Comprehensive Study of Drift From Mechanical Draft Cooling Towers Final Report

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September 1979

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COMPREHENSIVE STUDY OF DRIFT FROM MECHANICAL
DRAFT COOLING TOWERS
FINAL REPORT

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September 1979

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SUMMARY

A comprehensive experiment to study drift from mechanical draft cooling towers was conducted during June 1978 at the Pacific Gas and Electric Company's (PG&E) Pittsburg Power Plant located at Pittsburg, California. The objective of the experiment was to establish a data base for use in drift deposition model validation. This objective was met by the simultaneous measurement of cooling tower source emission parameters, meteorological variables and drift deposition patterns during seven of eight test runs. In this report, the results from six of these test runs are presented and discussed.

Environmental Systems Corporation (ESC) conducted the source characterization measurements. These measurements included cooling tower emission parameters such as updraft velocity and temperature profiles, liquid and mineral mass drift emission rates, and drift droplet size distributions. ESC also provided plant and cooling tower operational parameters, obtained either from its own measurement program or from the PG&E plant log.

Pacific Northwest Laboratory (PNL) carried out the meteorological and surface drift deposition measurements. The meteorological measurements included wet- and dry-bulb temperature and wind speed and direction on a continuous basis from sensors on a 10 m tower and on an intermittent basis from an instrumented tethered balloon system. The latter measurements provided information on the vertical structure of temperature, moisture and mass transport. Surface deposition measurements included both droplet and bulk mineral mass deposition rates.

Substantial variation in drift emissions were noticed. Large day-to-day variations for a given cell and large cell-to-cell variations were observed. Because of the large variability of drift mass emission a representative emission rate per cell was calculated by ESC using a weighted average based on both the pretest survey and the detailed characterization of seven cells. The problem of deriving a total droplet emission spectrum and rate from one or two towers is complicated and the modeler must decide on the amount of detail he needs to satisfactorily predict downwind deposition patterns.

Assuming that ESC's averaging procedure was reasonable, the emission rate per cell was found to be 4.8 g s^{-1} . If all 26 cells were operating the total emission rate would be 124 g s^{-1} . The latter value may be uncertain by anywhere from 30 to 70%, depending upon the validity of the averaging procedure. With a total circulating water flow rate of $20 \text{ m}^3 \text{ s}^{-1}$, the 124 g s^{-1} emission rate corresponds to a drift fraction of 0.0006% compared to the guaranteed drift rate of 0.004%.

Meteorological conditions during the drift study were characterized by relatively high winds, warm temperatures and moderate humidities. The relatively high winds increased the uncertainty in the measured deposition patterns. In spite of the large (factor of 2 or 3) uncertainty in the measured deposition rates, preliminary calculations of drift deposition rates by ESC using its own model and the source and meteorological data described above are in agreement with each other for test run 1, 6-16-78.

Although the present study did not encompass as wide a range of meteorological conditions as would be required for complete validation of various drift models, it has contributed a unique set of data for that purpose.

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INTRODUCTION

Both the Electric Power Research Institute's (EPRI) Reject Heat Management Program and the U.S. Department of Energy's Meteorological Effects of Thermal Energy Releases (METER) Program are investigating the environmental and meteorological effects of power plant cooling systems. An important element of this research is the study of drift from cooling towers. An essential step in the prediction and mitigation of drift effects is the modeling and prediction of drift dispersion patterns and concentrations. While a number of analytical models have been formulated to do this, there are little data available to validate and improve these models.

Drift is defined as that component of the circulating water that is entrained in the cooling tower exhaust airflow as small droplets and is carried out beyond the tower where it eventually is deposited on the ground. The drift droplets are produced mechanically within the tower whereas the visible plume condensate droplets are created through cooling of the saturated tower exhaust air. The differentiation between these droplet sources is important since the drift will contain concentrations of dissolved minerals and chemicals similar, if not identical, to concentrations of the circulating water. Depending upon the chemicals present in the circulating water, drift may have an adverse effect on the environment. Consequently, in order to assess environmental impact, it is important that the amount of drift and its resulting distributions in the air and on the ground be determined.

Each cooling tower can be expected to yield a unique drift distribution, depending on the type and size of the tower and the design of the drift eliminators. Meteorological conditions also play an important role in determining drift distribution. Generally, a complex model is required to provide cooling tower drift assessment for any particular tower under the varied modes of its operation and the range of meteorological conditions to which it will be subjected.

A number of models have been developed to estimate drift distributions. Chen (1977) and Policastro et al. (1978) have reviewed several of these models. By using a common set of input parameters based on representative values obtained from various field experiments, Chen (1977) found that among the 10 models which he considers the maximum deposition differs by two orders of magnitude with a wide range in downwind location of the peak deposition. He concluded that no particular model can claim superiority over another without verification from field data, in particular surface drift deposition measurements.

Policastro et al. (1978) compared the predictions of 10 models with field data taken during the Chalk Point dye tracer study, the most comprehensive study to date of drift from a single natural draft cooling tower (Webb, et al., 1977, 1978; Meyer and Stanbro, 1977, 1978). They found that three models, the ESC/Schrecker, Hosler-Pena-Pena and Wigley-Slawson models, compared most favorably with the deposition data and the predictions were generally within the error bounds of the data. Some discrepancies were noted, such as predictions of larger droplet diameters at deposition than were measured. In fact, they found that no model predicted each of the deposition parameters consistently within a factor of three.

At present several of the models are being fine tuned in an attempt to account more realistically for droplet breakaway and droplet evaporation (Chen and Jung, 1978; Hanna, 1978). Hanna has applied his model to data from the Chalk Point dye tracer experiment and has found that his predicted deposition rate is about a factor of three greater than the observed rate even though the predicted mass median droplet diameters are within 50% of the observed values.

The objective of the experimental work described in this report was to develop a data base that can be used for validation of drift deposition models for mechanical draft cooling towers. As in the Chalk Point study, the key experimental requirements were concurrent measurements of drift emission characteristics, ambient meteorological conditions

and downwind drift deposition patterns. The source characteristics, including drift mass emission, drift droplet size distribution and temperature and velocity profiles, and the meteorological data, including wind speed and direction and wet- and dry-bulb temperature profiles, provide the needed input to the models. The measured deposition patterns serve as comparisons to model outputs.

The drift study was conducted at the Pacific Gas and Electric (PG&E) oil fired Pittsburg Power Plant at Pittsburg, CA during the two week period June 12-26, 1978. The experiment was a cooperative effort involving the U.S. Department of Energy (DOE) through its METER (Meteorological Effects of Thermal Energy Releases) Program and the Electric Power Research Institute (EPRI), several contractors, including Pacific Northwest Laboratory (PNL) as the project coordinator, Environmental Systems Corporation (ESC, Knoxville, TN), Calfran Industries (Springfield, MA) and Xonics (Van Nuys, CA), and, of course PG&E. J. H. Meyer of Johns Hopkins University, Applied Physics Laboratory (JHU-APL) served as a technical consultant to the experiment.

Source characterization measurements were performed by ESC under EPRI sponsorship. Meteorological and surface deposition measurements were carried out by PNL. In addition other limited comparison tests were conducted by Calfran and Xonics. Calfran used a photographic technique to measure source drift droplet size distributions. These measurements were to be compared to the ESC derived size distributions and drift emission rates. The Calfran tests were performed after the June test rather than concurrently with ESC's measurements. During the final days of the June test and continuing until the end of the month, Xonics provided remote measurements of vertical wind profiles with a doppler acoustic radar system to compare to the wind measurements from the PNL tethered balloon system.

Analyses of the various data were carried out by the individual contractors. Assembly of the final report, including the coordination of all data was the responsibility of PNL. In addition, ESC also carried out a

calibration study of drift droplets impacting on water sensitive papers (SP) at oblique incidence. This study was jointly sponsored by PNL and EPRI.

This report is divided into sections describing the conclusions, background information about the Pittsburgh site, experiment design and execution, data analysis and reductions, and summary of results. Included in the Appendices are detailed listings of the meteorological and deposition data. No attempt is made in this report to use these data for drift model validation, although a comparison of measured deposition rates is compared to those calculated by R. Moore of ESC using the ESC model.

CONCLUSIONS AND RECOMMENDATIONS

A comprehensive experiment to study drift from mechanical draft cooling towers was conducted during June 1978 at the Pacific Gas and Electric Company's (PG&E) Pittsburg Power Plant located at Pittsburg, California. The objective of the experiment was to establish a data base for use in drift deposition model validation. This objective was met by the simultaneous measurement of cooling tower source emission parameters, meteorological variables and drift deposition patterns during seven of eight test runs. In this report, the results from six of these test runs are presented and discussed.

Environmental Systems Corporation (ESC) conducted the source characterization measurements. These measurements included cooling tower emission parameters such as updraft velocity and temperature profiles, liquid and mineral mass drift emission rates, and drift droplet size distributions. ESC also provided plant and cooling tower operational parameters, obtained either from its own measurement program or from the PG&E plant log.

Pacific Northwest Laboratory (PNL) carried out the meteorological and surface drift deposition measurements. The meteorological measurements included wet- and dry-bulb temperature and wind speed and direction on a continuous basis from sensors on a 10 m tower and on an intermittent basis from an instrumented tethered balloon system. The latter measurements provided information on the vertical structure of temperature, moisture and mass transport. Surface deposition measurements included both droplet and bulk mineral mass deposition rates.

