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PROGRESS REPORT

**Error Analysis of the Hydrodynamic Vertical Load Function
1/5-Scale MKI BWX Pressure Suppression
Experiment and Analysis Program**

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1. CONCLUSIONS

As a result of this study, we conclude that the general methodology taken for generation of the hydrodynamic vertical load function is both appropriate and valid. Further, we recommend that the second order fit technique be used for the ensuing production calculations since it best represents the physical expectation of continuous distributions.

2. INTRODUCTION

Because of time constraints, the final report for the 1/5-scale Mark I boiling water reactor pressure suppression experiment presented results without critical analysis of the data.^(a) In particular, error bounds were not determined for the hydrodynamic vertical load function (HVLF). The objective of this study is to calculate the HVLF and the maximum download and maximum upload ratios for the 90° sector to 7.5° sector (i.e., the 3D to 2D ratios) together with their associated error bounds.^(b)

This is a progress report documenting methodologies used to compute the HVLF, the 3D to 2D ratios, and error propagation for Test 1.3.1. Sufficient details are provided to permit assessment of data fit techniques used for the integration. Full exposition will appear in the final report.

(a) Final Air Test Results for the 1/5-Scale MKI BWR Pressure Suppression Experiment, UCRL-52371, October 1977.

(b) This work was performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore Laboratory under contract number W-7405-Eng-48 for NRC Contract 189A No. A0118-8.

This report is organized in the following manner:

1. Conclusions
2. Introduction
3. Basic Geometry and Methodology
4. Summary of Results
5. Discussion of Results

3. BASIC GEOMETRY AND METHODOLOGY

Two methods of integration to calculate the HVLF ($HVLF = \int_z \int_x p \, dx \, dz$) are used. The first employs a linear fit for the pressure profile at each time. The second employs a quadratic fit among every set of three pressure positions for the pressure profile at each time; an averaging technique is used to produce a smooth profile from the multiple curve fitting process.

The limits of integration across the pool (x direction) and axially (z direction) are defined by the positions of the transducers and the instrumented planes (Fig. 1 and 2). So that the z integration for the instrumented sector of the 90° torus sector may be accomplished for each section defined by transducer locations, missing data within a plane are filled in by interpolating with the fitting procedure. In addition, non-instrumented planes are provided with a pressure profile when symmetry arguments apply; the assumed pressure profiles at symmetric planes are adjusted with the ratio of measured pressures at 180° for each time point if this pressure measurement is available.

Figures 3.1 and 3.2 show that plane 4 is parallel the miter joint; also, plane 9 jogs to avoid the miter joint. The x distances used for these two planes are measured along the planes; therefore, the total pool widths are wider than that of planes perpendicular the axis. Appendix A lists the accumulated x distances and the associated Δz between planes.

Two HVLF's are produced for a particular test; one for a 45° , three-dimensional torus sector and the second for the 7.5° , two-dimensional torus sector. Four particular features of the HVLF's are of interest. Chronologically, these are:

- a) first peak down load, t_1
- b) first load reversal, t_2
- c) second peak down load, t_3
- d) peak up load, t_4

The times associated with these are identified as t_1 , t_2 , t_3 , and t_4 respectively. Although the dynamic tests on the 2D and 3D sectors were run simultaneously, the experimental results exhibit slight time differences between the two geometries so that, in general, there are two sets of the above four times which are identified. It is of interest to compute load ratios. In doing so, the peak loads themselves are used rather than identifying loads occurring at a common time.

To compute the uncertainties for the load, the one standard deviation (σ) error determined from end-to-end in situ calibration was applied to the pressure data. The vertical load functions were computed using pressure data adjusted with plus or minus σ . The difference between loads computed with the mean pressure and pressures adjusted for $\pm\sigma$ is the uncertainty presented in Tables 1 and 2.

▽ Base instrumentation plane

○ Symmetry plane

⊕ Pressure transducer

FIG. 3.1

45° TORUS SECTOR
VIEWED FROM TOP
ULLAGE
TEST 1.3.1

- ▽ Base instrumentation plane
- Symmetry plane
- ⊕ Pressure transducer

FIG.3.2 45° TORUS SECTOR
VIEWED FROM TOP
POOL
TEST 1.3.1

4. SUMMARY OF RESULTS (Air Test 1.3.1)

Presented are plots at t_1 and t_4 for the following:

