5th AIAA Propulsion Aerodynamic Workshop 2020
PAW05 – Ground Vortex Intake

Guidelines/Instructions for Participation in PAW05

Data Submittal Due By: November 1, 2020

1. Objectives: The main objective of the inlet portion of the 5th Propulsion Aerodynamics Workshop (PAW05) is to assess the accuracy of existing computer codes and modeling techniques in simulating the aerodynamic impact of ground vortex ingestion on inlet performance. Previous workshops focused on the internal flows of offset diffusers and the impact of boundary layer (BL) growth and separation on inlet performance. The PAW05 inlet configuration under investigation is the axisymmetric inlet with ground plane in cross-flow studied by Murphy[1].

   The degree of success of these simulations will be judged against measurements of total pressure recovery and distortion at the Aerodynamic Interface Plane (AIP). Previous workshops highlighted the relatively coarse resolution of total pressure measurements in the test data compare to simulations. The current test case rotates the axisymmetric model with fixed total pressure rakes in order to increase the AIP sampling. While the experiment did track the ground vortex formation and location, the committee will collect and compare only the AIP measurements.

   The expected standard computational analysis technique is Reynolds-averaged Navier-Stokes (RANS). Due to the complexity of the flow under consideration, participants are also encouraged to expand beyond RANS with different turbulence models including URANS, DES, and LES. Grid resolution and incoming boundary layer profile studies are of primary interest, but participants are encouraged to investigate further to contribute to the understanding of ground vortex simulations.

2. Inlet configuration: The test article under consideration is an axisymmetric inlet in proximity to a ground plane, as shown in Figure 1. The inner diameter (D_i) is 100mm, while the highlight or lip diameter (D_l) is 120mm. Multiple heights were tested, but for PAW05, the focus is on a height (h) of $0.25D_l$. The length (L_i) is $7D_l$, and the elliptical lip has an axis ratio of 2. Though the inlet only has 4 total pressure rakes with 9 probes each, the entire assembly rotates in order to sample additional circumferential locations. There is no hub or fan in the inlet, as flow is driven by a vacuum chamber. The velocity ratio (U_i/U_∞) is driven primarily by modifying the freestream velocity.

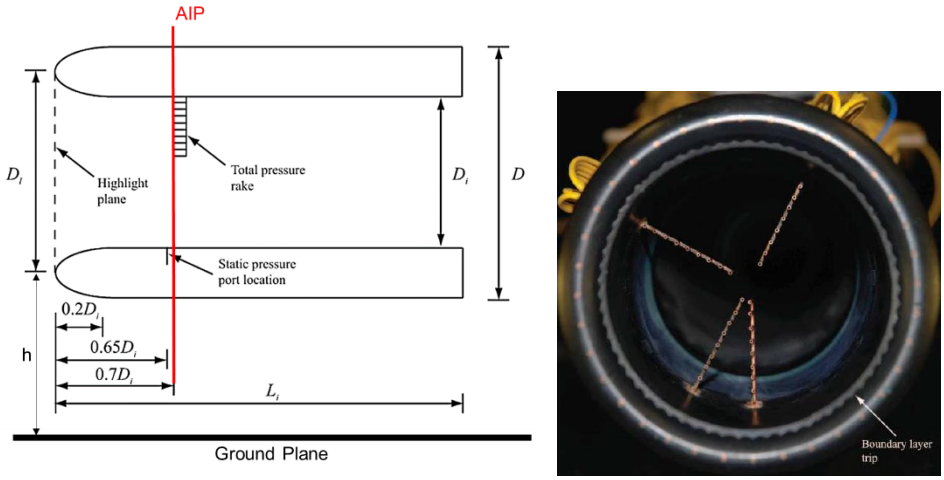

Figure 1.—Experimental configuration for axisymmetric inlet with inner diameter of 100mm and a lip diameter of 120mm. Total pressure is measured with 4 rakes each with 9 probes. The assembly is rotated in order to increase the measurement resolution at the AIP.

The computational domain provided by the committee, BL reporting location (Station A), and typical boundary conditions are presented in Figure 2. Note that the coordinate system that was established based on the headwind condition, and as such has flow in the Y direction for the crosswind condition. Note that the origin is at the center of the inlet at the beginning of the constant cross-section, placing the inlet highlight at -0.02m. The ground plane BL was measured in the tunnel at the location of the inlet centerline, but with an empty tunnel. The BL profiles for the requested conditions provided below should result in the measured BL at the measurement location. However, as the computation domain includes the inlet, the committee requests BL profiles 1m upstream of the inlet, at "Station A". The process for moving the measured BL to the inflow boundary is outlined below should participants wish to create new domains or simulate other conditions.

The provided grids were generated by Pointwise, and are hosted on their server. The PAW05 website will have the latest links to access the grids. Trends with grid refinement are of keen interest to the community as data are rarely available early in the design process for validation of grid refinement and solver parameters. Participants who desire to generate their own grids should note, with reasoning, regions of significant departure from the provided grid resolution. Participants should provide results on at least three grid levels of the same family for evaluation of grid convergence.

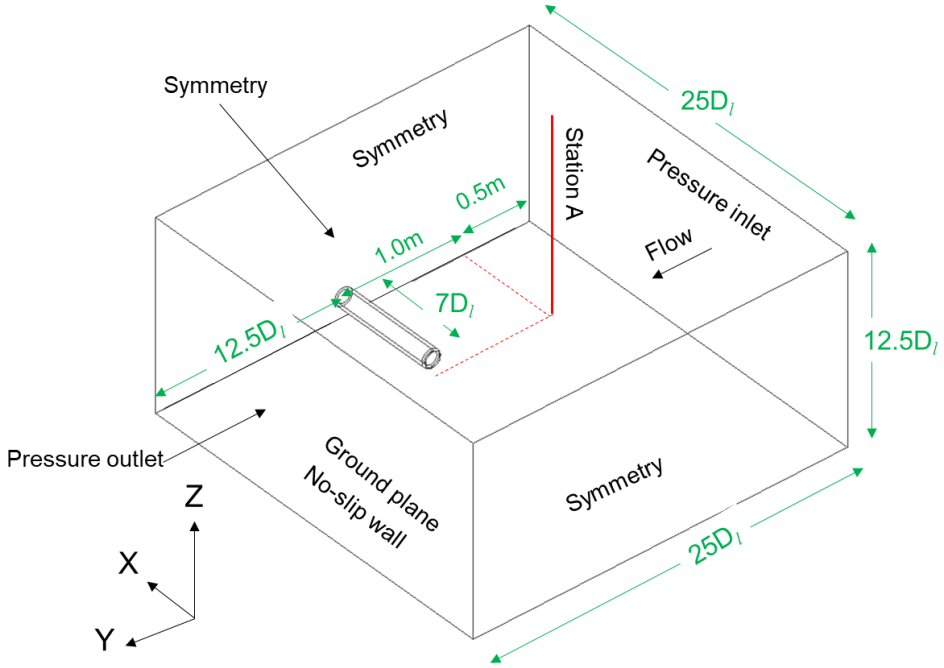

Figure 2.—Computation domain of experimental setup with boundary conditions for the crosswind configuration. Participants to report BL profile 1m upstream of the inlet highlight, at "Station A".