Substantial variation in drift emissions were noticed. Large day-to-day variations for a given cell and large cell-to-cell variations were observed. Because of the large variability of drift mass emission a representative emission rate per cell was calculated by ESC using a weighted average based on both the pretest survey and the detailed characterization of seven cells. The problem of deriving a total droplet emission spectrum and rate from one or two towers is complicated and the modeler must decide on the amount of detail he needs to satisfactorily predict downwind deposition patterns.

Assuming that ESC's averaging procedure was reasonable, the emission rate per cell was found to be 4.8 g s^{-1} . If all 26 cells were operating the total emission rate would be 124 g s^{-1} . The latter value may be uncertain by anywhere from 30 to 70%, depending upon the validity of the averaging procedure. With a total circulating water flow rate of $20 \text{ m}^3 \text{ s}^{-1}$, the 124 g s^{-1} emission rate corresponds to a drift fraction of 0.0006% compared to the guaranteed drift rate of 0.004%.

Comparison of drift droplet size distributions emitted from a reference cell on Tower 7-1 by several techniques were not as satisfactory as originally planned. The sensitive paper (SP) and light scattering (PILLS) devices were compared only on one day as a result of equipment malfunction. The results indicated that the PILLS device produced drift mass emission rates which were typically 20% lower than the SP method. On the other hand, data from the photographic device were not compared with simultaneous SP-acquired data, since these measurements were acquired nearly a month after completion of the main drift experiment. Consequently, while the photographic data show variations similar to those obtained by the SP method there was no way of proving whether the cooling towers were operating in similar modes during the two different test periods.

Meteorological conditions during the drift study were characterized by relatively high winds, warm temperatures and moderate humidities. The relatively high winds increased the uncertainty in the measured deposition patterns. In spite of the large (factor of 2 or 3) uncertainty in the measured deposition rates, preliminary calculations of drift deposition rates by ESC using its own model and the source and meteorological data described above are in agreement with each other for test run 1, 6-16-78.

Mineral depositions arising mainly from blowing dust produced substantial interference with the downwind deposition patterns, especially at the greater downwind distances where drift deposition rates were small. The measured drift mineral deposition rates were uncertain by as much as a factor of two or more after this variable background component was estimated and subtracted from the total deposition rates. The effects of various

structures, such as the electrical switchyards were apparent in data for the three days when winds were from the west or WNW.

Droplet deposition rates were also uncertain as a result of the relatively high winds, which produced droplet stains on the sensitive papers that were streaked and difficult to analyze in an automated manner. Calibration of sensitive papers for droplets incident at oblique angles was necessary to properly interpret these data.

The meteorological conditions during the test period did not provide drift data representative of all the conditions which would be encountered at the Pittsburg Plant, but they probably gave a reasonable picture of drift emissions and depositions during the dry, warm-to-hot summer conditions of the area. Winds were typically 5 m s^{-1} or larger from the 240-300 direction. Relative humidities and dry bulb temperatures were typically 50-60% and 15-20 C, respectively, during the experiment. Such warm temperatures, low humidities and high winds had the effect of rapidly drying out the drift droplets and dispersing them over a broad area. From a practical, experimental point of view this meant that the anticipated drift accumulation at the receptors was much smaller than what one might observe in the winter months at this site.

Comparison between several systems for the measurement of various meteorological variables, in particular the vertical profile of wind direction and speed, were carried out. In general there was favorable agreement between the in situ and remote sensing measurements.

In view of the uncertainties that arose in the interrogation of the deposition SP as a result of using an incorrect calibration equation and as a result of problems of measurement of the droplet stains with an automated scanning and reading device, certain (or all) of the SPs could be remeasured using a more manual approach.

Although the experiment plan had the benefit of input from several other groups that have been involved in drift experiments (e.g., the Chalk Point Cooling Tower Project), several improvements to the experiment design could have been made. Larger deposition pans would have made the

analysis of the bulk mineral deposition much easier and less uncertain. Some type of wind screen to reduce the horizontal wind component might have allowed for better control of the stain images. High-volume samplers should have been used to measure the air concentration of the dry non-depositing drift material.

While the present study did not encompass as wide a range of meteorological conditions as would be required for complete validation of various drift models, it has contributed a unique set of data for that purpose.

BACKGROUND

SITE EVALUATION AND SELECTION

Because of potential drift interferences from other sources, e.g., drift from the stack plume at Chalk Point (Meyer and Stanbro, 1977), plans were made to give high priority to nuclear power plants with mechanical draft cooling towers, such as the Palisades plant at South Haven, MI, the Duane Arnold plant near Cedar Rapids, IA, or the Prairie Island plant near Red Wind, MN. The oil-fired PG&E Pittsburg plant at Pittsburg, CA and the fossil fuel Jack Watson plant at Gulfport, MS, were also considered acceptable since they did not use saline or brackish waters for stack scrubbers.

Of this list of candidate sites, responsible personnel at only two plants were sufficiently familiar with the objectives of the proposed experiment to assure permission to conduct the study in the spring 1978. These two sites were the Palisades and Pittsburg plants. A site visit of the Palisades plant on 31 October 1977 was conducted. The site was found to be unacceptable because of terrain (numerous ridges of sand dunes) and ground cover (heavily forested with considerable underbrush) problems.

On 19 December 1977 a visit to the Pittsburg site was made. A maintenance outage was in effect on the unit using the two Marley cooling towers during the site visit so that actual operation of the towers could not be observed and preliminary test field samples could not be taken. In addition to examining the cooling towers, which were being plugged for leaks around the drift eliminators by PG&E and Marley personnel, potential ground-level sampling station locations were investigated, including those used by ESC during a cooling tower performance test conducted for PG&E in November 1977.

The site appeared to be suitable for the kind of drift study required for validation of drift models. Advantages of the site were:

- Drift data, already acquired at the site, could be used with PG&E's approval in program planning.
- The cooling towers employed salt water. Sodium had been used with good success for mineral measurements in previous drift programs.
- The site was flat with a number of potential ground-level measurement station locations; site plans and an aerial photograph of the site were to be provided by PG&E.
- Winds were said to be fairly constant from the west, which were verified subsequently on closer examination of the wind rose data supplied by PG&E from the on-site meteorology station.
- Liaison with PG&E and the plant had been established, and PG&E personnel had experience with drift measurement programs.
- The plant is currently undergoing maintenance so that the possibility of outage during anticipated spring measurements was expected to be small.

Disadvantages of the site were:

- The switchyards may sweep out droplets from the cooling towers under high wind conditions altering the droplet component downwind. In general, westerly winds will carry the drift over areas that have switchyards, oil storage tanks and other buildings that can influence downwind drift data.
- Under dry conditions, the area upwind of the switchyards is sprayed with salt water to prevent dust formation. This spraying must be coordinated with the measurements.
- Wind conditions, though steady from the west, may be too high to interpret deposition results reliably.
- The plant boundaries extend only 1 km from the cooling towers such that placement of stations beyond this point in residential areas could have required close supervision.
- The subject of emissions from the plant (including the cooling towers) were a sensitive one to PG&E since the plant falls within the jurisdiction of the Bay Area Air Pollution Control District.

On the basis of this site visit it was decided that the advantages outweighed the disadvantages and that the site was acceptable for the test.

Several other Pittsburg site visits were conducted after the maintenance outage was completed to examine the site in some detail for the location of the ground-based sampling stations, a 10-m meteorological tower and sites for operation of a tethered-balloon system. The most critical evaluations made were for the sampling station location to be free from interference from various structures, such as transmission lines and towers, electrical switchyards, fences and buildings. Several serious questions were raised concerning these possible interferences by J. H. Meyer (JHU/APL) who took part in one of the site visits. A subsequent survey indicated that only 4-5 of a total of 25-35 stations would be seriously shadowed by various structures. The decision was made to continue with the Pittsburg Power Plant as the prime study site.

PG&E PITTSBURG POWER PLANT DESCRIPTION

The site is located on the shore of Suisun Bay near the confluence of the Sacramento and San Joaquin Rivers (Fig. 1). The plant consists of seven oil-fired units. Units 1-6 employ once-through cooling, while Unit 7 (rated at 720 MWe net) is cooled by two 13-cell Marley rectangular mechanical draft cooling towers located, approximately 0.5 km from the unit, on the center berm in a cooling canal west of the plant. The two cooling tower units are identified as Tower 7-1 and Tower 7-2; Tower 7-2 is about 325 m west of Tower 7-1 measured from center to center (each tower is about 143 m in length). Individual cells are numbered 1-13 from west to east. Cell exit diameter is 10 m with the exit plane 5.5 m above the fan deck and 18 m above ground level. The canal was previously used as a spray canal for Unit 7.

