTINUE
   80 GO TO (88,93,98), ICODE
   88 PH1 = PH * PH
      PH4 = 1. - (1. - PH1)**10
      PHY = PH
      ZINGO = ZING
      ICODE = 2
      AP1CO = COSF(APP1 * DEGRAD)
      ZING = ZING * AP1CO
      GO TO 55
   93 PH2 = PH * PHY
      PH5 = 1. - (1. - PH2)**10
      ICODE = 3
      AP2CO = COSF(APP2 * DEGRAD)
      ZING = ZINGO* AP2CO
      GO TO 55
   98 PH3 = PH * PHY
      PH6 = 1. - (1. - PH3)**10
      ICODE = 1
  103 IF(KNT - KOUNT) 110,105,105
```

```
105 PRINT 703
    PRINT 704,IPG
    PRINT 705
    PRINT 700
    PRINT 701
    PRINT 702,KAPP1,KAPP2,KAPP1,KAPP2
    PRINT 706,RSD,IDST,TRG,PH1,PH2,PH3,PH4,PH5,PH6
    KNT = 4
    IPG = IPG + 1
    GO TO 130
110 GO TO (115,120,125), KODE
115 PRINT 706,RSD,IDST,TRG,PH1,PH2,PH3,PH4,PH5,PH6
    GO TO 130
120 PRINT 707,IDST,TRG,PH1,PH2,PH3,PH4,PH5,PH6
    GO TO 130
125 PRINT 708, TRG,PH1,PH2,PH3,PH4,PH5,PH6
130 KNT = KNT + 1
    IF(TINC) 140,140,135
135 TRG = TRG + TINC
    KODE = 3
    IF(TRG - TRGFI) 50,50,140
140 IF(DINC) 150,150,145
145 DST = DST + DINC
    KODE = 2
    IF(DST - DSTFI) 40,40,150
150 IF(RINC) 20,20,155
155 RSD = RSD + RINC
    KODE = 1
    IF(RSD - RSDFI) 35,35,20
999 PRINT 703
    PRINT 709
    STOP
```

```
680 FORMAT (8(F4.4,6X))
681 FORMAT (12F5.0)
697 FORMAT(13X,93H PROGRAM NO R454R . PROBABILITY OF A HIT ON A SQUARE
   1TARGET AT DIRECT AND 2 ANGULAR APPROACHES//)
698 FORMAT (49X,22HAREA OF A NORMAL CURVE//)
699 FORMAT (10(12H   Z     AREA )/)
700 FORMAT (23H  RADIAL              TARGET,25X,15HHIT PROBABILITY)
701 FORMAT (22H STD DEV  RANGE    SIZE,17X,11HSINGLE SHOT,15X,9HTEN SHO
   1TS)
702 FORMAT (40H  -MILS  METERS  FT x FT  APPROACH 0 DEG,I4,4H DEG,I4,
   14H DEG,8H    0 DEG,I4,4H DEG,I4,4H DEG/)
703 FORMAT (//)
704 FORMAT (37X,4HPAGE,I3)
705 FORMAT (1H1)
706 FORMAT (F6.1,I8,F9.2,F17.4,5F8.4)
707 FORMAT ( 6X, I8,F9.2,F17.4,5F8.4)
708 FORMAT (14X,    F9.2,F17.4,5F8.4)
709 FORMAT (14H END OF REPORT)
711 FORMAT (10(F5.2,F7.4))
    END
```

PROGRAM NO R454R PROBABILITY OF A HIT ON A SQUARE TARGET AT DIRECT AND 2 ANGULAR APPROACHES

AREA OF A NORMAL CURVE

Z	AREA	Z	AREA	Z	AREA	Z	AREA	Z	AREA	Z	AREA	Z	AREA	Z	AREA	Z	AREA	Z	AREA
0.01	0.0040	0.02	0.0080	0.03	0.0120	0.04	0.0160	0.05	0.0199	0.06	0.0239	0.07	0.0279	0.08	0.0319	0.09	0.0359	0.10	0.0398
0.11	0.0438	0.12	0.0478	0.13	0.0517	0.14	0.0557	0.15	0.0596	0.16	0.0636	0.17	0.0675	0.18	0.0714	0.19	0.0753	0.20	0.0793
0.21	0.0832	0.22	0.0871	0.23	0.0910	0.24	0.0948	0.25	0.0987	0.26	0.1026	0.27	0.1064	0.28	0.1103	0.29	0.1141	0.30	0.1179
0.31	0.1217	0.32	0.1255	0.33	0.1293	0.34	0.1331	0.35	0.1368	0.36	0.1406	0.37	0.1443	0.38	0.1480	0.39	0.1517	0.40	0.1554
0.41	0.1591	0.42	0.1628	0.43	0.1664	0.44	0.1700	0.45	0.1736	0.46	0.1772	0.47	0.1808	0.48	0.1844	0.49	0.1879	0.50	0.1915
0.51	0.1950	0.52	0.1985	0.53	0.2019	0.54	0.2054	0.55	0.2088	0.56	0.2123	0.57	0.2157	0.58	0.2190	0.59	0.2224	0.60	0.2257
0.61	0.2291	0.62	0.2324	0.63	0.2357	0.64	0.2389	0.65	0.2422	0.66	0.2454	0.67	0.2486	0.68	0.2517	0.69	0.2549	0.70	0.2580
0.71	0.2611	0.72	0.2642	0.73	0.2673	0.74	0.2704	0.75	0.2734	0.76	0.2764	0.77	0.2794	0.78	0.2823	0.79	0.2852	0.80	0.2881
0.81	0.2910	0.82	0.2939	0.83	0.2967	0.84	0.2995	0.85	0.3023	0.86	0.3051	0.87	0.3078	0.88	0.3106	0.89	0.3133	0.90	0.3159
0.91	0.3186	0.92	0.3212	0.93	0.3238	0.94	0.3264	0.95	0.3289	0.96	0.3315	0.97	0.3340	0.98	0.3365	0.99	0.3389	1.00	0.3413
1.01	0.3438	1.02	0.3461	1.03	0.3485	1.04	0.3508	1.05	0.3531	1.06	0.3554	1.07	0.3577	1.08	0.3599	1.09	0.3621	1.10	0.3643
1.11	0.3665	1.12	0.3686	1.13	0.3708	1.14	0.3729	1.15	0.3749	1.16	0.3770	1.17	0.3790	1.18	0.3810	1.19	0.3830	1.20	0.3849
1.21	0.3869	1.22	0.3888	1.23	0.3907	1.24	0.3925	1.25	0.3944	1.26	0.3962	1.27	0.3980	1.28	0.3997	1.29	0.4015	1.30	0.4032
1.31	0.4049	1.32	0.4066	1.33	0.4082	1.34	0.4099	1.35	0.4115	1.36	0.4131	1.37	0.4147	1.38	0.4162	1.39	0.4177	1.40	0.4192
1.41	0.4207	1.42	0.4222	1.43	0.4236	1.44	0.4251	1.45	0.4265	1.46	0.4279	1.47	0.4292	1.48	0.4306	1.49	0.4319	1.50	0.4332