3. Flow Conditions and Boundary Layer Profiles: The crosswind conditions of interest from the test are shown in Table 1. Participants are encourage to conduct further study to evaluate sensitivities and simulation procedures. The inlet conditions listed are all derived from the inlet static and total pressures measurements, assuming constant total temperature.

Table 1. Crosswind Operating Conditions for h/D_l=0.25

Case	Pt_∞(Pa)	Tt_∞(K)	U_∞ (m/s)	U*	$mdot_i$ (kg/s)
1	100,882.7	290	9.917	18.339	1.46
2	100,910.0	290	20.004	9.095	1.46
3	100,994.6	290	35.438	5.249	1.46

The incoming BL in the test was found to follow Equation 1 with an average δ of 0.124m and n of 8.28. In order to replicate the measured BL, the input profile is assumed to grow according to Equation 2. Solving Equation 2 for x using the average measured δ yields the length needed to generate the BL height. This length, reduced by the distance from the inflow boundary to inlet centerline, is the new distance over which the BL needs to develop prior to entering the domain. Equation 2 with the new distance yields the δ at the inflow than can be used in Equation 1 to define the inflow BL profile. For the domain provided by the committee, shown in Figure 2, the ground plane boundary profile would be: $u(y)=U_\infty*(y/0.104)^{(1/8.28)}$. Additional flow condition information, BL measurements, and details of the experiment can be found in Murphy's thesis[1] and paper[2] on the crosswind conditions.

$$\frac{y}{\delta} = \left(\frac{u(y)}{U_\infty}\right)^n \quad (1)$$

$$\frac{\delta}{x} \approx \frac{0.16}{Re_x^{1/7}} \quad (2)$$

4. Required Output: The output for each simulation should include the ground plane boundary layer velocity profile (in m/s) and the inlet static and total pressures (in Pa) at the points shown in Figure 3 and defined in the Appendix. The BL profile should be provided at the intersection of the inlet highlight plane and a plane 1m upstream of the inlet centerline. For the provided grids, this would be line in the Z-direction going through the point (-0.02, -1.0, -0.09) in meters. Should participants use a different coordinate system, results should be transformed to the provided system for ease of comparison. Note that the total pressure rake is not symmetric, with more resolution on the lower, upstream side. Each submission should include details of the simulation such as primary contact, organization, solver, turbulence model, grid type, initial y+, grid count (cells or nodes), and integrated inlet mass flow.

   Data must be submitted through the provided Excel template or a Tecplot point-formatted file. The DC60 calculation used by the committee assumes points are order according to the tables in the appendix, **it is the participant's responsibility to ensure data is submitted in the correct order**.

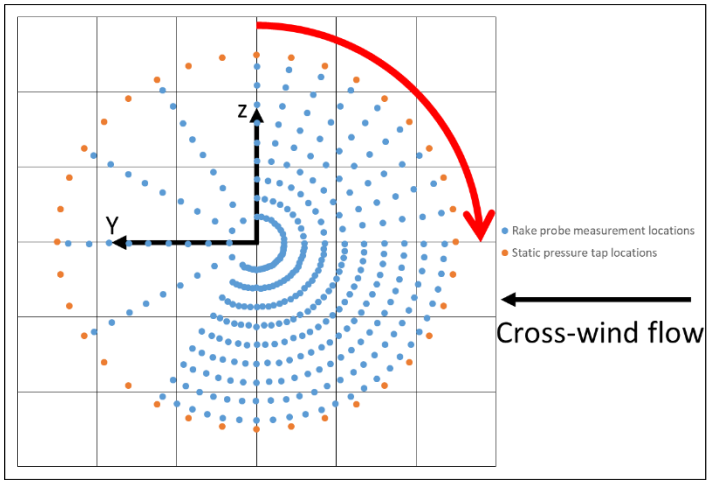

Figure A-1: Total and static pressure measurement locations looking into inlet. Theta 0 is the 12 o'clock position increasing in the clockwise direction.

References

1. Murphy, J., “Intake Ground Vortex Aerodynamics”, PhD thesis, Cranfield University, 2008.
2. J. P. Murphy, D. G. MacManus, “Ground vortex aerodynamics under crosswind conditions”, Exp Fluids (2011) 50:109–124
   DOI: 10.1007/s00348-010-0902-4