Towers 7-1 and 7-2 are unique in the sense that no direct connection exists between the condenser cooling water flow and the tower water flow. Cooling water for the Unit 7 condenser is withdrawn from one end (cold) of the canal and discharged to the other (hot). The two cooling towers

FIGURE 1. Location of the PG&E Pittsburg Power Plant on the South Shore of Suisun Bay in California

withdraw water from the hot leg and discharge it to the cold leg. The possibility existed that inlet water temperatures might be slightly different since the withdrawal points were not exactly the same in the hot leg. This difference, however, turned out to be small (<1.1 °C on the average). Since plume buoyancy is determined primarily by exit air conditions, which were monitored continuously during the source measurements, it should be possible to establish the relationship between net generation and tower load from these and other operational parameters to satisfy the requirements of model inputs.

The towers were stated to have a guaranteed drift rate of 0.004% and a nominal circulating water flow of $23.5 \text{ m}^3 \text{ s}^{-1}$. Because leaks were sealed around the cooling tower drift eliminators during the December 1977 maintenance outage, tower performance should have been near to the manufacturers specifications. Other factors related to cooling tower were blowdown and makeup rates. Makeup water was added to the cooling system at a constant rate throughout the day near the cold end of the canal. The canal water level was regulated by the blowdown rate.

Total dissolved solids concentration of the canal water has been found to vary over several orders of magnitude, with sodium ion concentrations varying between 0.01 and 1.5% by weight.

PRELIMINARY TESTS

Several tests were conducted at the site and in the laboratory to evaluate sampling methodology and to define measurement strategies. These included:

- pretest observations of drift eliminator condition;
- evaluation of drift emission characteristics of all operating cells using sensitive papers;
- evaluation of wind rose climatology for June from PG&E wind data over the seven year period, December 1970 - November 1977;

- basin/canal water dissolved solids;
- evaluation of deposition pans for background interference, recovery efficiency and recovery sensitivity.

ESC conducted the first two of the above tests while PNL carried out the rest.

The purpose of the source pretests was to devise a sampling strategy that would yield representative drift emission characteristics for both towers. It was clearly impractical to measure all twenty-six cells of Towers 7-1 and 7-2 simultaneously. Even if it were available most models could not accept such detailed information. However, knowledge of the magnitude of cell-to-cell variations, systematic variations with cell location and variations within a particular cell would be necessary to specify the range of variation of source parameters.

Practical considerations of instrument sample time and cell exit plane access dictated that comprehensive drift emissions measurements be limited to one cell characterization per day of testing for a minimum of six cells. Selection of individual cells for intensive measurement was on the basis of the pretest visual examination of drift eliminator condition, of droplet discharge in the plenum through leaks, and of drift at the fan stack exit plane and by exposure of sensitive papers for relative ranking of cell emissions.

Although leaks had been caulked during the maintenance outage, there still existed in the majority of the cells water droplet streams from the fill area that splashed on structural members in the plenum generating droplets small enough to be entrained in the updraft air flow. Because of the irregular spatial and temporal nature of their generation and the fact that they did not pass through the drift eliminators, these droplets could be expected to modify the emitted drift droplet size distribution. This point will be addressed in more detail in the discussion of results.

Ranking of cell emissions was divided into categories of high, medium and low drift emissions. It was found from examination of the sensitive papers (SPs) that all cells of Tower 7-1 were ranked medium, except for cell 3, which was high and cells 8 and 9, which were low; for Tower 7-2 4 cells were high (# 4,9,11,12), 6 cells were medium (# 1,2,3,6, 7,8) and 3 cells were not operating (# 5,10,13).

The decision was made to devote full characterization of 4 cells on Tower 7-1 (# 3,7,9,12--one high, 2 medium and 1 low), and of 2 or 3 cells on Tower 7-2 (# 3,7,12--one high and one or two medium). Furthermore, the middle cells of each tower (#7) were designated reference cells where limited SP exposures would be made daily (provided the tower was operating) as an indication of daily cell droplet emission variation. Details of the pretest source measurements are contained elsewhere (Webb, 1979).

Layout of ground-level stations for the measurement of drift deposition required the evaluation of the expected wind rose at the PG&E Pittsburgh Plant during June. PG&E provided summaries of wind measurements over a seven-year period from 1971-1977 for the month of June and for different times of the day. Frequencies of winds with speeds $\leq 5.4 \text{ m s}^{-1}$ and $\geq 5.4 \text{ m s}^{-1}$ as a function of direction and time of day are shown in Figs. 2 and 3, respectively. These figures show that winds are persistently from the west with wind speeds exceeding 5.4 m s^{-1} more frequently than below 5.4 m s^{-1} for all hours of the day except early morning hours. Consequently early morning starts for the tests were desirable.

During the later site visits, several deposition pans were exposed for a short time near one of the operating towers to test handling and recovery procedures as well as examine recovery sensitivity. Unexposed and exposed deposition pans were rinsed and the resulting samples were analyzed for various negative ion concentrations, including Cl^- and SO_4^{--} . It was found that ion interference from unexposed pans (either prerinsed or unrinsed) was small and that an 8-min sample showed sufficient deposition

FIGURE 2. Frequencies of Winds with Speeds $\leq 5.4 \text{ m s}^{-1}$ during June at Pittsburg, California as a Function of Wind Direction for Various 2-hr Time Periods

FIGURE 3. Frequencies of Winds with Speeds $\geq 5.4 \text{ m s}^{-1}$ during June at Pittsburg, California as a Function of Wind Direction for Various 2-hr Time Periods

material to be within the sensitivity range of the analyzer instruments (a discussion of the analyzers and recovery procedure follows in a later section). In addition, a known quantity of NaCl was deposited in an unexposed pan to test recovery efficiency. The results of this test showed that nearly all of the sample was recovered from the pan.

In summary the results of the various pretests gave reasonable assurance that sampling procedures and methodology to be employed in the comprehensive tests would result in successful recovery of information required for establishing a data base for drift from mechanical draft cooling towers.

EXPERIMENTAL

Eight test runs were conducted during the June 1978 drift study at the Pittsburgh Power Plant. Downwind deposition measurements were coordinated with ESC's source measurements on the first seven tests. The eighth test was conducted with no concurrent source measurements. In addition, limited droplet measurements were made on the fan deck of a single tower to examine near-field deposition during a ninth and final test. The tests were divided into two-tower operation (three tests), Tower 7-2 alone (two tests), and Tower 7-1 alone (three tests).

Meteorological conditions were much windier than the previous June climatology indicated. The winds, though persistently from SW to W to NW, were more intense during the morning hours than usual. Only two test runs were made where the wind speed could be classified as 5 m s^{-1} or less. The other tests were carried out under conditions where wind speeds ranged from 5 to 10 m s^{-1} . A summary of the test runs and average meteorological conditions is found in Table 1.

TABLE 1. Summary of Test Runs and Average Meteorological Conditions During the June 1978 Pittsburgh Drift Study

<u>Date</u>	<u>Run No.</u>	<u>Temperature (°C)</u>	<u>Relative Humidity (%)</u>	<u>Wind Speed (ms⁻¹)</u>	<u>Wind Direction (°)</u>	<u>Comment</u>
6-15	3	23.6	43	6.6	292	Both towers
6-16	1	18.4	55	4.8	269	Both towers
6-17	2	19.7	57	3.9	265	Tower 7-1 only
6-18	5	16.9	63	7.1	241	Tower 7-1 only
6-20	8	13.5	85	7.6	242	Tower 7-2 only
6-21	4	18.3	65	5.7	246	Tower 7-2 only
6-22	6	16.8	66	6.4	248	Both towers
6-24	7	16.7	61	7.7	248	Tower 7-1 only
6-25	x	15.9	65	5.4	268	Tower 7-1 only

In the following sections a description of the field experiment setup and test procedure and analysis procedures for the source characterization, meteorological, deposition, and other relevant measurements are given. Since a complete summary of the source measurements is contained in ESC's Final Report (Webb, 1979) only a condensed summary of these measurements with illustrative tables and figures is given here.

SOURCE CHARACTERIZATION

Because of the unique linkage between condenser cooling and the operation of the cooling towers, it was necessary to have a complete description of both plant and cooling tower systems. Such a description included:

- unit 7 generating load,
- unit 7 condenser water flow rate ,
- unit 7 condenser inlet and outlet water temperature ,
- canal inlet and outlet temperature ,
- cooling Tower 7-1 water flow rate,
- cooling Tower 7-1 inlet and discharge water temperature,
- cooling Tower 7-2 water flow rate,
- cooling Tower 7-2 inlet and discharge water temperature,
- cooling Tower 7-1 total fan power (airflow),
- cooling Tower 7-2 total fan power (airflow),
- flow rate, inlet/outlet water temperatures, and fan power for individual cell being monitored.

Plant and tower operational data were acquired from the PG&E plant log and data acquisition system or from instrumentation set up by ESC. Operational parameters available from PG&E sources included:

- instantaneous net-power generation at half hour intervals recorded on the half-hour and hour,
- condenser inlet and outlet circulating water temperatures (sensors and sensor accuracies not specified),
- cooling tower cold water temperatures,
- fan power from power meters located in each cooling tower control center (read and estimated by ESC).

Operational parameters acquired by ESC included:

- ambient wet- and dry-bulb temperatures,
- canal inlet and outlet temperatures,
- cooling tower hot and cold water temperatures,
- cooling tower water flow rate.

All ESC-acquired temperature measurements were obtained with platinum resistance temperature devices (RTD's) multiplexed to a data acquisition system. Data were acquired concurrently with cooling tower drift source and ground-level measurements.

