REVISIONS

Letter	ECO	Description	Check	Approve	Date
A	36-918	INITIAL RELEASE	WFM		6/23/97

NAME	DATE	MASSACHUSETTS INSTITUTE OF TECHNOLOGY CENTER FOR SPACE RESEARCH
DRAWN: F. Kasparian	6/23/97	
CHECKED: W. Mayer	6/23/97	DEA and DPA Depressuriztion Analysis
APPROVED: B Thurber	6/23/97	
RELEASED: D. Epps	6/24/97	

Scale	Sheet	Size	CAGE Code	Drawing Number	REV
NONE	1 OF 14	T	80230	36-01507	A

1.0 Introduction

An analysis was undertaken to determine the maximum pressure differential during ascent of the ACIS (AXAF CCD Imaging Spectrometer). The two MIT provided electronics units, the DEA (Detector Electronics Assembly) and the DPA (Digital Processor Assembly), were analyzed based on the filter media and the pressure profile of the Space Shuttle Cargo bay during launch as specified in IF1-20, Figure 3.4-2.

2.0 Analytical Approach

The vent filter airflow characteristics were used to determine an equivalent orifice diameter. The mass flow rate was considered instantaneous and was used to calculate the pressure change inside the DPA and DEA. The pressure change rate was used to estimate the new internal pressure. This was compared to the cargo bay pressure and the given time step in the recalculation of the flow properties.

3.0 Assumptions

- The conditions in the DPA and DEA are considered to be a uniform and stable at any given instant in the depressurization.
- The depressurization is assumed quasi-static so the flow equations can be applied at each instant of time. The process is isentropic. The venting air is assume to behave as an ideal gas.
- The internal volumes of the DEA and DPA do not consider the reduction due to the printed wiring boards, connectors, hardware or internal wiring. As such, the gas volume are overstated and provide an extra measure of conservatism to the analysis.
- The SIM pressure profile and the Shuttle Cargo Bay pressure profile are assumed to be identical.
- The calculations for the DEA and DPA are identical with the exception of the total internal volume of each assembly.

4.0 Constants

Volumes

• DEA	V_{DEA}	2095 in^3
• DPA	V_{DPA}	2310 in^3
• Gas Constant for Air	R	53.33 ft-lbf/lbm-^{o}R
• Specific Heat Ratio	k	1.4

5.0 Initial Conditions

Assume that the DPA internal pressure follows the SIM pressure for the first 15 seconds after launch. Assume a slight pressure gradient.

Time from lift-off	t =16 seconds
SIM Pressure	Psim = 13.7 psi
DPA Internal Pressure	Pdpa = 13.71 psi

6.0 Filter Characteristics

The 20 micron filter (165x1400 1 Warp Twilled Dutch Weave) was manufactured by Hydrodyne. The assembly has the following dimensions:

Filter Diameter = D_f=0.69 in

Filter Area:

$$A_{FILTER} = \Pi \bullet \langle \frac{D^2_f}{4} \rangle = 0.373 in^2$$

7.0 Equivalent Orifice Size

The filter properties are specified to have an airflow of 11 CFM for a 1 psi difference per square inch of filter area:

Air = 11 CFM/ in^2 => Q = (11 CFM/ in^2)*(0.373 in^2) = 4.11 CFM for 1 psid (27.68 inches of water)

Based on Manufacturer's data, the equivalent orifice area can be determined by the following relationship:

$$\Delta P = \left(\frac{Q/4000}{A_O} \right)^2 \rightarrow A_o = \frac{Q/4000}{\sqrt{\Delta P}} = \frac{4.11/4000}{\sqrt{27.68}} = 0.00019 ft^2 = 0.028 in^2$$

8.0 Calculation of Flow and Air Properties

Elapsed time from take off 16 seconds

The Mach Number at this instant is determined from the pressure ratio

Stagnation Pressure equals the pressure in the electronics boxes =13.71 psi

Nozzle Exit plane pressure equals the SIM pressure = 13.70 psi

Pressure Ratio:

$$Ratio = \frac{P_{SIM}}{P_{ebox}} = 0.999$$

$$M = \left[\frac{\left(\frac{P_{box}}{P_{SIM}} \right)^{\frac{k-1}{k}} - 1}{\left(\frac{k-1}{k} \right)} \right]^{\frac{1}{2}} = 0.032$$

