WIND TUNNEL MODELING FOR GEP STACK HEIGHT ISLAND END COGENERATION PROJECT

Prepared by
David E. Neff
Hesham El-Badry

FINAL REPORT
(September 1991)

for

Cabot Power Corporation
200 State Street
Boston, Massachusetts 02109

FLUID MECHANICS AND WIND ENGINEERING PROGRAM

Colorado State University

CER91-92DEN-HEB3

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 REPORT SUMMARY

Cabot Power Corporation requested Dr. David Neff of Colorado State University to perform a wind tunnel measurement program designed to study "Good Engineering Practice" (GEP) stack height determination as defined by the Environmental Protection Agency (EPA) for the Island End Cogeneration Project. This fluid model assessed the effects of adjacent rounded structures (two LNG tanks and a cement silo) on the stack gas plume from a 235 MW gas-fired cogeneration facility. The original objectives of this fluid modeling study, as stipulated in the STUDY PROTOCOL document, were to:

1) *Determine whether these rounded structures cause "excessive concentrations" downwind of the desired 45.7 meter (150 foot) plant stack configuration. An excessive concentration is defined as a "maximum ground-level concentration monitored or modeled in the presence of nearby structures or terrain obstacles that is 40% or more, in excess of maximum ground-level concentration, monitored or modeled for the same orientation and stack parameters in the absence of downwash, wake or eddy effects produced by nearby structures or terrain."*

2) *If the 45.7 meter plant stack configuration produces "excessive concentrations" then determine the minimum stack height which does not produce "excessive concentrations."*

3) *Insure that all modeling is consistent with EPA requirements for wind tunnel testing including those provided in Guideline for Use of Fluid Modeling to Determine Good Engineering Practice Height (EPA-450/4-81-003, July, 1981), (EPA-FM-GEP Guideline hereafter).*

A 1:400 scale model of the Island End Cogeneration Project and surrounding features was constructed and tested in a wind tunnel facility. These tests, both visual and concentration measurements, covered three plant stack heights (45.7m, 61m, and 73.1m) and four wind directions (140°, 150°, 320°, and 325°). The results from these tests determined that:

1) **The 45.7 meter plant stack configuration did not satisfy the EPA GEP criteria.**

2) **The highest stack tested in this study, 73.1 meters, also did not satisfy the EPA GEP criteria.**

Because atmospheric dispersion modeling conducted by HMM Associates demonstrated compliance of ambient air quality standards with the 73.1 meter stack, further fluid testing was not necessary. Full documentation of the testing conducted on the three stack heights identified above is provided in this report.

The organization of major topics discussed in this report are as follows:

Section 2 The compliance of the model design with the similarity criteria stipulated in the EPA-FM-GEP Guideline.

Section 3 Wind tunnel testing program and results for the demonstration of atmospheric dispersion comparability as specified in the EPA-FM-GEP Guideline.

Wind Tunnel testing program and results documenting Reynolds number invariance of the model flow around the rounded LNG tanks and silo structures.

Wind Tunnel testing program and results documenting the three non-GEP stack heights tested.

Section 4 Discussion of the instrumentation and measurement methodologies used.

2 FLUID MODEL DESIGN

2.1 PROJECT DEFINITION AND SITE SPECIFICATION

The Island End Cogeneration Project proposes to build a 235 Megawatt gas fire powerplant at a site north of downtown Boston, Massachusetts; see Figure 1. The proposed plant stack is located ~200 meters to the southeast of two large round LNG tanks (~58 meters high) and ~100 meters to the northwest of a rounded silo complex (~42 meters high); see Figure 2. The plant turbine building is ~26 meters high. The proposed plant stack height of 45.7 meters is 1.7 times the height of the turbine building. Whenever there are high wind speeds (causing little plume rise) from the southeast or northwest it can be hypothesized that the plume interaction with the LNG tanks and/or silo complex may cause "excessive concentrations".

The EPA suggests the use of a fluid model to determine the GEP stack height necessary to avoid these "excessive concentrations" from rounded structures. This fluid model is a reduced scale representation of the plant site, topography and structures adjacent to the plant site, the atmospheric wind structure of interest approaching the site, and plant stack discharge characteristics. Proper scaling of this phenomena is achievable in a boundary layer wind tunnel test facility.

2.1.1 *Wind Direction Specifications*

The meteorological conditions for which "excessive concentrations" are mostly to occur have already been stated as high winds from the southeast or northwest. Observation of the line up of the plant stack and the silo complex/LNG tanks shows that the wind directions of 140°, 150°, 320°, and 325° should cover the worst case scenarios.

2.1.2 *Wind Speed Specifications*

The worst case design wind speed, as specified in the EPA-FM-GEP Guideline, is that speed at which the lowest plume rise will occur but not more than the speed that is exceeded less than 2 percent of the time (i.e., 98th percentile wind speed). Table 1 shows the wind speed and direction frequency table observed at the Logan Intl Airport in Boston, Massachusetts for the years 1965 through 1974. The EPA-FM-GEP guideline states that "A frequency distribution based on categories of specific design wind directions would only be appropriate if on-site meteorology is used." Since Logan Intl Airport can not be considered on-site, the total frequency of observations for all wind directions (bottom line in Table 1) is the appropriate design specification. The shaded values in Table 1 indicate the design values used for this study, i.e., 11.3 meters/second at a height of 6.7 meters.

2.1.3 *Wind Speed Variation with Height Specifications*

The variation of mean wind speed with height above the ground (referred to as the boundary layer) at the study site is deduced from empirical equations known to correlate atmospheric data. The EPA-FM-GEP Guideline states that for heights up 100 meters the log-linear velocity profile relationship be used:

$U/u_* = 2.5*\ln[(z-d)/z_o]$; where

u_* ≡ friction velocity,

d ≡ displacement height,

z_o ≡ roughness length.

Table 1 in the EPA-FM-GEP Guideline lists suggested values of the roughness length for various types of ground cover. This Table indicates that for all wind direction of interest (140°,150°,320°,325°) that a roughness length of 0.5 meters is an appropriate value. The displacement height is estimated from Equation 6 in the EPA-FM-GEP Guideline: $d = H-z_o/2.5$; where H = the general roof-top level.

The mean velocity through the entire depth of the boundary layer (which the Guideline states to be 600 meters) is represented by the power law equation:

$U/U_\infty = (z/\delta)^p$; where

U ≡ mean wind speed at height z,

U_∞ ≡ wind speed at boundary layer height δ,

δ ≡ boundary layer height = 600 meters

p ≡ power law index.

The EPA-FM-GEP Guideline suggests that the power law index be estimated from the equation $p = 0.24+0.096*\log_{10}(z_o)+0.016*[\log_{10}(z_o)]^2$. For a study site roughness length value of 0.5 meters, the power law index equals 0.213. Given that U = 11.3 m/s at z = 6.7 m and solving the power law equation for U_∞ yields U_∞ = 29.4 m/s. Again using the power law equation but this time solving for the design wind speed at the design stack height of 45.7 meters yields U = 17 m/s.

2.1.4 *Plant Stack Parameter Specifications*

The proposed plant stack is a straight, steel stack with an internal diameter of 5.79 meters. The Air Quality Modeling Protocol done by HMM Associates, Inc. found that the worst case air pollution scenario was for fuel oil combustion. The stack gas exit velocity and temperature for this situation was reported as 20.4 m/s and 135°C respectively. This stack gas exit temperature coupled with an annual mean temperature in the Boston area of 10.8°C indicates that the stack gas specific gravity is 0.696.

2.1.5 *Study Area Downwind Extent Estimates*

The EPA-FM-GEP Guideline requires that the study area be of sufficient downwind extent such that the maximum ground level concentration be clearly resolved. Estimation of this downwind distance can be made using a Pasquill-Gifford (PG) elevated point source dispersion model (Turner, 1970). The maximum downwind distance is found using the highest expected stack height, 73.1 meters, and dispersion category D in the PG empirical model. Table 2 displays ground level normalized concentration, $\chi U_H/Q$ [m^{-2}], estimates for these conditions. The distance to the maximum concentration value is 1400 meters. A study area downwind extent of 2000 meters should be sufficient to satisfy all Guideline requirements.

2.1.6 *Summary of Prototype Specifications*

The following list summarizes important field scale site specifications that are needed for model scale test design:

1)	Wind Directions	140°,150°,320°,325°,
2)	Wind Speed at Design Stack Height	17 meters/second,
3)	Wind Profile Roughness Length	0.5 meters,
4)	Wind Profile Displacement Height	0.0 meters,
5)	Wind Profile Power Law Index	0.213,
6)	Plant Stack Inside Diameter	5.79 meters,
7)	Stack Gas Exit Velocity	20.4 meters/second,
8)	Stack Gas Specific Gravity	0.696,
9)	Downwind Extent of Study Area	2000 meters.

2.2 OVERVIEW OF EPA GUIDELINE SIMILARITY REQUIREMENTS

Snyder (1981) discusses in general terms the scaling techniques for a wide range of atmospheric diffusion problems. The EPA-FM-GEP Guideline specifically states the fluid modeling requirements for GEP stack height determination studies. This fluid model is in complete compliance with the EPA-FM-GEP Guideline. The major modeling requirements specified in the EPA-FM-GEP Guideline are summarized in the following list:

(1) The roughness Reynolds number, $u_* z_o/\nu$, characterizing the turbulent structure of the model boundary layer should be greater than 2.5.

(2) The model should be covered with roughness of size ϵ such that $\epsilon u_*/\nu > 20$.

(3) The fluid model stack effluent Reynolds number, $W_s D/\nu$, should be greater than 2,000.

(4) The model plume rise, dominated by the momentum length scale, should be match to the field plume rise by maintaining equality of the plume velocity ratio, W_s/U_s, the plume specific gravity, ρ_s/ρ_a, and stack geometric similarity, D/H_s.

(5) The design wind speed should near that of the 98th percentile wind speed expected at the site. Wind direction weighted frequencies are permissible only if on site meteorology is used.

(6) The model boundary layer's roughness length, z_o, friction velocity, u_*, and power law index, p, should be representative of the expected field conditions as stipulated in the EPA-FM-GEP Guideline's Table 1 and Figure 1.

(7) The flow over significant nearby structures and terrain should be Reynolds number independent. For sharp edged obstacles an object Reynolds number, $U_H H/\nu$, greater than 11,000 is sufficient. For any obstacles with an Re # < 11,000 or for any smooth shaped obstacles an Re # independence test must be performed.

(8) All structures and terrain features with heights greater than 1/20 the distance to the plant stack should be included in the geometrically scaled model.

(9) The flow blockage of the model in an adjustable roof wind tunnel should be less than 10 percent.

(10) The model boundary layer should be characteristic of Pasquill-Gifford C to D stability category with a field equivalent boundary layer height of 600 m.

2.3 MODEL SIMILARITY CRITERIA COMPLIANCE

To satisfy the EPA-FM-GEP similarity requirements for a fluid model of the Island End Cogeneration Project the following model design parameters were selected:

a)	Model to Field Length Scale Ratio	=	1:400
b)	Generic Model Surface Roughness, ϵ	≈	0.15 cm
c)	Model Roughness Length, z_o	≈	0.125 cm
d)	Site Power Law Index, p	≈	0.213
e)	Model Boundary Layer Height, δ	≈	150 cm
f)	Model Wind Speed at stack height	=	250 cm/s
g)	Model Stack Effluent Velocity	=	300 cm/s
h)	Model Stack Effluent Specific Gravity	=	0.696

Table 3, Parameter Chart for Model Scale Selection, details all pertinent scaled parameters and scaling criteria for both the full scale input data and several different possible model scales including the selected model scale of 1:400. The model wind speed at stack height in this table was set to 250 cm/s so that tests for Reynolds numbers invariance (at twice this wind speed) could be obtained in the selected wind tunnel testing facility.

Table 4, GEP Test Parameters, represents the information in Table 3 but for only the selected model scale, 1:400. These model test parameters satisfy many of the EPA-FM-GEP Guideline requirements mentioned in the previous section, i.e.:

Requirement
Number ↓

(1) Roughness RE# ($u_* z_o/\nu$) = 18.3 is greater than 2.5,
(2) Generic Roughness RE# ($u_* \epsilon/\nu$) = 21.9 is greater than 20,
(3) Stack Gas RE# = 2,895 is greater than 2,000,
(4) Velocity Ratio W/U = 1.2 is equal to field value,
(4) Stack Gas Specific Gravity = 0.696 is equal to field value,
(4) All length dimensions are scaled equally, 1:400,
(5) The design wind speed is representative of field values near to the 98th percentile,
(6) All model boundary layer characteristics are representative of field values,
(7) Turbine Building RE# is slightly less than 11,000,
(7) Measurements must be made to verify Reynolds number invariance around rounded structures (these tests are discussed in chapter 3.2 on Reynolds Number Invariance Verification Tests),
(8) The required site structures are reproduced at model scale and are discussed further in the next section on model construction,
(9) Wind tunnel blockage is less than 10 percent and is discussed further in a subsequent section on wind tunnel configuration,
(10) The equivalent wind tunnel dispersion category is the subject of the Atmospheric Dispersion Comparability Tests described in the next chapter.

2.4 MODEL CONSTRUCTION AND COVERAGE

Based on atmospheric data over the Boston area, the size of the concentration measurement grid, and modeling constraints discussed in earlier sections, a model scale of 1:400 was selected. The Environmental Wind Tunnel test facility has a width of 3.66 meters. This allows for the reduced scale construction of all significant buildings within a 730 meter radius of the plant stack. The tunnel test section extends 5 meters downwind of this stack location thus providing for scaled concentration measurements out to 2000 meters. The location of the Island End Cogeneration site along with a circle demarking the portion of the Project area replicated is shown in Figure 1.

The buildings surrounding the plant stack were fabricated from masonite and/or styrofoam and placed in their appropriate locations on a 3.6 meter diameter, 0.63 cm thick masonite sheet. All roads and waterways were painted on this masonite sheet. Modeled upwind and downwind structural and terrain features were also fabricated if their heights exceed 1/20th the distance to the plant stack. Figure 2 shows the location of the different site structures and their associated heights. The topography changes within the modeled area are mostly insignificant except for one small hill located 700 meters from the plant stack at a direction of 100° from north. Modeled topography representative of this hill was included as a removable section on the model. The two LNG tanks, the cement silo structure and the project buildings were all designed for easy removal. Figure 3 is a picture of the model site area in close to the powerplant. Figure 4 is a picture of the model site area and surrounding structures.

Four different plant stacks (equivalent to 45.7 m, 61 m, 73.1 m, 100 m) were constructed from brass tubing stock. Both the inside and outside of these model stacks were coated with sand roughness to ensure fully turbulent flow. An orifice, one-half the inside diameter, was placed in the base of each stack to initiate turbulent flow. The 100 meter model stack is for use in the atmospheric dispersion comparability test program. Model roughness elements of 0.15 cm were added to the rounded exterior surfaces of the LNG and silo structures to improve Reynolds number invariance performance, as specified in the GEP standards. Roughness elements of 0.15 cm were spread over all model ground level surfaces to ensure proper Reynolds number performances.

2.5 BOUNDARY LAYER WIND TUNNEL CONFIGURATION

All model tests were performed in the Environmental Wind Tunnel (EWT) test facility at Colorado State University (CSU). This tunnel has a 3.66 m by 2.13 m cross-section, a 17.4 m length, a wind speed range of 0 to 13 m/s and a flexible test section roof. A description of this facility is provided in Appendix D.2 and a facility drawing is provided in Figure A-2. Appropriate boundary layer development techniques were utilized to accurately represent wind conditions approaching the plant stack from the 140° and 320° wind directions. The 140° wind direction studies the plant stack plume when the silo structure is directly upwind and the LNG tanks are directly downwind. The 320° wind direction studies the opposite effects, i.e. when the LNG tanks are upwind and the silo structure is downwind. The Island End Cogeneration Project model stack was placed six meters from the end of the EWT's test section. This placement provides sufficient upwind fetch and a sufficient downwind measurement zone. The zones upwind and downwind of the turntable area were modeled with a generic roughness design (chain rows every 15 cm) to create the desired model boundary layer.

3 TEST PROGRAM

The original goals of the test program were to determine and fully document the GEP stack height for the Island End Cogeneration Project in complete compliance with the EPA-FM-GEP Guideline. Table 7 Field Test Conditions, lists the field conditions for each type of data test to be performed in this original specification. Table 8 Model Test Conditions, details the model conditions for each type of these data tests. Upon determination in this test program that the GEP stack height would be greater than 73.1 meters the decision was made to suspend all further testing. The shaded areas in these tables designate those tests which were not performed in the present test program.

3.1 ATMOSPHERIC DISPERSION COMPARABILITY TESTS

3.1.1 *Overview of EPA Guideline Requirements*

The EPA-FM-GEP Guideline requires that the wind tunnel testing facility demonstrate atmospheric dispersion comparability by acquiring and documenting a set of velocity and concentration profiles on a standardized stack plume released into a standardized model boundary layer. The EPA-FM-GEP Guideline similarity requirements for these atmospheric dispersion comparability tests (ADCT) are summarized below:

(1) All ADCT length scaling (stack height, study area distances, boundary layer height and roughness length, etc.) should be at the same ratio, 1:400, as for the GEP model tests,

(2) The ADCT flow velocity should match the GEP model design flow velocity at the proposed stack height; i.e., 250 cm/s at H = 45.7m/400 = 11.4 cm,

(3) The ADCT stack is to be the field equivalent of 100 meters high with an inside diameter of 5 meters and is placed at the same location within the test facility as the GEP stack tests,

(4) The ADCT wind boundary layer is represented by a characteristic roughness length, z_o, of less than 0.2 meters,

(5) The ADCT stack gas exit velocity is to be 1.5 times the ADCT wind speed at the stack top.

The EPA-FM-GEP Guideline requires that the following ADCT data be acquired and documented:

(6) Vertical profiles of mean velocity, longitudinal turbulent intensity, vertical turbulent intensity and Reynolds stress at the stack location, at the end of the planned study area (prototype 2 km downwind) and midway between these two locations,

(7) Lateral profiles of mean velocity and longitudinal turbulent intensity at three elevations (prototype 25 m, 45.7m, 100 m) near the stack and at three elevations (prototype 25 m, 45.7m, 100 m) at the end of the study area (prototype 2 km downwind),

(8) Vertical and lateral mean concentration profiles through the plume centerline at quarter intervals between the stack and the end of study area (prototype 0.5 km, 1.0 km and 1.5 km),

(9) Ground level longitudinal concentration profile through the ground level plume centerline with lateral points verifying location of ground level plume centerline.

The EPA-FM-GEP Guideline requires that the following ADCT data be analyzed:

(10) The velocity profiles are to be regressed upon to determine their power law index, roughness length, and friction velocity. These values are to be compared to the expected atmospheric values for this site.

(11) The concentration data are to be converted to the equivalent field values of $\chi U_H/Q$ [m^{-2}] and compared to estimates from the Pasquill-Gifford diffusion categories C and D.

(12) The measured model plume rise is to be compared to estimates from the EPA-FM-GEP Guidelines suggested model.

3.1.2 *Similarity Criteria Compliance*

The ADCT model scale and flow velocity were set to equal that of the site model test program, i.e. scale of 1:400 and U_H = 250 cm/s (where H = 45.7m/400 = 11.4cm). The ADCT boundary layer roughness length, z_o < 0.2 meters, is different from the GEP test program, thus different boundary layer development techniques were employed. The model stack represents a field stack of 100 m height and 5 m inside diameter, i.e. 25 cm high with I.D. = 1.25 cm. This stack was placed at the same location in the wind tunnel as that used in the main test program. A neutrally buoyant stack gas (100% ethane) was released at a flow rate such that the exhaust velocity was 1.5 times the mean velocity at the stack top. Table 6, Atmospheric Dispersion Comparability Test Parameters, lists the different prototype and model parameter values for this atmospheric dispersion comparability test program. This table shows that all of the required Guideline similarity criteria are satisfied.

3.1.3 *Wind Profile Measurements*

The field scale specifications for the EPA-FM-GEP ADCT velocity profile requirements are listed in Table 7. The model scale specifications are listed in Table 8. The lateral profiles were determined from abbreviated vertical velocity profiles at each of the required test positions and thus no run numbers and file names are included in this portion of these tables. Table 9 presents model, normalized, and field values of the average of the three tunnel centerline wind profiles, one at the stack location (X_m = 0 cm), one at the end of the study area (X_m = 500 cm), and one at half way between these two (X_m = 250 cm).

The averaged profile, mentioned in the previous paragraph, was examined to determine the following model boundary layer similarity parameters; the roughness length, the displacement height, the friction velocity, and the power law index. The top graph in Figure 5 displays the test data as symbols and the design power law curve (index = 0.18, see Table 6) as a line. This graph shows that the model profile is representative of the field design power law index value of 0.18. The middle graph in Figure 5 displays the mean velocity profile test data and the design log-lin law on log-lin coordinates. This graph shows that the model profile is representative of the field design values of roughness length equal to 0.2 meters, friction velocity equal to 1.25 meters/second, and a displacement height of 0.0 meters. The bottom graph in Figure 5 displays the longitudinal turbulent intensity profile test data and the EPA-FM-GEP suggested design curve. The EPA-FM-GEP Guideline states that a model turbulent intensity greater than this curve maybe too turbulent of a condition. The measured test data is slightly less turbulent than the suggested curve and thus complies with the Guidelines specifications.

Table 10 presents model, normalized and field values of the three tunnel centerline wind profiles, one at the stack location (X_m = 0 cm), one at the end of the study area (X_m = 500 cm), and one at half way between these two (X_m = 250 cm). The field values of mean velocity, longitudinal, and vertical turbulent intensity for all three locations are presented in the graphs in Figure 6. The consistency in profile shape between these three measurement locations is demonstrated.

Vertical velocity profiles of four heights each (Z_f = 10, 25, 43.7, 100 meters) were taken at six different crosswind positions (Y_f = ±360, ±240, ±120 meters) and two different downwind positions (X_f = 0, 2000 meters) to test the flow uniformity of the wind tunnel. These mean velocity and turbulent intensity data along with the appropriate height data from the tunnel centerline velocity profiles (Y_f = 0 meters) are presented in Table 11. Graphs of the lateral mean velocity and lateral turbulent intensity profiles for both downwind distances and for the heights of 6.3 cm model (43.7 meters field) and 25 cm model (100 meters field) are presented in Figure 7. Here again it is seen that the wind tunnel uniformity is within the bounds of acceptability.

3.1.4 *Stack Plume Visualization*

Visualization of the atmospheric dispersion comparability stack plume was documented on the video cassette VHS tape and included with this report in Appendix A. The specifications for this test is listed in Table 7 for field conditions and Table 8 for model conditions. The camera position for this film sequence was directly outside the wind tunnel from the model stack at a height slightly above model ground level. The film test observes the plume trajectories from the model stack down to the end of the model turntable, approximately 730 meters field equivalent distance, and zooms in on the stack to document downwash and near stack plume rise characteristics.

The EPA-FM-GEP Guideline states that for the conditions of this test there should be little stack downwash and low plume rise. The ADCT plume visualization shows that the model plume had little stack downwash and low plume rise.

3.1.5 *Concentration Measurements*

The specifications for these tests are listed in Table 7 for field conditions and Table 8 for model conditions. Seven concentration profiles of the test plume were measured, lateral and vertical profiles at field downwind distances of 500, 1000, and 1500 meters and a ground level profile with additional off-centerline line points. Table 12 through Table 18 lists for each of these concentration profiles field and model sample positions, measured model concentrations in both ppm, χ, and normalized model concentrations, $K_m = \chi U_m/Q_m$ [cm^{-2}], the equivalent field normalized concentration, K_f, and Pasquill-Gifford estimates of K_f for both dispersion categories C and D. Figure 8 through Figure 14 display plots of each concentration profile for the measured test data converted to field equivalent normalized concentrations and the Pasquill-Gifford dispersion estimates for both stability categories C and D.

The EPA-FM-GEP Guideline desires that the ADCT plume be representative of plume dispersion between Pasquill-Gifford dispersion categories C and D and it requires that the ADCT plume not be more stable then estimates based on dispersion category D. Observation of the test data with respect to the PG dispersion estimates for categories C and D in Figure 8 through Figure 14 for the vertical and lateral plume centerline profiles out to 1500 meters shows that the test plume meets the EPA requirements. The test data ground level concentration profile shown in Figure 14 stays between dispersion classes C and D out to 1500 meters. At distances greater than 1500 meters the test data display greater ground level concentrations than dispersion class C indicates and much greater than dispersion class D indicates. This behavior of being outside of the specification on the unstable side is considered "not critical" in the EPA-FM-GEP Guideline.

3.2 REYNOLDS NUMBER INDEPENDENCE VERIFICATION TESTS

3.2.1 *Test Specifications*

The GEP standards require that Reynolds number (Re) invariance of the concentration field be demonstrated when significant structures have rounded surfaces. The LNG tanks and silo structures are rounded. The method for demonstration of Reynolds number invariance is to measure the ground level longitudinal concentration distribution from a passive (non-buoyant with no release momentum) tracer gas released at the location of the plant stack at the height of the rounded shape in question. This test is done for two different free stream velocities, the higher one being at least twice that of the lower one. When these concentration profiles are normalized by the form $\chi U_\infty / Q$ [m^{-2}] their differences should not be greater than 10 percent. If they are greater than 10 percent then the design velocity, the lower of the two, should be increased and the Re independence tests redone.

Table 5 GEP Reynolds Number Invariance Test Parameters, lists the different prototype and model parameter values for these Reynolds number independence tests. Table 7 Field Test Conditions, details the field conditions for each type of data test performed in this test series. Table 8 Model Test Conditions, details the model conditions for each type of data test to be performed in this test series.

As noted in Table 7 and Table 8, the Reynolds number invariance tests are done for two different wind directions, 140° and 325°. At the 140° wind direction the height of a passively released tracer gas was the height of the LNG tank (approximately 61 meters). At the 325° wind direction the height of a passively released tracer gas is the height of the silo structure (approximately 45.7 meters). The passive releasing scheme was to introduce a tracer gas of specific gravity 1.0 through a tube pointing downwind at the appropriate height with an exit velocity near that of the local wind velocity.

3.2.2 *Wind Profile Measurements*

As specified in Table 7 and Table 8 of the field and model test conditions respectively, there were velocity profiles taken at two wind speeds (at design speed and at twice design speed) and two wind directions (140° and 325°), four profiles total in this test series. All four of these profiles were taken at the stack location with the model power plant removed but with the LNG tanks and silo structures present. The data for the 140° wind direction tests are listed in Table 19 and plotted in Figure 15. The data for the 325° tests are listed in Table 20 and plotted in Figure 16. These figures demonstrate that a change in Reynolds number by a factor of two produced no significant change in the shape of the wind tunnel mean velocity and turbulent intensity profiles for both wind directions tested.

3.2.3 *Concentration Measurements*

The concentration results for the Reynolds number invariance tests are listed in Table 21 for the 140° wind direction and in Table 22 for the 325° wind direction. These tables list both model and field distances to concentration measurement locations, the model reference velocity and flow rate used to calculate normalized field concentrations, normalized field concentrations, and the percent difference between the design Reynolds number concentration values and the higher Reynolds number concentration values. Both tables show that the design Reynolds number test results are within the desired ±10 percent of the test results at higher Reynolds numbers.

3.3 GEP STACK HEIGHT DETERMINATION TESTS

Table 4 GEP Test Parameters, lists the different prototype and model parameter values for all these tests. Table 7 Field Test Conditions, details the field conditions for each type of data test performed in each test series. Table 8 Model Test Conditions, details the model conditions for each type of data test performed in each test series.

In Table 7 and Table 8, under the heading of "Building Config.", Out refers to the removal of all significant structures that may alter the stack plume dispersion, i.e. the LNG tanks, the silo and the proposed site buildings, In refers to the inclusion of the LNG tanks and silo structure but not any proposed site buildings, In all refers to the inclusion of the LNG tanks, silo structure and all proposed site buildings. The 45.7 meter stack is documented with both visual observations and concentration data for one wind direction (140°) and all three building configurations. The 61 and 73.1 meter stacks are documented with both visual observations and concentration data for four wind directions (140°, 150°, 320°, 325°) and two building configurations (Out and In). There was a total of nineteen different run conditions studied.

3.3.1 *Wind Profiles Measurements*

The field and model scale specifications for the EPA-FM-GEP Guidelines GEP documentation of velocity profiles are listed in the shaded portions (not performed due to project redefinition) of Table 7 and Table 8 respectively. To document the GEP stack height determination test series an upwind tunnel centerline wind profile was measured. Table 23 presents model, normalized, and field equivalent values for this profile. This profile was examined to determine the following model boundary layer similarity parameters; the roughness length, the displacement height, the friction velocity, and the power law index. The top graph in Figure 17 displays the test data as symbols and the design power law curve (index = 0.21, see Table 4) as a line. This graph shows that the model profile is representative of the field design power law index value of 0.21. The middle graph in Figure 17 displays the mean velocity profile test data and the design log-lin law on log-lin coordinates. This graph shows that the model profile is representative of the field design values of roughness length equal to 0.5 meters, friction velocity equal to 1.49 meters/second, and a displacement height of 0.0 meters. The bottom graph in Figure 17 displays the longitudinal turbulent intensity profile test data and the EPA-FM-GEP suggested design curve. The EPA-FM-GEP Guideline states that a model turbulent intensity greater than this curve maybe too turbulent of a condition. The measured test data is slightly less turbulent than the suggested curve and thus complies with the Guidelines specifications.

3.3.2 *Stack Plume Visualization*

Visualization of the model plant stack plume for the nineteen tests (Vis. Run # 1 to 19) listed in Table 7 for field conditions and Table 8 for model conditions were documented on the video cassette VHS tape included with this report in Appendix A. Table 24 GEP Visual Test Results, lists the run conditions for each of these tests including the equivalent concentration run number and comments describing stack downwash, LNG tank impingement, LNG tank downwash, Silo impingement, and Silo downwash. The camera position for these film sequences was directly outside the wind tunnel from the plant stack at a height slightly above model ground level. Each film test observes the plume trajectories from the plant stack down to the end of the model turntable, approximately 730 meters field equivalent distance, and zooms in on the downwind structure (LNG tanks or Silo) to document impingement and downwash.

The visualization shows that for all stack heights (45.7, 61, 73.1 meters) and both wind directions toward the LNG tanks (140° and 150°), LNG tank impingement and LNG tank downwash were very noticeable. The wind directions (320° and 325°) with the silo complex downwind showed much less plume impingement on the silo as compared to the LNG tanks. For the 73.1 meter stack no impingement on the silo structure was observed but plume downwash behind the silo was still present. With the silo downwind the plume appears to be more affected by descending streamlines as the result of the upwind LNG tanks than by silo structure downwash.

3.3.3 *Concentration Measurements*

Concentration measurements downwind of the model plant stack were measured for the nineteen tests (Conc. Run # 20 to 39, excluding #23) listed in Table 7 for field conditions and Table 8 for model conditions. Table 25 through Table 27 GEP Concentration Test Results, lists the run conditions, the equivalent visualization run number, the model and field position of the concentration measurements, and the field normalized concentrations for stack heights 45.7, 61, and 73.1 meters respectively. All the sample locations presented here were at ground level.

Table 25 through Table 27 GEP Concentration Test Results also present the maximum ground level concentration observed in each test and the percent increase in this maximum ground level concentration between the runs with no buildings versus ones with buildings present. The influence of the LNG tanks and silo complex are seen to increase maximum ground level plume concentrations by 82 percent to 303 percent depending on stack height and wind direction conditions. The EPA-FM-GEP Guideline defines any concentrations greater than 40 percent as excessive. Thus all stacks and wind directions tested produced "excessive concentrations."

4 INSTRUMENTATION AND MEASUREMENT METHODOLOGY

Laboratory measurement techniques are discussed in this section, along with conversion methods used to convert measured model quantities to their meaningful field equivalents.

4.1 VELOCITY MEASUREMENT AND PRESENTATION

The techniques employed in the acquisition of velocity profiles are discussed in detail in Appendix D.3 including basic equations and errors associated with each technique. Single-hot-film (TSI 1220 Sensor), cross-film (TSI 1241) probes and pitot-static probes are used to measure velocity statistics. TSI 1125 Velocity Calibrator System and Pitot-static Probes are used for velocity calibration.

The approach mean velocity and turbulent statistics profiles are obtained from velocity measurement techniques. The approach mean velocity profiles for a suburban roughness condition are regressed to find the best log-log and log-linear fit. The log-log regression will find a power law exponent, p, such that $U/U_r = (z/z_r)^p$. The log-linear regression ($U/u_* = 2.5\ln\{(z-d)/z_o\}$) will find a best fit roughness length z_o, friction velocity u_*, and displacement height d.

Velocity measurements obtained in this study are summarized and presented through plots of vertical profiles of mean velocity, longitudinal and vertical turbulence intensity, and Reynolds stress. The height and velocity coordinates are normalized by a model reference height and the model velocity at the reference height. Since a neutral boundary layer's velocity is invariant with respect to wind speed, the normalized profiles can be converted to any field velocity at a specific height by the appropriate multiplicative constant. Each of the vertical profiles of mean velocity are plotted on linear-linear and log-linear paper to display the best fit regressions.

4.2 PLUME VISUALIZATION TECHNIQUES

Techniques employed to obtain a visible plume are discussed in Appendix D.4. A Smoke Generator System and a Video Camera System are used for plume visualization. Given a field to model wind speed ratio of 6.8 (= [17 m/s]/[2.5 m/s]) and a model to field length scale ratio of 400, then the time scale ratio between the model and the field is 1:58.8. Thus phenomena observed over the model in the wind tunnel will occur 58.8 times faster than observed at full scale. If the TV tapes were replayed in slow motion (58.8 times slower than the recorded speed) the observed plume trajectories and motions would appear realistic.

4.3 CONCENTRATION MEASUREMENT AND PRESENTATION

Techniques employed to obtain the concentration data are discussed in Appendix D.5. A gas chromatograph with flame ionization detector is used to measure gas concentrations. Figure A-5 shows a schematic of stack gas release, sampling, and analyzing methodology.

Concentration data are reported in terms of field scale normalized concentration, K_p, where $K_p = (\chi U_H/Q)_p$ $[m^{-2}]$. This normalized format is convenient because the concentration results, χ_p $[gm/m^3]$, from a test at one particular combination of wind speed, $(U_H)_p$ [m/s], and source mass flow rate, Q_p [gm/sec], can be extrapolated to other $(U_H)_p$ and Q_p values provided that flow physics, such as plume rise, remains the same. $(U_H)_p$ is the field wind speed at the stack height. The conversion from model units to field units is as follows:

$K_p = K_m*(H_m/H_p)^2$ $[m^{-2}]$; with $K_m = (\chi U_H/Q)_m$ $[cm^{-2}]$.
χ_m is the source normalized model concentration (ppm/10^6ppm),
$(U_H)_m$ [cm/s] is model wind speed at stack height,
Q_m [ccs] is the model stack flow rate,
H_m [cm] is the model stack height, and
H_p [m] is the field stack height.

4.4 STACK FLOW RATE AND COMPOSITION TECHNIQUES

An Omega mass flow controlling system was used to monitor and control all stack gas flow settings. This system has four mass flow channels with full scale responses of 0.1, 1, 10, and 100 SLPM for gases with unity gas factors. Different gases will have different gas factors and this must be taken into account when calculating the proper meter setting. The local atmospheric pressure ($\sim$630 mmHg at CSU) must also be accounted for in these calculations.

During a visual plume test the proper plume flow rate and specific gravity would be attained by mixing metered quantities of Air (SG = 1) and Helium (SG = 0.14) or Argon (SG = 1.38). This gas mixture is then pass through the smoke generator and then out the model stack. During a plume concentration test a hydrocarbon gas must be in the source mixture so that measurements of sample concentration can be made with a flame ionization type gas chromatograph. Depending upon many experimental considerations, a hydrocarbon, either methane (SG = 0.55), ethane (SG = 1.04), or propane (SG = 1.52) will be mixed with Helium (SG = 0.14), Nitrogen (SG = 0.967), or Argon (SG = 1.38). This mixture is passed directly into the model stack.

Table 28 Stack Gas Flow Settings and Composition, lists the settings and type of gas used to achieve the proper model stack effluent discharge velocities and specific gravities. A spreadsheet of these calculations for the ADCT tests is provided in Table 29. A spreadsheet of these calculations for the GEP tests is provided in Table 30. The double underlined values were used in the tests.

REFERENCES

Environmental Protection Agency, 1981: Guideline for Use of Fluid Modeling to Determine Good Engineering Practice Height, EPA-450/4-81-003, Research Triangle Park, North Carolina.

Snyder, W. H., 1981: Guideline for Fluid Modeling of Atmospheric Diffusion. EPA-600/8-81-009, Research Triangle Park, North Carolina.

Turner, D. B., 1970: Workbook of Atmospheric Dispersion Estimates. Publication No. AP-26, Office of Air Programs, Environmental Protection Agency, Research Triangle Park, North Carolina.

TABLES

T-2

WIND DIRECTION VS. WIND SPEED (PERCENT FREQUENCY OF OBSERVATIONS) -- ALL WEATHER {WINDFREQ.WK3}

WIND DIRECTION		WIND SPEED (KNOTS) at 6.7 meters height									TOTAL FREQ.	AVERAGE WIND SPEED	
		0–3	4–6	7–10	11–16	17–21	22–27	28–33	34–40	> 40			
		WIND SPEED (M/S) at 6.7 meters height											
	(deg)	0–1.5	2.1–3.1	3.6–5.1	5.7–8.2	8.7–10.8	11.3–13.9	14.4–17	17.5–20.6	>20.6	(%)	(knots)	(m/s)
N	0.0	0.3	1.4	3.0	2.2	0.4	0.1	0.0			7.4	9.8	5.0
NNE	22.5	0.2	0.8	0.9	0.7	0.2	0.1	0.0			2.9	9.5	4.9
NE	45.0	0.2	0.5	1.1	1.0	0.3	0.2	0.0	0.0	0.0	3.2	11.2	5.8
ENE	67.5	0.1	0.7	1.2	1.1	0.3	0.1	0.0	0.0		3.6	10.5	5.4
E	90.0	0.3	1.0	2.4	2.3	0.3	0.1	0.0	0.0		6.6	10.3	5.3
ESE	112.5	0.3	0.9	1.9	1.9	0.3	0.0		0.0		5.3	9.8	5.0
SE	135.0	0.2	1.0	1.6	0.6	0.0	0.0	0.0	0.0		3.5	8.1	4.2
SSE	157.5	0.2	0.8	1.1	0.4	0.0	0.0	0.0			2.5	7.8	4.0
S	180.0	0.3	1.6	3.0	1.8	0.2	0.1	0.0	0.0		7.0	9.1	4.7
SSW	202.5	0.1	0.7	2.0	2.4	0.6	0.1	0.0			5.9	11.1	5.7
SW	225.0	0.1	0.8	1.9	2.7	0.6	0.1	0.0			6.1	11.3	5.8
WSW	247.5	0.1	1.1	3.3	3.9	0.7	0.1	0.0			9.3	11.0	5.7
W	270.0	0.2	0.9	2.7	5.0	1.5	0.5	0.1	0.0		10.8	12.6	6.5
WNW	292.5	0.1	0.7	2.7	4.7	1.6	0.5	0.1			10.4	13.0	6.7
NW	315.0	0.1	0.8	3.1	4.1	1.1	0.3	0.0			9.4	11.8	6.1
NNW	337.5	0.1	0.7	2.2	2.2	0.4	0.0				5.6	10.6	5.5
CALM		0.3									0.3		
Total freq.(%)		3.3	14.3	34.2	36.9	8.5	2.3	0.4	0.1	0.0	100.0	10.9	5.6

LOGAN INTL. AIRPORT; BOSTON, MA. (YEARS 1965–1974)

Table 1 Wind Speed and Direction Frequency Table

Pasquill–Gifford Elevation Plane Dispersion Estimates for Stack Plumes (GEP test parameters {PGESTMAX.WK3})

Input Parameters	Field (mks)	Model (cgs)
Length Scale =	400.0	1.0
Stability =	D	D
Fetch (Open/Urban) =	Open	Open
Max. Downwind Dist. =	2000.0	500.0
Elevation =	0	0
Stack Height =	73.1	18.3
Stack Diameter =	5.79	1.45
Gas Temp (C) =	135.0	22.0
Ambient Temp (C) =	10.8	22.0
Tracer Fraction =	1.0	1.000
Wind Speed @H =	18.8	276
Velocity Ratio W/U =	1.09	1.09
Output 1 (Field/Model) =	Field	
Output 2 (K/Conc) =	K	
Option 1 (Yes/No) =	No	< Plume Rise Option

Calculated Parameters	Field (mks)	Model (cgs)
Stack Gas S.G. =	0.696	0.696
Stack Flow Rate =	537	493.20
Sigma Y_{max} =	146.1	36.5
Sigma Z_{max} =	60.0	15.0
L_M/H_s =	0.036	0.036
Fr_s =	4.91	144.15
L_B/H_s =	0.0011	0.0000

Handbook on Atm. Diffusion; Hanna	Open		Urban	
Stab.	Sig Y	Sig Z	Sig Y	Sig Z
A	401.7	400.0	477.0	831.4
B	292.1	240.0	477.0	831.4
C	200.8	135.2	328.0	400.0
D	146.1	60.0	238.5	221.4
E	109.5	37.5	184.0	140.3
F	73.0	20.0	184.0	140.3
For X = 2000 meters				

METHOD is GEP,
equality of density, velocity,
length scale ratios.
Eff. Stack Height is chosen
from the selection of model or
field since buoyancy force
equality is not forced.