	<u>Figures</u>	<u>Page</u>
a) Pressure Profile at the Instrumented Planes (p vs x)		
First Order Fit	1-10	13
Second Order Fit	11-20	24
b) Force Per Unit Length (FUL)		
At Each Instrumented Plane (FUL vs x)		
First Order Fit	21-30	35
Axially Between Transducer Positions (FUL vs Z)		
First Order Fit	31-42	46
Second Order Fit	43-54	60
c) Hydrodynamic Vertical Load Function (HVLF)		
First Order Fit	55-56	74
Second Order Fit	57-58	77

Tables 1 and 2 provide, for the First Order and Second Order fits respectively, a summary of mean pool, ullage, and net forces along with their associated errors (1 σ) for both the 45 $^{\circ}$ sector (3D) and the 7.5 $^{\circ}$ sector (2D). These are listed for the 4 times discussed in Section 3 and identified in the HVLF figures. In addition, the tables list, at each of the 4 times, the ratio of the 3D net force to the 2D net force.

TABLE 1: TEST 1.3.1

FORCE SUMMARY - mean $\pm$ std. dev.
(1ST order fit)

45° SECTOR - 3D

	t_1	t_2	t_3	t_4
point	1087	1092	1099	1133
POOL	40155 $\pm$ 96	34407 $\pm$ 92	38531 $\pm$ 89	32327 $\pm$ 35
ULLAGE	23642 $\pm$ 79	24266 $\pm$ 90	25699 $\pm$ 111	39892 $\pm$ 353
NET	16513 $\pm$ 124	10142 $\pm$ 129	12840 $\pm$ 142	75646 $\pm$ 355

7.5° SECTOR - 2D

	t_1	t_2	t_3	t_4
point	1085	1090	1094	1129
POOL	6607.9 $\pm$ 12.8	5566 $\pm$ 12.7	5222 $\pm$ 12.9	5386 $\pm$ 12.5
ULLAGE	3935.2 $\pm$ 11.5	4041.5 $\pm$ 11.6	4121 $\pm$ 11.6	6508 $\pm$ 12.7
NET	2672.6 $\pm$ 17.2	1525.4 $\pm$ 17.2	2162 $\pm$ 17.4	1122 $\pm$ 17.8

NET FORCE RATIOS

$F_{45}^N / 6 \times F_{7.5}^N$	1.030 $\pm$.010	1.108 $\pm$.019	0.990 $\pm$.014	1.124 $\pm$.056
---------------------------------	------------------	------------------	------------------	------------------

$$F_{45}^{N_1} / F_{45}^{N_2} = \underline{1.286} \qquad F_{7.5}^{N_1} / F_{7.5}^{N_2} = \underline{1.236}$$

TABLE 2: TEST 1.3.1

FORCE SUMMARY - mean $\pm$ std. dev.
(2nd order fit)

45° SECTOR - 3D

	t_1	t_2	t_3	t_4
point				
POOL	40831 $\pm$ 105	34878 $\pm$ 101	39153 $\pm$ 95	32268 $\pm$ 10
ULLAGE	23838 $\pm$ 81	24452 $\pm$ 95	25893 $\pm$ 120	40244 $\pm$ 404
NET	16994 $\pm$ 132.6	10426 $\pm$ 138.7	13260 $\pm$ 153	7975.7 $\pm$ 404

7.5° SECTOR - 2D

	t_1	t_2	t_3	t_4
point	1085	1090	1074	1129
POOL	6663.4 $\pm$ 14.9	5592.5 $\pm$ 14.9	6328.7 $\pm$ 15	5344.3 $\pm$ 14.5
ULLAGE	3935.2 $\pm$ 11.5	4041.5 $\pm$ 11.5	4121.0 $\pm$ 11.6	6508.2 $\pm$ 12.7
NET	2728.2 $\pm$ 18.8	1551.0 $\pm$ 18.8	2207.7 $\pm$ 19	1163.9 $\pm$ 19.3

NET FORCE RATIOS

$F_{45}^N / 6 \times F_{7.5}^N$	1.038 $\pm$.011	1.120 $\pm$.016	1.001 $\pm$.014	1.142 $\pm$.0609
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$$F_{45}^{N_1} / F_{45}^{N_2} = \underline{1.282} \qquad F_{7.5}^{N_1} / F_{7.5}^{N_2} = \underline{1.235}$$

5. DISCUSSION OF RESULTS

Although some analyses will be presented, the following is primarily a guide to the results in Section 4.