Appendix

Table A-2: Inlet Static Pressure

Tap #	Theta (°)	X (m)	Y (m)	Z (m)
1	9.0000E+01	4.5000E-02	-5.0000E-02	0.0000E+00
2	8.0000E+01	4.5000E-02	-4.9240E-02	8.6824E-03
3	7.0000E+01	4.5000E-02	-4.6985E-02	1.7101E-02
4	6.0000E+01	4.5000E-02	-4.3301E-02	2.5000E-02
5	5.0000E+01	4.5000E-02	-3.8302E-02	3.2139E-02
6	4.0000E+01	4.5000E-02	-3.2139E-02	3.8302E-02
7	3.0000E+01	4.5000E-02	-2.5000E-02	4.3301E-02
8	2.0000E+01	4.5000E-02	-1.7101E-02	4.6985E-02
9	1.0000E+01	4.5000E-02	-8.6824E-03	4.9240E-02
10	3.6000E+02	4.5000E-02	2.5517E-13	5.0000E-02
11	3.5000E+02	4.5000E-02	8.6824E-03	4.9240E-02
12	3.4000E+02	4.5000E-02	1.7101E-02	4.6985E-02
13	3.3000E+02	4.5000E-02	2.5000E-02	4.3301E-02
14	3.2000E+02	4.5000E-02	3.2139E-02	3.8302E-02
15	3.1000E+02	4.5000E-02	3.8302E-02	3.2139E-02
16	3.0000E+02	4.5000E-02	4.3301E-02	2.5000E-02
17	2.9000E+02	4.5000E-02	4.6985E-02	1.7101E-02
18	2.8000E+02	4.5000E-02	4.9240E-02	8.6824E-03
19	2.7000E+02	4.5000E-02	5.0000E-02	-5.1034E-13
20	2.6000E+02	4.5000E-02	4.9240E-02	-8.6824E-03
21	2.5000E+02	4.5000E-02	4.6985E-02	-1.7101E-02
22	2.4000E+02	4.5000E-02	4.3301E-02	-2.5000E-02
23	2.3000E+02	4.5000E-02	3.8302E-02	-3.2139E-02
24	2.2000E+02	4.5000E-02	3.2139E-02	-3.8302E-02
25	2.1000E+02	4.5000E-02	2.5000E-02	-4.3301E-02
26	2.0000E+02	4.5000E-02	1.7101E-02	-4.6985E-02
27	1.9000E+02	4.5000E-02	8.6824E-03	-4.9240E-02
28	1.8000E+02	4.5000E-02	-7.6551E-13	-5.0000E-02
29	1.7000E+02	4.5000E-02	-8.6824E-03	-4.9240E-02
30	1.6000E+02	4.5000E-02	-1.7101E-02	-4.6985E-02
31	1.5000E+02	4.5000E-02	-2.5000E-02	-4.3301E-02
32	1.4000E+02	4.5000E-02	-3.2139E-02	-3.8302E-02
33	1.3000E+02	4.5000E-02	-3.8302E-02	-3.2139E-02
34	1.2000E+02	4.5000E-02	-4.3301E-02	-2.5000E-02
35	1.1000E+02	4.5000E-02	-4.6985E-02	-1.7101E-02
36	1.0000E+02	4.5000E-02	-4.9240E-02	-8.6824E-03

Table A-3: Inlet Total Pressure

Tap #	R (m)	Theta (°)	X (m)	Y (m)	Z (m)
1	6.7600E-03	4.7377E-01	5.0000E-02	-5.5897E-05	6.7598E-03
2	1.1676E-02	2.7429E-01	5.0000E-02	-5.5897E-05	1.1676E-02
3	1.6704E-02	1.9173E-01	5.0000E-02	-5.5897E-05	1.6704E-02
4	2.1620E-02	1.4813E-01	5.0000E-02	-5.5897E-05	2.1620E-02
5	2.6536E-02	1.2069E-01	5.0000E-02	-5.5897E-05	2.6536E-02
6	3.1788E-02	1.0075E-01	5.0000E-02	-5.5897E-05	3.1788E-02
7	3.6704E-02	8.7257E-02	5.0000E-02	-5.5897E-05	3.6704E-02
8	4.1844E-02	7.6539E-02	5.0000E-02	-5.5897E-05	4.1844E-02
9	4.6872E-02	6.8329E-02	5.0000E-02	-5.5897E-05	4.6872E-02
10	6.7508E-03	1.0008E+01	5.0000E-02	-1.1732E-03	6.6480E-03
11	1.1638E-02	1.0231E+01	5.0000E-02	-2.0670E-03	1.1453E-02
12	1.6505E-02	9.9405E+00	5.0000E-02	-2.8491E-03	1.6257E-02
13	2.1722E-02	9.9225E+00	5.0000E-02	-3.7430E-03	2.1397E-02
14	2.6718E-02	9.9940E+00	5.0000E-02	-4.6368E-03	2.6313E-02
15	3.1825E-02	1.0008E+01	5.0000E-02	-5.5307E-03	3.1341E-02
16	3.6712E-02	1.0079E+01	5.0000E-02	-6.4245E-03	3.6145E-02
17	4.1819E-02	1.0079E+01	5.0000E-02	-7.3184E-03	4.1173E-02
18	4.6686E-02	9.9920E+00	5.0000E-02	-8.1005E-03	4.5978E-02
19	6.7950E-03	2.1714E+01	5.0000E-02	-2.5139E-03	6.3128E-03
20	1.1632E-02	2.0524E+01	5.0000E-02	-4.0782E-03	1.0894E-02
21	1.6720E-02	2.0130E+01	5.0000E-02	-5.7542E-03	1.5698E-02
22	2.1846E-02	2.0196E+01	5.0000E-02	-7.5419E-03	2.0503E-02
23	2.6763E-02	2.0402E+01	5.0000E-02	-9.3296E-03	2.5084E-02
24	3.1602E-02	2.0165E+01	5.0000E-02	-1.0894E-02	2.9665E-02
25	3.6728E-02	2.0199E+01	5.0000E-02	-1.2682E-02	3.4469E-02
26	4.1778E-02	1.9937E+01	5.0000E-02	-1.4246E-02	3.9274E-02
27	4.6837E-02	2.0164E+01	5.0000E-02	-1.6145E-02	4.3966E-02
28	6.8644E-03	3.3043E+01	5.0000E-02	-3.7430E-03	5.7542E-03
29	1.1650E-02	3.0869E+01	5.0000E-02	-5.9776E-03	1.0000E-02
30	1.6862E-02	3.0899E+01	5.0000E-02	-8.6592E-03	1.4469E-02
31	2.1655E-02	3.0203E+01	5.0000E-02	-1.0894E-02	1.8715E-02
32	2.6674E-02	3.0593E+01	5.0000E-02	-1.3575E-02	2.2961E-02
33	3.1813E-02	3.0032E+01	5.0000E-02	-1.5922E-02	2.7542E-02
34	3.6928E-02	3.0250E+01	5.0000E-02	-1.8603E-02	3.1899E-02
35	4.1834E-02	3.0229E+01	5.0000E-02	-2.1061E-02	3.6145E-02
36	4.6893E-02	3.0261E+01	5.0000E-02	-2.3631E-02	4.0503E-02
37	6.7229E-03	4.2306E+01	5.0000E-02	-4.5251E-03	4.9721E-03
38	1.1641E-02	4.1108E+01	5.0000E-02	-7.6536E-03	8.7709E-03
39	1.6791E-02	4.0953E+01	5.0000E-02	-1.1006E-02	1.2682E-02
40	2.1711E-02	4.0617E+01	5.0000E-02	-1.4134E-02	1.6480E-02
41	2.6874E-02	4.0278E+01	5.0000E-02	-1.7374E-02	2.0503E-02
42	3.1855E-02	4.0590E+01	5.0000E-02	-2.0726E-02	2.4190E-02
43	3.6703E-02	4.0308E+01	5.0000E-02	-2.3743E-02	2.7989E-02