Cooling tower water flow rate measurements were conducted only once for each tower and compared to values obtained by PG&E personnel. Since these measurements were within 5% of the PG&E values, more frequent checks were deemed unnecessary. Fan horsepower estimates were also compared to more accurate PG&E determinations.

Sensor deployment and other determinations of cooling tower operational parameters are shown schematically in Fig. 4.

Source characteristics included measurements of those variables required to describe the air/vapor and drift emissions from the fan stack. These variables included:

- updraft air velocity profiles,
- air dry- and wet-bulb temperature profiles,
- drift (water) flux profiles,

FIGURE 4. Cooling Tower Layout, Cell Designation and Identification of Cells Selected for Intensive Characterization. Measurement Location of Cooling Tower Parameters are Also Shown and Identified in the Legend (ESC, PG&E Drawing)

- mineral mass-flux profiles,
- drift droplet size distribution,
- droplet salinity vs. droplet diameter.

Drift emission measurements were made near the exit plane of selected cell fan stacks on both cooling towers while cooling tower and plant operational data were also acquired. Cells were selected for intensive measurement in accordance with the measurement strategy developed in the pretest plan described earlier (see Fig. 4). For characterization of cooling tower source emissions, measurements of droplet size, mineral mass flux, updraft air velocity and updraft air temperature were performed by ESC using the following instrumentation:

- Sensitive Paper System (SP),
- Particulate Instrumentation by Laser Light Scattering System (PILLS II),
- heated Glass Bead Isokinetic Sampling System (IK),
- Gill propeller anemometer,
- electronic psychrometer.

A sample of the circulating water was also acquired from the hot water basin of the cell under measurement for later chemical analysis of the mineral tracers, sodium and magnesium. Limited sensitive paper exposures were taken daily on designated reference cells as an indication of daily cell droplet emission variation.

In order to measure the drift emission of one cell, traverses were made across two orthogonal diameters of the exit plane of the cell fan stack. The exit plane is divided into annular regions whose areas are equal; the instrument package is located at a measurement point in each area. A diagram of one of the Pittsburgh fan stack exit planes with the measurement points shown is given in Figure 5. For the Pittsburgh measurements, each cell was divided into three annular areas each with four measurement points each as shown in the figure (Positions 1-12). Updraft

FIGURE 5. Equal Area Measurement Points for a PG&E Pittsburgh Unit #7 Cooling Tower Fan Stack (ESC Drawing). Intensive Characterization was Carried Out at Points 1-12. ESC and Calfran Droplet Comparison Studies were Made at Points A-F

air speed and temperature were also acquired at the center of the exit plane.

A summary of the pretest and comprehensive measurements is shown in Table 2 with pertinent comments. Cell characterization indicates measurements at 12 equal area points on cross diameters in the cell exit plane with SP, IK, anemometer, and $T_{\text{wet}}/T_{\text{dry}}$. The cells characterized are also marked with an X indicating the cross diameters in Figure 4. Although the PILLS instrument was available for use from June 15 through 18, equipment malfunction prevented its use until the 18th. On June 19, no source measurements were conducted while the equipment and scaffolding were moved from Tower 7-1 to 7-2.

It was intended that several different methods for measuring the emitted drift droplet size distribution be carried out simultaneously. ESC was to provide data with their SP and PILLS systems, as already indicated, while Calfran Industries was to demonstrate a photographic technique. Because of equipment and other problems, Calfran was unable to set up its instrumentation in time for coordinated measurements with ESC. Calfran eventually completed these measurements on the reference cell (#7) of Tower 7-1 toward the end of July.

In principle, the results of the photographic technique and the PILLS system are directly comparable since they both provide a measure of droplet size and number density in the cooling towers. However, since the PILLS system was only used during a limited test period, the more meaningful comparisons would be with the SP exposures. Since the SPs measure a droplet flux, intercomparisons of the PILLS, photographic and SP techniques can be made only by converting the measured droplet densities to droplet fluxes by means of the average updraft velocity at each measurement point and the size dependent settling velocity of each droplet size category. A more complete discussion of these points may be found elsewhere (Webb, 1979; Schrecker, et al., 1975).

TABLE 2. Summary of ESC Data Acquisition for the June 1978
Pittsburg Drift Study

June Date	Time of Runs (PDT)	Number of Cells Operating Tower		Cell # Charac- terized	SP	IK	PILLS	Opera- tional Param. Acqu.	Reference Cell Spot Checked		Comments
		7-1	7-2						1-7	2-7	
13	--	13	10 ^a		X				X	X	Pretest
14	--	13	10		X						Pretest
15	12:31-17:02	12	10	1-7	X	X		X		X	
16	7:30-12:00	12	10	1-12	X	X		X	X	X	Anemometer Malfunction
17	7:50-12:15	12	0 ^b	1-3	X	X		X	X		
18	7:33-13:02	12	0	1-9	X	X	X	X	X		
19	--	--	--	--	--	--	--	--	--	--	Moved Equipment from 7-1 to 7-2
20	8:51-13:22	0	10	2-7	X	X		X			
21	8:35-12:56	0	10	2-12	X	X		X		X	
22	8:00-12:27	12	10	2-3	X	X		X	X	X	Tower 1 Reference Data Acquired 6-23-78

^aThree of the 13 cells with water flow but no fan operation.

^b0 indicates no water pump or fan operation.

The Sensitive Paper methodology requires further elaboration since ESC's sampling procedures were modified to improve counting reliability and counting statistics, particularly for the larger droplet sizes. Two SP sizes were employed in the Pittsburgh measurements (with their respective holder/mechanical shutter mechanisms). A small-area SP (47 mm in diameter) was employed for good collection efficiency of small droplets and was interrogated for droplets in the size range of approximately 10 to 100 μm in diameter. A large-area SP (142 mm in diameter) was employed for better sample statistics in the larger size ranges ($>100 \mu\text{m}$) that typically occur less frequently than the small droplets in a cooling tower.

The processing of these exposed sensitive papers, which are chemically treated so that a droplet impinging on them will generate well-defined dark blue stains on the pale yellow background of the papers, consisted of measuring the stain diameters by means of a microscope and a semi-automated light-pen counter linked to a minicomputer. The counts of all measured stains were grouped by stain size ranges. Since the number of stains per stain size range usually decreased with increasing stain size, three sensitive paper counts for small ($>20\text{-}\mu\text{m}$ stains, 47-mm paper only), medium (200 to 1500- μm diameter stains, 142-mm paper only) and large stains ($>1000\text{-}\mu\text{m}$ diameters, 142-mm paper only) were typically made. The paper was divided into frames approximately 3 mm on a side for facilitating the counting procedure. The stain diameters given here should not be confused with drift droplet diameters which must be inferred from calibration data. The accuracy of the droplet diameter sizing of the SP methodology has been determined to be within $\pm 15\%$ of the true droplet diameter.

Once the stain sizes are counted and grouped according to size, calibration curves for specific droplet sizes and impaction velocities were employed via computer programs to generate the original droplet sizes from which the stains were formed. In addition, an experimentally determined correction factor was applied to the data for droplet diameters below 50 μm to account for the reduction in collection efficiency with decreasing droplet diameter for the specific size of the SP disc collector and impaction velocity.

Mineral mass flux emission rates were determined by heated glass bead isokinetic (IK) sampling tubes. The air velocity through the tube was adjusted so that it was equal to the time-mean velocity of the updraft air as determined by measurements with the propeller anemometer. The minerals collected in the IK tubes were stripped from the tubes with a wash solution which was then analyzed by atomic absorption or flame emission spectrophotometry. In this test, the wash solutions were analyzed for sodium and magnesium. The accuracy of the IK System has been determined to be within $\pm 15\%$ of the stated mineral mass fluxes for trace elements characteristically used in these evaluations (e.g., Na, Mg, etc.). In these instances, the chemical assays are considered straightforward and routine.

The mean drift droplet salinity may be estimated by computing the ratio of total mineral mass emission rate to total drift water mass emission rate. The resultant number may also be compared to the mean basin water salinity to estimate the amount of evaporation of the drift droplets that must have occurred in the fill and/or plenum sections of the cooling tower. It would have been desirable to have determined drift droplet salinity as a function of droplet size by some independent technique in order to identify physical processes occurring within the cooling tower that may alter droplet mineral concentrations. No technique, however, was readily available at the time of this study.

The remaining instrumentation used in the tower source measurements were the Gill propeller anemometer for updraft air speed and an ESC-developed electronic psychrometer for updraft air wet-bulb and dry-bulb temperatures. The anemometer was mounted in a manner that gave the vertical component of the updraft air velocity.

For characterization of the drift emission of a cell, moveable scaffolding was erected on the fan deck to support a beam which would be positioned over the exit plane of the fan stacks. The instrumentation was mounted on a carriage which could be moved back and forth along the traverse-beam once it was in position above one of the stacks. The instruments were linked via an umbilical cable to the control equipment which was situated in an enclosure on the fan deck.

METEOROLOGY

Meteorological parameters were measured in the boundary layer by a variety of instruments, including:

- instrumented 10-m tower,
- tethered-balloon system,
- monostatic acoustic sounder system,
- doppler acoustic wind system,
- all-sky camera,
- time-lapse camera systems.