5.1 Pressure Profile at the Instrumented Planes

The first order or linear fit (Figures 1 to 10) and second order or quadratic fit (Figures 11 to 20) of the pressure data are clearly evident in the figures. Zero pool position is the outside edge of the pool surface. These figures also exhibit the following:

- (1) The ullage pressure is essentially uniform at t_1 in all instrumented planes.
- (2) The ullage pressure is essentially uniform at t_4 in planes 4, 6, and, of course, 20 but begins to show a gradient in plane 9 (in the width direction) which becomes more pronounced in plane 11.
- (3) The pool pressure profiles exhibit an asymmetry at both t_1 and t_4 of the torus in planes 4 and 6. This effect is less prominent in planes 9 and 11.
- (4) The pressure profile for the 7.5° torus is skewed for t_1 but more symmetrical for t_4 .

These observations, for two times of Test 1.3.1, are insufficient for broad conclusions. The pressure profiles for other times and tests will be studied for these tendencies; also, corroborative evidence from other data will be investigated. From these data, it seem likely that temporal changes in pressure profiles relate to pool movements and that properly configured three-dimensional pools will exhibit pressure profile changes not duplicated by two-dimensional or pseudo three-dimensional pools; a few percent change in pressure is sufficient to alter the behavior of the vertical load function.

5.2 Force Per Unit Length Across the Pool (FUL vs x)

The force per unit length (FUL) vs distance across the pool for the first order fit is plotted in Figures 21 to 30 for the instrumented planes. The position $X=0$ is the outside edge of the pool surface.

These plots are the integrated pressure profiles distorted by the unequal distances between transducers. The histogram nature of these figures reflect the nature of the calculations; i.e., the average force per unit length is applied between transducer positions for the axial integration. Since interpretation of the figures 21 to 30 is difficult, the comparable set of curves for the second order fit is not presented although the results are essentially identical.

5.3 Force Per Unit Length Axially (FUL vs Z)

The FUL vs axial distance for each zone is plotted in figures 31-54. The axial zones are the axial spaces between transducer locations and are labeled with the left end transducer angular position; e.g., T1 at 128 means the curve for FUL at t_1 in the axial zone defined by the edge of the pool surface and angular position 128°. Figures 31 to 42 are for the first order fit and Figures 43 to 54 are for the second order fit. In general, the curves for second order fit, especially in the pool, are slightly higher than those for first order fit; the general shape of the curves are essentially identical for the two fits because of the gradual nature of the data.

5.4 Hydrodynamic Vertical Load Function

The hydrodynamic vertical load functions (HVLF) for the 90° and 7.5° torus sectors vs time for the first and second order fits are plotted in Figures 55-58. Comparing Figures 55 and 56 to 57 and 58 shows that the curves are similar in many ways. However, the magnitudes of forces differ for the two fits. Since it is expected that vent clearing will generate smooth spatial profiles, we recommend that the second order fit be used to compute the HVLF for the remaining tests.

5.5 Hydrodynamic Vertical Load Function Ratio

The 3D to 2D ratio (3D/2D) of the HVLF for the two fits are presented in Tables 1 and 2. Also presented are the pool, ullage, and net forces, the propagated uncertainties based on one standard deviation of the pressure data, and the ratio of the first peak force to second peak force of the double peak download. Note that both data fits gave $3D/2D > 1^a$. The upload has a higher ratio and also a higher uncertainty ($3D/2D = 1.142 \pm .0609$). Also, the magnitude of first peak of the double peak download is ~ 25 to 30% higher than the second peak.

^aexcept at t_3 for the 1st order fit.

PRESSURE PROFILES AT INSTRUMENTED PLANES
(p vs x)

FIRST ORDER FIT

<u>PLANE</u>	<u>TIME, t</u>	<u>FIGURE</u>
4	1	1
6	1	2
9	1	3
11	1	4
2D	1	5
4	4	6
6	4	7
9	4	8
11	4	9
2D	4	10

PRESSURE PROFILE FOR PLANE 4 T1, THE TIME AT MAX DOWNLOAD
 FILE(S): PLPH4131A (A)-ALPH4131A

FIGURE 1

PRESSURE PROFILE FOR PUMPDOWN OF THE TOP OF THE REACTOR
 FILES: 00000131A 0A 00000131A

FIGURE 2

PRESSURE PROFILE FOR PLANE 111- THE TIME AT DRY DOWNGO
 FILE(S) PLP1131R CRJ-ULP1131R

FIGURE 3

PRESSURE PROFILE FOR PHASE 11 TO THE 12TH STAGE OF THE
 FILED PLANETARY (A-100000000)