Distance to Max. Conc. Below

		X_p (m) =	0	100.0	200.0	300.0	400.0	500.0	600.0	700.0	800.0	900.0	1000.0	1100.0	1200.0	1300.0	1400.0	1500.0	1600.0	1700.0	1800.0	1900.0	2000.0
		X_m (cm) =	0	25.0	50.0	75.0	100.0	125.0	150.0	175.0	200.0	225.0	250.0	275.0	300.0	325.0	350.0	375.0	400.0	425.0	450.0	475.0	500.0
		X/X_{max} =	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00
Y_p (m)	Y_m (cm)	$Y/sigY_{max}$	Field K	$K*10^6$ (m^{-2})													Max. Conc. Below						
0	0	0		0.0	0.0	0.0	0.3	2.0	5.2	9.0	12.5	15.2	17.2	18.5	19.3	19.6	19.7	19.5	19.2	18.8	18.3	17.8	17.3
−18.3	−4.6	−0.125		0.0	0.0	0.0	0.3	1.8	4.8	8.5	11.9	14.7	16.7	18.1	18.9	19.3	19.4	19.2	19.0	18.6	18.2	17.7	17.2
−36.5	−9.1	−0.250		0.0	0.0	0.0	0.2	1.3	3.8	7.2	10.4	13.2	15.3	16.8	17.8	18.3	18.5	18.5	18.3	18.0	17.6	17.2	16.8
−54.8	−13.7	−0.375		0.0	0.0	0.0	0.1	0.7	2.6	5.4	8.4	11.1	13.3	14.9	16.1	16.8	17.2	17.3	17.3	17.1	16.8	16.5	16.1
−73.0	−18.3	−0.500		0.0	0.0	0.0	0.0	0.3	1.5	3.6	6.2	8.7	10.9	12.6	13.9	14.8	15.4	15.8	15.9	15.9	15.7	15.5	15.3
−91.3	−22.8	−0.625		0.0	0.0	0.0	0.0	0.1	0.8	2.2	4.2	6.3	8.4	10.2	11.6	12.7	13.5	14.0	14.3	14.4	14.5	14.4	14.2
−109.5	−27.4	−0.750		0.0	0.0	0.0	0.0	0.0	0.3	1.2	2.6	4.3	6.1	7.8	9.3	10.5	11.4	12.1	12.6	12.9	13.0	13.1	13.1
−127.8	−32.0	−0.875		0.0	0.0	0.0	0.0	0.0	0.1	0.6	1.4	2.7	4.2	5.7	7.1	8.4	9.4	10.2	10.8	11.2	11.5	11.7	11.8
−146.1	−36.5	−1.000		0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.7	1.6	2.7	4.0	5.3	6.4	7.5	8.3	9.0	9.6	10.0	10.3	10.5
−164.3	−41.1	−1.125		0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.9	1.7	2.7	3.7	4.8	5.8	6.8	7.4	8.0	8.5	8.9	9.2
−182.6	−45.6	−1.250		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	1.0	1.7	2.5	3.4	4.3	5.2	5.9	6.5	7.1	7.6	7.9
−200.8	−50.2	−1.375		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.5	1.0	1.7	2.4	3.1	3.9	4.6	5.2	5.8	6.3	6.7
−219.1	−54.8	−1.500		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.6	1.0	1.6	2.2	2.9	3.5	4.1	4.7	5.2	5.6
−237.3	−59.3	−1.625		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.6	1.0	1.5	2.1	2.6	3.2	3.7	4.2	4.6
−255.6	−63.9	−1.750		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.6	1.0	1.4	1.9	2.4	2.9	3.3	3.7
−273.9	−68.5	−1.875		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.7	1.0	1.3	1.8	2.2	2.6	3.0
−292.1	−73.0	−2.000		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.6	0.9	1.3	1.6	2.0	2.3
−310.4	−77.6	−2.125		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.4	0.6	0.9	1.2	1.5	1.8
−328.6	−82.2	−2.250		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.4	0.6	0.8	1.1	1.4
−346.9	−86.7	−2.375		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.8	1.0
−365.1	−91.3	−2.500		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.8
−383.4	−95.9	−2.625		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.6
−401.7	−100.4	−2.750		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.4
−419.9	−105.0	−2.875		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3
−438.2	−109.5	−3.000		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2
		H_{eff} (m) =	73	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1
		SigY (m) =		8.0	15.8	23.6	31.4	39.0	46.8	54.1	61.6	69.0	76.3	83.5	90.7	97.8	104.9	111.9	118.8	125.7	132.6	139.3	146.1
		SigZ (m) =		5.6	10.5	14.9	19.0	22.7	26.1	29.3	32.4	35.2	37.9	40.5	43.0	45.4	47.7	49.9	52.1	54.1	56.1	58.1	60.0
		COEFF =		3573.5	954.5	450.2	267.3	179.8	130.7	100.2	79.9	65.5	55.0	47.0	40.6	35.6	31.6	28.5	25.7	23.4	21.4	19.7	18.2

Table 2 Ground Level Pasquill-Gifford Dispersion Estimate to Determine Maximum Distance to Maximum Downwind Concentration

Parameter Chart for Model Scale Selection {GEPSCALE.WK3}

SCALE =	Full	Units	300	1:350	400	450	500	Units
SELECTED HEIGHT DIMENSIONS								
Generic Roughness Element Height =	0.60	m	0.20	0.17	0.15	0.13	0.12	cm
Airport Wind Instr. Height =	6.7	m	2.2	1.9	1.7	1.5	1.3	cm
Ref Height 10 m =	10.0	m	3.3	2.9	2.5	2.2	2.0	cm
Turbine Building Height =	26.9	m	9.0	7.7	6.7	6.0	5.4	cm
Base Case Stack Height =	45.7	m	15.2	13.1	11.4	10.2	9.1	cm
Option 1 Stack Height =	61.0	m	20.3	17.4	15.2	13.5	12.2	cm
Option 2 Stack Height =	73.1	m	24.4	20.9	18.3	16.2	14.6	cm
Boundary Layer Height =	600.0	m	200.0	171.4	150.0	133.3	120.0	cm
Silo Height =	42.0	m	14.0	12.0	10.5	9.3	8.4	cm
LNG Tank Height =	57.6	m	19.2	16.5	14.4	12.8	11.5	cm
SELECTED DISTANCE DIMENSIONS								
Distance to Silo =	100.0	m	33.3	28.6	25.0	22.2	20.0	cm
Distance to LNG Tanks =	210.0	m	70.0	60.0	52.5	46.7	42.0	cm
Distance to 2 km downwind =	2000.0	m	666.7	571.4	500.0	444.4	400.0	cm
APPROACH FLOW CHARACTERISTICS								
Roughness Length =	0.50	m	0.167	0.143	0.125	0.111	0.100	cm
Power Law Index =	0.213		0.213	0.213	0.213	0.213	0.213	
Friction Velocity =	1.49	m/s	21.9	21.9	21.9	21.9	21.9	cm/s
Max. Design Wind Speed @ airport =	11.3	m/s	166.2	166.2	166.2	166.2	166.2	cm/s
Wind Speed @ 10m =	12.3	m/s	181.0	181.0	181.0	181.0	181.0	cm/s
Wind Speed @ Turbine Bldg =	15.2	m/s	223.3	223.3	223.3	223.3	223.3	cm/s
Wind Speed @ Base Case Stack =	17.0	m/s	250.0	250.0	250.0	250.0	250.0	cm/s
Wind Speed @ Opt#1 Stack =	18.1	m/s	265.7	265.7	265.7	265.7	265.7	cm/s
Wind Speed @ Opt#2 Stack =	18.8	m/s	276.2	276.2	276.2	276.2	276.2	cm/s
Wind Speed @ BL =	29.4	m/s	432.1	432.1	432.1	432.1	432.1	cm/s
STACK FLOW CHARACTERISTICS								
Stack I.D. =	5.79	m	1.93	1.65	1.45	1.29	1.16	cm
Stack Exit Velocity =	20.4	m/s	300.0	300.0	300.0	300.0	300.0	cm/s
Stack Flow Rate =	537.1	m^3/s	877.8	644.9	493.8	390.1	316.0	ccs
Stack gas Temp. =	135.0	C	22.0	22.0	22.0	22.0	22.0	C
Ambient Temp. =	10.6	C	22.0	22.0	22.0	22.0	22.0	C
Stack Gas Equivalent MW =	29.0		20.1	20.1	20.1	20.1	20.1	
DIMENSIONLESS SCALING PARAMETERS								
Roughness RE # =	496.3		24.3	20.9	18.3	16.2	14.6	
Generic Roughness Element RE # =	595.6		29.2	25.0	21.9	19.5	17.5	
Turbine Bldg RE # =	272302.6		13350.1	11442.9	10012.5	8900.0	8010.0	
Stack RE # =	78744.0		3860.5	3309.0	2895.4	2573.7	2316.3	
W/U velocity ratio for Base Stack =	1.20		1.20	1.20	1.20	1.20	1.20	
W/U velocity ratio for Opt#1 Stack =	1.13		1.13	1.13	1.13	1.13	1.13	
W/U velocity ratio for Opt#2 Stack =	1.09		1.09	1.09	1.09	1.09	1.09	
Stack Gas Specific Gravity =	0.696		0.696	0.696	0.696	0.696	0.696	

Table 3 Parameter Chart for Model Scale Selection

GEP Test Parameters {GEPPARAM.WK3}

SCALE =	Full	Units	400	Units
SELECTED HEIGHT DIMENSIONS				
Generic Roughness Element Height =	0.60	m	0.15	cm
Airport Wind Instr. Height =	6.7	m	1.7	cm
Ref Height 10 m =	10.0	m	2.5	cm
Turbine Building Height =	26.9	m	6.7	cm
Base Case Stack Height =	45.7	m	11.4	cm
Option 1 Stack Height =	61.0	m	15.2	cm
Option 2 Stack Height =	73.1	m	18.3	cm
Boundary Layer Height =	600.0	m	150.0	cm
Silo Height =	42.0	m	10.5	cm
LNG Tank Height =	57.6	m	14.4	cm
SELECTED DISTANCE DIMENSIONS				
Distance to Silo =	100.0	m	25.0	cm
Distance to LNG Tanks =	210.0	m	52.5	cm
Distance to 2 km downwind =	2000.0	m	500.0	cm
APPROACH FLOW CHARACTERISTICS				
Roughness Length =	0.50	m	0.125	cm
Power Law Index =	0.213		0.213	
Friction Velocity =	1.49	m/s	21.9	cm/s
Max. Design Wind Speed @ airport =	11.3	m/s	166.2	cm/s
Wind Speed @ 10m =	12.3	m/s	181.0	cm/s
Wind Speed @ Turbine Bldg =	15.2	m/s	223.3	cm/s
Wind Speed @ Base Case Stack =	17.0	m/s	250.0	cm/s
Wind Speed @ Opt#1 Stack =	18.1	m/s	265.7	cm/s
Wind Speed @ Opt#2 Stack =	18.8	m/s	276.2	cm/s
Wind Speed @ BL =	29.4	m/s	432.1	cm/s
STACK FLOW CHARACTERISTICS				
Stack I.D. =	5.79	m	1.45	cm
Stack Exit Velocity =	20.4	m/s	300.0	cm/s
Stack Flow Rate =	537.1	m^3/s	493.8	ccs
Stack gas Temp. =	135.0	C	22.0	C
Ambient Temp. =	10.8	C	22.0	C
Stack Gas Equivalent MW =	29.0		20.1	
DIMENSIONLESS SCALING PARAMETERS				
Roughness RE # =	496.3		18.3	
Generic Roughness Element RE # =	595.6		21.9	
Turbine Bldg RE # =	272302.6		10012.5	
Stack RE # =	78744.0		2895.4	
W/U velocity ratio for Base Stack =	1.20		1.20	
W/U velocity ratio for Opt#1 Stack =	1.13		1.13	
W/U velocity ratio for Opt#2 Stack =	1.09		1.09	
Stack Gas Specific Gravity =	0.696		0.696	

Table 4 GEP Test Parameters

GEP Reynolds Number Invariance Test Parameters {REYPARAM.WK3}

SCALE =	Full	Units	400	Units
SELECTED HEIGHT DIMENSIONS				
Generic Roughness Element Height =	0.60	m	0.15	cm
Airport Wind Instr. Height =	6.7	m	1.7	cm
Turbine Building Height =	26.9	m	6.7	cm
Boundary Layer Height =	600.0	m	150.0	cm
Silo Height =	42.0	m	10.5	cm
LNG Tank Height =	57.6	m	14.4	cm
SELECTED DISTANCE DIMENSIONS				
Distance to Silo =	100.0	m	25.0	cm
Distance to LNG Tanks =	210.0	m	52.5	cm
Distance to 2 km downwind =	2000.0	m	500.0	cm
APPROACH FLOW CHARACTERISTICS				
Roughness Length =	0.50	m	0.125	cm
Power Law Index =	0.213		0.213	
Friction Velocity =	1.49	m/s	21.9	cm/s
Max. Design Wind Speed @ airport =	11.3	m/s	166.2	cm/s
Wind Speed @ Turbine Bldg =	15.2	m/s	223.3	cm/s
Wind Speed @ Silo Complex Height =	16.7	m/s	245.5	cm/s
Wind Speed @ LNG Tank Height =	17.9	m/s	262.6	cm/s
Wind Speed @ BL =	29.4	m/s	432.1	cm/s
STACK FLOW CHARACTERISTICS				
Stack I.D. =	2.79	m	0.70	cm
Stack Exit Velocity =	16.7	m/s	245.5	cm/s
Stack Flow Rate =	102.3	m^3/s	94.1	ccs
Stack gas Temp. =	22.0	C	22.0	C
Ambient Temp. =	22.0	C	22.0	C
Stack Gas Equivalent MW =	29.0		29.0	
DIMENSIONLESS SCALING PARAMETERS				
Roughness RE # =	496.3		18.3	
Generic Roughness Element RE # =	595.6		21.9	
Turbine Bldg RE # =	272302.6		10012.5	
Release Tube RE # =	31092.4		1143.3	
W/U velocity ratio for Silo Height =	1.00		1.00	
Stack Gas Specific Gravity =	1.000		1.000	

Table 5 GEP Reynolds Number Invariance Test Parameters

Atmospheric Dispersion Comparability Test Parameters {ADCPARAM.WK3}

SCALE =	Full	Units	400	Units
SELECTED HEIGHT DIMENSIONS				
Airport Wind Instr. Height =	6.7	m	1.7	cm
Ref Height 10 m =	10.0	m	2.5	cm
Base Case Stack Height =	45.7	m	11.4	cm
ADCT Stack Height =	100.0	m	25.0	cm
Boundary Layer Height =	600.0	m	150.0	cm
SELECTED DISTANCE DIMENSIONS				
Distance to 0.5 km downwind =	500.0	m	125.0	cm
Distance to 1.0 km downwind =	1000.0	m	250.0	cm
Distance to 1.5 km downwind =	1500.0	m	375.0	cm
Distance to 2.0 km downwind =	2000.0	m	500.0	cm
APPROACH FLOW CHARACTERISTICS				
Roughness Length < or = to	0.20	m	0.05	cm
Power Law Index =	0.18		0.18	
Friction Velocity =	1.25	m/s	18.4	cm/s
Max. Design Wind Speed @ airport =	12.0	m/s	176.7	cm/s
Wind Speed @ 10m =	12.9	m/s	190.0	cm/s
Wind Speed @ Base Case Stack =	17.0	m/s	250.0	cm/s
Wind Speed @ ADCT Stack =	19.6	m/s	288.0	cm/s
Wind Speed @ BL =	27.1	m/s	398.1	cm/s
ADCT STACK FLOW CHARACTERISTICS				
Stack I.D. =	5.00	m	1.25	cm
Stack Exit Velocity =	29.4	m/s	432.0	cm/s
Stack Flow Rate =	576.8	m^3/s	530.2	ccs
Stack gas Temp. =	22.0	C	22.0	C
Ambient Temp. =	22.0	C	22.0	C
Stack Gas Equivalent MW =	29.0		29.0	
DIMENSIONLESS SCALING PARAMETERS				
Roughness RE # =	166.9		6.1	
ADCT Stack RE # =	97921.4		3600.1	
ADCT W/U velocity ratio =	1.50		1.50	
ADCT Stack Gas Specific Gravity =	1.000		1.000	

Table 6 Atmospheric Dispersion Comparability Test Parameters

Field Test Conditions {GEPTESTS.WK3 Sheet A:}

Measurement Type	Run No.	File Name	Model Config	Stack Config	Building Config	Wind Dir. (deg)	Ref. Velocity (m/s)	Ref. Height (m)	Stack Height (m)	Effluent Velocity (m/s)	Position X (m)	Y (m)	Z (m)
ADCT Series													
Vel. Lateral Profile U,u'	From	From	Generic	Out	No		19.6	100.0			0	Profile	25.0
Vel. Lateral Profile U,u'	43	GEP043.PRF	Generic	Out	No		19.6	100.0			0	Profile	45.7
Vel. Lateral Profile U,u'	To	To	Generic	Out	No		19.6	100.0			0	Profile	100.0
Vel. Lateral Profile U,u'	67	GEP067.PRF	Generic	Out	No		19.6	100.0			2000	Profile	25.0
Vel. Lateral Profile U,u'	"	"	Generic	Out	No		19.6	100.0			2000	Profile	45.7
Vel. Lateral Profile U,u'	"	"	Generic	Out	No		19.6	100.0			2000	Profile	100.0
Vel. Vertical Profile U,u',w',uw	43	GEP043.PRF	Generic	Out	No		19.6	100.0			0	0	Profile
Vel. Vertical Profile U,u',w',uw	44	GEP044.PRF	Generic	Out	No		19.6	100.0			1000	0	Profile
Vel. Vertical Profile U,u',w',uw	45	GEP045.PRF	Generic	Out	No		19.6	100.0			2000	0	Profile
Visualization of Plume Elevation	0	TAPE #1	Generic	In	No		19.6	100.0	100.0	29.4	Profile	0	Profile
Concentration Vertical Profile	11	GEP011.GC	Generic	In	No		19.6	100.0	100.0	29.4	500	0	Profile
Concentration Vertical Profile	10	GEP010.GC	Generic	In	No		19.6	100.0	100.0	29.4	1000	0	Profile
Concentration Vertical Profile	9	GEP009.GC	Generic	In	No		19.6	100.0	100.0	29.4	1500	0	Profile
Concentration Lateral Profile	14	GEP014.GC	Generic	In	No		19.6	100.0	100.0	29.4	500	Profile	H_{eff}
Concentration Lateral Profile	13	GEP013.GC	Generic	In	No		19.6	100.0	100.0	29.4	1000	Profile	H_{eff}
Concentration Lateral Profile	12	GEP012.GC	Generic	In	No		19.6	100.0	100.0	29.4	1500	Profile	H_{eff}
Conc. Ground Level Profile	15	GEP015.GC	Generic	In	No		19.6	100.0	100.0	29.4	Profile	Profile	0.0
Re Invariance Series													
Vel. Vertical Profile U,u'	59	GEP059.PRF	In	Out	In	140	29.4	600.0			0	0	Profile
Vel. Vertical Profile U,u'	60	GEP060.PRF	In	Out	In	140	58.8	600.0			0	0	Profile
Vel. Vertical Profile U,u'	61	GEP061.PRF	In	Out	In	325	29.4	600.0			0	0	Profile
Vel. Vertical Profile U,u'	62	GEP062.PRF	In	Out	In	325	58.8	600.0			0	0	Profile
Conc. Ground Level Profile	16	GEP016.GC	In	Passive	In	140	29.4	600.0	61.0	17.0	Profile	Profile	0.0
Conc. Ground Level Profile	17	GEP017.GC	In	Passive	In	140	58.8	600.0	61.0	17.0	Profile	Profile	0.0
Conc. Ground Level Profile	18	GEP018.GC	In	Passive	In	325	29.4	600.0	45.7	17.0	Profile	Profile	0.0
Conc. Ground Level Profile	19	GEP019.GC	In	Passive	In	325	58.8	600.0	45.7	17.0	Profile	Profile	0.0
45.7 meter Stack Tests													
Vel. Vertical Profile U,u'	58	GEP058.PRF	In	Out	In	140	17.0	45.7			−1000	0	Profile
Visualization of Plume Elevation	1	TAPE # 2	In	In	Out	140	17.0	45.7	45.7	20.4	Profile	0	Profile
Visualization of Plume Elevation	2	TAPE # 2	In	In	In	140	17.0	45.7	45.7	20.4	Profile	0	Profile
Visualization of Plume Elevation	3	TAPE # 2	In	In	In all	140	17.0	45.7	45.7	20.4	Profile	0	Profile
Conc. Ground Level Profile	20	GEP020.GC	In	In	Out	140	17.0	45.7	45.7	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	21	GEP021.GC	In	In	In	140	17.0	45.7	45.7	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	22	GEP022.GC	In	In	In all	140	17.0	45.7	45.7	20.4	Profile	Profile	0.0

Table 7 Field Test Conditions (all tests)

Field Test Conditions {GEPTESTS.WK3 Sheet A:}

Measurement Type	Run No.	File Name	Model Config	Stack Config	Building Config	Wind Dir. (deg)	Ref. Velocity (m/s)	Ref. Height (m)	Stack Height (m)	Effluent Velocity (m/s)	Position X (m)	Y (m)	Z (m)
Stack Height Determination													
Visualization of Plume Elevation	4	TAPE # 2	In	In	Out	140	17.0	45.7	61.0	20.4	Profile	0	Profile
Visualization of Plume Elevation	5	TAPE # 2	In	In	In	140	17.0	45.7	61.0	20.4	Profile	0	Profile
Visualization of Plume Elevation	6	TAPE # 2	In	In	Out	140	17.0	45.7	73.1	20.4	Profile	0	Profile
Visualization of Plume Elevation	7	TAPE # 2	In	In	In	140	17.0	45.7	73.1	20.4	Profile	0	Profile
Visualization of Plume Elevation	10	TAPE # 2	In	In	Out	150	17.0	45.7	61.0	20.4	Profile	0	Profile
Visualization of Plume Elevation	11	TAPE # 2	In	In	In	150	17.0	45.7	61.0	20.4	Profile	0	Profile
Visualization of Plume Elevation	8	TAPE # 2	In	In	Out	150	17.0	45.7	73.1	20.4	Profile	0	Profile
Visualization of Plume Elevation	9	TAPE # 2	In	In	In	150	17.0	45.7	73.1	20.4	Profile	0	Profile
Visualization of Plume Elevation	12	TAPE # 2	In	In	Out	320	17.0	45.7	61.0	20.4	Profile	0	Profile
Visualization of Plume Elevation	13	TAPE # 2	In	In	In	320	17.0	45.7	61.0	20.4	Profile	0	Profile
Visualization of Plume Elevation	14	TAPE # 2	In	In	Out	320	17.0	45.7	73.1	20.4	Profile	0	Profile
Visualization of Plume Elevation	15	TAPE # 2	In	In	In	320	17.0	45.7	73.1	20.4	Profile	0	Profile
Visualization of Plume Elevation	18	TAPE # 2	In	In	Out	325	17.0	45.7	61.0	20.4	Profile	0	Profile
Visualization of Plume Elevation	19	TAPE # 2	In	In	In	325	17.0	45.7	61.0	20.4	Profile	0	Profile
Visualization of Plume Elevation	16	TAPE # 2	In	In	Out	325	17.0	45.7	73.1	20.4	Profile	0	Profile
Visualization of Plume Elevation	17	TAPE # 2	In	In	In	325	17.0	45.7	73.1	20.4	Profile	0	Profile
Conc. Ground Level Profile	24	GEP024.GC	In	In	Out	140	17.0	45.7	61.0	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	25	GEP025.GC	In	In	In	140	17.0	45.7	61.0	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	26	GEP026.GC	In	In	Out	140	17.0	45.7	73.1	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	27	GEP027.GC	In	In	In	140	17.0	45.7	73.1	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	30	GEP030.GC	In	In	Out	150	17.0	45.7	61.0	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	31	GEP031.GC	In	In	In	150	17.0	45.7	61.0	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	28	GEP028.GC	In	In	Out	150	17.0	45.7	73.1	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	29	GEP029.GC	In	In	In	150	17.0	45.7	73.1	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	32	GEP032.GC	In	In	Out	320	17.0	45.7	61.0	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	33	GEP033.GC	In	In	In	320	17.0	45.7	61.0	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	34	GEP034.GC	In	In	Out	320	17.0	45.7	73.1	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	35	GEP035.GC	In	In	In	320	17.0	45.7	73.1	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	38	GEP038.GC	In	In	Out	325	17.0	45.7	61.0	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	39	GEP039.GC	In	In	In	325	17.0	45.7	61.0	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	36	GEP036.GC	In	In	Out	325	17.0	45.7	73.1	20.4	Profile	Profile	0.0
Conc. Ground Level Profile	37	GEP037.GC	In	In	In	325	17.0	45.7	73.1	20.4	Profile	Profile	0.0
Visualization of Plume Elevation			In	In	Out	Worst Case	@ GEPSH'	GEPSH'	GEPSH'	20.4	Profile	0	Profile
Visualization of Plume Elevation			In	In	In	Worst Case	@ GEPSH'	GEPSH'	GEPSH'	20.4	Profile	0	Profile
Conc. Ground Level Profile			In	In	Out	Worst Case	@ GEPSH'	GEPSH'	GEPSH'	20.4	Profile	Profile	0.0
Conc. Ground Level Profile			In	In	In	Worst Case	@ GEPSH'	GEPSH'	GEPSH'	20.4	Profile	Profile	0.0

Table 7 Continued

Field Test Conditions {GEPTESTS.WK3 Sheet A:}

Measurement Type	Run No.	File Name	Model Config	Stack Config	Building Config	Wind Dir. (deg)	Ref. Velocity (m/s)	Ref. Height (m)	Stack Height (m)	Effluent Velocity (m/s)	Position X (m)	Y (m)	Z (m)
Stack Height Documentation													
Vel. Lateral Profile U,u'			In	Out	In	Worst Case	@ GEPSH	GEPSH			0	Profile	25.0
Vel. Lateral Profile U,u'			In	Out	In	Worst Case	@ GEPSH	GEPSH			0	Profile	45.7
Vel. Lateral Profile U,u'			In	Out	In	Worst Case	@ GEPSH	GEPSH			0	Profile	73.1
Vel. Lateral Profile U,u'			In	Out	In	Worst Case	@ GEPSH	GEPSH			2000	Profile	25.0
Vel. Lateral Profile U,u'			In	Out	In	Worst Case	@ GEPSH	GEPSH			2000	Profile	45.7
Vel. Lateral Profile U,u'			In	Out	In	Worst Case	@ GEPSH	GEPSH			2000	Profile	73.1
Vel. Vertical Profile U,u',w',uw,T			In	Out	In	Worst Case	@ GEPSH	GEPSH			0	0	Profile
Vel. Vertical Profile U,u',w',uw,T			In	Out	In	Worst Case	@ GEPSH	GEPSH			1000	0	Profile
Vel. Vertical Profile U,u',w',uw,T			In	Out	In	Worst Case	@ GEPSH	GEPSH			2000	0	Profile
Visualization of Plume Elevation			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	Profile	0	Profile
Visualization of Plume Elevation			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	Profile	0	Profile
Conc. Ground Level Profile			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	Profile	Profile	0.0
Conc. Ground Level Profile			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	Profile	Profile	0.0
Conc. Ground Level Profile Detail			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	Profile	Profile	0.0
Conc. Ground Level Profile Detail			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	Profile	Profile	0.0
Conc. Ground Level Profile Detail			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	Profile	Profile	0.0
Conc. Ground Level Profile Detail			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	Profile	Profile	0.0
Conc. Ground Level Profile Detail			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	Profile	Profile	0.0
Conc. Ground Level Profile Detail			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	Profile	Profile	0.0
Conc. Vertical & Lateral Profile			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	500	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	500	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	1000	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	1000	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	@GL Max	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	@GL Max	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	2000	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	20.4	2000	Profile	Profile

Table 7 Continued

Model Test Conditions {GEPTESTS.WK3 Sheet B:}

Measurement Type	Run No.	File Name	Model Config	Stack Config	Building Config	Wind Direction (deg)	Reference Velocity (cm/s)	Reference Height (cm)	Stack Height (cm)	Effluent Velocity (cm/s)	Position X (cm)	Y (cm)	Z (cm)
ADCT Series													
Vel. Lateral Profile U,u'	From	From	Generic	Out	No		288.0	25.0			0	Profile	6.3
Vel. Lateral Profile U,u'	43	GEP043.PRF	Generic	Out	No		288.0	25.0			0	Profile	11.4
Vel. Lateral Profile U,u'	To	To	Generic	Out	No		288.0	25.0			0	Profile	25.0
Vel. Lateral Profile U,u'	67	GEP067.PRF	Generic	Out	No		288.0	25.0			500	Profile	6.3
Vel. Lateral Profile U,u'	"	"	Generic	Out	No		288.0	25.0			500	Profile	11.4
Vel. Lateral Profile U,u'	"	"	Generic	Out	No		288.0	25.0			500	Profile	25.0
Vel. Vertical Profile U,u',w',uw	43	GEP043.PRF	Generic	Out	No		288.0	25.0			0	0	Profile
Vel. Vertical Profile U,u',w',uw	44	GEP044.PRF	Generic	Out	No		288.0	25.0			250	0	Profile
Vel. Vertical Profile U,u',w',uw	45	GEP045.PRF	Generic	Out	No		288.0	25.0			500	0	Profile
Visualization of Plume Elevation	0	TAPE #1	Generic	In	No		288.0	25.0	25.0	432.0	Profile	0	Profile
Concentration Vertical Profile	11	GEP011.GC	Generic	In	No		288.0	25.0	25.0	432.0	125	0	Profile
Concentration Vertical Profile	10	GEP010.GC	Generic	In	No		288.0	25.0	25.0	432.0	250	0	Profile
Concentration Vertical Profile	9	GEP009.GC	Generic	In	No		288.0	25.0	25.0	432.0	375	0	Profile
Concentration Lateral Profile	14	GEP014.GC	Generic	In	No		288.0	25.0	25.0	432.0	125	Profile	H_{eff}
Concentration Lateral Profile	13	GEP013.GC	Generic	In	No		288.0	25.0	25.0	432.0	250	Profile	H_{eff}
Concentration Lateral Profile	12	GEP012.GC	Generic	In	No		288.0	25.0	25.0	432.0	375	Profile	H_{eff}
Conc. Ground Level Profile	15	GEP015.GC	Generic	In	No		288.0	25.0	25.0	432.0	Profile	Profile	0.0
Re Invariance Series													
Vel. Vertical Profile U,u'	59	GEP059.PRF	In	Out	In	140	432.2	150.0			0	0	Profile
Vel. Vertical Profile U,u'	60	GEP060.PRF	In	Out	In	140	864.4	150.0			0	0	Profile
Vel. Vertical Profile U,u'	61	GEP061.PRF	In	Out	In	325	432.2	150.0			0	0	Profile
Vel. Vertical Profile U,u'	62	GEP062.PRF	In	Out	In	325	864.4	150.0			0	0	Profile
Conc. Ground Level Profile	16	GEP016.GC	In	Passive	In	140	432.2	150.0	15.3	250.0	Profile	Profile	0.0
Conc. Ground Level Profile	17	GEP017.GC	In	Passive	In	140	864.4	150.0	15.3	250.0	Profile	Profile	0.0
Conc. Ground Level Profile	18	GEP018.GC	In	Passive	In	325	432.2	150.0	11.4	250.0	Profile	Profile	0.0
Conc. Ground Level Profile	19	GEP019.GC	In	Passive	In	325	864.4	150.0	11.4	250.0	Profile	Profile	0.0
45.7 meter Stack Tests													
Vel. Vertical Profile U,u'	58	GEP058.PRF	In	Out	In	140	249.9	11.4			−250	0	Profile
Visualization of Plume Elevation	1	TAPE # 2	In	In	Out	140	250.0	11.4	11.4	300.0	Profile	0	Profile
Visualization of Plume Elevation	2	TAPE # 2	In	In	In	140	250.0	11.4	11.4	300.0	Profile	0	Profile
Visualization of Plume Elevation	3	TAPE # 2	In	In	In all	140	250.0	11.4	11.4	300.0	Profile	0	Profile
Conc. Ground Level Profile	20	GEP020.GC	In	In	Out	140	250.0	11.4	11.4	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	21	GEP021.GC	In	In	In	140	250.0	11.4	11.4	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	22	GEP022.GC	In	In	In all	140	250.0	11.4	11.4	300.0	Profile	Profile	0.0

Table 8 Model Test Conditions (all tests)

Model Test Conditions {GEPTESTS.WK3 Sheet B:}

Measurement Type	Run No.	File Name	Model Config	Stack Config	Building Config	Wind Direction (deg)	Reference Velocity (cm/s)	Reference Height (cm)	Stack Height (cm)	Effluent Velocity (cm/s)	Position X (cm)	Y (cm)	Z (cm)
Stack Height Determination													
Visualization of Plume Elevation	4	TAPE # 2	In	In	Out	140	250.0	11.4	15.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	5	TAPE # 2	In	In	In	140	250.0	11.4	15.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	6	TAPE # 2	In	In	Out	140	250.0	11.4	18.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	7	TAPE # 2	In	In	In	140	250.0	11.4	18.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	10	TAPE # 2	In	In	Out	150	250.0	11.4	15.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	11	TAPE # 2	In	In	In	150	250.0	11.4	15.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	8	TAPE # 2	In	In	Out	150	250.0	11.4	18.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	9	TAPE # 2	In	In	In	150	250.0	11.4	18.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	12	TAPE # 2	In	In	Out	320	250.0	11.4	15.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	13	TAPE # 2	In	In	In	320	250.0	11.4	15.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	14	TAPE # 2	In	In	Out	320	250.0	11.4	18.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	15	TAPE # 2	In	In	In	320	250.0	11.4	18.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	18	TAPE # 2	In	In	Out	325	250.0	11.4	15.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	19	TAPE # 2	In	In	In	325	250.0	11.4	15.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	16	TAPE # 2	In	In	Out	325	250.0	11.4	18.3	300.0	Profile	0	Profile
Visualization of Plume Elevation	17	TAPE # 2	In	In	In	325	250.0	11.4	18.3	300.0	Profile	0	Profile
Conc. Ground Level Profile	24	GEP024.GC	In	In	Out	140	250.0	11.4	15.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	25	GEP025.GC	In	In	In	140	250.0	11.4	15.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	26	GEP026.GC	In	In	Out	140	250.0	11.4	18.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	27	GEP027.GC	In	In	In	140	250.0	11.4	18.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	30	GEP030.GC	In	In	Out	150	250.0	11.4	15.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	31	GEP031.GC	In	In	In	150	250.0	11.4	15.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	28	GEP028.GC	In	In	Out	150	250.0	11.4	18.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	29	GEP029.GC	In	In	In	150	250.0	11.4	18.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	32	GEP032.GC	In	In	Out	320	250.0	11.4	15.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	33	GEP033.GC	In	In	In	320	250.0	11.4	15.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	34	GEP034.GC	In	In	Out	320	250.0	11.4	18.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	35	GEP035.GC	In	In	In	320	250.0	11.4	18.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	38	GEP038.GC	In	In	Out	325	250.0	11.4	15.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	39	GEP039.GC	In	In	In	325	250.0	11.4	15.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	36	GEP036.GC	In	In	Out	325	250.0	11.4	18.3	300.0	Profile	Profile	0.0
Conc. Ground Level Profile	37	GEP037.GC	In	In	In	325	250.0	11.4	18.3	300.0	Profile	Profile	0.0
Visualization of Plume Elevation			In	In	Out	Worst Case	@ GEPSH'	GEPSH'	GEPSH'	300.0	Profile	0	Profile
Visualization of Plume Elevation			In	In	In	Worst Case	@ GEPSH'	GEPSH'	GEPSH'	300.0	Profile	0	Profile
Conc. Ground Level Profile			In	In	Out	Worst Case	@ GEPSH'	GEPSH'	GEPSH'	300.0	Profile	Profile	0.0
Conc. Ground Level Profile			In	In	In	Worst Case	@ GEPSH'	GEPSH'	GEPSH'	300.0	Profile	Profile	0.0

Table 8 Continued

Model Test Conditions {GEPTESTS.WK3 Sheet B:}

Measurement Type	Run No.	File Name	Model Config	Stack Config	Building Config	Wind Direction (deg)	Reference Velocity (cm/s)	Reference Height (cm)	Stack Height (cm)	Effluent Velocity (cm/s)	Position X (cm)	Y (cm)	Z (cm)
Stack Height Documentation													
Vel. Lateral Profile U,u'			In	Out	In	Worst Case	@ GEPSH	GEPSH			0	Profile	6.3
Vel. Lateral Profile U,u'			In	Out	In	Worst Case	@ GEPSH	GEPSH			0	Profile	11.4
Vel. Lateral Profile U,u'			In	Out	In	Worst Case	@ GEPSH	GEPSH			0	Profile	18.3
Vel. Lateral Profile U,u'			In	Out	In	Worst Case	@ GEPSH	GEPSH			500	Profile	6.3
Vel. Lateral Profile U,u'			In	Out	In	Worst Case	@ GEPSH	GEPSH			500	Profile	11.4
Vel. Lateral Profile U,u'			In	Out	In	Worst Case	@ GEPSH	GEPSH			500	Profile	18.3
Vel. Vertical Profile U,u',w',uw,T			In	Out	In	Worst Case	@ GEPSH	GEPSH			0	0	Profile
Vel. Vertical Profile U,u',w',uw,T			In	Out	In	Worst Case	@ GEPSH	GEPSH			250	0	Profile
Vel. Vertical Profile U,u',w',uw,T			In	Out	In	Worst Case	@ GEPSH	GEPSH			500	0	Profile
Visualization of Plume Elevation			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	Profile	0	Profile
Visualization of Plume Elevation			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	Profile	0	Profile
Conc. Ground Level Profile			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	Profile	Profile	0.0
Conc. Ground Level Profile			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	Profile	Profile	0.0
Conc. Ground Level Profile Detail			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	Profile	Profile	0.0
Conc. Ground Level Profile Detail			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	Profile	Profile	0.0
Conc. Ground Level Profile Detail			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	Profile	Profile	0.0
Conc. Ground Level Profile Detail			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	Profile	Profile	0.0
Conc. Ground Level Profile Detail			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	Profile	Profile	0.0
Conc. Ground Level Profile Detail			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	Profile	Profile	0.0
Conc. Vertical & Lateral Profile			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	125	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	125	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	250	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	250	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	@GL Max	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	@GL Max	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	Out	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	500	Profile	Profile
Conc. Vertical & Lateral Profile			In	In	In	Worst Case	@ GEPSH	GEPSH	GEPSH	299.9	500	Profile	Profile