44	4.1841E-02	4.0560E+01	5.0000E-02	-2.7207E-02	3.1788E-02
45	4.6932E-02	4.0268E+01	5.0000E-02	-3.0335E-02	3.5810E-02
46	6.7618E-03	5.1710E+01	5.0000E-02	-5.3072E-03	4.1899E-03
47	1.1682E-02	5.1212E+01	5.0000E-02	-9.1061E-03	7.3184E-03
48	1.6691E-02	5.1250E+01	5.0000E-02	-1.3017E-02	1.0447E-02
49	2.1839E-02	5.0814E+01	5.0000E-02	-1.6927E-02	1.3799E-02
50	2.6760E-02	5.0761E+01	5.0000E-02	-2.0726E-02	1.6927E-02
51	3.1737E-02	5.0285E+01	5.0000E-02	-2.4413E-02	2.0279E-02
52	3.6745E-02	5.0429E+01	5.0000E-02	-2.8324E-02	2.3408E-02
53	4.1981E-02	5.0399E+01	5.0000E-02	-3.2346E-02	2.6760E-02
54	4.6887E-02	5.0221E+01	5.0000E-02	-3.6033E-02	3.0000E-02
55	6.8717E-03	6.2393E+01	5.0000E-02	-6.0894E-03	3.1844E-03
56	1.1722E-02	6.1847E+01	5.0000E-02	-1.0335E-02	5.5307E-03
57	1.6930E-02	6.0982E+01	5.0000E-02	-1.4804E-02	8.2123E-03
58	2.1933E-02	6.0889E+01	5.0000E-02	-1.9162E-02	1.0670E-02
59	2.6893E-02	6.0506E+01	5.0000E-02	-2.3408E-02	1.3240E-02
60	3.1993E-02	6.0615E+01	5.0000E-02	-2.7877E-02	1.5698E-02
61	3.6705E-02	6.0352E+01	5.0000E-02	-3.1899E-02	1.8156E-02
62	4.1957E-02	6.0397E+01	5.0000E-02	-3.6480E-02	2.0726E-02
63	4.6905E-02	6.0534E+01	5.0000E-02	-4.0838E-02	2.3073E-02
64	6.9619E-03	7.2728E+01	5.0000E-02	-6.6480E-03	2.0670E-03
65	1.1695E-02	7.1911E+01	5.0000E-02	-1.1117E-02	3.6313E-03
66	1.6995E-02	7.1803E+01	5.0000E-02	-1.6145E-02	5.3073E-03
67	2.1907E-02	7.1103E+01	5.0000E-02	-2.0726E-02	7.0950E-03
68	2.6995E-02	7.1040E+01	5.0000E-02	-2.5531E-02	8.7709E-03
69	3.1909E-02	7.0677E+01	5.0000E-02	-3.0112E-02	1.0559E-02
70	3.6855E-02	7.0796E+01	5.0000E-02	-3.4804E-02	1.2123E-02
71	4.1912E-02	7.0454E+01	5.0000E-02	-3.9497E-02	1.4022E-02
72	4.7069E-02	7.0662E+01	5.0000E-02	-4.4413E-02	1.5587E-02
73	6.9224E-03	8.3047E+01	5.0000E-02	-6.8715E-03	8.3799E-04
74	1.1884E-02	8.2708E+01	5.0000E-02	-1.1788E-02	1.5084E-03
75	1.7002E-02	8.1497E+01	5.0000E-02	-1.6816E-02	2.5140E-03
76	2.1887E-02	8.1043E+01	5.0000E-02	-2.1620E-02	3.4078E-03
77	2.6901E-02	8.0557E+01	5.0000E-02	-2.6536E-02	4.4134E-03
78	3.2081E-02	8.0882E+01	5.0000E-02	-3.1676E-02	5.0838E-03
79	3.7095E-02	8.0552E+01	5.0000E-02	-3.6592E-02	6.0894E-03
80	4.2165E-02	8.0775E+01	5.0000E-02	-4.1620E-02	6.7598E-03
81	4.7069E-02	8.0504E+01	5.0000E-02	-4.6425E-02	7.7654E-03
82	6.8771E-03	9.2328E+01	5.0000E-02	-6.8715E-03	-2.7933E-04
83	1.2017E-02	9.1865E+01	5.0000E-02	-1.2011E-02	-3.9106E-04
84	1.7155E-02	9.1306E+01	5.0000E-02	-1.7151E-02	-3.9106E-04
85	2.2184E-02	9.1299E+01	5.0000E-02	-2.2179E-02	-5.0279E-04
86	2.6988E-02	9.1068E+01	5.0000E-02	-2.6983E-02	-5.0279E-04
87	3.2125E-02	9.0697E+01	5.0000E-02	-3.2123E-02	-3.9106E-04
88	3.7041E-02	9.0605E+01	5.0000E-02	-3.7039E-02	-3.9106E-04