FIGURE 4

PRESSURE PROFILE FOR PLANE 2D 11: THE TIME AT VAN DOWNLOAD
 FILES: PLH2.D11A GR40LFI.D11A

FIGURE 5

PRESSURE PROFILE FOR PLANE 4 T4: THE TIME AT MAX UPLIFT
 FILE(S): T4PLW4 (A)-T4PLW4R

FIGURE 6

PRESSURE PROFILE FOR PLANE 6 14 THE T-1 AT 100% UFLUID
FILE(S) : TAPL100A (2) TAPL100B

FIGURE 7

PRESSURE PROFILE FOR PLANE 9 T4 THE TIME AT MAX UPLAND
 FILE(S)=T4PLM9A (H)=T4PLM9A

FIGURE 8

PRESSURE PROFILE FOR PLANE 11 T4 THE TIME AT MAX UPLOAD
 FILE(S): T4PLN11R T4--T4PLN11UR

FIGURE 9

PRESSURE PROFILES AT INSTRUMENTED PLANES
(p vs x)

SECOND ORDER FIT

<u>PLANE</u>	<u>TIME, t</u>	<u>FIGURE</u>
4	1	11
6	1	12
9	1	13

TEST131 SECOND ORDER FIT PRESSURE PROFILE FOR PLANE1 T1, TIME AT MAX DOWNLOAD
FILE(S): I1131624R C3-I1131624R

FIGURE 11

TEST131 SEC. ORDER FIT PRESSURE PROFILE FOR PLANES T1, T1MRT MAX DOWNLOAD
FILE(S):T131F06PA (A)-T1310P6UA

FIGURE 12

TEST 131 SECOND ORDER FIT PRESSURE PROFILE FOR PLANE 1 T1, TIME AT MAX DOWNLOAD
 FILE(S): T131P24R CO-11101994UR

FIGURE 11

TEST121 SEC. OMPER FIT PRESSURE PROFILE FOR PLANE 71: TIMEAT MAX DOWNLOAD
FILE(S):T1151576PR (A)-T1151PPGUR

FIGURE 12

TEST131 SEC. ORDER FIT PRESSURE PROFILE FOR PLANE 9 T1; TIME AT MAX DOWNLOAD
FILE(S):T131APP9A (N)-T131APP9A

FIGURE 13

TEST 1.3.1 SECOND ORDER FIT PLANE 4 T4 TIME AT MAX UPLOAD
 FILE(S): T4131PP4R (R)-T4131PP4UR

FIGURE 14

TEST131 SEC. ORDER PIT PRESSURE PROFILE FOR PLANE 20 T1- TIME AT MAX DOWNLOAD
FILE(S):T1131P20.PA (20-T1131P20)

FIGURE 15

TEST131 SEC. ORDER FIT PRESSURE PROFILE FOR PLANE 11 T1- TIME AT MAX DOWNLOAD
 FILE(S):T1131P11A (A)-T1131P11U

FIGURE 16

TEST 1.3.1 PRESSURE ERRORS FOR PLUME 6 T4-TIME AT MAX UPLOAD
 FILE(S): T401PP6A C74-T401PP6UA

FIGURE 17

TEST 1.3.1 SECOND ORDER FIT PLANE 9 T4. TIME AT MAX. UPLIFT
 FILE(S)-TAPPA131A (A)-TAPPA131A

FIGURE 18

TEST 1.3.1 SECOND ORDER FIT PLANE 11 T4: TIME AT MAX UNLOAD
FILE(S): EXP1113.M 3A-74P11131UR

FIGURE 19

TEST 1.3.1 SECOND ORDER FIT 7.5 SECTOR 14 TIME AT MAX UPLIFT
 FILE(S):T4131PR2DA (A)-T4131PR2DU

FIGURE 20

FORCE PER UNIT LENGTH AT
INSTRUMENTED PLANES
(FUL vs x)
FIRST ORDER FIT

<u>PLANE</u>	<u>TIME, t</u>	<u>FIGURE</u>
4	1	21
6	1	22
9	1	23
11	1	24
20	1	25
4	4	26
6	4	27
9	4	28
11	4	29
20	4	30