Table 8 Continued

Atmospheric Dispersion Comparability Test Centerline Velocity Profiles ADCVRES2.WK3 Sheet A:

Run No. =	Average of 43, 44, 45				Location =	(avg,0,Z)								
FIELD VALUES					NORMALIZED VALUES					MODEL VALUES				
Height (m)	Velocity (m/s)	Long. T.I. (%)	Vert. T.I. (%)	Re Stress	Height	Velocity	Long. T.I. (%)	Vert. T.I. (%)	Re Stress	Height (cm)	Velocity (cm/s)	Long. T.I. (%)	Vert. T.I. (%)	Re Stress $(cm/s)^2$
0.2														
4.0	9.7	26.5	13.1	0.62	0.088	0.570	26.5	13.1	0.62	1.0	142.4	26.5	13.1	−210.5
10.0	12.7	20.7	10.7	0.60	0.219	0.747	20.7	10.7	0.60	2.5	186.7	20.7	10.7	−202.6
16.0	13.9	19.4	10.0	0.59	0.350	0.820	19.4	10.0	0.59	4.0	204.9	19.4	10.0	−200.6
25.0	15.4	16.8	9.7	0.64	0.547	0.903	16.8	9.7	0.64	6.3	225.9	16.8	9.7	−217.4
30.0	15.8	16.1	9.1	0.57	0.656	0.931	16.1	9.1	0.57	7.5	232.8	16.1	9.1	−193.3
45.7	16.9	14.7	9.2	0.66	1.000	0.992	14.7	9.2	0.66	11.4	248.0	14.7	9.2	−225.0
60.0	17.7	13.0	8.7	0.58	1.313	1.043	13.0	8.7	0.58	15.0	260.7	13.0	8.7	−195.0
80.0	18.4	12.2	8.8	0.61	1.751	1.084	12.2	8.8	0.61	20.0	271.1	12.2	8.8	−206.4
100.0	19.2	11.2	8.6	0.62	2.188	1.127	11.2	8.6	0.62	25.0	281.6	11.2	8.6	−211.0
140.0	19.9	10.9	8.5	0.63	3.063	1.171	10.9	8.5	0.63	35.0	292.7	10.9	8.5	−211.7
200.0	21.4	9.9	8.0	0.67	4.376	1.259	9.9	8.0	0.67	50.0	314.6	9.9	8.0	−226.9
300.0	23.7	8.2	7.1	0.58	6.565	1.394	8.2	7.1	0.58	75.0	348.4	8.2	7.1	−195.6
400.0	26.0	7.0	6.3	0.58	8.753	1.528	7.0	6.3	0.58	100.0	381.9	7.0	6.3	−196.0
500.0	27.6	5.5	5.3	0.32	10.941	1.624	5.5	5.3	0.32	125.0	406.0	5.5	5.3	−109.0
References										References				
45.7	17.0			1.25					18.4	11.4	250.0			250.0
Roughness Length (m) =				0.20						Roughness Length (cm) =				0.05
Displacement Height (m) =				0.00						Displacement Height (cm) =				0.00
Friction Velocity (m/s) =				1.25						Friction Velocity (cm/s) =				18.40
Power Law Index =				0.18						Power Law Index =				0.18

Table 9 ADCT Reference Velocity and Turbulence Profiles

Atmospheric Dispersion Comparability Test Centerline Velocity Profiles ADCVRES2.WK3 Sheet B:

Run No. =	43				Location =	(0,0,Z)								
FIELD VALUES					NORMALIZED VALUES					MODEL VALUES				
Height (m)	Velocity (m/s)	Long. T.I. (%)	Vert. T.I. (%)	Re Stress	Height	Velocity	Long. T.I. (%)	Vert. T.I. (%)	Re Stress	Height (cm)	Velocity (cm/s)	Long. T.I. (%)	Vert. T.I. (%)	Re Stress $(cm/s)^2$
0.0														
4.0	9.3	27.2	13.5	0.66	0.088	0.547	27.2	13.5	0.66	1.0	136.7	27.2	13.5	−223.9
10.0	13.0	20.1	10.7	0.64	0.219	0.764	20.1	10.7	0.64	2.5	191.0	20.1	10.7	−217.9
16.0	13.9	19.1	10.1	0.65	0.350	0.815	19.1	10.1	0.65	4.0	203.8	19.1	10.1	−220.5
25.0	15.4	16.5	9.7	0.66	0.547	0.908	16.5	9.7	0.66	6.3	227.1	16.5	9.7	−224.5
30.0	15.8	15.6	9.3	0.54	0.656	0.927	15.6	9.3	0.54	7.5	231.7	15.6	9.3	−183.7
45.7	16.6	14.8	9.8	0.65	1.000	0.975	14.8	9.8	0.65	11.4	243.8	14.8	9.8	−220.5
60.0	17.7	12.3	9.2	0.57	1.313	1.039	12.3	9.2	0.57	15.0	259.8	12.3	9.2	−193.4
80.0	18.2	11.6	8.9	0.49	1.751	1.071	11.6	8.9	0.49	20.0	267.7	11.6	8.9	−165.3
100.0	19.2	10.4	8.5	0.40	2.188	1.130	10.4	8.5	0.40	25.0	282.6	10.4	8.5	−134.8
140.0	19.6	10.8	9.0	0.52	3.063	1.154	10.8	9.0	0.52	35.0	288.4	10.8	9.0	−177.6
200.0	21.2	9.8	8.2	0.56	4.376	1.248	9.8	8.2	0.56	50.0	311.9	9.8	8.2	−190.8
300.0	23.0	7.9	7.4	0.46	6.565	1.354	7.9	7.4	0.46	75.0	338.5	7.9	7.4	−155.9
400.0	25.4	7.1	6.7	0.58	8.753	1.494	7.1	6.7	0.58	100.0	373.6	7.1	6.7	−195.1
500.0	27.3	5.6	5.9	0.22	10.941	1.606	5.6	5.9	0.22	125.0	401.5	5.6	5.9	−76.0
References										References				
45.7	17.0			1.25					18.4	11.4	250.0			250.0

Atmospheric Dispersion Comparability Test Centerline Velocity Profiles ADCVRES2.WK3 Sheet C:

Run No. =	44				Location =	(1000,0,Z)								
FIELD VALUES					NORMALIZED VALUES					MODEL VALUES				
Height (m)	Velocity (m/s)	Long. T.I. (%)	Vert. T.I. (%)	Re Stress	Height	Velocity	Long. T.I. (%)	Vert. T.I. (%)	Re Stress	Height (cm)	Velocity (cm/s)	Long. T.I. (%)	Vert. T.I. (%)	Re Stress $(cm/s)^2$
0.0														
0.0	9.9	26.5	12.6	0.56	0.000	0.581	26.5	12.6	0.56		145.2	26.5	12.6	−188.9
10.0	12.5	20.8	10.7	0.57	0.219	0.738	20.8	10.7	0.57	2.5	184.4	20.8	10.7	−193.9
16.0	13.9	19.6	10.4	0.61	0.350	0.815	19.6	10.4	0.61	4.0	203.8	19.6	10.4	−208.1
25.0	15.3	17.3	9.6	0.69	0.547	0.900	17.3	9.6	0.69	6.3	224.9	17.3	9.6	−232.0
30.0	15.5	16.6	9.4	0.63	0.656	0.910	16.6	9.4	0.63	7.5	227.6	16.6	9.4	−212.7
45.7	16.6	15.1	9.0	0.64	1.000	0.976	15.1	9.0	0.64	11.4	244.0	15.1	9.0	−215.1
60.0	17.5	13.6	8.7	0.56	1.313	1.032	13.6	8.7	0.56	15.0	258.0	13.6	8.7	−190.0
80.0	18.3	12.6	9.0	0.72	1.751	1.077	12.6	9.0	0.72	20.0	269.3	12.6	9.0	−242.7
100.0	19.2	11.7	8.6	0.77	2.188	1.130	11.7	8.6	0.77	25.0	282.6	11.7	8.6	−260.4
140.0	19.6	11.3	8.5	0.66	3.063	1.154	11.3	8.5	0.66	35.0	288.6	11.3	8.5	−224.6
200.0	21.2	10.0	8.0	0.60	4.376	1.248	10.0	8.0	0.60	50.0	312.0	10.0	8.0	−201.6
300.0	23.7	8.2	7.0	0.63	6.565	1.394	8.2	7.0	0.63	75.0	348.5	8.2	7.0	−213.1
400.0	25.9	7.3	6.2	0.56	8.753	1.521	7.3	6.2	0.56	100.0	380.3	7.3	6.2	−190.7
500.0	27.6	5.4	5.1	0.31	10.941	1.625	5.4	5.1	0.31	125.0	406.3	5.4	5.1	−106.3
References										References				
45.7	17.0			1.25					18.4	11.4	250.0			250.0

Atmospheric Dispersion Comparability Test Centerline Velocity Profiles ADCVRES2.WK3 Sheet D:

Run No. =	45				Location =	(2000,0,Z)								
FIELD VALUES					NORMALIZED VALUES					MODEL VALUES				
Height (m)	Velocity (m/s)	Long. T.I. (%)	Vert. T.I. (%)	Re Stress	Height	Velocity	Long. T.I. (%)	Vert. T.I. (%)	Re Stress	Height (cm)	Velocity (cm/s)	Long. T.I. (%)	Vert. T.I. (%)	Re Stress $(cm/s)^2$
0.0														
0.0	9.9	25.9	13.0	0.65	0.000	0.582	25.9	13.0	0.65		145.4	25.9	13.0	−218.6
10.0	12.6	21.2	10.7	0.58	0.219	0.739	21.2	10.7	0.58	2.5	184.7	21.2	10.7	−195.9
16.0	14.1	19.6	9.6	0.51	0.350	0.829	19.6	9.6	0.51	4.0	207.2	19.6	9.6	−173.1
25.0	15.3	16.4	9.6	0.58	0.547	0.902	16.4	9.6	0.58	6.3	225.6	16.4	9.6	−195.6
30.0	16.3	16.1	8.7	0.54	0.656	0.956	16.1	8.7	0.54	7.5	239.0	16.1	8.7	−183.6
45.7	17.4	14.3	8.9	0.71	1.000	1.025	14.3	8.9	0.71	11.4	256.2	14.3	8.9	−239.5
60.0	18.0	13.0	8.2	0.60	1.313	1.058	13.0	8.2	0.60	15.0	264.4	13.0	8.2	−201.5
80.0	18.8	12.3	8.6	0.62	1.751	1.105	12.3	8.6	0.62	20.0	276.3	12.3	8.6	−211.3
100.0	19.0	11.6	8.6	0.70	2.188	1.119	11.6	8.6	0.70	25.0	279.7	11.6	8.6	−237.7
140.0	20.5	10.7	8.1	0.69	3.063	1.204	10.7	8.1	0.69	35.0	301.0	10.7	8.1	−232.8
200.0	21.8	10.1	7.8	0.85	4.376	1.280	10.1	7.8	0.85	50.0	320.0	10.1	7.8	−288.4
300.0	24.4	8.4	6.8	0.64	6.565	1.433	8.4	6.8	0.64	75.0	358.2	8.4	6.8	−217.7
400.0	26.7	6.6	6.1	0.60	8.753	1.568	6.6	6.1	0.60	100.0	392.0	6.6	6.1	−202.2
500.0	27.9	5.4	5.0	0.43	10.941	1.641	5.4	5.0	0.43	125.0	410.4	5.4	5.0	−144.8
References										References				
45.7	17.0			1.25					18.4	11.4	250.0			250.0

Table 10 ADCT Downwind Velocity and Turbulence Profile Variation

ADCT Lateral Velocity and Turb. Profiles ADCVRES1.WK3

Model Mean Wind Speed (cm/s) at X = 0 cm

	Y (cm)						
Z (cm)	−90.0	−60.0	−30.0	0.0	30.0	60.0	90.0
2.5	191	180	199	191	189	184	200
6.3	258	235	235	227	237	241	216
11.4	270	241	257	244	242	267	255
25.0	286	280	266	283	278	272	273
Run#=	54	53	52	43	55	56	57

Model Mean Wind Speed (cm/s) at X = 500 cm

	Y (cm)						
Z (cm)	−90.0	−60.0	−30.0	0.0	30.0	60.0	90.0
2.5	220	207	180	185	183	209	192
6.3	233	239	238	226	247	229	250
11.4	270	260	251	256	252	245	279
25.0	281	286	275	280	316	287	309
Run#=	48	47	46	45	49	50	51

Longitudinal Turbulent Intensity (%) at X = 0 cm

	Y (cm)						
Z (cm)	−90.0	−60.0	−30.0	0.0	30.0	60.0	90.0
2.5	19.85	21.51	21.29	20.11	19.45	19.57	22.04
6.3	14.34	16.58	15.52	16.51	16.21	15.53	19.00
11.4	16.08	15.00	12.45	14.75	14.16	11.95	17.82
25.0	11.73	13.38	12.74	10.37	13.00	13.84	12.02
Run#=	54	53	52	43	55	56	57

Longitudinal Turbulent Intensity (%) at X = 500 cm

	Y (cm)						
Z (cm)	−90.0	−60.0	−30.0	0.0	30.0	60.0	90.0
2.5	17.58	22.98	19.17	21.24	19.15	16.10	21.39
6.3	19.55	13.69	16.28	16.45	17.52	18.16	16.66
11.4	14.28	13.89	12.93	14.35	12.64	13.08	13.21
25.0	12.68	13.25	10.56	11.58	8.20	12.00	12.31
Run#=	48	47	46	45	49	50	51

Table 11 ADCT Crosswind Velocity and Turbulence Profile Variation

ADCT Stack Concentration Measurements ADCRES1.WK3 Sheet A:

Field Values (MKS)	Model Values (CGS)	RUN # 11
400	1	< Length Scale
17.0	250.0	< Wind Speed
576.8	530.2	< Flow Rate
22.0	22.0	< Stack Gas Temp. (C)
22.0	22.0	< Ambient Temp. (C)
104.0	26.0	< Effective Stack Height

Field Position X (m)	Y (m)	Z (m)	Model Position X (cm)	Y (cm)	Z (cm)	PG-C K*10⁶ (m⁻²)	Field K*10⁶ (m⁻²)	PG-D K*10⁶ (m⁻²)	Model K*10⁶ (cm⁻²)	Model Conc. (ppm)
500	0	0	125	0	0	4	0	0	8	17
500	0	16	125	0	4	6	1	0	22	47
500	0	32	125	0	8	13	6	1	98	208
500	0	40	125	0	10	19	10	3	160	340
500	0	48	125	0	12	26	18	9	295	626
500	0	56	125	0	14	35	27	19	432	917
500	0	64	125	0	16	45	33	38	531	1127
500	0	72	125	0	18	55	52	66	837	1775
500	0	80	125	0	20	64	69	103	1111	2356
500	0	88	125	0	22	71	80	140	1281	2717
500	0	96	125	0	24	76	90	169	1442	3058
500	0	104	125	0	26	78	91	180	1456	3089
500	0	112	125	0	28	76	93	169	1487	3153
500	0	120	125	0	30	71	87	140	1390	2949
500	0	128	125	0	32	64	79	103	1264	2681
500	0	136	125	0	34	55	67	66	1072	2273
500	0	144	125	0	36	45	59	38	937	1987
500	0	152	125	0	38	35	46	19	734	1557
500	0	160	125	0	40	26	36	9	571	1211
500	0	176	125	0	44	13	20	1	327	692
500	0	192	125	0	48	5	9	0	140	296
500	0	208	125	0	52	2	4	0	61	129
500	0	224	125	0	56	1	2	0	26	56
500	0	240	125	0	60	0	1	0	11	22
500	0	256	125	0	64	0	0	0	3	7
500	0	272	125	0	68	0	0	0	2	3
500	0	288	125	0	72	0	0	0	1	3
500	0	304	125	0	76	0	0	0	1	3
500	0	320	125	0	80	0	0	0	1	3
500	0	336	125	0	84	0	0	0	1	2
500	0	352	125	0	88	0	0	0	1	2
500	0	368	125	0	92	0	0	0	2	3
500	0	384	125	0	96	0	0	0	1	2
500	0	400	125	0	100	0	0	0	1	2
500	0	416	125	0	104	0	0	0	1	2
500	0	432	125	0	108	0	0	0	1	2
500	0	448	125	0	112	0	0	0	1	2
500	0	464	125	0	116	0	0	0	1	2

Table 12 ADCT Vertical Concentration Profile Data; X = 500 meters

ADCT Stack Concentration Measurements ADCRES1.WK3 Sheet B:

Field Values (MKS)			Model Values (CGS)					RUN # 14		
400			1			< Length Scale				
17.0			250.0			< Wind Speed				
576.8			530.2			< Flow Rate				
22.0			22.0			< Stack Gas Temp. (C)				
22.0			22.0			< Ambient Temp. (C)				
104.0			26.0			< Effective Stack Height				
Field Position			Model Position			PG-C	Field	PG-D	Model	Model
X (m)	Y (m)	Z (m)	X (cm)	Y (cm)	Z (cm)	$K*10^6$ (m^{-2})	$K*10^6$ (m^{-2})	$K*10^6$ (m^{-2})	$K*10^6$ (cm^{-2})	Conc. (ppm)
500	−32	104	125	−8	26	65	83	128	1325	2811
500	−24	104	125	−6	26	70	81	149	1300	2757
500	−16	104	125	−4	26	74	89	165	1429	3030
500	−8	104	125	−2	26	77	86	176	1379	2925
500	0	104	125	0	26	78	90	180	1444	3062
500	8	104	125	2	26	77	83	176	1321	2801
500	16	104	125	4	26	74	79	165	1260	2671
500	24	104	125	6	26	70	69	149	1101	2334
500	32	104	125	8	26	65	55	128	885	1876
500	40	104	125	10	26	59	53	106	850	1802
500	48	104	125	12	26	52	44	84	701	1487
500	56	104	125	14	26	45	35	64	558	1184
500	64	104	125	16	26	38	25	47	405	859
500	72	104	125	18	26	32	19	33	304	645
500	80	104	125	20	26	26	13	22	214	453
500	88	104	125	22	26	20	9	14	150	319
500	96	104	125	24	26	16	6	9	98	207
500	104	104	125	26	26	12	4	5	71	150
500	112	104	125	28	26	9	3	3	50	106
500	120	104	125	30	26	6	2	2	36	77
500	128	104	125	32	26	5	1	1	23	49
500	144	104	125	36	26	2	1	0	10	20
500	160	104	125	40	26	1	0	0	3	5
500	176	104	125	44	26	0	0	0	1	3
500	192	104	125	48	26	0	0	0	1	2
500	208	104	125	52	26	0	0	0	1	1
500	224	104	125	56	26	0	0	0	1	1
500	240	104	125	60	26	0	0	0	1	1
500	256	104	125	64	26	0	0	0	0	1
500	272	104	125	68	26	0	0	0	2	4
500	288	104	125	72	26	0	0	0	0	1
500	304	104	125	76	26	0	0	0	0	1
500	320	104	125	80	26	0	0	0	0	1
500	336	104	125	84	26	0	0	0	4	9
500	352	104	125	88	26	0	0	0	0	1

Table 13 ADCT Lateral Concentration Profile Data; X = 500 meters

ADCT Stack Concentration Measurements ADCRES1.WK3 Sheet C:

Field Values (MKS)	Model Values (CGS)	RUN # 10
400	1	< Length Scale
17.0	250.0	< Wind Speed
576.8	530.2	< Flow Rate
22.0	22.0	< Stack Gas Temp. (C)
22.0	22.0	< Ambient Temp. (C)
104.0	26.0	< Effective Stack Height

Field Position X (m)	Field Position Y (m)	Field Position Z (m)	Model Position X (cm)	Model Position Y (cm)	Model Position Z (cm)	PG–C K*10⁶ (m⁻²)	Field K*10⁶ (m⁻²)	PG–D K*10⁶ (m⁻²)	Model K*10⁶ (cm⁻²)	Model Conc. (ppm)
1000	0	0	250	0	0	15	7	3	112	238
1000	0	16	250	0	4	15	9	4	148	313
1000	0	32	250	0	8	16	14	9	229	486
1000	0	48	250	0	12	18	21	19	328	696
1000	0	64	250	0	16	19	21	32	343	727
1000	0	72	250	0	18	20	27	39	436	926
1000	0	80	250	0	20	21	30	45	478	1014
1000	0	88	250	0	22	21	30	50	473	1003
1000	0	96	250	0	24	21	32	54	513	1088
1000	0	104	250	0	26	21	32	55	517	1097
1000	0	112	250	0	28	21	32	54	504	1070
1000	0	120	250	0	30	20	31	50	489	1037
1000	0	128	250	0	32	20	29	45	472	1001
1000	0	144	250	0	36	18	26	32	417	884
1000	0	160	250	0	40	16	22	19	352	746
1000	0	176	250	0	44	13	18	9	287	609
1000	0	192	250	0	48	10	13	4	203	430
1000	0	208	250	0	52	8	10	1	155	328
1000	0	224	250	0	56	5	7	0	112	238
1000	0	240	250	0	60	4	5	0	74	157
1000	0	256	250	0	64	2	3	0	45	95
1000	0	272	250	0	68	1	2	0	28	59
1000	0	288	250	0	72	1	1	0	15	33
1000	0	304	250	0	76	0	1	0	9	19
1000	0	320	250	0	80	0	0	0	5	10
1000	0	336	250	0	84	0	0	0	3	6
1000	0	352	250	0	88	0	0	0	2	3
1000	0	368	250	0	92	0	0	0	2	4
1000	0	384	250	0	96	0	0	0	1	3
1000	0	400	250	0	100	0	0	0	1	3
1000	0	416	250	0	104	0	0	0	1	3
1000	0	432	250	0	108	0	0	0	1	3
1000	0	448	250	0	112	0	0	0	1	3
1000	0	464	250	0	116	0	0	0	2	3

Table 14 ADCT Vertical Concentration Profile Data; X = 1000 meters

ADCT Stack Concentration Measurements ADCRES1.WK3 Sheet D:

Field Values (MKS)			Model Values (CGS)					RUN # 13		
400			1			< Length Scale				
17.0			250.0			< Wind Speed				
576.8			530.2			< Flow Rate				
22.0			22.0			< Stack Gas Temp. (C)				
22.0			22.0			< Ambient Temp. (C)				
104.0			26.0			< Effective Stack Height				
Field Position			Model Position			PG−C	Field	PG−D	Model	Model
X (m)	Y (m)	Z (m)	X (cm)	Y (cm)	Z (cm)	K*10⁶ (m⁻²)	K*10⁶ (m⁻²)	K*10⁶ (m⁻²)	K*10⁶ (cm⁻²)	Conc. (ppm)
1000	−32	104	250	−8	26	20	32	50	513	1087
1000	−24	104	250	−6	26	21	31	52	489	1037
1000	−16	104	250	−4	26	21	33	54	533	1130
1000	−8	104	250	−2	26	21	31	55	502	1066
1000	0	104	250	0	26	21	34	55	546	1157
1000	8	104	250	2	26	21	32	55	514	1090
1000	16	104	250	4	26	21	32	54	514	1090
1000	24	104	250	6	26	21	30	52	477	1011
1000	32	104	250	8	26	20	26	50	409	867
1000	40	104	250	10	26	20	28	48	443	939
1000	48	104	250	12	26	19	26	45	418	886
1000	56	104	250	14	26	18	24	42	376	798
1000	64	104	250	16	26	18	23	39	368	780
1000	72	104	250	18	26	17	19	35	308	654
1000	80	104	250	20	26	16	18	32	290	616
1000	88	104	250	22	26	15	16	28	248	526
1000	96	104	250	24	26	14	15	25	237	503
1000	104	104	250	26	26	13	12	22	199	422
1000	112	104	250	28	26	12	12	19	185	393
1000	120	104	250	30	26	11	10	16	153	325
1000	128	104	250	32	26	10	8	13	132	280
1000	144	104	250	36	26	8	6	9	91	193
1000	160	104	250	40	26	7	4	6	57	120
1000	176	104	250	44	26	5	2	4	38	81
1000	192	104	250	48	26	4	2	2	26	56
1000	208	104	250	52	26	3	1	1	17	37
1000	224	104	250	56	26	2	1	1	9	18
1000	240	104	250	60	26	2	0	0	4	9
1000	256	104	250	64	26	1	0	0	2	5
1000	272	104	250	68	26	1	0	0	1	2
1000	288	104	250	72	26	0	0	0	1	2
1000	304	104	250	76	26	0	0	0	1	1
1000	320	104	250	80	26	0	0	0	0	1
1000	336	104	250	84	26	0	0	0	1	2
1000	352	104	250	88	26	0	0	0	0	1

Table 15 ADCT Lateral Concentration Profile Data; X = 1000 meters

ADCT Stack Concentration Measurements ADCRES1.WK3 Sheet E:

Field Values (MKS)	Model Values (CGS)		RUN # 9
400	1	< Length Scale	
17.0	250.0	< Wind Speed	
576.8	530.2	< Flow Rate	
22.0	22.0	< Stack Gas Temp. (C)	
22.0	22.0	< Ambient Temp. (C)	
104.0	26.0	< Effective Stack Height	

Field Position X (m)	Y (m)	Z (m)	Model Position X (cm)	Y (cm)	Z (cm)	PG-C K*10^6 (m^-2)	Field K*10^6 (m^-2)	PG-D K*10^6 (m^-2)	Model K*10^6 (cm^-2)	Model Conc. (ppm)
1500	0	0	375	0	0	12	13	7	202	429
1500	0	16	375	0	4	12	13	8	206	436
1500	0	32	375	0	8	12	14	11	227	481
1500	0	48	375	0	12	12	15	15	247	525
1500	0	64	375	0	16	12	14	21	227	482
1500	0	80	375	0	20	12	18	25	283	600
1500	0	96	375	0	24	11	18	28	286	607
1500	0	112	375	0	28	11	18	28	287	608
1500	0	128	375	0	32	10	17	25	276	586
1500	0	144	375	0	36	10	15	21	247	523
1500	0	160	375	0	40	9	13	15	214	454
1500	0	176	375	0	44	8	12	10	185	392
1500	0	192	375	0	48	7	10	6	154	327
1500	0	208	375	0	52	6	8	3	127	269
1500	0	224	375	0	56	5	6	2	103	219
1500	0	240	375	0	60	4	5	1	80	170
1500	0	256	375	0	64	3	4	0	59	126
1500	0	272	375	0	68	3	3	0	43	92
1500	0	288	375	0	72	2	2	0	31	67
1500	0	304	375	0	76	2	1	0	20	43
1500	0	320	375	0	80	1	1	0	14	29
1500	0	336	375	0	84	1	1	0	9	19
1500	0	352	375	0	88	1	0	0	6	13
1500	0	368	375	0	92	0	0	0	4	9
1500	0	384	375	0	96	0	0	0	3	6
1500	0	400	375	0	100	0	0	0	2	4
1500	0	416	375	0	104	0	0	0	1	3
1500	0	432	375	0	108	0	0	0	1	3
1500	0	448	375	0	112	0	0	0	1	2
1500	0	448	375	0	112	0	0	0	1	2
1500	0	464	375	0	116	0	0	0	1	3
1500	0	464	375	0	116	0	0	0	1	3

Table 16 ADCT Vertical Concentration Profile Data; X = 1500 meters

ADCT Stack Concentration Measurements ADCRES1.WK3 Sheet F:

Field Values (MKS)			Model Values (CGS)					RUN # 12		
400			1			< Length Scale				
17.0			250.0			< Wind Speed				
576.8			530.2			< Flow Rate				
22.0			22.0			< Stack Gas Temp. (C)				
22.0			22.0			< Ambient Temp. (C)				
104.0			26.0			< Effective Stack Height				
Field Position			Model Position			PG–C	Field	PG–D	Model	Model
X	Y	Z	X	Y	Z	K*10⁶	K*10⁶	K*10⁶	K*10⁶	Conc.
(m)	(m)	(m)	(cm)	(cm)	(cm)	(m^{-2})	(m^{-2})	(m^{-2})	(cm^{-2})	(ppm)
1500	−32	104	375	−8	26	11	18	27	289	612
1500	−24	104	375	−6	26	11	17	28	274	582
1500	−16	104	375	−4	26	11	19	28	297	629
1500	−8	104	375	−2	26	11	18	28	281	596
1500	0	104	375	0	26	11	19	28	300	635
1500	8	104	375	2	26	11	18	28	289	612
1500	16	104	375	4	26	11	19	28	305	646
1500	24	104	375	6	26	11	18	28	293	622
1500	32	104	375	8	26	11	16	27	251	533
1500	40	104	375	10	26	11	18	27	288	611
1500	48	104	375	12	26	11	19	26	302	640
1500	56	104	375	14	26	11	18	25	280	594
1500	64	104	375	16	26	10	18	24	283	601
1500	80	104	375	20	26	10	16	22	253	538
1500	96	104	375	24	26	9	14	20	222	471
1500	112	104	375	28	26	9	12	17	194	411
1500	128	104	375	32	26	8	10	15	163	346
1500	144	104	375	36	26	7	9	12	137	290
1500	160	104	375	40	26	7	6	10	100	213
1500	176	104	375	44	26	6	5	8	76	162
1500	192	104	375	48	26	5	4	7	60	127
1500	208	104	375	52	26	5	3	5	42	89
1500	224	104	375	56	26	4	2	4	28	59
1500	240	104	375	60	26	3	1	3	17	35
1500	256	104	375	64	26	3	1	2	13	27
1500	272	104	375	68	26	2	1	1	8	18
1500	288	104	375	72	26	2	0	1	5	11
1500	304	104	375	76	26	2	0	1	3	7
1500	320	104	375	80	26	1	0	0	2	4
1500	336	104	375	84	26	1	0	0	2	4
1500	352	104	375	88	26	1	0	0	1	1
1500	368	104	375	92	26	1	0	0	1	1
1500	384	104	375	96	26	0	0	0	0	1
1500	400	104	375	100	26	0	0	0	0	1
1500	416	104	375	104	26	0	0	0	0	1
1500	432	104	375	108	26	0	0	0	0	1

Table 17 ADCT Lateral Concentration Profile Data; X = 1500 meters

ADCT Stack Concentration Measurements ADCRES1.WK3 Sheet G:

Field Values (MKS)	Model Values (CGS)	RUN # 15
400	1	< Length Scale
17.0	250.0	< Wind Speed
576.8	530.2	< Flow Rate
22.0	22.0	< Stack Gas Temp. (C)
22.0	22.0	< Ambient Temp. (C)
104.0	26.0	< Effective Stack Height

Field Position X (m)	Y (m)	Z (m)	Model Position X (cm)	Y (cm)	Z (cm)	PG–C $K*10^6$ (m^{-2})	Field $K*10^6$ (m^{-2})	PG–D $K*10^6$ (m^{-2})	Model $K*10^6$ (cm^{-2})	Model Conc. (ppm)
200	0	0	50	0	0	0	0	0	0	1
300	0	0	75	0	0	0	0	0	0	0
400	0	0	100	0	0	1	0	0	1	2
700	0	0	175	0	0	11	2	0	25	54
800	0	0	200	0	0	14	4	1	59	125
900	0	0	225	0	0	15	5	2	82	174
1000	0	0	250	0	0	15	7	3	113	241
1100	0	0	275	0	0	15	8	4	135	287
1200	0	0	300	0	0	14	10	4	160	339
1300	0	0	325	0	0	14	11	5	173	366
1400	0	0	350	0	0	13	11	6	182	387
1500	0	0	375	0	0	12	12	7	189	400
1600	0	0	400	0	0	11	12	7	194	412
1700	0	0	425	0	0	11	13	7	203	430
1800	0	0	450	0	0	10	13	8	204	432
1900	0	0	475	0	0	9	13	8	202	429
2000	0	0	500	0	0	9	13	8	201	426
2100	0	0	525	0	0	8	12	8	198	420
500	−60	0	125	−15	0	2	0	0	6	13
500	−40	0	125	−10	0	3	1	0	14	29
500	−20	0	125	−5	0	4	1	0	22	47
500	20	0	125	5	0	4	1	0	13	28
500	40	0	125	10	0	3	0	0	6	13
500	60	0	125	15	0	2	0	0	2	4
1000	−60	0	250	−15	0	13	5	2	86	183
1000	−40	0	250	−10	0	14	6	2	103	219
1000	−20	0	250	−5	0	15	7	2	114	242
1000	0	0	250	0	0	15	7	3	113	241
1000	20	0	250	5	0	15	7	2	116	246
1000	40	0	250	10	0	14	7	2	111	235
1000	60	0	250	15	0	13	6	2	97	205
1500	−60	0	375	−15	0	11	10	6	162	343
1500	−40	0	375	−10	0	12	11	6	177	376
1500	−20	0	375	−5	0	12	12	6	187	397
1500	0	0	375	0	0	12	12	7	189	400
1500	20	0	375	5	0	12	12	6	187	396
1500	40	0	375	10	0	12	11	6	178	377
1500	60	0	375	15	0	11	10	6	159	337
2000	−60	0	500	−15	0	8	11	7	173	368
2000	−40	0	500	−10	0	9	12	8	189	401
2000	−20	0	500	−5	0	9	12	8	197	419
2000	0	0	500	0	0	9	13	8	201	426
2000	20	0	500	5	0	9	12	8	197	419
2000	40	0	500	10	0	9	12	8	188	399
2000	60	0	500	15	0	8	10	7	165	350

Table 18 ADCT Ground Level Concentration Profile Data

GEP Reynolds Number Invariance Test Velocity Profiles {REYVRES.WK3 A:}

Run Number =			59			60		
Wind Direction =			140.0			140.0		
Ref Wind Speed (cm/s) =			472.7			954.2		
Model Location (cm) =			(0,0,z)			(0,0,z)		
Field Height (m)	Model Height (cm)	Normalized Height	Model Velocity (cm/s)	Normalized Velocity	Turbulent Intensity (%)	Model Velocity (cm/s)	Normalized Velocity	Turbulent Intensity (%)
10.0	2.5	0.020	108.3	0.23	45.2	243	0.25	44.9
16.0	4.0	0.032	128.1	0.27	44.1	273	0.29	44.4
25.0	6.3	0.050	159.8	0.34	40.8	332	0.35	39.7
30.0	7.5	0.060	178.9	0.38	36.8	377	0.40	36.1
45.7	11.4	0.091	253.4	0.54	21.8	514	0.54	22.4
60.0	15.0	0.120	269.9	0.57	16.7	568	0.60	16.3
80.0	20.0	0.160	284.9	0.60	15.2	587	0.62	14.9
100.0	25.0	0.200	295.6	0.63	14.1	625	0.66	13.3
140.0	35.0	0.280	314.4	0.67	13.0	654	0.69	12.2
200.0	50.0	0.400	344.5	0.73	11.2	704	0.74	10.6
300.0	75.0	0.600	386.8	0.82	9.7	797	0.83	8.5
400.0	100.0	0.800	428.5	0.91	7.6	875	0.92	7.6
500.0	125.0	1.000	472.7	1.00	6.0	954	1.00	5.7

Table 19 Reynolds No. Invariance Test Velocity and Turbulence Profiles, 140° Wind Direction

GEP Reynolds Number Invariance Test Velocity Profiles {REYVRES.WK3 B:}

Run Number =			61			62		
Wind Direction =			325.0			325.0		
Ref Wind Speed (cm/s) =			465.5			951.0		
Model Location (cm) =			(0,0,z)			(0,0,z)		
Field Height (m)	Model Height (cm)	Normalized Height	Model Velocity (cm/s)	Normalized Velocity	Turbulent Intensity (%)	Model Velocity (cm/s)	Normalized Velocity	Turbulent Intensity (%)
10.0	2.5	0.020	161.4	0.35	32.9	351	0.37	30.5
16.0	4.0	0.032	176.0	0.38	31.4	378	0.40	29.3
25.0	6.3	0.050	199.2	0.43	29.1	414	0.44	28.6
30.0	7.5	0.060	204.0	0.44	29.1	447	0.47	26.6
45.7	11.4	0.091	236.9	0.51	24.6	503	0.53	22.6
60.0	15.0	0.120	267.9	0.58	18.2	574	0.60	17.0
80.0	20.0	0.160	284.2	0.61	16.3	611	0.64	14.3
100.0	25.0	0.200	310.6	0.67	13.2	635	0.67	12.2
140.0	35.0	0.280	324.9	0.70	11.2	672	0.71	10.9
200.0	50.0	0.400	337.9	0.73	11.1	720	0.76	10.2
300.0	75.0	0.600	389.0	0.84	8.1	798	0.84	8.2
400.0	100.0	0.800	423.3	0.91	7.8	873	0.92	7.6
500.0	125.0	1.000	465.5	1.00	6.2	951	1.00	5.8

Table 20 Reynolds No. Invariance Test Velocity and Turbulence Profiles, 325° Wind Direction

GEP Reynolds Number Invariance Tests (140 degree) {REYRES.WK3 A:}

RUN NO.						16		17		
RELEASE HEIGHT (m)						45.7		45.7		
WIND DIRECTION						140.0		140.0		
Model Velocity (cm/s)						473.0		954.0		
Model Release Flow Rate (ccs)						95.8		95.8		
Field Dist.			Model Dist.			Model	Field	Model	Field	Difference
X	Y	Z	X	Y	Z	Conc.	K_i*10^6	Conc.	K_i*10^6	in K_i
(m)	(m)	(m)	(cm)	(cm)	(cm)	(ppm)	(m^{-2})	(ppm)	(m^{-2})	(%)
320	0	0	80	0	0	915	282	446	277	1.7
372	0	0	93	0	0	964	298	462	287	3.5
420	0	0	105	0	0	985	304	476	297	2.4
472	0	0	118	0	0	933	288	457	284	1.2
520	0	0	130	0	0	874	270	432	269	0.4
620	0	0	155	0	0	755	233	375	234	−0.3
672	0	0	168	0	0	683	211	339	211	−0.3
760	0	0	190	0	0	594	183	292	182	0.9
840	0	0	210	0	0	534	165	262	163	0.9
920	0	0	230	0	0	487	150	238	148	1.4
1000	0	0	250	0	0	443	137	215	134	1.9
1080	0	0	270	0	0	411	127	199	124	2.4
1160	0	0	290	0	0	370	114	180	112	1.7
1240	0	0	310	0	0	339	104	166	103	1.1
1320	0	0	330	0	0	315	97	155	97	0.7
1400	0	0	350	0	0	295	91	144	89	1.8
1480	0	0	370	0	0	271	84	134	83	0.4
1560	0	0	390	0	0	248	76	121	76	1.1
1640	0	0	410	0	0	242	75	118	74	1.4
1720	0	0	430	0	0	225	69	110	69	1.1
1800	0	0	450	0	0	214	66	104	65	1.9
1960	0	0	490	0	0	191	59	95	59	−0.2
2040	0	0	510	0	0	186	58	91	57	1.0
2120	0	0	530	0	0	176	54	86	53	1.7

Table 21 GEP Reynolds Number Invariance Concentration Results for 140° Wind Direction