89	4.1958E-02	9.0687E+01	5.0000E-02	-4.1955E-02	-5.0279E-04
90	4.7209E-02	9.0610E+01	5.0000E-02	-4.7207E-02	-5.0279E-04
91	6.9709E-03	9.9689E+01	5.0000E-02	-6.8715E-03	-1.1732E-03
92	1.2105E-02	9.7158E+01	5.0000E-02	-1.2011E-02	-1.5084E-03
93	1.7027E-02	9.6216E+01	5.0000E-02	-1.6927E-02	-1.8436E-03
94	2.2197E-02	9.6213E+01	5.0000E-02	-2.2067E-02	-2.4022E-03
95	2.7122E-02	9.5793E+01	5.0000E-02	-2.6983E-02	-2.7374E-03
96	3.2169E-02	9.5681E+01	5.0000E-02	-3.2011E-02	-3.1844E-03
97	3.7105E-02	9.5616E+01	5.0000E-02	-3.6927E-02	-3.6313E-03
98	4.2264E-02	9.5537E+01	5.0000E-02	-4.2067E-02	-4.0782E-03
99	4.7089E-02	9.5514E+01	5.0000E-02	-4.6871E-02	-4.5251E-03
100	6.9512E-03	1.0348E+02	5.0000E-02	-6.7597E-03	-1.6201E-03
101	1.2030E-02	1.0152E+02	5.0000E-02	-1.1788E-02	-2.4022E-03
102	1.7157E-02	1.0146E+02	5.0000E-02	-1.6816E-02	-3.4078E-03
103	2.2263E-02	1.0114E+02	5.0000E-02	-2.1844E-02	-4.3017E-03
104	2.7129E-02	1.0080E+02	5.0000E-02	-2.6648E-02	-5.0838E-03
105	3.2214E-02	1.0049E+02	5.0000E-02	-3.1676E-02	-5.8659E-03
106	3.7012E-02	1.0070E+02	5.0000E-02	-3.6369E-02	-6.8715E-03
107	4.2228E-02	1.0060E+02	5.0000E-02	-4.1508E-02	-7.7654E-03
108	4.7205E-02	1.0043E+02	5.0000E-02	-4.6425E-02	-8.5475E-03
109	7.1022E-03	1.0786E+02	5.0000E-02	-6.7597E-03	-2.1788E-03
110	1.2121E-02	1.0743E+02	5.0000E-02	-1.1564E-02	-3.6313E-03
111	1.6968E-02	1.0665E+02	5.0000E-02	-1.6257E-02	-4.8603E-03
112	2.2139E-02	1.0597E+02	5.0000E-02	-2.1285E-02	-6.0894E-03
113	2.7234E-02	1.0583E+02	5.0000E-02	-2.6201E-02	-7.4302E-03
114	3.2222E-02	1.0580E+02	5.0000E-02	-3.1006E-02	-8.7709E-03
115	3.7180E-02	1.0560E+02	5.0000E-02	-3.5810E-02	-1.0000E-02
116	4.2168E-02	1.0560E+02	5.0000E-02	-4.0614E-02	-1.1341E-02
117	4.7264E-02	1.0556E+02	5.0000E-02	-4.5531E-02	-1.2682E-02
118	7.2328E-03	1.1320E+02	5.0000E-02	-6.6480E-03	-2.8492E-03
119	1.2107E-02	1.1195E+02	5.0000E-02	-1.1229E-02	-4.5251E-03
120	1.7151E-02	1.1080E+02	5.0000E-02	-1.6033E-02	-6.0894E-03
121	2.2213E-02	1.1108E+02	5.0000E-02	-2.0726E-02	-7.9888E-03
122	2.7194E-02	1.1082E+02	5.0000E-02	-2.5419E-02	-9.6648E-03
123	3.2176E-02	1.1064E+02	5.0000E-02	-3.0112E-02	-1.1341E-02
124	3.7198E-02	1.1067E+02	5.0000E-02	-3.4804E-02	-1.3128E-02
125	4.2324E-02	1.1064E+02	5.0000E-02	-3.9609E-02	-1.4916E-02
126	4.7163E-02	1.1045E+02	5.0000E-02	-4.4190E-02	-1.6480E-02
127	7.2724E-03	1.1794E+02	5.0000E-02	-6.4245E-03	-3.4078E-03
128	1.2118E-02	1.1716E+02	5.0000E-02	-1.0782E-02	-5.5307E-03
129	1.7264E-02	1.1632E+02	5.0000E-02	-1.5475E-02	-7.6536E-03
130	2.2312E-02	1.1599E+02	5.0000E-02	-2.0056E-02	-9.7765E-03
131	2.7259E-02	1.1588E+02	5.0000E-02	-2.4525E-02	-1.1899E-02
132	3.2207E-02	1.1581E+02	5.0000E-02	-2.8994E-02	-1.4022E-02
133	3.7207E-02	1.1553E+02	5.0000E-02	-3.3575E-02	-1.6034E-02

134	4.2304E-02	1.1558E+02	5.0000E-02	-3.8156E-02	-1.8268E-02
135	4.7353E-02	1.1551E+02	5.0000E-02	-4.2737E-02	-2.0391E-02
136	7.2069E-03	1.2234E+02	5.0000E-02	-6.0894E-03	-3.8547E-03
137	1.2323E-02	1.2203E+02	5.0000E-02	-1.0447E-02	-6.5363E-03
138	1.7227E-02	1.2147E+02	5.0000E-02	-1.4693E-02	-8.9944E-03
139	2.2285E-02	1.2126E+02	5.0000E-02	-1.9050E-02	-1.1564E-02
140	2.7286E-02	1.2092E+02	5.0000E-02	-2.3408E-02	-1.4022E-02
141	3.2096E-02	1.2090E+02	5.0000E-02	-2.7542E-02	-1.6480E-02
142	3.7290E-02	1.2052E+02	5.0000E-02	-3.2123E-02	-1.8939E-02
143	4.2406E-02	1.2065E+02	5.0000E-02	-3.6480E-02	-2.1620E-02
144	4.7351E-02	1.2041E+02	5.0000E-02	-4.0838E-02	-2.3966E-02
145	7.3408E-03	1.2696E+02	5.0000E-02	-5.8659E-03	-4.4134E-03
146	1.2369E-02	1.2692E+02	5.0000E-02	-9.8882E-03	-7.4302E-03
147	1.7263E-02	1.2631E+02	5.0000E-02	-1.3911E-02	-1.0223E-02
148	2.2315E-02	1.2604E+02	5.0000E-02	-1.8045E-02	-1.3128E-02
149	2.7277E-02	1.2600E+02	5.0000E-02	-2.2067E-02	-1.6034E-02
150	3.2354E-02	1.2558E+02	5.0000E-02	-2.6313E-02	-1.8827E-02
151	3.7251E-02	1.2548E+02	5.0000E-02	-3.0335E-02	-2.1620E-02
152	4.2369E-02	1.2556E+02	5.0000E-02	-3.4469E-02	-2.4637E-02
153	4.7448E-02	1.2532E+02	5.0000E-02	-3.8715E-02	-2.7430E-02
154	7.2793E-03	1.3189E+02	5.0000E-02	-5.4190E-03	-4.8603E-03
155	1.2262E-02	1.3205E+02	5.0000E-02	-9.1061E-03	-8.2123E-03
156	1.7264E-02	1.3106E+02	5.0000E-02	-1.3017E-02	-1.1341E-02
157	2.2330E-02	1.3115E+02	5.0000E-02	-1.6816E-02	-1.4693E-02
158	2.7407E-02	1.3087E+02	5.0000E-02	-2.0726E-02	-1.7933E-02
159	3.2243E-02	1.3078E+02	5.0000E-02	-2.4413E-02	-2.1061E-02
160	3.7248E-02	1.3050E+02	5.0000E-02	-2.8324E-02	-2.4190E-02
161	4.2326E-02	1.3040E+02	5.0000E-02	-3.2235E-02	-2.7430E-02
162	4.7319E-02	1.3040E+02	5.0000E-02	-3.6033E-02	-3.0670E-02
163	7.2724E-03	1.3687E+02	5.0000E-02	-4.9720E-03	-5.3073E-03
164	1.2408E-02	1.3646E+02	5.0000E-02	-8.5474E-03	-8.9944E-03
165	1.7225E-02	1.3579E+02	5.0000E-02	-1.2011E-02	-1.2346E-02
166	2.2283E-02	1.3602E+02	5.0000E-02	-1.5475E-02	-1.6034E-02
167	2.7339E-02	1.3583E+02	5.0000E-02	-1.9050E-02	-1.9609E-02
168	3.2315E-02	1.3556E+02	5.0000E-02	-2.2626E-02	-2.3073E-02
169	3.7371E-02	1.3548E+02	5.0000E-02	-2.6201E-02	-2.6648E-02
170	4.2349E-02	1.3553E+02	5.0000E-02	-2.9665E-02	-3.0223E-02
171	4.7483E-02	1.3519E+02	5.0000E-02	-3.3464E-02	-3.3687E-02
172	7.3203E-03	1.4182E+02	5.0000E-02	-4.5251E-03	-5.7542E-03
173	1.2328E-02	1.4162E+02	5.0000E-02	-7.6536E-03	-9.6648E-03
174	1.7493E-02	1.4148E+02	5.0000E-02	-1.0894E-02	-1.3687E-02
175	2.2468E-02	1.4065E+02	5.0000E-02	-1.4246E-02	-1.7374E-02
176	2.7389E-02	1.4063E+02	5.0000E-02	-1.7374E-02	-2.1173E-02
177	3.2381E-02	1.4046E+02	5.0000E-02	-2.0614E-02	-2.4972E-02
178	3.7460E-02	1.4045E+02	5.0000E-02	-2.3855E-02	-2.8883E-02

