MEASUREMENT OF TURBULENT VELOCITY,
INTENSITY AND SCALE IN ROD BUNDLE FLOW
CHANNELS CONTAINING A GRID SPACER

D. S. Rowe and C. C. Chapman

Battelle

Pacific Northwest Laboratories
Richland, Washington 99352

JUNE 1973

Prepared for the U.S. Atomic Energy
Commission under Contract AT(45-1):1830

NOTICE

The report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
U.S. ATOMIC ENERGY COMMISSION
Under Contract AT(45-1)-1830

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151
Price: Printed Copy \$5.45; Microfiche \$0.95

MEASUREMENT OF TURBULENT VELOCITY,
INTENSITY AND SCALE IN ROD BUNDLE FLOW
CHANNELS CONTAINING A GRID SPACER

By

D. S. Rowe and C. C. Chapman

June 1973

BATTELLE
PACIFIC NORTHWEST LABORATORIES
RICHLAND, WASHINGTON 99352

MEASUREMENT OF TURBULENT VELOCITY, INTENSITY AND SCALE
IN ROD BUNDLE FLOW CHANNELS CONTAINING A GRID SPACER

D. S. Rowe and C. C. Chapman

ABSTRACT

An experimental study was performed to evaluate the effect of grid spacers on the axial turbulent flow structure in a model rod bundle with a pitch-to-diameter ratio of 1.25. Experimental measurements were performed in water at a nominal Reynolds number of 100,000. Local axial velocity, turbulence intensity and Eulerian time correlations were measured at selected positions downstream from the spacer by using a laser-Doppler velocimeter.

The results show that flow passing through the spacer emerges with increased axial turbulence intensity and decreased axial macroscale. The effect of the spacer on the turbulent structure was found to be weakly dependent on Reynolds number with decreased influence downstream from the spacer.

With increased distance downstream from the spacer the axial macroscale increased monotonically to its fully developed values. The turbulence intensity for an interior channel varied significantly with distance downstream from the spacer. The high intensity observed at the trailing edge of the spacer rapidly decayed to values below the fully developed condition at a moderate distance from the spacer. Further downstream the level of intensity increased to nearly twice the level of intensity of fully developed flow before finally decaying to approximately the developed

state. A qualitative analysis of the kinetic energy equation for turbulence indicated that the intermediate position of low intensity was probably due to a change from strongly nonisotropic turbulence at the spacer to nearly isotropic turbulence at the "quiet" position.

Crossflow mixing estimates based on the product of axial intensity and scale would indicate reduced crossflow mixing downstream from the spacer. However, the inherent assumption of a constant ratio of Lagrangian lateral intensity and scale to the Eulerian axial intensity and scale is invalid for the developing flow downstream of the spacer. If the decrease of axial intensity is due to a change toward isotropy, the product of the lateral intensity and scale would probably not decrease. The net effect would not be a decrease but possibly an increase in crossflow mixing.

TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION	1
2.0 SUMMARY AND CONCLUSIONS.	3
3.0 EXPERIMENTAL PROGRAM	6
3.1 Description of Test Section	6
3.2 Instrumentation	11
3.3 Method of Data Acquisition.	14
4.0 EXPERIMENTAL RESULTS	17
4.1 Interior Region Flow Structure.	18
4.1.1 Mean Velocity.	18
4.1.2 Turbulence Intensity	26
4.1.3 Turbulence Scale	37
4.1.4 Effect of Reynolds Numbers	39
4.2 Wall Region Flow Structure.	43
4.2.1 Mean Velocity.	43
4.2.2 Turbulence Intensity	46
4.2.3 Turbulence Scale	50
5.0 DISCUSSION OF RESULTS.	53
5.1 Production and Decay of Turbulence.	53
5.2 Implications Regarding Crossflow Mixing	65
6.0 CONCLUSIONS AND RECOMMENDATIONS.	68
7.0 NOMENCLATURE	70
8.0 BIBLIOGRAPHY	72
APPENDIX A - Tabulation of Reduced Data	73
DISTRIBUTION.	91

MEASUREMENT OF TURBULENT VELOCITY,
INTENSITY AND SCALE IN ROD BUNDLE FLOW
CHANNELS CONTAINING A GRID SPACER

1.0 INTRODUCTION

The objective of this report is to present the results of an experimental study of axial flow and turbulence through a rod bundle containing a "grid" spacer. This study represents an extension of an earlier study⁽²⁾ where axial flow and turbulence parameters were measured in the same rod bundle but without the spacer.

As in the previous study, the motivation for performing this study is to obtain a more complete understanding of the turbulent flow processes in rod bundles so that an improved understanding of crossflow mixing processes can be developed. Crossflow mixing is important to the thermal hydraulic performance of rod bundles since it provides a mechanism to equalize temperature within a rod bundle. Crossflow mixing is often an important fuel design consideration; since fuel design are often selected with the thought of using grid spacers to promote mixing and to improve the thermal-hydraulic performance of rod bundles in addition to providing fuel rod support. In the design process, however, fuel designers are confronted with decisions concerning the configuration and placement of grid spacers to optimize mixing and rod bundle performance. Presently, such decisions must be made with very little knowledge of the effect of grid spacers on the turbulent flow and mixing processes. Most of what

is known has been inferred from experimental studies of crossflow mixing by using tracers or subchannel sampling methods. There is no known data in the open literature concerning the effect of grid spacers on the turbulent flow structure in rod bundles. This study represents a first step in understanding the influence of grid spacers on the structure of rod bundle turbulence.

2.0 SUMMARY AND CONCLUSIONS

An experimental study was performed to evaluate the effect of a "simple-grid" spacer on the turbulent flow in a model bundle flow channel with a pitch-to-diameter ratio of 1.25. Experimental measurements were performed in water at a nominal Reynolds number of 100,000. Local axial velocity, turbulence intensity and Eulerian time correlations were measured at several positions downstream of the grid by using a laser-Doppler velocimeter⁽¹⁾ (LDV). The autocorrelation function provided an indication of the dominant frequency of turbulence and an estimate of the axial macroscale of turbulence by using Taylor's hypothesis.

The experimental results generally show the following characteristics:

1. The grid spacer causes significant local velocity perturbations in the wake of the grid spacer; however, they recover in a rather short distance ($< 18 X/D$). Larger perturbations associated with gross flow redistribution generally recover before encountering the second grid spacer at $53 X/D$.
2. Flow passing through the grid spacer emerges with increased axial turbulence intensity and decreased axial macroscale.
3. The wall and interior subchannels exhibit significantly different turbulence intensity recovery behavior downstream of the grid. The interior subchannel intensity decreases by about a factor of two at only 14.25 inches ($18 X/D$) downstream of the grid followed by an increase and gradual decay to near fully developed conditions. The wall subchannel does not show this intermediate decrease

- of intensity but generally decays monotonically downstream of the grid spacer to the fully developed condition.
4. The axial macroscale of turbulence as estimated by Taylor's hypothesis increases monotonically from ~ 0.15 of the average hydraulic diameter (D) at 2.25 inches ($3 X/D$) downstream from the grid spacer to $\sim 0.4 D$ at 38.25 inches ($47 X/D$) downstream from the spacer.
 5. The turbulence intensity shows a moderate decrease with increase in Reynolds number. The effect becomes more pronounced near the trailing edge of the spacer.

The observed region of low turbulence intensity behind the grid spacer is believed to be caused by a shift toward isotropic turbulence. A qualitative analysis of the turbulence kinetic energy equation shows that the axial component turbulence intensity is normally nonisotropic with higher values in the axial direction. In the wake of the grid, however, turbulence and pressure-velocity diffusion processes are believed to make the turbulence more isotropic, thus reducing the axial intensity and increasing the lateral intensities.

Crossflow mixing estimates based on the product of axial intensity and scale would indicate reduced crossflow mixing downstream from the spacer. However, the inherent assumption of a constant ratio of Lagrangian lateral intensity and scale to the Eulerian axial intensity and scale is invalid for the developing flow downstream of the spacer. If

the decrease of axial intensity is due to a change toward isotropy, the product of the lateral intensity and scale would probably not decrease. The net effect would not be a decrease but possibly an increase in crossflow mixing.

3.0 EXPERIMENTAL PROGRAM

The experiments were performed in Battelle-Northwest's thermal-hydraulic laboratory located in 189-D building on the Hanford Atomic Project near Richland, Washington. All experimental work was done in the hydraulics loop which is an isothermal recirculating flow loop with flow capability of 900 gpm at temperatures up to 200°F.

Axial velocity measurements of the turbulent flow were made within a rod bundle test section by using a laser-Doppler velocimeter. The following sections describe the test section, instrumentation and the method of data acquisition.

3.1 Description of Test Section

Figure 3.1 shows an overall view of the test section used for the experimental program. Flow entered the bottom of the flow housing, flowed vertically up through the test section, emerged at the top of the flow housing, and returned to the flow loop. Rubber expansion bellows were used to help isolate the flow housing from the normal vibrations of the flow loop.

Figure 3.2 shows a cross-sectional view of the test section. It consisted of a front and back plate and flow housing body. The back plate contained the inlet and outlet nozzles and was permanently installed in the flow facility. The front plate was bolted to the back plate with the flow housing body placed between them. A continuous "O-ring" sealed the joint between the plates and the flow housing body. Dimensions of the test section (4.00 x 1.25 inches) were maintained by the restraining shoulder next to the "O-ring" groove on the front and back plates.

FIGURE 3.1. Flow test section.

FIGURE 3.2 Test section construction details.

The front and back plate each contained 5 window ports 2 inches high by 4 inches wide located at 1 foot intervals. The optically flat ($\lambda/4$) viewing windows, fabricated from quartz, transmitted the laser beam. The windows were sealed by an "O-ring" and were held in place by thick cover plates. A shim was placed between the window and cover plate to position the window to be "flush" with the inner surface of the flow housing (± 0.001 inch).

An 8 inch long flow straightening section was placed at the inlet of the flow channel. The flow conditioner consisted of four eccentric screens (60% open) with 1/4 inch holes in a triangular array followed by a bank of 1/4 inch O. D. tubes (0.020 inch wall) 3-1/4 inch long. The screens tended to equalize the inlet velocity distribution and the tubes helped to establish a fixed scale of turbulence and straighten the flow. The inlet ends of the rods had a 60° taper to minimize the flow disturbance due to flow area change upon entering the rod bundle.

The 3 by 2-1/2 rod bundle array used for this study had a pitch to diameter ratio of 1.25. The rod bundle consisted of six 1 inch diameter full rods, three half rods, a lower and an upper tie plate, and two grid spacers. The three half rods were bolted onto the back plate. Except for the addition of the two grid spacers, the test section used for this report was the same as the test section used in the previous study.⁽²⁾ Figure 3.3 shows a cross sectional view of the rod bundle at a grid spacer. The grid spacer was constructed from 1-1/2 inch high by 0.050 inch thick stainless steel sheet stock and 1/4" O.D. tubing (0.020 inch wall). The sheet stock was slit and fitted together as an "egg crate". Similarly

FIGURE 3.3 Rod bundle cross-section.

the tubing was fit into companion slots and were fixed to the plates by tack welds. The assembled grid spacer was positioned on the rod bundle and held by retaining pins driven through holes in the rods. All data, except for one set, was taken using the test section configuration shown in Figure 3.4. To enable measurements downstream of the second spacer, both spacers were moved upstream six inches as shown by the dotted outline.

3.2 Instrumentation

A two-component laser-Doppler velocimeter (LDV) manufactured by Laser Systems and Electronics was used to measure the turbulent flow velocities in the test section. The LDV operates from the principle that light scattered from a moving particle experiences a frequency shift.⁽¹⁾ This frequency shift depends upon the scattering angle, wavelength of laser light and the local velocity of the scattering particles. By using a system of optics and electronics the frequency shift can be detected and measured.

All measurements performed for this study used the single component optics system shown in Figure 3.5. This is the same system as the one used in the previous study⁽²⁾ of rod bundle turbulence without grids.

An electronic readout system⁽²⁾ was used to measure the local velocity and instantaneous fluctuating velocity component from the Doppler signal. The fluctuating velocity output signal of the readout was amplified, low pass filtered, and then electronically processed to obtain the "rms" fluctuating velocity and the Eulerian time correlation (autocorrelation) function.

FIGURE 3.4 Flow test section with grid spacer locations.

FIGURE 3.5 One-component laser-Doppler velocimeter optical arrangement.

The laser and optics system were mounted on a traversing table that was used to position the entire LDV system as an integral body. The table could be positioned arbitrarily in a horizontal plane by moving the table along its two orthogonal axes. The table could also be adjusted vertically to position the LDV unit at any of the five viewing windows.

3.3 Method of Data Acquisition

After adjusting the flow rate and/or the fluid temperature to achieve the desired Reynolds number, the loop was allowed to stabilize. The loop maintained a very stable flow rate and temperature; therefore, adjustment during data acquisition was not required.

The LDV signal was optimized by injecting a small amount of milk into the loop to provide a sufficient concentration of scattering centers in the sample volume. The signal to noise ratio was maximized by adjusting the polarizing filters to attenuate the reference beam and, thus, improve the heterodyning of the two beams. After an optimum LDV signal was achieved, the reference coordinates within the rod bundle were established from the loss of the LDV signal at the channel boundaries. This provided the required information for locating the interior or wall gap center line and the window surfaces. This procedure was followed at each of the window positions.

With the local coordinates established, data was taken by stepping across the flow channel along the lines as shown in Figure 3.6. At selected positions within the flow field, data readings were recorded and were used as "raw" input data for the data reduction program.⁽²⁾ The data reduction program took the raw data and computed a consistent set of

FIGURE 3.6 Data regions within data planes.

coordinates, normalized values for the mean velocity, turbulent intensity and turbulent scale for each data point in the flow field. As in the previous study⁽²⁾ the turbulence scale estimates were obtained by fitting the correlation function plots to the equation

$$R(\tau) = e^{\alpha_1 \tau} \cos \alpha_2 \tau . \quad (3.1)$$

By using the definition for Eulerian macro time scale

$$T_E = \int_0^{\infty} R(\tau) d\tau \quad (3.2)$$

and Taylor's hypothesis, the turbulence macro scale was calculated from the equation

$$\Lambda = - \frac{\bar{u} \alpha_1}{\alpha_1^2 + \alpha_2^2} . \quad (3.3)$$

4.0 EXPERIMENTAL RESULTS

The results of this experimental study have provided new and somewhat surprising information concerning the effect of a grid spacer on the turbulent flow structure in rod bundles. The most interesting observation from the data was that a region of rather quiet turbulent flow exists downstream of the grid spacer. Flow emerging from the grid spacers had rather high turbulence intensity in the axial direction but at only 14 inches downstream of the grid, the intensity decayed to a level that was lower than at the center of pipe flow. The turbulence intensity then increased to a high level downstream of this quiet region before eventually decaying to values typical of those obtained without the grid spacer.

The data presented in the following sections were obtained on four planes downstream from the first spacer and on one plane downstream from the second spacer. Data was acquired at each plane within the interior region and the wall region as shown in Figure 3.6. Data was taken at selected points within the interior region along transverse lines located at $\pm .600$ inch and $\pm .120$ inch relative to the interior region center line as well as on the region center line. Data was taken at selected points in the wall region along lines at $-.120$ inch, $-.060$ inch, $.050$ inch and $.090$ inch relative to the wall region center line and along the wall region center line.

The wall and interior regions lie on a common plane which is perpendicular to the direction of flow. To facilitate the discussion of the experimental results, each downstream plane was assigned an identification number. The axial position of each plane is defined in Table 4.1.

TABLE 4.1 Distance Downstream From Grid Spacer for Identified Plane

Plane 1	2.25 inches downstream first spacer
Plane 2	14.25 inches downstream first spacer
Plane 3	26.25 inches downstream first spacer
Plane 4	38.25 inches downstream first spacer
Plane 5	1.25 inches downstream second spacer

The graphical presentation of the reduced data given in this chapter represents a significant portion of the entire data; however, complete tabulation of the reduced data is presented in Appendix A. A listing of the data reduction computer program is given in Reference 2.

4.1 Interior Region Flow Structure

The flow structure of the interior region was investigated and is presented in the following subsections. The results include mean velocity and turbulence intensity maps, macroscale along selected traverse lines and the effect of Reynolds number on both turbulence intensity and scale along the interior centerline.

4.1.1 Mean Velocity

Figures 4.1 through 4.5 give the mean velocity maps at the five measurement planes. Figure 4.1 shows the flow distribution at Plane 1 located at 2.25 inches downstream of the first spacer. The flow redistribution caused by the spacer can be determined by comparing this map with the map for nearly developed flow at Plane 4 given in Figure 4.4. The comparison shows that the mean velocity has decreased locally in the wake of the

FIGURE 4.1 Axial velocity ($\frac{\bar{u}}{U}$) map, interior region, Plane 1.

FIGURE 4.2 Axial velocity ($\frac{\bar{u}}{U}$) map, interior region, Plane 2.

FIGURE 4.3 Axial velocity ($\bar{u}/\bar{U}$) map, interior region, Plane 3.

FIGURE 4.4 Axial velocity ($\frac{\bar{u}}{U}$) map, interior region, Plane 4.

FIGURE 4.5 Axial velocity ($\frac{\bar{u}}{U}$) map, interior region, Plane 5.

grid plate. The position of maximum velocity has been shifted from the center of the interior subchannel to the centers of the four symmetric quadrants of the interior subchannel. The asymmetry of the isovels (lines of constant mean velocity) about the region centerline indicate how the flow is adjusting toward the fully developed condition.

Figure 4.2 presents the mean velocity map at Plane 2 located 14.25 inches downstream of the first grid spacer. The form and near symmetry of the isovels suggests that the flow is nearly developed; however, when compared with the results for nearly developed flow given in Figure 4.4, it is observed that the flow near the gap has not recovered. Plane 2 has higher velocity gradients in the gap region than does Plane 4. Except for this difference the map at Plane 2 shows close similarity to the map at Plane 4.

The velocity contour map for Plane 3 located 26.25 inches downstream of the first grid spacer is given in Figure 4.3. The velocity gradient at Plane 3 is nearly fully developed. The noticeable change which has occurred between Plane 2 and Plane 3 is the isovel distortion in both the wall and interior subchannels. The distortion could be attributed to crossflow into the gaps. Near the subchannel centers the velocity gradients are small; therefore, small changes in local velocity would result in relatively large shifts in the isovels. Thus, isovel distortions near the subchannel centers do not represent significant changes in velocity.

Figure 4.6 presents a velocity map for fully developed flow obtained in the previous study.⁽²⁾ A comparison with the map at Plane 4 shows somewhat

FIGURE 4.6 Axial velocity ($\frac{\bar{u}}{U}$) map, interior region, fully developed flow no grid spacer (2).

higher velocity in the present study. The reason for this discrepancy is believed to be caused by a small null offset found in the LDV electronics subsequent to the present experiments. The discrepancy between the two data sets are caused by the offsets being in the opposite directions for the two electronic readout channels available in the LDV system. In the first study all data was taken using one of the electronic channels. In the present study it was necessary to use a portion of the other electronic channel because of an electrical component failure early in the experimental program. This change was used through the remainder of the study. Aside from the noted discrepancy in the magnitude, the form of the velocity contours at Plane 4 compares favorably with the previous study.

Figure 4.5 presents the mean velocity map at Plane 5 which is 1.25 inches downstream from the second grid spacer. When the maps for Plane 1 and Plane 5 are compared, larger velocity reductions are observed at Plane 5. This was anticipated since Plane 5 is 1 inch closer to the grid. Assuming that the development of the mean velocity is independent of the spacer, the data indicate a rapid recovery of the local flow perturbation between 1.25" and 2.25" downstream from the spacers. The recovery in the rod gap is most rapid.

4.1.2 Turbulence Intensity

The axial turbulence intensity along the interior centerline at the four positions downstream the first spacer is given in Figure 4.7. The turbulence intensity at the four positions roughly exhibit the same form. Relative maxima occur midway between the gap center and the subchannel

FIGURE 4.7 Axial intensity ($\frac{u'}{u}$) along interior center line.

centers and relative minima occur at the gap and the subchannel centers. The most interesting feature is the change in the turbulence intensity with distance downstream from the grid spacer. The change with downstream position is most pronounced around the interior subchannel center. The intensity at the subchannel center at the first position downstream from the grid spacer is 0.058. A general increase in turbulence intensity was expected due to the passage of the flow through the grid spacer. However, the general decrease of axial turbulence intensity at only 14.25" downstream from the spacer was a surprise. The level of intensity of 0.028 found at Plane 2 is less than at the center of fully developed pipe flow. It is also below the level of intensity found for the same rod bundle without grid spacers. Between Plane 2 and Plane 3 the intensity increased nearly to the level observed at Plane 1. Further downstream at Plane 4, the intensity has decayed and has finally approached values typical of a fully developed condition.

Figures 4.8 through 4.11 present the axial turbulence intensity maps for the interior regions at the planes downstream the first spacer. Figure 4.12 gives the intensity map for one-half of the interior region 1.25 inches downstream from the second spacer. These figures provide a vivid general picture of turbulence intensity within the rod bundle geometry.

The turbulence intensity map for Plane 1 is given in Figure 4.8. The change in the axial intensity map due to the flow passing through the grid spacer can be determined by contrasting Plane 1 to Plane 4

FIGURE 4.8 Axial intensity ($\frac{u'}{\bar{u}}$) map, interior region, Plane 1.

FIGURE 4.9 Axial intensity ($\frac{u'}{u}$) map, interior region, Plane 2.

FIGURE 4.10 Axial intensity ($\frac{u'}{u}$) map, interior region, Plane 3.

FIGURE 4.11 Axial intensity ($\frac{u'}{\bar{u}}$) map, interior region, Plane 4.

FIGURE 4.12 Axial intensity ($\frac{u'}{\bar{u}}$) map, interior region, Plane 5.

(Figure 4.11) for nearly developed flow. The comparison shows that the intensity in the interior region has increased with the largest increase occurring about the interior subchannel center. Passage through the spacer has caused a scrambling of the intensity contours. Another noticeable difference between the maps for Plane 1 and Plane 4 is the zones of high intensity gradients in Plane 1 at the rod surfaces near the rod gap centers.

At Plane 2 (Figure 4.9) the level of intensity has experienced a general drop particularly about both the wall and interior subchannel centers. The axial intensity about the interior subchannel center has decreased over 50% from the intensity observed at Plane 1. When Plane 2 is compared to the nearly developed condition at Plane 4, it is seen that the intensity around the interior subchannel center is lower at Plane 2. The comparison also shows that the form of the intensity contours at Plane 2 are similar to Plane 4. The localized high intensity zones observed at Plane 1 near the rod gap centers have almost vanished at Plane 2.

Only 12 inches downstream from Plane 2 at Plane 3, the level of intensity in the interior subchannel has increased nearly 50%. High intensity gradients have developed normal to the region centerline and rod surfaces. At Plane 4 the level of intensity has decayed and the intensity gradients have decreased. The intensity map is very similar to the one obtained in the previous study for fully developed flow (Figure 4.13); however, the values in the present study are about 15% lower. This is believed to be caused by the lower cutoff frequency of 3 kHz as compared to 4 kHz in the previous study. Figure 4.14 presents a comparison of data along the interior center line at Plane 4 with the data from the previous experiment with a 3 kHz cutoff. The agreement is excellent.

FIGURE 4.14 Axial intensity ($\frac{u'}{u}$) along interior center line.

FIGURE 4.13 Axial intensity ($\frac{u'}{u}$) map, interior region, fully developed flow, no grid spacer. (2)

The turbulence intensity map 1.25 inches downstream of the second grid spacer (Plane 5) is shown in Figure 4.12. A comparison of this map with the map for Plane 1 at 2.25 inches downstream from the first spacer shows several similarities. The intensity contours for both maps are scrambled particularly about the subchannel centers. The high intensity gradients at the rod gap centers noted at Plane 1 are even more pronounced at Plane 5. However, the level of intensity at Plane 5 around the interior subchannel center is seen to be lower than the intensity at Plane 1. This discrepancy can again be attributed to the different cutoff frequencies since data at Plane 5 was taken with a 1 kHz cutoff and data at Plane 1 was taken with a 3 kHz cutoff.

Review of the intensity maps downstream from the first grid spacer shows the general trend noted for only the interior center lines, particularly around the interior subchannel center. First, the flow emerges from the spacer with high axial intensity, then after decreasing rapidly to a low level of intensity, the intensity increases to high level before decaying to the nearly developed condition.

4.1.3 Turbulence Scale

Figure 4.15 shows the axial macroscale of turbulence as estimated by Taylor's hypothesis in the interior region at the various downstream planes. At the different planes the macroscale along lines $-.120''$ and $-.060''$ offset from the interior centerline as well as on the interior centerline are given. Comparison of the macroscale data found at the different downstream planes shows a general increase in scale with increasing distance downstream from the grid spacer. Generally, the scale also increases as

FIGURE 4.15 Axial scale (Λ/D) for interior region.

the distance from a boundary decreases. However, exceptions to this trend are found particularly at Plane 1. These exceptions found at Plane 1 may be due to the lingering influence of the grid spacer.

The turbulence scale at Plane 5 along the centerline is presented in Figure 4.16. The results at Plane 1 are included for comparison. The scale at Plane 5 is observed to be smaller between the wall and rod gap, but show close similarity in the interior subchannel. The results for the two planes immediately downstream from the two grid spacers indicate that the axial macroscale experiences a marked reduction during passage through the grid spacers. Comparison between plane 4 for nearly developed flow and Plane 1 or Plane 5 shows that this reduction is about 50%. Figure 4.17 compares the macroscale found at Plane 4 with the macroscale found in fully developed flow of the previous study. The results are very nearly the same.