1.51	0.4345	1.52	0.4357	1.53	0.4370	1.54	0.4382	1.55	0.4394	1.56	0.4406	1.57	0.4418	1.58	0.4429	1.59	0.4441	1.60	0.4452
1.61	0.4463	1.62	0.4474	1.63	0.4484	1.64	0.4495	1.65	0.4505	1.66	0.4515	1.67	0.4525	1.68	0.4535	1.69	0.4545	1.70	0.4554
1.71	0.4564	1.72	0.4573	1.73	0.4582	1.74	0.4591	1.75	0.4599	1.76	0.4608	1.77	0.4616	1.78	0.4625	1.79	0.4633	1.80	0.4641
1.81	0.4649	1.82	0.4656	1.83	0.4664	1.84	0.4671	1.85	0.4678	1.86	0.4686	1.87	0.4693	1.88	0.4699	1.89	0.4706	1.90	0.4713
1.91	0.4719	1.92	0.4726	1.93	0.4732	1.94	0.4738	1.95	0.4744	1.96	0.4750	1.97	0.4756	1.98	0.4761	1.99	0.4767	2.00	0.4772
2.01	0.4778	2.02	0.4783	2.03	0.4788	2.04	0.4793	2.05	0.4798	2.06	0.4803	2.07	0.4808	2.08	0.4812	2.09	0.4817	2.10	0.4821
2.11	0.4826	2.12	0.4830	2.13	0.4834	2.14	0.4838	2.15	0.4842	2.16	0.4846	2.17	0.4850	2.18	0.4854	2.19	0.4857	2.20	0.4861
2.21	0.4864	2.22	0.4868	2.23	0.4871	2.24	0.4875	2.25	0.4878	2.26	0.4881	2.27	0.4884	2.28	0.4887	2.29	0.4890	2.30	0.4893
2.31	0.4896	2.32	0.4898	2.33	0.4901	2.34	0.4904	2.35	0.4906	2.36	0.4909	2.37	0.4911	2.38	0.4913	2.39	0.4916	2.40	0.4918
2.41	0.4920	2.42	0.4922	2.43	0.4925	2.44	0.4927	2.45	0.4929	2.46	0.4931	2.47	0.4932	2.48	0.4934	2.49	0.4936	2.50	0.4938
2.51	0.4940	2.52	0.4941	2.53	0.4943	2.54	0.4945	2.55	0.4946	2.56	0.4948	2.57	0.4949	2.58	0.4951	2.59	0.4952	2.60	0.4953
2.61	0.4955	2.62	0.4956	2.63	0.4957	2.64	0.4959	2.65	0.4960	2.66	0.4961	2.67	0.4962	2.68	0.4963	2.69	0.4964	2.70	0.4965
2.71	0.4966	2.72	0.4967	2.73	0.4968	2.74	0.4969	2.75	0.4970	2.76	0.4971	2.77	0.4972	2.78	0.4973	2.79	0.4974	2.80	0.4974
2.81	0.4975	2.82	0.4976	2.83	0.4977	2.84	0.4977	2.85	0.4978	2.86	0.4979	2.87	0.4979	2.88	0.4980	2.89	0.4981	2.90	0.4981
2.91	0.4982	2.92	0.4982	2.93	0.4983	2.94	0.4984	2.95	0.4984	2.96	0.4985	2.97	0.4985	2.98	0.4986	2.99	0.4986	3.00	0.4987
3.01	0.4987	3.02	0.4987	3.03	0.4988	3.04	0.4988	3.05	0.4989	3.06	0.4989	3.07	0.4989	3.08	0.4990	3.09	0.4990	3.10	0.4990
3.11	0.4991	3.12	0.4991	3.13	0.4991	3.14	0.4992	3.15	0.4992	3.16	0.4992	3.17	0.4992	3.18	0.4993	3.19	0.4993	3.20	0.4993
3.21	0.4993	3.22	0.4994	3.23	0.4994	3.24	0.4994	3.25	0.4994	3.26	0.4994	3.27	0.4995	3.28	0.4995	3.29	0.4995	3.30	0.4995
3.31	0.4995	3.32	0.4995	3.33	0.4996	3.34	0.4996	3.35	0.4996	3.36	0.4996	3.37	0.4996	3.38	0.4996	3.39	0.4997	3.40	0.4997
3.41	0.4997	3.42	0.4997	3.43	0.4997	3.44	0.4997	3.45	0.4997	3.46	0.4997	3.47	0.4997	3.48	0.4997	3.49	0.4998	3.50	0.4998
3.51	0.4998	3.52	0.4998	3.53	0.4998	3.54	0.4998	3.55	0.4998	3.56	0.4998	3.57	0.4998	3.58	0.4998	3.59	0.4998	3.60	0.4998
3.61	0.4998	3.62	0.4999	3.63	0.4999	3.64	0.4999	3.65	0.4999	3.66	0.4999	3.67	0.4999	3.68	0.4999	3.69	0.4999	3.70	0.4999
3.71	0.4999	3.72	0.4999	3.73	0.4999	3.74	0.4999	3.75	0.4999	3.76	0.4999	3.77	0.4999	3.78	0.4999	3.79	0.4999	3.80	0.4999
3.81	0.4999	3.82	0.4999	3.83	0.4999	3.84	0.4999	3.85	0.4999	3.86	0.4999	3.87	0.4999	3.88	0.4999	3.89	0.4999	3.90	0.5000
3.91	0.5000	3.92	0.5000	3.93	0.5000	3.94	0.5000	3.95	0.5000	3.96	0.5000	3.97	0.5000	3.98	0.5000	3.99	0.5000	4.00	0.5000

RADIAL STD DEV -MILS	RANGE METERS	TARGET SIZE FT X FT	HIT PROBABILITY SINGLE SHOT APPROACH 0 DEG	25 DEG	45 DEG	TEN SHOTS 0 DEG	25 DEG	45 DEG
6.5	1000	50.00	0.8146	0.7826	0.6850	1.0000	1.0000	1.0000
		100.00	0.9980	0.9964	0.9800	1.0000	1.0000	1.0000
	1500	50.00	0.5342	0.4995	0.4133	0.9995	0.9990	0.9952
		100.00	0.9464	0.9289	0.8580	1.0000	1.0000	1.0000
	2000	50.00	0.3514	0.3246	0.2621	0.9868	0.9802	0.9522
		100.00	0.8146	0.7826	0.6850	1.0000	1.0000	1.0000
	2500	50.00	0.2429	0.2228	0.1778	0.9381	0.9196	0.8589
		100.00	0.6646	0.6282	0.5313	1.0000	0.9999	0.9995
	3000	50.00	0.1759	0.1609	0.1275	0.8556	0.8278	0.7443
		100.00	0.5342	0.4995	0.4133	0.9995	0.9990	0.9952
7.0	1000	50.00	0.7679	0.7334	0.6340	1.0000	1.0000	1.0000
		100.00	0.9960	0.9928	0.9686	1.0000	1.0000	1.0000
	1500	50.00	0.4833	0.4503	0.3698	0.9986	0.9975	0.9901
		100.00	0.9213	0.8996	0.8191	1.0000	1.0000	1.0000
	2000	50.00	0.3121	0.2874	0.2311	0.9763	0.9663	0.9278
		100.00	0.7679	0.7334	0.6340	1.0000	1.0000	1.0000