The nozzle exit plane temperature at this instant can then be determined from the Mach Number

$$T_{exit} = \frac{T_{box}}{\left[1 + \frac{k-1}{2} \bullet M^2 \right]} = 513.893R$$

Mass flow rate:

$$dm = \frac{P_{exit} \bullet A_o \bullet M \bullet (k \bullet R \bullet 32.2 \bullet T_{exit})^{\frac{1}{2}}}{R \bullet T_{exit}} = 0.0050 \frac{lbm}{s}$$

Corresponding housing pressure change

$$dp = \frac{dm \bullet R \bullet 12 \bullet T_{box} \bullet k}{V} = 0.094 \frac{psi}{s}$$

9.0 Flow and Properties at the Next Elapsed Time Interval

Time Interval $\Delta T = 1$ second

Elapsed Time from Lift-off t=17 seconds

New Electronics Box Pressure

$$Pebox_t = Pebox_{t-\Delta t} - dp_{t-\Delta t} \bullet \Delta t = 13.6 psi$$

The SIM pressure = 13.57 psi.

Pressure Ratio:

$$Ratio = \frac{P_{SIM}}{P_{ebox}} = 0.997$$

The new Electronic Box Temperature (based on Isentropic Flow)

$$Tebox = Tebox \bullet \left(\frac{Pebox_t}{Pebox_{t-\Delta t}} \right)^{\frac{k-1}{k}} = 512.92R$$

This process is continued at 1 second intervals following the launch pressure profile.

10.0 Results

Unit	Max ΔP	time after launch
DEA	.412	52
DPA	.388	52

The largest span in both electronics boxes are the -X panels. The panel with the largest load is in the DEA. Consider this panel to be a simply supported plate uniformly loaded. From, Formulas for Stress and Strain, Roark, Fifth Edition, page 386:

$$Max\sigma = \frac{\beta q b^2}{t^2}$$

Where: q = applied load = 0.412 lb/in^2

β = Coefficient based on the ratio of the long side to short side

11.75/11.25 = 1.05 => β= 0.2874

b = short side = 11.25 inches

t = thickness = 0.125 inches

$$Max\sigma = \frac{(0.2874)\ (0.412)\ (11.25)^2}{(0.125)^2} = 959psi$$

The yield strength of 6061-T6 aluminum is 35,000 psi. The Margin of Safety with a factor of Safety of 2.0 is

MS={[Allowbale stress or load]/(F.S.)(Limit stress or load]}-1.0>0

= 35000/{(2)(959)}-1 = 17.25 >> 0

11.0 Conclusion

Based on the above calculation, the pressure differential will not present a structural problem to the panels or components in the DEA or DPA.