HRC TEST 1.3.1 U 11/29/78 16:21:32

A B

PLANE 4 AT T1

1st Order Fit

FIGURE 21

NRC TEST 1.8.1 U 11/29/78 16:31:02

PLANE 5 RT T1

1st Order Fit

FIGURE 22

NRC TEST 1.3.1 U 11/29/78 17:22:11

A B
PLANE 9 AT T1

1st Order Fit

FIGURE 23

NRC TEST 1.3.1 U 11/29/78 16:33:19

FIGURE 24

NRC TEST 1.8.1 U 11/29/78 16:35:19

A B
PLANE 2 D AT T1

FIGURE 25

NRC TEST 1.3.1 U 11/27/78 16:24:19

A B
PLANE 4 RT Y4

1st Order Fit

FIGURE 26

MEC TEST 1.3.1 U 11/29/78 16:22:57

A B
PLANE 6 AT T4

1st Order Fit

FIGURE 27

NRC TEST 1.5.1 U 11/29/78 16:25:28

R

PLANE 9 RT 74

1st Order Fit

FIGURE 28

WRC TEST 1.8.1 U 11/27/78 16:34:17

PLANE 1 1 AT T4

FIGURE 29

NHC TEST 1.2.1 U 11/24/78 16:26:28

PLANE 2 B AT T4

1st Order Fit

FIGURE 30

AXIAL FORCE DISTRIBUTIONS

AT ANGULAR POSITIONS

(FUL vs Z)

FIRST ORDER FIT

<u>INDEX</u>	<u>ZONE^a</u>	<u>TIME, t</u>	<u>FIGURE</u>
128	1P	1	31
140	2P	1	
155	3P	1	
160	4P	1	32
165	5P	1	
180	6P	1	
195	7P	1	33
200	8P	1	
205	9P	1	
220	10P	1	34
235	11P	1	
269	12P	1	
45	1U	1	35
12	2U	1	
348	3U	1	
315	4U	1	36
270	5U	1	
128	1P	4	37
140	2P	4	
155	3P	4	
160	4P	4	38
165	5P	4	
180	6P	4	
195	7P	4	39
200	8P	4	
205	9P	4	
220	10P	4	40
235	11P	4	
269	12P	4	
45	1U	4	41
12	2U	4	
348	3U	4	
315	4U	4	42
270	5U	4	

^asee Figures 3.1 & 3.2 for location

NRC TEST 1.3.1 R 12/05/70 10:26:06

A B C
T1 AT 128 T1 AT 140 T1 AT 160

FIGURE 31

NRC TEST 1.3.1 R 12/86/78 18:26:22
 A B C
 T1 AT 169 T1 AT 165 T1 AT 180

FIGURE 32

NRC TEST 1.3.1 R 12/05/78 10:25:43

R B C
T1 AT 195 T1 AT 200 T1 AT 205

FIGURE 33

NRC TEST 1.3.1 R 12/85/78 10.25.56

A B C
T1 AT 228 T1 AT 235 T1 AT 269

Z - IN.

FIGURE 34

NRC TEST 1.3.1 R 12/05/78 10:27:16

A B C
T1 AT 45 T1 AT 12 T1 AT 340

Z - IN.

FIGURE 35

NRC TEST 1.3.1 R 12/05/78 10:27:41

T1 AT 215 T1 AT 270

Z - IN.

FIGURE 36

HRC TEST 1.3.1 R 12/05/78 10:42:00

A B C
T4 AT 120 T4 AT 140 T4 AT 160

FIGURE 37

NRC TEST 1.3.1 R 12/05/78 10:42:35

A B C
T4 AT 160 T4 AT 165 T4 AT 180

FIGURE 38

NRC TEST 1.3.1 R 12/05/79 10:42:58

A B C
T4 AT 195 T4 AT 200 T4 AT 205

FIGURE 39

132

NRC TEST 1.3.1 R 12/05/79 19:43:04

A B C
T4 AT 220 T4 AT 235 T4 AT 269

Z - IN.

FIGURE 40

MRC TEST 1.3.1 R 12/05/78 10:43.13

A B C
T4 RT 45 T4 RT 12 T4 RT 349

FIGURE 41

NRG TEST 1.3.1 R 12/05/78 10:43:21

A B
T4 AT 315 T4 AT 270

Z - IN.

FIGURE 42

AXIAL FORCE DISTRIBUTIONS

AT ANGULAR POSITIONS

(FUL vs Z)

SECOND ORDER FIT

<u>INDEX</u>	<u>ZONE^a</u>	<u>TIME, t</u>	<u>FIGURE</u>
128	1P	1	43
140	2P	1	
155	3P	1	
160	4P	1	44
165	5P	1	
180	6P	1	
195	7P	1	45
200	8P	1	
205	9P	1	
220	10P	1	46
235	11P	1	
269	12P	1	
4 ^c	1U	1	47
12	2U	1	
348	3U	1	
315	4U	1	48
270	5U	1	
128	1P	4	49
140	2P	4	
155	3P	4	
160	4P	4	50
165	5P	4	
180	6P	4	
195	7P	4	51
200	8P	4	
205	9P	4	
220	10P	4	52
235	11P	4	
269	12P	4	
45	1U	4	53
12	2U	4	
348	3U	4	
315	4U	4	54
270	5U	4	