179	4.2310E-02	1.4057E+02	5.0000E-02	-2.6871E-02	-3.2682E-02
180	4.7460E-02	1.4044E+02	5.0000E-02	-3.0223E-02	-3.6592E-02
181	7.4839E-03	1.4595E+02	5.0000E-02	-4.1899E-03	-6.2011E-03
182	1.2411E-02	1.4638E+02	5.0000E-02	-6.8715E-03	-1.0335E-02
183	1.7463E-02	1.4595E+02	5.0000E-02	-9.7765E-03	-1.4469E-02
184	2.2486E-02	1.4532E+02	5.0000E-02	-1.2793E-02	-1.8492E-02
185	2.7412E-02	1.4563E+02	5.0000E-02	-1.5475E-02	-2.2626E-02
186	3.2464E-02	1.4552E+02	5.0000E-02	-1.8380E-02	-2.6760E-02
187	3.7361E-02	1.4548E+02	5.0000E-02	-2.1173E-02	-3.0782E-02
188	4.2449E-02	1.4508E+02	5.0000E-02	-2.4302E-02	-3.4804E-02
189	4.7466E-02	1.4536E+02	5.0000E-02	-2.6983E-02	-3.9050E-02
190	7.3255E-03	1.5129E+02	5.0000E-02	-3.5195E-03	-6.4246E-03
191	1.2426E-02	1.5125E+02	5.0000E-02	-5.9776E-03	-1.0894E-02
192	1.7483E-02	1.5073E+02	5.0000E-02	-8.5474E-03	-1.5251E-02
193	2.2237E-02	1.5067E+02	5.0000E-02	-1.0894E-02	-1.9385E-02
194	2.7489E-02	1.5067E+02	5.0000E-02	-1.3464E-02	-2.3966E-02
195	3.2561E-02	1.5005E+02	5.0000E-02	-1.6257E-02	-2.8212E-02
196	3.7453E-02	1.5041E+02	5.0000E-02	-1.8492E-02	-3.2570E-02
197	4.2414E-02	1.5023E+02	5.0000E-02	-2.1061E-02	-3.6816E-02
198	4.7570E-02	1.5021E+02	5.0000E-02	-2.3631E-02	-4.1285E-02
199	7.3238E-03	1.5519E+02	5.0000E-02	-3.0726E-03	-6.6480E-03
200	1.2428E-02	1.5585E+02	5.0000E-02	-5.0838E-03	-1.1341E-02
201	1.7431E-02	1.5598E+02	5.0000E-02	-7.0949E-03	-1.5922E-02
202	2.2582E-02	1.5591E+02	5.0000E-02	-9.2178E-03	-2.0615E-02
203	2.7473E-02	1.5536E+02	5.0000E-02	-1.1452E-02	-2.4972E-02
204	3.2467E-02	1.5507E+02	5.0000E-02	-1.3687E-02	-2.9441E-02
205	3.7469E-02	1.5523E+02	5.0000E-02	-1.5698E-02	-3.4022E-02
206	4.2370E-02	1.5529E+02	5.0000E-02	-1.7709E-02	-3.8492E-02
207	4.7521E-02	1.5533E+02	5.0000E-02	-1.9832E-02	-4.3184E-02
208	7.3169E-03	1.5991E+02	5.0000E-02	-2.5139E-03	-6.8715E-03
209	1.2473E-02	1.6092E+02	5.0000E-02	-4.0782E-03	-1.1788E-02
210	1.7456E-02	1.6075E+02	5.0000E-02	-5.7542E-03	-1.6480E-02
211	2.2582E-02	1.6049E+02	5.0000E-02	-7.5419E-03	-2.1285E-02
212	2.7249E-02	1.6023E+02	5.0000E-02	-9.2178E-03	-2.5642E-02
213	3.2375E-02	1.6013E+02	5.0000E-02	-1.1006E-02	-3.0447E-02
214	3.7501E-02	1.6005E+02	5.0000E-02	-1.2793E-02	-3.5251E-02
215	4.2589E-02	1.6014E+02	5.0000E-02	-1.4469E-02	-4.0056E-02
216	4.7610E-02	1.6003E+02	5.0000E-02	-1.6257E-02	-4.4749E-02
217	7.3595E-03	1.6459E+02	5.0000E-02	-1.9553E-03	-7.0950E-03
218	1.2426E-02	1.6515E+02	5.0000E-02	-3.1843E-03	-1.2011E-02
219	1.7465E-02	1.6574E+02	5.0000E-02	-4.3016E-03	-1.6927E-02
220	2.2452E-02	1.6545E+02	5.0000E-02	-5.6424E-03	-2.1732E-02
221	2.7548E-02	1.6532E+02	5.0000E-02	-6.9832E-03	-2.6648E-02
222	3.2643E-02	1.6523E+02	5.0000E-02	-8.3240E-03	-3.1564E-02
223	3.7494E-02	1.6524E+02	5.0000E-02	-9.5530E-03	-3.6257E-02