FIGURE 1. DEA Depressurization

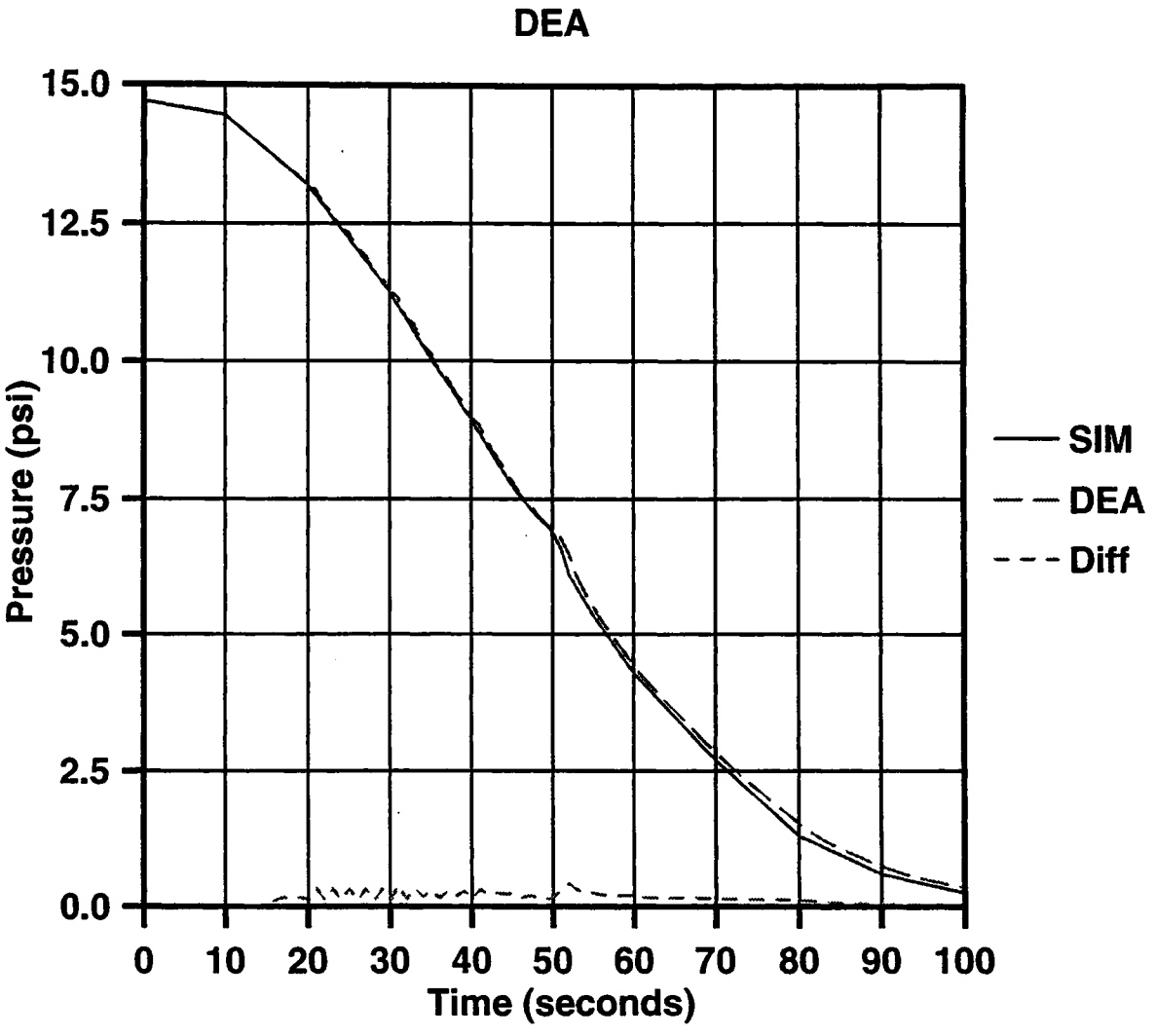
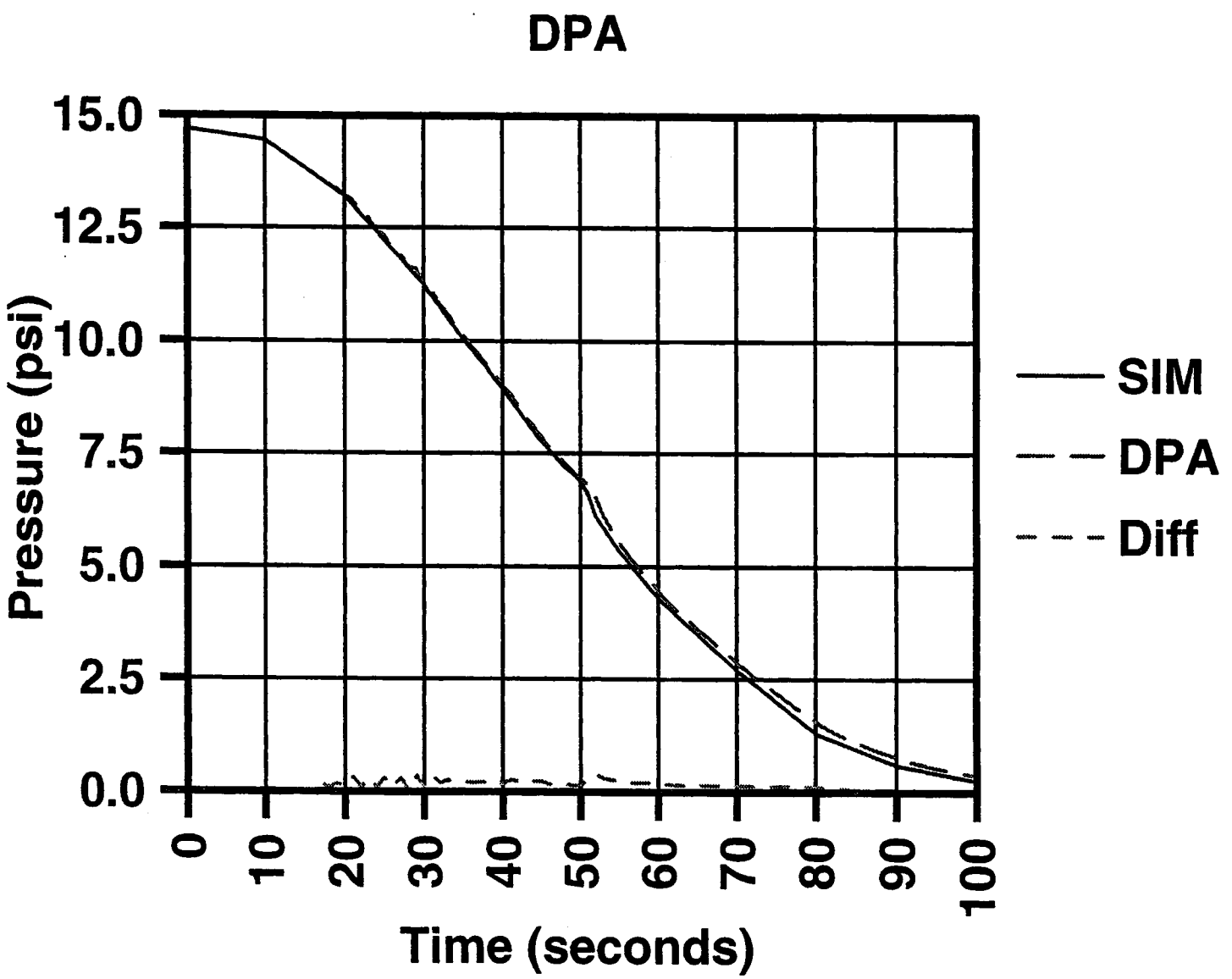