GEP Reynolds Number Invariance Tests (325 degree) {REYRES.WK3 B:}

RUN NO.						18		19		
RELEASE HEIGHT (m)						61.0		61.0		
WIND DIRECTION						325.0		325.0		
Model Velocity (cm/s)						465.5		951.0		
Model Release Flow Rate (ccs)						95.8		95.8		
Field Dist.			Model Dist.			Model	Field	Model	Field	Difference
X	Y	Z	X	Y	Z	Conc.	K_j*10^6	Conc.	K_j*10^6	in K_j
(m)	(m)	(m)	(cm)	(cm)	(cm)	(ppm)	(m^{-2})	(ppm)	(m^{-2})	(%)
160	0	0	40	0	0	1974	600	1020	633	-5.6
212	0	0	53	0	0	2590	787	1221	758	3.7
260	0	0	65	0	0	2243	681	1067	662	2.8
360	0	0	90	0	0	1603	487	760	472	3.1
460	0	0	115	0	0	1206	366	574	356	2.9
560	0	0	140	0	0	978	297	466	289	2.7
664	0	0	166	0	0	779	237	378	234	1.0
760	0	0	190	0	0	643	195	311	193	1.4
840	0	0	210	0	0	579	176	275	170	3.0
920	0	0	230	0	0	506	154	236	147	4.5
1000	0	0	250	0	0	459	139	215	133	4.3
1080	0	0	270	0	0	421	128	196	121	5.1
1160	0	0	290	0	0	381	116	177	110	5.1
1240	0	0	310	0	0	351	107	161	100	6.5
1320	0	0	330	0	0	325	99	148	92	6.9
1400	0	0	350	0	0	302	92	137	85	7.5
1480	0	0	370	0	0	270	82	124	77	6.3
1560	0	0	390	0	0	243	74	112	69	6.0
1640	0	0	410	0	0	242	74	108	67	8.5
1720	0	0	430	0	0	224	68	101	63	8.1
1800	0	0	450	0	0	215	65	97	60	8.0
1880	0	0	470	0	0	205	62	92	57	8.2
1960	0	0	490	0	0	194	59	88	54	7.7
2040	0	0	510	0	0	189	57	85	53	8.0
2120	0	0	530	0	0	174	53	77	48	9.4

Table 22 GEP Reynolds Number Invariance Concentration Results for 325° Wind Direction

GEP Stack Height Determination Tests Series Reference Velocity Profile {GEPVRES.WK3}

Run No. =	58		Location =Upwind Ref.						
FIELD VALUES			NORMALIZED VALUES			MODEL VALUES			
Height (m)	Velocity (m/s)	Long. T.I. (%)	Height	Velocity	Long. T.I. (%)	Height (cm)	Norm Vel. (cm/s)	Velocity (cm/s)	Long. T.I. (%)
0.5									
10.0	11.5	26.7	0.219	0.674	26.7	2.5	168.6	178.8	26.7
16.0	12.5	24.9	0.350	0.736	24.9	4.0	184.1	195.3	24.9
25.0	14.9	20.9	0.547	0.879	20.9	6.3	219.8	233.1	20.9
30.0	14.9	22.0	0.656	0.875	22.0	7.5	218.8	232.1	22.0
45.7	17.0	18.9	1.000	1.000	18.9	11.4	250.0	265.2	18.9
60.0	17.2	17.2	1.313	1.014	17.2	15.0	253.5	268.9	17.2
80.0	18.4	15.0	1.751	1.080	15.0	20.0	270.0	286.4	15.0
100.0	19.4	13.9	2.188	1.142	13.9	25.0	285.6	302.9	13.9
140.0	20.3	12.8	3.063	1.193	12.8	35.0	298.2	316.3	12.8
200.0	21.8	12.2	4.376	1.284	12.2	50.0	321.1	340.6	12.2
300.0	24.8	9.7	6.565	1.460	9.7	75.0	365.0	387.2	9.7
400.0	27.3	8.2	8.753	1.606	8.2	100.0	401.6	426.0	8.2
500.0	30.2	7.2	10.941	1.779	7.2	125.0	444.8	471.8	7.2
References						References			
45.7	17.0					11.4	250.0	265.2	
Roughness Length (m)		0.50				Roughness Length (cm) =			0.13
Displacement Height (m		0.00				Displacement Height (cm) =			0.00
Friction Velocity (m/s) =		1.49				Friction Velocity (cm/s) =			21.90
Power Law Index =		0.21				Power Law Index =			0.21

Table 23 GEP Reference Velocity and Turbulence Profiles

Visual Test Results {VISRES.WK3}

Visual Run No.	Equil. Conc. Run No.	Building Config.	Stack Height (m)	Wind Direction (deg)	Tape Index (CSU)	Stack Downwash	LNG Tank Impingement	LNG Tank Downwash	Silo Bldg. Impingement	Silo Bldg. Downwash
1	20	Out	45.7	140	00:46	B	–	–	–	–
2	21	In	45.7	140	02:02	B	F	F		
3	22	In all	45.7	140	04:11	B	F	F		
4	24	Out	61.0	140	06:32	B	–	–	–	–
5	25	In	61.0	140	08:23	B	D	F		
6	26	Out	73.1	140	11:28	C	–	–	–	–
7	27	In	73.1	140	13:01	C	C	D		
8	28	Out	73.1	150	15:35	C	–	–	–	–
9	29	In	73.1	150	17:11	C	C	D		
10	30	Out	61.0	150	19:35	B	–	–	–	–
11	31	In	61.0	150	21:03	B	D	F		
12	32	Out	61.0	320	23:30	B	–	–	–	–
13	33	In	61.0	320	24:50	B			B	C
14	34	Out	73.1	320	27:06	C	–	–	–	–
15	35	In	73.1	320	28:50	C			A	B
16	36	Out	73.1	325	31:01	C	–	–	–	–
17	37	In	73.1	325	32:41	C			A	B
18	38	Out	61.0	325	34:51	B	–	–	–	–
19	39	In	61.0	325	36:11	B			C	D

Note : Plume characteristics are evaluated on a A to F scale,
A being not noticeable, F being very noticeable

Table 24 GEP Visual Test Results

GEP Stack Height Determination Test Results

RUN NO.				20	21	22
Equil. Visual Run No.				1	2	3
STACK (m)				45.7	45.7	45.7
WIND DIR.				140	140	140
CONFIG.				OUT	IN	INall
Field Dist.		Model Dist.				
X (m)	Y (m)	X (cm)	Y (cm)	$K*10^6$ (m^{-2})	$K*10^6$ (m^{-2})	$K*10^6$ (m^{-2})
200	0	50	0	7	156	275
300	0	75	0	26	183	190
400	0	100	0	53	202	211
500	0	125	0	57	183	195
600	0	150	0	63	155	169
700	0	175	0	68	133	144
800	0	200	0	68	117	127
900	0	225	0	67	104	114
1000	0	250	0	65	94	105
1100	0	275	0	60	83	93
1200	0	300	0	56	75	84
1300	0	325	0	53	69	77
1400	0	350	0	51	63	70
1500	0	375	0	46	59	64
1600	0	400	0	44	53	58
1800	0	450	0	39	46	50
1900	0	475	0	38	43	47
2000	0	500	0	37	41	45
2100	0	525	0	34	39	42
300	−40	75	−10	7	140	143
300	−20	75	−5	20	170	177
300	0	75	0	26	183	190
300	20	75	5	14	216	202
300	40	75	10	16	192	188
500	−40	125	−10			
500	−20	125	−5			
500	0	125	0	57	183	195
500	20	125	5	51	185	194
500	40	125	10	40	164	169
1000	−40	250	−10	57	89	95
1000	−20	250	−5	59	89	96
1000	0	250	0	65	94	105
1000	20	250	5	60	91	102
1000	40	250	10	58	91	103
1500	−40	375	−10	41	55	58
1500	−20	375	−5	45	58	62
1500	0	375	0	46	59	64
1500	20	375	5	46	57	63
1500	40	375	10	44	56	61
2000	−40	500	−10	34	41	43
2000	−20	500	−5	36	41	45
2000	0	500	0	37	41	45
2000	20	500	5	36	41	45
2000	40	500	10	34	40	45
Maximum Value			=	68	216	275
Field Dist. (m) to			=	800	300	200
Percent Increase			=		216	303

GEPRES.WK3 Sheet A:

Table 25 GEP Concentration Test Results for the 45.7 m Stack Height

GEP Stack Height Determination Test Results

RUN NO.				24	25	30	31	32	33	38	39
Equil. Visual Run No.				4	5	10	11	12	13	18	19
STACK (m)				61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0
WIND DIR.				140	140	150	150	320	320	325	325
CONFIG.				OUT	IN	OUT	IN	OUT	IN	OUT	IN
Field Dist.		Model Dist.									
X (m)	Y (m)	X (cm)	Y (cm)	$K*10^6$ (m^{-2})	$K*10^6$ (m^{-2})	$K*10^6$ (m^{-2})	$K*10^6$ (m^{-2})	$K*10^6$ (m^{-2})	$K*10^6$ (m^{-2})	$K*10^6$ (m^{-2})	$K*10^6$ (m^{-2})
200	0	50	0	1	24	0	8	0	50	0	100
300	0	75	0	6	83	6	60	2	90	6	154
400	0	100	0	17	115	18	101	23	110	21	164
500	0	125	0	27	126	31	120	38	116	35	166
600	0	150	0	38	120	42	115	50	114	47	156
700	0	175	0	45	111	56	109	53	101	56	138
800	0	200	0	54	109	61	103	61	101	58	126
900	0	225	0	55	103	60	94	60	97	59	114
1000	0	250	0	54	94	60	87	63	90	59	105
1100	0	275	0	53	85	57	78	60	82	58	95
1200	0	300	0	51	77	56	72	59	75	57	87
1300	0	325	0	50	72	52	67		72	54	79
1400	0	350	0	47	67	51	62	53	65	52	72
1500	0	375	0	45	61	48	56	48	59	48	67
1600	0	400	0	43	56	45	53	46	54	45	61
1800	0	450	0	38	49	40	46	41	48	40	53
1900	0	475	0	36	46	39	44	39	45	38	50
2000	0	500	0	35	44	37	42	38	43	37	47
2100	0	525	0	33		34	39	37	41	35	44
300	−40	75	−10	2	61	3	46	3	61	3	84
300	−20	75	−5	6	73	6	60	5	84	5	129
300	0	75	0	6	83	6	60	6	90	6	154
300	20	75	5	3	103	1	32	10	70	7	134
300	40	75	10	3	77	2	27	9	45	5	76
500	−40	125	−10			26	92	22	103	23	133
500	−20	125	−5			33	119	32	113	30	158
500	0	125	0	27	126	31	120	38	116	35	166
500	20	125	5	26	114	31	117	40	107	32	161
500	40	125	10	20	93	19	85	35	86	25	132
1000	−40	250	−10	47	88	50	76	47	78	47	96
1000	−20	250	−5	50	87	55	79	53	80	53	97
1000	0	250	0	54	94	60	87	63	90	59	105
1000	20	250	5	50	88	54	81	63	84	57	100
1000	40	250	10	46	83	50	80	61	84	57	102
1500	−40	375	−10	40	59	43	54	41		39	60
1500	−20	375	−5	43	60	46	57	45	57	44	65
1500	0	375	0	45	61	48	56	48	59	48	67
1500	20	375	5	44	60	46	55	50	59	48	67
1500	40	375	10	41	57	42	54	0	14	46	65
2000	−40	500	−10	23	44	35	40	35	43	35	45
2000	−20	500	−5	34	44	37	42	37	43	36	47
2000	0	500	0	35	44	37	42	38	43	37	47
2000	20	500	5	34	44	36	41	38	44	37	46
2000	40	500	10	34		36	40	37	45	37	47
Maximum Value			=	55	126	61	120	63	116	59	166
Field Dist. (m) to			=	900	500	800	500	1000	500	1000	500
Percent Increase			=		127		97		82		180

GEPRES.WK3 Sheet B:

Table 26 GEP Concentration Test Results for the 61.0 m Stack Height

GEP Stack Height Determination Test Results

RUN NO.				26	27	28	29	34	35	36	37
Equil. Visual Run No.				6	7	8	9	14	15	16	17
STACK (m)				73.1	73.1	73.1	73.1	73.1	73.1	73.1	73.1
WIND DIR.				140	140	150	150	320	320	325	325
CONFIG.				OUT	IN	OUT	IN	OUT	IN	OUT	IN
Field Dist.		Model Dist.									
X (m)	Y (m)	X (cm)	Y (cm)	K*10^6 (m^{-2})	K*10^6 (m^{-2})	K*10^6 (m^{-2})	K*10^6 (m^{-2})	K*10^6 (m^{-2})	K*10^6 (m^{-2})	K*10^6 (m^{-2})	K*10^6 (m^{-2})
200	0	50	0	1	0	0	1	0	13	0	27
300	0	75	0	2	31	2	24	2	35	3	57
400	0	100	0	9	53	8	64	8	54	8	78
500	0	125	0	18	73	15	90		66	17	94
600	0	150	0	27	78	24		27	74	26	105
700	0	175	0	32	77	35	95	32	73	37	105
800	0	200	0	39	81	41	94	38	80	41	102
900	0	225	0	41	79	44	88	40	79	44	97
1000	0	250	0	42	74	45	83	42	75	46	89
1100	0	275	0	43	68	45	76	44	72	46	83
1200	0	300	0	43	65	45	71	42	68	46	78
1300	0	325	0	42	60		67		61		71
1400	0	350	0	41	62	42	62	39	60	44	67
1500	0	375	0	40	54	40	58	39	56	42	62
1600	0	400	0	37	52	39	52	35	51	41	56
1800	0	450	0		45	36	46	33	45	38	49
1900	0	475	0	33	43	35	44	33	43	37	46
2000	0	500	0	33	41	34	43	31	43	36	45
2100	0	525	0	31		33		31	41	34	42
300	−40	75	−10	1	21	1	14	0	23	1	30
300	−20	75	−5	2	25	2	26	1	33	1	49
300	0	75	0	2	31	2	24	2	35	3	57
300	20	75	5	1	39	1	11	3	25	2	48
300	40	75	10	1	28	1	7	3	13	1	25
500	−40	125	−10				80	10	57	12	79
500	−20	125	−5				88	14	64	17	91
500	0	125	0	18	73	15	90		66	17	94
500	20	125	5	15	62	14	89	19	58	16	91
500	40	125	10	10	48	11	57	16	45	13	74
1000	−40	250	−10	38	72	36	73	33	63	38	84
1000	−20	250	−5	40	71	41	78	37	69	39	84
1000	0	250	0	42	74	45	83	42	75	46	89
1000	20	250	5	40	69	41	77	24	69	44	83
1000	40	250	10	36	65	38	73	43	71	44	83
1500	−40	375	−10	35	52	36	53	31	49	36	56
1500	−20	375	−5	39	54	39	56	36	53	40	61
1500	0	375	0	40	54	40	58	39	56	42	62
1500	20	375	5	39		40		38	57	43	60
1500	40	375	10	36	50	36	54	37	55		58
2000	−40	500	−10	31	40	33	41	28	39	32	43
2000	−20	500	−5	33	41	33	42	31	41	35	44
2000	0	500	0	33	41	34	43	31	43	36	45
2000	20	500	5	32	40	33	41	32	43	35	43
2000	40	500	10	31	39	32	41	34	43	35	45
Maximum Value			=	43	81	45	95	44	80	46	105
Field Dist. (m) to			=	1100	800	1100	700	1100	800	1100	700
Percent Increase			=		88		111		82		127

GEPRES.WK3 Sheet C:

Table 27 GEP Concentration Test Results for the 73.1 m Stack Height

Omega Mass Flow Controller System Settings {MASSFLOW.WK3}

Test Program	Test Type	Total Flow Rate (ccs)	Specific Gravity	Gas mixture component 1					Gas mixture component 2				
				Type	Percent of Total (%)	Flow Rate (ccs)	Meter FS Range (SLPM)	Meter Setting (%FS)	Type	Percent of Total (%)	Flow Rate (ccs)	Meter FS Range (SLPM)	Meter Setting (%FS)
ADCT	Visual	530.2	1.000	Air	100.0	530.2	100.0	26.4					
ADCT	Conc.	530.2	1.036	Ethane	100.0	530.2	100.0	53.2					
Re Inv	Conc.	95.8	1.036	Ethane	100.0	95.8	10.0	96.1					
GEP	Visual	493.8	0.696	Air	64.7	319.6	10.0	15.9	Helium	35.3	174.2	100.0	59.6
GEP	Conc.	493.8	0.696	Methane	65.4	322.8	10.0	22.2	Nitrogen	34.6	171.0	100.0	85.1

Table 28 Stack Gas Flow Settings and Composition

ADCT Stack Gas Calc. for Omega mass flow system MASSMIX.WK3 A:

Source Plume =	Visual	A	B	C
Tracer Type =	Air	CH4	C2H6	C3H8
INPUT > Total Flow (ccs) =	530.20		530.20	
INPUT > S.G. mixture =	1.000		1.036	

Plume	Gas Type	Gas Flow (%)	Gas Flow (ccs)	Meter 1 setting (slpm0.1) 1000.0	Meter 2 setting (slpm1) 100.0	Meter 3 setting (slpm10) 10.0	Meter 4 setting (slpm100) 1.0
Visual	Air	100.0	530.2				26.4
"	He						
Visual	Air	100.0	530.2				26.4
"	Ar						
A	CH4						
"	He						
A	CH4						
"	N2						
A	CH4						
"	Ar						
B	C2H6	100.0	530.2				53.2
"	He	0.0	0.0				
B	C2H6	100.0	530.2				53.2
"	N2	0.0	0.0				
B	C2H6						
"	Ar						
C	C3H8						
"	He						
C	C3H8						
"	N2						
C	C3H8						
"	Ar						

Units & STP Factor =			20.1
Gas Conversion Factors			
Gas	K Value	MW	SG
AIR	1.000	29.0	1.000
N2	1.000	28.0	0.967
Ar	1.443	40.0	1.381
He	1.454	4.0	0.138
CH4	0.723	16.0	0.552
C2H6	0.496	30.0	1.036
C3H8	0.357	44.0	1.519

Table 29 Example Calculational Spreadsheet for Omega Mass Controller System, ADCT Test Parameters

GEP Stack Gas Calc. for Omega mass flow system MASSMIX.WK3 B:

Source Plume =				Visual	A	B	C
Tracer Type =				Air	CH4	C2H6	C3H8
INPUT > Total Flow (ccs) =				493.80	493.80		
INPUT > S.G. mixture =				0.696	0.696		
Plume	Gas Type	Gas Flow (%)	Gas Flow (ccs)	Meter 1 setting (slpm0.1) 1000.0	Meter 2 setting (slpm1) 100.0	Meter 3 setting (slpm10) 10.0	Meter 4 setting (slpm100) 1.0
Visual	Air	64.7	319.6				15.9
"	He	35.3	174.2			59.6	
Visual	Air						
"	Ar						
A	CH4						
"	He						
A	CH4	65.4	322.8				22.2
"	N2	34.6	171.0			85.1	
A	CH4	82.7	408.3				28.1
"	Ar	17.3	85.5			29.5	
B	C2H6						
"	He						
B	C2H6						
"	N2						
B	C2H6						
"	Ar						
C	C3H8						
"	He						
C	C3H8						
"	N2						
C	C3H8						
"	Ar						

Units & STP Factor =			20.1
Gas Conversion Factors			
Gas	K Value	MW	SG
AIR	1.000	29.0	1.000
N2	1.000	28.0	0.967
Ar	1.443	40.0	1.381
He	1.454	4.0	0.138
CH4	0.723	16.0	0.552
C2H6	0.496	30.0	1.036
C3H8	0.357	44.0	1.519

Table 30 Example Calculational Spreadsheet for Omega Mass Controller System, GEP Test Parameters

FIGURES

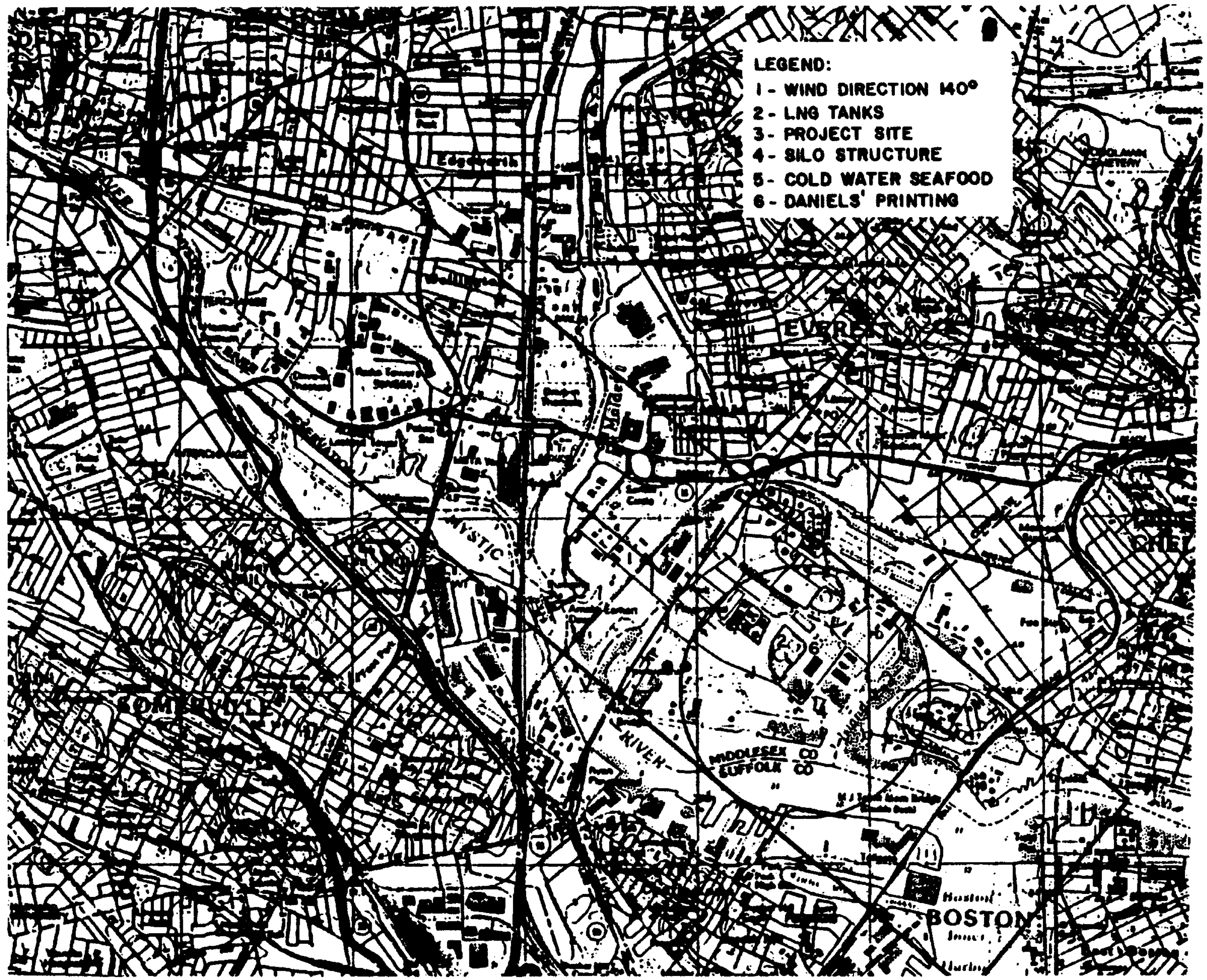


Figure 1 Topographic Map Detailing Test Study Area (grid lines are one km)

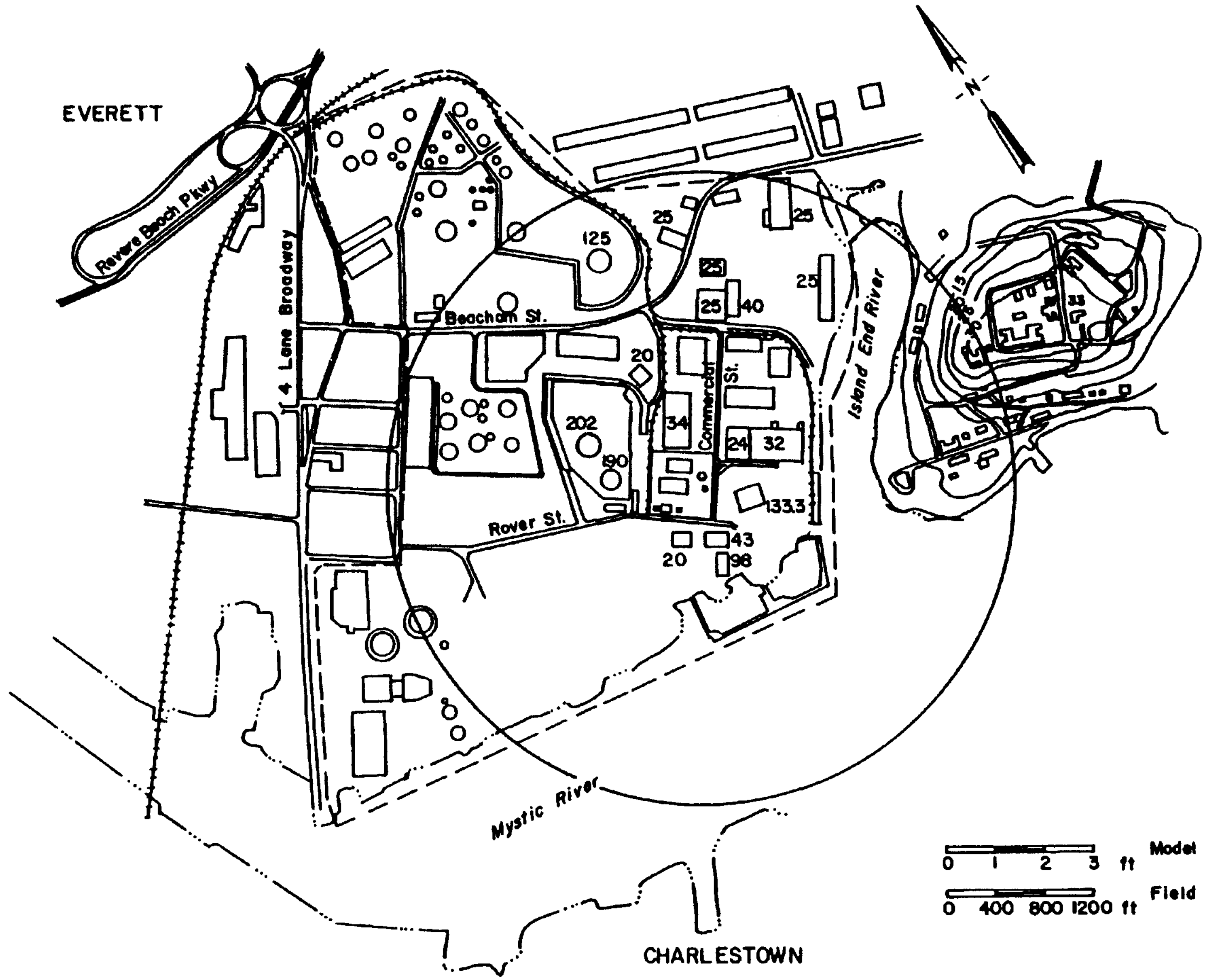


Figure 2 Plan View of Study Area Structures (heights are feet above MSL)

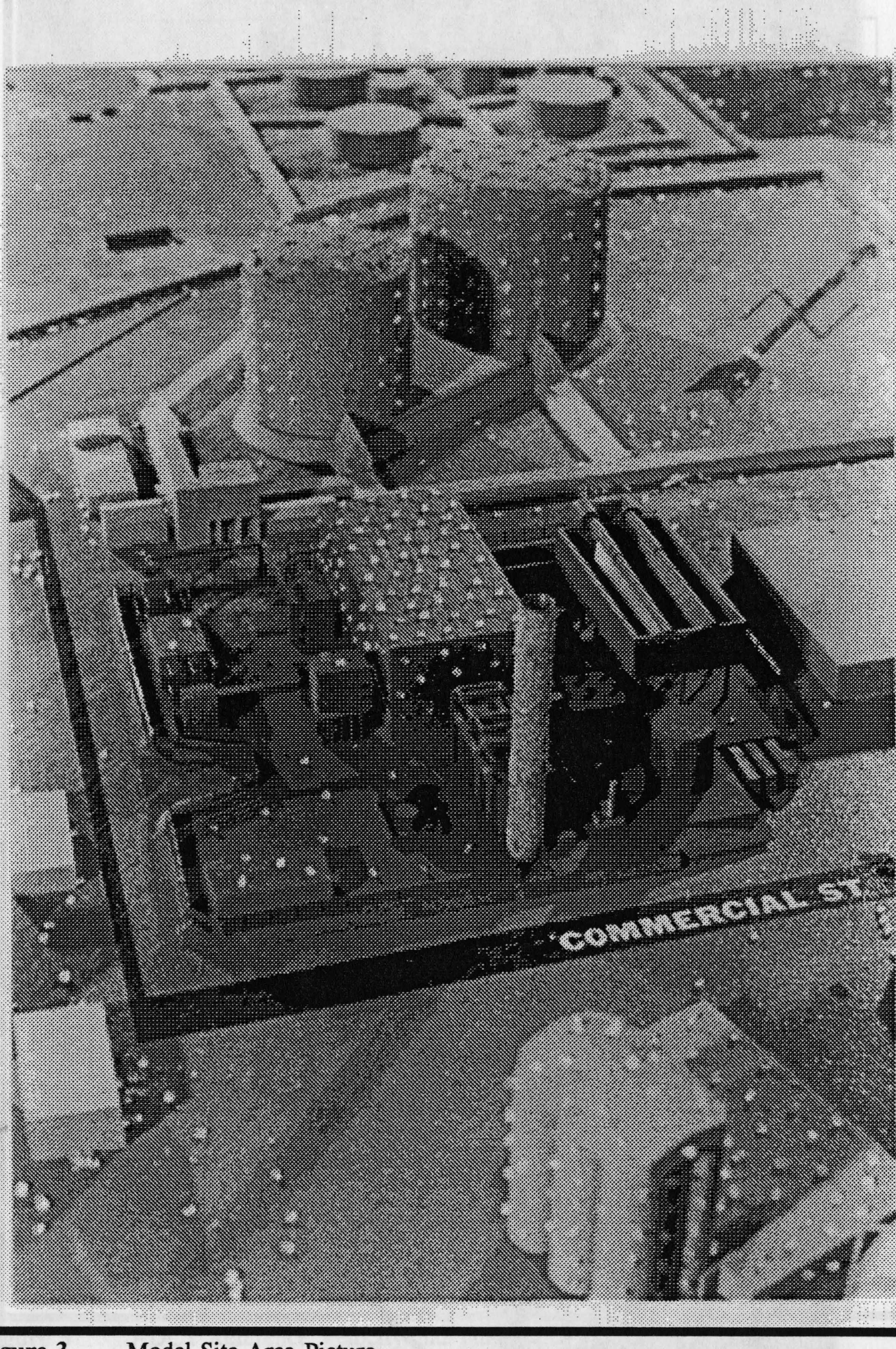


Figure 3 Model Site Area Picture

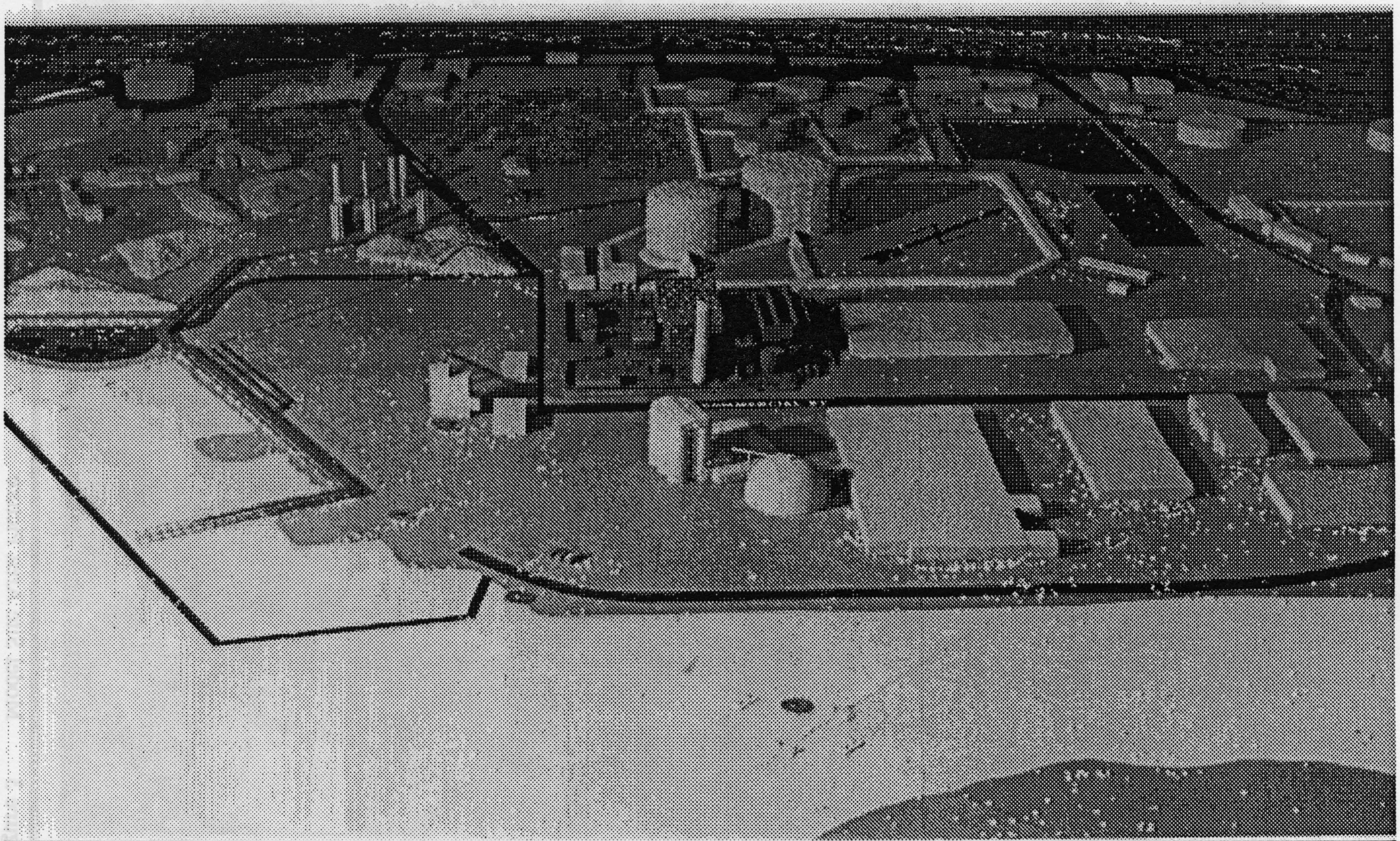
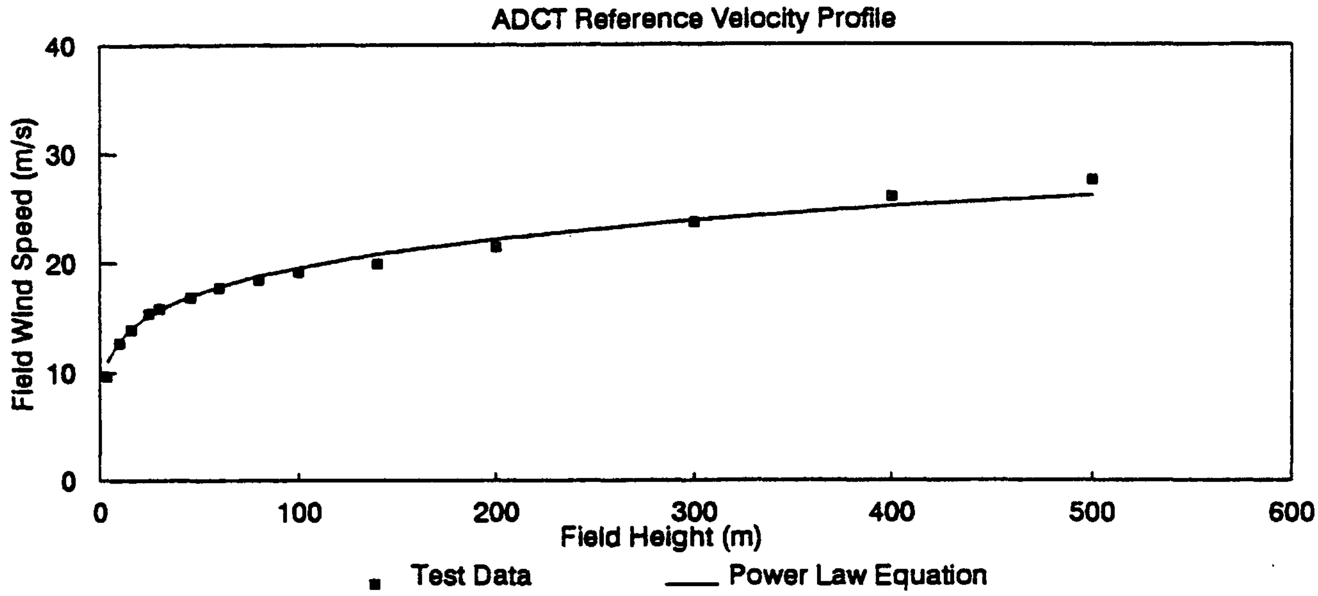
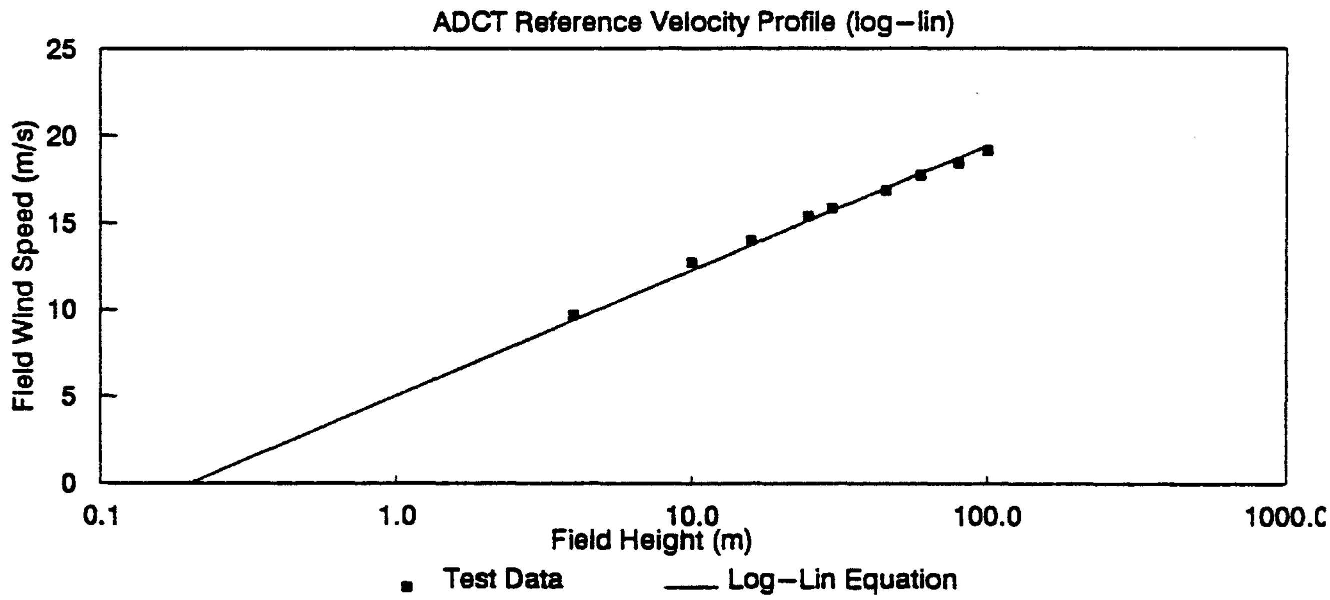