	2500	50.00	0.2135	0.1956	0.1556	0.9094	0.8865	0.8156
		100.00	0.6115	0.5752	0.4818	0.9999	0.9998	0.9986
	3000	50.00	0.1538	0.1404	0.1111	0.8118	0.7798	0.6921
		100.00	0.4833	0.4503	0.3698	0.9986	0.9975	0.9901
7.5	1000	50.00	0.7212	0.6855	0.5863	1.0000	1.0000	0.9999
		100.00	0.9918	0.9867	0.9538	1.0000	1.0000	1.0000
	1500	50.00	0.4381	0.4068	0.3321	0.9969	0.9946	0.9823
		100.00	0.8923	0.8667	0.7788	1.0000	1.0000	1.0000
	2000	50.00	0.2782	0.2559	0.2050	0.9616	0.9479	0.8991
		100.00	0.7212	0.6855	0.5863	1.0000	1.0000	0.9999
	2500	50.00	0.1888	0.1728	0.1371	0.8766	0.8499	0.7711
		100.00	0.5619	0.5265	0.4375	0.9997	0.9994	0.9968
	3000	50.00	0.1355	0.1236	0.0976	0.7667	0.7326	0.6419
		100.00	0.4381	0.4068	0.3321	0.9969	0.9946	0.9823
8.0	1000	50.00	0.6758	0.6395	0.5418	1.0000	1.0000	0.9996
		100.00	0.9858	0.9785	0.9365	1.0000	1.0000	1.0000
	1500	50.00	0.3979	0.3685	0.2994	0.9937	0.9899	0.9715
		100.00	0.8604	0.8314	0.7383	1.0000	1.0000	1.0000
	2000	50.00	0.2494	0.2290	0.1828	0.9432	0.9257	0.8672
		100.00	0.6758	0.6395	0.5418	1.0000	1.0000	0.9996
	2500	50.00	0.1681	0.1536	0.1217	0.8412	0.8113	0.7267
		100.00	0.5166	0.4825	0.3982	0.9993	0.9986	0.9938
	3000	50.00	0.1201	0.1095	0.0863	0.7217	0.6863	0.5945
		100.00	0.3979	0.3685	0.2994	0.9937	0.9899	0.9715

RADIAL STD DEV -MILS	RANGE METERS	TARGET SIZE FT X FT	HIT PROBABILITY SINGLE SHOT APPROACH 0 DEG	25 DEG	45 DEG	TEN SHOTS 0 DEG	25 DEG	45 DEG
8.5	1000	50.00	0.6324	0.5959	0.5010	1.0000	0.9999	0.9990
		100.00	0.9778	0.9675	0.9167	1.0000	1.0000	1.0000
	1500	50.00	0.3623	0.3349	0.2708	0.9689	0.9831	0.9575
		100.00	0.8264	0.7950	0.6982	1.0000	1.0000	1.0000
	2000	50.00	0.2246	0.2058	0.1639	0.9214	0.9002	0.8331
		100.00	0.6324	0.5959	0.5010	1.0000	0.9999	0.9990
	2500	50.00	0.1505	0.1374	0.1087	0.8044	0.7719	0.6835
		100.00	0.4755	0.4427	0.3632	0.9984	0.9971	0.9890
	3000	50.00	0.1072	0.0977	0.0769	0.6784	0.6422	0.5509
		100.00	0.3623	0.3349	0.2708	0.9689	0.9831	0.9575
9.0	1000	50.00	0.5911	0.5551	0.4634	0.9999	0.9997	0.9980
		100.00	0.9671	0.9539	0.8945	1.0000	1.0000	1.0000
	1500	50.00	0.3308	0.3052	0.2460	0.9620	0.9738	0.9406
		100.00	0.7914	0.7581	0.6593	1.0000	1.0000	1.0000
	2000	50.00	0.2030	0.1859	0.1478	0.8966	0.8721	0.7979
		100.00	0.5911	0.5551	0.4634	0.9999	0.9997	0.9980
	2500	50.00	0.1355	0.1236	0.0976	0.7667	0.7326	0.6419
		100.00	0.4381	0.4068	0.3321	0.9969	0.9946	0.9823
	3000	50.00	0.0962	0.0876	0.0689	0.6363	0.6002	0.5105
		100.00	0.3308	0.3052	0.2460	0.9620	0.9738	0.9406
9.5	1000	50.00	0.5527	0.5175	0.4293	0.9997	0.9993	0.9963
		100.00	0.9540	0.9379	0.8706	1.0000	1.0000	1.0000
	1500	50.00	0.3031	0.2790	0.2241	0.9730	0.9621	0.9210
		100.00	0.7562	0.7214	0.6219	1.0000	1.0000	0.9999
	2000	50.00	0.1845	0.1687	0.1338	0.8698	0.8424	0.7623
		100.00	0.5527	0.5175	0.4293	0.9997	0.9993	0.9963
	2500	50.00	0.1224	0.1117	0.0880	0.7291	0.6939	0.6021
		100.00	0.4043	0.3746	0.3045	0.9944	0.9908	0.9735
	3000	50.00	0.0868	0.0790	0.0621	0.5966	0.5609	0.4733
		100.00	0.3031	0.2790	0.2241	0.9730	0.9621	0.9210
10.0	1000	50.00	0.5166	0.4825	0.3982	0.9993	0.9986	0.9938
		100.00	0.9386	0.9196	0.8452	1.0000	1.0000	1.0000
	1500	50.00	0.2782	0.2559	0.2050	0.9616	0.9479	0.8991
		100.00	0.7212	0.6855	0.5863	1.0000	1.0000	0.9999
	2000	50.00	0.1681	0.1536	0.1217	0.8412	0.8113	0.7267
		100.00	0.5166	0.4825	0.3982	0.9993	0.9986	0.9938
	2500	50.00	0.1113	0.1014	0.0799	0.6926	0.6566	0.5650
		100.00	0.3737	0.3456	0.2799	0.9987	0.9856	0.9625
	3000	50.00	0.0787	0.0716	0.0563	0.5596	0.5244	0.4396
		100.00	0.2782	0.2559	0.2050	0.9616	0.9479	0.8991

END OF REPORT

5. PROGRAM R455R

a. DESCRIPTION

This program gives the same 9-column output as Program R454R, but the calculations are based on integration of the normal curve by Simpson's 1/3 Rule. The actual integration is carried out by use of the equation

$$Y(I) = \frac{1}{\sqrt{2\pi}} e^{-(t^2/2)}$$

or

$$Y(I) = .392944 \times EXPF(-X \times X \times .5)$$

in the SUBROUTINE CVNORM. Load limits equal 2151(DECIMAL) words. including the SUBROUTINE.