FIGURE 2. DPA Depressuriztion



12.0 DEA Depressurization

TABLE 1.

time	Psim	Pebox	Ratio	Mach #	Tebox	Texit	dm	dP
0	14.7	14.7	-	-	-	-	-	0
1	14.675	14.675	-	-	-	-	-	0
2	14.65	14.65	-	-	-	-	-	0
3	14.625	14.625	-	-	-	-	-	0
4	14.6	14.6	-	-	-	-	-	0
5	14.575	14.575	-	-	-	-	-	0
6	14.55	14.55	-	-	-	-	-	0
7	14.525	14.525	-	-	-	-	-	0
8	14.5	14.5	-	-	-	-	-	0
9	14.475	14.475	-	-	-	-	-	0
10	14.45	14.45	-	-	-	-	-	0
11	14.325	14.325	-	-	-	-	-	0
12	14.2	14.2	-	-	-	-	-	0
13	14.075	14.075	-	-	-	-	-	0
14	13.95	13.95	-	-	-	-	-	0
15	13.825	13.825	-	-	-	-	-	0
16	13.7	13.71	0.999270	0.032287	514	513.892	0.000502	0.110424
17	13.575	13.59957	0.998192	0.050838	512.8137	512.5488	0.000784	0.172110
18	13.45	13.46	0.999257	0.03258	511.3044	511.1958	0.000499	0.109125
19	13.325	13.35087	0.998061	0.05265	510.1166	509.8339	0.000799	0.174506
20	13.2	13.21	0.999242	0.032893	508.5729	508.4628	0.000495	0.107817
21	13.005	13.10218	0.992582	0.103184	507.3834	506.3053	0.001535	0.333148
22	12.81	12.82	0.999219	0.033389	504.2370	504.124	0.00049	0.105758
23	12.615	12.71424	0.992194	0.105863	503.0449	501.9199	0.001534	0.330147
24	12.42	12.43	0.999195	0.033909	499.8058	499.6909	0.000485	0.103677
25	12.225	12.32632	0.991780	0.108652	498.6111	497.4366	0.001533	0.326938
26	12.03	12.04	0.999169	0.03445	495.2741	495.1566	0.000479	0.101573
27	11.835	11.93842	0.991336	0.111559	494.0767	492.8500	0.001531	0.323518
28	11.64	11.65	0.999141	0.035027	490.6364	490.5161	0.000473	0.099444
29	11.445	11.55055	0.990861	0.114596	489.4362	488.1540	0.001528	0.319882
30	11.25	11.26	0.999111	0.035629	485.8864	485.7631	0.000468	0.097289
31	11.01	11.16271	0.986319	0.140417	484.6832	482.7794	0.001811	0.375472
32	10.77	10.78723	0.998402	0.047803	479.9682	479.7489	0.000605	0.124213
33	10.53	10.66302	0.987524	0.134037	478.3826	476.6698	0.001664	0.340492
34	10.29	10.32253	0.996848	0.067166	473.9674	473.5401	0.000817	0.165738
35	10.05	10.15679	0.989485	0.122975	471.7805	470.3578	0.001467	0.296003
36	9.833	9.860790	0.997181	0.063508	467.8105	467.4335	0.000743	0.148769