4.1.4 Effect of Reynolds Number

All experimental data were taken at a nominal Reynolds number of 100,000 with the exception of some centerline traverses. The influence of different Reynolds numbers on the turbulence intensities are shown in Figure 4.18. The data indicate that the turbulence intensity decreases slightly with increasing Reynolds number. The largest influence of Reynolds number on intensity is observed at plane 2. At Plane 4, the influence of Reynolds number on the intensity is small. These results are consistent with the results of the previous study.⁽²⁾

Figure 4.19 shows the macroscale along the interior centerline at Planes 1, 2, and 4 at three different Reynolds numbers. The effect of Reynolds number on scale is weak. However, the results at Plane 1

FIGURE 4.16. Axial Scale (Λ/D) Along Interior Center Line for Plane 1 and Plane 5

FIGURE 4.17. Axial Scale (Λ/D) Along Interior Center Line for Plane 4 and Fully Developed Flow

FIGURE 4.18. Axial Intensity ($\frac{u'}{u}$) Along Interior Centerline for Different Reynolds Numbers

FIGURE 4.19. Axial Turbulence Scale (Λ/D) Along Interior Centerline for Different Reynolds Numbers

indicate a slight increase in scale with a increase in Reynolds number. As the distance from the spacer increases, the effect of Reynolds number essentially vanishes. Thus, the effect of increasing Reynolds number causes a slight decrease in turbulence intensity and a slight increase in turbulence scale. The influence of Reynolds number on both intensity and scale diminishes rapidly with distance downstream from the grid.

4.2 Wall Region Flow Structure

The following results are for the side wall region which was defined in Figure 3.6. Data within this region were limited to Planes 1, 2, and 4. The flow structure within the wall region is described by mean velocity maps, turbulence intensity maps and macroscale plots for three planes downstream from the first grid spacer.

4.2.1 Mean Velocity Maps

Figures 4.20 through 4.23 give mean velocity maps for the wall region at Planes 1, 2, 4 and for fully developed flow with no grid spacer.⁽²⁾ Except for the apparent velocity peaks on both sides of the wall subchannel center, it may not be immediately obvious that the flow has passed through the spacer. When the map for Plane 1 (Figure 4.20) is contrasted with the map for Plane 4 (Figure 4.22), other flow changes are recognized, in particular the reduced velocity downstream of the cylindrical spacer in the rod gap. Note the general increase in the mean velocity in the corner subchannel, implying increased flow in the corner subchannel immediately downstream of the spacer.

FIGURE 4.20. Axial Velocity ($\frac{\bar{u}}{U}$)
Map, Wall Region,
Plane 1

FIGURE 4.21. Axial Velocity ($\frac{\bar{u}}{U}$)
Map, Wall Region,
Plane 2

FIGURE 4.22. Axial Velocity ($\frac{\bar{u}}{U}$) Map, Wall Region, Plane 4

FIGURE 4.23. Axial Velocity ($\frac{\bar{u}}{U}$) Map, Wall Region, Fully Developed Flow, No Grid Spacers⁽²⁾

The velocity map shows only a modest change in velocity downstream from the grid plate which parallels the channel wall. The largest change in mean velocity below a grid plate occurred about the wall subchannel center. It is interesting to note that the orientation of the grid plate relative to the isovels has an apparent influence on the recovery rate of the mean velocity. When the grid plate is parallel to the isovels, the flow redevelops rapidly. The greatest change in velocity distribution occurs in a zone where the grid plate is normal to the isovels. Comparing the recovery of the mean velocity in the wall and interior regions, it appears that the wall region shows more rapid development toward the fully developed condition than the interior region.

Figure 4.21 presents the mean velocity map for Plane 2. This map shows similarity to the map for nearly developed flow at Plane 4 (Figure 4.22). The isovel contours have established the form of fully developed flow except for the distortions near the wall in the wall subchannel. These distortions indicate the presence of secondary flows. Figure 4.22 presents the map for nearly fully developed flow at Plane 4. The isovels exhibit close similarity to the fully developed flow condition in Figure 4.23 except for moderate distortion near the channel wall in the wall subchannel. As for the interior region data discussed earlier, the wall channel dimensionless velocity is somewhat higher than the fully developed velocity measured in the previous study.

4.2.2 Turbulence Intensity

Figures 4.24 through 4.26 give turbulence intensity maps for three positions downstream the first grid spacer in the wall region. Figure 4.27

FIGURE 4.24. Axial Intensity ($\frac{u'}{\bar{u}}$)
Map, Wall Region,
Plane 1

FIGURE 4.25. Axial Intensity ($\frac{u'}{\bar{u}}$)
Map, Wall Region,
Plane 2

FIGURE 4.26. Axial Intensity ($\frac{u'}{\bar{u}}$)
 Map, Wall Region,
 Plane 4

is the intensity map for fully developed flow as reported in the previous study.⁽²⁾ The influence of the grid spacer on the turbulence intensity field can be observed by comparing the map for nearly developed flow (Figure 4.26) to the map at Plane 1 (Figure 4.24). Although the intensity contours have experienced untrackable distortions, the change in magnitude of turbulence intensity exhibit certain characteristics. The level of intensity in the area nearest the wall in the wall subchannel has decreased. A similar reduction in intensity is observed in the corner subchannel midway between the rod gap and the corner. Referring to the mean velocity map for this plane, it is noted that these areas of reduced intensity correspond to areas least affected by the grid plate. Areas about the wall and corner subchannel centers have experienced a marked increase in intensity. Again referring to the isovel map for Plane 1, these areas correspond to areas of high isovel distortion. The areas of greatest isovel distortion closely correspond to areas of increased turbulent intensity, notably in the rod-wall gap area.

The axial intensity map for Plane 2 is given in Figure 4.25. The large drop in intensity observed for the interior subchannel at this plane does not appear in the wall region. When the map for Plane 2 is compared to the map for nearly fully developed flow, a strong similarity in the shape of the intensity contours is seen. The noticeable exception between the two maps is found near the rod gap adjacent the corner. The eruption of high turbulence intensity off the wall toward the rod gap center correlates closely to the isovel distortion associated with an implied

secondary flow observed in the mean velocity map for this plane. The level of intensity has decreased about the wall and corner subchannel center between Plane 1 and Plane 2.

The axial intensity map at Plane 4 is presented in Figure 4.26.

For fully developed flow the intensity map is given in Figure 4.27. Comparison shows close correlation. The generally higher level of intensity for the fully developed intensity map from the previous study may be due, in part, to the 4 kHz cutoff frequency. The cutoff frequency for the present study was maintained at 3 kHz . However, the difference may be due to the fact that the intensity field has not reached a fully developed condition.

4.2.3 Turbulence Scale

The turbulence macroscale in the wall region at Planes 1, 2, and 4 is given in Figure 4.28. The general trend of increasing macroscale with increasing distance downstream from the grid spacer is again observed. Comparison with the results for the interior region given in Figure 4.15, show that the macroscale is roughly of the same magnitude at each of the corresponding planes.

FIGURE 4.27. Axial Intensity ($\frac{u'}{u}$)
 Map, Wall Region,
 Fully Developed Flow
 No Grid Spacers⁽²⁾

FIGURE 4.28. Axial Scale (Λ/D) for Wall Region

5.0 DISCUSSION OF RESULTS

The experimental data have shown some interesting behavior concerning turbulent flow in rod bundle flow channels containing a simple grid spacer. Of particular interest is the reduction of turbulence intensity at an intermediate position between the two grid spacers, where the turbulence intensity was lower than the intensity for fully developed flow in rod bundles or in round tubes. Although a firm explanation for this behavior is not available, considerable insight concerning the possible mechanisms that could produce it are available from a theoretical treatment of nonisotropic turbulence. The following discussion reviews the more significant terms of the theoretical equations governing the production and decay of turbulence. The second section contains a brief discussion of the results of this study as it could apply to the crossflow mixing processes downstream of grid spacers.

5.1 Production and Decay of Turbulence

The axial component of turbulence intensity was the primary turbulence parameter measured in this study. It is but one component of several used to characterize a turbulent flow field. More generally, the intensity is the square root of single point correlation $\overline{u_i^2}$ normalized to the local velocity. $\overline{u_i^2}$ is also a single component of the more general correlation $\overline{u_i u_j}$ where i and j refer to the three cartesian coordinate directions. The term $-\rho \overline{u_i u_j}$ is recognized as being the turbulent shear stress tensor. Starting with the equations of motion for each velocity component, assuming uniform density and uniform viscosity, the dynamic equations⁽³⁾ for $\overline{u_i u_j}$ can be written as

$$\begin{aligned}
\frac{D}{Dt} \overline{u_i u_j} &= - \overline{u_j u_k} \frac{\partial \bar{u}_i}{\partial x_k} - \overline{u_i u_k} \frac{\partial \bar{u}_j}{\partial x_k} \\
&\quad - \frac{\partial}{\partial x_k} \overline{u_i u_j u_k} \\
&\quad - \frac{1}{\rho} \left(\frac{\partial}{\partial x_i} \overline{p u_j} + \frac{\partial}{\partial x_j} \overline{p u_i} \right) \\
&\quad + \frac{1}{\rho} \overline{p \left(\frac{\partial u_j}{\partial x_i} + \frac{\partial u_i}{\partial x_j} \right)} \\
&\quad + \nu \frac{\partial^2 \overline{u_i u_j}}{\partial x_\ell \partial x_\ell} - 2 \nu \overline{\frac{\partial u_i}{\partial x_\ell} \frac{\partial u_j}{\partial x_\ell}}
\end{aligned} \tag{5.1}$$

A contraction of these equations gives a scalar equation for the kinetic energy ($\overline{q^2}/2$) of turbulence where

$$\frac{\overline{q^2}}{2} \equiv \frac{1}{2} \overline{u_i^2} = \frac{1}{2} (\overline{u_1^2} + \overline{u_2^2} + \overline{u_3^2})$$

The equation can be written as

$$(I) \quad \frac{D(\overline{q^2})}{Dt} = - \overline{u_i u_k} \frac{\partial \bar{u}_i}{\partial x_k} \tag{II}$$

$$- \frac{\partial}{\partial x_k} \overline{\left(\frac{p}{\rho} + \frac{q^2}{2} \right) u_k} \tag{III}$$

$$+ \nu \frac{\partial^2}{\partial x_\ell \partial x_\ell} \left(\frac{\overline{q^2}}{2} \right) \quad (IV)$$

$$- \nu \frac{\partial u_i}{\partial x_\ell} \frac{\partial u_i}{\partial x_\ell} \quad (V) \quad (5.2)$$

Physical significance and importance can be given to each of the terms in the above equation.

The first term (I) represents the gain or loss of turbulence energy as the flow moves along the flow channel. It includes both the temporal and spatial changes of energy along a streamline.

The second term is called the production term since it represents the extraction of mean flow energy into turbulence energy. Because this term is the only source of turbulence energy, the integral of it over the entire extent of a flow field is essentially positive. However, this fact does not preclude the possibility that this term can be negative in part of the flow field. In regions where this term is negative, turbulence energy is returned to the mean flow.

The third term is the convective diffusion by turbulence of the turbulence energy. According to Hinze⁽³⁾ and Bradshaw⁽⁴⁾ the pressure component of this term represents a "scrambling" of the turbulence by the pressure and tends to make the turbulence more nearly isotropic and reduces the turbulence shear stress.

The fourth and fifth terms in combination represent the work done per unit mass and of time by the viscous shear stresses of the turbulent

motion plus the dissipation per unit of mass by the turbulent motion.

In the following discussion these terms will be referred to by the symbol ϵ_{ij} .

In the present study only the axial component of turbulence $\overline{u_1^2}$ was measured and it changed significantly downstream of a grid spacer in the interior regions of the bundle. To help explain why this occurred it is worthwhile to review the dynamic equations for $\overline{u_i u_j}$. To simplify the discussion the equations are written for the case of turbulent flow between infinite, plane, parallel walls. For this case assume that the axial velocity $\overline{U_1}$ is a function of the axial and lateral coordinates x_1 and x_2 and the velocity component $\overline{U_3}$ is zero. Because of the uniformity of flow in the x_3 direction the derivatives with respect to x_3 are zero as are all correlations involving $\overline{u_1 u_3}$ and $\overline{u_2 u_3}$. While these approximations are not entirely valid for the three dimensional flow in rod bundles, they would apply roughly in a direction normal to a wall in a developing flow field. Consider then, x_2 to be the lateral distance from the wall and x_1 to be in the direction of flow. The axial velocity gradient in the x_2 direction would, therefore, be much larger than in the x_1 direction. With the above simplifications the equations are

$$\begin{aligned} \frac{D}{Dt} (\overline{u_1^2}) = & -2 \overline{u_1^2} \frac{\partial \overline{U_1}}{\partial x_1} - 2 \overline{u_1 u_2} \frac{\partial \overline{U_1}}{\partial x_2} \\ & - \frac{\partial}{\partial x_1} \overline{u_1^3} - \frac{\partial}{\partial x_2} \overline{u_1^2 u_2} \\ & - \frac{2}{\rho} \frac{\partial}{\partial x_1} \overline{p u_1} + \frac{2}{\rho} p \frac{\partial \overline{u_1}}{\partial x_1} - \epsilon_{11} \end{aligned} \quad (5.3)$$

$$\begin{aligned}
\frac{D}{Dt} (\overline{u^2}) &= - 2 \overline{u_2 u_1} \frac{\partial \overline{U}}{\partial x_1} - 2 \overline{u_2 u_2} \frac{\partial \overline{U}}{\partial x_2} \\
&\quad - \frac{\partial}{\partial x_1} \overline{u_2^2 u_1} - \frac{\partial}{\partial x_2} \overline{u_2^3} \\
&\quad - \frac{2}{\rho} \frac{\partial \overline{p u_2}}{\partial x_2} + \frac{2}{\rho} \overline{p} \frac{\partial \overline{u_2}}{\partial x_2} - \epsilon_{22}
\end{aligned} \tag{5.4}$$

$$\begin{aligned}
\frac{D(\overline{u^2})}{Dt^3} &= - \frac{\partial}{\partial x_1} \overline{u_3^2 u_1} - \frac{\partial \overline{u_3^2 u_2}}{\partial x_2} \\
&\quad - \frac{2}{\rho} \frac{\partial}{\partial x_3} \overline{p u_3} + \frac{2}{\rho} \overline{p} \frac{\partial \overline{u_3}}{\partial x_3} - \epsilon_{33}
\end{aligned} \tag{5.5}$$

$$\begin{aligned}
\frac{D(\overline{u_1 u_2})}{Dt} &= - \overline{u_1 u_2} \frac{\partial \overline{U}}{\partial x_1} - \overline{u_2^2} \frac{\partial \overline{U}}{\partial x_2} \\
&\quad - \overline{u_1 u_1} \frac{\partial \overline{U}}{\partial x_1} - \overline{u_1 u_2} \frac{\partial \overline{U}}{\partial x_2} \\
&\quad - \frac{\partial}{\partial x_1} \overline{u_1^2 u_2} - \frac{\partial}{\partial x_2} \overline{u_1 u_2^2} \\
&\quad - \frac{1}{\rho} \left(\frac{\partial}{\partial x_1} \overline{p u_2} + \frac{\partial}{\partial x_2} \overline{p u_1} \right) \\
&\quad + \frac{1}{\rho} \overline{p} \left(\frac{\partial \overline{u_2}}{\partial x_1} + \frac{\partial \overline{u_1}}{\partial x_2} \right) - \epsilon_{12}
\end{aligned} \tag{5.6}$$

There are several interesting features of the above equations that are related to the results of the present experiments. First, consider the case of fully developed flow where the derivatives of $\overline{U}_2$ and derivatives with respect to x_1 are zero. For this case, only the expressions for $\overline{u_1^2}$ and $\overline{u_1 u_2}$ contain the turbulence generation term $\overline{u_1 u_2} \partial \overline{U}_1 / \partial x_2$, indicating that the turbulence is strongly nonisotropic in the axial direction particularly in regions of high shear stress. The only way the other components ($\overline{u_2^2}$, $\overline{u_3^2}$) gain turbulence energy is through the turbulence and pressure diffusion terms. Thus, turbulence energy is generated in the axial direction and then is passed on to the other components.

For the case of developing flow, the derivatives of $\overline{U}_2$ and derivatives in the x_1 direction are not zero and additional turbulence generation terms are present in the equations for $\overline{u_2^2}$ and $\overline{u_1 u_2}$ but not in the equation for $\overline{u_3^2}$. Normally, the turbulence generation terms are positive. However, in certain regions of the flow field the production terms may result in a net reduction in turbulence energy. Consider the term $-\overline{u_1^2} \partial \overline{U}_1 / \partial x_1$. When the flow is accelerating in the axial direction, this term would be negative and would cause a reduction in turbulence energy of $\overline{u_1^2}$. The use of a contracting section upstream from a working section to reduce turbulence has been known empirically for many years and almost wholly eliminates undesirable turbulent fluctuations.⁽⁵⁾ The experimental results given by MacPail⁽⁶⁾ show the strong influence of accelerating flow on the reduction of axial intensity. By using the continuity equation the term $-\overline{u_2^2} \partial \overline{U}_2 / \partial x_2$ in the equation for $\overline{u_2^2}$ can be written as $+\overline{u_2^2} \partial \overline{U}_1 / \partial x_1$ which is positive for an accelerating flow in the x_1 direction. Turbulence ($\overline{u_2^2}$) is

therefore generated in the x_2 direction from this term in an axially accelerating flow. Batchelor and Proudman⁽⁷⁾ have shown theoretically that an accelerating flow causes a reduction in axial intensity and an increase in the lateral intensities. The experimental data of MacPail verify this to be the case. The term $\overline{u_2 u_1} \partial \overline{U}_2 / \partial x_1$ is similar to the term $\overline{u_1 u_2} \partial \overline{U}_1 / \partial x_2$. Their importance depends upon the location in the flow field. Near the center of the flow channel they are both small because of the small shear stress and velocity gradients. Near the wall, they would have more importance. The former would usually be smaller, however, because $\partial \overline{U}_2 / \partial x_1$ is less than $\partial \overline{U}_1 / \partial x_2$ for most cases.

The interaction between the shear stress and the lateral axial velocity gradient, $-\overline{u_1 u_2} \frac{\partial \overline{U}_1}{\partial x_2}$ may also result in a negative production of turbulence energy or energy reversal. When a turbulent eddy with positive shear stress ($-\overline{u_1 u_2} > 0$) erupts into a zone of negative mean velocity gradient, energy reversal will occur and the eddy will be rapidly attenuated. Similarly, when a eddy with negative shear stress ($-\overline{u_1 u_2} < 0$) migrates into a positive velocity gradient, energy reversal will occur. Bradshaw⁽⁴⁾ and Eskinazi and Erian⁽⁸⁾ give examples of developed flows in which energy reversal occurs. Bradshaw also discusses the likelihood of energy reversal at the meeting of boundary layers in developing flows. In a region of energy reversal some of the turbulence energy is returned to the mean flow and the loss is made up by diffusion from adjacent zones. Eskinazi and Erian⁽⁸⁾ noted this higher diffusion in their experimental work.

For this study regions of energy reversal could be present in the wake of the grid spacer. The accelerating flow and the adjacent but opposite shear-velocity gradients in the wake of the spacer would indicate a region of possible energy reversal. This phenomena is believed to contribute, in part, to the reduction of axial turbulence intensity in the velocity recovery region behind the grid, but does not explain the general reduction of intensity found at Plane 2.

The viscous effect, denoted by ϵ_{11} , ϵ_{22} , ϵ_{33} , and ϵ_{12} above causes a negative contribution and is more significant with increasing intensity. It damps out the greater intensity components at a higher rate than the smaller ones; thus, it tends to equalize the components. The effect is greater for smaller eddies since they are closer in size to the dissipation scale of turbulence. The passage of the flow through the spacer causes a reduction in scale of turbulence. This implies that a larger number of turbulent eddies are closer to the dissipation scale. Dissipation of the smaller eddies by the viscous stresses would result in an increase in the macroscale since the smaller eddies would be eliminated from the turbulent eddy "population". This effect of increasing macroscale with increasing distance downstream from the spacer was observed in the experiments.

The rapid decay of turbulence intensity between Plane 1 and Plane 2 might be attributed to viscous dissipation. However, the average size of the eddies at the spacer's trailing edge is nearly two orders of magnitude greater than the size of the dissipating eddies. Thus it would require greater downstream distance (time) than 14 inches for the eddies to be dissipated.

The marked decrease in scale experienced by the flow due to passage through the grid has some interesting implications. Since the diffusive action of turbulence is determined mainly by the larger eddies, the reduction in scale would imply decreased diffusion of turbulence energy from the rod surfaces. For rod bundles without spacers, the diffusion from the wall is the primary source of turbulent energy at the interior of the subchannel. For developing flow in a pipe with wire gauge transition, Shàron⁽⁹⁾ presents the radial distribution of axial intensity at a number of positions downstream from the entrance. At an axial position of 18 X/D, the results show little increase of intensity about the center due to diffusion of turbulence energy from the wall. Between 20 and 40 X/D the axial intensity develops to nearly the fully developed intensity distribution. If the interior subchannel of the present study is thought to be analogous to pipe flow, turbulence energy diffusion from the wall would not be significant until Plane 3. The increase of intensity observed at Plane 3 thus may be due, in part, to the increased influence of turbulent diffusion from the wall.

It is somewhat difficult to assess the importance of the remaining terms of the above equations; however, there does appear to be a consensus^(3,4) that they tend to make the turbulence more isotropic. As mentioned previously for the flow field under discussion the turbulence is primarily generated in the axial direction and is transferred to the lateral components by turbulence and pressure diffusion.

For the case of developed flow and $\overline{u_1^2} > \overline{u_2^2} + \overline{u_3^2}$, Hinze discusses the pressure velocity-gradient correlation (pressure-velocity diffusion) to

show that it decreases $\overline{u_1^2}$ and $\overline{u_1 u_2}$ but increases $\overline{u_2^2}$ and $\overline{u_3^2}$. The general direction is toward isotropy. This term would be the strongest in regions of significant pressure fluctuations and, according to Hinze, in the smaller scale range of turbulence. This term is believed to provide a major contribution to the observed reduction in axial component turbulence intensity in the present experiments. The reduction is believed to be a transfer of energy from the axial to the lateral components of turbulence. Within the grid the turbulence would be highly nonisotropic in the axial direction with added generation of turbulence due to the shear on the grid plates.

Then in the smaller scale turbulent flow and pressure pulsations of the wake region the energy is "scrambled" or transferred to the lateral components. This would tend toward isotropy which would reduce $\overline{u_1^2}$. Farther downstream the transfer of turbulence from the axial component would become weaker due to the reduction of pressure pulsations. The flow would then revert back to its normal nonisotropic state and gradually achieve its fully developed profile.

To show that the magnitude of such a transfer is consistent with the observed experimental results, consider the reasonable case where $\overline{u_1^2}$ is four times $\overline{u_2^2}$ and $\overline{u_3^2}$. The turbulence energy is therefore,

$$\frac{\overline{q^2}}{2} = \frac{\overline{u_1^2}}{2} \left(1 + \frac{1}{4} + \frac{1}{4}\right) = \frac{3}{4} \overline{u_1^2} \quad (5.7)$$

For isotropy with the same turbulence energy,

$$\frac{\overline{q^2}}{2} = \frac{(\overline{u_1^2})_{\text{iso}}}{2} (1 + 1 + 1) = \frac{3}{2} (\overline{u_1^2})_{\text{iso}}; \quad (5.8)$$

therefore, $\overline{u_1^2}$ for isotropy is one half that for the nonisotropic case. When stated in terms of intensity this is $\sqrt{2}$ change which is consistent with the magnitude of change observed downstream of the grid spacer. Additional factors which are probably also involved in the reduction of $\overline{u_1^2}$ behind the grid are energy reversal and viscosity effects. These would not be as important in the region where $\overline{u_1^2}$ recovers because the turbulence scale is larger and the velocity profiles have recovered to near those of fully developed flow.

Although the above discussion is somewhat speculative because complete data are not available, it is consistent with the experimental observations. In summary, consider the description of turbulent flow behind the grid spacer presented in Figure 5.1. The axial component intensity increases when passing through the grid spacer because of the added shear stress and velocity gradient interaction. The flow emerges with generally increased intensity, reduced macroscale and significant velocity distortions (wake). Following the grid spacer, the axial component intensity decreases most probably by transfer of turbulence energy to the lateral velocity components by action of the pressure-velocity correlations in the wake. This decrease would also be assisted by increased dissipation associated with the smaller macroscale and possibly assisted by local "energy-reversal" in the immediate wake of the grid strap. This decrease could be rather general as indicated by the reduced intensity throughout the flow field as shown in Figure 4.9. Following the reduction, $\overline{u_1^2}$ again increases but now due to the reduced dissipation and reduced transfer to isotropy. Wall shear stress is again important and begins to develop nonisotropic turbulence in the axial direction.

Figure 5.1. Production and dissipation of axial turbulence intensity.

The turbulence diffusion and pressure-velocity correlation carries the turbulence to the central part of the channel. The flow continues in this manner toward a fully developed flow field which is essentially achieved prior to entering the second grid spacer.

It is natural to wonder if the phenomena observed in the present experiments would occur in rod bundles with grid spacers used for nuclear power reactors. It probably would, but would be dependent upon the design of the grid spacer. The tendency toward increased intensity and reduced scale upon emerging from a grid could be expected but the magnitudes would depend upon the design features of the grid. The tendency toward isotropy should also exist with a tendency for reduced axial component intensity and increased lateral component intensity. The recovery of the flow from the grid perturbation should also occur; however, the length over which this would occur is uncertain. The present experiments show the axial component intensity distribution to be rather insensitive to Reynolds number; however, the data do not show that the distances can be scaled to some dimension like hydraulic diameter. Experimentation in bundles of different size would help to determine the scaling parameters.