Data collected on the 10 m tower included:

- dry-bulb temperature,
- wet-bulb temperature,
- three-component u, v, and w winds.

Temperatures were measured with precision matched thermistors. Winds were measured with a three-component Gill anemometer. Data from these sensors were interrogated and stored by the data acquisition system every 2 s. Subsequently, 1-min averages were computed and recorded onto a seven track magnetic tape. The system was in continuous operation over the entire experimental period (June 16-25), except for occasional system checks.

A portable tethered balloon system (Tethersonde: Ambient Analysis, Inc.) provided vertical profiles of temperature, moisture and horizontal wind speed and direction within the vicinity of the cooling towers as well as upwind of the towers. Profiling was performed from the surface up to as high as 400 m on one occasion. However, the bulk of the profiles extended up to only 100 m. During the experimental period, the tethered-balloon system was flown on only 7 days (June 15, 16, 17, 21, 23, 24 and 25). Its operation was limited to wind speeds $\lesssim 10 \text{ m s}^{-1}$. The system was interfaced with a desk-top calculator (HP-97) and provided the following printed outputs on paper tape at approximately 30-s intervals:

- time,
- pressure,
- height,
- temperature,
- relative humidity,
- mixing ratio,
- wind speed and direction,
- potential temperature.

The tethered-balloon system wind speed was measured by a three-cup anemometer driving a miniature tachometer/generator. The output voltage was a linear function of RPM, which in turn was linear with wind speed, with a stated accuracy of $\pm 0.25 \text{ m s}^{-1}$ over 0.5 to 20 m s^{-1} . The wind direction sensor was a magnetically actuated circular potentiometer. The direction measurement relied on the balloon as an effective wind vane to orient the instrument package into the prevailing wind with a stated accuracy of ± 2 degrees. The pressure change was detected by a temperature compensated aneroid, piezoresistive strain gauge element. Height was determined from the indicated pressure change. The data were telemetered to the ground receiver and converted to engineering units. (See Morris, et al., 1975 for a comprehensive review of the balloon system).

During the last 3 days of the experiment a Doppler acoustic wind system (Xondar 600, Xonics, Inc.) was employed to determine the wind profile in the boundary layer. Measurements of the horizontal wind speed and direction by the Doppler acoustic system were compared with those determined from the tethered-balloon system. Fixed level (time series analysis) as well as profiling modes provided the basis for the comparison. In addition, vertical velocity data from the acoustic sensor were matched against those obtained from the Gill anemometer on the 10-m meteorological

tower. The Doppler acoustic system, balloon system and tower were operated approximately 1.5 km upwind of the cooling towers during this study.

A schematic of the Doppler acoustic wind system field setup is shown in Fig. 6. The system contains two receiver antennas which were placed to form a right angle, with the transmitter antenna at the apex. This general configuration enables determination of the horizontal wind field. With the addition of a third receiver, collocated with the transmitter antenna, the vertical component of the wind is attainable. The distance by which the receivers were displaced from the transmitter was approximately the same as the maximum altitude (400 m) at which the wind was to be sampled. A lower altitude limit (150 m) was chosen so that the elevation angle from the receiver to the scattering region at maximum altitude was not to exceed 50° .

The transmitter generates radiated pulses every 5 s in a pencil beam vertically upward, with a pulse of energy occupying at any instant only a spatial cell at some determinable altitude. Similarly, the receiver antenna forms a fan beam, narrow in azimuth to match the width of the transmitter beam it intercepts and broad in elevation to cover the desired range of altitudes. The scattered pulse arrives at the receiver after the time interval required to traverse the distance up to the altitude in question and thence to the receiver. Differentiation between signals from various altitudes can be determined by their time of arrival at the receiver; that is, signals from the lowest altitudes arrive before those from the higher altitudes. In all, the velocity components from six altitudes were attainable at 50-m intervals.

The portion of the received signal that is associated with each altitude is transformed so that its frequency spectrum, with regard to the Doppler shift, can be examined. In order to produce a confident estimate of the received signal, an integration of a number of spectra is performed. This final averaging period is 2 min during which time 20-30 signals are processed. Following this processing, real-time display of the wind field

FIGURE 6. Schematic of the Field Deployment of the Doppler Acoustic Wind Sensor Showing the Transmitter, 3 Receivers and 3 Spatial Cells from Which the 3-Component Winds are Computed

with height is provided via a teletype. Further details of the principles and application of Doppler frequency shift to determine wind velocity components are discussed by Balser, et al. (1976), Little (1969) and McAllister, et al. (1969).

A monostatic acoustic sounder (Eschosonde, Scientific Engineering Systems) was also employed during the drift study. The sounder was operated continuously during the test period, with the data from this device recorded on a strip chart. The acoustic sounder provided primarily qualitative data of temperature variability to heights of a few hundred meters in the atmosphere. These data were complementary to the tower and balloon data from some tens of meters above the ground and on up. Real-time information was displayed for general condition with respect to atmospheric stability and the presence of convection proceeding from the surface.

Sky condition, relative to the presence of visible cooling tower plumes, was recorded with an all-sky camera (35-mm Nikon camera with a 7.5-mm fisheye lens). In general, skies were clear for almost the entire duration of the test, with the exception of some occasional morning stratus clouds. Consequently, while these data would be available for further examination, no further reference will be made to them in this report.

Plume photography was also conducted during the experiment using two automatic time-lapse camera systems (16-mm Bolex H-16 Reflex movie camera with MRI Model 107-E Intervalometer for automatic time-lapse control and a 16 to 100-mm zoom lens at the 16-mm setting). Time lapse movies were made at a rate of about 3 frames min^{-1} . The cameras were set up at two widely separated locations with the frame centered on the cooling tower cell under intensive measurement; the wide angle 16-mm lens setting, however, usually included the entire tower or both towers. The location geometry was selected such that plume dimensions and directions could be estimated by triangulation. Visible plume lengths were, in general, very short during the test period, hence, as with respect to sky condition, no further reference is made to this phase of the study.

In addition, standard meteorological parameters were recorded at a PG&E meteorological facility on the plant site, southeast of the cooling towers. Data from this facility were used occasionally to fill in dropouts from the instrumented 10-m tower record.

DRIFT DEPOSITION

Experience (Schrecker, et al., 1975; Webb, et al., 1977) and modeling studies (Chen, 1977; Policastro, et al., 1978) of drift from natural draft and mechanical draft cooling towers have indicated that the amount of drift material deposited downwind can be quite small. Moreover, nearly 100% of the drift mass is deposited within 1-2 km of the tower. Therefore, the results of field measurements of drift deposition would be sensitive to the accuracy and precision of the collection methods used, the density of sampling stations employed and the magnitude and variability of background deposition other than drift. In addition, structures of various types could cause interferences in the measured deposition patterns.

The sampling configuration and deposition receptors used in the Pittsburg drift study were designed and selected to optimize the recovery of drift deposition rates from total deposition rates. To insure that the drift plume was intercepted by the downwind sampling stations, a series of arcs, roughly at distances of 1/4, 1/2 or 3/4 km from Tower 7-1, were established downwind of the towers. An intermediate arc, roughly at 0.3 km from Tower 7-1, was set up after the second test day to better define the drift entering the switchyard area. Individual stations were surveyed along each arc with angular spacings of roughly 10-15 degrees with respect to one of the towers (typically Tower 7-1). The lateral extent of each arc was chosen to accommodate wind direction changes typical of normal climatological variation at Pittsburg in June as well as to allow for the extremes of each arc to provide information on background deposition. In addition, several upwind stations were also established for background data. This sampling configuration was patterned after that used by Meyer and Stanbro (1977a) in the Chalk Point Cooling Tower Project. The sampling

FIGURE 7. Sampling Station and Plant Layout for the PG&E Pittsburgh Power Plant Cooling Tower Drift Study

TABLE 3. Downwind Sampling Station Identification and Location Relative to Both Cooling Towers

($\theta = 0^\circ = \text{North}$)

Station ID	Tower 7-1		Tower 7-2		Station ID	Tower 7-1		Tower 7-2	
	$R_1(\text{m})$	$\theta_1(^{\circ})$	$R_2(\text{m})$	$\theta_2(^{\circ})$		$R_1(\text{m})$	$\theta_1(^{\circ})$	$R_2(\text{m})$	$\theta_2(^{\circ})$
UUA	821	278	500	280	2A	420	60	722	73
UUB	825	269	500	265	2B	420	68	733	77
					2E	560	95	884	93
UA	566	280	250	290	2F	550	101	871	97
UB	573	267	250	260	2G	595	110	906	103
					2H	625	120	919	110
OA	125	310	245	69	2I	605	132	871	117
OBN	110	275	216	86	2J	505	144	741	123
OBS	110	256	219	95	2K	480	158	664	131
OC	115	230	246	106					
OD	170	220	249	120	3A	695	86	1020	87
OE	250	220	248	139	3B	750	94	1074	92
					3C	775	101	1095	97
1X	160	6	379	64	3E	765	119	1059	110
1ZZ	135	20	394	70	3F	745	124	1028	114
1Z	230	37	501	68					
1Y	230	53	529	74					
1A	215	64	528	79	Tower 7-2	325	269	-	-
1B	215	77	537	84	Tower 7-1	-	-	325	89
1C	215	92	540	90					
1D	225	105	545	96					
1E	255	120	559	103					
1F	275	130	562	108					
1G	300	144	555	115					
1I	235	163	451	119					
1J	275	178	429	129					
1AZ	320	62	627	76					
1AA	305	72	623	81					
1AB	270	84	594	87					
1AC	285	90	610	89					
1AD	305	105	624	97					
1AE	325	116	632	103					
1AF	375	111	687	101					

station configuration and plant layout are shown in Fig. 7. Station identification and location relative to the cooling towers are given in Table 3. All sampling sites were located to within ± 10 m.