b. OUTPUT

Same as second and subsequent pages of Program R454R except that the final page also gives the number of incremental areas considered in the calculations.

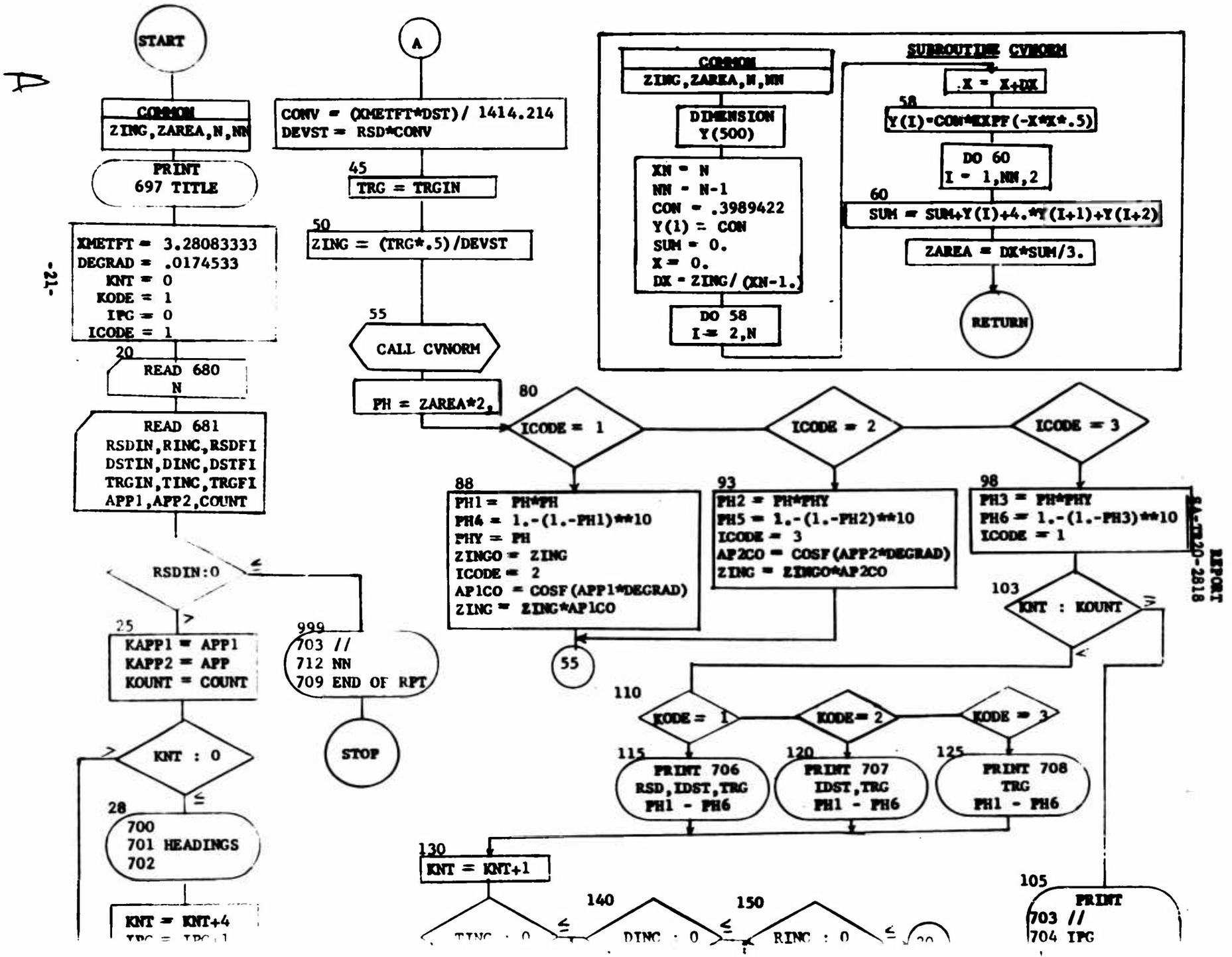
c. INPUT

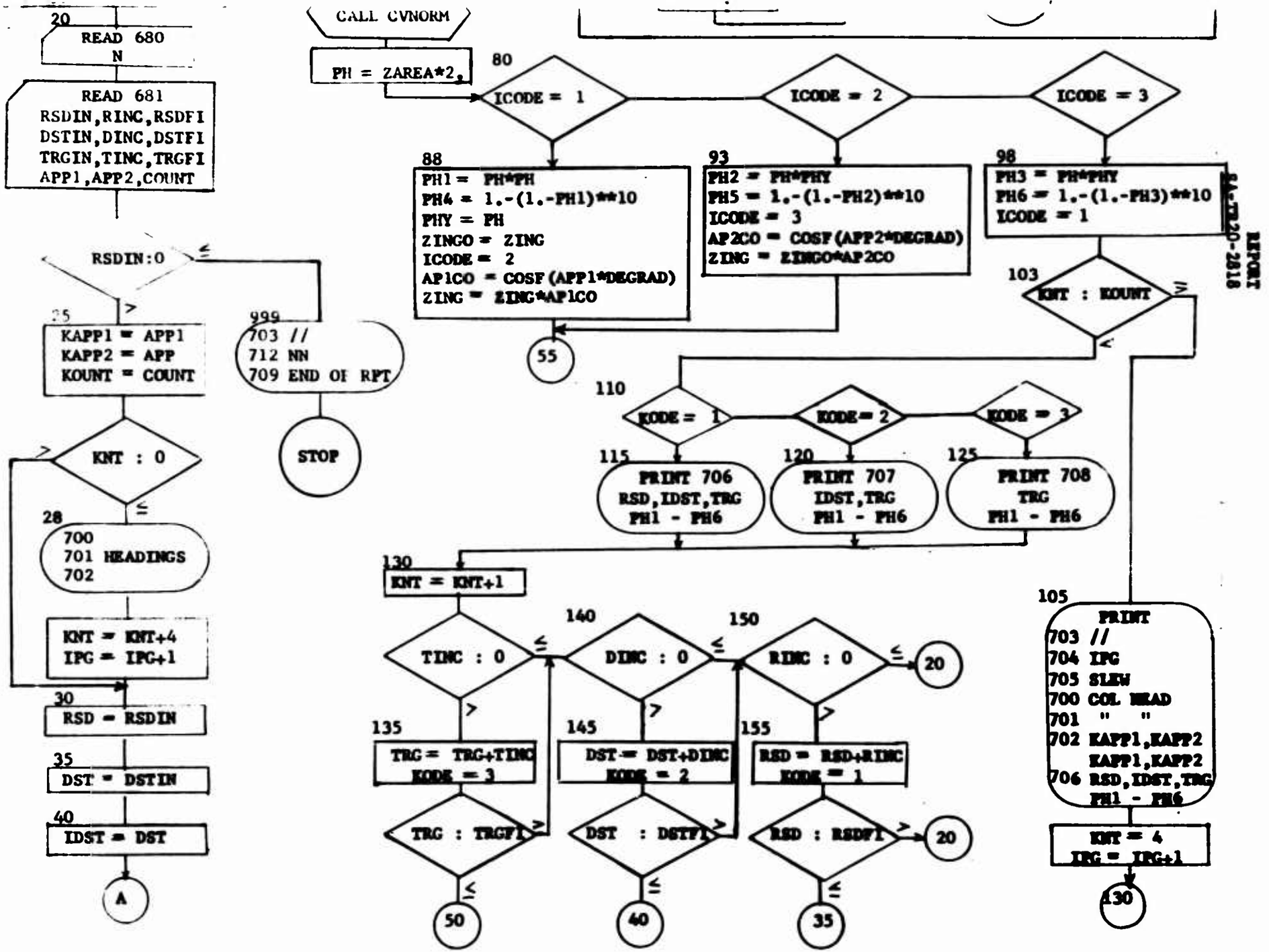
(1) First Card, Columns 1-5, number of increments of area to be calculated, I format.

(2) Second Card, Data Card fully described under Program R454R.

PROGRAM R455R. P_{HIT} ON A SQUARE TARGET AT DIRECT AND TWO ANGULAR APPROACHES

INTEGRATION OF THE NORMAL CURVE BY SIMPSON'S 1/3 RULE




20
READ 680
N
READ 681
RSDIN,RINC,RSDFI
DSTIN,DINC,DSTFI
TRGIN,TINC,TRGFI
APP1,APP2,COUNT
RSDIN:0
25
KAPP1 = APP1
KAPP2 = APP
KOUNT = COUNT
KNT : 0
28
700
701 HEADINGS
702
KNT = KNT+4
IPG = IPG+1
30
RSD = RSDIN
35
DST = DSTIN
40
IDST = DST
A
999
703 //
712 NN
709 END OF RPT
STOP
CALL CVNORM
PH = ZAREA*2.
80
ICODE = 1
ICODE = 2
ICODE = 3
88
PH1 = PH*PH
PH4 = 1.-(1.-PH1)**10
PHY = PH
ZINGO = ZING
ICODE = 2
AP1CO = COSF(APP1*DEGRAD)
ZING = ZING*AP1CO
55
93
PH2 = PH*PHY
PH5 = 1.-(1.-PH2)**10
ICODE = 3
AP2CO = COSF(APP2*DEGRAD)
ZING = ZINGO*AP2CO
98
PH3 = PH*PHY
PH6 = 1.-(1.-PH3)**10
ICODE = 1
103
KNT : KOUNT
110
KODE = 1
KODE = 2
KODE = 3
115
PRINT 706
RSD,IDST,TRG
PH1 - PH6
120
PRINT 707
IDST,TRG
PH1 - PH6
125
PRINT 708
TRG
PH1 - PH6
130
KNT = KNT+1
140
TINC : 0
DINC : 0
150
RINC : 0
20
135
TRG = TRG+TINC
KODE = 3
145
DST = DST+DINC