TABLE 1.

time	Psim	Pebox	Ratio	Mach #	Tebox	Texit	dm	dP
37	9.617	9.712020	0.990216	0.118597	465.7830	464.4764	0.001362	0.271395
38	9.4	9.440624	0.995696	0.078514	462.0265	461.4576	0.000884	0.174767
39	9.15	9.265856	0.987496	0.134191	459.5664	457.9172	0.001477	0.290325
40	8.95	8.975531	0.997155	0.063805	455.4054	455.0349	0.000689	0.134226
41	8.7	8.841304	0.984017	0.151886	453.4490	451.3665	0.001601	0.310517
42	8.462	8.530786	0.991936	0.107606	448.8406	447.8035	0.001107	0.212640
43	8.225	8.318146	0.988802	0.126938	445.6152	444.1837	0.001275	0.243047
44	7.988	8.075098	0.989213	0.124564	441.8556	440.4886	0.001220	0.230638
45	7.75	7.844460	0.987958	0.131668	438.2124	436.6982	0.001257	0.235594
46	7.567	7.608865	0.994497	0.088816	434.4111	433.7268	0.000830	0.154345
47	7.383	7.454520	0.990405	0.117436	431.8749	430.6870	0.001075	0.198654
48	7.2	7.255866	0.992300	0.105138	428.5549	427.6095	0.000942	0.172727
49	7.05	7.083139	0.995321	0.081877	425.6149	425.0451	0.000720	0.131200
50	6.9	6.951938	0.992528	0.103559	423.3474	422.4413	0.000894	0.162045
51	6.6	6.789893	0.972032	0.201709	420.5042	417.1100	0.001678	0.301787
52	6.1	6.488105	0.940181	0.298157	415.0772	407.8262	0.002318	0.411578
53	5.85	6.076527	0.962720	0.233601	407.3773	402.9792	0.001752	0.305331
54	5.6	5.771195	0.970336	0.207855	401.4207	397.9818	0.001502	0.257870
55	5.35	5.513325	0.970376	0.207711	396.2120	392.8224	0.001443	0.244584
56	5.14	5.268740	0.975565	0.188322	391.1084	388.3538	0.001264	0.211511
57	4.93	5.057228	0.974842	0.191134	386.5566	383.7527	0.001238	0.204718
58	4.72	4.852509	0.972692	0.199273	382.0196	379.0095	0.001243	0.203206
59	4.51	4.649302	0.970037	0.208918	377.3788	374.1130	0.001254	0.202401
60	4.3	4.446901	0.966965	0.219591	372.6100	369.0508	0.001265	0.201641
61	4.14	4.245259	0.975205	0.189727	367.7024	365.0741	0.001058	0.166422
62	3.98	4.078833	0.975769	0.187523	363.5248	360.9860	0.001011	0.157221
63	3.82	3.921612	0.974089	0.194021	359.4649	356.7788	0.001010	0.155294
64	3.66	3.766317	0.971771	0.202668	355.3390	352.4437	0.001017	0.154578
65	3.5	3.611738	0.969062	0.212360	351.1096	347.9711	0.001025	0.154027
66	3.34	3.457711	0.963352	0.222992	346.7647	343.3500	0.001034	0.153457
67	3.18	3.304253	0.962395	0.234642	342.2960	338.5679	0.001043	0.152826
68	3.02	3.151427	0.958295	0.247440	337.6960	333.6108	0.001053	0.152114
69	2.86	2.999313	0.953551	0.261551	332.9562	328.4623	0.001062	0.151304
70	2.7	2.848008	0.948030	0.277172	328.0682	323.1037	0.001071	0.150380
71	2.56	2.697627	0.948981	0.274536	323.0226	318.2257	0.001014	0.140116
72	2.42	2.557510	0.946232	0.282098	318.1372	313.1531	0.000993	0.135125
73	2.28	2.422385	0.941221	0.295452	313.2413	307.8664	0.000988	0.132405
74	2.14	2.289979	0.934506	0.312585	308.2508	302.3425	0.000990	0.130563
75	2	2.159416	0.926176	0.332817	303.1237	296.5540	0.000995	0.128999