Inspection of Fig. 7 reveals several important features. Because of structural interferences such as buildings, fences, electrical switchyards, transmission towers, etc., it was not possible or practical to set up the stations on true arc circles or at equal angular spacings. Some stations were near roads, which, if unpaved and dusty, could result in receptor contamination. Structural interferences may also affect drift deposition patterns by acting as screening agents. The effect of such interferences, of course, would be difficult to model. In an attempt to establish a visual record of potential interferences, photographs were taken of each station along a line of view towards the cooling towers. For upwind stations, photographs were taken toward the prevailing upwind direction also. These photographs and their identifications may be found in Appendix B, Sampling Station Identification.

At each sampling station, receptors were deployed to measure deposition of

- bulk mineral mass,
- drift droplet mass,
- drift droplet size distribution.

Deposition buckets were used to collect total mineral deposition. These buckets consisted of circular plastic cartons with tight-fitting snap on lids with dimensions 15 cm in diameter and ~7 cm high. These type of buckets, as opposed to deposition funnels and bottles as alternatives, could be covered and stored indefinitely without additional handling, such as rinsing. Since each bucket could be rinsed in a clean laboratory environment, rather than in the field, it was felt that the chances for additional contamination were minimized.

Large sensitive papers (293-mm dia, Millipore, Type HA filter paper, sensitized by J. H. Meyer), similar to those used by ESC for the source measurements, were employed to collect drift water droplets. Other large filter papers (Millipore HA and Whatman No. 1) were also used to collect drift. The latter papers could be developed for Cl^- ion by a procedure using AgNO_3 and exposure to bright light and would produce stain images similar to those produced directly by water drops on the sensitive papers.

In addition, it was felt that these untreated papers could be used as backup deposition pans. Subsequent laboratory analysis of filter blanks indicated substantial quantities of the same mineral ions that were used as drift tracers and, therefore, the untreated papers may be unsuitable as backups for the deposition pans.

Each sampling station consisted of two buckets, one sensitive paper, and one or two untreated filter papers. Each sampler was mounted on a square plywood platform (30.5 cm x 30.5 cm) nailed to the top of a wooden stake driven into the ground. The platforms were approximately 1 m above the surface and set up along a line perpendicular to the station's radius from the cooling tower (usually Tower 7-1). The samplers were maintained in a horizontal attitude.

The sampling buckets were held in place on the platform by placing them into identical plastic cartons stapled to the platform. Small strips of masking tape were used to insure that the buckets were not blown out of their holders by gusting winds. The filter papers were premounted on square sheets of poster board (30.5 cm x 30.5 cm) and covered by a second sheet that had a 27.9 cm circular hole cut in it. The papers were further protected by a waxed-paper cover sheet, which accompanied the packaged filter papers as separator sheets.

In addition, an attempt was made to measure air concentrations of drift downwind from the cooling towers. Rotating arm samplers similar to those described by Schrecker, et al. (1975) were employed. Both sensitive and untreated filter papers, in the form of 2.5-cm x 15-cm strips premounted on poster board, were exposed with this device.

Because of the windy conditions which were encountered during the test, a few SPs were exposed at an angle to the horizontal. The tilt angle was usually between 45 and 60 degrees and the droplet stains were more nearly circular than those on the horizontal SPs. With such a sampling attitude, however, the measurements were no longer those of deposition but rather of impaction, although it was felt that these measurements would provide additional information on drift concentration and drift deposition rates.

Not all of the sampling stations shown in Figure 7 were used during any one experiment. The sampling array was centered along the mean wind direction at the beginning of a test run. The angular sector of each downwind arc, referenced to Tower 7-1, was typically 60-80 degrees, although occasionally, with two tower operation, the sector was expanded to about 100 degrees.

Based on earlier unpublished estimates and measurements of downwind drift deposition by ESC for PG&E at the Pittsburg plant and also on measurements at Chalk Point by Meyer and Stanbro (1977a), a minimum exposure time of 2 hr was estimated to be necessary to insure that the depositions were within the sensitivity and analysis limits. On the average, the test runs were of about 4 hr duration, which should have been adequate to meet the analysis requirements.

Test runs were initiated on the basis of wind speed and direction. The ideal plan was to wait for light wind conditions, i.e., wind speeds $\leq 5 \text{ m s}^{-1}$ and for the wind to be blowing in a direction to intercept the sampling arc. The climatological data, which was discussed earlier in the pretest summary, indicated that the prevailing winds would be westerly at speeds near 5 m s^{-1} , or perhaps greater. Actual wind conditions were more vigorous than anticipated, as indicated in Table 1. Because of ESC's schedule constraints, it was decided that coordination of deposition measurements with source measurements were more desirable than waiting

for some indefinite time for light winds; consequently, wind conditions were frequently less than ideal. Once the wind pattern established itself in the morning, it persisted in that direction for most of the day.

With the plume centerline established from the mean wind direction, the sampling stations to be used were identified and the deposition buckets and filter papers were pre-labeled with the date and station identification. The station array was divided into areas so that all samplers could be opened and closed within 15-20 minutes. At the beginning of the experiment, the samplers were set out and uncovered; the start time was recorded on each sampler. At the end of the experiment, the samplers were covered and the stop time was recorded. The samplers were periodically monitored. The SP samplers located nearest the cooling towers along the plume centerline often had to be covered and replaced during a run. On other occasions, such as after a wind shift, the condition of SPs located near the plume boundary was noted, along with the time, directly onto the sampler cover.

Once the experiment was underway and the deposition samplers were set out and uncovered, the rotating arm samplers were set up near stations along the plume centerline. In addition, samples of basin (cold) water and canal water were taken periodically during the test run. On several occasions, blank deposition buckets were taken. Handling procedures were identical to those used to set out and take up the field samples except that the exposure time was very brief, ~ 1 min. Whenever wind conditions permitted, the tethered-balloon system was operated just south of the cooling towers to provide vertical profiles of wind, temperature and relative humidity.

The analysis of the deposition samples were of two types:

- chemical analysis of the bulk deposition,
- droplet size distribution analysis of sensitive papers.

In addition, chemical analysis of the canal and basin water samples was also required.

Chemical analysis was carried out using ion chromatography (Ion Chromatograph, Dionx System 10). Two instruments were available; one was used for quantitative analysis of positive ions, including Na^+ , NH_4^+ and K^+ , and the other was used for quantitative analysis of negative ions, including Cl^- , NO_3^- and $\text{SO}_4^{=}$. In addition, atomic absorption spectro-photography (Atomic Absorption Spectrophotometer, Perkin Elmer 306) was used for quantitative analysis of Ca^{++} and Mg^{++} . The purpose in analyzing the samples for such a large number of (tracer) ions was the redundancy they provided in separating drift from background deposition by a statistical technique, which is described later in the results. The choice of ions was by no means unique. In fact the ion species, NH_4^+ and NO_3^- , were near or below the detection limits of the ion chromatographs and perhaps other species, such as metallic ions, might have provided suitable tracers also. The available instrumentation, however, was set up for this particular set of ions for several other projects and was used for the drift samples on a time shared basis. The choice of ions was one of convenience. (ESC, for example, only analyzed for Na^+ and Mg^{++} in the basin water samples).

Samples were recovered from the deposition pans by rinsing with 10 ml of double-distilled, deionized water. Since two buckets were exposed at each station, analysis could be done by combining both buckets or by using each bucket individually. Both methods were used in this study in order to

- examine sample variability from bucket to bucket, or to
- average the samples from each station.

In some cases, individual or combined samples were analyzed more than once in order to

- examine instrument reproducibility.

Each sample would then have a quantitative uncertainty that was the result of

- deposition variability
- instrument reproducibility.

The uncertainty in the drift deposition rates arose from these two uncertainties and also the uncertainty in determining background deposition rates. Deposition bucket handling blanks were analyzed in the same manner as the regular deposition buckets.

Canal and basin water samples were analyzed on the ion chromatography and atomic absorption instruments only after dilution by factors of 10 and/or 100 with double-distilled, deionized water. Analysis of several water samples were repeated with different dilution factors to estimate reproducibility. Basin water samples obtained by ESC were also analyzed.

Drift droplet size distributions were obtained from the sensitive papers with an automated scanning and sizing device, the Quantimet 720 system. The system was interfaced with a mini-computer which allowed the measured stain sizes to be converted to droplet sizes from suitable calibration data and binned according to size category. The number and volume size distributions were stored on cassette tape for later hard copy retrieval.