5.2 Implications Regarding Crossflow Mixing

An estimate for rod bundle crossflow mixing was made in the previous study⁽²⁾ by assuming that the product of axial component intensity and macroscale, as estimated by Taylor's hypothesis, could be used to approximate the eddy diffusion coefficient

$$\epsilon \approx u'_1 \Lambda \quad (5.9)$$

The crossflow mixing was written as

$$\frac{w'}{GD} \propto \left(\frac{u'_1}{U}\right) \left(\frac{\bar{u}}{U}\right) \left(\frac{\Lambda}{D}\right) \left(\frac{S}{\Delta y}\right). \quad (5.10)$$

The implication of this equation is that crossflow mixing is dependent upon turbulence intensity, scale and a diffusion related geometric parameter. The results of this study taken at face value would suggest that mixing decreased behind the grid spacer because of reduced intensity and scale. This, however, may not be the case. An important assumption in Equation (5.10) is the factor of proportionality which includes at least the ratios v'/u'_1 and Λ_L/Λ . These are the ratio of lateral Lagrangian fluctuating velocity component to the axial Eulerian component and the ratio of Lagrangian lateral macroscale to the axial Eulerian macroscale. Values of these ratios are not known; however, they would not necessarily be constants in the wake region of the grid spacer.

The ratio v'/u'_1 could increase in the region of reduced u'_1 if the previous discussion concerning the change to isotropy is valid. For the simple example considered previously, the reduction of $\bar{u}_1^2$ by a factor of two would correspond to a factor of two increase each in $\bar{u}_2^2$ and $\bar{u}_3^2$. This would correspond to a $\sqrt{2}$ increase in $\bar{v}'$ if $\bar{v}' \approx \bar{u}_2'$.

The ratio Λ_L/Λ could also be larger behind the grid than in fully developed flow. Axial scale Λ is normally larger than the scale in the lateral direction. With the tendency toward isotropy in the wake of the grid, the axial scale could interact in such a way that, while the total scale may be reduced, the lateral scale could be increased.

The net effect is that the crossflow mixing would probably not be decreased in the wake of the grid, but it is not possible to state that the mixing is higher behind the grid. It could be that, with the rather simple grid considered in this study, there might not have been a significant change in mixing even though the turbulent structure changed drastically. A mixing experiment with and without the grids would certainly help to determine how the flow structure changes affect crossflow mixing.

6.0 CONCLUSIONS AND RECOMMENDATIONS

68

The present experimental study has yielded some new and interesting information concerning the turbulent flow structure in a rod bundle with grid spacers. The presence of the grid spacer in a rod bundle results in significant changes in axial mean velocity, turbulence intensity and turbulence scale. The influence of the grid spacer on the flow structure can be readily observed as far downstream from the spacer as $32X/D$. The following conclusion can be made regarding the experimental results:

1. Fully developed turbulent flow passing through a grid spacer emerges with increased axial intensity and decreased axial macroscale.
2. The velocity perturbations caused by the spacer are most significant in the interior subchannel and least significant in the corner subchannel. Local velocity perturbations in the wake of the grid spacer recover in a rather short distance $\sim 18X/D$. The large flow redistributions caused by the spacer require $\sim 47X/D$ to return to the nearly developed condition.
3. For an interior subchannel the axial intensity varies significantly with position downstream from the grid spacer: First emerging from the spacer with high intensity, then after decreasing rapidly to a low level of intensity, the intensity again increases to a high level before decaying to the nearly fully developed condition. The intermediate, "quiet", downstream position is believed to be due to the transfer of turbulence energy from the axial component to the lateral components.

4. For a wall subchannel the high intensity near the trailing edge of the spacer decays monotonically downstream of the spacer toward the fully developed condition.
5. The axial macroscale increases monotonically from $\sim 0.15D$ near the trailing edge of the spacer ($3X/D$) to $\sim 0.4D$ for nearly developed flow ($47X/D$) in the interior subchannel.
6. The effect of the grid spacer on the axial intensity, scale and mean velocity is weakly dependent upon Reynolds Number.

As a result of this study the following recommendations are offered for future studies:

- Obtain additional data at more planes downstream from the spacer including the measurement of the lateral component of turbulence. This could help identify the cause for the "quiet" region downstream of the grid observed in the present study. Perform an adjunct scalar mixing experiment with the turbulent flow measurements. This would lead to a better understanding of the cross flow mixing mechanism in rod bundles with grid spacers.
- Evaluate the effect of spacer design by using different model spacers in the rod bundle. This would indicate the influence of spacer design on downstream turbulence structure.

7.0 NOMENCLATURE

70

A	Flow area
d	Rod diameter
D	Hydraulic diameter ($4A/P_w$)
G	Mass flux (ρU)
i,j,k,l	Tensor indices for coordinate directions
P	Rod pitch
p	Fluctuating pressure
P_w	Wetted perimeter
q^2	Kinetic energy of turbulence
Re	Reynolds number, channel average (UD/ν)
$R(\tau)$	Eulerian time correlation function
s	Rod gap spacing
t	time
T_E	Eulerian macro time scale
u'	"rms" of fluctuating velocity in x direction
u'_i	"rms" of fluctuating velocity in i direction
u_i	Fluctuating velocity in i direction, $i = 1,2,3$
u_1, u_2, u_3	Fluctuating velocity in the x,y, and z directions
$\bar{u}$	Local mean velocity in x direction
U	Channel average velocity
$\bar{U}_i$	Average velocity in i direction
$\bar{U}_1, \bar{U}_2, \bar{U}_3$	Average velocity in the x, y, and z directions
$\overline{u_i u_j}$	Turbulent shear stress tensor
v'	"rms" of Lagrangian fluctuating velocity in lateral direction

w'	Turbulent crossflow per unit length	71
x	Coordinate direction parallel to flow	
x_i	Coordinate in i direction	
X	Distance from trailing edge of spacer	
y	Coordinate direction parallel to window surface	
Δy	Centroid or "mixing" distance between subchannels	
z	Coordinate direction perpendicular to window surface	
$\alpha_1, \alpha_1,$	Function fit parameters	
ϵ	Eddy diffusivity	
ϵ_{ij}	Combined viscosity terms of turbulent energy equation	
λ	Wavelength of light	
Λ	Eulerian longitudinal space macroscale as estimated by Taylor's hypothesis	
Λ_L	Lagrangian space macroscale	
ν	Kinematic viscosity	
ρ	Fluid density	
σ	Standard deviation	
τ	Time delay	

8.0 BIBLIOGRAPHY

72

1. Yeh, Y. and H. Z. Cummins. Localized fluid flow measurements with a H_e-N_e laser spectrometer. Applied Physics Letters 4:176-178. 1964.
2. Rowe, D. S. Measurement of turbulent velocity, intensity and scale in rod bundle flow channels. 1973. 222 p. (Battelle Memorial Institute. Pacific Northwest Laboratories. BNWL-1736).
3. Hinze, J. O. Turbulence. New York, McGraw-Hill, 1959. 586 p.
4. Bradshaw, P. An Introduction to Turbulence and its Measurement. New York, Pergamon Press, 1971. 218 p.
5. Batchelor, G. K. The Theory of Homogeneous Turbulence. London, Cambridge University Press, 1953. 197 p.
6. MacPail, D. C. Turbulence changes in contracting and distorted passages. Rep. No. Aero. 1928, British R.A.E.
7. Batchelor, G. K. and I. Proudman. The effect of rapid distortion of a fluid in turbulent motion. Quarterly Journal of Mechanics and Applied Mathematics, Vol. VII, Pt. 1, 1954.
8. Eskinazi, S. and F. F. Erian. Energy reversal in turbulent flows. Physics of Fluids 10:1988-1998. 1969.
9. Shàrèn, V. KR. An experimental investigation of naturally developing turbulent flow and flow with fixed transition in a parallel pipe. American Society of Mechanical Engineers, ASME Paper 72-WA/FE-38.

APPENDIX A

Tabulation of Reduced Data

[illegible]

TABLE B-1 (CONT.), TABULATION OF EXPERIMENTAL DATA.

PLANE 1 2.25 INCHES DOWNSTREAM SPACER													
INTERIOR MAP RUN 294 -420													
RUN	REYNOLDS NUMBER	Z IN.	Y IN.	$\bar{U}$ FT/SEC	$\bar{U}/U$	$\bar{U}/U^*$	$U/\bar{U}$	U/U^*	$V/\bar{U}$	V/U^*	V/U^* CUTOFF KHZ	λ/D	CURVE FIT $F(HZ)$ °
Av374	101056.	1.329	.605	16.8	1.08	-	.074	-	-	-	3.00	-	-
Av375	101056.	1.195	.605	18.0	1.16	-	.072	-	-	-	3.00	-	-
Av376	101056.	1.060	.605	17.7	1.14	-	.060	-	-	-	3.00	-	-
Av377	101056.	.926	.605	15.7	1.01	-	.073	-	-	-	3.00	-	-
Av378	101056.	.792	.605	12.8	.82	-	.054	-	-	-	3.00	-	-
Av379	101056.	.658	.605	14.4	.93	-	.069	-	-	-	3.00	-	-
Av380	101056.	.523	.605	16.4	1.06	-	.060	-	-	-	3.00	-	-
Av381	101056.	.389	.605	16.3	1.05	-	.068	-	-	-	3.00	-	-
Av382	101056.	.255	.605	16.4	1.06	-	.064	-	-	-	3.00	-	-
Av383	101056.	.121	.605	14.7	.96	-	.055	-	-	-	3.00	-	-
Av384	101056.	.121	.745	14.9	.96	-	.062	-	-	-	3.00	-	-
Av385	101056.	.255	.745	18.3	1.18	-	.057	-	-	-	3.00	-	-
Av386	101056.	.389	.745	18.3	1.18	-	.064	-	-	-	3.00	-	-
Av387	101056.	.523	.745	17.3	1.11	-	.056	-	-	-	3.00	-	-
Av388	101056.	.658	.745	12.3	.79	-	.082	-	-	-	3.00	-	-
Av389	101056.	.792	.745	9.7	.63	-	.074	-	-	-	3.00	-	-
Av390	101056.	.926	.745	13.6	.88	-	.059	-	-	-	3.00	-	-
Av391	101056.	1.060	.745	18.5	1.19	-	.057	-	-	-	3.00	-	-
Av392	101056.	1.195	.745	19.7	1.27	-	.053	-	-	-	3.00	-	-
Av393	101056.	1.329	.745	17.6	1.14	-	.077	-	-	-	3.00	-	-
Av394	101056.	1.463	.745	17.8	1.15	-	.076	-	-	-	3.00	-	-
Av395	101056.	1.597	.745	19.7	1.27	-	.060	-	-	-	3.00	-	-
Av396	101056.	1.732	.745	18.6	1.20	-	.057	-	-	-	3.00	-	-
Av397	101056.	1.866	.745	14.5	.93	-	.092	-	-	-	3.00	-	-
Av398	101056.	2.000	.745	9.0	.58	-	.105	-	-	-	3.00	-	-
Av399	101056.	1.128	.625	16.6	1.07	-	.066	-	-	-	10.00	-	-
Av400	101056.	1.128	.625	16.6	1.07	-	.068	-	-	-	7.00	-	-
Av401	101056.	1.128	.625	16.6	1.07	-	.066	-	-	-	4.00	-	-
Av402	101056.	1.128	.625	16.6	1.07	-	.065	-	-	-	3.00	-	-
Av403	101056.	1.128	.625	16.6	1.07	-	.063	-	-	-	2.00	-	-
Av404	101056.	1.128	.625	16.6	1.07	-	.059	-	-	-	1.00	-	-
Av405	101056.	1.128	.625	16.6	1.07	-	.055	-	-	-	.50	-	-
Av406	50529.	.121	.625	7.1	.91	-	.048	-	-	-	2.00	.08	0.013
Av407	50529.	.255	.625	7.6	.98	-	.064	-	-	-	2.00	.11	0.022
Av408	50529.	.389	.625	7.6	.98	-	.056	-	-	-	2.00	.20	0.040
Av409	50529.	.523	.625	7.4	.96	-	.060	-	-	-	2.00	.15	0.067
Av410	50529.	.658	.625	6.5	.84	-	.061	-	-	-	2.00	.08	0.019
Av411	50529.	.792	.625	6.1	.78	-	.052	-	-	-	2.00	.07	0.035
Av412	50529.	.926	.625	7.4	.95	-	.062	-	-	-	2.00	.09	0.028
Av413	50529.	1.060	.625	8.1	1.04	-	.057	-	-	-	2.00	.17	0.043
Av414	50529.	1.195	.625	9.3	1.06	-	.059	-	-	-	2.00	.18	0.048
Av415	50529.	1.329	.625	8.0	1.03	-	.066	-	-	-	2.00	.12	0.038
Av416	50529.	1.463	.625	7.9	1.02	-	.066	-	-	-	2.00	.11	0.016
Av417	50529.	1.597	.625	8.2	1.06	-	.059	-	-	-	2.00	.22	0.046
Av418	50529.	1.732	.625	8.0	1.03	-	.059	-	-	-	2.00	.18	0.038
Av419	50529.	1.866	.625	7.1	.92	-	.067	-	-	-	2.00	.10	0.044
Av420	50529.	2.000	.625	6.0	.77	-	.051	-	-	-	2.00	.08	0.014

PLANE 1 2.25 INCHES DOWNSTREAM SPACER INTERIOR TRAVERSES RUN 598 - 615

RUN	REYNOLDS NUMBER	Z IN.	Y IN.	$\bar{U}$ FT/SEC	$\bar{U}/U$	$\bar{U}/U^*$	$U/\bar{U}$	U/U^*	$V/\bar{U}$	V/U^* CUTOFF KHZ	λ/D	CURVE FIT °
Av598	102382.	1.688	.749	19.4	1.25	-	.058	-	-	3.00	-	-
Av599	102382.	1.688	.719	18.8	1.21	-	.064	-	-	3.00	-	-
Av600	102382.	1.688	.609	17.9	1.16	-	.069	-	-	3.00	-	-
Av601	102382.	1.688	.629	17.1	1.10	-	.068	-	-	3.00	-	-
Av602	102382.	1.688	.629	16.7	1.08	-	.063	-	-	3.00	-	-
Av603	102382.	1.688	.599	16.9	1.09	-	.068	-	-	3.00	-	-
Av604	102382.	1.688	.569	17.6	1.13	-	.069	-	-	3.00	-	-
Av605	102382.	1.688	.539	18.4	1.18	-	.066	-	-	3.00	-	-
Av606	102382.	1.688	.509	19.0	1.23	-	.055	-	-	3.00	-	-
Av607	102382.	2.003	.509	11.5	.74	-	.061	-	-	3.00	-	-
Av608	102382.	2.003	.539	13.0	.84	-	.048	-	-	3.00	-	-
Av609	102382.	2.003	.569	13.2	.85	-	.045	-	-	3.00	-	-
Av610	102382.	2.003	.629	13.2	.85	-	.049	-	-	3.00	-	-
Av611	102382.	2.003	.639	13.2	.85	-	.053	-	-	3.00	-	-
Av612	102382.	2.003	.669	13.0	.84	-	.060	-	-	3.00	-	-
Av613	102382.	2.003	.719	12.4	.80	-	.063	-	-	3.00	-	-
Av614	102382.	2.003	.749	10.3	.66	-	.073	-	-	3.00	-	-
Av615	102382.	2.003	.811	INCHES.	AVERAGE VELOCITY, U = 15.5 FT/SEC.	-	-	-	-	-	-	-
HYDRAULIC DIAMETER, D = .611 INCHES.												
* QUESTIONABLE DATA POINT.												
- NO DATA POINT.												

* QUESTIONABLE DATA POINT.

- NO DATA POINT.

TABLE B-1 (CONT.), TABULATION OF EXPERIMENTAL DATA.

PLANE 1 2.25 INCHES DOWNSTREAM SPACER WALL MAP RUN 447 -597													
RUN	REYNOLDS	Z	Y	U	U/U*	U/U*	U/U*	V/U*	V/U*	CUTOFF	Λ/D	CURVE	FIT
	NUMBER	IN.	IN.	FT/SEC								F(HZ)	°
AG447	102382.	.081	1.755	14.1	.91	-	.050	-	-	3.00	.15	96.	.014
AG448	102382.	.148	1.755	15.5	1.00	-	.059	-	-	3.00	-	-	-
AG449	102382.	.215	1.755	17.1	1.10	-	.059	-	-	3.00	.17	0.	.016
AG450	102382.	.282	1.755	17.8	1.15	-	.053	-	-	3.00	-	-	-
AG451	102382.	.349	1.755	17.5	1.13	-	.059	-	-	3.00	.16	0.	.013
AG452	102382.	.416	1.755	17.6	1.13	-	.058	-	-	3.00	-	-	-
AG453	102382.	.483	1.755	17.4	1.12	-	.049	-	-	3.00	.20	0.	.022
AG454	102382.	.550	1.755	16.3	1.05	-	.061	-	-	3.00	-	-	-
AG455	102382.	.617	1.755	13.8	.89	-	.082	-	-	3.00	.16	60.	.015
AG456	102382.	.685	1.755	10.8	.69	-	.093	-	-	3.00	-	-	-
AG457	102382.	.752	1.755	-	-	-	-	-	-	-	-	-	-
AG458	102382.	.819	1.755	8.1	.52	-	.151	-	-	3.00	-	-	-
AG459	102382.	.886	1.755	11.3	.72	-	.096	-	-	3.00	.19	0.	.021
AG460	102382.	.953	1.755	14.5	.94	-	.089	-	-	3.00	.18	0.	.020
AG461	102382.	1.020	1.755	17.3	1.11	-	.059	-	-	3.00	.22	0.	.028
AG462	102382.	1.087	1.755	18.6	1.20	-	.049	-	-	3.00	-	-	-
AG463	102382.	1.154	1.755	19.2	1.24	-	.046	-	-	3.00	.21	0.	.044
AG464	102382.	1.221	1.755	19.3	1.24	-	.049	-	-	3.00	-	-	-
AG465	102382.	1.288	1.755	18.3	1.16	-	.071	-	-	3.00	-	-	-
AG466	102382.	1.356	1.755	16.3	1.05	-	.074	-	-	3.00	-	-	-
AG467	102382.	1.423	1.755	16.1	1.04	-	.068	-	-	3.00	.18	106.	.017
AG468	102382.	1.490	1.755	17.7	1.14	-	.069	-	-	3.00	-	-	-
AG469	102382.	1.557	1.755	18.8	1.21	-	.058	-	-	3.00	.12	0.	.009
AG470	102382.	1.624	1.755	13.8	1.21	-	.058	-	-	3.00	-	-	-
AG471	102382.	1.691	1.755	18.6	1.20	-	.052	-	-	3.00	.21	0.	.021
AG472	102382.	1.758	1.755	18.3	1.16	-	.052	-	-	3.00	-	-	-
AG473	102382.	1.825	1.755	16.3	1.05	-	.073	-	-	3.00	.21	0.	.013
AG474	102382.	1.892	1.755	13.6	.87	-	.099	-	-	3.00	-	-	-
AG475	102382.	1.960	1.755	10.6	.69	-	.097	-	-	3.00	-	-	-
AG476	102382.	2.027	1.755	9.6	.62	-	.078	-	-	3.00	-	-	-
AG477	102382.	2.027	1.815	11.7	.75	-	.058	-	-	3.00	-	-	-
AG478	102382.	1.960	1.815	12.7	.82	-	.087	-	-	3.00	.10	151.	.009
AG479	102382.	1.892	1.815	14.9	.96	-	.075	-	-	3.00	-	-	-
AG480	102382.	1.825	1.815	16.1	1.03	-	.067	-	-	3.00	.12	0.	.014
AG481	102382.	1.758	1.815	16.6	1.07	-	.065	-	-	3.00	-	-	-
AG482	102382.	1.691	1.815	16.9	1.09	-	.066	-	-	3.00	.14	109.	.014
AG483	102382.	1.557	1.815	16.7	1.08	-	.072	-	-	3.00	.12	0.	.013
AG484	102382.	1.490	1.815	16.2	1.04	-	.070	-	-	3.00	-	-	-
AG485	102382.	1.423	1.815	15.3	.99	-	.061	-	-	3.00	.12	0.	.012
AG486	102382.	1.356	1.815	15.7	1.01	-	.065	-	-	3.00	-	-	-
AG487	101058.	1.289	1.815	17.1	1.10	-	.066	-	-	3.00	-	-	-
AG488	101058.	1.221	1.815	17.8	1.15	-	.068	-	-	3.00	-	-	-
AG489	101058.	1.154	1.815	17.6	1.13	-	.071	-	-	3.00	.23	16.	.008
AG490	101058.	1.020	1.815	16.9	1.09	-	.063	-	-	3.00	.18	0.	.022
AG491	101058.	.953	1.815	16.1	1.04	-	.062	-	-	3.00	-	-	-
AG492	101058.	1.087	1.815	17.1	1.10	-	.068	-	-	3.00	-	-	-
AG493	101058.	.886	1.815	14.1	.91	-	.075	-	-	3.00	.15	82.	.010
AG494	101058.	.819	1.815	12.3	.77	-	.067	-	-	3.00	-	-	-
AG495	101058.	.752	1.815	11.6	.75	-	.064	-	-	3.00	.08	98.	.017
AG496	101058.	.685	1.815	13.2	.85	-	.078	-	-	3.00	-	-	-
AG497	101058.	.617	1.815	14.9	.96	-	.061	-	-	3.00	.18	0.	.043
AG498	101058.	.550	1.815	15.8	1.02	-	.060	-	-	3.00	-	-	-
AG499	101058.	.483	1.815	16.0	1.03	-	.066	-	-	3.00	.20	0.	.020
AG500	101058.	.416	1.815	15.8	1.02	-	.070	-	-	3.00	-	-	-
AG501	101058.	.349	1.815	15.7	1.01	-	.070	-	-	3.00	.15	0.	.011
AG502	101058.	.282	1.815	16.3	1.03	-	.066	-	-	3.00	-	-	-
AG503	101058.	.215	1.815	15.9	1.02	-	.054	-	-	3.00	.17	1.	.020
AG504	101058.	.148	1.815	15.2	.98	-	.047	-	-	3.00	-	-	-
AG505	101058.	.081	1.815	14.3	.90	-	.057	-	-	3.00	.14	0.	.009
AG506	101058.	.081	1.875	13.7	.88	-	.077	-	-	3.00	.12	0.	.019
AG507	101058.	.148	1.875	15.7	1.01	-	.043	-	-	3.00	-	-	-
AG508	101058.	.215	1.875	15.2	.98	-	.050	-	-	3.00	.14	0.	.011
AG509	101058.	.282	1.875	14.4	.93	-	.061	-	-	3.00	-	-	-
AG510	101058.	.349	1.875	14.1	.91	-	.058	-	-	3.00	.18	0.	.017
AG511	101058.	.483	1.875	14.2	.91	-	.061	-	-	3.00	.17	79.	.032
AG512	101058.	.617	1.875	13.2	.85	-	.063	-	-	3.00	.11	0.	.014
AG513	101058.	.685	1.875	12.4	.80	-	.062	-	-	3.00	-	-	-
AG514	101058.	.752	1.875	11.6	.75	-	.049	-	-	3.00	.08	74.	.019
AG515	101058.	.819	1.875	11.9	.77	-	.055	-	-	3.00	-	-	-
AG516	101058.	.886	1.875	13.4	.86	-	.070	-	-	3.00	.11	97.	.008
AG517	101058.	1.020	1.875	14.8	.95	-	.062	-	-	3.00	.14	0.	.012
AG518	101058.	1.154	1.875	15.4	.99	-	.066	-	-	3.00	.18	88.	.025
AG519	101058.	1.289	1.875	15.4	.99	-	.064	-	-	3.00	.17	0.	.019
AG520	101058.	1.356	1.875	14.9	.96	-	.049	-	-	3.00	-	-	-
AG521	101058.	1.423	1.875	15.3	.96	-	.046	-	-	3.00	.08	0.	.010
AG522	101058.	1.490	1.875	15.1	.97	-	.052	-	-	3.00	-	-	-
AG523	101058.	1.557	1.875	15.3	.97	-	.054	-	-	3.00	.15	0.	.012
AG524	101058.	1.691	1.875	15.1	.97	-	.058	-	-	3.00	.13	126.	.023
AG525	101058.	1.825	1.875	14.3	.90	-	.072	-	-	3.00	.13	98.	.015
AG526	101058.	1.960	1.875	11.9	.77	-	.083	-	-	3.00	.09	141.	.006

HYDRAULIC DIAMETER, D = .811 INCHES. AVERAGE VELOCITY, U = 15.5 FT/SEC.
 * QUESTIONABLE DATA POINT. - NO DATA POINT.

TABLE B-1 (CONT.), TABULATION OF EXPERIMENTAL DATA.