Figure 4 Model Site and Surroundings Picture





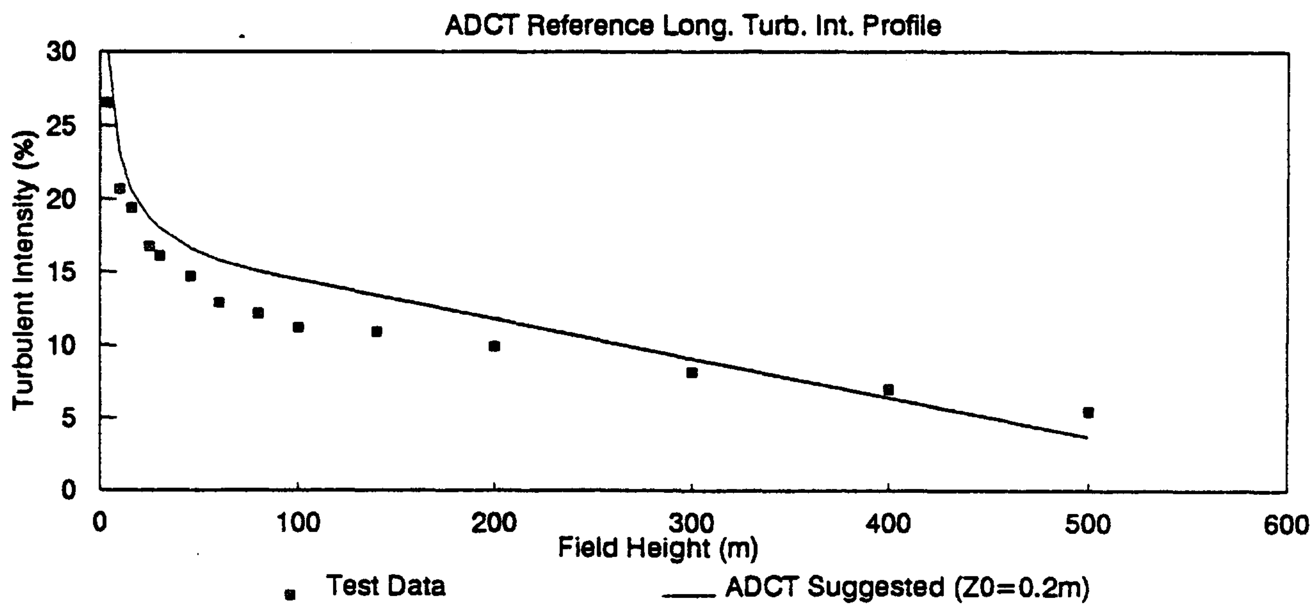


Figure 5 ADCT Reference Velocity and Turbulence Profile

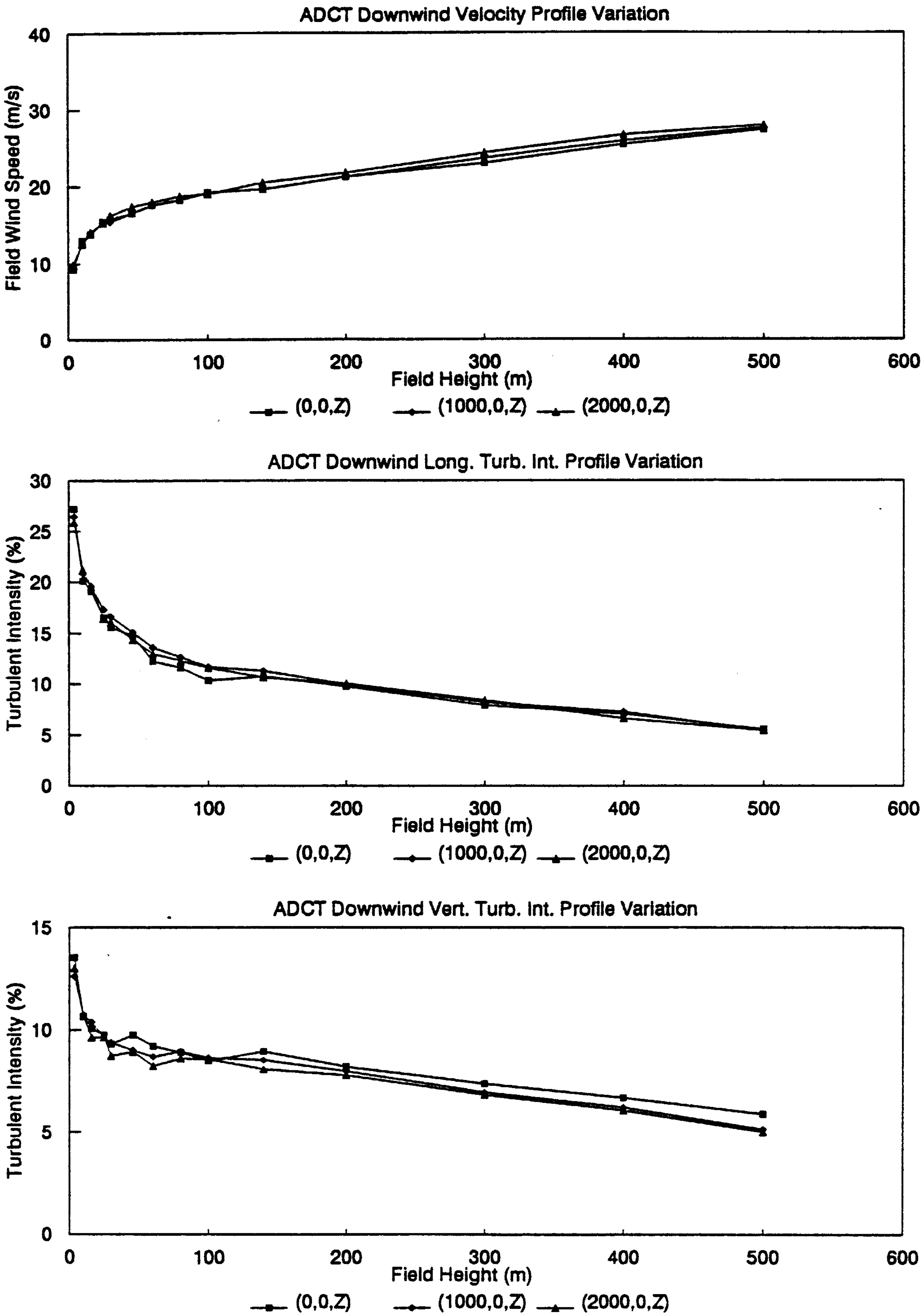


Figure 6 ADCT Downwind Velocity and Turbulent Profile Variation

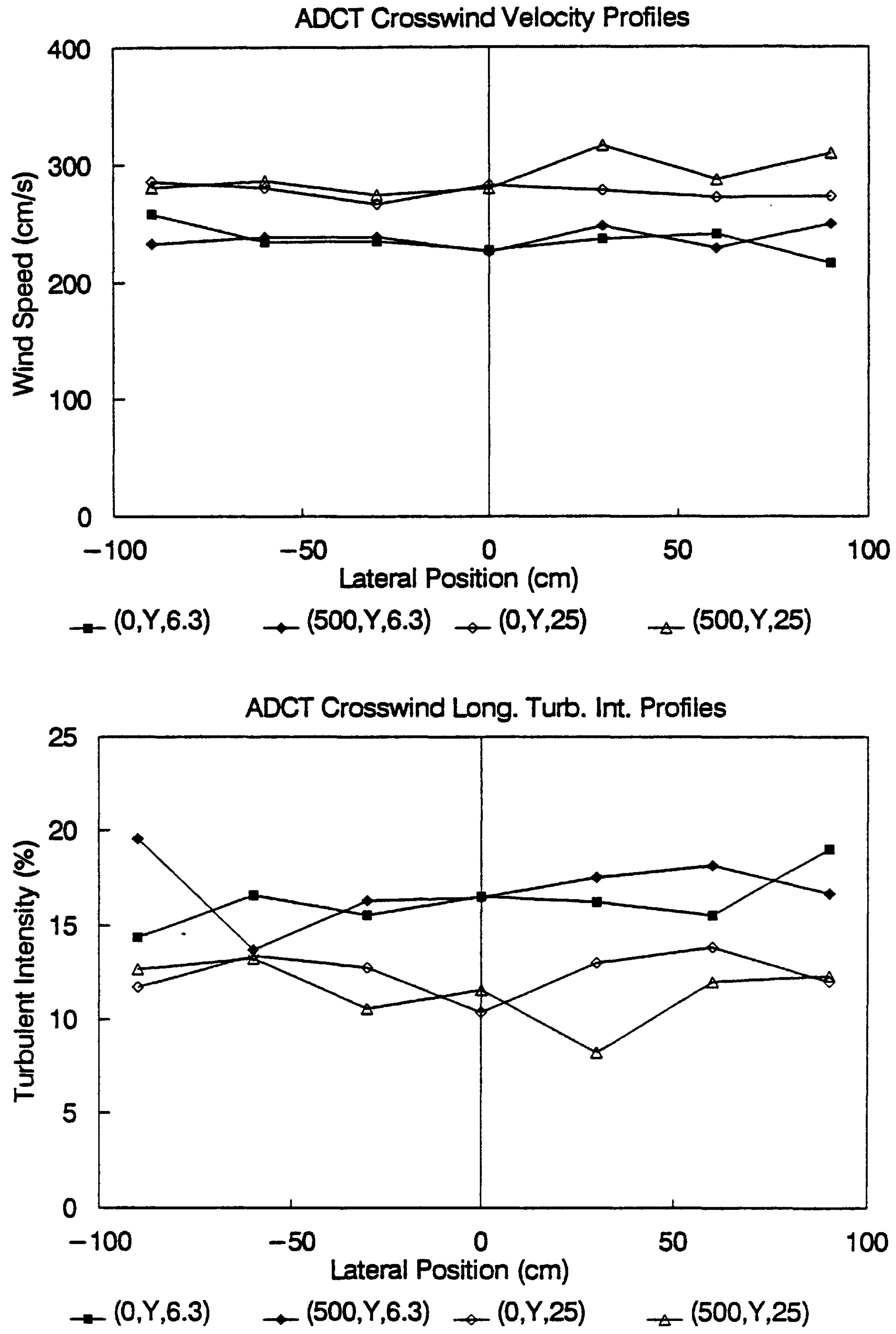


Figure 7 ADCT Crosswind Velocity and Turbulence Profile Variations

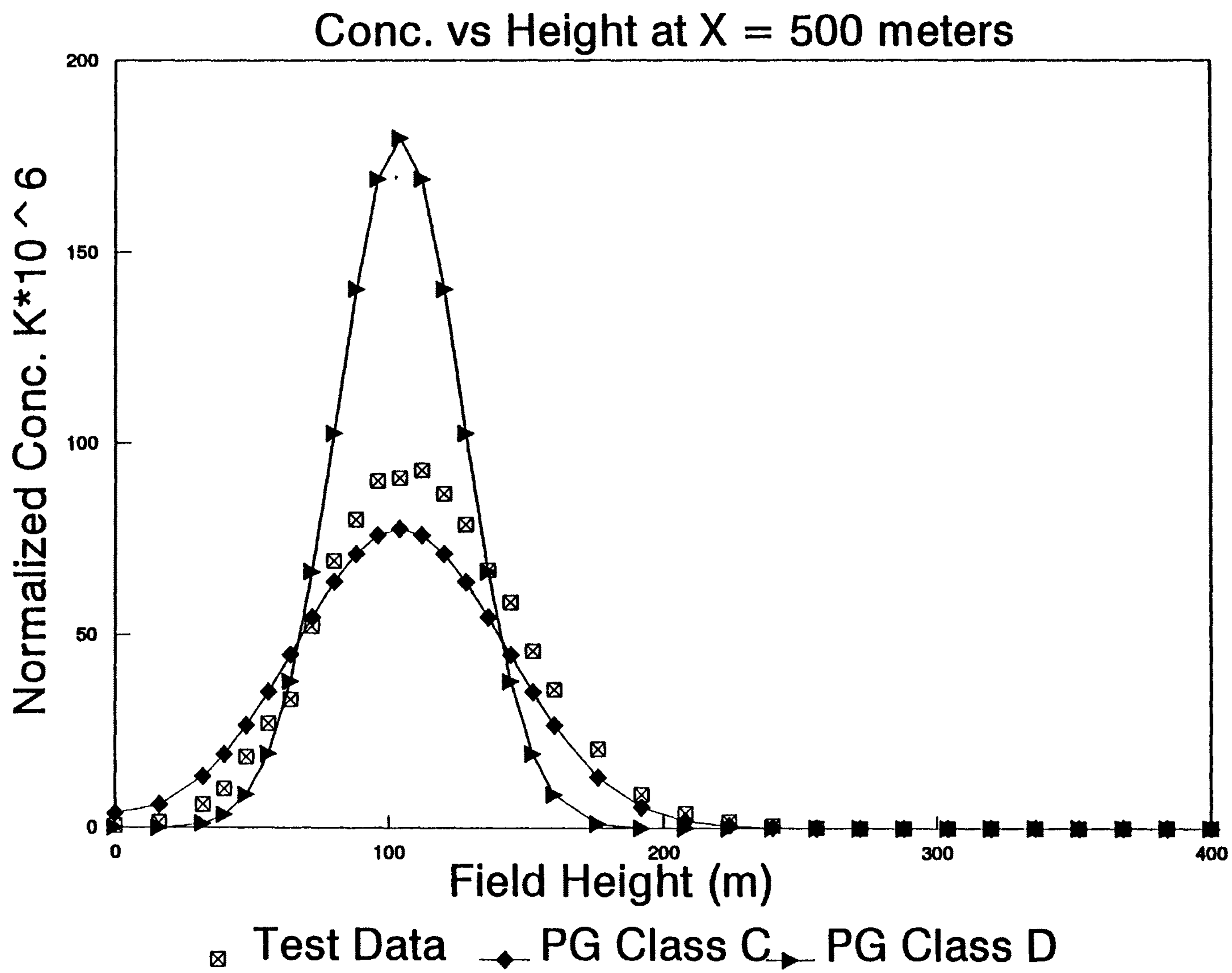


Figure 8 ADCT Vertical Concentration Profile; X = 500 meters

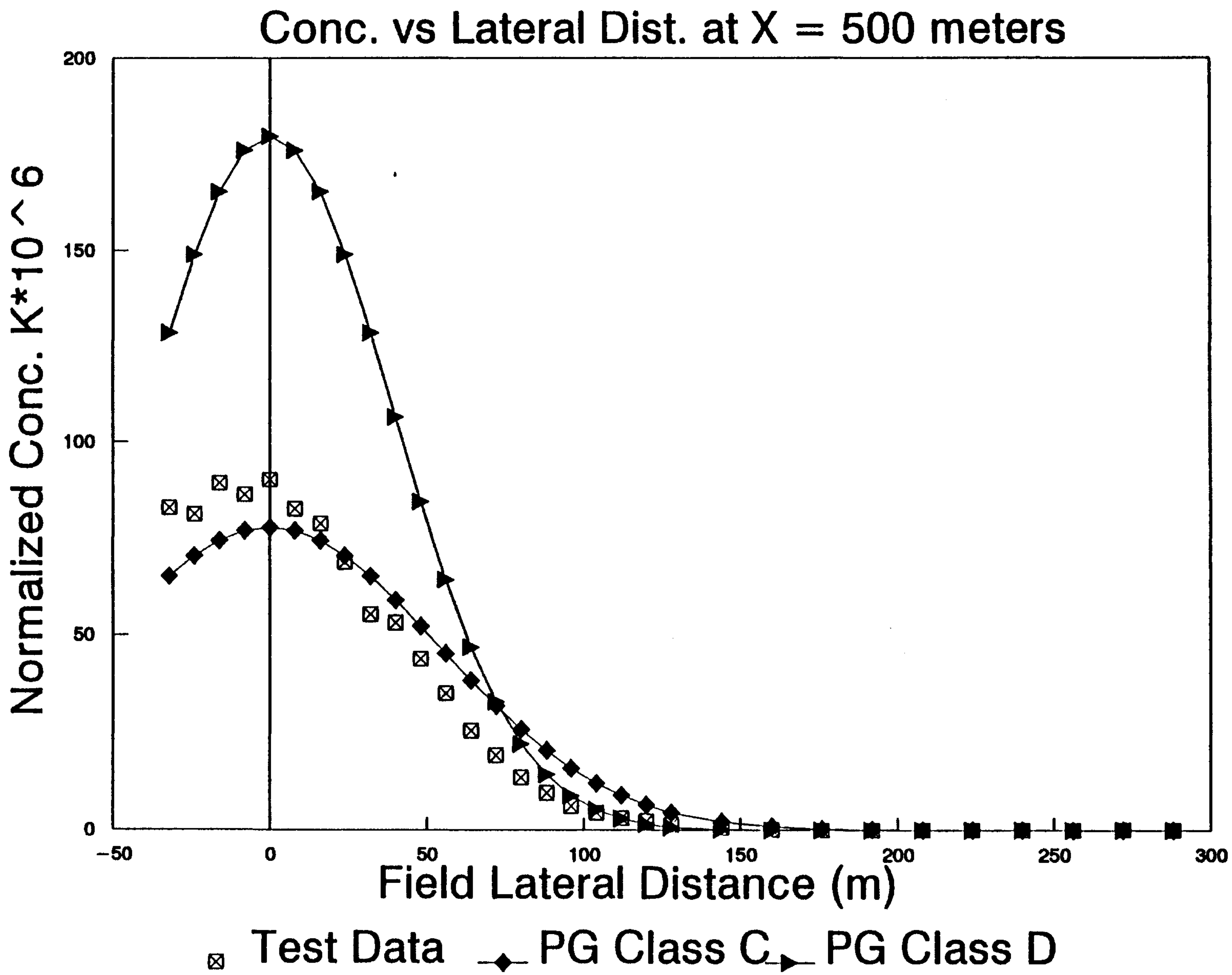


Figure 9 ADCT Lateral Concentration Profile; X = 500 meters

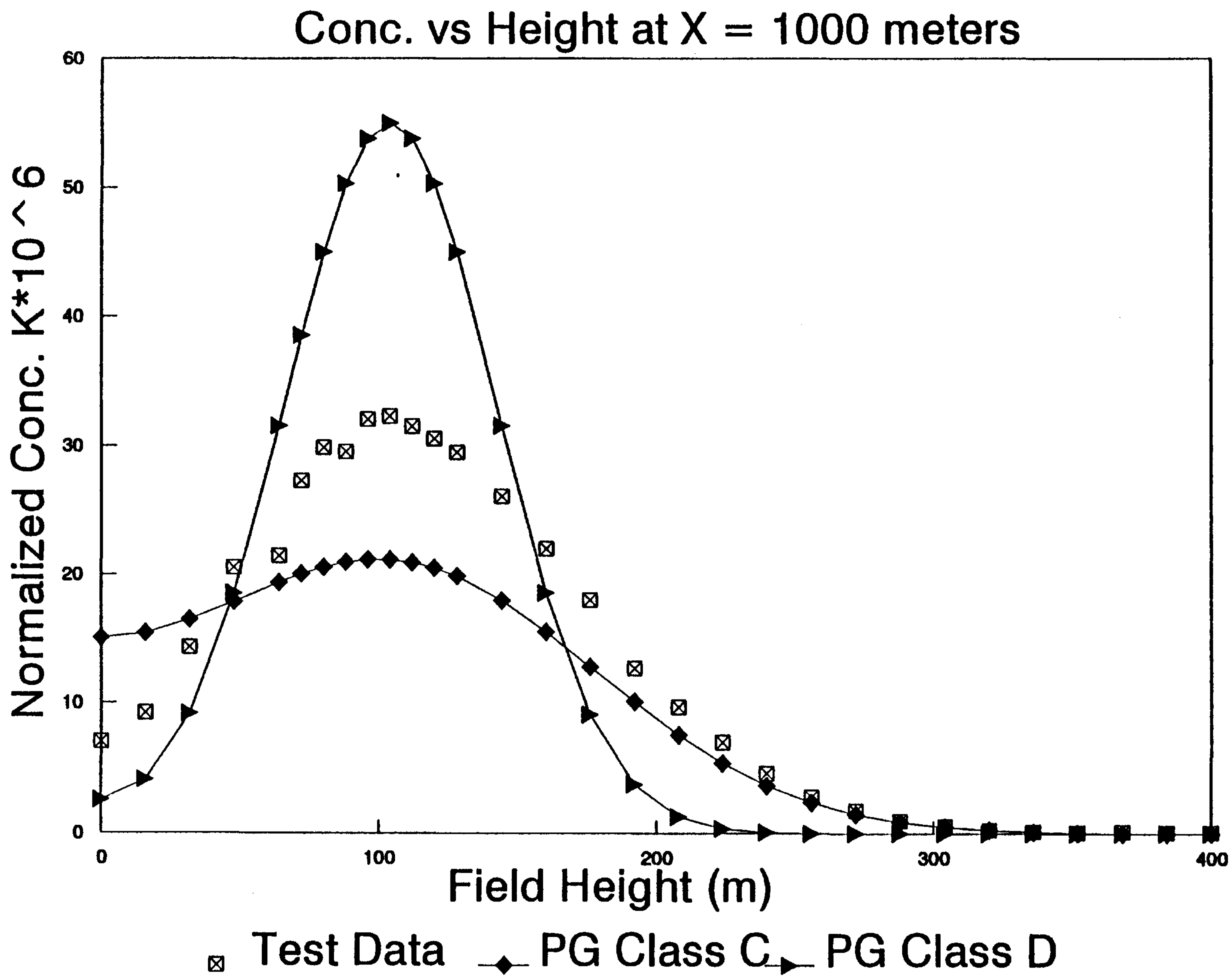


Figure 10 ADCT Vertical Concentration Profile; X = 1000 meters

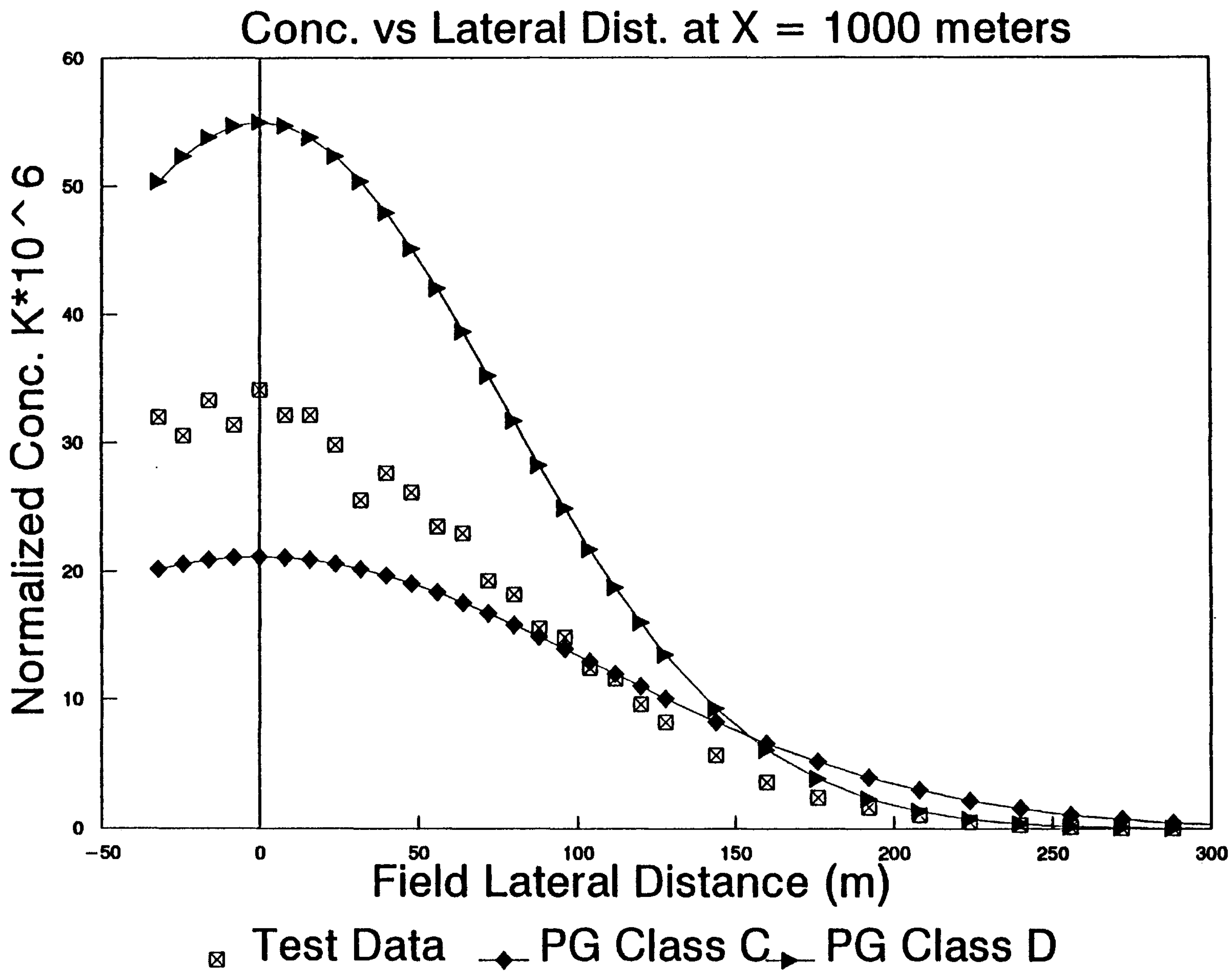


Figure 11 ADCT Lateral Concentration Profile; X = 1000 meters

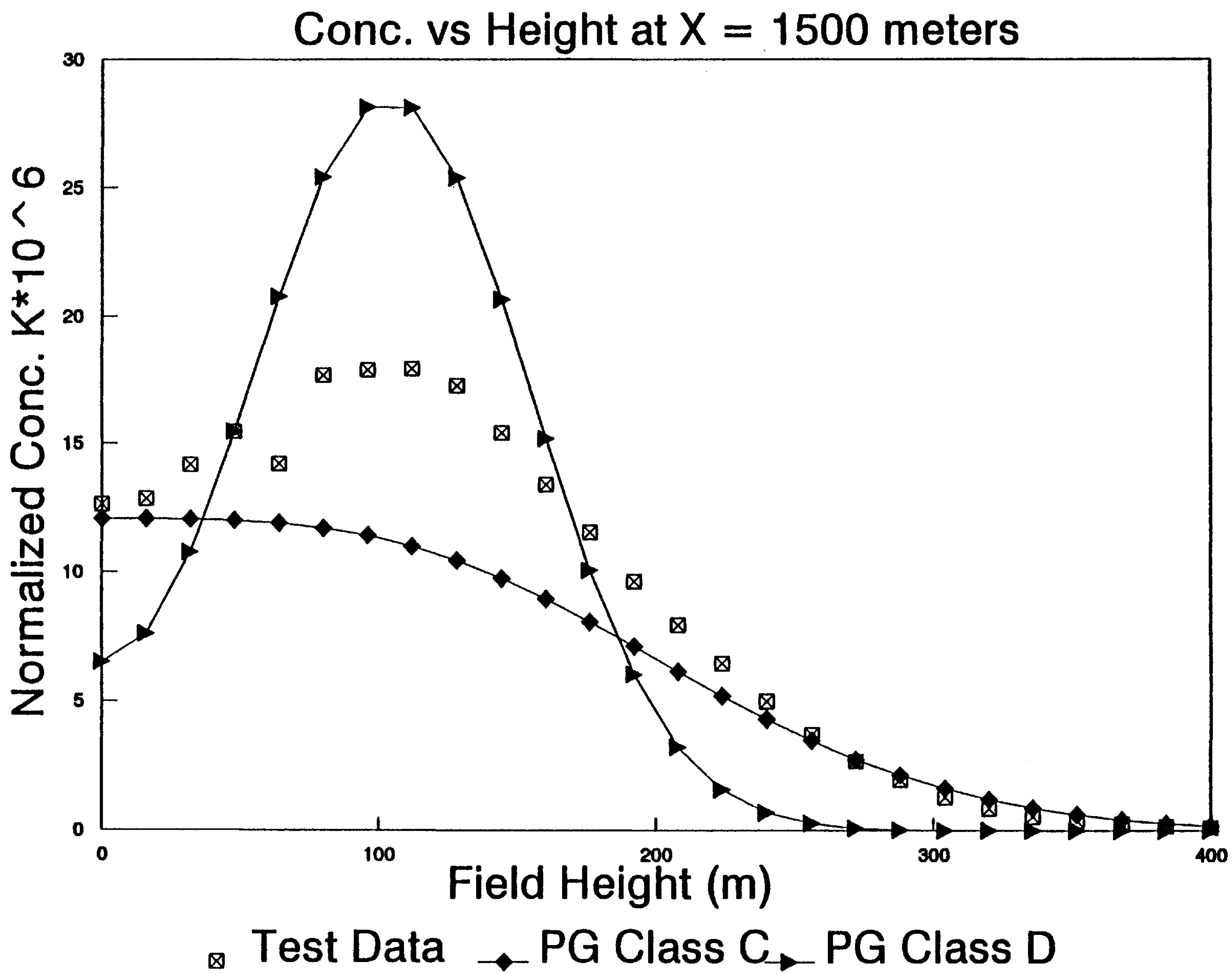


Figure 12 ADCT Vertical Concentration Profile; X = 1500 meters

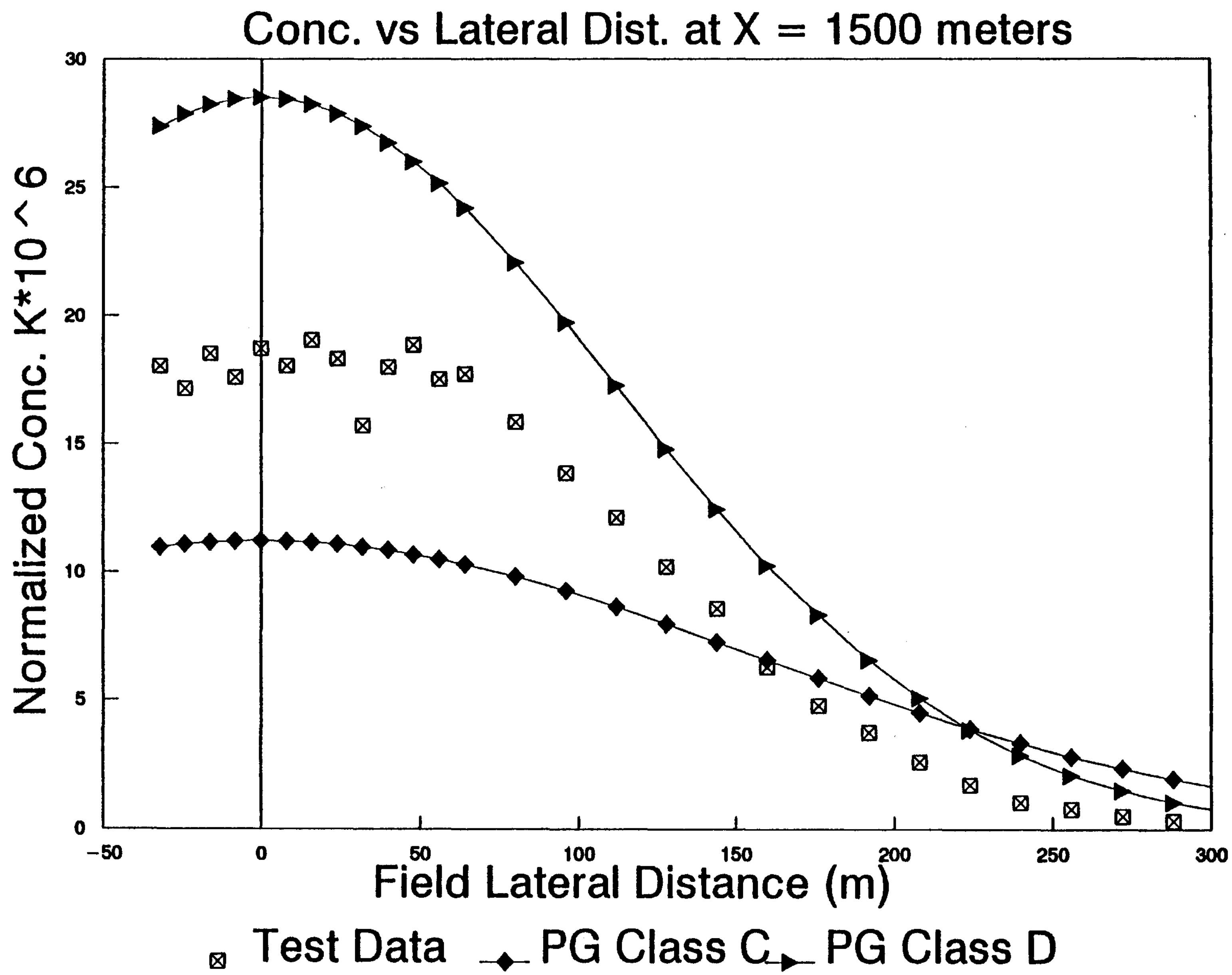


Figure 13 ADCT Lateral Concentration Profile; X = 1500 meters

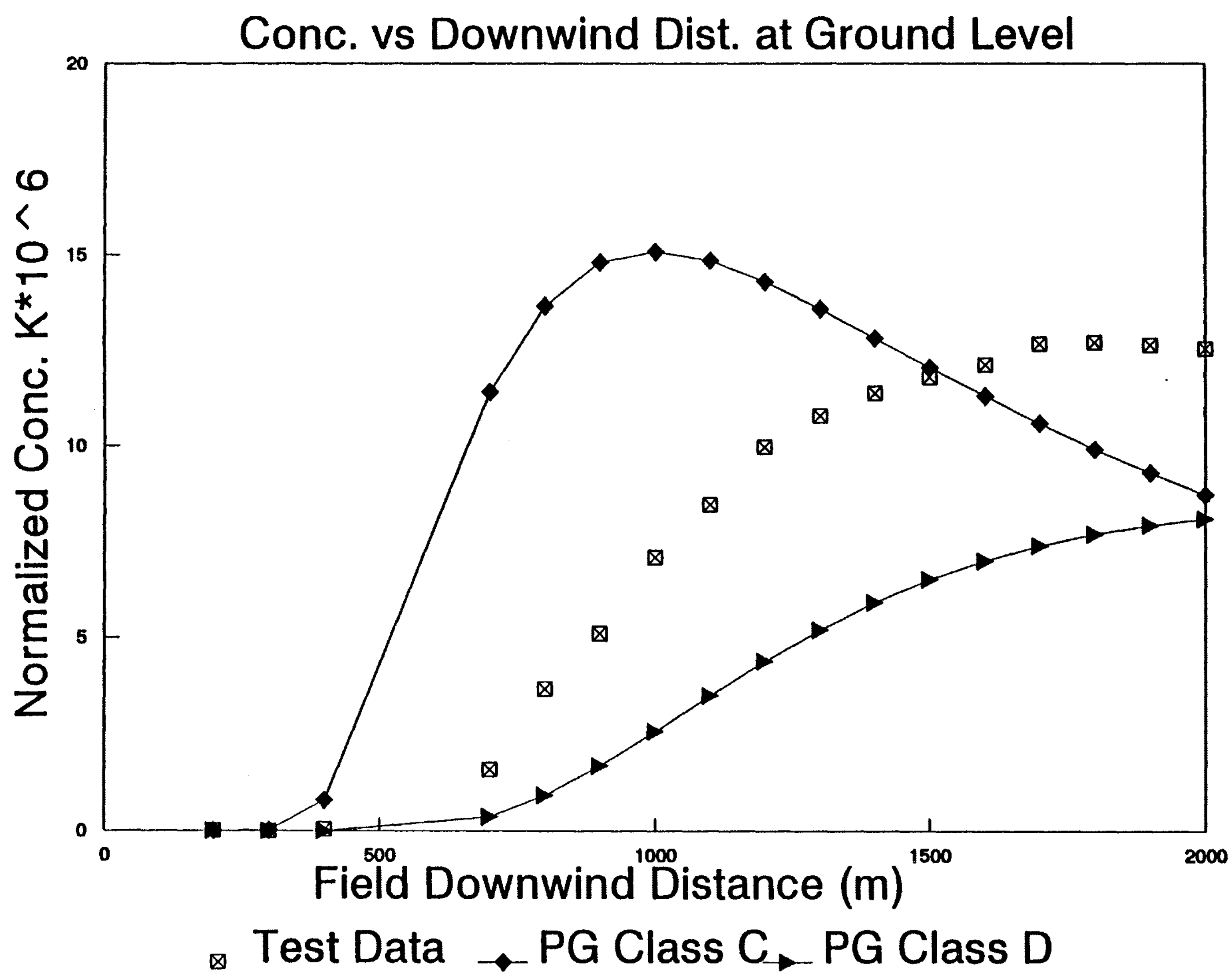


Figure 14 ADCT Ground Level Concentration Profile

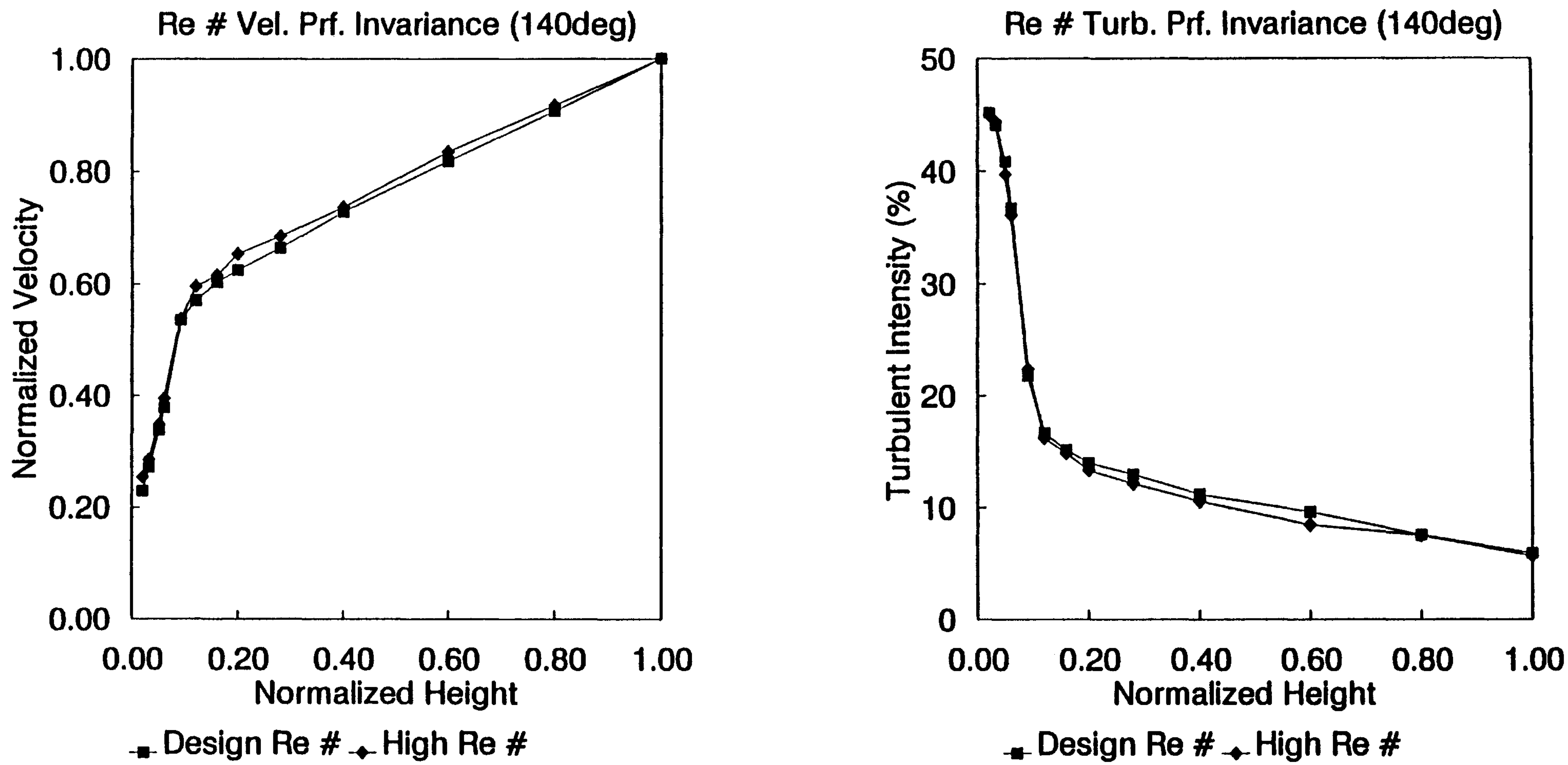
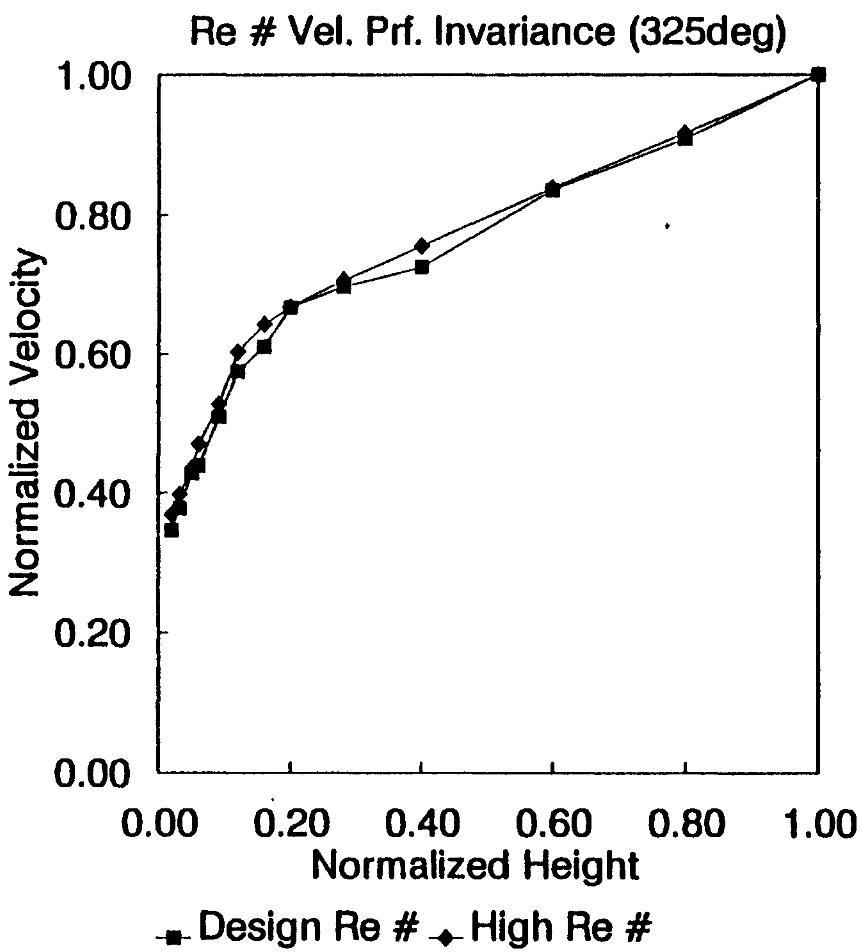