^asee Figs. 3.1 & 3.2 for location

NRC TEST 1.3.1 R 12/86/78 17:32:04

R B C
T1 AT 128 T1 AT 146 T1 AT 165

FIGURE 43

HRC TEST 1.3.1 R 12/85/78 17:32:27

A B C
T1 AT 160 T1 AT 165 T1 AT 160

FIGURE 44

MRC TEST 1.3.1 R 12/05/78 17:32:43

A B C
T1 AT 195 T1 AT 200 T1 AT 205

FIGURE 45

NRC TEST 1.3.1 R 12/05/78 17:32:59

A B C
T1 AT 228 T1 AT 235 T1 AT 269

Z - IN.

FIGURE 46

NRC TEST 1.3.1 R 12/05/70 17:33:16

A B C
T1 AT 45 T1 AT 12 T1 AT 348

FIGURE 47

NRC TEST 1.3.1 R 12/05/70 17:33:33

A B
T1 AT 315 T1 AT 270

Z - IN.

FIGURE 48

NRC TEST 1.3.1 R 12/85/78 17.62/26

A B C
T4 AT 128 T4 AT 140 T4 AT 155

FIGURE 49

NRC TEST 1.3.1 R 12/85/78 17:53:03

A B C
T4 RT 160 T4 RT 165 T4 RT 183

FIGURE 50

NRC TEST 1.3.1 R 12/05/78 17:53.15

A B C
T4 AT 195 T4 AT 200 T4 AT 205

FIGURE 51

MRC TEST 1.3.1 R 12/85/78 17:53:39

A B C
T4 AT 229 T4 AT 235 T4 AT 259

Z - IN.

FIGURE 52

NRC TEST 1.3.1 R 12/05/78 17:54:06

A B C
T4 AT 45 T4 AT 12 T4 AT 548

FIGURE 53

NRC TEST 1.3.1 R 12/05/70 17:54:35

FI B
T4 AT 315 T4 AT 270

Z - IN.

FIGURE 54

HYDRODYNAMIC VERTICAL LOAD FUNCTION

FIRST ORDER FIT

	<u>FIGURE</u>
45° Sector	55
7.5° Sector	56

HULF - 45° Sector, First Order Fit

FILE(S):SOCKALL

REC0006

FIGURE 55

HALF 2D - 7.5° Sector, First Order Fit

FILE(S):SOCKALL

HYDRODYNAMIC VERTICAL LOAD FUNCTION

SECOND ORDER FIT

45° Sector
7.5° Sector

FIGURE

57

58

HVLF - 45 DEG SECTOR, SECOND ORDER FIT
FILES ..P45HVLF131

FIGURE 57

HVLF 2D - 7.5 DEG SECTOR, SECOND ORDER FIT
FILES ..P2DHVLF131

FIGURE 58

APPENDIX A

NRC TEST 1.3.1 H50 = 2.10 H7.5 = 2.40

PLANE AND AXIAL LOCATIONS

THETA XT DELZT

PLANE = 1

TOTAL ULLAGE WIDTH = 7.4281E+01

TOTAL POOL WIDTH = 7.4281E+01

45.0000	1.0836E+01	5.6250E+00
12.0000	2.9406E+01	5.6250E+00
348.0000	4.4875E+01	5.6250E+00
315.0000	6.3445E+01	5.6250E+00
270.0000	7.4281E+01	5.6250E+00
128.0000	7.8267E+00	5.6250E+00
140.0000	1.3229E+01	5.6250E+00
155.0000	2.1419E+01	5.6250E+00
160.0000	2.4418E+01	5.6250E+00
165.0000	2.7513E+01	5.6250E+00
180.0000	3.7141E+01	5.6250E+00
195.0000	4.6769E+01	5.6250E+00
200.0000	4.9864E+01	5.6250E+00
205.0000	5.2862E+01	5.6250E+00
220.0000	6.1052E+01	5.6250E+00
235.0000	6.7613E+01	5.6250E+00
269.0000	7.4281E+01	5.6250E+00
0.	0.	0.