KODE = 2
155
RSD = RSD+RINC
KODE = 1
TRG : TRGFI
DST : DSTFI
RSD : RSDFI
20
50
40
35
105
PRINT
703 //
704 IPG
705 SLEW
700 COL HEAD
701 " "
702 KAPP1,KAPP2
KAPP1,KAPP2
706 RSD,IDST,TRG
PH1 - PH6
KNT = 4
IPG = IPG+1
A30

```
C      PROGRAM R455R   CHARGE TO R701R       BY H. LUNDY
C      PROBABILITY OF A HIT ON A SQUARE TARGET AT DIRECT AND 2 ANGULAR APPROACHES
C      INTEGRATION OF THE NORMAL CURVE BY SIMPSONS 1/3 RULE
C      SUBROUTINE CVNORM IS CALLED
C      N MUST BE ODD
C      ICODE              - STORAGE CONTROL
C      IPG                - COUNT OF PAGES
C      KNT AND KOUNT      - COUNT OF PRINTED LINES
C      KODE               - FORMAT CONTROL
       COMMON ZING, ZAREA, N, NN
       PRINT 697
       XMETFT = 3.28083333
       DEGRAD = .0174533
       KNT = 0
       KODE = 1
       IPG = 0
       ICODE = 1
   20  READ 680, N
       READ 681,RSDIN,RINC,RSDFI,DSTIN,DINC,DSTFI, TRGIN,TINC,TRGFI, APP1
      1,APP2,COUNT
       IF(RSDIN) 999,999,25
   25  KAPP1 = APP1
       KAPP2 = APP2
       KOUNT = COUNT
       IF(KNT) 28,28,30
   28  PRINT 700
       PRINT 701
       PRINT 702,KAPP1,KAPP2,KAPP1,KAPP2
       KNT = KNT + 4
       IPG = IPG + 1
   30  RSD = RSDIN
   35  DST = DSTIN
   40  IDST = DST
       CONV = (XMETFT * DST) / 1414.214
       DEVST = RSD * CONV
   45  TRG = TRGIN
   50  ZING = (TRG * .5) / DEVST
```

```
 55 CALL CVNORM
    PH = ZAREA * 2.