PLATE 1 2.25 INCHES DOWNSTREAM SPACER														WALL MAP		RUN 447 -597	
RUN	REYNOLDS	Z	Y	U	U/U	U/U'	U/U'	V/U	V/U'	CUTOFF	A/D	CURVE	FIT				
NUMBER	IN.	IN.	IN.	FT/SEC						KHZ		F(HZ)	°				
AG527	101058	2.027	1.875	11.4	.73	-.059	-	-	-	3.00	-	-	-				
AG528	101058	2.027	1.925	10.8	.70	-.064	-	-	-	3.00	-	-	-				
AG529	101058	1.960	1.925	10.5	.68	-.084	-	-	-	3.00	.10	80.	.008				
AG530	101058	1.893	1.925	11.3	.73	-.102	-	-	-	3.00	-	-	-				
AG531	101058	1.825	1.925	12.7	.82	-.085	-	-	-	3.00	-	-	-				
AG532	101058	1.758	1.925	13.8	.89	-.061	-	-	-	3.00	-	-	-				
AG533	101058	1.691	1.925	14.4	.92	-.049	-	-	-	3.00	-	-	-				
AG534	101058	1.557	1.925	14.5	.93	-.047	-	-	-	3.00	.11	0.	.011				
AG535	101058	1.423	1.925	14.6	.94	-.049	-	-	-	3.00	.11	0.	.011				
AG536	101058	1.289	1.925	14.4	.93	-.050	-	-	-	3.00	.15	0.	.013				
AG537	101058	1.154	1.925	14.3	.92	-.050	-	-	-	3.00	.16	22.	.021				
AG538	101058	1.020	1.925	13.8	.89	-.053	-	-	-	3.00	.14	0.	.011				
AG539	101058	.886	1.925	12.2	.79	-.058	-	-	-	3.00	.13	0.	.011				
AG540	101058	.839	1.925	11.6	.74	-.048	-	-	-	3.00	-	-	-				
AG541	101058	.752	1.925	11.5	.74	-.046	-	-	-	3.00	.08	0.	.033				
AG542	101058	.617	1.925	12.5	.80	-.063	-	-	-	3.00	.14	113.	.013				
AG543	101058	.483	1.925	13.4	.86	-.052	-	-	-	3.00	.14	0.	.021				
AG544	101058	.349	1.925	13.5	.87	-.046	-	-	-	3.00	.13	0.	.021				
AG545	101058	.215	1.925	14.4	.93	-.053	-	-	-	3.00	.11	0.	.011				
AG546	101058	.081	1.925	14.4	.92	-.071	-	-	-	3.00	-	-	-				
AG547	101058	.081	1.925	12.6	.83	-.085	-	-	-	3.00	-	-	-				
AG548	101058	.215	1.925	13.4	.86	-.056	-	-	-	3.00	-	-	-				
AG549	101058	.349	1.925	13.2	.85	-.049	-	-	-	3.00	-	-	-				
AG550	101058	.483	1.925	12.9	.83	-.054	-	-	-	3.00	-	-	-				
AG551	101058	.617	1.925	11.4	.73	-.073	-	-	-	3.00	-	-	-				
AG552	101058	.752	1.925	11.2	.72	-.052	-	-	-	3.00	-	-	-				
AG553	101058	.886	1.925	11.4	.74	-.059	-	-	-	3.00	-	-	-				
AG554	101058	1.020	1.925	13.0	.84	-.061	-	-	-	3.00	-	-	-				
AG555	101058	1.154	1.925	13.6	.87	-.051	-	-	-	3.00	.14	0.	.021				
AG556	101058	1.289	1.925	13.7	.88	-.052	-	-	-	3.00	-	-	-				
AG557	101058	1.423	1.925	13.5	.87	-.059	-	-	-	3.00	-	-	-				
AG558	101058	1.557	1.925	14.1	.91	-.049	-	-	-	3.00	-	-	-				
AG559	101058	1.691	1.925	13.4	.86	-.063	-	-	-	3.00	-	-	-				
AG560	101058	1.825	1.925	11.5	.74	-.096	-	-	-	3.00	-	-	-				
AG561	101058	1.960	1.925	9.7	.62	-.083	-	-	-	3.00	-	-	-				
AG562	101058	.752	1.925	11.0	.71	-.057	-	-	-	3.00	-	-	-				
AG563	101058	.752	1.925	11.4	.73	-.048	-	-	-	3.00	-	-	-				
AG564	101058	.752	1.925	11.5	.74	-.047	-	-	-	3.00	-	-	-				
AG565	101058	.752	1.829	11.6	.75	-.046	-	-	-	3.00	-	-	-				
AG566	101058	.752	1.829	11.6	.75	-.053	-	-	-	3.00	-	-	-				
AG567	102382	.752	1.829	11.6	.75	-.056	-	-	-	3.00	-	-	-				
AG568	102382	.752	1.729	11.3	.73	-.065	-	-	-	3.00	-	-	-				
AG569	102382	.752	1.729	10.0	.64	-.074	-	-	-	3.00	-	-	-				
AG570	102382	.752	1.759	8.4	.54	-.112	-	-	-	3.00	-	-	-				
AG571	102382	1.376	1.729	16.3	1.03	-.068	-	-	-	3.00	-	-	-				
AG572	102382	1.376	1.729	15.8	1.02	-.068	-	-	-	3.00	-	-	-				
AG573	102382	1.376	1.729	15.5	1.00	-.063	-	-	-	3.00	-	-	-				
AG574	102382	1.376	1.829	15.1	.97	-.056	-	-	-	3.00	-	-	-				
AG575	102382	1.376	1.829	14.9	.96	-.051	-	-	-	3.00	-	-	-				
AG576	102382	1.376	1.829	14.8	.95	-.047	-	-	-	3.00	-	-	-				
AG577	102382	1.376	1.929	14.5	.93	-.049	-	-	-	3.00	-	-	-				
AG578	102382	1.376	1.929	14.3	.90	-.054	-	-	-	3.00	-	-	-				
AG579	102382	1.376	1.929	12.9	.83	-.064	-	-	-	3.00	-	-	-				
AG580	102382	2.003	1.929	9.9	.64	-.079	-	-	-	3.00	-	-	-				
AG581	102382	2.003	1.929	10.3	.67	-.069	-	-	-	3.00	-	-	-				
AG582	102382	2.003	1.929	10.7	.69	-.069	-	-	-	3.00	-	-	-				
AG583	102382	2.003	1.829	11.1	.72	-.071	-	-	-	3.00	-	-	-				
AG584	102382	2.003	1.829	11.6	.74	-.069	-	-	-	3.00	-	-	-				
AG585	102382	2.003	1.829	11.8	.76	-.071	-	-	-	3.00	-	-	-				
AG586	102382	2.003	1.729	11.6	.75	-.067	-	-	-	3.00	-	-	-				
AG587	102382	2.003	1.729	10.8	.70	-.067	-	-	-	3.00	-	-	-				
AG588	102382	2.003	1.729	9.2	.60	-.093	-	-	-	3.00	-	-	-				
AG589	102382	1.688	1.929	12.8	.82	-.073	-	-	-	3.00	-	-	-				
AG590	102382	1.688	1.929	13.9	.89	-.057	-	-	-	3.00	-	-	-				
AG591	102382	1.688	1.929	14.4	.93	-.051	-	-	-	3.00	-	-	-				
AG592	102382	1.688	1.829	14.8	.95	-.054	-	-	-	3.00	-	-	-				
AG593	102382	1.688	1.829	15.5	1.00	-.061	-	-	-	3.00	-	-	-				
AG594	102382	1.688	1.829	16.3	1.05	-.066	-	-	-	3.00	-	-	-				
AG595	102382	1.688	1.729	17.4	1.12	-.067	-	-	-	3.00	-	-	-				
AG596	102382	1.688	1.729	18.3	1.18	-.057	-	-	-	3.00	-	-	-				
AG597	102382	1.688	1.729	18.6	1.20	-.054	-	-	-	3.00	-	-	-				
HYDRAULIC DIAMETER, U = .811 INCHES. AVERAGE VELOCITY, U = 15.5 FT/SEC.																	
* QUESTIONABLE DATA POINT.																	

* QUESTIONABLE DATA POINT.

INCHES. AVERAGE VELOCITY, U = 15.5 FT/SEC.
- NO DATA POINT.

TABLE B-1 (CONT.), TABULATION OF EXPERIMENTAL DATA.

PLANE 1 2.25 INCHES DOWNSTREAM SPACER				INTERIOR CL				RUN 421 - 446 2RE					
RUN	REYNOLDS NUMBER	Z IN.	γ IN.	$\bar{U}$ FT/SEC	$\bar{U}/U^*$	$U/\bar{U}$	U/U^*	$V/\bar{U}$	V/U^*	CUTOFF KHZ	λ/D	CURVE F(HZ)	FIT $^\circ$
AG421	203479.	2.010	.625	13.6	.88	-	.045	-	-	3.00	.11	0.	.016
AG422	203479.	1.877	.625	15.7	1.01	-	.055	-	-	3.00	.18	0.	.020
AG423	203479.	1.743	.625	16.3	1.05	-	.060	-	-	3.00	.22	0.	.020
AG424	203479.	1.609	.625	16.6	1.07	-	.061	-	-	3.00	.27	0.	.022
AG425	203479.	1.476	.625	15.8	1.02	-	.059	-	-	3.00	.15	0.	.012
AG426	203479.	1.342	.625	15.9	1.02	-	.063	-	-	3.00	.14	0.	.027
AG427	203479.	1.209	.625	16.7	1.07	-	.066	-	-	3.00	.32	0.	.021
AG428	203479.	1.075	.625	16.5	1.06	-	.057	-	-	3.00	.35	0.	.021
AG429	203479.	.942	.625	15.8	1.02	-	.056	-	-	3.00	.21	0.	.021
AG430	203479.	.808	.625	13.7	.88	-	.046	-	-	3.00	.12	0.	.008
AG431	203479.	.674	.625	14.6	.94	-	.050	-	-	3.00	.14	0.	.017
AG432	203479.	.541	.625	15.4	.99	-	.052	-	-	3.00	.22	0.	.026
AG433	203479.	.407	.625	15.7	1.01	-	.064	-	-	3.00	.26	40.	.027
AG434	203479.	.274	.625	15.4	.99	-	.055	-	-	3.00	.21	0.	.015
AG435	203479.	.140	.625	15.1	.97	-	.046	-	-	3.00	.14	0.	.031
AG436	203479.	.073	.625	13.1	.84	-	.073	-	-	3.00	-	-	-
AG437	203479.	.741	.625	13.6	.88	-	.044	-	-	3.00	-	-	-
AG438	203479.	.341	.625	15.6	1.01	-	.061	-	-	3.00	-	-	-
AG439	203479.	.341	.625	15.6	1.01	-	.064	-	-	10.00	-	-	-
AG440	203479.	.341	.625	15.6	1.01	-	.063	-	-	7.00	-	-	-
AG441	203479.	.341	.625	15.6	1.01	-	.063	-	-	5.00	-	-	-
AG442	203479.	.341	.625	15.6	1.01	-	.062	-	-	4.00	-	-	-
AG443	203479.	.341	.625	15.6	1.01	-	.061	-	-	3.00	-	-	-
AG444	203479.	.341	.625	15.6	1.01	-	.061	-	-	2.00	-	-	-
AG445	203479.	.341	.625	15.6	1.01	-	.058	-	-	1.00	-	-	-
AG446	203479.	.341	.625	15.6	1.01	-	.051	-	-	.50	-	-	-
PLANE 2 14.25 INCHES DOWNSTREAM SPACER				INTERIOR CL				RUN 634 - 650 2R					
RUN	REYNOLDS NUMBER	Z IN.	γ IN.	$\bar{U}$ FT/SEC	$\bar{U}/U^*$	$U/\bar{U}$	U/U^*	$V/\bar{U}$	V/U^*	CUTOFF KHZ	λ/D	CURVE F(HZ)	FIT $^\circ$
AG634	203479.	.060	.625	11.9	.76	-	.099	-	-	3.00	.33	0.	.021
AG635	203479.	.127	.625	14.3	.92	-	.077	-	-	3.00	-	-	-
AG636	203479.	.194	.625	15.0	1.00	-	.061	-	-	3.00	.36	0.	.006
AG637	203479.	.327	.625	17.3	1.12	-	.044	-	-	3.00	.29	54.	.009
AG638	203479.	.461	.625	17.5	1.13	-	.041	-	-	3.00	.20	101.	.016
AG639	203479.	.594	.625	16.5	1.06	-	.051	-	-	3.00	.18	97.	.020
AG640	203479.	.728	.625	15.7	1.01	-	.045	-	-	3.00	.23	76.	.017
AG641	203479.	.861	.625	16.3	1.03	-	.050	-	-	3.00	.23	81.	.027
AG642	203479.	.995	.625	17.2	1.11	-	.051	-	-	3.00	.20	92.	.020
AG643	203479.	1.129	.625	18.4	1.19	-	.039	-	-	3.00	.26	82.	.019
AG644	203479.	1.262	.625	19.1	1.23	-	.025	-	-	3.00	.21	102.	.027
AG645	203479.	1.396	.625	19.2	1.24	-	.026	-	-	3.00	.24	75.	.087
AG646	203479.	1.529	.625	19.3	1.22	-	.029	-	-	3.00	.22	99.	.018
AG647	203479.	1.663	.625	18.2	1.17	-	.048	-	-	3.00	.22	97.	.014
AG648	203479.	1.796	.625	17.2	1.10	-	.053	-	-	3.00	.17	101.	.013
AG649	203479.	1.930	.625	16.1	1.04	-	.053	-	-	3.00	.18	98.	.021
AG650	203479.	2.064	.625	15.6	1.02	-	.048	-	-	3.00	.31	42.	.015
PLANE 2 14.25 INCHES DOWNSTREAM SPACER				INTERIOR CL				RUN 651 - 667 .5RE					
RUN	REYNOLDS NUMBER	Z IN.	γ IN.	$\bar{U}$ FT/SEC	$\bar{U}/U^*$	$U/\bar{U}$	U/U^*	$V/\bar{U}$	V/U^*	CUTOFF KHZ	λ/D	CURVE F(HZ)	FIT $^\circ$
AG651	50529.	2.081	.625	7.7	.99	-	.061	-	-	2.00	.28	29.	.014
AG652	50529.	1.946	.625	7.7	.99	-	.062	-	-	2.00	.25	36.	.029
AG653	50529.	1.812	.625	8.2	1.06	-	.067	-	-	2.00	.16	49.	.022
AG654	50529.	1.676	.625	8.9	1.14	-	.061	-	-	2.00	.19	48.	.017
AG655	50529.	1.544	.625	9.4	1.21	-	.047	-	-	2.00	.28	39.	.023
AG656	50529.	1.409	.625	9.7	1.25	-	.034	-	-	2.00	.24	45.	.037
AG657	50529.	1.275	.625	9.7	1.25	-	.032	-	-	2.00	.34	32.	.017
AG658	50529.	1.141	.625	9.2	1.19	-	.050	-	-	2.00	.26	42.	.017
AG659	50529.	1.007	.625	8.5	1.10	-	.060	-	-	2.00	.38	23.	.021
AG660	50529.	.872	.625	7.8	1.01	-	.060	-	-	2.00	.45	20.	.027
AG661	50529.	.738	.625	7.5	.97	-	.054	-	-	2.00	.28	17.	.030
AG662	50529.	.604	.625	7.8	1.01	-	.066	-	-	2.00	.18	45.	.046
AG663	50529.	.470	.625	8.5	1.09	-	.061	-	-	2.00	.16	53.	.010
AG664	50529.	.336	.625	8.8	1.13	-	.044	-	-	2.00	.25	0.	.040
AG665	50529.	.201	.625	8.3	1.03	-	.066	-	-	2.00	.40	16.	.015
AG666	50529.	.134	.625	7.4	.95	-	.077	-	-	2.00	-	-	-
AG667	50529.	.067	.625	6.4	.82	-	.100	-	-	2.00	-	-	-
HYDRAULIC DIAMETER, D = .811 INCHES. AVERAGE VELOCITY, U = 7.8 FT/SEC.													
* QUESTIONABLE DATA POINT. - NO DATA POINT.													

TABLE B-1 (CONT.), TABULATION OF EXPERIMENTAL DATA.

PLANE 2		14.25 INCHES DOWNSTREAM SPACER		INTERIOR MAP		RUN 061 - 792				
RUN	REYNOLDS NUMBER	Z IN.	Y I., FT/SEC	$\bar{U}/U$	$\bar{U}/U^*$	$\bar{U}/U^*$	$V/\bar{U}$	V/U^* CUTOFF KHZ	λ/D	CURVE FIT σ F(HZ)
A6748	101058	1.409	.625 19.5	1.25	-	-.029	-	3.00	-	-
A6749	101058	1.476	.625 19.4	1.25	-	-.030	-	3.00	-	-
A6750	101058	1.544	.625 19.2	1.24	-	-.034	-	3.00	-	-
A6751	101058	1.611	.625 18.8	1.21	-	-.045	-	3.00	-	-
A6752	101058	1.678	.625 16.2	1.17	-.051	-	-	3.00	-	-
A6753	101058	1.745	.625 17.6	1.13	-.056	-	-	3.00	-	-
A6754	101058	1.812	.625 17.3	1.09	-.059	-	-	3.00	-	-
A6755	101058	1.879	.625 16.4	1.06	-.058	-	-	3.00	-	-
A6756	101058	1.946	.625 16.1	1.03	-.054	-	-	3.00	-	-
A6757	101058	2.013	.625 15.7	1.01	-.052	-	-	3.00	-	-
A6758	101058	1.946	.625 15.6	1.00	-.062	-	-	3.00	-	-
A6759	101058	1.812	.625 16.8	1.08	-.064	-	-	3.00	-	-
A6760	101058	1.678	.625 18.2	1.17	-.053	-	-	3.00	-	-
A6761	101058	1.544	.625 19.2	1.24	-.036	-	-	3.00	-	-
A6762	101058	1.409	.625 19.5	1.25	-.032	-	-	3.00	-	-
A6763	101058	1.275	.625 19.4	1.25	-.030	-	-	3.00	-	-
A6764	101058	1.141	.625 18.4	1.16	-.050	-	-	3.00	-	-
A6765	101058	1.007	.625 16.6	1.07	-.062	-	-	3.00	-	-
A6766	101058	.872	.625 15.1	.97	-.063	-	-	3.00	-	-
A6767	101058	.738	.625 14.6	.94	-.061	-	-	3.00	-	-
A6768	101058	.604	.625 15.9	1.02	-.062	-	-	3.00	-	-
A6769	101058	.470	.625 17.3	1.12	-.049	-	-	3.00	-	-
A6770	101058	.336	.625 17.6	1.13	-.043	-	-	3.00	-	-
A6771	101058	.201	.625 16.1	1.03	-.059	-	-	3.00	-	-
A6772	101058	.067	.625 12.7	.82	-.104	-	-	3.00	-	-
A6773	101058	.067	.745 13.3	.86	-.095	-	-	3.00	-	-
A6774	101058	.201	.745 16.6	1.07	-.056	-	-	3.00	-	-
A6775	101058	.336	.745 17.6	1.13	-.039	-	-	3.00	-	-
A6776	101058	.470	.745 16.4	1.05	-.062	-	-	3.00	-	-
A6777	101058	.604	.745 14.2	.92	-.074	-	-	3.00	-	-
A6778	101058	.738	.745 11.2	.72	-.072	-	-	3.00	-	-
A6779	101058	.872	.745 11.4	.74	-.074	-	-	3.00	-	-
A6780	101058	1.007	.745 14.7	.95	-.074	-	-	3.00	-	-
A6781	101058	1.141	.745 17.5	1.13	-.062	-	-	3.00	-	-
A6782	101058	1.275	.745 19.1	1.23	-.039	-	-	3.00	-	-
A6783	101058	1.409	.745 19.2	1.24	-.043	-	-	3.00	-	-
A6784	101058	1.544	.745 18.9	1.22	-.045	-	-	3.00	-	-
A6785	101058	1.678	.745 17.6	1.13	-.064	-	-	3.00	-	-
A6786	101058	1.812	.745 15.6	1.06	-.079	-	-	3.00	-	-
A6787	101058	1.946	.745 12.7	.82	-.076	-	-	3.00	-	-
A6788	101058	1.678	.625 18.2	1.17	-.053	-	-	10.00	-	-
A6789	101058	1.678	.625 18.2	1.17	-.053	-	-	7.00	-	-
A6790	101058	1.678	.625 18.2	1.17	-.053	-	-	3.00	-	-
A6791	101058	1.678	.625 18.2	1.17	-.052	-	-	2.00	-	-
A6792	101058	1.678	.625 18.2	1.17	-.051	-	-	1.00	-	-

PLANE 2 14.25 INCHES DOWNSTREAM SPACER INTERIOR CL RUN 616 - 633

RUN REYNOLDS NUMBER Z IN. Y I., FT/SEC $\bar{U}/U$ $\bar{U}/U^*$ $\bar{U}/U^*$ $V/\bar{U}$ V/U^* V/U^* CUTOFF KHZ λ/D CURVE FIT $F(HZ)$ σ

A6616 101058 .000 .625 9.9 .64 - .237 - - - 3.00 .20 - .039

A6617 101058 .134 .625 15.3 .97 - .076 - - - 3.00 - - .006

A6618 101058 .268 .625 17.0 1.16 - .055 - - - 3.00 .33 - .006

A6619 101058 .403 .625 17.4 1.12 - .047 - - - 3.00 - - .017

A6620 101058 .537 .625 16.3 1.05 - .062 - - - 3.00 .15 - .017

A6621 101058 .671 .625 15.3 1.06 - .051 - - - 3.00 .21 - .030

A6622 101058 .805 .625 15.8 1.02 - .060 - - - 3.00 .21 - .030

A6623 101058 .940 .625 16.9 1.09 - .061 - - - 3.00 .24 - .014

A6624 101058 1.074 .625 18.3 1.18 - .048 - - - 3.00 .24 - .065

A6625 101058 1.208 .625 19.1 1.23 - .035 - - - 3.00 .17 - .020

A6626 101058 1.342 .625 19.1 1.23 - .034 - - - 3.00 .23 - .020

A6627 101058 1.476 .625 19.3 1.22 - .052 - - - 3.00 .17 - .023

A6628 101058 1.611 .625 16.2 1.17 - .061 - - - 3.00 .24 - .044

A6629 101058 1.745 .625 15.9 1.09 - .059 - - - 3.00 .24 - .044

A6630 101058 1.879 .625 15.5 1.02 - .066 - - - 3.00 .24 - .044

A6631 101058 2.013 .625 16.2 1.04 - .090 - - - 3.00 .24 - .044

A6632 101058 2.148 .625 13.5 .87 - .090 - - - 3.00 .24 - .044

A6633 101058 .067 .625 13.5 .87 - .090 - - - 3.00 .24 - .044

* QUESTIONABLE DATA POINT. - NO DATA POINT. AVERAGE VELOCITY, $U = 15.5$ FT/SEC.

HYDRAULIC DIAMETER, $D = .740$ INCHES. AVERAGE VELOCITY, $U =$

TABLE B-1 (CONT.), TABULATION OF EXPERIMENTAL DATA.