PLANE = 3

TOTAL ULLAGE WIDTH = 7.4449E+01

TOTAL POOL WIDTH = 7.4654E+01

45.0000	1.0836E+01	1.4000E+01
12.0000	2.9406E+01	1.4000E+01
348.0000	4.4875E+01	1.4000E+01
315.0000	6.3613E+01	1.2750E+01
270.0000	7.4449E+01	1.1500E+01
128.0000	7.8267E+00	1.4000E+01
140.0000	1.3229E+01	1.4000E+01
155.0000	2.1419E+01	1.4000E+01
160.0000	2.4418E+01	1.4000E+01
165.0000	2.7513E+01	1.4000E+01
180.0000	3.7141E+01	1.4000E+01
195.0000	4.6769E+01	1.4000E+01
200.0000	4.9864E+01	1.4000E+01
205.0000	5.2862E+01	1.4000E+01
220.0000	6.1425E+01	1.2750E+01
235.0000	6.7986E+01	1.1500E+01
269.0000	7.4654E+01	1.1500E+01
0.	0.	0.

PLANE = 4

TOTAL ULLAGE WIDTH = 7.5737E+01

TOTAL POOL WIDTH = 7.5737E+01

45.0000	1.1049E+01	1.7633E+01
12.0000	2.9982E+01	1.4708E+01
348.0000	4.5754E+01	1.1323E+01
315.0000	6.4688E+01	9.1893E+00
270.0000	7.5737E+01	7.5165E+00
128.0000	7.9800E+00	1.7932E+01
140.0000	1.3488E+01	1.6616E+01
155.0000	2.1839E+01	1.5265E+01
160.0000	2.4895E+01	1.4152E+01
165.0000	2.8052E+01	1.3546E+01
180.0000	3.7868E+01	1.2280E+01
195.0000	4.7685E+01	1.0365E+01

200.0000	5.0041E+01	9.0999E+00
205.0000	5.3890E+01	8.4938E+00
220.0000	6.2248E+01	8.6329E+00
235.0000	6.8938E+01	8.4176E+00
269.0000	7.5737E+01	7.1019E+00
0.	0.	0.

PLANE = 4A

TOTAL ULLAGE WIDTH = 7.4281E+01

TOTAL POOL WIDTH = 7.4281E+01

45.0000	1.0836E+01	1.9591E+01
12.0000	2.9406E+01	1.6666E+01
348.0000	4.4875E+01	1.3281E+01
315.0000	6.3445E+01	9.8958E+00
270.0000	7.4281E+01	6.9711E+00
128.0000	7.8267E+00	1.9890E+01
140.0000	1.3229E+01	1.8575E+01
155.0000	2.1419E+01	1.7223E+01
160.0000	2.4418E+01	1.6110E+01
165.0000	2.7513E+01	1.5504E+01
180.0000	3.7141E+01	1.4239E+01
195.0000	4.6769E+01	1.2324E+01
200.0000	4.9864E+01	1.1050E+01
205.0000	5.2862E+01	1.0452E+01
220.0000	6.1052E+01	9.3394E+00
235.0000	6.7613E+01	7.8723E+00
269.0000	7.4281E+01	6.5566E+00
0.	0.	0.

PLANE = 5

TOTAL ULLAGE WIDTH = 7.4281E+01

TOTAL POOL WIDTH = 7.4281E+01

45.0000	1.0836E+01	9.0000E+00
12.0000	2.9406E+01	9.0000E+00
348.0000	4.4875E+01	9.0000E+00
315.0000	6.3445E+01	9.0000E+00
270.0000	7.4281E+01	9.0000E+00
128.0000	7.8267E+00	9.0000E+00
140.0000	1.3229E+01	9.0000E+00
155.0000	2.1419E+01	9.0000E+00
160.0000	2.4418E+01	9.0000E+00
165.0000	2.7513E+01	9.0000E+00
180.0000	3.7141E+01	9.0000E+00
195.0000	4.6769E+01	9.0000E+00
200.0000	4.9864E+01	9.0000E+00
205.0000	5.2862E+01	9.0000E+00
220.0000	6.1052E+01	9.0000E+00
235.0000	6.7613E+01	9.0000E+00
269.0000	7.4281E+01	9.0000E+00
0.	0.	0.

PLANE = 6

TOTAL ULLAGE WIDTH = 7.4281E+01

TOTAL POOL WIDTH = 7.4281E+01

45.0000	1.0836E+01	9.0000E+00
12.0000	2.9406E+01	9.0000E+00
348.0000	4.4875E+01	9.0000E+00
315.0000	6.3445E+01	9.0000E+00
270.0000	7.4281E+01	9.0000E+00
128.0000	7.8267E+00	9.0000E+00
140.0000	1.3229E+01	9.0000E+00
155.0000	2.1419E+01	9.0000E+00
160.0000	2.4418E+01	9.0000E+00