 80 GO TO (88,93,98), ICODE
 88 PH1 = PH * PH
    PH4 = 1. - (1. - PH1)**10
    PHY = PH
    ZINGO = ZING
    ICODE = 2
    AP1CO = COSF(APP1 * DEGRAD)
    ZING = ZING * AP1CO
    GO TO 55
 93 PH2 = PH * PHY
    PH5 = 1. - (1. - PH2)**10
    ICODE = 3
    AP2CO = COSF(APP2 * DEGRAD)
    ZING = ZINGO* AP2CO
    GO TO 55
 98 PH3 = PH * PHY
    PH6 = 1. - (1. - PH3)**10
    ICODE = 1
103 IF(KNT - KOUNT) 110,105,105
105 PRINT 703
    PRINT 704,IPG
    PRINT 705
    PRINT 700
    PRINT 701
    PRINT 702,KAPP1,KAPP2,KAPP1,KAPP2
    PRINT 706,RSD,IDST,TRG,PH1,PH2,PH3,PH4,PH5,PH6
    KNT = 4
    IPG = IPG + 1
    GO TO 130
110 GO TO (115,120,125), KODE
115 PRINT 706,RSD,IDST,TRG,PH1,PH2,PH3,PH4,PH5,PH6
    GO TO 130
120 PRINT 707,IDST,TRG,PH1,PH2,PH3,PH4,PH5,PH6
    GO TO 130
125 PRINT 708, TRG,PH1,PH2,PH3,PH4,PH5,PH6
130 KNT = KNT + 1
```

```
      IF(TINC) 140,140,135
  135 TRG = TRG + TINC
      KODE = 3
      IF(TRG - TRGF) 50,50,140
  140 IF(DINC) 150,150,145
  145 DST = DST + DINC
      KODE = 2
      IF(DST - DSTF) 40,40,150
  150 IF(RINC) 20,20,155
  155 RSD = RSD + RINC
      KODE = 1
      IF(RSD - RSDF) 35,35,20
  999 PRINT 703
      PRINT 712, NN
      PRINT 709
      STOP
  680 FORMAT (I5)
  681 FORMAT (12F5.0)
  697 FORMAT (30H   PROGRAM R455R   BY H. LUNDY/ 77H   PROBABILITY OF A
     1HIT ON A SQUARE TARGET AT DIRECT AND 2 ANGULAR APPROACHES//)
  700 FORMAT (23H  RADIAL          TARGET,25X,15HHIT PROBABILITY)
  701 FORMAT (22H STD DEV  RANGE   SIZE,17X,11HSINGLE SHOT,15X,9HTEN SHO
     1TS)
  702 FORMAT (40H  -MILS  METERS  FT X FT  APPROACH 0 DEG,I4,4H DEG,I4,
     14H DEG,8H   0 DEG,I4,4H DEG,I4,4H DEG/)
  703 FORMAT (//)
  704 FORMAT (37X,4HPAGE,I3)
  705 FORMAT (1H1)
  706 FORMAT (F6.1,I8,F9.2,F17.4,5F8.4)
  707 FORMAT ( 6X, I8,F9.2,F17.4,5F8.4)
  708 FORMAT (14X,    F9.2,F17.4,5F8.4)
  709 FORMAT (14H END OF REPORT)
  712 FORMAT (38H HIT PROBABILITY CALCULATIONS BASED ON, I4, 39H  INCREM
     1ENTAL AREAS OF THE NORMAL CURVE//)
      END
```

```
      SUBROUTINE CVNORM
      COMMON ZING, ZAREA, N, NN
      DIMENSION Y(500)
      XN = N
      NN = N - 1
      CON = .3989422
      Y(1) = CON
      SUM = 0.
      X = 0.
      DX = ZING / (XN - 1.)
      DO 58 I = 2,N
      X = X + DX
   58 Y(I) = CON * EXPF(-X *X * .5)
      DO 60   I = 1,NN,2
   60 SUM = SUM + Y(I) + 4.*Y(I+1) + Y(I+2)
      ZAREA = DX * SUM / 3.
      RETURN
      END
```

PROGRAM R455H BY H. LUNDY
PROBABILITY OF A HIT ON A SQUARE TARGET AT DIRECT AND 2 ANGULAR APPROACHES

RADIAL STD DEV -MILS	RANGE METERS	TARGET SIZE FT X FT	HIT PROBABILITY SINGLE SHOT APPROACH 0 DEG	25 DEG	45 DEG	TEN SHOTS 0 DEG	25 DEG	45 DEG
6.5	1000	50.00	0.8148	0.7827	0.6851	1.0000	1.0000	1.0000
		100.00	0.9982	0.9964	0.9801	1.0000	1.0000	1.0000
	1500	50.00	0.5343	0.4996	0.4134	0.9995	0.9990	0.9952
		100.00	0.9466	0.9290	0.8581	1.0000	1.0000	1.0000
	2000	50.00	0.3515	0.3246	0.2622	0.9868	0.9802	0.9522
		100.00	0.8148	0.7827	0.6851	1.0000	1.0000	1.0000
	2500	50.00	0.2428	0.2228	0.1778	0.9381	0.9196	0.8589
		100.00	0.6647	0.6283	0.5313	1.0000	0.9999	0.9995
	3000	50.00	0.1760	0.1609	0.1275	0.8556	0.8269	0.7445
		100.00	0.5343	0.4996	0.4134	0.9995	0.9990	0.9952
7.0	1000	50.00	0.7679	0.7335	0.6341	1.0000	1.0000	1.0000
		100.00	0.9958	0.9927	0.9685	1.0000	1.0000	1.0000
	1500	50.00	0.4834	0.4503	0.3699	0.9986	0.9975	0.9901
		100.00	0.9214	0.8996	0.8191	1.0000	1.0000	1.0000
	2000	50.00	0.3120	0.2874	0.2311	0.9762	0.9662	0.9278
		100.00	0.7679	0.7335	0.6341	1.0000	1.0000	1.0000
	2500	50.00	0.2134	0.1955	0.1556	0.9093	0.8865	0.8156
		100.00	0.6114	0.5752	0.4818	0.9999	0.9998	0.9986
	3000	50.00	0.1538	0.1404	0.1111	0.8117	0.7798	0.6920
		100.00	0.4834	0.4503	0.3699	0.9986	0.9975	0.9901
7.5	1000	50.00	0.7212	0.6855	0.5863	1.0000	1.0000	0.9999
		100.00	0.9919	0.9868	0.9540	1.0000	1.0000	1.0000
	1500	50.00	0.4381	0.4069	0.3321	0.9969	0.9946	0.9823
		100.00	0.8923	0.8667	0.7788	1.0000	1.0000	1.0000
	2000	50.00	0.2783	0.2559	0.2050	0.9616	0.9479	0.8991
		100.00	0.7212	0.6855	0.5863	1.0000	1.0000	0.9999
	2500	50.00	0.1888	0.1728	0.1371	0.8766	0.8499	0.7712
		100.00	0.5620	0.5266	0.4375	0.9997	0.9994	0.9968
	3000	50.00	0.1354	0.1236	0.0976	0.7667	0.7326	0.6410