PLANE 2 14.25 INCHES DOWNSTREAM SPACER				INTERIOR MAP				RUN 668 - 792							
RUN	REYNOLDS NUMBER	Z IN.	Y IN.	U FT/SEC	U/U*	U/U*	U/U*	V/U*	V/U*	V/U*	CUTOFF KHZ	A/D F(HZ)	CURVE F(HZ)	FIT °	
AG668	101058.	.067	.505	12.4	.86	-	.094	-	-	-	3.00	.43	0.	.019	
AG669	101058.	.134	.505	14.7	.95	-	.071	-	-	-	3.00	-	-	-	
AG670	101058.	.201	.505	15.9	1.02	-	.071	-	-	-	3.00	.39	42.	.015	
AG671	101058.	.266	.505	16.9	1.09	-	.053	-	-	-	3.00	-	-	-	
AG672	101058.	.336	.505	17.6	1.13	-	.042	-	-	-	3.00	.33	37.	.001	
AG673	101058.	.403	.505	17.5	1.13	-	.044	-	-	-	3.00	-	-	-	
AG674	101058.	.470	.505	16.7	1.07	-	.059	-	-	-	3.00	.29	63.	.009	
AG675	101058.	.537	.505	15.4	.99	-	.074	-	-	-	3.00	-	-	-	
AG676	101058.	.604	.505	14.1	.91	-	.068	-	-	-	3.00	.34	8.	.015	
AG677	101058.	.671	.505	12.8	.82	-	.066	-	-	-	3.00	-	-	-	
AG678	101058.	.738	.505	11.3	.73	-	.070	-	-	-	3.00	.29	0.	.024	
AG679	101058.	.805	.505	10.4	.67	-	.086	-	-	-	3.00	-	-	-	
AG680	101058.	.872	.505	11.6	.75	-	.068	-	-	-	3.00	.29	41.	.020	
AG681	101058.	.940	.505	13.4	.86	-	.072	-	-	-	3.00	-	-	-	
AG682	101058.	1.007	.505	14.9	.96	-	.067	-	-	-	3.00	.30	37.	.015	
AG683	101058.	1.074	.505	16.2	1.05	-	.063	-	-	-	3.00	-	-	-	
AG684	101058.	1.141	.505	17.3	1.12	-	.059	-	-	-	3.00	.33	36.	.011	
AG685	101058.	1.208	.505	18.3	1.18	-	.047	-	-	-	3.00	-	-	-	
AG686	101058.	1.275	.505	16.9	1.22	-	.037	-	-	-	3.00	.30	71.	.020	
AG687	101058.	1.342	.505	19.1	1.23	-	.035	-	-	-	3.00	-	-	-	
AG688	101058.	1.409	.505	19.3	1.23	-	.037	-	-	-	3.00	.25	84.	.015	
AG689	101058.	1.476	.505	18.9	1.22	-	.039	-	-	-	3.00	-	-	-	
AG690	101058.	1.544	.505	18.5	1.19	-	.045	-	-	-	3.00	.25	88.	.015	
AG691	101058.	1.611	.505	17.9	1.15	-	.054	-	-	-	3.00	-	-	-	
AG692	101058.	1.678	.505	17.1	1.10	-	.064	-	-	-	3.00	.26	72.	.007	
AG693	101058.	1.745	.505	16.4	1.06	-	.065	-	-	-	3.00	-	-	-	
AG694	101058.	1.812	.505	15.4	.99	-	.073	-	-	-	3.00	.35	39.	.009	
AG695	101058.	1.879	.505	14.4	.93	-	.074	-	-	-	3.00	-	-	-	
AG696	101058.	1.946	.505	13.1	.84	-	.074	-	-	-	3.00	.36	0.	.025	
AG697	101058.	2.013	.505	11.9	.77	-	.067	-	-	-	3.00	-	-	-	
AG698	101058.	2.013	.505	14.9	.96	-	.059	-	-	-	3.00	-	-	-	
AG699	101058.	1.946	.505	15.2	.98	-	.065	-	-	-	3.00	.28	59.	.019	
AG700	101058.	1.879	.505	15.9	1.02	-	.061	-	-	-	3.00	-	-	-	
AG701	101058.	1.812	.505	16.6	1.07	-	.062	-	-	-	3.00	.25	78.	.020	
AG702	101058.	1.745	.505	17.2	1.11	-	.061	-	-	-	3.00	-	-	-	
AG703	101058.	1.678	.505	17.9	1.15	-	.056	-	-	-	3.00	.21	99.	.020	
AG704	101058.	1.611	.505	18.5	1.19	-	.046	-	-	-	3.00	-	-	-	
AG705	101058.	1.544	.505	19.3	1.22	-	.036	-	-	-	3.00	.31	60.	.017	
AG706	101058.	1.476	.505	19.2	1.24	-	.033	-	-	-	3.00	-	-	-	
AG707	101058.	1.409	.505	19.3	1.25	-	.031	-	-	-	3.00	.23	91.	.015	
AG708	101058.	1.342	.505	19.4	1.25	-	.030	-	-	-	3.00	-	-	-	
AG709	101058.	1.275	.505	19.3	1.24	-	.032	-	-	-	3.00	.25	90.	.034	
AG710	101058.	1.208	.505	19.3	1.22	-	.037	-	-	-	3.00	-	-	-	
AG711	101058.	1.141	.505	18.3	1.18	-	.047	-	-	-	3.00	.26	81.	.012	
AG712	101058.	1.074	.505	17.6	1.13	-	.055	-	-	-	3.00	-	-	-	
AG713	101058.	1.007	.505	16.8	1.08	-	.056	-	-	-	3.00	.21	90.	.015	
AG714	101058.	.940	.505	16.1	1.04	-	.058	-	-	-	3.00	-	-	-	
AG715	101058.	.872	.505	15.5	1.00	-	.056	-	-	-	3.00	.26	69.	.011	
AG716	101058.	.805	.505	15.3	.97	-	.056	-	-	-	3.00	-	-	-	
AG717	101058.	.738	.505	14.9	.96	-	.055	-	-	-	3.00	.30	0.	.015	
AG718	101058.	.671	.505	15.2	.98	-	.057	-	-	-	3.00	-	-	-	
AG719	101058.	.604	.505	15.7	1.01	-	.061	-	-	-	3.00	.25	75.	.019	
AG720	101058.	.537	.505	16.5	1.06	-	.059	-	-	-	3.00	-	-	-	
AG721	101058.	.470	.505	17.3	1.11	-	.051	-	-	-	3.00	.23	87.	.024	
AG722	101058.	.403	.505	17.7	1.14	-	.041	-	-	-	3.00	-	-	-	
AG723	101058.	.336	.505	17.5	1.13	-	.046	-	-	-	3.00	.34	23.	.005	
AG724	101058.	.266	.505	16.8	1.08	-	.055	-	-	-	3.00	-	-	-	
AG725	101058.	.201	.505	15.7	1.01	-	.067	-	-	-	3.00	.34	22.	.010	
AG726	101058.	.134	.505	14.5	.93	-	.077	-	-	-	3.00	-	-	-	
AG727	101058.	.067	.505	12.2	.79	-	.100	-	-	-	3.00	.41	0.	.019	
AG728	101058.	.067	.625	12.3	.77	-	.102	-	-	-	3.00	-	-	-	
AG729	101058.	.134	.625	14.4	.93	-	.075	-	-	-	3.00	-	-	-	
AG730	101058.	.201	.625	15.7	1.01	-	.065	-	-	-	3.00	-	-	-	
AG731	101058.	.268	.625	16.8	1.08	-	.056	-	-	-	3.00	-	-	-	
AG732	101058.	.336	.625	17.5	1.13	-	.044	-	-	-	3.00	-	-	-	
AG733	101058.	.403	.625	17.8	1.14	-	.040	-	-	-	3.00	-	-	-	
AG734	101058.	.470	.625	17.5	1.13	-	.050	-	-	-	3.00	-	-	-	
AG735	101058.	.537	.625	16.9	1.09	-	.058	-	-	-	3.00	-	-	-	
AG736	101058.	.604	.625	16.3	1.05	-	.058	-	-	-	3.00	-	-	-	
AG737	101058.	.671	.625	15.8	1.02	-	.054	-	-	-	3.00	-	-	-	
AG738	101058.	.738	.625	15.5	1.00	-	.048	-	-	-	3.00	-	-	-	
AG739	101058.	.805	.625	15.7	1.01	-	.050	-	-	-	3.00	-	-	-	
AG740	101058.	.872	.625	16.1	1.04	-	.053	-	-	-	3.00	-	-	-	
AG741	101058.	.940	.625	16.7	1.07	-	.055	-	-	-	3.00	-	-	-	
AG742	101058.	1.007	.625	17.3	1.12	-	.054	-	-	-	3.00	-	-	-	
AG743	101058.	1.074	.625	18.3	1.16	-	.050	-	-	-	3.00	-	-	-	
AG744	101058.	1.141	.625	18.7	1.20	-	.043	-	-	-	3.00	-	-	-	
AG745	101058.	1.208	.625	19.2	1.24	-	.032	-	-	-	3.00	-	-	-	
AG746	101058.	1.275	.625	19.5	1.26	-	.028	-	-	-	3.00	-	-	-	
AG747	101058.	1.342	.625	19.5	1.26	-	.029	-	-	-	3.00	-	-	-	

HYDRAULIC DIAMETER, D = .811 INCHES. AVERAGE VELOCITY, U = 15.5 FT/SEC.
 * QUESTIONABLE DATA POINT. - NO DATA POINT.

TABLE B-1 (CONT.), TABULATION OF EXPERIMENTAL DATA.

PLANE 2 14.25 INCHES DOWNSTREAM SPACER				WALL MAP				RUN 825 -942				CUTOFF KHZ	A/D	CURVE F(HZ)	FIT °
RUN	REYNOLDS NUMBER	Z IN.	Y IN.	U FT/SEC	U/U*	U/U*	U/U*	V/U*	V/U*	V/U*	V/U*				
AG825	102382.	2.067	1.757	8.9	.57	-	.139	-	-	-	-	3.00	-	-	-
AG826	102382.	2.067	1.757	9.3	.58	-	.118	-	-	-	-	3.00	-	-	-
AG827	102382.	1.463	1.757	16.4	1.06	-	.056	-	-	-	-	3.00	-	-	-
AG828	102382.	.993	1.757	13.1	.84	-	.089	-	-	-	-	3.00	-	-	-
AG829	102382.	.792	1.757	5.6	.36	-	.382	-	-	-	-	3.00	-	-	-
AG830	102382.	.389	1.757	15.5	1.00	-	.058	-	-	-	-	3.00	-	-	-
AG831	102382.	.054	1.757	12.9	.83	-	.102	-	-	-	-	3.00	-	-	-
AG832	102382.	.000	1.815	9.6	.62	-	.197	-	-	-	-	3.00	-	-	-
AG833	102382.	.054	1.815	12.8	.82	-	.095	-	-	-	-	3.00	.36	0.	.030
AG834	102382.	.121	1.815	14.6	.94	-	.073	-	-	-	-	3.00	-	-	-
AG835	102382.	.188	1.815	15.4	.99	-	.057	-	-	-	-	3.00	.24	0.	.020
AG836	102382.	.255	1.815	15.7	1.01	-	.056	-	-	-	-	3.00	-	-	-
AG837	102382.	.322	1.815	15.6	1.01	-	.055	-	-	-	-	3.00	.25	0.	.024
AG838	102382.	.389	1.815	15.5	1.00	-	.054	-	-	-	-	3.00	-	-	-
AG839	102382.	.456	1.815	15.2	.98	-	.054	-	-	-	-	3.00	.22	69.	.030
AG840	102382.	.523	1.815	14.8	.95	-	.056	-	-	-	-	3.00	-	-	-
AG841	102382.	.591	1.815	14.2	.92	-	.058	-	-	-	-	3.00	.24	05.	.048
AG842	102382.	.658	1.815	13.6	.86	-	.064	-	-	-	-	3.00	-	-	-
AG843	102382.	.725	1.815	12.9	.83	-	.065	-	-	-	-	3.00	.25	0.	.021
AG844	102382.	.792	1.815	12.6	.81	-	.067	-	-	-	-	3.00	-	-	-
AG845	102382.	.859	1.815	13.3	.84	-	.067	-	-	-	-	3.00	.34	36.	.013
AG846	102382.	.926	1.815	13.7	.88	-	.069	-	-	-	-	3.00	-	-	-
AG847	102382.	.993	1.815	14.7	.95	-	.065	-	-	-	-	3.00	.29	51.	.017
AG848	102382.	1.060	1.815	15.6	1.01	-	.059	-	-	-	-	3.00	-	-	-
AG849	102382.	1.127	1.815	16.4	1.06	-	.051	-	-	-	-	3.00	.25	76.	.028
AG850	102382.	1.195	1.815	16.9	1.09	-	.047	-	-	-	-	3.00	-	-	-
AG851	102382.	1.262	1.815	17.3	1.10	-	.046	-	-	-	-	3.00	.25	33.	.015
AG852	102382.	1.329	1.815	16.8	1.08	-	.051	-	-	-	-	3.00	-	-	-
AG853	102382.	1.396	1.815	16.4	1.05	-	.057	-	-	-	-	3.00	.28	56.	.009
AG854	102382.	1.463	1.815	16.3	1.03	-	.061	-	-	-	-	3.00	-	-	-
AG855	102382.	1.530	1.815	15.9	1.02	-	.060	-	-	-	-	3.00	.33	0.	.008
AG856	102382.	1.597	1.815	16.3	1.03	-	.057	-	-	-	-	3.00	-	-	-
AG857	102382.	1.664	1.815	16.1	1.04	-	.052	-	-	-	-	3.00	.23	63.	.020
AG858	102382.	1.731	1.815	15.9	1.03	-	.050	-	-	-	-	3.00	-	-	-
AG859	102382.	1.799	1.815	15.3	.99	-	.056	-	-	-	-	3.00	.25	69.	.031
AG860	102382.	1.866	1.815	14.5	.93	-	.062	-	-	-	-	3.00	-	-	-
AG861	102382.	1.933	1.815	13.7	.88	-	.068	-	-	-	-	3.00	.27	26.	.016
AG862	102382.	2.000	1.815	13.1	.85	-	.069	-	-	-	-	3.00	-	-	-
AG863	102382.	2.067	1.815	13.3	.86	-	.068	-	-	-	-	3.00	.24	34.	.031
AG864	102382.	2.067	1.757	9.4	.61	-	.093	-	-	-	-	3.00	-	-	-
AG865	102382.	2.000	1.875	14.1	.91	-	.054	-	-	-	-	3.00	.26	27.	.008
AG866	102382.	1.866	1.875	14.9	.96	-	.057	-	-	-	-	3.00	.21	83.	.034
AG867	102382.	1.731	1.875	15.4	.99	-	.058	-	-	-	-	3.00	.28	45.	.012
AG868	102382.	1.597	1.875	14.9	.96	-	.068	-	-	-	-	3.00	.31	22.	.007
AG869	102382.	1.463	1.875	14.9	.96	-	.069	-	-	-	-	3.00	.33	0.	.008
AG870	102382.	1.329	1.875	15.9	1.02	-	.065	-	-	-	-	3.00	.32	14.	.011
AG871	102382.	1.195	1.875	16.3	1.05	-	.056	-	-	-	-	3.00	.28	0.	.009
AG872	102382.	1.060	1.875	15.7	1.01	-	.078	-	-	-	-	3.00	.23	80.	.038
AG873	102382.	.926	1.875	14.5	.93	-	.058	-	-	-	-	3.00	.23	73.	.033
AG874	102382.	.792	1.875	13.9	.89	-	.051	-	-	-	-	3.00	.29	0.	.017
AG875	102382.	.658	1.875	14.1	.91	-	.053	-	-	-	-	3.00	.26	60.	.027
AG876	102382.	.523	1.875	14.5	.93	-	.060	-	-	-	-	3.00	.28	20.	.012
AG877	102382.	.389	1.875	14.6	.94	-	.061	-	-	-	-	3.00	.27	0.	.025
AG878	102382.	.255	1.875	14.9	.96	-	.061	-	-	-	-	3.00	.30	0.	.012
AG879	102382.	.121	1.875	14.3	.92	-	.066	-	-	-	-	3.00	.32	0.	.025
AG880	102382.	.054	1.875	12.6	.81	-	.090	-	-	-	-	3.00	.39	0.	.025
AG881	102382.	.188	1.875	14.9	.96	-	.058	-	-	-	-	3.00	-	-	-
AG882	102382.	.054	1.925	12.4	.80	-	.086	-	-	-	-	3.00	-	-	-
AG883	102382.	.121	1.925	13.9	.90	-	.065	-	-	-	-	3.00	.31	0.	.032
AG884	102382.	.188	1.925	14.3	.92	-	.067	-	-	-	-	3.00	-	-	-
AG885	102382.	.255	1.925	13.9	.90	-	.073	-	-	-	-	3.00	.35	0.	.024
AG886	102382.	.389	1.925	13.5	.87	-	.072	-	-	-	-	3.00	.37	0.	.033
AG887	102382.	.523	1.925	13.6	.87	-	.070	-	-	-	-	3.00	.32	0.	.019
AG888	102382.	.658	1.925	13.5	.87	-	.061	-	-	-	-	3.00	.37	12.	.016
AG889	102382.	.792	1.925	13.7	.88	-	.053	-	-	-	-	3.00	.23	0.	.034
AG890	102382.	.926	1.925	14.4	.93	-	.056	-	-	-	-	3.00	.28	0.	.046
AG891	102382.	1.060	1.925	15.2	.98	-	.061	-	-	-	-	3.00	.30	52.	.010
AG892	102382.	1.195	1.925	15.4	.99	-	.071	-	-	-	-	3.00	.37	0.	.011
AG893	102382.	1.329	1.925	15.1	.97	-	.071	-	-	-	-	3.00	.35	0.	.015
AG894	102382.	1.463	1.925	14.1	.91	-	.078	-	-	-	-	3.00	.34	0.	.017
AG895	102382.	1.597	1.925	14.1	.91	-	.074	-	-	-	-	3.00	.36	0.	.017
AG896	102382.	1.731	1.925	14.7	.95	-	.064	-	-	-	-	3.00	.36	14.	.014
AG897	102382.	1.866	1.925	14.5	.94	-	.059	-	-	-	-	3.00	.31	38.	.017
AG898	102382.	2.000	1.925	14.1	.91	-	.053	-	-	-	-	3.00	.28	0.	.019
AG899	102382.	2.000	1.965	13.1	.84	-	.066	-	-	-	-	3.00	-	-	-
AG900	102382.	1.866	1.965	13.5	.87	-	.073	-	-	-	-	3.00	-	-	-
AG901	102382.	1.731	1.965	13.5	.87	-	.078	-	-	-	-	3.00	-	-	-
AG902	102382.	1.597	1.965	12.9	.83	-	.083	-	-	-	-	3.00	-	-	-
AG903	102382.	1.463	1.965	13.3	.84	-	.083	-	-	-	-	3.00	-	-	-
AG904	102382.	1.329	1.965	14.3	.90	-	.078	-	-	-	-	3.00	-	-	-

HYDRAULIC DIAMETER, D = .811 INCHES. AVERAGE VELOCITY, U = 15.5 FT/SEC.
 * QUESTIONABLE DATA POINT. - NO DATA POINT.

TABLE B-1 (CONT.), TABULATION OF EXPERIMENTAL DATA.

PLANE 2 14.25 INCHES DOWNSTREAM SPACER				WALL MAP				RUN 825 -942						
RJN	REYNOLDS NUMBER	Z IN.	Y IN.	$\bar{U}$ FT/SEC	$\bar{U}/U^*$	$\bar{U}/U^*$	$U'/\bar{U}$	U'/U^*	$V/\bar{U}$	V/U^*	CUTOFF KHZ	Δ/D	CURVE F (HZ)	FIT °
AG965	102382.	1.195	1.965	14.1	.91	-	.081	-	-	-	3.00	-	-	-
AG966	102382.	1.060	1.965	14.3	.90	-	.070	-	-	-	3.00	-	-	-
AG967	102382.	.926	1.965	13.3	.86	-	.066	-	-	-	3.00	-	-	-
AG968	102382.	.792	1.965	12.6	.81	-	.060	-	-	-	3.00	-	-	-
AG969	102382.	.658	1.965	12.4	.80	-	.070	-	-	-	3.00	-	-	-
AG910	102382.	.523	1.965	12.4	.80	-	.078	-	-	-	3.00	-	-	-
AG911	102382.	.389	1.965	12.3	.79	-	.082	-	-	-	3.00	-	-	-
AG912	102382.	.255	1.965	12.7	.82	-	.083	-	-	-	3.00	-	-	-
AG913	102382.	.186	1.965	13.2	.85	-	.076	-	-	-	3.00	-	-	-
AG914	102382.	.121	1.965	12.9	.83	-	.073	-	-	-	3.00	-	-	-
AG915	102382.	.054	1.965	12.3	.77	-	.078	-	-	-	3.00	-	-	-
AG916	102382.	1.378	1.973	13.3	.86	-	.087	-	-	-	3.00	-	-	-
AG917	102382.	1.378	1.948	14.2	.91	-	.081	-	-	-	3.00	-	-	-
AG918	102382.	1.378	1.923	14.8	.95	-	.074	-	-	-	3.00	-	-	-
AG919	102382.	1.378	1.898	15.3	.98	-	.072	-	-	-	3.00	-	-	-
AG920	102382.	1.378	1.873	15.5	1.00	-	.065	-	-	-	3.00	-	-	-
AG921	102382.	1.378	1.848	16.0	1.03	-	.064	-	-	-	3.00	-	-	-
AG922	102382.	1.378	1.823	16.3	1.05	-	.057	-	-	-	3.00	-	-	-
AG923	102382.	1.378	1.798	16.6	1.07	-	.055	-	-	-	3.00	-	-	-
AG924	102382.	1.378	1.773	16.9	1.09	-	.051	-	-	-	3.00	-	-	-
AG925	102382.	1.691	1.773	16.3	1.03	-	.054	-	-	-	3.00	-	-	-
AG926	102382.	1.691	1.798	16.1	1.04	-	.049	-	-	-	3.00	-	-	-
AG927	102382.	1.691	1.823	16.3	1.03	-	.050	-	-	-	3.00	-	-	-
AG928	102382.	1.691	1.848	15.8	1.02	-	.054	-	-	-	3.00	-	-	-
AG929	102382.	1.691	1.873	15.3	.99	-	.061	-	-	-	3.00	-	-	-
AG930	102382.	1.691	1.898	15.1	.97	-	.065	-	-	-	3.00	-	-	-
AG931	102382.	1.691	1.923	14.6	.94	-	.068	-	-	-	3.00	-	-	-
AG932	102382.	1.691	1.948	14.3	.90	-	.072	-	-	-	3.00	-	-	-
AG933	102382.	1.691	1.973	13.3	.84	-	.081	-	-	-	3.00	-	-	-
AG934	102382.	2.004	1.973	12.7	.82	-	.068	-	-	-	3.00	-	-	-
AG935	102382.	2.004	1.948	13.6	.87	-	.061	-	-	-	3.00	-	-	-
AG936	102382.	2.004	1.923	14.1	.91	-	.056	-	-	-	3.00	-	-	-
AG937	102382.	2.004	1.898	14.3	.92	-	.051	-	-	-	3.00	-	-	-
AG938	102382.	2.004	1.873	14.3	.90	-	.058	-	-	-	3.00	-	-	-
AG939	102382.	2.004	1.848	13.9	.90	-	.059	-	-	-	3.00	-	-	-
AG940	102382.	2.004	1.823	13.4	.86	-	.067	-	-	-	3.00	-	-	-
AG941	102382.	2.004	1.798	12.5	.81	-	.069	-	-	-	3.00	-	-	-
AG942	102382.	2.004	1.773	11.3	.71	-	.074	-	-	-	3.00	-	-	-

PLANE 2 14.25 INCHES DOWNSTREAM SPACER WALL CL-.125 RUN 793 -824														
RJN	REYNOLDS NUMBER	Z IN.	Y IN.	$\bar{U}$ FT/SEC	$\bar{U}/U^*$	$\bar{U}/U^*$	$U'/\bar{U}$	U'/U^*	$V/\bar{U}$	V/U^*	CUTOFF KHZ	Δ/D	CURVE F(HZ)	FIT °
AG793	101058.	2.040	1.757	9.3	.58	-	.092	-	-	-	3.00	-	-	-
AG794	101058.	1.973	1.757	9.8	.63	-	.087	-	-	-	3.00	.24	26.	.026
AG795	101058.	1.906	1.757	11.0	.75	-	.074	-	-	-	3.00	-	-	-
AG796	101058.	1.839	1.757	13.2	.85	-	.067	-	-	-	3.00	.28	0.	.017
AG797	101058.	1.772	1.757	14.5	.93	-	.063	-	-	-	3.00	-	-	-
AG798	101058.	1.705	1.757	15.5	1.00	-	.053	-	-	-	3.00	.22	68.	.019
AG799	101058.	1.638	1.757	16.3	1.03	-	.046	-	-	-	3.00	-	-	-
AG800	101058.	1.570	1.757	16.1	1.03	-	.050	-	-	-	3.00	.22	21.	.007
AG801	101058.	1.503	1.757	16.1	1.03	-	.050	-	-	-	3.00	-	-	-
AG802	101058.	1.436	1.757	16.3	1.05	-	.051	-	-	-	3.00	.27	42.	.013
AG803	101058.	1.369	1.757	16.5	1.06	-	.049	-	-	-	3.00	-	-	-
AG804	101058.	1.302	1.757	16.7	1.08	-	.042	-	-	-	3.00	.25	38.	.011
AG805	101058.	1.235	1.757	16.5	1.07	-	.045	-	-	-	3.00	-	-	-
AG806	101058.	1.168	1.757	15.9	1.02	-	.053	-	-	-	3.00	.23	75.	.017
AG807	101058.	1.101	1.757	14.9	.96	-	.067	-	-	-	3.00	-	-	-
AG808	101058.	1.034	1.757	13.5	.87	-	.079	-	-	-	3.00	.29	31.	.010
AG809	101058.	.966	1.757	11.9	.76	-	.088	-	-	-	3.00	-	-	-
AG810	101058.	.899	1.757	10.3	.66	-	.083	-	-	-	3.00	.25	0.	.034
AG813	101058.	.698	1.757	9.2	.59	-	.088	-	-	-	3.00	-	-	-
AG814	101058.	.631	1.757	11.4	.74	-	.079	-	-	-	3.00	.22	0.	.034
AG815	101058.	.564	1.757	12.9	.83	-	.070	-	-	-	3.00	-	-	-
AG816	101058.	.497	1.757	13.9	.90	-	.063	-	-	-	3.00	.23	49.	.023
AG817	101058.	.430	1.757	14.7	.95	-	.058	-	-	-	3.00	-	-	-
AG818	101058.	.362	1.757	15.3	.98	-	.051	-	-	-	3.00	.23	48.	.028
AG819	101058.	.295	1.757	15.6	1.01	-	.044	-	-	-	3.00	-	-	-
AG820	101058.	.228	1.757	15.6	1.00	-	.044	-	-	-	3.00	.26	0.	.013
AG821	101058.	.161	1.757	15.3	.96	-	.054	-	-	-	3.00	-	-	-
AG822	101058.	.094	1.757	13.8	.89	-	.073	-	-	-	3.00	.34	0.	.030
AG823	101058.	.027	1.757	11.1	.71	-	.123	-	-	-	3.00	-	-	-
AG824	101058.	.000	1.757	9.3	.58	-	.240	-	-	-	3.00	-	-	-

HYDRAULIC DIAMETER, D = .811 INCHES. AVERAGE VELOCITY, U = 15.5 FT/SEC.
 * QUESTIONABLE DATA POINT. - NO DATA POINT.