Under normal magnification (X1), the lower resolution limit was a stain size 300 μ m. A magnification factor of about 10 could be used for droplet stains in the range 730 μ m. Analysis time at this X10 magnification would be roughly 100 times as great for the same area at X1 magnification. Some compromises were, therefore, necessary in the actual analysis process. The main analysis effort was made at X1 magnification. Intensive analyses of several SPs were made at both magnifications. The program written for the mini-computer automatically merged the distributions obtained at different magnifications and analyzed areas.

Analysis of the sensitive papers was complicated because of the non-circular, often streaky character of the stains arising from the very-windy conditions encountered during the experiment. The Quantimet system was capable of two modes of measurement in which the stain diameter or width could be obtained:

- stain area (area method), or
- stain chord width (feret method).

The former method is applicable when the stains are circular or nearly circular, for then

$$\text{Stain diameter } D_s = 2(\text{stain area}/\pi)^{1/2} .$$

The latter method is applicable in any case, but a problem arises in the interpretation of the measured chord length, L_{Ch} . Although little guidance was available, it was postulated that the width of an elongated stain or streak was more readily related to true droplet diameter, than, for example, its length.

In order to test this hypothesis, a study was conducted for EPRI and PNL by ESC to establish a relationship between stain sizes and shapes of known droplet sizes impacting on water sensitive papers under conditions simulating those encountered in the field, including oblique angle impaction under windy conditions. A complete discussion of this study is found elsewhere (Webb et al., 1979); only a summary of results is given here.

The calibration experiment was conducted with a range of drop sizes that could be expected to be seen at ground level downwind of a mechanical draft cooling tower at distances between 100 m to 1000 m from the source. Five droplet sizes were chosen to cover this size range (nominally these were 200, 300, 400, 600 and 800 μm in diameter). The droplets were allowed to impact on sensitive papers supplied by ESC. In two cases the actual papers employed in the field experiment were used as a basis for comparison.

For simulation of droplet deposition under windy conditions, the droplets were allowed to reach their natural settling velocity and to impact upon horizontally oriented sensitive papers moving at a known velocity. The horizontal velocity of the papers was obtained by positioning them on a rotating disk at known distances from its center. The area around the

papers was covered by an absorbent material to avoid possible droplet splashing. For droplet impaction simulating 0 m s^{-1} wind speed conditions (i.e., vertical settling), the disk was at rest. As a reference, droplets were also allowed to impact at 45° onto a paper moving at 7.5 m s^{-1} . This was accomplished by mounting the paper on an arm connected to the motor and orienting the holder at the proper angle.

Stain dimensions were measured using techniques already discussed by ESC (see Webb, 1979). Since a variety of stain shapes were seen, a classification table (Table 4) was assembled to show how stain dimensions were acquired. In this table, images of actual droplet stains together with diagrams indicating the dimensions of stain length, L , and stain width, W , are also shown. In all cases, the stain length denotes the longer dimension of an elongated stain. Furthermore, as expected, the stain elongation was always in the direction of travel of the paper. In general, the widest portion of an unsymmetrical stain (such as the bowling pin shape) was nearest the point of first impact of the droplet.

The results of this study indicate that stain width is related consistently with droplet size and simulated horizontal wind speed, whereas stain length resulted in considerable ambiguity. Figures 8 and 9 summarize the relationship between droplet size and stain width for various impaction conditions. In general, for a constant droplet size, increasing simulated wind speed results in decreased stain width with the amount of decrease dependent on droplet size. It also appeared, that, for the range of simulated wind speeds and droplet sizes used in this study, droplets larger than about $800 \text{ }\mu\text{m}$ produce nearly circular stains and follow a calibration curve appropriate for settling alone. Further studies with droplets larger than $800 \text{ }\mu\text{m}$ would be required to verify this conjecture.

The results of the calibration study can be used to interpret the drift droplet stains measured using the feret or chord method on the Quantimet system. However another uncertainty in the determination of droplet size distributions arose. Because of wind direction variability, the elongated droplet stains and streaks were not all parallel to one

TABLE 4. ESC Stain Shape Classification

A. CIRCULAR

INCOMPLETE

B. ELLIPSE

C. ELLIPSE W/TAIL DOT

D. FOOTPRINT

E. BOWLING PIN

HOLLOW END

F. SPOON

G. STREAK

FIGURE 8. Droplet Diameter Versus Stain Diameter or Width for Droplets Settling at 0 m s⁻¹ Simulated Horizontal Wind Speed and for Droplets Impacting on a Tilted 45° Angle Surface at 7.5 m s⁻¹

FIGURE 9. Droplet Diameter Versus Stain Diameter or Width for Droplets Impacting at Simulated Horizontal Wind Speeds of 0, 2.5, 5, 7.5 and 10 m s⁻¹

another. Since a preferred axis or orientation of the SP was required for using the feret method, stains that were not aligned along this preferred direction would have had their apparent widths overestimated.

Most of the SP droplet stain analysis had been completed prior to the calibration study, where the calibration curve supplied by Meyer with the SPs (see curve labeled Meyer in Fig. 8) was used to convert measured stain widths to droplet diameters. Consequently, some correction of these results were required. A quantitative discussion of how these corrections were made will be given later with the results.

Procedures for analyzing the untreated filter paper samples were not developed in detail as these samples were regarded as backup to the main experiment and no analysis of these papers was carried out. In principle, these papers could be used to

- verify droplet size distributions derived from the SPs,
- verify drift deposition rates derived from the bucket samplers.

In order to analyze the untreated filter papers for droplet size information, they would have to be developed with a AgNO_3 solution and exposed to bright light, and interrogated in a manner similar to that used for the SPs, although different calibration curves might be necessary.

Mineral ion deposition rates could be determined by rinsing the papers and analyzing for the various ion species as done for the deposition pans. But as described earlier, substantial interference of most of these ions was present in unexposed papers. In any case, none of the untreated papers have been analyzed by any method but will be kept in storage if later analysis is required.

A similar discussion applies to the analysis of the SPs and untreated papers (UPs) exposed on the rotating arm samplers. The SPs, of course, could be analyzed directly; the UPs could be developed or rinsed. No analysis of these samples has been carried out. These samples also are in storage until later analysis is indicated.

Once the results of the chemical and droplet analyses were available, they were then converted to deposition rates using the actual sampling time and exposed or analyzed area. The downwind deposition patterns were obtained by combining data from all of the sampling stations in each arc. It became apparent from preliminary analysis of the test run 1, 6-16-78, that larger background values of mineral deposition were present in the data than originally anticipated, primarily as a result of the windy conditions at the site. Fortunately, the sampling procedure allowed for enough outside-the-plume stations such that, with suitable statistical procedures, it was possible to eliminate most of the influence of this variable background component.

Ratios of mineral ion mass deposition provided a convenient method to distinguish drift from non-soil, background aerosol since the ratios for drift droplets should be similar to those of the basin and/or canal water. The problem of soil contamination in the deposition pans was not so straightforward. This is because the soil had been exposed to drift deposition, and, more importantly, canal water from spray trucks as a part of PG&E's dust abatement efforts. The upwind and off-plume stations in most cases provided a useful indicator for estimating the non-soil background. Soil samples, collected near many of the sampling stations, were examined to see if any useful method for qualitative estimates of soil/dust contamination could be found. These samples, however, were too inhomogeneous to help in the evaluation of the soil background.

RESULTS

In the following sections, the results from the source characterization, meteorological conditions and deposition measurements are summarized for the June 1978 Pittsburg drift study. Source measurements are summarized for all seven tests, including all days from 15 June through 22 June (except 19 June which was used to transfer equipment from Tower 7-1 to Tower 7-2). Details of the source measurements and results are given elsewhere (Webb, 1979) and, hence, only a summary is given below. Meteorological data are presented for the period 6-15-78 through 6-24-78. Drift deposition data are presented only for test runs 1 through 6, as listed in Table 1, and include all test runs from 6-15-78 through 6-22-78, except for the 6-20-78 run (test run 8).

SOURCE CHARACTERIZATION

Average plant and cooling tower operational parameters obtained by ESC during the drift study are summarized in Tables 5 and 6. Although most tests were conducted in the morning (largely because winds were lighter and the expected problems with ground-level droplet determinations were less), the tower operating parameters remained reasonably uniform. The stability in operating conditions was mainly attributable to steady plant load and a rise in wet-bulb temperature of typically 4°C or less during the test. The associated rise in tower operating equilibrium was typically 4 to 5°C as a function of time for each test day (about 5 hr duration). Because plant load was held essentially constant for the tests, variations in cold water temperature for the test cell and tower closely paralleled those of the hot water temperature.