		100.00	0.4381	0.4069	0.3321	0.9969	0.9946	0.9823
8.0	1000	50.00	0.6757	0.6394	0.5418	1.0000	1.0000	0.9996
		100.00	0.9859	0.9784	0.9366	1.0000	1.0000	1.0000
	1500	50.00	0.3979	0.3686	0.2994	0.9937	0.9899	0.9715
		100.00	0.8603	0.8314	0.7382	1.0000	1.0000	1.0000
	2000	50.00	0.2494	0.2289	0.1828	0.9432	0.9257	0.8672
		100.00	0.6757	0.6394	0.5418	1.0000	1.0000	0.9996
	2500	50.00	0.1681	0.1536	0.1217	0.8412	0.8113	0.7268
		100.00	0.5167	0.4825	0.3982	0.9993	0.9986	0.9938
	3000	50.00	0.1201	0.1095	0.0863	0.7219	0.6864	0.5947
		100.00	0.3979	0.3686	0.2994	0.9937	0.9899	0.9715

RADIAL STD DEV -MILS	RANGE METERS	TARGET SIZE FT X FT	HIT PROBABILITY SINGLE SHOT APPROACH 0 DEG	25 DEG	45 DEG	TEN SHOTS 0 DEG	25 DEG	45 DEG
8.5	1000	50.00	0.6322	0.5959	0.5009	1.0000	0.9999	0.9998
		100.00	0.9777	0.9675	0.9166	1.0000	1.0000	1.0000
	1500	50.00	0.3624	0.3349	0.2709	0.9889	0.9831	0.9575
		100.00	0.8264	0.7949	0.6982	1.0000	1.0000	1.0000
	2000	50.00	0.2245	0.2058	0.1640	0.9214	0.9002	0.8332
		100.00	0.6322	0.5959	0.5009	1.0000	0.9999	0.9998
	2500	50.00	0.1505	0.1374	0.1087	0.8043	0.7719	0.6834
		100.00	0.4755	0.4427	0.3632	0.9984	0.9971	0.9898
	3000	50.00	0.1072	0.0977	0.0769	0.6782	0.6422	0.5508
		100.00	0.3624	0.3349	0.2709	0.9889	0.9831	0.9575
9.0	1000	50.00	0.5911	0.5552	0.4635	0.9999	0.9997	0.9988
		100.00	0.9670	0.9539	0.8945	1.0000	1.0000	1.0000
	1500	50.00	0.3309	0.3052	0.2460	0.9820	0.9738	0.9406
		100.00	0.7914	0.7580	0.6593	1.0000	1.0000	1.0000
	2000	50.00	0.2031	0.1859	0.1478	0.8967	0.8722	0.7979
		100.00	0.5911	0.5552	0.4635	0.9999	0.9997	0.9988
	2500	50.00	0.1354	0.1236	0.0976	0.7667	0.7326	0.6418
		100.00	0.4381	0.4069	0.3321	0.9969	0.9946	0.9823
	3000	50.00	0.0962	0.0876	0.0689	0.6364	0.6003	0.5104
		100.00	0.3309	0.3052	0.2460	0.9820	0.9738	0.9406
9.5	1000	50.00	0.5526	0.5174	0.4293	0.9997	0.9993	0.9963
		100.00	0.9540	0.9379	0.8706	1.0000	1.0000	1.0000
	1500	50.00	0.3030	0.2790	0.2241	0.9730	0.9621	0.9210
		100.00	0.7562	0.7214	0.6219	1.0000	1.0000	0.9999
	2000	50.00	0.1844	0.1687	0.1338	0.8697	0.8423	0.7622
		100.00	0.5526	0.5174	0.4293	0.9997	0.9993	0.9963
	2500	50.00	0.1225	0.1117	0.0881	0.7293	0.6940	0.6023
		100.00	0.4043	0.3746	0.3045	0.9944	0.9909	0.9735
	3000	50.00	0.0868	0.0790	0.0621	0.5968	0.5610	0.4734
		100.00	0.3030	0.2790	0.2241	0.9730	0.9621	0.9210
10.0	1000	50.00	0.5167	0.4825	0.3982	0.9993	0.9986	0.9938
		100.00	0.9387	0.9197	0.8453	1.0000	1.0000	1.0000
	1500	50.00	0.2783	0.2559	0.2050	0.9616	0.9479	0.8991
		100.00	0.7212	0.6855	0.5863	1.0000	1.0000	0.9999
	2000	50.00	0.1681	0.1536	0.1217	0.8412	0.8113	0.7268
		100.00	0.5167	0.4825	0.3982	0.9993	0.9986	0.9938
	2500	50.00	0.1113	0.1014	0.0799	0.6926	0.6567	0.5651
		100.00	0.3738	0.3457	0.2799	0.9907	0.9856	0.9625
	3000	50.00	0.0787	0.0716	0.0563	0.5595	0.5243	0.4395
		100.00	0.2783	0.2559	0.2050	0.9616	0.9479	0.8991

HIT PROBABILITY CALCULATIONS BASED ON 100 INCREMENTAL AREAS OF THE NORMAL CURVE

END OF REPORT

PROGRAM R455R BY H. LUNDY
PROBABILITY OF A HIT ON A SQUARE TARGET AT DIRECT AND 2 ANGULAR APPROACHES

RADIAL STD DEV -MILS	RANGE METERS	TARGET SIZE FT X FT	APPROACH	HIT PROBABILITY SINGLE SHOT 0 DEG	25 DEG	45 DEG	TEN SHOTS 0 DEG	25 DEG	45 DEG
6.5	1000	50.00		0.8148	0.7827	0.6851	1.0000	1.0000	1.0000
		100.00		0.9982	0.9964	0.9800	1.0000	1.0000	1.0000
	1500	50.00		0.5343	0.4996	0.4134	0.9995	0.9990	0.9952
		100.00		0.9466	0.9290	0.8581	1.0000	1.0000	1.0000
	2000	50.00		0.3515	0.3246	0.2622	0.9868	0.9802	0.9522
		100.00		0.8146	0.7827	0.6851	1.0000	1.0000	1.0000
	2500	50.00		0.2428	0.2228	0.1778	0.9381	0.9196	0.8589
		100.00		0.6647	0.6283	0.5313	1.0000	0.9999	0.9995
	3000	50.00		0.1760	0.1609	0.1275	0.8556	0.8269	0.7445
		100.00		0.5343	0.4996	0.4134	0.9995	0.9990	0.9952
7.0	1000	50.00		0.7679	0.7335	0.6342	1.0000	1.0000	1.0000
		100.00		0.9958	0.9927	0.9685	1.0000	1.0000	1.0000
	1500	50.00		0.4834	0.4503	0.3699	0.9986	0.9975	0.9901
		100.00		0.9214	0.8996	0.8191	1.0000	1.0000	1.0000
	2000	50.00		0.3120	0.2874	0.2311	0.9762	0.9662	0.9278
		100.00		0.7679	0.7335	0.6342	1.0000	1.0000	1.0000
	2500	50.00		0.2134	0.1955	0.1556	0.9093	0.8865	0.8156
		100.00		0.6114	0.5752	0.4818	0.9999	0.9998	0.9986
	3000	50.00		0.1538	0.1404	0.1111	0.8117	0.7798	0.6920