Figure 15 Reynolds No. Invariance Test Velocity and Turbulence Profiles, 140° Wind Direction



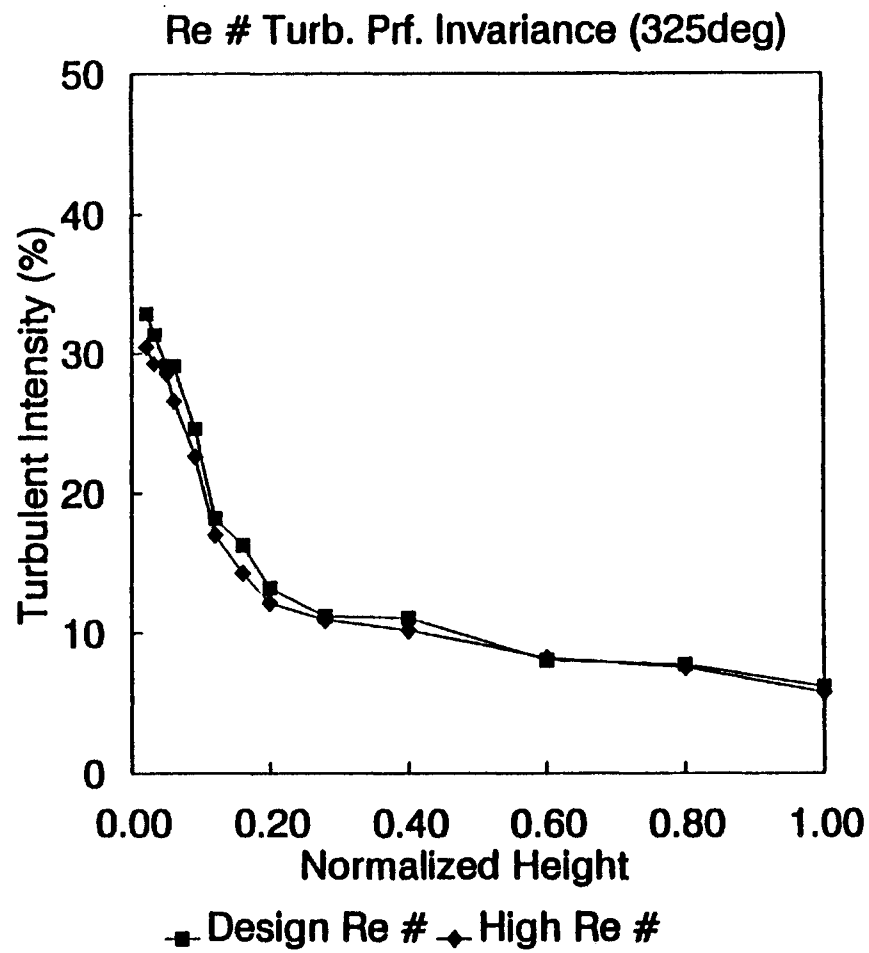
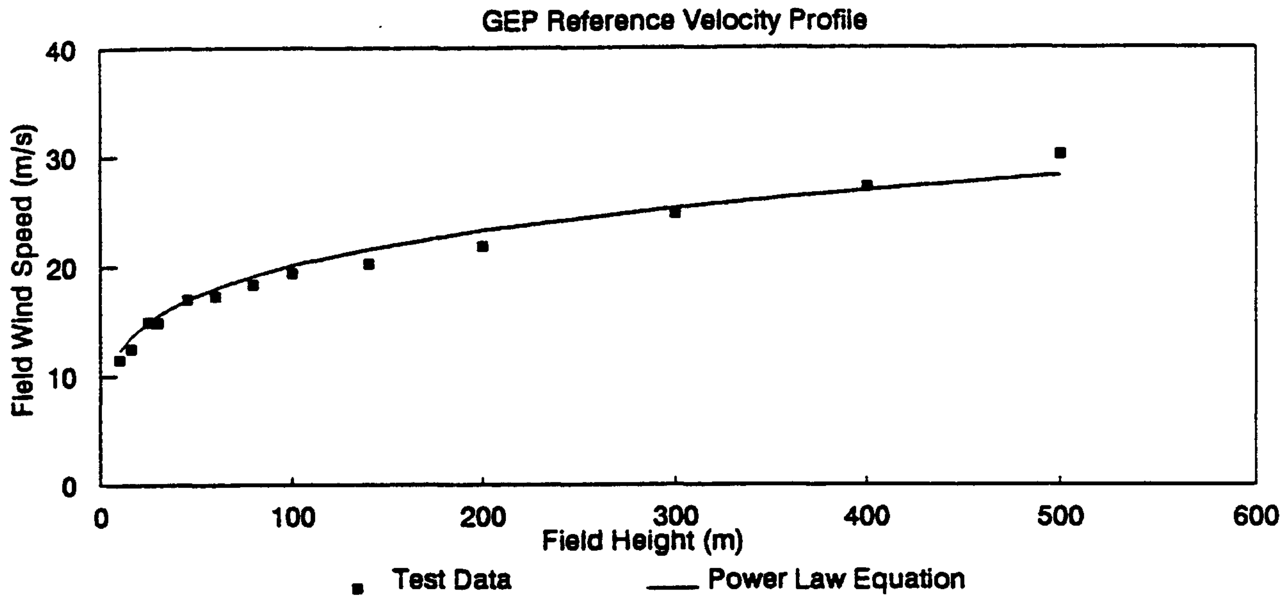
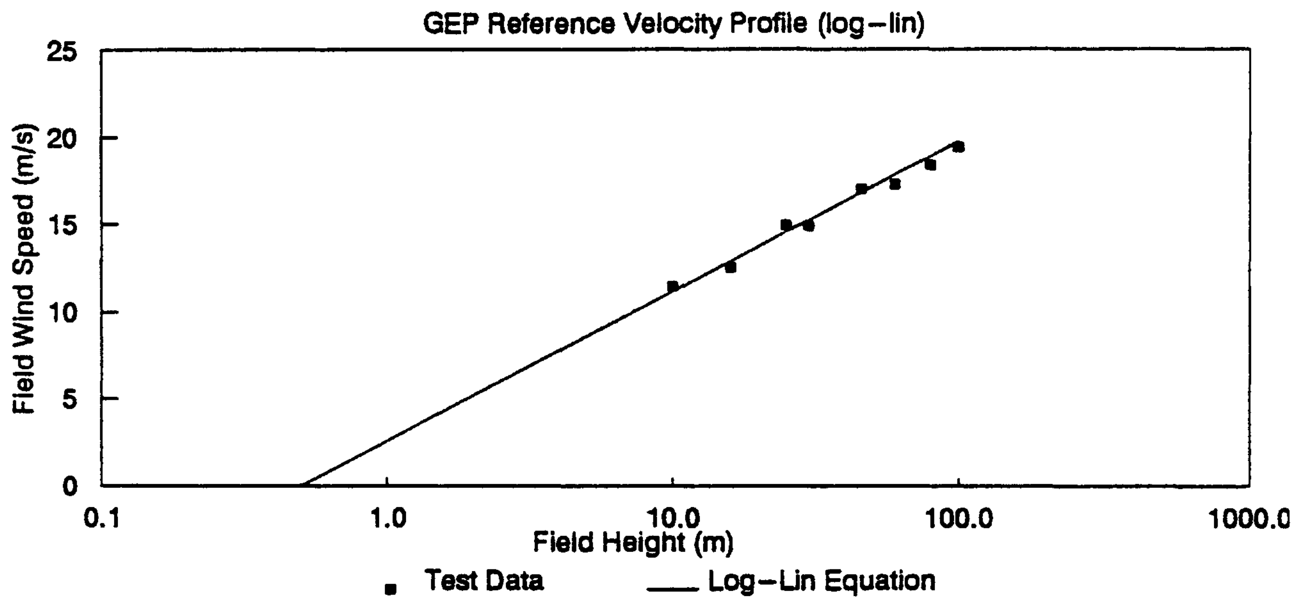


Figure 16 Reynolds No. Invariance Test Velocity and Turbulence Profiles, 325° Wind Direction





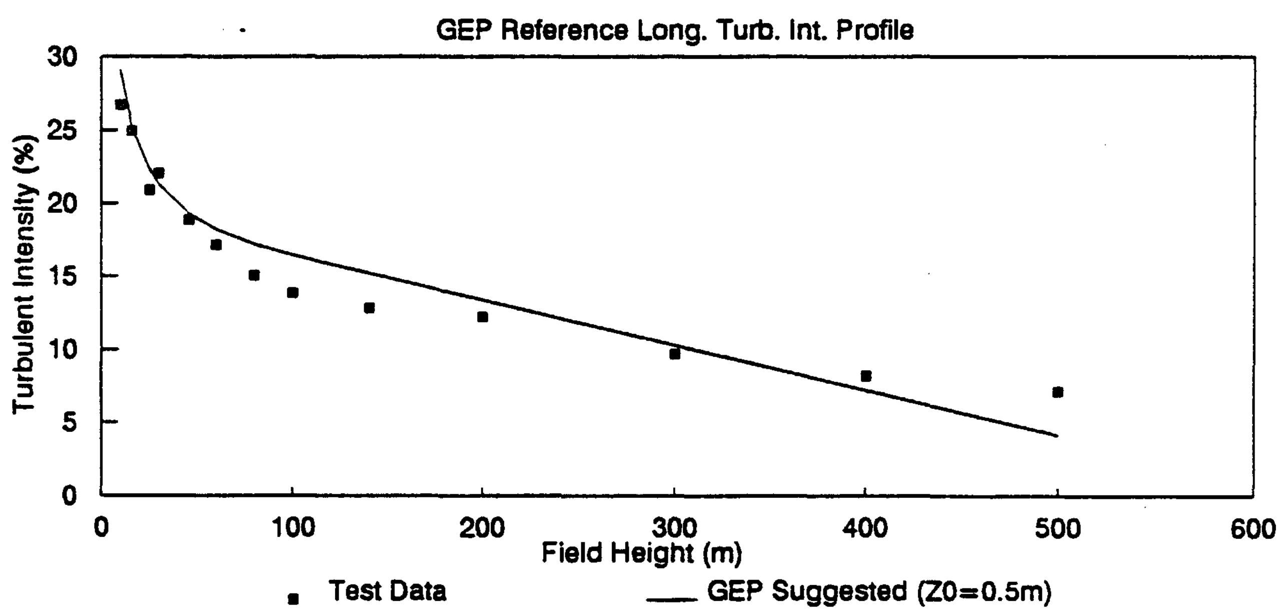


Figure 17 GEP Reference Velocity and Turbulence Profiles

APPENDIX A: VIDEO TAPE ENCLOSURE

APPENDIX B: VELOCITY PROFILE DATA PRINTOUTS

File Name = GEP043.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	1.00	1.37	27.21	13.53	-.0224
2	2.66	1.91	20.11	10.68	-.0218
3	4.09	2.04	19.15	10.07	-.0221
4	6.43	2.27	16.51	9.74	-.0225
5	7.47	2.32	15.57	9.31	-.0184
6	11.43	2.44	14.75	9.76	-.0221
7	14.96	2.60	12.27	9.21	-.0193
8	19.92	2.68	11.61	8.90	-.0165
9	25.04	2.83	10.37	8.47	-.0135
10	34.95	2.88	10.78	8.96	-.0178
11	49.93	3.12	9.78	8.20	-.0191
12	75.09	3.39	7.94	7.39	-.0156
13	100.10	3.74	7.09	6.68	-.0195
14	124.95	4.01	5.59	5.89	-.0076

File Name = GEP044.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	1.00	1.45	26.46	12.63	-.0189
2	2.67	1.84	20.82	10.75	-.0194
3	3.97	2.04	19.55	10.38	-.0208
4	6.36	2.25	17.32	9.64	-.0232
5	7.64	2.28	16.64	9.38	-.0213
6	11.17	2.44	15.07	9.00	-.0215
7	14.79	2.58	13.59	8.68	-.0190
8	19.90	2.69	12.65	8.97	-.0243
9	24.91	2.83	11.71	8.64	-.0260
10	34.95	2.89	11.30	8.54	-.0225
11	50.00	3.12	9.96	7.99	-.0202
12	75.17	3.48	8.22	6.96	-.0213
13	100.16	3.80	7.27	6.21	-.0191
14	124.78	4.06	5.41	5.13	-.0106

File Name = GEP045.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	1.00	1.45	25.91	13.01	-.0219
2	2.41	1.85	21.24	10.68	-.0196
3	4.15	2.07	19.57	9.62	-.0173
4	6.19	2.26	16.45	9.63	-.0196
5	7.60	2.39	16.10	8.73	-.0184
6	11.55	2.56	14.35	8.94	-.0239
7	14.77	2.64	12.99	8.22	-.0202
8	19.96	2.76	12.28	8.61	-.0211
9	25.00	2.80	11.58	8.57	-.0238
10	35.20	3.01	10.66	8.09	-.0233
11	50.06	3.20	10.06	7.78	-.0288
12	75.10	3.58	8.40	6.83	-.0218
13	100.22	3.92	6.61	6.07	-.0202
14	124.83	4.10	5.40	5.02	-.0145

File Name = GEP046.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	2.50	1.80	19.17	10.53	-.0127
2	6.12	2.38	16.28	8.96	-.0169
3	11.22	2.51	12.93	8.66	-.0151
4	25.17	2.75	10.56	8.98	-.0178

File Name = GEP047.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	2.50	2.07	22.98	10.15	-.0207
2	6.46	2.39	13.69	8.82	-.0150
3	11.18	2.60	13.89	9.34	-.0175
4	25.15	2.86	13.25	9.25	-.0248

File Name = GEP048.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	2.50	2.20	17.58	10.34	-.0230
2	6.21	2.33	19.55	10.91	-.0262
3	11.47	2.70	14.28	9.12	-.0254
4	24.81	2.81	12.68	9.88	-.0407

File Name = GEP049.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	2.50	1.83	19.15	10.43	-.0178
2	6.37	2.47	17.52	9.05	-.0112
3	11.17	2.52	12.64	9.49	-.0191
4	25.09	3.16	8.20	8.29	-.0033

File Name = GEP050.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	2.50	2.09	16.10	10.39	-.0226
2	6.24	2.29	18.16	9.93	-.0223
3	11.56	2.45	13.08	8.76	-.0129
4	24.89	2.87	12.00	9.65	-.0215

File Name = GEP051.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	2.50	1.92	21.39	11.06	-.0220
2	6.24	2.50	16.66	8.59	-.0226
3	11.56	2.79	13.21	9.50	-.0185
4	25.06	3.09	12.31	8.14	-.0250

File Name = GEP052.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	2.50	1.99	21.29	9.96	-.0216
2	6.44	2.35	15.52	9.12	-.0116
3	11.53	2.57	12.45	8.85	-.0186
4	24.79	2.66	12.74	9.10	-.0143

File Name = GEP053.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	2.50	1.80	21.51	10.53	-.0115
2	6.40	2.35	16.58	9.79	-.0263
3	11.19	2.41	15.00	9.66	-.0187
4	24.80	2.80	13.38	10.21	-.0258

File Name = GEP054.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	2.50	1.91	19.85	10.17	-.0138
2	6.50	2.58	14.34	8.98	-.0129
3	11.41	2.70	16.08	9.82	-.0209
4	25.10	2.86	11.73	10.96	-.0440

File Name = GEP055.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	2.50	1.89	19.45	9.52	-.0150
2	6.27	2.37	16.21	8.54	-.0243
3	11.20	2.42	14.16	9.53	-.0188
4	24.80	2.78	13.00	10.23	-.0281

File Name = GEP056.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	2.50	1.84	19.57	9.46	-.0163
2	6.38	2.41	15.53	9.38	-.0177
3	11.37	2.67	11.95	8.77	-.0137
4	24.95	2.72	13.84	9.97	-.0420

File Name = GEP057.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT U(%)	TURB.INT W(%)	STRESS $(m/s)^2$
1	2.50	2.00	22.04	10.13	-.0256
2	6.36	2.16	19.00	10.05	-.0195
3	11.63	2.55	17.82	10.55	-.0359
4	24.89	2.73	12.02	10.35	-.0216

File Name = GEP058.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT (%)
1	1.00	1.41	30.98
2	2.67	1.79	26.72
3	4.04	1.95	24.91
4	6.33	2.33	20.92
5	7.33	2.32	22.02
6	11.39	2.65	18.86
7	14.84	2.69	17.15
8	19.78	2.86	15.05
9	24.87	3.03	13.88
10	34.99	3.16	12.81
11	49.78	3.41	12.25
12	74.90	3.87	9.71
13	99.84	4.26	8.20
14	125.07	4.72	7.17

File Name = GEP059.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT (%)
1	2.50	1.08	45.17
2	4.00	1.28	44.05
3	6.31	1.60	40.83
4	7.50	1.79	36.79
5	11.38	2.53	21.76
6	14.79	2.70	16.69
7	20.13	2.85	15.20
8	24.82	2.96	14.06
9	34.88	3.14	12.99
10	49.88	3.45	11.18
11	75.11	3.87	9.66
12	99.98	4.28	7.60
13	124.94	4.73	5.99

File Name = GEP060.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT (%)
1	2.50	2.43	44.90
2	4.06	2.73	44.37
3	6.16	3.32	39.68
4	7.39	3.77	36.12
5	11.33	5.14	22.41
6	14.79	5.68	16.25
7	20.18	5.87	14.86
8	24.85	6.25	13.33
9	35.03	6.54	12.18
10	49.85	7.04	10.58
11	74.91	7.97	8.46
12	99.79	8.75	7.55
13	124.78	9.54	5.69

File Name = GEP061.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT (%)
1	2.50	1.61	32.88
2	3.93	1.76	31.36
3	6.39	1.99	29.15
4	7.46	2.04	29.10
5	11.56	2.37	24.62
6	15.17	2.68	18.21
7	19.88	2.84	16.31
8	25.17	3.11	13.23
9	35.06	3.25	11.20
10	50.12	3.38	11.10
11	75.15	3.89	8.07
12	99.98	4.23	7.77
13	125.04	4.65	6.16

File Name = GEP062.PRF APRFL.FOR Output

RECORD NO.	HEIGHT (cm)	VELOCITY (m/s)	TURB.INT (%)
1	2.50	3.51	30.47
2	3.91	3.78	29.28
3	6.42	4.14	28.56
4	7.68	4.47	26.62
5	11.35	5.03	22.63
6	14.81	5.74	17.01
7	19.91	6.11	14.29
8	24.96	6.35	12.17
9	34.82	6.72	10.92
10	50.10	7.20	10.21
11	74.95	7.98	8.24
12	99.88	8.73	7.56
13	124.97	9.51	5.78

APPENDIX C: CONCENTRATION DATA FILE PRINTOUTS

RUN NUMBER 9 FILE NAME GEP009.GC
BY NEFF ON 07-10-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 530.2
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE C2H6
TRACER CONCENTRATION (PPM) 1000000.0
BACKGROUND CONCENTRATION (PPM) 19.22

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	375.0	.0	.0	428.6	447.8
2	375.0	.0	4.0	436.1	455.3
3	375.0	.0	8.0	480.7	499.9
4	375.0	.0	12.0	524.9	544.1
5	375.0	.0	16.0	482.0	501.2
6	375.0	.0	20.0	599.8	619.0
7	375.0	.0	24.0	606.9	626.1
8	375.0	.0	28.0	608.2	627.4
9	375.0	.0	32.0	586.0	605.2
10	375.0	.0	36.0	522.9	542.1
11	375.0	.0	40.0	454.3	473.5
12	375.0	.0	44.0	391.7	410.9
13	375.0	.0	48.0	326.9	346.1
14	375.0	.0	52.0	269.1	288.3
15	375.0	.0	56.0	219.4	238.6
16	375.0	.0	60.0	169.8	189.1
17	375.0	.0	64.0	126.0	145.3
18	375.0	.0	68.0	91.6	110.8
19	375.0	.0	72.0	66.7	85.9
20	375.0	.0	76.0	43.4	62.6
21	375.0	.0	80.0	28.8	48.0
22	375.0	.0	84.0	19.2	38.4
23	375.0	.0	88.0	13.4	32.6
24	375.0	.0	92.0	9.3	28.5
25	375.0	.0	96.0	5.5	24.7
26	375.0	.0	100.0	3.8	23.0
27	375.0	.0	104.0	3.2	22.4
28	375.0	.0	108.0	3.0	22.2
29	375.0	.0	112.0	2.4	21.6
30	375.0	.0	116.0	2.8	22.0

RUN NUMBER 10 FILE NAME GEP010.GC
BY NEFF ON 07-10-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 530.2
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE C2H6
TRACER CONCENTRATION (PPM) 1000000.0
BACKGROUND CONCENTRATION (PPM) 28.21

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	250.0	.0	.0	238.4	266.6
2	250.0	.0	4.0	313.4	341.6
3	250.0	.0	8.0	485.8	514.0
4	250.0	.0	12.0	696.3	724.5
5	250.0	.0	16.0	726.8	755.0
6	250.0	.0	20.0	1014.0	1042.2
7	250.0	.0	24.0	1087.7	1115.9
8	250.0	.0	28.0	1069.9	1098.1
9	250.0	.0	32.0	1000.7	1028.9
10	250.0	.0	36.0	883.7	911.8
11	250.0	.0	40.0	746.0	774.2
12	250.0	.0	44.0	609.2	637.4
13	250.0	.0	48.0	430.4	458.6
14	250.0	.0	52.0	327.9	356.1
15	250.0	.0	56.0	237.7	265.9
16	250.0	.0	60.0	156.5	184.7
17	250.0	.0	64.0	95.5	123.7
18	250.0	.0	68.0	59.4	87.6
19	250.0	.0	72.0	32.8	61.1
20	250.0	.0	76.0	18.8	47.0
21	250.0	.0	80.0	10.3	38.5
22	250.0	.0	84.0	6.1	34.3
23	250.0	.0	88.0	3.3	31.5
24	250.0	.0	92.0	4.3	32.5
25	250.0	.0	96.0	3.1	31.3
26	250.0	.0	100.0	3.0	31.2
27	250.0	.0	104.0	3.0	31.2
28	250.0	.0	108.0	3.1	31.3
29	250.0	.0	112.0	3.1	31.4
30	250.0	.0	116.0	3.5	31.7
35	250.0	.0	18.0	925.7	953.9
36	250.0	.0	22.0	1003.1	1031.3
37	250.0	.0	26.0	1096.7	1124.9
38	250.0	.0	30.0	1036.7	1064.9

RUN NUMBER 11 FILE NAME GEP011.GC
BY NEFF ON 07-10-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 530.2
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE C2H6
TRACER CONCENTRATION (PPM) 1000000.0
BACKGROUND CONCENTRATION (PPM) 25.03

TUBE NO.	X	Y	Z	CONCENTRATIONS	(PPM)
	(cm)	(cm)	(cm)	Source 1	Tracer 1
1	125.0	.0	.0	16.6	41.7
2	125.0	.0	4.0	47.5	72.5
3	125.0	.0	8.0	208.0	233.0
4	125.0	.0	12.0	626.4	651.5
5	125.0	.0	16.0	1126.9	1151.9
6	125.0	.0	20.0	2355.5	2380.5
7	125.0	.0	24.0	3058.2	3083.2
8	125.0	.0	28.0	3152.7	3177.7
9	125.0	.0	32.0	2681.4	2706.4
10	125.0	.0	36.0	1987.0	2012.0
11	125.0	.0	40.0	1211.2	1236.2
12	125.0	.0	44.0	692.5	717.5
13	125.0	.0	48.0	296.2	321.3
14	125.0	.0	52.0	129.5	154.5
15	125.0	.0	56.0	56.1	81.1
16	125.0	.0	60.0	22.4	47.4
17	125.0	.0	64.0	6.6	31.6
18	125.0	.0	68.0	3.3	28.4
19	125.0	.0	72.0	2.9	27.9
20	125.0	.0	76.0	3.0	28.0
21	125.0	.0	80.0	2.6	27.6
22	125.0	.0	84.0	2.4	27.4
23	125.0	.0	88.0	2.4	27.5
24	125.0	.0	92.0	3.4	28.5
25	125.0	.0	96.0	2.3	27.3
26	125.0	.0	100.0	2.3	27.3
27	125.0	.0	104.0	2.4	27.5
28	125.0	.0	108.0	2.4	27.5
29	125.0	.0	112.0	2.2	27.2
30	125.0	.0	116.0	2.5	27.5
33	125.0	.0	10.0	340.3	365.4
34	125.0	.0	14.0	917.2	942.2
35	125.0	.0	18.0	1775.3	1800.3
36	125.0	.0	22.0	2717.2	2742.2
37	125.0	.0	26.0	3088.6	3113.6
38	125.0	.0	30.0	2948.6	2973.6
39	125.0	.0	34.0	2272.7	2297.7
40	125.0	.0	38.0	1556.5	1581.5

RUN NUMBER 12 FILE NAME GEP012.GC
BY NEFF ON 07-11-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 530.2
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE C2H6
TRACER CONCENTRATION (PPM) 1000000.0
BACKGROUND CONCENTRATION (PPM) 37.12

TUBE NO.	X	Y	Z	CONCENTRATIONS	(PPM)
	(cm)	(cm)	(cm)	Source 1	Tracer 1
1	375.0	-8.0	26.0	612.1	649.2
2	375.0	-4.0	26.0	628.8	665.9
3	375.0	.0	26.0	635.3	672.4
4	375.0	4.0	26.0	646.0	683.1
5	375.0	8.0	26.0	533.0	570.1
6	375.0	12.0	26.0	640.0	677.1
7	375.0	16.0	26.0	601.0	638.1
8	375.0	20.0	26.0	537.5	574.6
9	375.0	24.0	26.0	470.5	507.6
10	375.0	28.0	26.0	411.5	448.6
11	375.0	32.0	26.0	345.7	382.8
12	375.0	36.0	26.0	289.8	327.0
13	375.0	40.0	26.0	212.9	250.0
14	375.0	44.0	26.0	162.0	199.1
15	375.0	48.0	26.0	126.9	164.0
16	375.0	52.0	26.0	88.6	125.7
17	375.0	56.0	26.0	58.5	95.6
18	375.0	60.0	26.0	35.2	72.3
19	375.0	64.0	26.0	26.7	63.9
20	375.0	68.0	26.0	17.7	54.8
21	375.0	72.0	26.0	11.1	48.3
22	375.0	76.0	26.0	6.6	43.7
23	375.0	80.0	26.0	4.2	41.3
24	375.0	84.0	26.0	3.7	40.9
25	375.0	88.0	26.0	1.4	38.5
26	375.0	92.0	26.0	1.2	38.3
27	375.0	96.0	26.0	.8	37.9
28	375.0	100.0	26.0	.8	38.0
29	375.0	104.0	26.0	.6	37.7
30	375.0	108.0	26.0	.8	37.9
31	375.0	-6.0	26.0	582.0	619.1
32	375.0	-2.0	26.0	596.3	633.4
33	375.0	2.0	26.0	611.9	649.0
34	375.0	6.0	26.0	621.8	658.9
35	375.0	10.0	26.0	610.7	647.8
36	375.0	14.0	26.0	594.5	631.6

RUN NUMBER 13 FILE NAME GEP013.GC
BY NEFF ON 07-11-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 530.2
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE C2H6
TRACER CONCENTRATION (PPM) 1000000.0
BACKGROUND CONCENTRATION (PPM) 24.34

TUBE NO.	X	Y	Z	CONCENTRATIONS	(PPM)
	(cm)	(cm)	(cm)	Source 1	Tracer 1
1	250.0	-8.0	26.0	1087.1	1111.4
2	250.0	-4.0	26.0	1129.9	1154.2
3	250.0	.0	26.0	1157.2	1181.5
4	250.0	4.0	26.0	1090.4	1114.7
5	250.0	8.0	26.0	867.0	891.3
6	250.0	12.0	26.0	886.1	910.4
7	250.0	16.0	26.0	780.1	804.5
8	250.0	20.0	26.0	616.0	640.3
9	250.0	24.0	26.0	502.6	526.9
10	250.0	28.0	26.0	392.6	416.9
11	250.0	32.0	26.0	279.6	303.9
12	250.0	36.0	26.0	192.9	217.3
13	250.0	40.0	26.0	120.1	144.4
14	250.0	44.0	26.0	80.6	104.9
15	250.0	48.0	26.0	56.0	80.3
16	250.0	52.0	26.0	36.6	60.9
17	250.0	56.0	26.0	18.4	42.7
18	250.0	60.0	26.0	9.5	33.8
19	250.0	64.0	26.0	4.8	29.2
20	250.0	68.0	26.0	2.1	26.5
21	250.0	72.0	26.0	1.9	26.3
22	250.0	76.0	26.0	1.1	25.4
23	250.0	80.0	26.0	.9	25.2
24	250.0	84.0	26.0	1.6	25.9
25	250.0	88.0	26.0	.7	25.1
31	250.0	-6.0	26.0	1037.2	1061.5
32	250.0	-2.0	26.0	1065.6	1089.9
33	250.0	2.0	26.0	1090.5	1114.8
34	250.0	6.0	26.0	1011.5	1035.8
35	250.0	10.0	26.0	938.5	962.8
36	250.0	14.0	26.0	797.6	821.9
37	250.0	18.0	26.0	653.6	677.9
38	250.0	22.0	26.0	526.3	550.7
39	250.0	26.0	26.0	421.6	445.9
40	250.0	30.0	26.0	324.8	349.1

RUN NUMBER 14 FILE NAME GEP014.GC
BY NEFF ON 07-11-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 530.2
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE C2H6
TRACER CONCENTRATION (PPM) 1000000.0
BACKGROUND CONCENTRATION (PPM) 23.08

TUBE NO.	X	Y	Z	CONCENTRATIONS	(PPM)
	(cm)	(cm)	(cm)	Source 1	Tracer 1
1	125.0	-8.0	26.0	2810.8	2833.8
2	125.0	-4.0	26.0	3030.0	3053.0
3	125.0	.0	26.0	3062.0	3085.0
4	125.0	4.0	26.0	2671.2	2694.2
5	125.0	8.0	26.0	1876.0	1899.0
6	125.0	12.0	26.0	1487.5	1510.5
7	125.0	16.0	26.0	859.1	882.2
8	125.0	20.0	26.0	453.1	476.2
9	125.0	24.0	26.0	207.5	230.6
10	125.0	28.0	26.0	106.4	129.5
11	125.0	32.0	26.0	49.3	72.4
12	125.0	36.0	26.0	20.2	43.3
13	125.0	40.0	26.0	5.3	28.4
14	125.0	44.0	26.0	2.8	25.9
15	125.0	48.0	26.0	1.7	24.7
16	125.0	52.0	26.0	1.5	24.6
17	125.0	56.0	26.0	1.4	24.5
18	125.0	60.0	26.0	1.3	24.4
19	125.0	64.0	26.0	1.0	24.0
20	125.0	68.0	26.0	3.5	26.6
21	125.0	72.0	26.0	.9	24.0
22	125.0	76.0	26.0	.8	23.9
23	125.0	80.0	26.0	.9	23.9
24	125.0	84.0	26.0	9.5	32.5
25	125.0	88.0	26.0	.8	23.9
31	125.0	-6.0	26.0	2756.6	2779.6
32	125.0	-2.0	26.0	2925.5	2948.5
33	125.0	2.0	26.0	2801.0	2824.0
34	125.0	6.0	26.0	2334.0	2357.0
35	125.0	10.0	26.0	1801.7	1824.7
36	125.0	14.0	26.0	1183.9	1207.0
37	125.0	18.0	26.0	645.1	668.2
38	125.0	22.0	26.0	318.7	341.8
39	125.0	26.0	26.0	149.5	172.6
40	125.0	30.0	26.0	76.8	99.9

RUN NUMBER 15 FILE NAME GEP015.GC
BY NEFF ON 07-11-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 530.2
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE C2H6
TRACER CONCENTRATION (PPM) 1000000.0
BACKGROUND CONCENTRATION (PPM) 23.50

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	.5	24.0
2	75.0	.0	.0	.0	20.0
3	100.0	.0	.0	1.6	25.1
6	175.0	.0	.0	54.0	77.5
7	200.0	.0	.0	125.1	148.6
8	225.0	.0	.0	173.7	197.2
9	250.0	.0	.0	240.6	264.1
10	275.0	.0	.0	286.7	310.2
11	300.0	.0	.0	338.5	362.0
12	325.0	.0	.0	366.3	389.8
13	350.0	.0	.0	386.7	410.2
14	375.0	.0	.0	400.4	423.9
15	400.0	.0	.0	411.6	435.1
16	425.0	.0	.0	430.1	453.6
17	450.0	.0	.0	431.7	455.2
18	475.0	.0	.0	429.3	452.8
19	500.0	.0	.0	426.2	449.7
20	525.0	.0	.0	419.7	443.2
21	125.0	-15.0	.0	13.3	36.8
22	125.0	-10.0	.0	29.1	52.6
23	125.0	-5.0	.0	46.7	70.2
24	125.0	5.0	.0	28.1	51.6
25	125.0	10.0	.0	12.6	36.1
26	125.0	15.0	.0	4.2	27.7
27	250.0	-15.0	.0	183.1	206.6
28	250.0	-10.0	.0	219.0	242.5
29	250.0	-5.0	.0	242.3	265.8
30	250.0	5.0	.0	246.1	269.6
31	250.0	10.0	.0	234.5	258.0
32	250.0	15.0	.0	205.2	228.7
33	375.0	-15.0	.0	343.1	366.6
34	375.0	-10.0	.0	375.8	399.3
35	375.0	-5.0	.0	396.6	420.1
36	375.0	5.0	.0	395.6	419.1
37	375.0	10.0	.0	376.5	400.0
38	375.0	15.0	.0	336.9	360.4
39	500.0	-15.0	.0	367.7	391.2
40	500.0	-10.0	.0	401.0	424.5
41	500.0	-5.0	.0	418.6	442.1
42	500.0	5.0	.0	418.5	442.0
43	500.0	10.0	.0	398.5	422.0
44	500.0	15.0	.0	350.3	373.8

RUN NUMBER 16 FILE NAME GEP016.GC
BY NEFF ON 07-14-91
WIND SPEED 473.00 CM/S AT 125.0 CM
AIR TEMP. 27.0 C AT 125.0 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 95.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE C2H6
TRACER CONCENTRATION (PPM) 1000000.0
BACKGROUND CONCENTRATION (PPM) 8.97

TUBE NO.	X	Y	Z	CONCENTRATIONS (PPM)	
	(cm)	(cm)	(cm)	Source 1	Tracer 1
1	80.0	.0	.0	914.6	923.6
2	92.5	.0	.0	964.3	973.3
3	105.0	.0	.0	984.8	993.8
4	117.5	.0	.0	933.2	942.1
5	130.0	.0	.0	873.7	882.6
6	155.0	.0	.0	755.0	764.0
7	167.5	.0	.0	682.6	691.6
8	190.0	.0	.0	593.7	602.6
9	210.0	.0	.0	533.7	542.7
10	230.0	.0	.0	487.2	496.2
11	250.0	.0	.0	442.5	451.5
12	270.0	.0	.0	411.5	420.4
13	290.0	.0	.0	370.2	379.2
14	310.0	.0	.0	338.5	347.5
15	330.0	.0	.0	315.2	324.1
16	350.0	.0	.0	295.0	304.0
17	370.0	.0	.0	270.7	279.7
18	390.0	.0	.0	247.8	256.7
19	410.0	.0	.0	241.9	250.8
20	430.0	.0	.0	224.7	233.6
21	450.0	.0	.0	214.2	223.1
23	490.0	.0	.0	191.3	200.3
24	510.0	.0	.0	186.4	195.3
25	530.0	.0	.0	176.0	184.9

RUN NUMBER 17 FILE NAME GEP017.GC
BY NEFF ON 07-14-91
WIND SPEED 954.00 CM/S AT 125.0 CM
AIR TEMP. 27.0 C AT 125.0 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 95.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE C2H6
TRACER CONCENTRATION (PPM) 1000000.0
BACKGROUND CONCENTRATION (PPM) 3.78

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	80.0	.0	.0	445.8	449.6
2	92.5	.0	.0	461.6	465.3
3	105.0	.0	.0	476.4	480.2
4	117.5	.0	.0	457.0	460.7
5	130.0	.0	.0	431.6	435.3
6	155.0	.0	.0	375.3	379.1
7	167.5	.0	.0	339.4	343.1
8	190.0	.0	.0	291.6	295.4
9	210.0	.0	.0	262.2	266.0
10	230.0	.0	.0	238.1	241.9
11	250.0	.0	.0	215.3	219.1
12	270.0	.0	.0	199.1	202.9
13	290.0	.0	.0	180.4	184.2
14	310.0	.0	.0	165.9	169.7
15	330.0	.0	.0	155.1	158.9
16	350.0	.0	.0	143.6	147.4
17	370.0	.0	.0	133.7	137.4
18	390.0	.0	.0	121.5	125.3
19	410.0	.0	.0	118.2	122.0
20	430.0	.0	.0	110.2	114.0
21	450.0	.0	.0	104.2	108.0
23	490.0	.0	.0	95.0	98.8
24	510.0	.0	.0	91.5	95.3
25	530.0	.0	.0	85.8	89.6