TABLE 1.

time	Psim	Pebox	Ratio	Mach #	Tebox	Texit	dm	dP
76	1.86	2.030416	0.916068	0.356112	297.8356	290.4684	0.001000	0.127442
77	1.72	1.902974	0.903848	0.382786	292.3702	284.0462	0.001005	0.125750 3017954
78	1.58	1.777223	0.889027	0.413394	286.7148	277.2390	0.001009	0.123831
79	1.44	1.653392 622882	0.870936 5096173 93	0.448728 9616466 27	280.8590 43467832	269.9862 81171045	0.001012 3715624 2329	0.121604 4376867 49
80	1.3	1.531788	0.848681	0.489865	274.7952	262.2107	0.001012	0.118984
81	1.23	1.412803	0.870609	0.449351	268.5194	258.0966	0.000885	0.101709
82	1.16	1.311094	0.884756	0.421916	262.8481	253.8118	0.000790	0.088903
83	1.09	1.222191	0.891840	0.407711	257.6274	249.3380	0.000724	0.079829
84	1.02	1.142361	0.892886	0.405584	252.7031	244.6540	0.000680	0.073586
85	0.95	1.068774	0.888868	0.413713	247.9410	239.7345	0.000653	0.069293
86	0.88	0.999481	0.880456	0.430379	243.2377	234.5487	0.000636	0.066226
87	0.81	0.933254	0.867930	0.454421	238.5194	229.0594	0.000626	0.063867
88	0.74	0.869387	0.851174	0.485365	233.7370	223.2198	0.000618	0.061865
89	0.67	0.807522	0.829698	0.523397	228.8589	216.9713	0.000612	0.059987
90	0.6	0.747534	0.802638	0.569339	223.8669	210.2373	0.000606	0.058068
91	0.565	0.689466	0.819474	0.540982	218.7540	206.6578	0.000547	0.051209
92	0.53	0.638257	0.830386	0.522203	213.9832	202.9163	0.000500	0.045774
93	0.495	0.592482	0.835467	0.513336	209.4813	198.9938	0.000463	0.041544
94	0.46	0.550937	0.83494	0.514260	205.1750	194.8679	0.000436	0.038280
95	0.425	0.51265	0.829014	0.524583	200.9965	190.5112	0.000415	0.035745
96	0.39	0.47691	0.81776	0.5439	196.888	185.890	0.00040	0.03372
97	0.355	0.443185	0.801018	0.5720	192.805	180.9627	0.00038	0.032044
98	0.32	0.41114	0.778321	0.60922	188.715	175.674	0.000378	0.030560
99	0.285	0.380580	0.748856	0.656280	184.5962	169.956	0.000369	0.029159
100	0.25	0.351421	0.711396	0.714783	180.4395	163.7111	0.000359	0.027745

13.0 DPA Depressurization

TABLE 2.