		100.00		0.4834	0.4503	0.3699	0.9986	0.9975	0.9901
7.5	1000	50.00		0.7212	0.6855	0.5863	1.0000	1.0000	0.9999
		100.00		0.9919	0.9868	0.9540	1.0000	1.0000	1.0000
	1500	50.00		0.4381	0.4069	0.3321	0.9969	0.9946	0.9823
		100.00		0.8923	0.8667	0.7788	1.0000	1.0000	1.0000
	2000	50.00		0.2783	0.2559	0.2050	0.9616	0.9479	0.8991
		100.00		0.7212	0.6855	0.5863	1.0000	1.0000	0.9999
	2500	50.00		0.1888	0.1728	0.1371	0.8766	0.8499	0.7712
		100.00		0.5620	0.5266	0.4375	0.9997	0.9994	0.9968
	3000	50.00		0.1354	0.1236	0.0976	0.7667	0.7326	0.6418
		100.00		0.4381	0.4069	0.3321	0.9969	0.9946	0.9823
8.0	1000	50.00		0.6757	0.6394	0.5419	1.0000	1.0000	0.9996
		100.00		0.9859	0.9784	0.9366	1.0000	1.0000	1.0000
	1500	50.00		0.3979	0.3686	0.2994	0.9937	0.9899	0.9715
		100.00		0.8603	0.8314	0.7382	1.0000	1.0000	1.0000
	2000	50.00		0.2494	0.2289	0.1828	0.9432	0.9257	0.8672
		100.00		0.6757	0.6394	0.5419	1.0000	1.0000	0.9996
	2500	50.00		0.1681	0.1536	0.1217	0.8412	0.8113	0.7268
		100.00		0.5167	0.4825	0.3982	0.9993	0.9986	0.9938
	3000	50.00		0.1201	0.1095	0.0863	0.7219	0.6864	0.5947
		100.00		0.3979	0.3686	0.2994	0.9937	0.9899	0.9715

RADIAL STD DEV -MILS	RANGE METERS	TARGET SIZE FT X FT	HIT PROBABILITY SINGLE SHOT APPROACH 0 DEG	25 DEG	45 DEG	TEN SHOTS 0 DEG	25 DEG	45 DEG
8.5	1000	50.00	0.6322	0.5959	0.5009	1.0000	0.9999	0.9998
		100.00	0.9777	0.9674	0.9166	1.0000	1.0000	1.0000
	1500	50.00	0.3624	0.3349	0.2709	0.9889	0.9831	0.9575
		100.00	0.8264	0.7949	0.6982	1.0000	1.0000	1.0000
	2000	50.00	0.2245	0.2058	0.1640	0.9214	0.9002	0.8332
		100.00	0.6322	0.5959	0.5009	1.0000	0.9999	0.9998
	2500	50.00	0.1505	0.1374	0.1087	0.8043	0.7719	0.6834
		100.00	0.4755	0.4427	0.3632	0.9984	0.9971	0.9890
	3000	50.00	0.1072	0.0977	0.0769	0.6782	0.6422	0.5508
		100.00	0.3624	0.3349	0.2709	0.9889	0.9831	0.9575
9.0	1000	50.00	0.5911	0.5552	0.4635	0.9999	0.9997	0.9980
		100.00	0.9670	0.9539	0.8945	1.0000	1.0000	1.0000
	1500	50.00	0.3309	0.3052	0.2460	0.9820	0.9738	0.9406
		100.00	0.7914	0.7580	0.6593	1.0000	1.0000	1.0000
	2000	50.00	0.2031	0.1859	0.1478	0.8967	0.8722	0.7979
		100.00	0.5911	0.5552	0.4635	0.9999	0.9997	0.9980
	2500	50.00	0.1354	0.1236	0.0976	0.7667	0.7326	0.6418
		100.00	0.4381	0.4069	0.3321	0.9969	0.9946	0.9823
	3000	50.00	0.0962	0.0876	0.0689	0.6364	0.6003	0.5104
		100.00	0.3309	0.3052	0.2460	0.9820	0.9738	0.9406
9.5	1000	50.00	0.5526	0.5174	0.4293	0.9997	0.9993	0.9963
		100.00	0.9540	0.9379	0.8706	1.0000	1.0000	1.0000
	1500	50.00	0.3030	0.2790	0.2241	0.9730	0.9621	0.9210
		100.00	0.7562	0.7214	0.6219	1.0000	1.0000	0.9999
	2000	50.00	0.1844	0.1687	0.1338	0.8697	0.8423	0.7622
		100.00	0.5526	0.5174	0.4293	0.9997	0.9993	0.9963
	2500	50.00	0.1225	0.1117	0.0881	0.7293	0.6940	0.6023
		100.00	0.4043	0.3746	0.3045	0.9944	0.9909	0.9735
	3000	50.00	0.0868	0.0790	0.0621	0.5968	0.5610	0.4734
		100.00	0.3030	0.2790	0.2241	0.9730	0.9621	0.9210
10.0	1000	50.00	0.5167	0.4825	0.3982	0.9993	0.9986	0.9938
		100.00	0.9387	0.9197	0.8453	1.0000	1.0000	1.0000
	1500	50.00	0.2783	0.2559	0.2050	0.9616	0.9479	0.8991
		100.00	0.7212	0.6855	0.5863	1.0000	1.0000	0.9999
	2000	50.00	0.1681	0.1536	0.1217	0.8412	0.8113	0.7268
		100.00	0.5167	0.4825	0.3982	0.9993	0.9986	0.9938
	2500	50.00	0.1113	0.1014	0.0799	0.6926	0.6567	0.5651
		100.00	0.3736	0.3457	0.2799	0.9907	0.9856	0.9625
	3000	50.00	0.0787	0.0716	0.0563	0.5595	0.5243	0.4395
		100.00	0.2783	0.2559	0.2050	0.9616	0.9479	0.8991

HIT PROBABILITY CALCULATIONS BASED ON 10 INCREMENTAL AREAS OF THE NORMAL CURVE

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13. ABSTRACT

Probability of a hit by a single shot or by a ten-shot burst at direct or angular approach to a square target is calculated. Parameters include dispersion in mils, distance from the target in meters, and size of the target in feet. A normal distribution is assumed. Solution by linear interpolation of normal curve areas from standard tables was accurate to 0.0002 when contrasted with integration of the normal curve by Simpson's 1/3 Rule in sample problems.

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14 KEY WORDS	LINK A		LINK B		LINK C	
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2. Target						
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