RUN NUMBER 18 FILE NAME GEP018.GC
BY NEFF ON 07-15-91
WIND SPEED 465.50 CM/S AT 125.0 CM
AIR TEMP. 27.0 C AT 125.0 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 95.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE C2H6
TRACER CONCENTRATION (PPM) 1000000.0
BACKGROUND CONCENTRATION (PPM) 5.66

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	40.0	.0	.0	1974.3	1979.9
2	52.5	.0	.0	2590.1	2595.7
3	65.0	.0	.0	2242.6	2248.2
4	90.0	.0	.0	1603.1	1608.7
5	115.0	.0	.0	1206.5	1212.1
6	140.0	.0	.0	977.5	983.2
7	165.5	.0	.0	778.9	784.6
8	190.0	.0	.0	643.4	649.0
9	210.0	.0	.0	578.8	584.5
10	230.0	.0	.0	505.7	511.4
11	250.0	.0	.0	459.0	464.7
12	270.0	.0	.0	421.1	426.8
13	290.0	.0	.0	381.4	387.0
14	310.0	.0	.0	351.5	357.1
15	330.0	.0	.0	324.8	330.5
16	350.0	.0	.0	302.0	307.6
17	370.0	.0	.0	270.4	276.1
18	390.0	.0	.0	243.0	248.7
19	410.0	.0	.0	242.2	247.8
20	430.0	.0	.0	224.4	230.1
21	450.0	.0	.0	214.7	220.4
22	470.0	.0	.0	204.6	210.2
23	490.0	.0	.0	194.3	199.9
24	510.0	.0	.0	188.7	194.3
25	530.0	.0	.0	173.8	179.4

RUN NUMBER 19 FILE NAME GEP019.GC
BY NEFF ON 07-15-91
WIND SPEED 951.00 CM/S AT 125.0 CM
AIR TEMP. 27.0 C AT 125.0 CM

SOURCE DESIGNATION	1
SOURCE FLOW RATE (CCS)	95.8
SOURCE GAS TEMPERATURE (C)	27.0
TRACER TYPE	C2H6
TRACER CONCENTRATION (PPM)	1000000.0
BACKGROUND CONCENTRATION (PPM)	4.18

TUBE NO.	X	Y	Z	CONCENTRATIONS (PPM)	
	(cm)	(cm)	(cm)	Source 1	Tracer 1
1	40.0	.0	.0	1020.4	1024.6
2	52.5	.0	.0	1221.3	1225.5
3	65.0	.0	.0	1067.1	1071.3
4	90.0	.0	.0	760.1	764.3
5	115.0	.0	.0	573.5	577.7
6	140.0	.0	.0	465.7	469.9
7	165.5	.0	.0	377.6	381.8
8	190.0	.0	.0	310.5	314.7
9	210.0	.0	.0	274.7	278.9
10	230.0	.0	.0	236.4	240.5
11	250.0	.0	.0	215.1	219.3
12	270.0	.0	.0	195.6	199.8
13	290.0	.0	.0	177.2	181.4
14	310.0	.0	.0	160.8	165.0
15	330.0	.0	.0	148.0	152.2
16	350.0	.0	.0	136.8	140.9
17	370.0	.0	.0	124.0	128.2
18	390.0	.0	.0	111.8	116.0
19	410.0	.0	.0	108.5	112.7
20	430.0	.0	.0	101.0	105.2
21	450.0	.0	.0	96.7	100.8
22	470.0	.0	.0	91.9	96.1
23	490.0	.0	.0	87.8	92.0
24	510.0	.0	.0	84.9	89.1
25	530.0	.0	.0	77.0	81.2

RUN NUMBER 20 FILE NAME GEP020.GC
BY NEFF ON 07-16-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 692000.0
BACKGROUND CONCENTRATION (PPM) 12.13

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	155.8	119.9
2	75.0	-10.0	.0	157.5	121.2
3	75.0	-5.0	.0	441.0	317.3
4	75.0	.0	.0	568.3	405.4
5	75.0	5.0	.0	303.2	221.9
6	75.0	10.0	.0	342.5	249.1
7	100.0	.0	.0	1162.6	816.6
10	125.0	.0	.0	1263.0	886.1
11	125.0	5.0	.0	1126.9	791.9
12	125.0	10.0	.0	879.7	620.9
13	150.0	.0	.0	1380.4	967.4
14	175.0	.0	.0	1487.4	1041.4
15	200.0	.0	.0	1502.7	1052.0
16	225.0	.0	.0	1477.0	1034.2
17	250.0	-10.0	.0	1253.4	879.5
18	250.0	-5.0	.0	1306.3	916.1
19	250.0	.0	.0	1421.5	995.8
20	250.0	5.0	.0	1326.1	929.7
21	250.0	10.0	.0	1276.4	895.4
22	275.0	.0	.0	1314.5	921.8
23	300.0	.0	.0	1233.3	865.5
24	325.0	.0	.0	1168.7	820.9
25	350.0	.0	.0	1122.3	788.7
26	375.0	-10.0	.0	903.9	637.6
27	375.0	-5.0	.0	984.7	693.5
28	375.0	.0	.0	1017.9	716.5
29	375.0	5.0	.0	1010.5	711.4
30	375.0	10.0	.0	967.0	681.3
31	400.0	.0	.0	964.3	679.4
33	450.0	.0	.0	860.5	607.6
34	475.0	.0	.0	827.4	584.7
35	500.0	-10.0	.0	748.8	530.3
36	500.0	-5.0	.0	784.7	555.1
37	500.0	.0	.0	812.3	574.2
38	500.0	5.0	.0	785.3	555.5
39	500.0	10.0	.0	742.6	526.0
40	525.0	.0	.0	757.8	536.5

RUN NUMBER 21 FILE NAME GEP021.GC
BY NEFF ON 07-16-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 692000.0
BACKGROUND CONCENTRATION (PPM) 16.36

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	3435.3	2393.5
2	75.0	-10.0	.0	3086.7	2152.3
3	75.0	-5.0	.0	3737.9	2602.9
4	75.0	.0	.0	4024.0	2800.9
5	75.0	5.0	.0	4753.6	3305.8
6	75.0	10.0	.0	4225.0	2940.0
7	100.0	.0	.0	4445.1	3092.3
10	125.0	.0	.0	4015.5	2795.0
11	125.0	5.0	.0	4060.1	2825.9
12	125.0	10.0	.0	3609.8	2514.3
13	150.0	.0	.0	3409.4	2375.6
14	175.0	.0	.0	2933.8	2046.5
15	200.0	.0	.0	2570.9	1795.4
16	225.0	.0	.0	2289.6	1600.7
17	250.0	-10.0	.0	1958.5	1371.6
18	250.0	-5.0	.0	1964.0	1375.4
19	250.0	.0	.0	2074.1	1451.6
20	250.0	5.0	.0	1993.7	1396.0
21	250.0	10.0	.0	1997.6	1398.7
22	275.0	.0	.0	1830.0	1282.7
23	300.0	.0	.0	1656.2	1162.4
24	325.0	.0	.0	1508.6	1060.3
25	350.0	.0	.0	1392.8	980.2
26	375.0	-10.0	.0	1204.0	849.5
27	375.0	-5.0	.0	1271.6	896.3
28	375.0	.0	.0	1291.8	910.3
29	375.0	5.0	.0	1260.0	888.3
30	375.0	10.0	.0	1225.9	864.7
31	400.0	.0	.0	1164.4	822.1
33	450.0	.0	.0	1011.7	716.4
34	475.0	.0	.0	955.8	677.8
35	500.0	-10.0	.0	890.7	632.7
36	500.0	-5.0	.0	907.1	644.1
37	500.0	.0	.0	907.3	644.2
38	500.0	5.0	.0	892.9	634.3
39	500.0	10.0	.0	887.9	630.8
40	525.0	.0	.0	850.9	605.2

RUN NUMBER 22 FILE NAME GEP022.GC
BY NEFF ON 07-17-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 692000.0
BACKGROUND CONCENTRATION (PPM) 17.63

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	6052.6	4205.9
2	75.0	-10.0	.0	3151.0	2198.1
3	75.0	-5.0	.0	3892.0	2710.8
4	75.0	.0	.0	4170.0	2903.2
5	75.0	5.0	.0	4443.9	3092.7
6	75.0	10.0	.0	4135.9	2879.6
7	100.0	.0	.0	4632.9	3223.5
10	125.0	.0	.0	4288.8	2985.4
11	125.0	5.0	.0	4272.3	2974.0
12	125.0	10.0	.0	3705.3	2581.6
13	150.0	.0	.0	3708.0	2583.5
14	175.0	.0	.0	3165.6	2208.2
15	200.0	.0	.0	2798.4	1954.1
16	225.0	.0	.0	2499.7	1747.4
17	250.0	-10.0	.0	2083.8	1459.6
18	250.0	-5.0	.0	2107.2	1475.8
19	250.0	.0	.0	2311.6	1617.2
20	250.0	5.0	.0	2252.2	1576.1
21	250.0	10.0	.0	2260.7	1582.0
22	275.0	.0	.0	2054.9	1439.6
23	300.0	.0	.0	1851.4	1298.8
24	325.0	.0	.0	1693.9	1189.8
25	350.0	.0	.0	1537.1	1081.3
26	375.0	-10.0	.0	1282.6	905.2
27	375.0	-5.0	.0	1359.1	958.1
28	375.0	.0	.0	1397.4	984.6
29	375.0	5.0	.0	1380.8	973.1
30	375.0	10.0	.0	1351.5	952.8
31	400.0	.0	.0	1280.0	903.3
33	450.0	.0	.0	1103.3	781.1
34	475.0	.0	.0	1044.1	740.1
35	500.0	-10.0	.0	946.9	672.9
36	500.0	-5.0	.0	984.1	698.6
37	500.0	.0	.0	998.3	708.4
38	500.0	5.0	.0	982.1	697.2
39	500.0	10.0	.0	984.8	699.1
40	525.0	.0	.0	929.1	660.6

RUN NUMBER 23 FILE NAME GEP023.GC
BY NEFF ON 07-17-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 692000.0
BACKGROUND CONCENTRATION (PPM) 15.84

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	185.1	143.9
2	75.0	-10.0	.0	269.9	202.6
3	75.0	-5.0	.0	578.5	416.2
4	75.0	.0	.0	617.4	443.1
5	75.0	5.0	.0	354.2	260.9
6	75.0	10.0	.0	406.7	297.3
7	100.0	.0	.0	1164.6	821.7
10	125.0	.0	.0	1328.1	934.9
11	125.0	5.0	.0	1210.2	853.3
12	125.0	10.0	.0	982.8	695.9

RUN NUMBER 24 FILE NAME GEP024.GC
BY NEFF ON 07-18-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 21.20

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	15.2	31.2
2	75.0	-10.0	.0	47.3	52.1
3	75.0	-5.0	.0	113.8	95.6
4	75.0	.0	.0	114.4	96.0
5	75.0	5.0	.0	71.2	67.8
6	75.0	10.0	.0	67.9	65.6
7	100.0	.0	.0	346.9	248.0
10	125.0	.0	.0	566.3	391.5
11	125.0	5.0	.0	536.3	372.0
12	125.0	10.0	.0	417.5	294.2
13	150.0	.0	.0	794.4	540.7
14	175.0	.0	.0	923.7	625.3
15	200.0	.0	.0	1109.0	746.5
16	225.0	.0	.0	1147.4	771.6
17	250.0	-10.0	.0	978.9	661.4
18	250.0	-5.0	.0	1024.0	690.9
19	250.0	.0	.0	1120.3	753.9
20	250.0	5.0	.0	1026.4	692.5
21	250.0	10.0	.0	956.4	646.7
22	275.0	.0	.0	1088.3	732.9
23	300.0	.0	.0	1050.2	708.0
24	325.0	.0	.0	1031.8	696.0
25	350.0	.0	.0	980.6	662.5
26	375.0	-10.0	.0	837.5	568.9
27	375.0	-5.0	.0	887.5	601.6
28	375.0	.0	.0	920.5	623.2
29	375.0	5.0	.0	905.4	613.3
30	375.0	10.0	.0	852.8	578.9
31	400.0	.0	.0	880.4	597.0
33	450.0	.0	.0	777.7	529.8
34	475.0	.0	.0	739.5	504.8
35	500.0	-10.0	.0	482.9	337.0
36	500.0	-5.0	.0	709.7	485.4
37	500.0	.0	.0	727.4	496.9
38	500.0	5.0	.0	694.1	475.1
39	500.0	10.0	.0	693.6	474.8
40	525.0	.0	.0	678.2	464.7

RUN NUMBER 25 FILE NAME GEP025.GC
BY NEFF ON 07-18-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 24.90

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	492.7	347.1
2	75.0	-10.0	.0	1259.7	848.7
3	75.0	-5.0	.0	1508.2	1011.2
4	75.0	.0	.0	1723.0	1151.7
5	75.0	5.0	.0	2124.7	1414.4
6	75.0	10.0	.0	1594.4	1067.6
7	100.0	.0	.0	2375.8	1578.6
10	125.0	.0	.0	2598.9	1724.5
11	125.0	5.0	.0	2366.3	1572.4
12	125.0	10.0	.0	1932.6	1288.8
13	150.0	.0	.0	2475.5	1643.8
14	175.0	.0	.0	2292.3	1524.0
15	200.0	.0	.0	2246.4	1494.0
16	225.0	.0	.0	2120.7	1411.8
17	250.0	-10.0	.0	1810.0	1208.6
18	250.0	-5.0	.0	1789.4	1195.1
19	250.0	.0	.0	1949.9	1300.1
20	250.0	5.0	.0	1811.8	1209.8
21	250.0	10.0	.0	1724.7	1152.8
22	275.0	.0	.0	1749.3	1168.9
23	300.0	.0	.0	1595.6	1068.4
24	325.0	.0	.0	1480.2	992.9
25	350.0	.0	.0	1386.7	931.8
26	375.0	-10.0	.0	1229.7	829.1
27	375.0	-5.0	.0	1245.8	839.6
28	375.0	.0	.0	1252.5	844.0
29	375.0	5.0	.0	1238.5	834.8
30	375.0	10.0	.0	1172.5	791.7
31	400.0	.0	.0	1159.4	783.1
33	450.0	.0	.0	1014.3	688.2
34	475.0	.0	.0	957.0	650.8
35	500.0	-10.0	.0	907.5	618.4
36	500.0	-5.0	.0	918.6	625.6
37	500.0	.0	.0	914.8	623.1
38	500.0	5.0	.0	900.6	613.8
39	500.0	10.0	.0	895.3	610.4
40	525.0	.0	.0	867.0	591.9

RUN NUMBER 26 FILE NAME GEP026.GC
BY NEFF ON 07-18-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 18.13

TUBE NO.	X	Y	Z	CONCENTRATIONS (PPM)	
	(cm)	(cm)	(cm)	Source 1	Tracer 1
1	50.0	.0	.0	22.9	33.1
2	75.0	-10.0	.0	22.0	32.5
3	75.0	-5.0	.0	31.2	38.6
4	75.0	.0	.0	40.7	44.7
5	75.0	5.0	.0	28.1	36.5
6	75.0	10.0	.0	25.0	34.5
7	100.0	.0	.0	170.2	129.4
10	125.0	.0	.0	348.7	246.2
11	125.0	5.0	.0	297.2	212.5
12	125.0	10.0	.0	200.8	149.4
13	150.0	.0	.0	534.2	367.5
14	175.0	.0	.0	628.5	429.2
15	200.0	.0	.0	778.4	527.2
16	225.0	.0	.0	820.4	554.6
17	250.0	-10.0	.0	766.0	519.1
18	250.0	-5.0	.0	791.9	536.0
19	250.0	.0	.0	839.1	566.9
20	250.0	5.0	.0	802.5	542.9
21	250.0	10.0	.0	726.2	493.0
22	275.0	.0	.0	856.1	578.0
23	300.0	.0	.0	850.1	574.1
24	325.0	.0	.0	834.0	563.5
25	350.0	.0	.0	824.0	557.0
26	375.0	-10.0	.0	697.4	474.3
29	375.0	5.0	.0	777.3	526.5
30	375.0	10.0	.0	723.5	491.3
31	400.0	.0	.0	737.7	500.6
34	475.0	.0	.0	658.2	448.5
35	500.0	-10.0	.0	623.5	425.9
36	500.0	-5.0	.0	652.1	444.6
37	500.0	.0	.0	650.9	443.8
38	500.0	5.0	.0	628.2	429.0
40	525.0	.0	.0	625.6	427.3
41	375.0	-5.0	.0	784.1	530.9
42	375.0	.0	.0	793.4	537.0
43	500.0	10.0	.0	622.1	425.0

RUN NUMBER 27 FILE NAME GEP027.GC
BY NEFF ON 07-18-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 31.57

TUBE NO.	X	Y	Z	CONCENTRATIONS	(PPM)
	(cm)	(cm)	(cm)	Source 1	Tracer 1
1	50.0	.0	.0	.0	.3
2	75.0	-10.0	.0	421.3	307.1
3	75.0	-5.0	.0	491.0	352.7
4	75.0	.0	.0	622.4	438.6
5	75.0	5.0	.0	781.5	542.7
6	75.0	10.0	.0	551.3	392.1
7	100.0	.0	.0	1059.3	724.3
10	125.0	.0	.0	1452.7	981.6
11	125.0	5.0	.0	1224.1	832.1
12	125.0	10.0	.0	948.3	651.7
13	150.0	.0	.0	1542.6	1040.4
14	175.0	.0	.0	1528.4	1031.1
15	200.0	.0	.0	1609.2	1083.9
16	225.0	.0	.0	1571.2	1059.1
17	250.0	-10.0	.0	1430.8	967.3
18	250.0	-5.0	.0	1421.0	960.8
19	250.0	.0	.0	1470.1	992.9
20	250.0	5.0	.0	1376.4	931.7
21	250.0	10.0	.0	1287.9	873.8
22	275.0	.0	.0	1359.4	920.6
23	300.0	.0	.0	1290.3	875.4
24	325.0	.0	.0	1184.5	806.2
25	350.0	.0	.0	1234.1	838.6
26	375.0	-10.0	.0	1035.5	708.8
30	375.0	10.0	.0	1002.7	687.3
31	400.0	.0	.0	1035.8	709.0
33	450.0	.0	.0	900.6	620.5
34	475.0	.0	.0	848.5	586.5
35	500.0	-10.0	.0	804.7	557.8
36	500.0	-5.0	.0	818.5	566.8
37	500.0	.0	.0	814.7	564.4
38	500.0	5.0	.0	791.2	549.0
41	375.0	-5.0	.0	1070.4	731.5
42	375.0	.0	.0	1081.0	738.5
43	500.0	10.0	.0	774.0	537.7

RUN NUMBER 28 FILE NAME GEP028.GC
BY NEFF ON 07-18-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 29.12

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	.8	29.6
2	75.0	-10.0	.0	21.8	43.4
3	75.0	-5.0	.0	39.8	55.2
4	75.0	.0	.0	33.3	50.9
5	75.0	5.0	.0	13.8	38.1
6	75.0	10.0	.0	12.3	37.2
7	100.0	.0	.0	153.1	129.3
10	125.0	.0	.0	298.2	224.1
11	125.0	5.0	.0	286.9	216.7
12	125.0	10.0	.0	209.2	165.9
13	150.0	.0	.0	470.9	337.1
14	175.0	.0	.0	701.6	487.9
15	200.0	.0	.0	824.3	568.2
16	225.0	.0	.0	881.1	605.3
17	250.0	-10.0	.0	711.3	494.3
18	250.0	-5.0	.0	812.2	560.3
19	250.0	.0	.0	888.5	610.2
20	250.0	5.0	.0	819.2	564.8
21	250.0	10.0	.0	759.6	525.8
22	275.0	.0	.0	898.3	616.6
23	300.0	.0	.0	885.9	608.5
25	350.0	.0	.0	834.8	575.0
26	375.0	-10.0	.0	724.4	502.8
29	375.0	5.0	.0	788.6	544.9
30	375.0	10.0	.0	724.2	502.7
31	400.0	.0	.0	768.0	531.4
33	450.0	.0	.0	713.8	495.9
34	475.0	.0	.0	689.9	480.3
35	500.0	-10.0	.0	648.6	453.3
36	500.0	-5.0	.0	665.3	464.2
37	500.0	.0	.0	671.1	468.0
38	500.0	5.0	.0	653.4	456.4
40	525.0	.0	.0	652.5	455.8
41	375.0	-5.0	.0	773.4	534.9
42	375.0	.0	.0	801.4	553.2
43	500.0	10.0	.0	636.3	445.2

RUN NUMBER 29 FILE NAME GEP029.GC
BY NEFF ON 07-19-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 33.71

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	27.1	51.5
2	75.0	-10.0	.0	280.3	217.1
3	75.0	-5.0	.0	507.4	365.6
4	75.0	.0	.0	487.1	352.3
5	75.0	5.0	.0	215.2	174.5
6	75.0	10.0	.0	135.2	122.1
7	100.0	.0	.0	1263.6	860.1
8	125.0	-10.0	.0	1595.2	1076.9
9	125.0	-5.0	.0	1742.9	1173.5
10	125.0	.0	.0	1783.4	1200.0
11	125.0	5.0	.0	1765.7	1188.4
12	125.0	10.0	.0	1135.4	776.2
14	175.0	.0	.0	1891.2	1270.5
15	200.0	.0	.0	1877.9	1261.8
16	225.0	.0	.0	1753.4	1180.4
17	250.0	-10.0	.0	1451.6	983.0
18	250.0	-5.0	.0	1546.1	1044.8
19	250.0	.0	.0	1649.5	1112.4
20	250.0	5.0	.0	1536.0	1038.2
21	250.0	10.0	.0	1461.4	989.4
22	275.0	.0	.0	1507.1	1019.3
23	300.0	.0	.0	1408.7	954.9
24	325.0	.0	.0	1335.7	907.2
25	350.0	.0	.0	1228.1	836.8
26	375.0	-10.0	.0	1062.5	728.5
30	375.0	10.0	.0	1080.8	740.5
31	400.0	.0	.0	1041.7	714.9
33	450.0	.0	.0	911.3	629.7
34	475.0	.0	.0	872.6	604.4
35	500.0	-10.0	.0	825.4	573.5
36	500.0	-5.0	.0	838.9	582.3
37	500.0	.0	.0	859.5	595.8
38	500.0	5.0	.0	821.1	570.7
40	525.0	.0	.0	.0	2.4
41	375.0	-5.0	.0	1117.0	764.2
42	375.0	.0	.0	1144.3	782.0
43	500.0	10.0	.0	821.4	570.9

RUN NUMBER 30 FILE NAME GEP030.GC
BY NEFF ON 07-19-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 18.52

TUBE NO.	X	Y	Z	CONCENTRATIONS	(PPM)
	(cm)	(cm)	(cm)	Source 1	Tracer 1
1	50.0	.0	.0	7.9	23.7
2	75.0	-10.0	.0	65.2	61.2
3	75.0	-5.0	.0	128.2	102.4
4	75.0	.0	.0	122.8	98.8
5	75.0	5.0	.0	29.6	37.9
6	75.0	10.0	.0	31.7	39.3
7	100.0	.0	.0	363.4	256.2
8	125.0	-10.0	.0	543.3	373.9
9	125.0	-5.0	.0	674.5	459.6
10	125.0	.0	.0	633.3	432.7
11	125.0	5.0	.0	631.7	431.7
12	125.0	10.0	.0	387.2	271.7
13	150.0	.0	.0	876.5	591.7
14	175.0	.0	.0	1163.3	779.3
15	200.0	.0	.0	1257.1	840.6
16	225.0	.0	.0	1247.8	834.5
17	250.0	-10.0	.0	1031.4	693.0
18	250.0	-5.0	.0	1143.7	766.5
19	250.0	.0	.0	1232.7	824.7
20	250.0	5.0	.0	1121.2	751.7
21	250.0	10.0	.0	1024.8	688.7
22	275.0	.0	.0	1187.3	795.0
23	300.0	.0	.0	1152.8	772.4
24	325.0	.0	.0	1085.7	728.5
25	350.0	.0	.0	1052.5	706.8
26	375.0	-10.0	.0	886.6	598.4
27	375.0	-5.0	.0	957.3	644.6
28	375.0	.0	.0	984.9	662.6
29	375.0	5.0	.0	950.7	640.2
30	375.0	10.0	.0	876.0	591.4
31	400.0	.0	.0	923.6	622.5
33	450.0	.0	.0	833.5	563.6
34	475.0	.0	.0	799.2	541.2
35	500.0	-10.0	.0	732.5	497.6
36	500.0	-5.0	.0	759.6	515.3
37	500.0	.0	.0	758.2	514.4
38	500.0	5.0	.0	738.0	501.1
39	500.0	10.0	.0	741.4	503.4
40	525.0	.0	.0	713.5	485.1

RUN NUMBER 31 FILE NAME GEP031.GC
BY NEFF ON 07-19-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 18.93

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	167.1	128.2
2	75.0	-10.0	.0	942.9	635.6
3	75.0	-5.0	.0	1245.8	833.7
4	75.0	.0	.0	1231.9	824.6
5	75.0	5.0	.0	669.6	456.8
6	75.0	10.0	.0	561.6	386.2
7	100.0	.0	.0	2096.8	1390.2
8	125.0	-10.0	.0	1898.8	1260.7
9	125.0	-5.0	.0	2461.0	1628.4
10	125.0	.0	.0	2482.7	1642.6
11	125.0	5.0	.0	2421.1	1602.3
12	125.0	10.0	.0	1759.0	1169.3
13	150.0	.0	.0	2387.5	1580.3
14	175.0	.0	.0	2251.7	1491.5
15	200.0	.0	.0	2123.7	1407.8
16	225.0	.0	.0	1952.0	1295.5
17	250.0	-10.0	.0	1576.8	1050.1
18	250.0	-5.0	.0	1635.8	1088.7
19	250.0	.0	.0	1797.9	1194.7
20	250.0	5.0	.0	1682.9	1119.5
21	250.0	10.0	.0	1651.2	1098.8
22	275.0	.0	.0	1613.9	1074.4
23	300.0	.0	.0	1493.4	995.6
24	325.0	.0	.0	1395.7	931.7
25	350.0	.0	.0	1281.6	857.1
26	375.0	-10.0	.0	1115.1	748.2
27	375.0	-5.0	.0	1172.6	785.8
28	375.0	.0	.0	1166.3	781.7
29	375.0	5.0	.0	1147.3	769.2
30	375.0	10.0	.0	1109.0	744.2
31	400.0	.0	.0	1089.3	731.3
33	450.0	.0	.0	959.8	646.6
34	475.0	.0	.0	909.2	613.5
35	500.0	-10.0	.0	827.5	560.1
36	500.0	-5.0	.0	867.0	586.0
37	500.0	.0	.0	867.8	586.4
38	500.0	5.0	.0	838.0	567.0
39	500.0	10.0	.0	823.7	557.6
40	525.0	.0	.0	814.1	551.3

RUN NUMBER 32 FILE NAME GEP032.GC
BY NEFF ON 07-19-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 29.28

TUBE NO.	X	Y	Z	CONCENTRATIONS	(PPM)
	(cm)	(cm)	(cm)	Source 1	Tracer 1
1	50.0	.0	.0	.0	29.3
2	75.0	-10.0	.0	53.9	64.5
3	75.0	-5.0	.0	107.1	99.3
4	75.0	.0	.0	123.7	110.2
5	75.0	5.0	.0	203.6	162.5
6	75.0	10.0	.0	195.4	157.1
7	100.0	.0	.0	486.0	347.1
8	125.0	-10.0	.0	452.2	325.0
9	125.0	-5.0	.0	663.4	463.1
10	125.0	.0	.0	787.7	544.4
11	125.0	5.0	.0	818.1	564.3
12	125.0	10.0	.0	724.1	502.8
13	150.0	.0	.0	1032.3	704.4
14	175.0	.0	.0	1101.8	749.8
15	200.0	.0	.0	1254.8	849.9
16	225.0	.0	.0	1251.2	847.5
17	250.0	-10.0	.0	980.3	670.4
18	250.0	-5.0	.0	1104.1	751.3
19	250.0	.0	.0	1311.9	887.2
20	250.0	5.0	.0	1294.1	875.6
21	250.0	10.0	.0	1268.7	859.0
22	275.0	.0	.0	1240.4	840.4
23	300.0	.0	.0	1213.2	822.7
25	350.0	.0	.0	1093.5	744.4
26	375.0	-10.0	.0	845.7	582.3
27	375.0	-5.0	.0	923.8	633.4
28	375.0	.0	.0	985.2	673.6
29	375.0	5.0	.0	1028.0	701.6
31	400.0	.0	.0	955.8	654.3
33	450.0	.0	.0	839.1	578.0
34	475.0	.0	.0	811.4	559.9
35	500.0	-10.0	.0	718.6	499.2
36	500.0	-5.0	.0	761.3	527.2
37	500.0	.0	.0	790.9	546.5
38	500.0	5.0	.0	789.2	545.4
39	500.0	10.0	.0	759.2	525.8
40	525.0	.0	.0	757.7	524.8

RUN NUMBER 33 FILE NAME GEP033.GC
BY NEFF ON 07-19-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 32.09

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	1036.5	709.9
2	75.0	-10.0	.0	1259.4	855.7
3	75.0	-5.0	.0	1746.4	1174.2
4	75.0	.0	.0	1858.4	1247.4
5	75.0	5.0	.0	1456.5	984.6
6	75.0	10.0	.0	940.6	647.2
7	100.0	.0	.0	2276.9	1521.1
8	125.0	-10.0	.0	2120.3	1418.7
9	125.0	-5.0	.0	2329.6	1555.6
10	125.0	.0	.0	2390.5	1595.4
11	125.0	5.0	.0	2219.7	1483.7
12	125.0	10.0	.0	1777.2	1194.3
13	150.0	.0	.0	2349.5	1568.6
14	175.0	.0	.0	2097.8	1404.0
15	200.0	.0	.0	2094.3	1401.7
16	225.0	.0	.0	1996.8	1337.9
17	250.0	-10.0	.0	1609.1	1084.4
18	250.0	-5.0	.0	1664.3	1120.5
19	250.0	.0	.0	1853.6	1244.3
20	250.0	5.0	.0	1735.9	1167.3
21	250.0	10.0	.0	1735.7	1167.2
22	275.0	.0	.0	1695.2	1140.7
23	300.0	.0	.0	1546.9	1043.7
24	325.0	.0	.0	1484.2	1002.7
25	350.0	.0	.0	1337.2	906.6
27	375.0	-5.0	.0	1177.1	801.9
28	375.0	.0	.0	1230.0	836.5
29	375.0	5.0	.0	1216.8	827.8
30	375.0	10.0	.0	286.2	219.3
31	400.0	.0	.0	1118.0	763.2
33	450.0	.0	.0	992.1	680.9
34	475.0	.0	.0	931.9	641.5
35	500.0	-10.0	.0	887.8	612.7
36	500.0	-5.0	.0	881.0	608.3
37	500.0	.0	.0	897.6	619.1
38	500.0	5.0	.0	910.0	627.2
39	500.0	10.0	.0	921.0	634.4
40	525.0	.0	.0	852.1	589.3

RUN NUMBER 34 FILE NAME GEP034.GC
BY NEFF ON 07-19-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 18.16

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	.5	18.5
2	75.0	-10.0	.0	8.8	23.9
3	75.0	-5.0	.0	23.8	33.7
4	75.0	.0	.0	34.0	40.4
5	75.0	5.0	.0	65.8	61.2
6	75.0	10.0	.0	60.4	57.6
7	100.0	.0	.0	167.9	128.0
8	125.0	-10.0	.0	191.8	143.6
9	125.0	-5.0	.0	269.1	194.2
11	125.0	5.0	.0	377.2	264.9
12	125.0	10.0	.0	319.2	226.9
13	150.0	.0	.0	539.9	371.2
14	175.0	.0	.0	637.2	434.9
15	200.0	.0	.0	751.0	509.3
16	225.0	.0	.0	804.7	544.4
17	250.0	-10.0	.0	651.5	444.2
18	250.0	-5.0	.0	740.7	502.6
19	250.0	.0	.0	826.9	558.9
20	250.0	5.0	.0	472.5	327.2
21	250.0	10.0	.0	847.7	572.5
22	275.0	.0	.0	871.1	587.8
23	300.0	.0	.0	844.8	570.6
25	350.0	.0	.0	776.9	526.3
26	375.0	-10.0	.0	613.0	419.0
27	375.0	-5.0	.0	714.6	485.5
28	375.0	.0	.0	783.9	530.8
29	375.0	5.0	.0	763.7	517.6
30	375.0	10.0	.0	740.3	502.3
31	400.0	.0	.0	699.8	475.8
33	450.0	.0	.0	647.9	441.9
34	475.0	.0	.0	648.0	441.9
35	500.0	-10.0	.0	552.5	379.5
36	500.0	-5.0	.0	613.1	419.1
37	500.0	.0	.0	618.0	422.3
38	500.0	5.0	.0	630.9	430.8
39	500.0	10.0	.0	667.7	454.8
40	525.0	.0	.0	619.3	423.1

RUN NUMBER 35 FILE NAME GEP035.GC
BY NEFF ON 07-19-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 21.76

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	253.3	187.4
2	75.0	-10.0	.0	448.5	315.0
3	75.0	-5.0	.0	666.0	457.3
4	75.0	.0	.0	703.4	481.8
5	75.0	5.0	.0	507.1	353.4
6	75.0	10.0	.0	265.0	195.0
7	100.0	.0	.0	1067.5	719.8
8	125.0	-10.0	.0	1137.8	765.8
9	125.0	-5.0	.0	1279.6	858.6
10	125.0	.0	.0	1319.7	884.8
11	125.0	5.0	.0	1156.3	778.0
12	125.0	10.0	.0	897.0	608.4
13	150.0	.0	.0	1470.7	983.5
14	175.0	.0	.0	1450.8	970.6
15	200.0	.0	.0	1583.6	1057.4
16	225.0	.0	.0	1567.1	1046.6
17	250.0	-10.0	.0	1260.4	846.0
18	250.0	-5.0	.0	1372.1	919.1
19	250.0	.0	.0	1487.9	994.8
20	250.0	5.0	.0	1363.6	913.5
21	250.0	10.0	.0	1406.7	941.7
22	275.0	.0	.0	1435.9	960.8
23	300.0	.0	.0	1353.1	906.7
24	325.0	.0	.0	1212.1	814.5
25	350.0	.0	.0	1194.0	802.6
26	375.0	-10.0	.0	965.7	653.3
27	375.0	-5.0	.0	1047.7	706.9
28	375.0	.0	.0	1109.9	747.6
29	375.0	5.0	.0	1129.8	760.6
30	375.0	10.0	.0	1098.2	740.0
31	400.0	.0	.0	1015.4	685.8
33	450.0	.0	.0	894.0	606.4
34	475.0	.0	.0	865.4	587.7
35	500.0	-10.0	.0	776.1	529.3
36	500.0	-5.0	.0	813.0	553.5
37	500.0	.0	.0	850.0	577.7
38	500.0	5.0	.0	857.8	582.8
39	500.0	10.0	.0	853.2	579.7
40	525.0	.0	.0	813.5	553.8

RUN NUMBER 36 FILE NAME GEP036.GC
BY NEFF ON 07-19-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 19.31

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	.2	19.5
2	75.0	-10.0	.0	16.7	30.2
3	75.0	-5.0	.0	26.4	36.6
4	75.0	.0	.0	55.5	55.6
5	75.0	5.0	.0	31.4	39.8
6	75.0	10.0	.0	26.6	36.7
7	100.0	.0	.0	160.6	124.4
8	125.0	-10.0	.0	246.7	180.6
9	125.0	-5.0	.0	342.6	243.4
10	125.0	.0	.0	344.1	244.4
11	125.0	5.0	.0	324.7	231.7
12	125.0	10.0	.0	268.3	194.8
13	150.0	.0	.0	519.8	359.3
14	175.0	.0	.0	739.0	502.6
15	200.0	.0	.0	819.6	555.3
16	225.0	.0	.0	868.4	587.2
17	250.0	-10.0	.0	748.4	508.8
18	250.0	-5.0	.0	784.3	532.2
19	250.0	.0	.0	919.2	620.5
20	250.0	5.0	.0	867.9	586.9
21	250.0	10.0	.0	870.7	588.7
22	275.0	.0	.0	919.5	620.7
23	300.0	.0	.0	914.9	617.6
25	350.0	.0	.0	868.8	587.5
26	375.0	-10.0	.0	724.8	493.3
27	375.0	-5.0	.0	787.5	534.3
28	375.0	.0	.0	838.5	567.7
29	375.0	5.0	.0	862.5	583.3
31	400.0	.0	.0	818.0	554.3
33	450.0	.0	.0	759.2	515.8
34	475.0	.0	.0	726.3	494.3
35	500.0	-10.0	.0	643.1	439.9
36	500.0	-5.0	.0	688.9	469.9
37	500.0	.0	.0	708.8	482.8
38	500.0	5.0	.0	699.1	476.5
39	500.0	10.0	.0	701.2	477.9
40	525.0	.0	.0	681.0	464.7

RUN NUMBER 37 FILE NAME GEP037.GC
BY NEFF ON 07-19-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM

SOURCE DESIGNATION	1
SOURCE FLOW RATE (CCS)	493.8
SOURCE GAS TEMPERATURE (C)	27.0
TRACER TYPE	CH4
TRACER CONCENTRATION (PPM)	654000.0
BACKGROUND CONCENTRATION (PPM)	30.26

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	533.2	379.0
2	75.0	-10.0	.0	599.9	422.6
3	75.0	-5.0	.0	969.6	664.3
4	75.0	.0	.0	1128.7	768.4
5	75.0	5.0	.0	947.1	649.6
6	75.0	10.0	.0	490.1	350.8
7	100.0	.0	.0	1554.6	1046.9
8	125.0	-10.0	.0	1562.2	1051.9
9	125.0	-5.0	.0	1820.2	1220.6
10	125.0	.0	.0	1872.5	1254.8
11	125.0	5.0	.0	1810.1	1214.0
12	125.0	10.0	.0	1463.0	987.0
13	150.0	.0	.0	2081.3	1391.4
14	175.0	.0	.0	2084.3	1393.3
15	200.0	.0	.0	2032.3	1359.3
16	225.0	.0	.0	1936.2	1296.5
17	250.0	-10.0	.0	1678.7	1128.1
18	250.0	-5.0	.0	1677.5	1127.3
19	250.0	.0	.0	1780.6	1194.7
20	250.0	5.0	.0	1656.9	1113.8
21	250.0	10.0	.0	1656.9	1113.8
22	275.0	.0	.0	1651.8	1110.5
23	300.0	.0	.0	1547.8	1042.5
24	325.0	.0	.0	1414.2	955.1
25	350.0	.0	.0	1326.8	898.0
26	375.0	-10.0	.0	1114.1	758.8
27	375.0	-5.0	.0	1209.4	821.2
28	375.0	.0	.0	1226.3	832.2
29	375.0	5.0	.0	1185.1	805.3
30	375.0	10.0	.0	1151.8	783.5
31	400.0	.0	.0	1109.8	756.0
33	450.0	.0	.0	968.2	663.4
34	475.0	.0	.0	908.8	624.6
35	500.0	-10.0	.0	850.0	586.1
36	500.0	-5.0	.0	876.1	603.2
37	500.0	.0	.0	886.9	610.3
38	500.0	5.0	.0	865.4	596.2
39	500.0	10.0	.0	900.4	619.1
40	525.0	.0	.0	830.3	573.3

RUN NUMBER 38 FILE NAME GEP038.GC
BY NEFF ON 07-19-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 19.32

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	6.7	23.7
2	75.0	-10.0	.0	70.7	65.5
3	75.0	-5.0	.0	100.1	84.8
4	75.0	.0	.0	118.0	96.5
5	75.0	5.0	.0	138.1	109.7
6	75.0	10.0	.0	105.9	88.6
7	100.0	.0	.0	441.4	308.0
8	125.0	-10.0	.0	466.7	324.5
9	125.0	-5.0	.0	628.5	430.4
10	125.0	.0	.0	721.7	491.3
11	125.0	5.0	.0	657.6	449.4
12	125.0	10.0	.0	522.5	361.0
13	150.0	.0	.0	964.5	650.1
14	175.0	.0	.0	1159.8	777.8
15	200.0	.0	.0	1195.5	801.1
16	225.0	.0	.0	1216.5	814.9
17	250.0	-10.0	.0	963.6	649.5
18	250.0	-5.0	.0	1086.5	729.9
19	250.0	.0	.0	1225.3	820.6
20	250.0	5.0	.0	1174.2	787.2
21	250.0	10.0	.0	1169.1	783.9
22	275.0	.0	.0	1205.7	807.8
23	300.0	.0	.0	1185.3	794.5
24	325.0	.0	.0	1122.0	753.1
25	350.0	.0	.0	1068.2	717.9
26	375.0	-10.0	.0	808.6	548.1
27	375.0	-5.0	.0	918.0	619.7
28	375.0	.0	.0	989.1	666.2
29	375.0	5.0	.0	995.1	670.1
30	375.0	10.0	.0	956.1	644.6
31	400.0	.0	.0	935.8	631.3
33	450.0	.0	.0	829.5	561.8
34	475.0	.0	.0	794.1	538.6
35	500.0	-10.0	.0	719.3	489.7
36	500.0	-5.0	.0	750.1	509.9
37	500.0	.0	.0	764.0	519.0
38	500.0	5.0	.0	759.0	515.7
39	500.0	10.0	.0	757.6	514.8
40	525.0	.0	.0	718.0	488.9

RUN NUMBER 39 FILE NAME GEP039.GC
BY NEFF ON 07-19-91
WIND SPEED 250.00 CM/S AT 11.4 CM
AIR TEMP. 27.0 C AT 11.4 CM
SOURCE DESIGNATION 1
SOURCE FLOW RATE (CCS) 493.8
SOURCE GAS TEMPERATURE (C) 27.0
TRACER TYPE CH4
TRACER CONCENTRATION (PPM) 654000.0
BACKGROUND CONCENTRATION (PPM) 23.49

TUBE NO.	X (cm)	Y (cm)	Z (cm)	CONCENTRATIONS (PPM) Source 1	Tracer 1
1	50.0	.0	.0	2072.0	1378.5
2	75.0	-10.0	.0	1736.6	1159.2
3	75.0	-5.0	.0	2671.7	1770.7
4	75.0	.0	.0	3175.1	2099.9
5	75.0	5.0	.0	2780.4	1841.8
6	75.0	10.0	.0	1569.3	1049.8
7	100.0	.0	.0	3399.2	2246.5
8	125.0	-10.0	.0	2754.5	1824.9
9	125.0	-5.0	.0	3276.1	2166.0
10	125.0	.0	.0	3433.8	2269.1
11	125.0	5.0	.0	3322.0	2196.0
12	125.0	10.0	.0	2720.1	1802.4
13	150.0	.0	.0	3233.9	2138.4
14	175.0	.0	.0	2848.6	1886.4
15	200.0	.0	.0	2598.3	1722.7
16	225.0	.0	.0	2367.1	1571.5
17	250.0	-10.0	.0	1984.0	1321.0
18	250.0	-5.0	.0	2016.3	1342.1
19	250.0	.0	.0	2174.1	1445.3
20	250.0	5.0	.0	2075.3	1380.7
21	250.0	10.0	.0	2118.4	1408.9
22	275.0	.0	.0	1954.8	1301.9
23	300.0	.0	.0	1803.1	1202.7
24	325.0	.0	.0	1637.1	1094.1
25	350.0	.0	.0	1498.5	1003.5
26	375.0	-10.0	.0	1243.5	836.7
27	375.0	-5.0	.0	1336.0	897.2
28	375.0	.0	.0	1382.6	927.7
29	375.0	5.0	.0	1379.5	925.7
30	375.0	10.0	.0	1344.1	902.5
31	400.0	.0	.0	1262.0	848.8
33	450.0	.0	.0	1089.1	735.8
34	475.0	.0	.0	1025.8	694.3
35	500.0	-10.0	.0	940.5	638.5
36	500.0	-5.0	.0	974.3	660.7
37	500.0	.0	.0	975.9	661.7
38	500.0	5.0	.0	954.5	647.7
39	500.0	10.0	.0	980.8	664.9
40	525.0	.0	.0	917.4	623.5

APPENDIX D: FACILITIES AND TECHNIQUES

D.1: FLUID DYNAMICS AND DIFFUSION LABORATORY

Engineering Research Center (ERC) is located at Foothills Campus of Colorado State University in Fort Collins, Colorado. This ERC has facilities for Agricultural & Chemical Engineering, Civil Engineering, Electrical Engineering and Mechanical Engineering Department including Groundwater Laboratory, Geotechnical Laboratory, Hydraulics Laboratory, Fluid Dynamics and Diffusion Laboratory (FDDL), Thermofluid Laboratory, Laser laboratory, Aerosol Science Laboratory and Heat Transfer Laboratory.