PLATE 2 14.25 INCHES DOWNSTREAM SPACER INTERIOR TRAVERSE RUN 943 - 966

RUN	HYDROLYS NUMBER	Z	I ₁	I ₂	T ₁ /SEC	T ₂ /U	INTERIOR TRAVERSE RUN 943 - 966				CURVE FIT F(4Z)	°
							U ₁ ²	U ₂ ²	W/U	W/U ² CUTOFF KHZ		
A6943	102382	1.691	7.8	10.7	1.06	-	0.71	-	-	-	-	-
A6944	102383	1.691	6.98	17.1	1.10	-	0.69	-	-	-	-	-
A6945	102384	1.691	6.73	17.3	1.11	-	0.65	-	-	-	-	-
A6946	102385	1.691	6.48	17.3	1.12	-	0.63	-	-	-	-	-
A6947	102386	1.691	6.23	17.4	1.12	-	0.59	-	-	-	-	-
A6948	102387	1.691	5.98	17.3	1.11	-	0.59	-	-	-	-	-
A6949	102388	1.691	5.73	17.1	1.10	-	0.60	-	-	-	-	-
A6950	102389	1.691	5.46	16.8	1.08	-	0.67	-	-	-	-	-
A6951	102390	1.691	5.21	16.4	1.06	-	0.71	-	-	-	-	-
A6952	102391	2.004	5.23	12.6	.82	-	0.75	-	-	-	-	-
A6953	102392	2.004	5.49	14.3	.90	-	0.75	-	-	-	-	-
A6954	102393	2.004	5.73	14.6	.95	-	0.65	-	-	-	-	-
A6955	102394	2.004	5.98	15.2	.98	-	0.58	-	-	-	-	-
A6956	102395	2.004	6.23	15.4	.99	-	0.57	-	-	-	-	-
A6957	102396	2.004	6.48	15.3	.99	-	0.57	-	-	-	-	-
A6958	102397	2.004	6.73	15.3	.97	-	0.65	-	-	-	-	-
A6959	102398	2.004	6.98	14.2	.92	-	0.71	-	-	-	-	-
A6960	102399	2.004	7.23	12.8	.82	-	0.77	-	-	-	-	-
A6961	102362	1.678	6.25	17.5	1.13	-	0.64	-	-	-	-	-
A6962	102383	1.678	6.25	17.5	1.13	-	0.63	-	-	-	-	-
A6963	102384	1.678	6.25	17.5	1.13	-	0.62	-	-	-	-	-
A6964	102385	1.678	6.25	17.5	1.13	-	0.62	-	-	-	-	-
A6965	102386	1.678	6.25	17.5	1.13	-	0.60	-	-	-	-	-
A6966	102362	1.678	6.25	17.5	1.13	-	0.57	-	-	-	-	-

ROUT	REYNOLDS	Z	Y	$\bar{u}$	$\bar{u}/U$	$\bar{u}/U^*$	$u'/\bar{u}$	u'/U^*	$v'/\bar{u}$	v'/U^*	CUTOFF
------	----------	---	---	-----------	-------------	---------------	--------------	----------	--------------	----------	--------

Run	Method	Z	γ	$\bar{U}$	$\bar{V}/U$	$\bar{V}/U^*$	$\bar{U}/\bar{V}$	U/U^*	V/U	V/U^*	V/U^*	Cut-off	M/D	Curve	Fit
	NUMER	IN.	1	FT/SEC								KHZ		F(42)	°
A9967	101050.6	.081	.645	14.3	.92	—	—	—	—	—	—	3.00	—	—	—
A9968	101050.6	.143	.645	16.3	1.03	—	—	—	—	—	—	3.00	.41	0.	.03
A9969	101050.6	.215	.645	16.9	1.09	—	—	—	—	—	—	3.00	—	—	—
A9970	101050.6	.282	.645	17.4	1.12	—	—	—	—	—	—	3.00	.22	0.	.02
A9971	101050.6	.349	.645	17.5	1.12	—	—	—	—	—	—	3.00	—	—	—
A9972	101050.6	.416	.645	17.2	1.11	—	—	—	—	—	—	3.00	.27	71.	.01
A9973	101050.6	.483	.645	16.8	1.06	—	—	—	—	—	—	3.00	—	—	—
A9974	101050.6	.550	.645	16.4	1.06	—	—	—	—	—	—	3.00	.21	92.	.03
A9975	101050.6	.617	.645	16.1	1.03	—	—	—	—	—	—	3.00	—	—	—
A9976	101050.6	.685	.645	15.9	1.02	—	—	—	—	—	—	3.00	.25	66.	.02
A9977	101050.6	.752	.645	15.9	1.02	—	—	—	—	—	—	3.00	—	—	—
A9978	101050.6	.819	.645	16.2	1.04	—	—	—	—	—	—	3.00	.26	35.	.03
A9979	101050.6	.886	.645	16.0	1.07	—	—	—	—	—	—	3.00	—	—	—
A9980	101050.6	.953	.645	17.1	1.14	—	—	—	—	—	—	3.00	.25	79.	.02
A9981	101050.6	1.020	.645	17.6	1.16	—	—	—	—	—	—	3.00	—	—	—
A9982	101050.6	1.087	.645	18.0	1.16	—	—	—	—	—	—	3.00	.26	77.	.02
A9983	101050.6	1.154	.645	18.5	1.19	—	—	—	—	—	—	3.00	—	—	—
A9984	101050.6	1.221	.645	18.9	1.22	—	—	—	—	—	—	3.00	.31	21.	.02
A9985	101050.6	1.289	.645	19.2	1.24	—	—	—	—	—	—	3.00	—	—	—
A9986	101050.6	1.356	.645	19.3	1.24	—	—	—	—	—	—	3.00	.30	0.	.01
A9987	101050.6	1.423	.645	19.1	1.23	—	—	—	—	—	—	3.00	—	—	—
A9988	101050.6	1.490	.645	18.7	1.20	—	—	—	—	—	—	3.00	—	—	—
A9989	101050.6	1.557	.645	18.3	1.18	—	—	—	—	—	—	3.00	—	—	—
A9990	101050.6	1.624	.645	17.9	1.16	—	—	—	—	—	—	3.00	—	—	—
A9991	101050.6	1.691	.645	17.5	1.13	—	—	—	—	—	—	3.00	—	—	—
A9992	101050.6	1.758	.645	17.2	1.11	—	—	—	—	—	—	3.00	—	—	—
A9993	101050.6	1.825	.645	16.8	1.08	—	—	—	—	—	—	3.00	—	—	—
A9994	101050.6	1.893	.645	16.4	1.06	—	—	—	—	—	—	3.00	—	—	—
A9995	101050.6	1.960	.645	16.1	1.04	—	—	—	—	—	—	3.00	—	—	—
A9996	101050.6	2.027	.645	16.1	1.04	—	—	—	—	—	—	3.00	—	—	—
A9997	101050.6	2.094	.749	13.9	.70	—	—	—	—	—	—	3.00	—	—	—
A9998	101050.6	2.004	.719	13.6	.68	—	—	—	—	—	—	3.00	—	—	—
A9999	101050.6	2.004	.668	15.1	.97	—	—	—	—	—	—	3.00	—	—	—
A9900	101050.6	2.004	.659	15.9	1.02	—	—	—	—	—	—	3.00	—	—	—
A9901	101050.6	2.004	.645	16.1	1.04	—	—	—	—	—	—	3.00	—	—	—
A9902	101050.6	2.004	.599	15.9	1.02	—	—	—	—	—	—	3.00	—	—	—
A9903	101050.6	2.004	.599	15.3	.98	—	—	—	—	—	—	3.00	—	—	—
A9904	101050.6	2.004	.539	14.1	.91	—	—	—	—	—	—	3.00	—	—	—
A9905	101050.6	2.004	.519	12.9	.83	—	—	—	—	—	—	3.00	—	—	—
A9906	101050.6	2.004	.504	10.7	.69	—	—	—	—	—	—	3.00	—	—	—
A9907	101050.6	1.691	.504	15.3	.96	—	—	—	—	—	—	3.00	—	—	—
A9908	101050.6	1.691	.519	15.7	1.08	—	—	—	—	—	—	3.00	—	—	—
A9909	101050.6	1.691	.539	17.1	1.09	—	—	—	—	—	—	3.00	—	—	—
A9910	101050.6	1.691	.569	17.3	1.12	—	—	—	—	—	—	3.00	—	—	—
A9911	101050.6	1.691	.599	17.5	1.13	—	—	—	—	—	—	3.00	—	—	—
A9912	101050.6	1.691	.645	17.6	1.13	—	—	—	—	—	—	3.00	—	—	—
A9913	101050.6	1.691	.639	17.5	1.13	—	—	—	—	—	—	3.00	—	—	—
A9914	101050.6	1.691	.669	17.3	1.11	—	—	—	—	—	—	3.00	—	—	—
A9915	101050.6	1.691	.719	16.9	1.09	—	—	—	—	—	—	3.00	—	—	—
A9916	101050.6	1.691	.749	16.5	1.06	—	—	—	—	—	—	3.00	—	—	—

HYDRA

NUMERICAL DATA POINT.

AVERAGE VELOCITY, $U = 15.5$ FT/SEC.

— NO DATA POINT.

TABLE B-1 (CONT.), TABULATION OF EXPERIMENTAL DATA.

PLANE 3 26.25 INCHES DOWNSTREAM SPACER				INTERIOR MAP				RUN 1050 - 1129						
RUN	REYNOLDS NUMBER	Z IN.	Y IN.	U FT/SEC	U/U'	U/U'	U/U'	U/U'	V/U'	V/U'	CUTOFF KHZ	A/D	CURVE F(HZ)	FIT °
AG1050	101050.	2.040	.625	16.4	1.06	-	.058	-	-	-	3.00	-	-	-
AG1051	101050.	1.905	.625	16.6	1.07	-	.058	-	-	-	3.00	-	-	-
AG1052	101050.	1.638	.625	18.2	1.17	-	.060	-	-	-	3.00	-	-	-
AG1053	101050.	1.369	.625	19.5	1.26	-	.049	-	-	-	3.00	-	-	-
AG1054	101050.	1.101	.625	18.3	1.18	-	.057	-	-	-	3.00	-	-	-
AG1055	101050.	.832	.625	16.5	1.06	-	.057	-	-	-	3.00	-	-	-
AG1056	101050.	.564	.625	16.6	1.07	-	.053	-	-	-	3.00	-	-	-
AG1057	101050.	.295	.625	17.9	1.15	-	.036	-	-	-	3.00	-	-	-
AG1058	101050.	.161	.625	16.6	1.07	-	.066	-	-	-	3.00	-	-	-
AG1059	101050.	.027	.625	12.3	.77	-	.148	-	-	-	3.00	-	-	-
AG1060	101050.	.094	.625	15.1	.97	-	.093	-	-	-	3.00	-	-	-
AG1061	101050.	.094	.505	15.2	.98	-	.089	-	-	-	3.00	-	-	-
AG1062	101050.	.161	.505	10.6	1.07	-	.063	-	-	-	3.00	.37	0.	.027
AG1063	101050.	.295	.505	17.8	1.14	-	.038	-	-	-	3.00	.29	0.	.017
AG1064	101050.	.430	.505	17.1	1.10	-	.055	-	-	-	3.00	.27	63.	.025
AG1065	101050.	.564	.505	16.1	1.03	-	.063	-	-	-	3.00	.28	58.	.018
AG1066	101050.	.698	.505	15.5	1.00	-	.059	-	-	-	3.00	.27	0.	.021
AG1067	101050.	.832	.505	15.8	1.01	-	.066	-	-	-	3.00	.29	0.	.020
AG1068	101050.	.966	.505	17.3	1.09	-	.069	-	-	-	3.00	.30	62.	.020
AG1069	101050.	1.101	.505	17.9	1.15	-	.066	-	-	-	3.00	.28	63.	.015
AG1070	101050.	1.235	.505	19.3	1.22	-	.060	-	-	-	3.00	.34	20.	.007
AG1071	101050.	1.369	.505	19.4	1.25	-	.051	-	-	-	3.00	.31	52.	.018
AG1072	101050.	1.503	.505	18.8	1.21	-	.060	-	-	-	3.00	.29	58.	.020
AG1073	101050.	1.638	.505	18.3	1.16	-	.064	-	-	-	3.00	.28	75.	.018
AG1074	101050.	1.772	.505	17.3	1.12	-	.065	-	-	-	3.00	.27	74.	.021
AG1075	101050.	1.906	.505	16.1	1.04	-	.070	-	-	-	3.00	.30	37.	.008
AG1076	101050.	2.040	.505	15.7	1.01	-	.071	-	-	-	3.00	.31	0.	.020
AG1077	101050.	2.040	.505	12.1	.78	-	.088	-	-	-	3.00	.22	0.	.026
AG1078	101050.	1.306	.505	13.8	.89	-	.095	-	-	-	3.00	.29	0.	.025
AG1079	101050.	1.772	.505	16.4	1.06	-	.080	-	-	-	3.00	.33	22.	.018
AG1080	101050.	1.638	.505	17.3	1.11	-	.078	-	-	-	3.00	.32	47.	.008
AG1081	101050.	1.503	.505	18.4	1.18	-	.066	-	-	-	3.00	.30	47.	.012
AG1082	101050.	1.369	.505	19.1	1.23	-	.056	-	-	-	3.00	.28	79.	.022
AG1083	101050.	1.235	.505	18.5	1.19	-	.064	-	-	-	3.00	.34	29.	.006
AG1084	101050.	1.101	.505	17.1	1.10	-	.079	-	-	-	3.00	.31	21.	.008
AG1085	101050.	.966	.505	15.1	.97	-	.106	-	-	-	3.00	.31	0.	.018
AG1086	101050.	.832	.505	11.2	.72	-	.110	-	-	-	3.00	-	-	-
AG1087	101050.	.698	.505	11.4	.73	-	.092	-	-	-	3.00	-	-	-
AG1088	101050.	.564	.505	14.3	.92	-	.087	-	-	-	3.00	.30	0.	.026
AG1089	101050.	.430	.505	16.3	1.05	-	.069	-	-	-	3.00	-	-	-
AG1090	101050.	.295	.505	17.6	1.14	-	.041	-	-	-	3.00	.29	0.	.020
AG1091	101050.	.161	.505	16.9	1.09	-	.057	-	-	-	3.00	-	-	-
AG1092	101050.	.094	.505	15.5	1.00	-	.086	-	-	-	3.00	-	-	-
AG1093	101050.	.094	.605	15.5	1.00	-	.086	-	-	-	3.00	-	-	-
AG1094	101050.	.161	.605	16.7	1.08	-	.064	-	-	-	3.00	-	-	-
AG1095	101050.	.295	.605	17.8	1.14	-	.040	-	-	-	3.00	-	-	-
AG1096	101050.	.430	.605	17.2	1.11	-	.055	-	-	-	3.00	-	-	-
AG1097	101050.	.564	.605	16.2	1.04	-	.064	-	-	-	3.00	-	-	-
AG1098	101050.	.698	.605	15.2	.98	-	.072	-	-	-	3.00	-	-	-
AG1099	101050.	.832	.605	15.6	1.00	-	.075	-	-	-	3.00	-	-	-
AG1100	101050.	.966	.605	17.1	1.10	-	.065	-	-	-	3.00	-	-	-
AG1101	101050.	1.101	.605	18.1	1.17	-	.066	-	-	-	3.00	-	-	-
AG1102	101050.	1.235	.605	19.1	1.23	-	.055	-	-	-	3.00	-	-	-
AG1103	101050.	1.369	.605	19.5	1.26	-	.049	-	-	-	3.00	-	-	-
AG1104	101050.	1.369	.745	19.3	1.24	-	.054	-	-	-	3.00	-	-	-
AG1105	101050.	1.235	.745	18.7	1.20	-	.066	-	-	-	3.00	-	-	-
AG1106	101050.	1.101	.745	17.3	1.11	-	.082	-	-	-	3.00	-	-	-
AG1107	101050.	.966	.745	15.2	.98	-	.097	-	-	-	3.00	-	-	-
AG1108	101050.	.832	.745	11.6	.75	-	.127	-	-	-	3.00	-	-	-
AG1109	101050.	.698	.745	11.7	.75	-	.095	-	-	-	3.00	-	-	-
AG1110	101050.	.564	.745	14.4	.93	-	.090	-	-	-	3.00	-	-	-
AG1111	101050.	.430	.745	16.3	1.05	-	.072	-	-	-	3.00	-	-	-
AG1112	101050.	.295	.745	17.5	1.13	-	.049	-	-	-	3.00	-	-	-
AG1113	101050.	.161	.745	16.9	1.09	-	.059	-	-	-	3.00	-	-	-
AG1114	101050.	.094	.745	15.6	1.00	-	.082	-	-	-	3.00	-	-	-
AG1115	101050.	2.004	.746	13.9	.70	-	.104	-	-	-	3.00	-	-	-
AG1116	101050.	2.004	.716	13.7	.88	-	.093	-	-	-	3.00	-	-	-
AG1117	101050.	2.004	.686	15.4	.99	-	.078	-	-	-	3.00	-	-	-
AG1118	101050.	2.004	.656	16.1	1.04	-	.065	-	-	-	3.00	-	-	-
AG1119	101050.	2.004	.626	16.4	1.06	-	.056	-	-	-	3.00	-	-	-
AG1120	101050.	2.004	.596	16.2	1.05	-	.058	-	-	-	3.00	-	-	-
AG1121	101050.	2.004	.566	15.7	1.01	-	.071	-	-	-	3.00	-	-	-
AG1122	101050.	2.004	.536	14.6	.94	-	.082	-	-	-	3.00	-	-	-
AG1123	101050.	2.004	.506	12.3	.79	-	.091	-	-	-	3.00	-	-	-
AG1124	101050.	2.004	.626	16.4	1.06	-	.058	-	-	-	10.00	-	-	-
AG1125	101050.	2.004	.626	16.4	1.06	-	.058	-	-	-	7.00	-	-	-
AG1126	101050.	2.004	.626	16.4	1.06	-	.057	-	-	-	4.00	-	-	-
AG1127	101050.	2.004	.626	16.4	1.06	-	.055	-	-	-	2.00	-	-	-
AG1128	101050.	2.004	.626	16.4	1.06	-	.053	-	-	-	1.00	-	-	-
AG1129	101050.	2.004	.626	16.4	1.06	-	.049	-	-	-	.50	-	-	-

HYDRAULIC DIAMETER, D = .811 INCHES. AVERAGE VELOCITY, U = 15.5 FT/SEC.

* QUESTIONABLE DATA POINT. - NO DATA POINT.

TABLE B-1 (CONT.). TABULATION OF EXPERIMENTAL DATA.

PLATE J 26.25 INCHES DOWNSTREAM SPACER																			WALL TRAVERSES RUN 1017-1049																		
RUN	KEYNOIDS NUMBER	Z IN.	Y IN.	U	U/U	U/U*	U/U*	U/U*	U/U*	V/U	V/U*	V/U*	V/U*	V/U*	CUTOFF KHZ	λ/D	CURVE FIT	FIT																			
Av1017	101050	2.004	1.875	15.1	.97	-.042	-	-	-	-	-	-	-	-	10.00	.31	0.	.025																			
Av1018	101050	2.004	1.875	15.1	.97	-.042	-	-	-	-	-	-	-	-	7.00	.25	0.	.033																			
Av1019	101050	2.004	1.875	15.1	.97	-.040	-	-	-	-	-	-	-	-	4.00	.24	0.	.033																			
Av1020	101050	2.004	1.875	15.1	.97	-.038	-	-	-	-	-	-	-	-	3.00	.25	0.	.033																			
Av1021	101050	2.004	1.875	15.1	.97	-.036	-	-	-	-	-	-	-	-	2.00	.20	0.	.043																			
Av1022	101050	2.004	1.875	15.1	.97	-.034	-	-	-	-	-	-	-	-	1.00	.27	0.	.027																			
Av1023	101050	2.004	1.908	11.8	.76	-.074	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1024	101050	2.004	1.968	13.7	.88	-.062	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1025	101050	2.004	1.928	14.7	.94	-.050	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1026	101050	2.004	1.898	15.1	.97	-.043	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1027	101050	2.004	1.863	15.1	.97	-.043	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1028	101050	2.004	1.836	14.6	.94	-.056	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1029	101050	2.004	1.802	13.6	.88	-.069	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1030	101050	2.004	1.778	11.6	.75	-.090	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1031	101050	2.004	1.758	9.6	.62	-.097	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1032	101050	1.691	1.758	16.2	1.04	-.053	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1033	101050	1.691	1.778	16.4	1.06	-.049	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1034	101050	1.691	1.808	16.5	1.07	-.043	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1035	101050	1.691	1.836	16.4	1.06	-.040	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1036	101050	1.691	1.868	16.1	1.04	-.055	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1037	101050	1.691	1.898	15.7	1.01	-.062	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1038	101050	1.691	1.928	15.1	.97	-.072	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1039	101050	1.691	1.958	14.1	.91	-.083	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1040	101050	1.691	1.988	12.3	.79	-.090	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1041	101050	1.379	1.968	12.8	.82	-.091	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1042	101050	1.379	1.938	14.6	.94	-.085	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1043	101050	1.379	1.928	15.5	1.00	-.076	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1044	101050	1.379	1.898	16.2	1.04	-.070	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1045	101050	1.379	1.868	16.7	1.08	-.058	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1046	101050	1.379	1.838	17.3	1.10	-.053	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1047	101050	1.379	1.808	17.3	1.12	-.046	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1048	101050	1.379	1.778	17.5	1.13	-.042	-	-	-	-	-	-	-	-	3.00	-	-	-																			
Av1049	101050	1.379	1.758	17.6	1.14	-.039	-	-	-	-	-	-	-	-	3.00	-	-	-																			

PLATE I 38.25 INCHES DOWNSTREAM SPACER INTERIOR MAP RUN 1 - 140

RUN	KEYNOIDS NUMBER	Z IN.	Y IN.	U	U/U	U/U*	U/U*	U/U*	U/U*	V/U	V/U*	V/U*	V/U*	V/U*	CUTOFF KHZ	λ/D	CURVE FIT F(HZ)	θ
Av 1	101050	.034	.625	12.6	.81	-.109	-	-	-	-	-	-	-	-	3.00	.39	0.	.021
Av 2	101050	.101	.625	15.5	1.00	-.073	-	-	-	-	-	-	-	-	3.00	-	-	-
Av 3	101050	.168	.625	16.9	1.09	-.055	-	-	-	-	-	-	-	-	3.00	.56	0.	.026
Av 4	101050	.235	.625	17.7	1.14	-.041	-	-	-	-	-	-	-	-	3.00	-	-	-
Av 5	101050	.302	.625	18.3	1.16	-.033	-	-	-	-	-	-	-	-	3.00	.29	0.	.020
Av 6	101050	.369	.625	17.8	1.15	-.037	-	-	-	-	-	-	-	-	3.00	-	-	-
Av 7	101050	.436	.625	17.5	1.12	-.042	-	-	-	-	-	-	-	-	3.00	.35	43.	.012
Av 8	101050	.503	.625	17.1	1.10	-.044	-	-	-	-	-	-	-	-	3.00	.32	54.	.023
Av 9	101050	.570	.625	16.7	1.08	-.040	-	-	-	-	-	-	-	-	3.00	-	-	-
Av 10	101050	.638	.625	16.5	1.06	-.040	-	-	-	-	-	-	-	-	3.00	.24	0.	.026
Av 11	101050	.705	.625	16.4	1.06	-.045	-	-	-	-	-	-	-	-	3.00	-	-	-
Av 12	101050	.772	.625	16.4	1.06	-.045	-	-	-	-	-	-	-	-	3.00	.45	9.	.034
Av 13	101050	.839	.625	16.6	1.08	-.049	-	-	-	-	-	-	-	-	3.00	.37	52.	.017
Av 14	101050	.906	.625	17.3	1.11	-.048	-	-	-	-	-	-	-	-	3.00	-	-	-
Av 15	101050	.973	.625	17.8	1.14	-.048	-	-	-	-	-	-	-	-	3.00	.39	38.	.013
Av 16	101050	1.040	.625	18.2	1.17	-.049	-	-	-	-	-	-	-	-	3.00	.40	40.	.020
Av 17	101050	1.107	.625	18.6	1.20	-.045	-	-	-	-	-	-	-	-	3.00	.40	38.	.013
Av 18	101050	1.174	.625	19.3	1.22	-.045	-	-	-	-	-	-	-	-	3.00	.40	0.	.018
Av 19	101050	1.242	.625	19.3	1.24	-.042	-	-	-	-	-	-	-	-	3.00	.40	0.	.018
Av 20	101050	1.309	.625	19.6	1.26	-.037	-	-	-	-	-	-	-	-	3.00	.36	0.	.031
Av 21	101050	1.376	.625	19.6	1.26	-.036	-	-	-	-	-	-	-	-	3.00	.36	0.	.031
Av 22	101050	1.443	.625	19.6	1.26	-.038	-	-	-	-	-	-	-	-	3.00	.40	40.	.020
Av 23	101050	1.510	.625	19.3	1.24	-.048	-	-	-	-	-	-	-	-	3.00	.35	60.	.021
Av 24	101050	1.577	.625	19.3	1.22	-.048	-	-	-	-	-	-	-	-	3.00	.36	47.	.021
Av 25	101050	1.644	.625	18.7	1.20	-.051	-	-	-	-	-	-	-	-	3.00	.39	46.	.025
Av 26	101050	1.711	.625	18.4	1.18	-.055	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 27	101050	1.779	.625	17.9	1.16	-.052	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 28	101050	1.846	.625	17.6	1.13	-.049	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 29	101050	1.913	.625	17.3	1.11	-.046	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 30	101050	1.980	.625	17.1	1.10	-.047	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 31	101050	2.047	.625	17.1	1.10	-.059	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 32	101050	2.047	.625	16.2	1.04	-.059	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 33	101050	1.960	.625	16.3	1.05	-.059	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 34	101050	1.913	.625	16.6	1.07	-.059	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 35	101050	1.846	.625	17.2	1.11	-.053	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 36	101050	1.779	.625	17.8	1.15	-.055	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 37	101050	1.711	.625	18.1	1.17	-.054	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 38	101050	1.644	.625	18.4	1.19	-.046	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 39	101050	1.577	.625	18.8	1.21	-.046	-	-	-	-	-	-	-	-	3.00	.42	16.	.020
Av 40	101050	1.510	.625	19.1	1.23	-.046	-	-	-	-	-	-	-	-	3.00	.42	16.	.020

HYDRAULIC DIAMETER, D = .811 INCHES. AVERAGE VELOCITY, U = 15.5 FT/SEC.
* QUESTIONABLE DATA POINT. - NO DATA POINT.

TABLE B-1 (CONT.), TABULATION OF EXPERIMENTAL DATA.