224	4.2562E-02	1.6533E+02	5.0000E-02	-1.0782E-02	-4.1173E-02
225	4.7578E-02	1.6510E+02	5.0000E-02	-1.2235E-02	-4.5978E-02
226	7.3408E-03	1.6903E+02	5.0000E-02	-1.3966E-03	-7.2067E-03
227	1.2408E-02	1.7041E+02	5.0000E-02	-2.0670E-03	-1.2235E-02
228	1.7515E-02	1.7027E+02	5.0000E-02	-2.9609E-03	-1.7263E-02
229	2.2603E-02	1.7047E+02	5.0000E-02	-3.7430E-03	-2.2291E-02
230	2.7580E-02	1.7056E+02	5.0000E-02	-4.5251E-03	-2.7207E-02
231	3.2725E-02	1.7007E+02	5.0000E-02	-5.6424E-03	-3.2235E-02
232	3.7665E-02	1.7052E+02	5.0000E-02	-6.2011E-03	-3.7151E-02
233	4.2608E-02	1.6996E+02	5.0000E-02	-7.4301E-03	-4.1955E-02
234	4.7495E-02	1.6991E+02	5.0000E-02	-8.3240E-03	-4.6760E-02
235	7.3663E-03	1.7347E+02	5.0000E-02	-8.3796E-04	-7.3184E-03
236	1.2503E-02	1.7513E+02	5.0000E-02	-1.0614E-03	-1.2458E-02
237	1.7328E-02	1.7501E+02	5.0000E-02	-1.5083E-03	-1.7263E-02
238	2.2376E-02	1.7499E+02	5.0000E-02	-1.9553E-03	-2.2291E-02
239	2.7517E-02	1.7546E+02	5.0000E-02	-2.1787E-03	-2.7430E-02
240	3.2462E-02	1.7516E+02	5.0000E-02	-2.7374E-03	-3.2346E-02
241	3.7398E-02	1.7512E+02	5.0000E-02	-3.1843E-03	-3.7263E-02
242	4.2446E-02	1.7509E+02	5.0000E-02	-3.6313E-03	-4.2291E-02
243	4.7605E-02	1.7509E+02	5.0000E-02	-4.0782E-03	-4.7430E-02
244	7.4304E-03	1.8043E+02	5.0000E-02	5.5897E-05	-7.4302E-03
245	1.2235E-02	1.8026E+02	5.0000E-02	5.5897E-05	-1.2235E-02
246	1.7374E-02	1.7982E+02	5.0000E-02	-5.5835E-05	-1.7374E-02
247	2.2626E-02	1.8014E+02	5.0000E-02	5.5897E-05	-2.2626E-02
248	2.7430E-02	1.7988E+02	5.0000E-02	-5.5835E-05	-2.7430E-02
249	3.2570E-02	1.8010E+02	5.0000E-02	5.5897E-05	-3.2570E-02
250	3.7598E-02	1.8009E+02	5.0000E-02	5.5897E-05	-3.7598E-02
251	4.2514E-02	1.8023E+02	5.0000E-02	1.6763E-04	-4.2514E-02
252	4.7654E-02	1.8007E+02	5.0000E-02	5.5897E-05	-4.7654E-02
253	7.3357E-03	1.8393E+02	5.0000E-02	5.0282E-04	-7.3184E-03
254	1.2392E-02	1.8491E+02	5.0000E-02	1.0615E-03	-1.2346E-02
255	1.7450E-02	1.8533E+02	5.0000E-02	1.6201E-03	-1.7374E-02
256	2.2376E-02	1.8501E+02	5.0000E-02	1.9553E-03	-2.2291E-02
257	2.7646E-02	1.8498E+02	5.0000E-02	2.4023E-03	-2.7542E-02
258	3.2573E-02	1.8482E+02	5.0000E-02	2.7375E-03	-3.2458E-02
259	3.7519E-02	1.8504E+02	5.0000E-02	3.2961E-03	-3.7374E-02
260	4.2557E-02	1.8489E+02	5.0000E-02	3.6313E-03	-4.2402E-02
261	4.7736E-02	1.8517E+02	5.0000E-02	4.3017E-03	-4.7542E-02
262	7.3950E-03	1.8825E+02	5.0000E-02	1.0615E-03	-7.3184E-03
263	1.2408E-02	1.8959E+02	5.0000E-02	2.0671E-03	-1.2235E-02
264	1.7534E-02	1.9009E+02	5.0000E-02	3.0727E-03	-1.7263E-02
265	2.2401E-02	1.8991E+02	5.0000E-02	3.8548E-03	-2.2067E-02
266	2.7489E-02	1.8971E+02	5.0000E-02	4.6369E-03	-2.7095E-02
267	3.2505E-02	1.9000E+02	5.0000E-02	5.6425E-03	-3.2011E-02
268	3.7501E-02	1.9004E+02	5.0000E-02	6.5363E-03	-3.6927E-02