time	Psim	Pebox	Ratio	Mach #	Tebox	Texit	dm	dP
0	14.7	14.7	-	-	-	-	-	0
1	14.675	14.675	-	-	-	-	-	0
2	14.65	14.65	-	-	-	-	-	0
3	14.625	14.625	-	-	-	-	-	0
4	14.6	14.6	-	-	-	-	-	0
5	14.575	14.575	-	-	-	-	-	0
6	14.55	14.55	-	-	-	-	-	0
7	14.525	14.525	-	-	-	-	-	0
8	14.5	14.5	-	-	-	-	-	0
9	14.475	14.475	-	-	-	-	-	0
10	14.45	14.45	-	-	-	-	-	0
11	14.325	14.325	-	-	-	-	-	0
12	14.2	14.2	-	-	-	-	-	0
13	14.075	14.075	-	-	-	-	-	0
14	13.95	13.95	-	-	-	-	-	0
15	13.825	13.825	-	-	-	-	-	0
16	13.7	13.71	0.999270	0.032287	514	513.8928	0.000502	0.100147
17	13.575	13.60985	0.997439	0.060534	512.9244	512.5488	0.000934	0.185901
18	13.45	13.46	0.999257	0.032586	511.3044	511.1958	0.000499	0.098968
19	13.325	13.36103	0.997303	0.062122	510.2274	509.8339	0.000943	0.186776
20	13.2	13.21	0.999242	0.032893	508.5729	508.4628	0.000495	0.097782
21	13.005	13.11221	0.991823	0.108365	507.4944	506.3053	0.001612	0.317383
22	12.81	12.82	0.999219	0.033389	504.2370	504.1245	0.000490	0.095915
23	12.615	12.72408	0.991426	0.110973	503.1562	501.9199	0.001608	0.313943
24	12.42	12.43	0.999195	0.033909	499.8058	499.6909	0.000485	0.094028
25	12.225	12.33597	0.991004	0.113692	498.7226	497.4366	0.001604	0.310333
26	12.03	12.04	0.999169	0.034455	495.2741	495.1566	0.000479	0.092119
27	11.835	11.94788	0.990552	0.116530	494.1885	492.8500	0.001599	0.306549
28	11.64	11.64133	0.999885	0.012781	490.5321	490.5161	0.000172	0.032903
29	11.445	11.60842	0.985922	0.142463	490.1355	488.1543	0.001899	0.361173
30	11.25	11.26	0.999111	0.035629	485.8864	485.7631	0.000468	0.088234
31	11.01	11.17176	0.985520	0.144499	484.7955	482.7794	0.001863	0.350506
32	10.77	10.82125	0.995263	0.082387	480.4002	479.7489	0.001042	0.194324
33	10.53	10.62693	0.990878	0.114488	477.9194	476.6698	0.001421	0.263508
34	10.29	10.36342	0.992914	0.100835	474.5031	473.5401	0.001227	0.225916
35	10.05	10.13750	0.991367	0.111357	471.5244	470.3578	0.001328	0.242959
36	9.833	9.894549	0.993779	0.094457	468.2676	467.4335	0.001105	0.200868

TABLE 2.

time	Psim	Pebox	Ratio	Mach #	Tebox	Texit	dm	dP
37	9.617	9.693680	0.992089	0.106575	465.5316	464.4764	0.001224	0.221065
38	9.4	9.472614	0.992334	0.104906	462.4733	461.4576	0.001181	0.211986
39	9.15	9.260628	0.988053	0.131141	459.4923	457.9172	0.001443	0.257278
40	8.95	9.003349	0.994074	0.092181	455.8082	455.0349	0.000995	0.176029
41	8.7	8.827320	0.985576	0.144215	453.2440	451.3665	0.001520	0.267273
42	8.462	8.560046	0.988545	0.128391	449.2799	447.8035	0.001321	0.230324
43	8.225	8.329722	0.987427	0.134561	445.7923	444.1837	0.001351	0.233756
44	7.988	8.095965	0.986664	0.138621	442.1815	440.4886	0.001358	0.232948
45	7.75	7.863011	0.985626	0.143961	438.5083	436.6982	0.001374	0.233772
46	7.567	7.629244	0.991841	0.108243	434.7432	433.7268	0.001012	0.170729
47	7.383	7.458514	0.989875	0.120659	431.9410	430.6870	0.001105	0.185137
48	7.2	7.273377	0.989911	0.120442	428.8501	427.6095	0.001079	0.179576
49	7.05	7.093800	0.993825	0.094105	425.7979	425.0451	0.000828	0.136819
50	6.9	6.956981	0.991809	0.108455	423.4351	422.4413	0.000937	0.153944
51	6.6	6.803036	0.970154	0.208501	420.7366	417.1100	0.001734	0.283070
52	6.1	6.519965	0.935587	0.309879	415.6586	407.8262	0.002409	0.388489
53	5.85	6.131476	0.954093	0.259974	408.4264	402.9792	0.001950	0.308970
54	5.6	5.822506	0.961785	0.236588	402.4371	397.9818	0.001709	0.266873
55	5.35	5.555632	0.962986	0.232746	397.0784	392.8224	0.001617	0.249099
56	5.14	5.306533	0.968617	0.213913	391.9079	388.3538	0.001436	0.218338
57	4.93	5.088195	0.968909	0.212895	387.2314	383.7527	0.001379	0.207164
58	4.72	4.881030	0.967008	0.219443	382.6598	379.0095	0.001369	0.203287
59	4.51	4.677743	0.964140	0.229003	378.0369	374.1130	0.001374	0.201562
60	4.3	4.476181	0.960640	0.240197	373.3093	369.0508	0.001384	0.200410
61	4.14	4.275770	0.968246	0.215200	368.4555	365.0741	0.001200	0.171551
62	3.98	4.104219	0.969733	0.209996	364.1698	360.9860	0.001132	0.159959
63	3.82	3.944259	0.968496	0.214334	360.0568	356.7788	0.001115	0.155842
64	3.66	3.788417	0.966102	0.222503	355.9335	352.4437	0.001116	0.154170
65	3.5	3.634247	0.963060	0.232508	351.7334	347.9711	0.001123	0.153216
66	3.34	3.481030	0.959486	0.243788	347.4312	343.3500	0.001131	0.152446
67	3.18	3.328584	0.955361	0.256250	343.0143	338.5679	0.001140	0.151683
68	3.02	3.176900	0.950612	0.269966	338.4736	333.6108	0.001149	0.150861
69	2.86	3.026038	0.945130	0.285081	333.8012	328.4623	0.001158	0.149947
70	2.7	2.876091	0.938774	0.301790	328.9892	323.1037	0.001166	0.148914
71	2.56	2.727176	0.938699	0.301981	324.0296	318.2257	0.001115	0.140214
72	2.42	2.586961	0.935460	0.310199	319.1797	313.1531	0.001092	0.135198
73	2.28	2.451763	0.929942	0.323796	314.3220	307.8664	0.001083	0.132056
74	2.14	2.319707	0.922530	0.341365	309.3889	302.3425	0.001081	0.129791
75	2	2.189916	0.913276	0.362337	304.3408	296.5540	0.001083	0.127881