PLANE 4 38.25 INCHES DOWNSTREAM SPACER				INTERIOR MAP				RUN 1 - 140							
RUN	REYNOLDS NUMBER	Z IN.	γ ILL	$\bar{U}$ FT/SEC	$\bar{U}/U^*$	$\bar{U}/U^*$	$U'/\bar{U}$	U'/U^*	$V/\bar{U}$	V/U^*	CUTOFF KHZ	Δ/D	CURVE F (HZ)	FIT	
AG 41	101050.	1.443	.505	19.4	1.25	-	.042	-	-	-	3.00	-	-	-	-
AG 42	101050.	1.376	.505	19.5	1.26	-	.037	-	-	-	3.00	.40	0.	.015	-
AG 43	101050.	1.309	.505	19.3	1.25	-	.040	-	-	-	3.00	-	-	-	-
AG 44	101050.	1.242	.505	19.3	1.22	-	.046	-	-	-	3.00	.46	0.	.025	-
AG 45	101050.	1.174	.505	18.6	1.20	-	.052	-	-	-	3.00	-	-	-	-
AG 46	101050.	1.107	.505	18.1	1.17	-	.054	-	-	-	3.00	.37	19.	.023	-
AG 47	101050.	1.040	.505	17.7	1.14	-	.057	-	-	-	3.00	-	-	-	-
AG 48	101050.	.973	.505	17.1	1.10	-	.060	-	-	-	3.00	.45	24.	.019	-
AG 49	101050.	.906	.505	16.5	1.06	-	.064	-	-	-	3.00	-	-	-	-
AG 50	101050.	.839	.505	15.8	1.02	-	.064	-	-	-	3.00	.45	35.	.027	-
AG 51	101050.	.772	.505	15.4	.99	-	.060	-	-	-	3.00	-	-	-	-
AG 52	101050.	.705	.505	15.3	.99	-	.057	-	-	-	3.00	.41	27.	.014	-
AG 53	101050.	.638	.505	15.7	1.01	-	.056	-	-	-	3.00	-	-	-	-
AG 54	101050.	.570	.505	16.1	1.04	-	.055	-	-	-	3.00	.38	38.	.025	-
AG 55	101050.	.503	.505	16.6	1.07	-	.052	-	-	-	3.00	-	-	-	-
AG 56	101050.	.436	.505	17.1	1.10	-	.046	-	-	-	3.00	.37	0.	.014	-
AG 57	101050.	.369	.505	17.5	1.13	-	.045	-	-	-	3.00	-	-	-	-
AG 58	101050.	.302	.505	17.8	1.15	-	.035	-	-	-	3.00	.61	0.	.035	-
AG 59	101050.	.235	.505	17.7	1.14	-	.039	-	-	-	3.00	-	-	-	-
AG 60	101050.	.168	.505	16.9	1.09	-	.054	-	-	-	3.00	.50	0.	.020	-
AG 61	101050.	.101	.505	15.5	1.00	-	.071	-	-	-	3.00	.48	0.	.027	-
AG 62	101050.	.034	.505	12.8	.83	-	.100	-	-	-	3.00	-	-	-	-
AG 63	101050.	.034	.505	12.8	.83	-	.106	-	-	-	3.00	.38	10.	.018	-
AG 64	101050.	.101	.505	15.6	1.00	-	.072	-	-	-	3.00	-	-	-	-
AG 65	101050.	.168	.505	16.9	1.09	-	.052	-	-	-	3.00	-	-	-	-
AG 66	101050.	.235	.505	17.5	1.12	-	.038	-	-	-	3.00	-	-	-	-
AG 67	101050.	.302	.505	17.3	1.11	-	.045	-	-	-	3.00	.47	0.	.025	-
AG 68	101050.	.369	.505	16.7	1.08	-	.055	-	-	-	3.00	-	-	-	-
AG 69	101050.	.436	.505	16.1	1.03	-	.062	-	-	-	3.00	-	-	-	-
AG 70	101050.	.503	.505	15.2	.98	-	.070	-	-	-	3.00	-	-	-	-
AG 71	101050.	.570	.505	14.1	.91	-	.075	-	-	-	3.00	.38	28.	.028	-
AG 72	101050.	.638	.505	12.7	.81	-	.075	-	-	-	3.00	-	-	-	-
AG 73	101050.	.705	.505	10.4	.67	-	.090	-	-	-	3.00	-	-	-	-
AG 74	101050.	.772	.505	-	-	-	-	-	-	-	-	-	-	-	-
AG 75	101050.	.839	.505	10.8	.70	-	.096	-	-	-	3.00	-	-	-	-
AG 76	101050.	.906	.505	13.4	.86	-	.083	-	-	-	3.00	-	-	-	-
AG 77	101050.	.973	.505	15.3	.99	-	.078	-	-	-	3.00	.48	25.	.019	-
AG 78	101050.	1.040	.505	16.4	1.06	-	.077	-	-	-	3.00	-	-	-	-
AG 79	101050.	1.107	.505	17.2	1.11	-	.071	-	-	-	3.00	-	-	-	-
AG 80	101050.	1.174	.505	17.8	1.15	-	.073	-	-	-	3.00	-	-	-	-
AG 81	101050.	1.242	.505	18.5	1.19	-	.057	-	-	-	3.00	.43	0.	.021	-
AG 82	101050.	1.309	.505	18.9	1.22	-	.047	-	-	-	3.00	-	-	-	-
AG 83	101050.	1.376	.505	19.1	1.23	-	.045	-	-	-	3.00	-	-	-	-
AG 84	101050.	1.443	.505	18.8	1.21	-	.048	-	-	-	3.00	-	-	-	-
AG 85	101050.	1.510	.505	18.5	1.19	-	.053	-	-	-	3.00	.45	0.	.021	-
AG 86	101050.	1.577	.505	18.3	1.16	-	.058	-	-	-	3.00	-	-	-	-
AG 87	101050.	1.644	.505	17.6	1.13	-	.065	-	-	-	3.00	-	-	-	-
AG 88	101050.	1.711	.505	17.2	1.11	-	.065	-	-	-	3.00	-	-	-	-
AG 89	101050.	1.779	.505	16.4	1.06	-	.069	-	-	-	3.00	.46	0.	.039	-
AG 90	101050.	1.846	.505	15.2	.98	-	.073	-	-	-	3.00	-	-	-	-
AG 91	101050.	1.913	.505	13.4	.86	-	.078	-	-	-	3.00	-	-	-	-
AG 92	101050.	1.980	.505	11.7	.75	-	.080	-	-	-	3.00	-	-	-	-
AG 93	101050.	2.047	.505	11.3	.73	-	.083	-	-	-	3.00	.52	7.	.029	-
AG 94	101050.	2.047	.605	16.3	1.05	-	.059	-	-	-	3.00	-	-	-	-
AG 95	101050.	1.913	.605	16.5	1.06	-	.061	-	-	-	3.00	-	-	-	-
AG 96	101050.	1.779	.605	17.6	1.13	-	.058	-	-	-	3.00	-	-	-	-
AG 97	101050.	1.644	.605	18.4	1.19	-	.056	-	-	-	3.00	-	-	-	-
AG 98	101050.	1.510	.605	19.2	1.24	-	.046	-	-	-	3.00	-	-	-	-
AG 99	101050.	1.376	.605	19.6	1.26	-	.036	-	-	-	3.00	-	-	-	-
AG100	101050.	1.242	.605	19.1	1.23	-	.045	-	-	-	3.00	-	-	-	-
AG101	101050.	1.107	.605	18.3	1.18	-	.053	-	-	-	3.00	-	-	-	-
AG102	101050.	.973	.605	17.3	1.12	-	.057	-	-	-	3.00	-	-	-	-
AG103	101050.	.839	.605	16.1	1.04	-	.058	-	-	-	3.00	-	-	-	-
AG104	101050.	.705	.605	15.6	1.00	-	.054	-	-	-	3.00	-	-	-	-
AG105	101050.	.570	.605	16.1	1.04	-	.056	-	-	-	3.00	-	-	-	-
AG106	101050.	.436	.605	17.3	1.10	-	.050	-	-	-	3.00	-	-	-	-
AG107	101050.	.302	.605	17.9	1.15	-	.034	-	-	-	3.00	-	-	-	-
AG108	101050.	.235	.605	17.7	1.14	-	.038	-	-	-	3.00	-	-	-	-
AG109	101050.	.168	.605	16.9	1.09	-	.053	-	-	-	3.00	-	-	-	-
AG110	101050.	.101	.605	15.6	1.01	-	.072	-	-	-	3.00	-	-	-	-
AG111	101050.	.034	.605	12.9	.83	-	.099	-	-	-	3.00	-	-	-	-
AG112	101050.	.034	.745	12.9	.83	-	.099	-	-	-	3.00	-	-	-	-
AG113	101050.	.101	.745	15.6	1.01	-	.070	-	-	-	3.00	-	-	-	-
AG114	101050.	.168	.745	17.3	1.09	-	.051	-	-	-	3.00	-	-	-	-
AG115	101050.	.235	.745	17.6	1.13	-	.038	-	-	-	3.00	-	-	-	-
AG116	101050.	.302	.745	17.5	1.12	-	.039	-	-	-	3.00	-	-	-	-
AG117	101050.	.369	.745	16.9	1.09	-	.054	-	-	-	3.00	-	-	-	-
AG118	101050.	.436	.745	16.2	1.04	-	.059	-	-	-	3.00	-	-	-	-
AG119	101050.	.570	.745	14.5	.93	-	.076	-	-	-	3.00	-	-	-	-
AG120	101050.	.705	.745	12.4	.80	-	.070	-	-	-	3.00	-	-	-	-

HYDRAULIC DIAMETER, $D = .811$ INCHES. AVERAGE VELOCITY, $U = 15.5$ FT/SEC.
 * QUESTIONABLE DATA POINT. - NO DATA POINT.

TABLE B-1 (CONT.), TABULATION OF EXPERIMENTAL DATA.

PLATE 4 38.25 INCHES DOWNSTREAM SPACER													
INTERIOR MAP RUN 1 - 140													
RUN	REYNOLDS NUMBER	Z IN.	γ IN.	$\bar{U}$ FT/SEC	$\bar{U}/U^*$	$\bar{U}/U^*$	U/U^*	U/U^*	U/U^*	$V/\bar{U}$	V/U^*	CUTOFF FREQ. γ/D	CURVE FIT θ
Av121	101058	.839	.745	12.8	.82	-	.075	-	-	-	-	3.00	-
Av122	101058	.973	.745	15.7	1.01	-	.078	-	-	-	-	3.00	-
Av123	101058	1.107	.745	17.6	1.13	-	.063	-	-	-	-	3.00	-
Av124	101058	1.242	.745	18.8	1.21	-	.052	-	-	-	-	3.00	-
Av125	101058	1.376	.745	19.4	1.25	-	.040	-	-	-	-	3.00	-
Av126	101058	1.510	.745	19.9	1.22	-	.048	-	-	-	-	3.00	-
Av127	101058	1.644	.745	17.9	1.16	-	.066	-	-	-	-	3.00	-
Av128	101058	1.779	.745	16.5	1.06	-	.074	-	-	-	-	3.00	-
Av129	101058	1.913	.745	13.6	.88	-	.079	-	-	-	-	3.00	-
Av130	101058	2.047	.745	11.7	.75	-	.081	-	-	-	-	3.00	-
Av131	101058	1.510	.625	19.2	1.24	-	.046	-	-	-	-	10.00	-
Av132	101058	1.510	.625	19.2	1.24	-	.045	-	-	-	-	7.00	-
Av133	101058	1.510	.625	19.2	1.24	-	.044	-	-	-	-	4.00	-
Av134	101058	1.510	.625	19.2	1.24	-	.044	-	-	-	-	3.00	-
Av135	101058	1.510	.625	19.2	1.24	-	.043	-	-	-	-	3.00	-
Av136	101058	1.510	.625	19.2	1.24	-	.042	-	-	-	-	1.00	-
Av137	101058	1.510	.625	19.2	1.24	-	.040	-	-	-	-	.50	-
Av138	101058	1.510	.625	19.2	1.24	-	.038	-	-	-	-	.30	-
Av139	101058	1.510	.625	19.2	1.24	-	.036	-	-	-	-	.20	-
Av140	101058	1.510	.625	19.2	1.24	-	.029	-	-	-	-	.10	-
PLATE 4 30.25 INCHES DOWNSTREAM SPACER													
INTERIOR CL RUN 1090 - 1109													
RUN	REYNOLDS NUMBER	Z IN.	γ IN.	$\bar{U}$ FT/SEC	$\bar{U}/U^*$	$\bar{U}/U^*$	U/U^*	U/U^*	U/U^*	$V/\bar{U}$	V/U^*	CUTOFF FREQ. γ/D	CURVE FIT θ
Av1690	101058	.081	.625	13.9	.96	-	.084	-	-	-	-	3.00	-
Av1691	101058	.215	.625	16.9	1.03	-	.040	-	-	-	-	3.00	.38
Av1692	101058	.349	.625	16.1	1.03	-	.042	-	-	-	-	3.00	0. .026
Av1693	101058	.483	.625	15.3	.99	-	.047	-	-	-	-	3.00	-
Av1694	101058	.617	.625	14.7	.95	-	.045	-	-	-	-	3.00	-
Av1695	101058	.752	.625	14.7	.95	-	.043	-	-	-	-	3.00	-
Av1696	101058	.886	.625	15.2	.98	-	.048	-	-	-	-	3.00	-
Av1697	101058	1.020	.625	16.9	1.03	-	.050	-	-	-	-	3.00	-
Av1698	101058	1.154	.625	16.7	1.07	-	.047	-	-	-	-	3.00	-
Av1699	101058	1.289	.625	17.3	1.11	-	.039	-	-	-	-	3.00	-
Av1700	101058	1.423	.625	17.3	1.12	-	.040	-	-	-	-	3.00	-
Av1701	101058	1.557	.625	16.9	1.09	-	.050	-	-	-	-	3.00	-
Av1702	101058	1.691	.625	16.3	1.05	-	.055	-	-	-	-	3.00	-
Av1703	101058	1.825	.625	15.7	1.01	-	.053	-	-	-	-	3.00	-
Av1704	101058	1.960	.625	15.1	.97	-	.051	-	-	-	-	3.00	-
Av1705	101058	2.094	.625	15.4	.99	-	.053	-	-	-	-	3.00	-
Av1706	101058	2.094	.625	15.4	.99	-	.057	-	-	-	-	10.00	-
Av1707	101058	2.094	.625	15.4	.99	-	.056	-	-	-	-	7.00	-
Av1708	101058	2.094	.625	15.4	.99	-	.052	-	-	-	-	2.00	-
Av1709	101058	2.094	.625	15.4	.99	-	.049	-	-	-	-	1.00	-

PLATE 4 38.25 INCHES DOWNSTREAM SPACER													
INTERIOR CL RUN 270 - 293 .5RE													
RUN	REYNOLDS NUMBER	Z IN.	γ IN.	$\bar{U}$ FT/SEC	$\bar{U}/U^*$	$\bar{U}/U^*$	U/U^*	U/U^*	U/U^*	$V/\bar{U}$	V/U^*	CUTOFF FREQ. γ/D	CURVE FIT θ
Av270	50529	.034	.625	6.3	.61	-	.113	-	-	-	-	2.00	.35
Av271	50529	.168	.625	8.5	1.10	-	.058	-	-	-	-	2.00	.62
Av272	50529	.302	.625	9.2	1.18	-	.034	-	-	-	-	2.00	.43
Av273	50529	.436	.625	8.9	1.14	-	.043	-	-	-	-	2.00	.33
Av274	50529	.570	.625	8.5	1.09	-	.046	-	-	-	-	2.00	.31
Av275	50529	.705	.625	8.2	1.06	-	.044	-	-	-	-	2.00	.36
Av276	50529	.839	.625	8.4	1.08	-	.051	-	-	-	-	2.00	.37
Av277	50529	.973	.625	8.9	1.15	-	.051	-	-	-	-	2.00	.43
Av278	50529	1.107	.625	9.4	1.21	-	.050	-	-	-	-	2.00	.38
Av279	50529	1.242	.625	9.8	1.26	-	.044	-	-	-	-	2.00	.43
Av280	50529	1.376	.625	10.1	1.30	-	.037	-	-	-	-	2.00	.45
Av281	50529	1.510	.625	9.9	1.27	-	.045	-	-	-	-	2.00	.36
Av282	50529	1.644	.625	9.9	1.27	-	.045	-	-	-	-	2.00	.37
Av283	50529	1.779	.625	9.6	1.23	-	.051	-	-	-	-	2.00	.35
Av284	50529	1.913	.625	9.2	1.18	-	.055	-	-	-	-	2.00	.37
Av285	50529	2.047	.625	8.8	1.13	-	.050	-	-	-	-	2.00	.37
Av286	50529	2.047	.625	8.6	1.11	-	.049	-	-	-	-	2.00	-
Av287	50529	2.047	.625	8.6	1.11	-	.051	-	-	-	-	10.00	-
Av288	50529	2.047	.625	8.6	1.11	-	.050	-	-	-	-	7.00	-
Av289	50529	2.047	.625	8.6	1.11	-	.050	-	-	-	-	4.00	-
Av290	50529	2.047	.625	8.6	1.11	-	.050	-	-	-	-	3.00	-
Av291	50529	2.047	.625	8.6	1.11	-	.049	-	-	-	-	2.00	-
Av292	50529	2.047	.625	8.6	1.11	-	.049	-	-	-	-	1.00	-
Av293	50529	2.047	.625	8.6	1.11	-	.047	-	-	-	-	.50	-

* QUESTIONABLE DATA POINT.

- NO DATA POINT. AVERAGE VELOCITY, U = 7.8 FT/SEC.

TABLE B-1 (CONT.). TABULATION OF EXPERIMENTAL DATA.

PLATE 4 38.25 INCHES DOWNSTREAM SPACER				WALL MAP		RUN 141 - 269						CUTOFF KHZ	A/D	CURVE FIT F (HZ)	FIT °
RUN	REYNOLDS NUMBER	Z IN.	Y IN.	U FT/SEC	U/U*	U/U*	U/U*	V/U	V/U*	V/U*	V/U*				
AG141	101058.	.027	1.755	9.9	.64	-	.142	-	-	-	-	3.00	-	-	-
AG142	101058.	.094	1.755	13.3	.86	-	.079	-	-	-	-	3.00	-	-	-
AG143	101058.	.161	1.755	15.1	.97	-	.056	-	-	-	-	3.00	-	-	-
AG144	101058.	.228	1.755	16.1	1.03	-	.037	-	-	-	-	3.00	-	-	-
AG145	101058.	.295	1.755	16.1	1.04	-	.036	-	-	-	-	3.00	-	-	-
AG146	101058.	.362	1.755	15.8	1.02	-	.043	-	-	-	-	3.00	-	-	-
AG147	101058.	.430	1.755	15.1	.97	-	.051	-	-	-	-	3.00	-	-	-
AG148	101058.	.497	1.755	14.4	.93	-	.057	-	-	-	-	3.00	-	-	-
AG149	101058.	.564	1.755	13.4	.86	-	.065	-	-	-	-	3.00	-	-	-
AG150	101058.	.631	1.755	12.0	.77	-	.070	-	-	-	-	3.00	-	-	-
AG151	101058.	.698	1.755	10.3	.66	-	.084	-	-	-	-	3.00	-	-	-
AG152	101058.	.765	1.755	8.2	.53	-	.109	-	-	-	-	3.00	-	-	-
AG153	101058.	.832	1.755	9.6	.62	-	.084	-	-	-	-	3.00	-	-	-
AG154	101058.	.899	1.755	11.5	.74	-	.070	-	-	-	-	3.00	-	-	-
AG155	101058.	.966	1.755	13.2	.85	-	.068	-	-	-	-	3.00	-	-	-
AG156	101058.	1.034	1.755	14.6	.94	-	.066	-	-	-	-	3.00	-	-	-
AG157	101058.	1.101	1.755	15.6	1.01	-	.059	-	-	-	-	3.00	-	-	-
AG158	101058.	1.168	1.755	16.4	1.06	-	.054	-	-	-	-	3.00	-	-	-
AG159	101058.	1.235	1.755	17.1	1.10	-	.045	-	-	-	-	3.00	-	-	-
AG160	101058.	1.302	1.755	17.7	1.14	-	.037	-	-	-	-	3.00	-	-	-
AG161	101058.	1.369	1.755	17.9	1.16	-	.035	-	-	-	-	3.00	-	-	-
AG162	101058.	1.436	1.755	18.0	1.16	-	.035	-	-	-	-	3.00	-	-	-
AG163	101058.	1.503	1.755	17.9	1.15	-	.037	-	-	-	-	3.00	-	-	-
AG164	101058.	1.570	1.755	17.6	1.13	-	.040	-	-	-	-	3.00	-	-	-
AG165	101058.	1.638	1.755	17.1	1.10	-	.045	-	-	-	-	3.00	-	-	-
AG166	101058.	1.705	1.755	16.4	1.06	-	.052	-	-	-	-	3.00	-	-	-
AG167	101058.	1.772	1.755	15.5	1.00	-	.059	-	-	-	-	3.00	-	-	-
AG168	101058.	1.839	1.755	14.1	.91	-	.068	-	-	-	-	3.00	-	-	-
AG169	101058.	1.906	1.755	12.6	.81	-	.069	-	-	-	-	3.00	-	-	-
AG170	101058.	1.973	1.755	11.1	.71	-	.073	-	-	-	-	3.00	-	-	-
AG171	101058.	2.040	1.755	10.4	.67	-	.073	-	-	-	-	3.00	-	-	-
AG172	101058.	2.040	1.815	14.5	.93	-	.052	-	-	-	3.00	.30	50.	.045	-
AG173	101058.	1.973	1.815	14.7	.94	-	.054	-	-	-	3.00	-	-	-	-
AG174	101058.	1.906	1.815	15.1	.97	-	.055	-	-	-	3.00	.39	0.	.025	-
AG175	101058.	1.839	1.815	15.8	1.01	-	.049	-	-	-	3.00	-	-	-	-
AG176	101058.	1.772	1.815	16.4	1.06	-	.045	-	-	-	3.00	.43	0.	.034	-
AG177	101058.	1.705	1.815	16.8	1.08	-	.042	-	-	-	3.00	-	-	-	-
AG178	101058.	1.638	1.815	17.1	1.10	-	.043	-	-	-	3.00	.46	0.	.020	-
AG179	101058.	1.570	1.815	17.3	1.11	-	.047	-	-	-	3.00	-	-	-	-
AG180	101058.	1.503	1.815	17.5	1.12	-	.046	-	-	-	3.00	.56	0.	.043	-
AG181	101058.	1.436	1.815	17.6	1.13	-	.045	-	-	-	3.00	-	-	-	-
AG182	101058.	1.369	1.815	17.7	1.14	-	.040	-	-	-	3.00	.48	0.	.038	-
AG183	101058.	1.302	1.815	17.6	1.14	-	.038	-	-	-	3.00	-	-	-	-
AG184	101058.	1.235	1.815	17.3	1.12	-	.038	-	-	-	3.00	.41	0.	.036	-
AG185	101058.	1.168	1.815	16.9	1.09	-	.042	-	-	-	3.00	-	-	-	-
AG186	101058.	1.101	1.815	16.4	1.06	-	.045	-	-	-	3.00	.43	0.	.034	-
AG187	101058.	1.034	1.815	15.8	1.02	-	.048	-	-	-	3.00	-	-	-	-
AG188	101058.	.966	1.815	15.1	.97	-	.052	-	-	-	3.00	.43	0.	.033	-
AG189	101058.	.899	1.815	14.4	.93	-	.052	-	-	-	3.00	-	-	-	-
AG190	101058.	.832	1.815	13.9	.90	-	.052	-	-	-	3.00	.34	44.	.027	-
AG191	101058.	.765	1.815	13.7	.88	-	.052	-	-	-	3.00	-	-	-	-
AG192	101058.	.698	1.815	13.9	.90	-	.050	-	-	-	3.00	.25	0.	.036	-
AG193	101058.	.631	1.815	14.4	.93	-	.048	-	-	-	3.00	-	-	-	-
AG194	101058.	.564	1.815	14.9	.96	-	.044	-	-	-	3.00	.27	0.	.034	-
AG195	101058.	.497	1.815	15.3	.99	-	.040	-	-	-	3.00	-	-	-	-
AG196	101058.	.430	1.815	15.6	1.01	-	.039	-	-	-	3.00	.30	0.	.036	-
AG197	101058.	.362	1.815	15.9	1.02	-	.040	-	-	-	3.00	-	-	-	-
AG198	101058.	.295	1.815	16.1	1.04	-	.037	-	-	-	3.00	.47	0.	.040	-
AG199	101058.	.228	1.815	16.1	1.04	-	.035	-	-	-	3.00	-	-	-	-
AG200	101058.	.161	1.815	15.3	.99	-	.050	-	-	-	3.00	.40	0.	.040	-
AG201	101058.	.094	1.815	13.5	.87	-	.169	-	-	-	3.00	-	-	-	-
AG202	101058.	.027	1.815	10.0	.64	-	.135	-	-	-	3.00	.21	0.	.030	-
AG203	101058.	.027	1.875	10.0	.64	-	.130	-	-	-	3.00	-	-	-	-
AG204	101058.	.094	1.875	13.7	.88	-	.071	-	-	-	3.00	-	-	-	-
AG205	101058.	.161	1.875	15.2	.98	-	.049	-	-	-	3.00	-	-	-	-
AG206	101058.	.295	1.875	15.4	.99	-	.053	-	-	-	3.00	-	-	-	-
AG207	101058.	.430	1.875	15.2	.98	-	.050	-	-	-	3.00	-	-	-	-
AG208	101058.	.564	1.875	15.0	.97	-	.041	-	-	-	3.00	-	-	-	-
AG209	101058.	.698	1.875	14.8	.95	-	.037	-	-	-	3.00	-	-	-	-
AG210	101058.	.832	1.875	14.8	.95	-	.037	-	-	-	3.00	-	-	-	-
AG211	101058.	.966	1.875	15.4	.99	-	.044	-	-	-	3.00	-	-	-	-
AG212	101058.	1.101	1.875	16.1	1.04	-	.049	-	-	-	3.00	-	-	-	-
AG213	101058.	1.235	1.875	16.7	1.08	-	.048	-	-	-	3.00	-	-	-	-
AG214	101058.	1.369	1.875	16.8	1.08	-	.057	-	-	-	3.00	-	-	-	-
AG215	101058.	1.503	1.875	16.5	1.07	-	.061	-	-	-	3.00	.67	0.	.043	-
AG216	101058.	1.638	1.875	16.3	1.05	-	.060	-	-	-	3.00	-	-	-	-
AG217	101058.	1.772	1.875	16.2	1.05	-	.047	-	-	-	3.00	-	-	-	-
AG218	101058.	1.906	1.875	15.7	1.01	-	.043	-	-	-	3.00	-	-	-	-
AG219	101058.	2.040	1.875	15.3	.98	-	.036	-	-	-	3.00	-	-	-	-
AG220	101058.	2.040	1.925	14.5	.94	-	.050	-	-	-	3.00	-	-	-	-

HYDRAULIC DIAMETER, D = .811 INCHES. AVERAGE VELOCITY, U = 15.5 FT/SEC.