The FDDL is an integral part of the Fluid Mechanics and Wind Engineering Program, and houses facilities with unique research capabilities. Special boundary layer wind tunnels for simulation of atmospheric motions provide a capability for unique research on wind engineering and environmental problems of state, national and international concerns. Modern instrumentation and a variety of flow facilities support fundamental investigations on turbulence and turbulent diffusion. The Fluid Mechanics and Wind Engineering Program was awarded in 1989 from National Society of Professional Engineers for its distinguished research.

Research developed during the first three decades has revolved around basic fluid dynamics - turbulence, heat and mass transfer, boundary layers, jets and wakes, vortex dynamics, and flow separation; physical modeling - winds near the surface of Earth (atmospheric boundary layers), atmospheric diffusion, and mountain and urban winds; basic studies in aerosol mechanics - particle generation techniques, sampling and collection investigations, development of ambient aerosol samplers and fractional systems, behavior of particles in turbulent shear flows, deposition of particles in plant canopies; wind engineering - air pollution control, behavior of smoke plumes from power plant stacks, hazard analysis of liquid natural gas (LNG) storage, industrial aerodynamics, environmental design for urban centers, wind power, heat transfer from buildings, and wind forces on buildings and bridges; turbomachinery - effects of turbulence on the performance of blade cascades; and instrumentation - aerosol and tracer gas concentration sensors and hot wire anemometry. Research in these areas is sponsored primarily by the National Science Foundation, the Office of Naval Research, Project SQUID, the National Aeronautics and Space Administration, the Department of Energy, the Gas Research Institute, the Department of Transportation, the Nuclear Regulatory Commission, the Environmental Protection Agency, and the Electric Power Research Institute.

Research in the Program is complemented by a wide variety of laboratory investigations of wind forces on structures, atmospheric diffusion, and other wind engineering problems associated with the design and planning of major engineering projects. These investigations, sponsored by leading consulting and industrial firms throughout the country, utilize many of the research results obtained by the Program staff and students and help identify areas that will be productive for new research.

Figure A-1 below shows the plan view layout of the FDDL laboratory facilities including the meteorological wind tunnel, environmental wind tunnel and industrial aerodynamics wind tunnel.

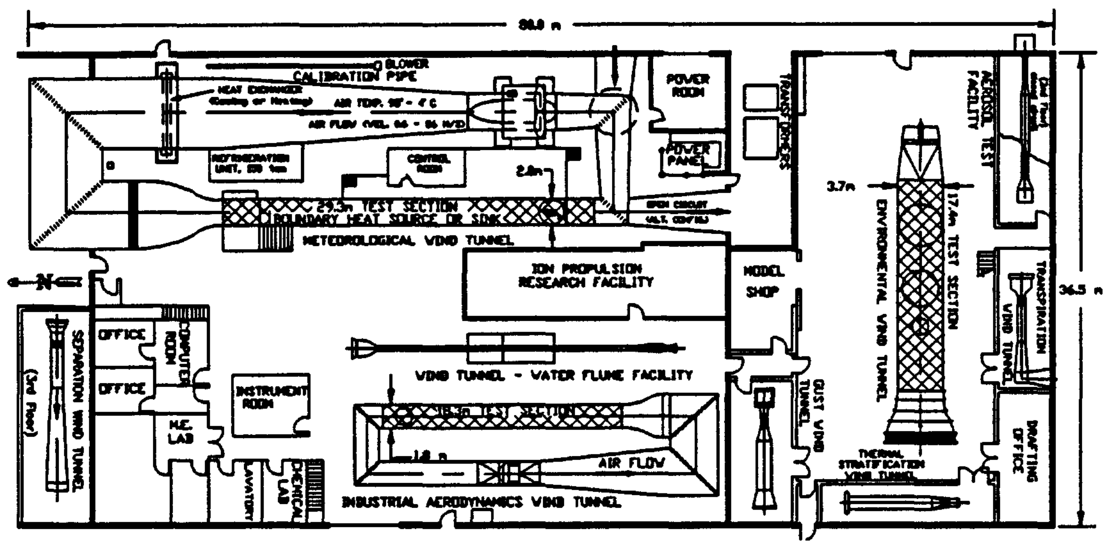


Figure A-1 Fluid Dynamics and Diffusion Laboratory Layout

The unique meteorological wind tunnel has an overall length of 200 feet with a 6-foot by 6-foot test or working section 100 feet long. Heating and cooling of air in the 18-foot by 18-foot return flow section of the recirculating tunnel provides extreme flexibility for simulating a wide range of atmospheric thermal stratifications, as well as elevated inversions. This thermal control, coupled with well-controlled flow speeds from 0.0 to 100 miles per hour and a long test section, enables boundary layer flows similar to those found in the real atmosphere to be modeled with accuracy. Thus, this facility provides an ideal medium for fundamental studies on the relationship of mean wind speed and turbulence to surface roughness, thermal stratification and topography. On the other hand, the simulation of natural winds for specific sites provides an ideal means for physical modeling of wind effects on existing or proposed buildings, urban developments, or any other of man's activities on earth's surface.

The FDDL houses an environmental wind tunnel with working section 60 feet long and a cross section of 12 by 8 feet. Using wind speed from 0.5 miles per hour up to 34 miles per hour, this facility provides excellent capability for investigation of wind effects on large areas. Dispersion of cloud seeding materials over mountain ranges, dispersion of automobile exhaust in new urban developments and existing cities, effects of buildings and topography on power plant plumes, and heat island effects over large urban areas have been investigated successfully in this facility.

The industrial aerodynamics wind tunnel with a working section 60 feet long and 6 feet by 6 feet in cross section provides additional capabilities for basic studies of boundary layer characteristics. Many studies of evaporation from soil and water surfaces, wind pressures on model structures, ventilation of buildings, and the movement of soil and snow by wind have been made in this wind tunnel, which has a speed range of 1 to 70 miles per hour.

A gust wind tunnel equipped with two arrays of oscillating air foils provides opportunities for research on the effects of turbulence scale on the aerodynamics of bluff bodies and aerodynamic stability of long-span bridge decks.

Instrumentation for measurement of flow variables and tracer gas concentrations is available to support either the most advanced studies on turbulence and diffusion or the applied investigations of wind engineering. This instrumentation includes hot wire anemometer system; electronic pressure transducers and meters; aerosol, radioactive gas, and helium and hydrocarbon concentration measurement systems; optical systems; and strain gage balances. Data processing equipment includes analog-to-digital converters connected to PC, AT and 386 type computer, spectral analyzers, probability density analyzers, and a variety of special purpose systems. Additional data processing and numerical analyses are accomplished on the University CDC 170 model 720 digital computer, or the CRAY 1 digital computer of the National Center for Atmospheric Research (NCAR). Recording capabilities are provided by 50 FM magnetic tape channels, 25 digital tape channels, floppy disks, and a variety of motion and still picture cameras.

D.2: ENVIRONMENTAL WIND TUNNEL DESCRIPTION

This wind tunnel, especially designed to study atmospheric flow phenomena, incorporates special features such as an adjustable ceiling, a rotating turntable and a long test section to permit adequate reproduction of micrometeorological behavior. Mean wind speeds of 0.1 to 15 m/sec in the EWT can be obtained. A boundary-layer thickness up to 1.5 m can be developed over the downwind portion of the EWT test section by using vortex generators at the test section entrance and surface roughness on the floor. The flexible test section on the EWT roof is adjustable in height to permit the longitudinal pressure gradient to be set at zero.

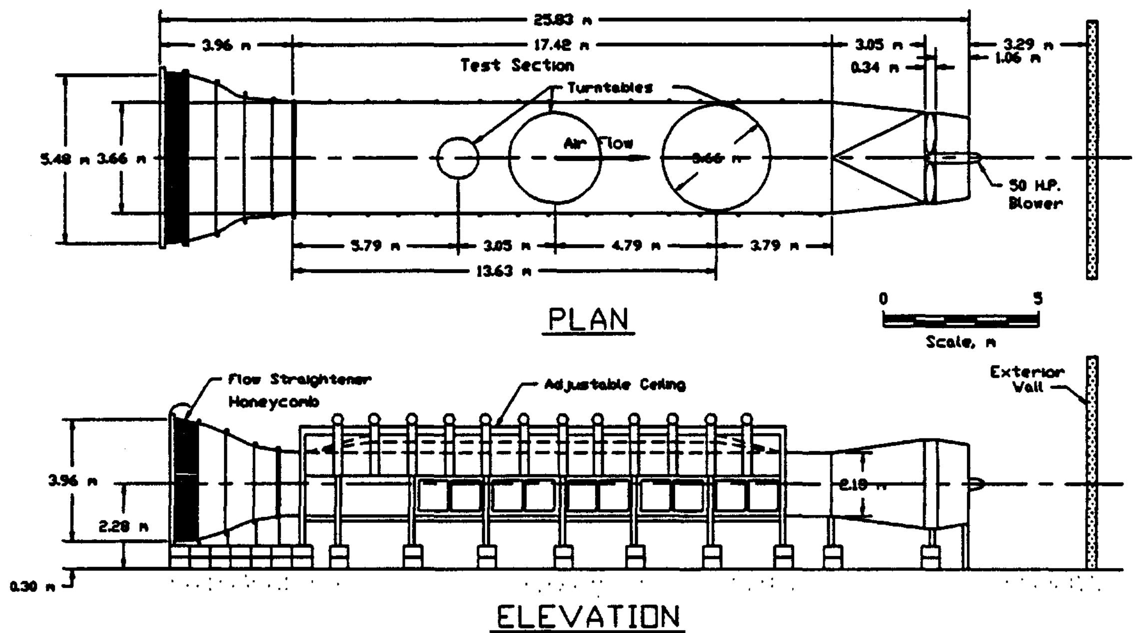


Figure A-2 Environmental Wind Tunnel Schematic

D.3: <u>WIND SPEED MEASUREMENT DESCRIPTION</u>

Velocity Standards

a. CSU Mass Flow System

The velocity standard used in the present study consisted of a Omega Model FMA-78P4 mass controller and a profile conditioning section designed and calibrated by the Fluid Dynamics and Diffusion (FDDL) staff at Colorado State University (CSU). The mass flow controller sets mass flow rate independent of temperature and pressure. The profile conditioning section forms a flat velocity profile of very low turbulence at the position where the hot-film-probe is located. Incorporating a measurement of the ambient atmospheric pressure, temperature and a profile correction factor permits the calibration of velocity at the measurement station from 0.1 - 2.0 m/s to within ± 5 percent and from 2.0 - 4.7 m/s to within ± 3 percent. This calibration nozzle is mounted on two computer controlled rotary tables for precise flow angle calibrations of multi-film probes.

b. TSI Calibrator

The TSI Model 1125 Velocity Calibrator System is designed to calibrate hot wire and hot film sensors over wide ranges of velocities. It is primarily for air but can also be modified for use in water and other fluids. In air the velocity range is from approximately 0.1 m/s to 305 m/s. This wide range can be covered using manometers with a range of 0.5 inch of water to approximately 400 inch of water (30 inch of mercury). The calibrator has been designed to be as simple and flexible as possible, while still maintaining good calibration accuracy.

In using the calibrator for air, the unit can be connected to a shop compressed air line. An On-Off line valve, pressure regulator, needle valve, and a heat exchanger are installed in line with the calibrator. This arrangement gives good control of the velocity through the calibrator. Essentially the same arrangement can be used for calibrating in other gases. Rather than the compressed air line the source can be a tank of bottled gas or other convenient supply.

The accuracy of the system is primarily dependent on the accuracy of the pressure measurement. When using the inside chambers with the exterior nozzle in place, the accuracy is ± 2 percent down to 3 m/s. Below 3 m/s, the accuracy is ± 5 percent down to approximately 0.1 m/s. Below 0.1 m/s, approximately ± 10 percent accuracy can be expected.

c. Pitot Probe

Pitot-static probes are used as a velocity standard during the calibration of the different hot film systems and to provide the reference upwind velocity measurement. The principles of operation of pitot-static probes are described in any fundamental text on fluid mechanics and will not be discussed in detail here. The operational relationship for these probes is $U = (2g_c\Delta P/\rho)^{1/2}$, where U = velocity, g_c = gravitational conversion constant, ΔP = difference between static and stagnation pressures, and ρ is the air density. ρ is calculated from ideal gas law and ΔP is measured using a Datametrics Electronic Manometer. The pitot-static probe measurements are accurate to within ± 2 percent of the actual velocity.

Single-Hot-Film Probe Measurements

Single-hot-film (TSI 1220 Sensor) measurements are used to document the longitudinal turbulence levels. During calibration the probe voltages are recorded at several velocities covering the range of interest. These voltage-velocity (E,U) pairs are then regressed to the equation $E^2 = A + BU^c$ via a least squares approach for various assumed values of the exponent c. Convergence to the minimum residual error was accelerated by using the secant method to find the best new estimate for the exponent c.

The hot-film-probe is mounted on a vertical traverse and positioned over the measurement location in the wind tunnel. The anemometer's output voltage is digitized and stored within an IBM AT computer. This voltage time series was converted to a velocity time series using the inverse of the calibration equation; $U = [(E^2 - A)/B]^{1/c}$. The velocity time series is then analyzed for pertinent statistical quantities, such as mean velocity and root-mean-square turbulent velocity fluctuations. The computer system moves the velocity probe to a vertical position, acquire the data, then moves on to the next vertical positions, thus obtaining an entire vertical velocity profile automatically.

Error Statement

The calibration curve yields hot film anemometer velocities that were always within 2 percent of the known calibrator velocity. Considering the accumulative effect of calibrator, calibration curve fit and other errors the model velocity time series should be accurate to within 5 percent.

Cross-Film Probe Measurements

Cross-film measurements are used to document longitudinal, lateral and vertical turbulence levels along with cross-component correlations such as Reynolds stresses.

During the calibration of the TSI 1241 X-film probe it is placed at the nozzle of the calibrator with the probe support axis parallel to air flow. In this position the angle between each sensor and the flow vector is 45°. Thus, the yaw angles for each sensor are 45°. The voltage from each anemometer channel are digitized for several velocities covering the range of interest. These voltage-velocity pairs (E_i, U_i; i = 1,2), at a fixed angle, are fit to the equation

$$E_{i,j}^2 = A_i + B_i'(U_j)^{ci} \; ; \; i = 1,2; \; j = 1,n$$

where $B_i' = B_i(\cos^2\phi_i + k^2\sin^2\phi_i)^{ci/2}$
ϕ_i = yaw angle between velocity vector and film i
k = yaw factor
n = number of the calibration points

via a least squares fit with the secant method to find the best new estimate of exponent, c_i.

Note that if the yaw factor, k, equals zero then a sample cosine law dependence of the heat flux exists. To determine the yaw factor, k, the air velocity is set at a constant value, and the probe is rotated about its third axis so that voltage samples are taken for a wide range of yaw angle variation on both films. These voltage-yaw angle pairs, (E_i, ϕ_i; i = 1,2) are regressed to the equation

$$B_i' = (E_{i,j}^2 - A_i)/U^{ci} = B_i(\cos^2\phi_{i,j} + k_i^2\sin^2\phi_{i,j})^{ci/2}$$

where i = 1,2 and j = 1,n

via a least squares approach with the secant method to find the best new estimate for the yaw factor, k_i. A_i, B_i, c_i and k_i for both films are thus obtained. For the reduction algorithm used, k_i must be equal for both films and not a function of velocity. Providing that both films have similar aspect ratio, then both k_i values should be of similar magnitude; hence, setting them equal does not introduce large errors. Once a value for k is specified then a least squares fit will determine the optimal values for B_i. Once the value of k is determined for a specific probe, it is no longer necessary to perform further angle calibrations.

Given the calibration constants A_i, B_i, and c_i, then the equations

$$E_i^2 = A_i + B_i(V_{eff,i})^{ci} \; ; \; i = 1,2;$$

where $V_{eff,i} = V(\cos^2\phi_i + k^2\sin^2\phi_i)^{1/2}$; i = 1,2;
$V_{eff,i}$ = effective cooling velocity for film i, and
V = total velocity vector approaching sensor array

are defined. To take measurements with this calibrated X-film probe, both anemometer signals and the temperature signal are digitized and stored on a disk file within an IBM AT computer. These voltage time series are converted to u and v (or w) velocity time series using the following algorithm proposed by Brunn [1974],

$$u = (V_{eff,1} + V_{eff,2})/[2(\cos^2\alpha + k^2\sin^2\alpha)^{1/2}],$$

$$v \text{ (or } w) = (V_{eff,1} - V_{eff,2})/[(\cos^2\alpha + k^2\sin^2\alpha)^{1/2} \text{ A } \tan\alpha],$$

where $A = \cos^2\alpha(1-k^2)/[\cos^2\alpha(1 - k^2) + k^2]$,

$\alpha = 45°$,

$V_{eff,i} = [E_i^2 - A_i^*)/B_i^*]^{1/ci}$,

$A_{i*} = A_i \, T_{factor}$,

$B_i^* = B_i \, T_{factor}$,

$T_{factor} = (T_{sensor} - T_{environment})/(T_{sensor} - T_{calibration})$.

Error Statement

The accuracy of X-film velocity measurements and associated reduction algorithms can be estimated by directing different known mean velocity vectors at the probe. Tests at calibration temperature determine that the mean velocity magnitude is generally within ±5 percent of the calibration value. The error in angle calculation was approximately ±2° for angular deviations of 15° or less and somewhat larger than this for greater deviations. Considering cumulative effect of calibrator, calibration curve fit and temperature correction errors, the model longitudinal velocity time series should be accurate to within ±10 percent. The lateral or vertical velocity time series errors are greater than those of the longitudinal component but should be accurate to within ±15 percent.

Velocity Measurement System

A flow-logic chart of velocity calibration system, velocity measurement system, and the positioning system with the wind tunnel is displayed in Figure A-3 on the following page.

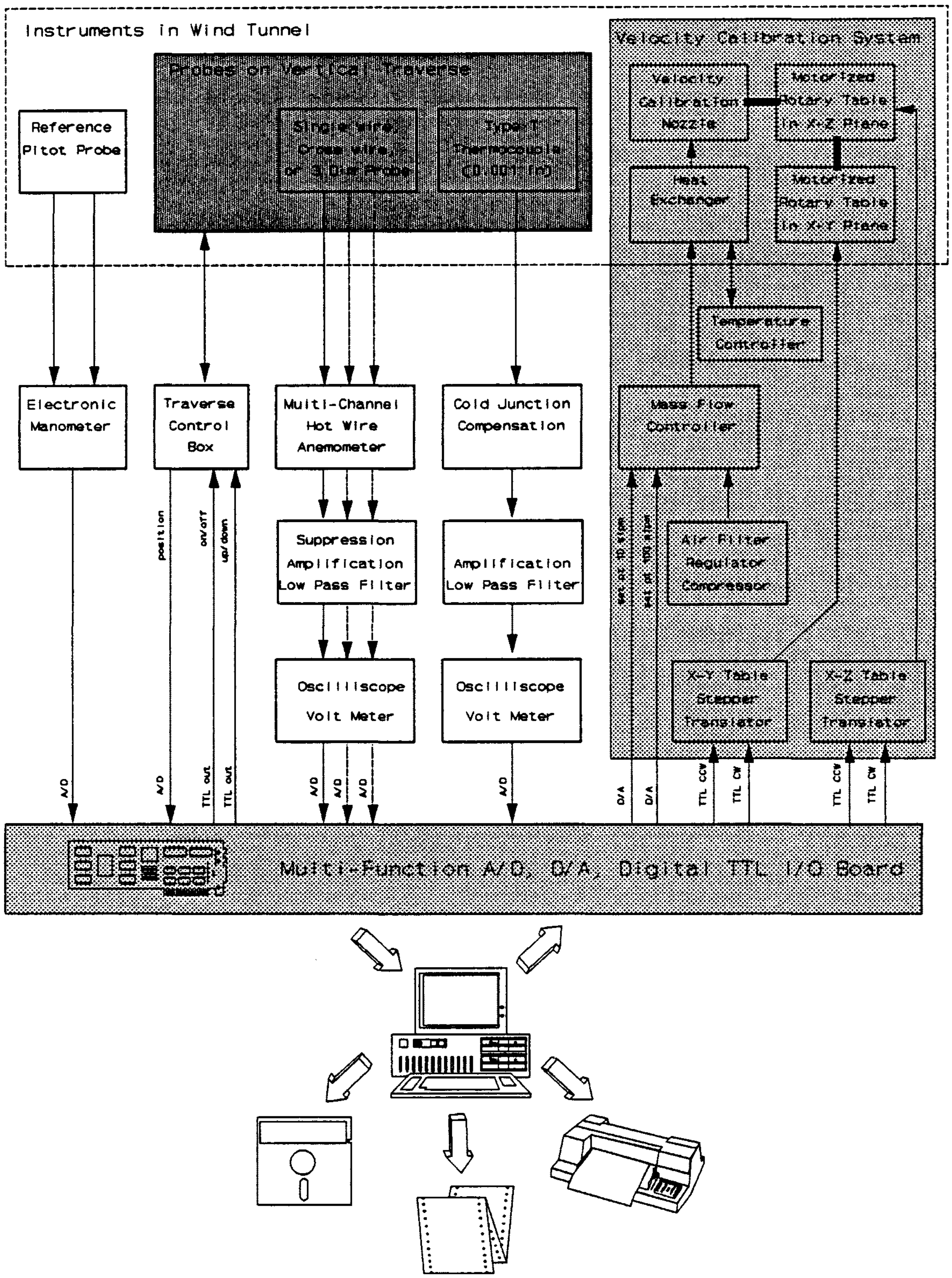


Figure A-3 Velocity Calibration and Measurement System

D.4: FLOW VISUALIZATION TECHNIQUES

Smoke Generator System

A visible plume is produced by passing the metered simulant gas through a Rosco Model 8215 Fog/Smoke Machine located outside the wind tunnel and then out of the model stack. The plume is illuminated with high intensity back lighting. The visible plumes for each test are recorded on VHS video cassettes with a Panasonic Omnivision II camera/recorder system. Run number titles are placed on the video cassette with a title generator.

Video Image Analysis System

Digital image processing and computer aided enhancement methods provide a means to modernize and significantly improve the conventional smoke wire technique. The visible behavior of the smoke line is now recorded on by a high-resolution television camera system on VCR tape. The analog images may be transformed into digital arrays, and the images can then be enhanced and manipulated by a computer system.

The hardware components of the FDDL Video Image Processing System (VIPS) are presented in the figure on the following page. The image capturing part of the system includes a SVHS camcorder and a four-head one-half inch tape VCR recorder. These images may be edited into convenient sequences using a dual-monitor, dual-SVHS VCR recorder editing system. Unfortunately, most VCR systems can not be controlled well enough to maintain adequate picture registration when advancing frame-by-frame under computer control [Lee et al., 1988]. Hence, the edited VCR tape must be additionally recorded onto a video disk. Currently this transfer is being accomplished at another laboratory.

Computer control may be used to command a video-disk player to project each individual video frame to a high-resolution video monitor. We use a high-resolution image capturing board installed in a PC-386 compatible microcomputer to digitize the image. A standard NTSC video signal (30 frames/sec) can be digitized with 8-bit precision. The board we use produces an intensity field of 512 x 512 pixels at 256 possible grey levels. Given the image interweaving typical of an NTSC signal the frames can be split to provide images at 60 frames/sec.

Once the video picture is digitized, the image may be enhanced by a) subtracting the background, b) overlaying a coordinate system, c) enhancing front, center, or back edge of the image, or d) assigning colors to different intensity levels. One can also extract edge pixel locations to calculate velocities or combine images to provide animation.

Often it is appropriate to print or restore enhanced images. The FDDL VIPS includes hardware to project the image to a RGB or VGA monitor; store the digital image to floppy or hard disks, streaming tapes, optical digital disk, or on network file-servers; or print to a laser printer or color slide maker. Alternatively, a VGA-to-NTSC hardware card can reformulate the signal to record to a conventional VCR or a color video printer.

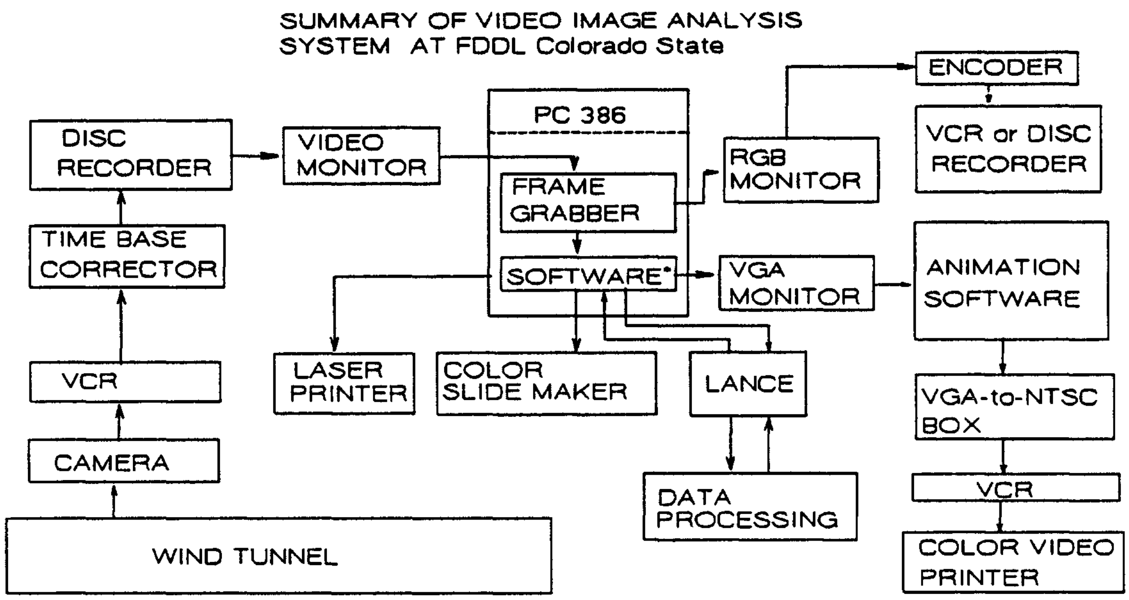


Figure A-4 Video Image Analysis System

D.5: CONCENTRATION MEASUREMENT DESCRIPTION

The experimental measurements of concentration were performed using a Hewlett Packard gas-chromatograph and a sampling systems designed by Fluid Dynamics and Diffusion Laboratory staff.

Gas Chromatograph

A gas chromatograph (Hewlett-Packard Model 5710A) (GC) with flame ionization detector (FID) operates on the principle that the electrical conductivity of a gas is directly proportional to the concentration of charged particles within the gas. The ions in this case are formed by the burning a mixture of hydrogen and the sample gas in the FID. The ions and electrons formed pass between an electrode gap and decrease the gap resistance. The resulting voltage drop is amplified by an electrometer and passed to a Hewlett-Packard Model 3390A integrator. When no effluent gas is flowing, a carrier gas (nitrogen) flows through the FID. Due to certain impurities in the carrier, some ions and electrons are formed creating a background voltage or zero shift. When the effluent gas enters the FID, the voltage increase above this zero shift is proportional to the degree of ionization or correspondingly the amount of tracer gas present. Since the chromatograph used in this study features a temperature control on the flame and electrometer, there is very low drift of the zero shift. Even given any zero drift, the HP 3390A, which integrates the effluent peak, also subtracts out the zero drift.

The lower limit of measurement is imposed by the instrument sensitivity and the background concentration of tracer within the air in the wind tunnel. Background concentrations are measured and subtracted from all data.

Sampling System

The tracer gas sampling system consists of a series of fifty 30 cc syringes mounted between two circular aluminum plates. A variable-speed motor raises a third plate, which lifts the plunger on all 50 syringes, simultaneously. Computer controlled valves and tubing are connected such that airflow from each tunnel sampling point passes over the top of each designated syringe. When the syringe plunger is raised, a sample from the tunnel is drawn into the syringe container. The sampling procedure consists of flushing (taking and expending a sample) the syringe three times after which the test sample is taken. The draw rate is variable and generally set to be approximately 6 cc/min.

The sampling system is periodically calibrated to insure proper function of each of the valves and tubing assemblies. To calibrate the sampler each intake is connected to a manifold. The manifold, in turn, is connected to a gas cylinder having a known concentration of tracer gas. The gas is turned on, and a valve on the manifold is opened to release the pressure produced in the manifold. The manifold is allowed to flush for about one minute. Normal sampling procedures are carried out during calibration to insure exactly the same procedure is reproduced as when taking a sample from the tunnel. Each sample is then analyzed for tracer gas concentration. Percent error is calculated, and "bad" syringe/tube systems (error > 2 percent) are not used or repaired.

Test Procedure

The test procedure consisted of:

1) Setting the proper tunnel wind speed,
2) Releasing the metered mixtures of source gas from the plant stack,
3) Withdrawing samples of air from the tunnel designated locations, and
4) Analyzing the samples with a FID.

The samples were drawn into each syringe over a 200 s (approximate) time period and then consecutively injected into the GC.

The procedure for analyzing the samples from the tunnel is:

1) Introduce the sample into the GC which separates the ethane tracer gas from other hydrocarbons,
2) The voltage output from the chromatograph FID electrometer is sent to the HP 3390A Integrator,
3) the HP 3390A communicates the measured concentration in ppm to an IBM computer for storage, and
4) These values, χ_{mea}, along with the response levels for the background χ_{bg} and source χ_{source} are converted into source normalized model concentration by the equation:

$$\chi_m = (\chi_{mea}-\chi_{bg})/(\chi_{source}-\chi_{bg})$$

5) Field equivalent concentration values are related to model values by the equation:

$$\chi_p=\frac{\chi_m}{\chi_m+(1-\chi_m)[V(T_a/T_s)]_m/[V(T_a/T_s)]_p}$$

where $V = Q/U_H L^2$,

and L is the characteristic length scale. When there is no distortion in the model-field volume flux ratio, V, and the plumes are isothermal this equation reduces to $\chi_p = \chi_m$.

Error Statement

Background concentrations, χ_{bg}, (the result of previous tests within the laboratory), are measured to an accuracy of 20 percent. The larger measured concentrations, χ_{mea}, are accurate to 2 percent. The source gas concentration, χ_{source}, is known to within 10 percent. Thus the source normalized concentration for $\chi_{mea} >> \chi_{bg}$ is accurate to approximately 3 percent. For low concentration values, $\chi_{mea} > \chi_{bg}$, the errors are larger.

Concentration Measurement System

A flow-logic chart of the source gas release, gas sampling, and concentration measurement systems is displayed in Figure A-5 on the following page.

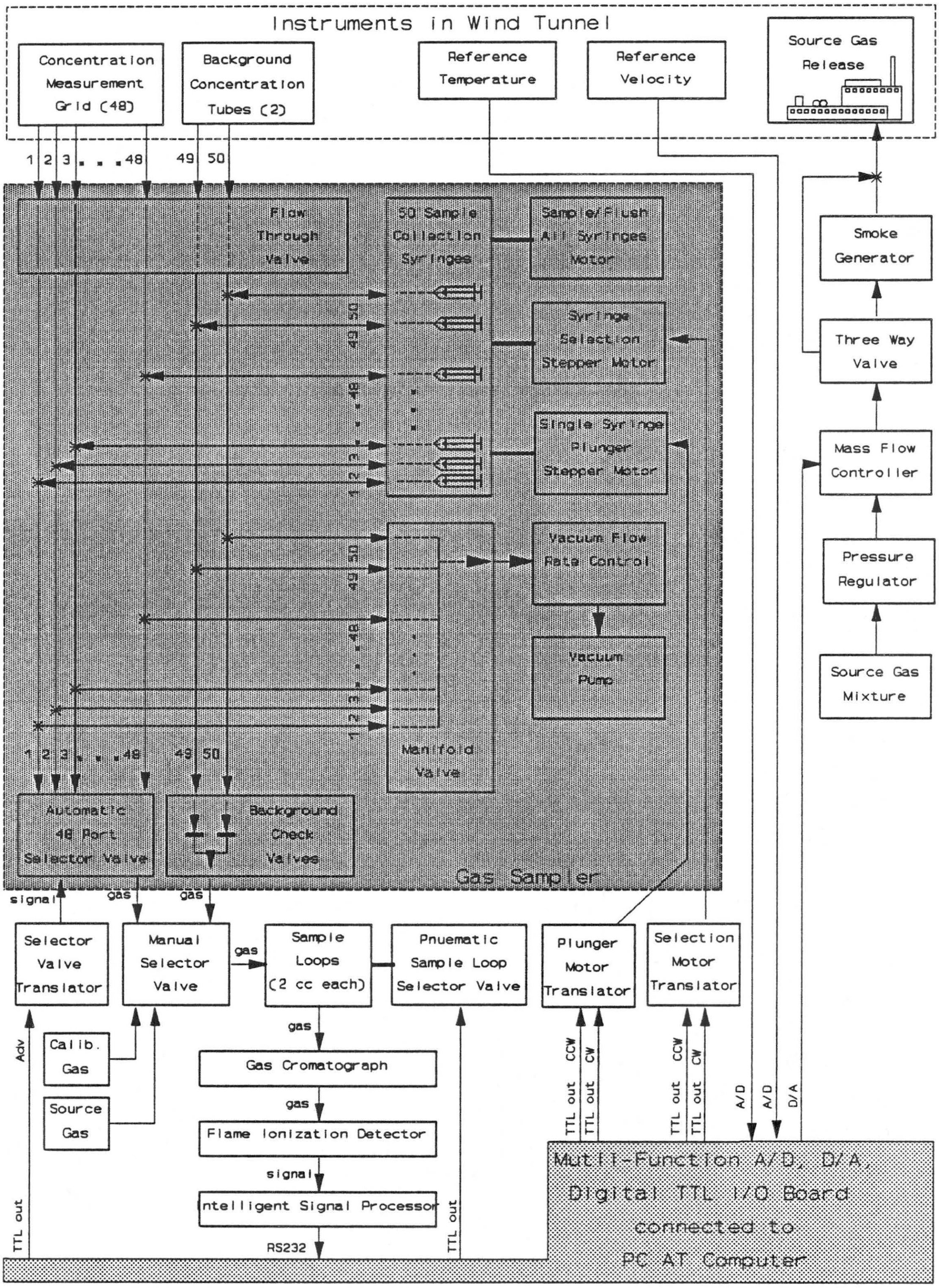


Figure A-5 Concentration Sampling and Measurement System Schematic