TABLE 2.

time	Psim	Pebox	Ratio	Mach #	Tebox	Texit	dm	dP
76	1.86	2.062034	0.902021	0.386653	299.1535	290.4684	0.001086	0.126048
77	1.72	1.935986	0.888436	0.414581	293.8105	284.0462	0.001089	0.124127
78	1.58	1.811858	0.872032	0.446641	288.3002	277.2390	0.001091	0.122008
79	1.44	1.689849	0.852146	0.483602	282.6146	269.9862	0.001091	0.119600
80	1.3	1.570249	0.827893	0.526523	276.7491	262.2107	0.001088	0.116809
81	1.23	1.453439	0.846268	0.494199	270.7038	258.0966	0.000974	0.102274
82	1.16	1.351164	0.858518	0.471956	265.1187	253.8118	0.000884	0.090970
83	1.09	1.260194	0.864946	0.460026	259.8912	249.3380	0.000817	0.082407
84	1.02	1.177787	0.866030	0.457994	254.9177	244.6540	0.000768	0.076022
85	0.95	1.101764	0.862253	0.465048	250.1046	239.7345	0.000734	0.071258
86	0.88	1.030506	0.853948	0.480325	245.3714	234.5487	0.000710	0.067621
87	0.81	0.962885	0.841221	0.503192	240.6590	229.0594	0.000693	0.064714
88	0.74	0.898170	0.823897	0.533412	235.9224	223.2198	0.000680	0.062237
89	0.67	0.835932	0.801500	0.571231	231.1311	216.9713	0.000668	0.059965
90	0.6	0.775966	0.773228	0.617442	226.2673	210.2373	0.000657	0.057726
91	0.565	0.718240	0.786644	0.595695	221.3245	206.6578	0.000602	0.051740
92	0.53	0.666499	0.795198	0.581662	216.6468	202.9163	0.000557	0.046816
93	0.495	0.619683	0.798794	0.575720	212.1852	198.9938	0.000520	0.042802
94	0.46	0.576880	0.797391	0.578042	207.8902	194.8679	0.000490	0.039540
95	0.425	0.537340	0.790931	0.588679	203.7153	190.5112	0.000466	0.036871
96	0.39	0.500469	0.779268	0.607689	199.6195	185.8902	0.000447	0.034648
97	0.355	0.465821	0.762094	0.635281	195.5693	180.9623	0.000431	0.032738
98	0.32	0.433083	0.738888	0.671964	191.5395	175.6748	0.000417	0.031028
99	0.285	0.402054	0.708858	0.718711	187.5140	169.9560	0.000404	0.029418
100	0.25	0.372636	0.670895	0.777166	183.4869	163.7111	0.000390	0.027821