* QUESTIONABLE DATA POINT. - NO DATA POINT.

TABLE B-1 (CONT.). TABULATION OF EXPERIMENTAL DATA.

PLANE 4 38.25 INCHES DOWNSTREAM SPACER WALL MAP RUN 14, - 269													
RUN	REYNOLDS NUMBER	Z IN.	Y IN.	U FT/SEC	U/U'	U/U'	U/U'	V/U	V/U'	V/U' CUTOFF KHZ	N/D	CURVE FIT F(HZ)	°
Av221	101058.	1.906	1.925	15.3	.97	-	.050	-	-	3.00	-	-	-
Av222	101058.	1.772	1.925	15.3	.98	-	.061	-	-	3.00	-	-	-
Av223	101058.	1.638	1.925	15.2	.98	-	.069	-	-	3.00	-	-	-
Av224	101058.	1.503	1.925	15.4	.99	-	.071	-	-	3.00	.55	0.	.034
Av225	101058.	1.369	1.925	15.7	1.01	-	.066	-	-	3.00	-	-	-
Av226	101058.	1.235	1.925	15.5	1.00	-	.062	-	-	3.00	-	-	-
Av227	101058.	1.101	1.925	15.3	.97	-	.060	-	-	3.00	-	-	-
Av228	101058.	.966	1.925	14.4	.93	-	.056	-	-	3.00	-	-	-
Av229	101058.	.832	1.925	14.1	.91	-	.047	-	-	3.00	-	-	-
Av230	101058.	.698	1.925	14.3	.90	-	.050	-	-	3.00	-	-	-
Av231	101058.	.564	1.925	14.1	.91	-	.057	-	-	3.00	-	-	-
Av232	101058.	.430	1.925	14.3	.90	-	.061	-	-	3.00	-	-	-
Av233	101058.	.295	1.925	14.1	.91	-	.068	-	-	3.00	-	-	-
Av234	101058.	.161	1.925	14.2	.92	-	.061	-	-	3.00	-	-	-
Av235	101058.	.094	1.925	13.5	.87	-	.061	-	-	3.00	-	-	-
Av236	101058.	.027	1.925	9.9	.64	-	.130	-	-	3.00	-	-	-
Av237	101058.	.027	1.905	9.3	.66	-	.147	-	-	3.00	-	-	-
Av238	101058.	.094	1.905	12.2	.79	-	.067	-	-	3.00	-	-	-
Av239	101058.	.161	1.905	12.6	.81	-	.074	-	-	3.00	-	-	-
Av240	101058.	.295	1.905	12.7	.82	-	.076	-	-	3.00	-	-	-
Av241	101058.	.430	1.905	12.6	.81	-	.073	-	-	3.00	-	-	-
Av242	101058.	.564	1.905	12.8	.82	-	.065	-	-	3.00	-	-	-
Av243	101058.	.698	1.905	12.7	.82	-	.061	-	-	3.00	-	-	-
Av244	101058.	.832	1.905	12.7	.82	-	.058	-	-	3.00	-	-	-
Av245	101058.	.966	1.905	13.3	.84	-	.063	-	-	3.00	-	-	-
Av246	101058.	1.101	1.905	13.5	.87	-	.073	-	-	3.00	-	-	-
Av247	101058.	1.235	1.905	14.3	.90	-	.070	-	-	3.00	-	-	-
Av248	101058.	1.369	1.905	14.2	.92	-	.071	-	-	3.00	-	-	-
Av249	101058.	1.503	1.905	14.3	.96	-	.078	-	-	3.00	.54	5.	.035
Av250	101058.	1.638	1.905	13.8	.89	-	.073	-	-	3.00	-	-	-
Av251	101058.	1.772	1.905	13.9	.89	-	.067	-	-	3.00	-	-	-
Av252	101058.	1.906	1.905	13.6	.88	-	.064	-	-	3.00	-	-	-
Av253	101058.	2.040	1.905	13.2	.85	-	.060	-	-	3.00	-	-	-
Av254	50529.	2.040	1.815	7.2	.92	-	.054	-	-	2.00	.25	0.	.037
Av255	50529.	1.906	1.815	7.5	.97	-	.056	-	-	2.00	.34	0.	.042
Av256	50529.	1.772	1.815	8.3	1.07	-	.049	-	-	2.00	.44	0.	.063
Av257	50529.	1.638	1.815	8.7	1.12	-	.044	-	-	2.00	.45	0.	.041
Av258	50529.	1.503	1.815	8.9	1.15	-	.044	-	-	2.00	.59	0.	.053
Av259	50529.	1.369	1.815	9.3	1.16	-	.044	-	-	2.00	.39	0.	.044
Av260	50529.	1.235	1.815	8.8	1.13	-	.046	-	-	2.00	.35	0.	.016
Av261	50529.	1.101	1.815	8.3	1.07	-	.046	-	-	2.00	.42	0.	.036
Av262	50529.	.966	1.815	7.6	.97	-	.052	-	-	2.00	.41	0.	.035
Av263	50529.	.832	1.815	6.9	.89	-	.054	-	-	2.00	.25	0.	.033
Av264	50529.	.698	1.815	6.9	.89	-	.053	-	-	2.00	.20	0.	.032
Av265	50529.	.564	1.815	7.4	.95	-	.045	-	-	2.00	.36	0.	.039
Av266	50529.	.430	1.815	7.8	1.01	-	.043	-	-	2.00	.29	0.	.029
Av267	50529.	.295	1.815	8.1	1.04	-	.040	-	-	2.00	.40	0.	.079
Av268	50529.	.161	1.815	7.8	1.00	-	.050	-	-	2.00	.39	0.	.049
Av269	50529.	.027	1.815	5.2	.67	-	.134	-	-	2.00	.25	0.	.014

* QUESTIONABLE DATA POINT.

- NO DATA POINT.

AVERAGE VELOCITY, U = 7.8 FT/SEC.

TABLE B-1 (CONT.), TABULATION OF EXPERIMENTAL DATA.

PLANE 5 1.25 INCHES DOWNSTREAM SPACER 2 INTERIOR MAP RUN 1110 - 1169

RUN	KEYNOLOS NUMBER	Z IN.	Y IN.	U FT/SEC	U/U*	U/U*	U/U*	V/U*	V/U*	CUTOFF KHZ	A/D	CURVE FIT F(HZ)
AG1110	101058.	.081	.620	13.3	.86	-	.058	-	-	1.00	-	-
AG1111	101058.	.148	.620	14.5	.93	-	.039	-	-	1.00	.11	0. .049
AG1112	101058.	.215	.620	14.7	.95	-	.042	-	-	1.00	-	-
AG1113	101058.	.282	.620	15.2	.98	-	.051	-	-	1.00	.19	2. .033
AG1114	101058.	.349	.620	15.5	1.00	-	.055	-	-	1.00	-	-
AG1115	101058.	.416	.620	15.4	.99	-	.050	-	-	1.00	.15	117. .028
AG1116	101058.	.483	.620	15.3	.98	-	.047	-	-	1.00	-	-
AG1117	101058.	.550	.620	14.8	.96	-	.048	-	-	1.00	.18	0. .025
AG1118	101058.	.617	.620	13.9	.90	-	.060	-	-	1.00	-	-
AG1119	101058.	.685	.620	12.4	.80	-	.067	-	-	1.00	.10	135. .010
AG1120	101058.	.752	.620	10.9	.70	-	.062	-	-	1.00	-	-
AG1121	101058.	.819	.620	10.7	.69	-	.055	-	-	1.00	.11	40. .025
AG1122	101058.	.886	.620	12.1	.76	-	.061	-	-	1.00	-	-
AG1123	101058.	.953	.620	14.1	.91	-	.058	-	-	1.00	.15	54. .026
AG1124	101058.	1.020	.620	15.4	.99	-	.049	-	-	1.00	-	-
AG1125	101058.	1.087	.620	15.9	1.02	-	.046	-	-	1.00	.16	0. .019
AG1126	101058.	1.154	.620	15.8	1.02	-	.050	-	-	1.00	-	-
AG1127	101058.	1.221	.620	15.7	1.01	-	.052	-	-	1.00	.21	0. .028
AG1128	101058.	1.289	.620	15.5	1.00	-	.054	-	-	1.00	-	-
AG1129	101058.	1.356	.620	15.2	.98	-	.051	-	-	1.00	.16	0. .014
AG1130	101058.	1.423	.620	15.1	.97	-	.046	-	-	1.00	-	-
AG1131	101058.	1.490	.620	15.8	1.02	-	.051	-	-	1.00	.16	0. .015
AG1132	101058.	1.557	.620	16.1	1.04	-	.052	-	-	1.00	-	-
AG1133	101058.	1.624	.620	16.3	1.03	-	.051	-	-	1.00	.22	35. .018
AG1134	101058.	1.691	.620	15.8	1.02	-	.051	-	-	1.00	-	-
AG1135	101058.	1.758	.620	15.6	1.01	-	.050	-	-	1.00	.21	56. .018
AG1136	101058.	1.825	.620	15.2	.98	-	.051	-	-	1.00	-	-
AG1137	101058.	1.893	.620	14.2	.91	-	.056	-	-	1.00	.14	0. .035
AG1138	101058.	1.960	.620	12.7	.82	-	.061	-	-	1.00	-	-
AG1139	101058.	2.027	.620	11.6	.74	-	.051	-	-	1.00	.09	128. .015
AG1140	101058.	2.027	.500	10.7	.69	-	.057	-	-	1.00	.09	0. .018
AG1141	101058.	1.960	.500	11.8	.76	-	.071	-	-	1.00	-	-
AG1142	101058.	1.893	.500	14.3	.90	-	.068	-	-	1.00	.19	0. .015
AG1143	101058.	1.825	.500	15.6	1.00	-	.050	-	-	1.00	-	-
AG1144	101058.	1.758	.500	15.9	1.03	-	.052	-	-	1.00	.21	0. .038
AG1145	101058.	1.691	.500	16.1	1.04	-	.054	-	-	1.00	-	-
AG1146	101058.	1.624	.500	16.4	1.06	-	.060	-	-	1.00	.18	0. .030
AG1147	101058.	1.557	.500	16.7	1.08	-	.056	-	-	1.00	-	-
AG1148	101058.	1.490	.500	16.3	1.03	-	.054	-	-	1.00	.15	0. .039
AG1149	101058.	1.423	.500	15.3	.99	-	.052	-	-	1.00	-	-
AG1150	101058.	1.356	.500	15.8	1.02	-	.057	-	-	1.00	.14	0. .033
AG1151	101058.	1.289	.500	16.2	1.04	-	.061	-	-	1.00	-	-
AG1152	101058.	1.221	.500	16.3	1.03	-	.060	-	-	1.00	.21	8. .017
AG1153	101058.	1.154	.500	16.3	1.03	-	.057	-	-	1.00	-	-
AG1154	101058.	1.087	.500	16.1	1.03	-	.050	-	-	1.00	.22	0. .011
AG1155	101058.	1.020	.500	15.8	1.02	-	.046	-	-	1.00	-	-
AG1156	101058.	.953	.500	14.7	.95	-	.055	-	-	1.00	.11	0. .040
AG1157	101058.	.886	.500	12.7	.82	-	.076	-	-	1.00	-	-
AG1158	101058.	.819	.500	10.3	.66	-	.074	-	-	1.00	.13	59. .012
AG1159	101058.	.752	.500	9.8	.63	-	.066	-	-	1.00	-	-
AG1160	101058.	.685	.500	11.6	.75	-	.081	-	-	1.00	.11	123. .013
AG1161	101058.	.617	.500	13.8	.89	-	.067	-	-	1.00	-	-
AG1162	101058.	.550	.500	15.2	.98	-	.051	-	-	1.00	.17	0. .040
AG1163	101058.	.483	.500	15.8	1.02	-	.048	-	-	1.00	-	-
AG1164	101058.	.416	.500	15.9	1.02	-	.053	-	-	1.00	.17	101. .021
AG1165	101058.	.349	.500	15.9	1.03	-	.056	-	-	1.00	-	-
AG1166	101058.	.282	.500	15.7	1.01	-	.055	-	-	1.00	.16	75. .023
AG1167	101058.	.215	.500	14.9	.96	-	.049	-	-	1.00	-	-
AG1168	101058.	.148	.500	14.3	.92	-	.040	-	-	1.00	.18	0. .040
AG1169	101058.	.081	.500	13.6	.87	-	.047	-	-	1.00	-	-

HYDRA LIC DIAMETER, D = .811 INCHES.

AVERAGE VELOCITY, U = 15.5 FT/SEC.

* QUESTIONABLE DATA POINT. - NO DATA POINT.

TABLE B-1 (CONT.). TABULATION OF EXPERIMENTAL DATA.
 PLANE 5 1.25 INCHES DOWNSTREAM SPACER 2 INTERIOR MAP RUN 1170 TO 1229

RUN	KEYNUMBER	Z	TN	Y	U	U/SEC	U/U	U/U	U/U	U/U	W/U	V/U	CUTOFF KHZ	W/D	CURVE FIT
Ag1170	101050	.081	.505	13.5	.87	-.043	-	-	-	-	-	-	1.00	.21	0.060
Ag1171	101050	.148	.505	14.4	.92	-.047	-	-	-	-	-	-	1.00	-	-
Ag1172	101050	.215	.505	15.6	1.00	-.059	-	-	-	-	-	-	1.00	-	-
Ag1173	101050	.282	.505	16.8	1.08	-.051	-	-	-	-	-	-	1.00	.14	0.014
Ag1174	101050	.349	.505	17.1	1.10	-.055	-	-	-	-	-	-	1.00	-	-
Ag1175	101050	.416	.505	17.0	1.10	-.048	-	-	-	-	-	-	1.00	.22	0.022
Ag1176	101050	.483	.505	16.6	1.07	-.044	-	-	-	-	-	-	1.00	-	-
Ag1177	101050	.550	.505	15.2	.98	-.057	-	-	-	-	-	-	1.00	.20	0.029
Ag1178	101050	.617	.505	12.7	.82	-.077	-	-	-	-	-	-	1.00	-	-
Ag1179	101050	.685	.505	9.9	.64	-.093	-	-	-	-	-	-	1.00	.16	.019
Ag1180	101050	.752	.505	7.1	.46	-.098	-	-	-	-	-	-	1.00	-	-
Ag1181	101050	.819	.505	7.7	.50	-.105	-	-	-	-	-	-	1.00	-	-
Ag1182	101050	.886	.505	13.7	.69	-.084	-	-	-	-	-	-	1.00	-	-
Ag1183	101050	.953	.505	13.7	.88	-.068	-	-	-	-	-	-	1.00	.12	0.022
Ag1184	101050	1.020	.505	15.9	1.02	-.054	-	-	-	-	-	-	1.00	-	-
Ag1185	101050	1.087	.505	16.8	1.08	-.050	-	-	-	-	-	-	1.00	.30	0.031
Ag1186	101050	1.154	.505	17.2	1.11	-.054	-	-	-	-	-	-	1.00	-	-
Ag1187	101050	1.221	.505	17.4	1.12	-.060	-	-	-	-	-	-	1.00	.17	0.021
Ag1188	101050	1.289	.505	17.5	1.13	-.054	-	-	-	-	-	-	1.00	-	-
Ag1189	101050	1.356	.505	16.6	1.07	-.061	-	-	-	-	-	-	1.00	.18	0.031
Ag1190	101050	1.423	.505	15.7	1.01	-.059	-	-	-	-	-	-	1.00	-	-
Ag1191	101050	1.490	.505	16.4	1.06	-.060	-	-	-	-	-	-	1.00	.24	0.034
Ag1192	101050	1.557	.505	17.3	1.12	-.051	-	-	-	-	-	-	1.00	-	-
Ag1193	101050	1.624	.505	17.5	1.12	-.051	-	-	-	-	-	-	1.00	.18	0.030
Ag1194	101050	1.691	.505	16.8	1.08	-.055	-	-	-	-	-	-	1.00	-	-
Ag1195	101050	1.758	.505	16.3	1.05	-.050	-	-	-	-	-	-	1.00	.34	0.042
Ag1196	101050	1.825	.505	14.8	.95	-.068	-	-	-	-	-	-	1.00	-	-
Ag1197	101050	1.893	.505	12.0	.77	-.089	-	-	-	-	-	-	1.00	.22	0.019
Ag1198	101050	1.960	.505	8.6	.56	-.107	-	-	-	-	-	-	1.00	-	-
Ag1199	101050	2.027	.505	6.8	.44	-.092	-	-	-	-	-	-	1.00	-	-
Ag1200	101050	2.004	.519	9.1	.59	-.066	-	-	-	-	-	-	1.00	-	-
Ag1201	101050	2.004	.539	13.2	.66	-.063	-	-	-	-	-	-	1.00	-	-
Ag1202	101050	2.004	.539	13.9	.70	-.058	-	-	-	-	-	-	1.00	-	-
Ag1203	101050	2.004	.599	11.4	.74	-.058	-	-	-	-	-	-	1.00	-	-
Ag1204	101050	2.004	.629	11.8	.76	-.058	-	-	-	-	-	-	1.00	-	-
Ag1205	101050	2.004	.639	12.1	.77	-.061	-	-	-	-	-	-	1.00	-	-
Ag1206	101050	2.004	.689	11.7	.75	-.061	-	-	-	-	-	-	1.00	-	-
Ag1207	101050	2.004	.719	10.9	.70	-.058	-	-	-	-	-	-	1.00	-	-
Ag1208	101050	2.004	.749	7.6	.49	-.082	-	-	-	-	-	-	1.00	-	-
Ag1209	101050	1.691	.749	18.0	1.16	-.052	-	-	-	-	-	-	3.00	-	-
Ag1210	101050	1.691	.719	17.9	1.16	-.051	-	-	-	-	-	-	3.00	-	-
Ag1211	101050	1.691	.689	17.3	1.11	-.057	-	-	-	-	-	-	3.00	-	-
Ag1212	101050	1.691	.659	16.4	1.06	-.060	-	-	-	-	-	-	3.00	-	-
Ag1213	101050	1.691	.629	15.8	1.01	-.055	-	-	-	-	-	-	3.00	-	-
Ag1214	101050	1.691	.599	15.5	1.00	-.053	-	-	-	-	-	-	3.00	-	-
Ag1215	101050	1.691	.569	15.8	1.02	-.055	-	-	-	-	-	-	3.00	-	-
Ag1216	101050	1.691	.539	16.4	1.06	-.058	-	-	-	-	-	-	3.00	-	-
Ag1217	101050	1.691	.509	17.0	1.10	-.056	-	-	-	-	-	-	3.00	-	-
Ag1218	101050	1.691	.479	17.3	1.10	-.057	-	-	-	-	-	-	10.00	-	-
Ag1219	101050	1.691	.449	15.6	1.01	-.057	-	-	-	-	-	-	7.00	-	-
Ag1220	101050	1.691	.419	15.6	1.01	-.055	-	-	-	-	-	-	4.00	-	-
Ag1221	101050	1.691	.389	15.6	1.01	-.054	-	-	-	-	-	-	3.00	-	-
Ag1222	101050	1.691	.359	15.6	1.01	-.052	-	-	-	-	-	-	2.00	-	-
Ag1223	101050	1.691	.329	15.6	1.01	-.049	-	-	-	-	-	-	1.00	-	-
Ag1224	101050	1.691	.299	15.6	1.01	-.045	-	-	-	-	-	-	.50	-	-
Ag1225	101050	1.691	.269	15.0	.97	-.051	-	-	-	-	-	-	3.00	.14	0.032
Ag1226	101050	1.154	.615	15.7	1.01	-.054	-	-	-	-	-	-	3.00	.20	0.026
Ag1227	101050	.819	.615	13.6	.69	-.061	-	-	-	-	-	-	3.00	.10	0.015
Ag1228	101050	.349	.615	15.4	.99	-.057	-	-	-	-	-	-	3.00	-	-
Ag1229	101050	.148	.615	14.4	.93	-.042	-	-	-	-	-	-	3.00	.18	0.031

* QUESTIONABLE DATA POINT. - NO DATA POINT. AVERAGE VELOCITY, U = 15.5 FT/SEC.

No. of
Copies

Offsite

- 1 AEC Advisory Committee for Reactor Safeguards
Washington, D. C.
M. C. Gaskr
- 1 AEC Chicago Patent Office, Washington, D. C.
A. A. Churm
- 7 AEC Directorate of Licensing, Washington, D. C.
E. G. Case (3)
V. Stello
T. Novak
D. Ross
G. M. Lauben
- 2 AEC Directorate of Reactor Standards, Washington, D. C.
- 1 AEC Office of Assistant General Counsel for Patents
Washington, D. C.
R. A. Anderson
- 2 AEC Technical Information Center
- 20 AEC Division of Reactor Development and Technology
Washington, D. C.
Assistant Director, Reactor Technology
Chief, Special Technology Branch
Chief, Reactor Physics Branch

Assistant Director, Reactor Engineering
Chief, Core Design Branch
Chief, Fuel Engineering Branch

Assistant Director, Nuclear Safety
Chief, Fast Reactor Safety Branch
Chief, Thermal Reactor Safety Branch
Chief, Analysis and Evaluation Branch

Assistant Director, Plant Engineering
Assistant Director, Program Analysis

<u>No. of Copies</u>	<u>Offsite</u>
	Chief, Water Projects Branch Chief, LMFBR Projects Branch E. Davidson F. Goldner R. Impara T. Speis R. M. Scroggins (2)
2	<u>Argonne National Laboratory</u> H. Fauske R. P. Stein
1	<u>Atomic Energy Commission</u> Brussels Office U. S. Mission to the European Communities APO, New York, N. Y. 09667
1	<u>Atomic Energy of Canada, Limited</u> Chalk River, Ontario, Canada G. A. Wikhammer
5	<u>Atomics International</u> P. O. Box 591, Canoga Park, California 91305 Louis Bernath Donald T. Eggan David C. Fulton H. Morowitz W. B. Wolfe
2	<u>Babcock and Wilcox Company</u> P. O. Box 1260 Lynchburg, Virginia 24502 R. E. Willard C. Morgan
2	<u>Babcock and Wilcox</u> Alliance Research Center 1562 Beeson Street Alliance, Ohio 44601 J. S. Gellerstadt G. D. Lindstrom

<u>No. of Copies</u>	<u>Offsite</u>
1	<u>Brookhaven National Laboratory</u> O. E. Dwyer
2	<u>Chicago Operations Office</u> Richard J. Bariboldi
1	<u>Columbia University</u> Department of Chemical Engineering J. E. Casterline
2	<u>Combustion Engineering, Inc.</u> F. Bevilacqua P. Zamola
1	<u>duPont Company, Wilmington, Delaware 19898</u> J. S. Neill
1	<u>Gulf-General Atomic</u> P.O. Box 608 San Diego 12, California 92112 R. Katz
1	<u>General Electric Company, San Jose (Trumbull)</u> BRDO, Sunnyvale, California P. Magee
4	<u>General Electric Company, San Jose</u> Earl Janssen R. T. Lahey S. Levy W. Sutherland
1	<u>Georgia Institute of Technology</u> Novak Zuber
2	<u>Idaho Nuclear, Inc.</u> Idaho Falls, Idaho C. Solbrig L. Ybarrando

<u>No. of Copies</u>	<u>Offsite</u>
2	<u>Exxon Nuclear Corp.</u> Bellevue, Washington L. P. Bupp G. A. Sofer
1	<u>Knolls Atomic Power Laboratory</u> General Electric Company Schenectady, New York G. H. Halsey
1	<u>Union Carbide Corporation (ORNL)</u> Floyd L. Culler
1	<u>Nuclear Fuel Services</u> Rockville, Md. R. T. Berringer
1	<u>Union Carbide Corp. (ORNL-Y-12)</u> M. Fontana H. W. Hoffman
1	<u>Gulf United Nuclear Fuels Corporation</u> Grasslands Road Elmsford, New York H. S. Chung
1	<u>University of Minnesota</u> Department of Chemical Engineering Minneapolis, Minnesota 55455 H. S. Isbin
1	<u>Westinghouse Bettis Atomic Power Laboratory</u> S. Green
2	<u>Westinghouse Electric Corporation</u> H. Chelemer L. S. Tong

<u>No. of Copies</u>	<u>Offsite</u>
2	<u>Westinghouse Electric Corporation</u> <u>Waltz Mill Site</u> P. O. Box 158 Madison, Pa. E. Novendstern R. Markley <u>Onsite-Hanford</u>
1	<u>AEC/RL Patent Attorney</u> R. M. Poteat
2	<u>AEC/RL-RDT Sr. Site Representative, PNP</u> F. Standerfer
58	<u>Battelle-Northwest</u> D. T. Aase R. T. Allemann N. E. Carter C. C. Chapman (5) P. D. Cohn D. L. Condotta J. C. Fox S. Goldsmith B. M. Johnson C. W. Lindenmeier T. I. McSweeney C. A. Oster L. T. Pedersen D. S. Rowe (30) A. M. Sutey D. S. Trent C. L. Wheeler W. C. Wolkenhauer F. R. Zaloudek Technical Information Files (5) Technical Publications (1)

<u>No. of Copies</u>	<u>Onsite-Hanford</u>
2	<u>United Nuclear Industries, Inc.</u> R. Shoemaker R. Baars
8	<u>Westinghouse-Hanford</u> W. M. Gajewski J. W. Hagan J. Muraoka R. E. Peterson J. M. Yatabe