269	4.2699E-02	1.8987E+02	5.0000E-02	7.3185E-03	-4.2067E-02
270	4.7735E-02	1.9018E+02	5.0000E-02	8.4358E-03	-4.6983E-02
271	7.3306E-03	1.9457E+02	5.0000E-02	1.8436E-03	-7.0950E-03
272	1.2398E-02	1.9435E+02	5.0000E-02	3.0727E-03	-1.2011E-02
273	1.7601E-02	1.9452E+02	5.0000E-02	4.4134E-03	-1.7039E-02
274	2.2452E-02	1.9455E+02	5.0000E-02	5.6425E-03	-2.1732E-02
275	2.7576E-02	1.9491E+02	5.0000E-02	7.0950E-03	-2.6648E-02
276	3.2564E-02	1.9501E+02	5.0000E-02	8.4358E-03	-3.1453E-02
277	3.7494E-02	1.9476E+02	5.0000E-02	9.5531E-03	-3.6257E-02
278	4.2698E-02	1.9478E+02	5.0000E-02	1.0894E-02	-4.1285E-02
279	4.7606E-02	1.9503E+02	5.0000E-02	1.2346E-02	-4.5978E-02
280	7.2432E-03	1.9844E+02	5.0000E-02	2.2905E-03	-6.8715E-03
281	1.2405E-02	1.9974E+02	5.0000E-02	4.1900E-03	-1.1676E-02
282	1.7636E-02	1.9981E+02	5.0000E-02	5.9777E-03	-1.6592E-02
283	2.2476E-02	1.9961E+02	5.0000E-02	7.5419E-03	-2.1173E-02
284	2.7392E-02	1.9991E+02	5.0000E-02	9.3296E-03	-2.5754E-02
285	3.2690E-02	1.9967E+02	5.0000E-02	1.1006E-02	-3.0782E-02
286	3.7320E-02	1.9968E+02	5.0000E-02	1.2570E-02	-3.5140E-02
287	4.2551E-02	1.9972E+02	5.0000E-02	1.4358E-02	-4.0056E-02
288	4.7429E-02	1.9976E+02	5.0000E-02	1.6034E-02	-4.4637E-02
289	7.4253E-03	2.0444E+02	5.0000E-02	3.0727E-03	-6.7598E-03
290	1.2428E-02	2.0415E+02	5.0000E-02	5.0838E-03	-1.1341E-02
291	1.7477E-02	2.0435E+02	5.0000E-02	7.2067E-03	-1.5922E-02
292	2.2378E-02	2.0433E+02	5.0000E-02	9.2179E-03	-2.0391E-02
293	2.7381E-02	2.0421E+02	5.0000E-02	1.1229E-02	-2.4972E-02
294	3.2670E-02	2.0477E+02	5.0000E-02	1.3687E-02	-2.9665E-02
295	3.7564E-02	2.0508E+02	5.0000E-02	1.5922E-02	-3.4022E-02
296	4.2417E-02	2.0484E+02	5.0000E-02	1.7821E-02	-3.8492E-02
297	4.7567E-02	2.0479E+02	5.0000E-02	1.9944E-02	-4.3184E-02
298	7.1303E-03	2.0958E+02	5.0000E-02	3.5196E-03	-6.2011E-03
299	1.2231E-02	2.0926E+02	5.0000E-02	5.9777E-03	-1.0670E-02
300	1.7247E-02	2.1014E+02	5.0000E-02	8.6592E-03	-1.4916E-02
301	2.2530E-02	2.0892E+02	5.0000E-02	1.0894E-02	-1.9721E-02
302	2.7503E-02	2.0985E+02	5.0000E-02	1.3687E-02	-2.3855E-02
303	3.2645E-02	2.0942E+02	5.0000E-02	1.6034E-02	-2.8436E-02
304	3.7495E-02	2.0935E+02	5.0000E-02	1.8380E-02	-3.2682E-02
305	4.2359E-02	2.0964E+02	5.0000E-02	2.0950E-02	-3.6816E-02
306	4.7514E-02	2.0967E+02	5.0000E-02	2.3520E-02	-4.1285E-02
307	7.3289E-03	2.3619E+02	5.0000E-02	6.0894E-03	-4.0782E-03
308	1.2360E-02	2.3868E+02	5.0000E-02	1.0559E-02	-6.4246E-03
309	1.7323E-02	2.3872E+02	5.0000E-02	1.4804E-02	-8.9944E-03
310	2.2381E-02	2.3889E+02	5.0000E-02	1.9162E-02	-1.1564E-02
311	2.7229E-02	2.3928E+02	5.0000E-02	2.3408E-02	-1.3911E-02
312	3.2288E-02	2.3931E+02	5.0000E-02	2.7765E-02	-1.6480E-02
313	3.7041E-02	2.3945E+02	5.0000E-02	3.1899E-02	-1.8827E-02

314	4.2253E-02	2.3940E+02	5.0000E-02	3.6369E-02	-2.1508E-02
315	4.7255E-02	2.3952E+02	5.0000E-02	4.0726E-02	-2.3966E-02
316	6.8772E-03	2.6767E+02	5.0000E-02	6.8715E-03	-2.7933E-04
317	1.2129E-02	2.6815E+02	5.0000E-02	1.2123E-02	-3.9106E-04
318	1.7270E-02	2.6833E+02	5.0000E-02	1.7263E-02	-5.0279E-04
319	2.2071E-02	2.6898E+02	5.0000E-02	2.2067E-02	-3.9106E-04
320	2.7210E-02	2.6918E+02	5.0000E-02	2.7207E-02	-3.9106E-04
321	3.2014E-02	2.6930E+02	5.0000E-02	3.2011E-02	-3.9106E-04
322	3.7040E-02	2.6957E+02	5.0000E-02	3.7039E-02	-2.7933E-04
323	4.2070E-02	2.6932E+02	5.0000E-02	4.2067E-02	-5.0279E-04
324	4.7208E-02	2.6953E+02	5.0000E-02	4.7207E-02	-3.9106E-04
325	6.8207E-03	2.9677E+02	5.0000E-02	6.0894E-03	3.0726E-03
326	1.1821E-02	2.9790E+02	5.0000E-02	1.0447E-02	5.5307E-03
327	1.6930E-02	2.9902E+02	5.0000E-02	1.4804E-02	8.2123E-03
328	2.1890E-02	2.9951E+02	5.0000E-02	1.9050E-02	1.0782E-02
329	2.7088E-02	2.9926E+02	5.0000E-02	2.3631E-02	1.3240E-02
330	3.2091E-02	2.9929E+02	5.0000E-02	2.7989E-02	1.5698E-02
331	3.6844E-02	2.9932E+02	5.0000E-02	3.2123E-02	1.8045E-02
332	4.2054E-02	2.9953E+02	5.0000E-02	3.6592E-02	2.0726E-02
333	4.6905E-02	2.9947E+02	5.0000E-02	4.0838E-02	2.3073E-02
334	6.5917E-03	3.2887E+02	5.0000E-02	3.4079E-03	5.6425E-03
335	1.1650E-02	3.2913E+02	5.0000E-02	5.9777E-03	1.0000E-02
336	1.6652E-02	3.2956E+02	5.0000E-02	8.4358E-03	1.4358E-02
337	2.1558E-02	3.2965E+02	5.0000E-02	1.0894E-02	1.8603E-02
338	2.6810E-02	3.2986E+02	5.0000E-02	1.3464E-02	2.3184E-02
339	3.1676E-02	3.2959E+02	5.0000E-02	1.6034E-02	2.7318E-02
340	3.6678E-02	3.2972E+02	5.0000E-02	1.8492E-02	3.1676E-02
341	4.1778E-02	3.2990E+02	5.0000E-02	2.0950E-02	3.6145E-02
342	4.6836E-02	3.2986E+02	5.0000E-02	2.3520E-02	4.0503E-02