165.0000	2.7513E+01	9.0000E+00
180.0000	3.7141E+01	9.0000E+00
195.0000	4.6769E+01	9.0000E+00
200.0000	4.9864E+01	9.0000E+00
205.0000	5.2862E+01	9.0000E+00
220.0000	6.1952E+01	9.0000E+00
235.0000	6.7613E+01	9.0000E+00
269.0000	7.4281E+01	9.0000E+00
0.	0.	0.
PLANE = 8		
TOTAL ULLAGE WIDTH	=	7.5737E+01
TOTAL POOL WIDTH	=	7.5737E+01
45.0000	1.1049E+01	1.9591E+01
12.0000	2.9982E+01	1.6666E+01
349.0000	4.5754E+01	1.3291E+01
315.0000	6.4599E+01	9.8958E+00
270.0000	7.5737E+01	6.9711E+00
120.0000	7.9000E+00	1.9090E+01
140.0000	1.3488E+01	1.8575E+01
155.0000	2.1839E+01	1.7223E+01
160.0000	2.4096E+01	1.6110E+01
165.0000	2.6052E+01	1.5504E+01
180.0000	3.7868E+01	1.4239E+01
195.0000	4.7685E+01	1.2324E+01
200.0000	5.0341E+01	1.1059E+01
205.0000	5.3598E+01	1.0452E+01
220.0000	6.2246E+01	9.3394E+00
235.0000	6.8938E+01	7.8723E+00
269.0000	7.5737E+01	6.3566E+00
0.	0.	0.
PLANE = 9		
TOTAL ULLAGE WIDTH	=	7.4449E+01
TOTAL POOL WIDTH	=	7.4554E+01
45.0000	1.0836E+01	1.7633E+01
12.0000	2.9406E+01	1.4708E+01
349.0000	4.4075E+01	1.1323E+01
315.0000	6.3613E+01	9.1893E+00
270.0000	7.4449E+01	7.5165E+00
120.0000	7.8257E+00	1.7932E+01
140.0000	1.3229E+01	1.6616E+01
155.0000	2.1419E+01	1.5265E+01
160.0000	2.4418E+01	1.4152E+01
165.0000	2.7513E+01	1.3546E+01
180.0000	3.7141E+01	1.2280E+01
195.0000	4.6769E+01	1.0365E+01
200.0000	4.9864E+01	9.8998E+00
205.0000	5.2862E+01	8.4938E+00
220.0000	6.1425E+01	8.6329E+00
235.0000	6.7986E+01	8.4176E+00
269.0000	7.4654E+01	7.1019E+00
0.	0.	0.
PLANE = 11		
TOTAL ULLAGE WIDTH	=	7.4281E+01
TOTAL POOL WIDTH	=	7.4281E+01
45.0000	1.0836E+01	1.4000E+01
12.0000	2.9406E+01	1.4000E+01
349.0000	4.4875E+01	1.4000E+01
315.0000	6.3445E+01	1.2750E+01
270.0000	7.4281E+01	1.1500E+01
120.0000	7.8267E+00	1.4000E+01

140.0000	1.3229E+01	1.4900E+01
155.0000	2.1419E+01	1.4900E+01
160.0000	2.4418E+01	1.4000E+01
165.0000	2.7513E+01	1.4600E+01
180.0000	3.7141E+01	1.4200E+01
195.0000	4.6769E+01	1.4300E+01
200.0000	4.9954E+01	1.4800E+01
205.0000	5.2962E+01	1.4500E+01
220.0000	6.1052E+01	1.2750E+01
235.0000	6.7613E+01	1.1500E+01
269.0000	7.4281E+01	1.1500E+01
0.	0.	0.

PLANE = 2D

TOTAL ULLAGE WIDTH = 7.4245E+01

TOTAL POOL WIDTH = 7.4245E+01

45.0000	1.0818E+01	1.7660E+01
12.0000	2.9388E+01	1.7660E+01
349.0000	4.4857E+01	1.7660E+01
315.0000	6.3427E+01	1.7660E+01
270.0000	7.4245E+01	1.7660E+01
128.0000	7.0085E+00	1.7660E+01
140.0000	1.3211E+01	1.7660E+01
155.0000	2.1401E+01	1.7660E+01
160.0000	2.4399E+01	1.7660E+01
165.0000	2.7494E+01	1.7660E+01
180.0000	3.7122E+01	1.7660E+01
195.0000	4.6751E+01	1.7660E+01
200.0000	4.9946E+01	1.7660E+01
205.0000	5.2844E+01	1.7660E+01
220.0000	6.1034E+01	1.7660E+01
235.0000	6.7595E+01	1.7660E+01
269.0000	7.4245E+01	1.7660E+01