Average Unit #7 plant load varied from 682 MW to 416 MW over the 7 days of measurements. Rated capacity for Unit #7 is 720 MW net. Average condenser hot water temperature varied from 30.3°C to 36.5°C over the 7 days. Cooling Tower 7-1 operated during 5 of the test days and Tower 7-2 also operated during 5 test days. (Both towers were in operation during 3 of the test days.) Cooling tower average hot water

TABLE 5. Plant Operational Data

Date	Time (PST)		Plant Load ¹ (MWe)	Water Temperatures (°C)				Avg Ambient Temperature (°C)	
	Start	Stop		Condenser ²		Canal		Drybulb	Wetbulb
6-15	1130	1610	517	26.2	34.3	33.3	25.5	23.9	16.3
6-16	0630	1115	682	25.6	36.5	35.7	25.5	20.9	14.6
6-17	0630	1130	493	24.6	32.6	32.0	24.6	21.6	17.6
6-18	0630	1215	504	24.2	32.3	31.6	24.0	18.9	14.1
6-20	0745	1230	518	24.1	32.2	31.5	24.1	19.0	14.8
6-21	0730	1200	416	23.5	30.3	30.3	23.9	20.3	16.2
6-22	0700	1130	512	24.5	32.8	32.0	24.1	20.0	15.1
6-24	0700	1200	511	22.8	31.1	-	-		
6-25	0730	0900	509	29.1	37.2	-	-		

¹Average, PG&E Plant Hour or Demand Log, Instantaneous Net generation at 1/2 - 1 hr intervals.

²Average, PG&E Plant Hour or Demand Log, condenser circulating water temperatures.

TABLE 6. Cooling Tower Operational Data

Date	Time (PST)		Tower ID	Operating Cells ¹	Water Flow (m ³ /s)	Fan Power ³ (kw)	Water Temperature (°C)				Test Cell ID
	Start	Stop					All Cells		Test Cells		
							Hot	Cold	Hot	Cold ²	
6-15	1130	1610	7-1	12	9.5	153	33.4	25.0	33.3	23.7	7
			7-2	10	10.4	151	32.2	27.3	—	—	—
6-16	0630	1115	7-1	12	9.5	155	35.6	24.5	35.6	26.5	12
			7-2	10	10.4	154	34.6	27.6	—	—	—
6-17	0630	1130	7-1	12	9.5	153	32.0	23.9	32.0	22.9	3
			7-2	0	—	—	—	—	—	—	—
6-18	0630	1215	7-1	12	9.5	156	31.6	22.8	31.6	23.9	9
			7-2	0	—	—	—	—	—	—	—
6-20	0745	1230	7-1	0	—	—	—	—	—	—	—
			7-2	10	10.4	156	31.2	25.2	31.5	22.5	7
6-21	0730	1200	7-1	0	—	—	—	—	—	—	—
			7-2	10	10.4	151	29.9	24.9	30.0	24.7	12
6-22	0700	1130	7-1	12	9.5	155	32.1	23.5	—	—	—
			7-2	10	10.4	154	31.4	25.6	31.3	23.7	3
6-24	0700	1200	7-1	11	9.5	~155	25.8	21.7	—	—	—
			7-2	0	—	—	—	—	—	—	—
6-25	0730	0900	7-1	11	9.5	~155	~30.5	24.1	—	—	—
			7-2	0	—	—	—	—	—	—	—

¹Cell 4 on 7-1, Cells 5, 10, 13 on 7-2 not operating, cell 12 on 7-1 out on 6-24, 6-25.

²Average, PG&E Cooling Tower Data Logger paper tape printout.

³Average fan power per cell at the fan based on volt-ampere readings, fan efficiency of about 0.92, ambient psychrometric state and other cooling tower operating parameters.

temperatures for Towers 7-1 and 7-2 differed by as much as 1.2°C for those days when both towers operated while average cold water temperatures differed by as much as 3.1°C, with Tower 7-2 yielding warmer water. The large variations (i.e., up to 5°C) seen in the cold water temperature measurements made at the north-side weirs of each cooling tower were attributable to the lack of mixing and the fact that some fans were not operational (cell number 4 on Tower 7-1 and numbers 5, 10, and 13 on Tower 7-2).

With regard to water flow rate, little change was expected or noted for either tower. Similarly, for horsepower, variations of less than 10 percent from the average of approximately 205 horsepower were noted from cell to cell, suggesting that expected volumetric air flows could be within 3 percent from cell to cell. Because of decreasing air density, fan horsepower usually dropped approximately 2-3 percent from the morning to the afternoon. Finally, compared to design conditions, the water flow rate was approximately 19 percent below design for Tower 7-1 and 11 percent below design for Tower 7-2. Horsepower for both towers was approximately 8 percent above design.

Drift emission characteristics are based upon data derived from updraft air speed, temperature, mineral and liquid drift mass emission measurements from four cells of Tower 7-1 and three cells of Tower 7-2. The velocity profile for each cell exhibited the double-lobed structure common to fan driven flows. The highest observed average air speed was 12.7 m s^{-1} in one of the lobe regions and the lowest speed was -4.6 m s^{-1} in the center region over the hub of the fan (see Figure 10 for a typical example). The air speed profiles were not bilaterally symmetric, as a result of the influence of external crosswinds. Calculated volumetric air flow rates were $557 \pm 17 \text{ m}^3 \text{ s}^{-1}$, which corresponds to an average updraft air velocity of $7.1 \pm 0.2 \text{ m s}^{-1}$ for a cell exit area of 77.8 m^2 . Individual cooling tower air flow rates are given in Table 7.

FIGURE 10. Updraft Air Speed and Dry-Bulb Temperature Profiles for the PG&E Pittsburgh Unit 7, Cooling Tower 7-1, Cell 12, 6-16-78, 0730-1200 PDT (ESC)

TABLE 7. Cooling Tower Air-Flow Rates (ESC)

<u>Date</u>	<u>Location (Tower-Cell)</u>	<u>Net Updraft Volumetric Air-Flow (m³/s)</u>	<u>Avg. Updraft Air Velocity (m/s)</u>
6-15-78	1-7	579	7.4
6-16-78	1-12	535	6.9
6-17-78	1-3	535	6.9
6-18-78	1-9	562	7.2
6-20-78	2-7	571	7.3
6-21-78	2-12	564	7.2
6-22-78	2-3	554	7.1

Typical cell temperature profiles are also shown in Figure 10; these profiles were not bilaterally symmetric either, with higher temperatures toward the rim on the downwind side of the cell. As expected for saturated air, wet- and dry-bulb temperatures were the same within sensor accuracy ($\pm 0.2^{\circ}\text{C}$); dry-bulb temperatures varied by as much as 6°C during a given day's characterization. Temperature profiles, in general, reflected the increase in ambient temperature through the day and varied from cell to cell.

Mineral concentration of the cooling tower circulating water increased dramatically during the field test. Sodium ion concentration derived from chemical analysis of circulating water samples collected by ESC and PNL are shown in Figure 11 and Table 8. Values calculated from PG&E's cooling tower water analysis, assuming that Na^{+} represents 34% of the salts in seawater, are also shown. Mineral ion ratios, referenced to Na^{+} , are listed in Table 8 for completeness.

FIGURE 11. Sodium Ion Concentration of the Cooling Tower Circulating Water as a Function of Sample Collection Time and Day. The PG&E Value is Calculated from a Total Salt Concentration, Assuming that Na^+ is 34% of the Salts in Seawater

TABLE 8. Sodium Ion Concentration and Mineral Ion Concentration Ratios of the Pittsburg Unit 7 Cooling Tower Circulating Water

Date	Basin/Canal Water Sodium Concentration ⁵ (mg/l)				Mineral Ion Concentration Ratio ⁵					
	ESC ¹	PNL ²	ESC/PNL ³	PG&E ⁴	$\frac{\text{Mg}^{++}}{\text{Na}^{+}}$		$\frac{\text{Ca}^{++2}}{\text{Na}^{+}}$	$\frac{\text{K}^{+2}}{\text{Na}^{+}}$	$\frac{\text{Cl}^{-2}}{\text{Na}^{+}}$	$\frac{\text{SO}_4^{-2}}{\text{Na}^{+}}$
					ESC ¹	PNL ²				
6-13	--	--	--	57	--	--	--	--	--	--
6-15	96	102(10)	48	--	0.17	0.15(1)	0.17(1)	0.18(10)	1.11(5)	0.79(3)
6-16	105	132(26)	123	--	0.16	0.13(3)	0.14(3)	0.25(14)	1.27(47)	1.00(36)
6-17	125	140(43)	109	--	0.15	0.16(2)	0.15(3)	0.047(7)	1.63(31)	0.72(14)
6-18	204(30)	192(66)	244(34)	--	0.14	0.15(3)	0.12(3)	0.072(40)	1.67(36)	0.62(17)
6-20	275	296(30)	420	202	0.14	0.14(1)	0.10(1)	0.037(5)	1.74(24)	0.47(5)
6-21	--	450(75)	--	--	--	0.12(1)	0.074(8)	0.035(11)	1.68(29)	0.41(7)
6-22	466(30)	701(142)	963(87)	--	0.13	0.090(13)	0.053(8)	0.041(16)	1.26(16)	0.27(4)
6-24	--	653(167)	--	--	--	0.10(2)	0.063(12)	0.044(5)	1.46(17)	0.31(6)
Average					0.15(2)	0.13(3)	0.11(4)	0.046(13) ⁶	1.48(24)	0.57(25)

¹ESC analysis of ESC samples.

²PNL analysis of PNL samples.

³PNL analysis of ESC samples.

⁴Calculated by ESC from PG&E analysis, assuming Na⁺ is 34% of salts in seawater.

⁵Shorthand notation for standard deviation, e.g., 204(30) = 204 ± 30, 0.15(1) = 0.15 ± 0.01

⁶Averaged w/o 6-15 and 6-16.

As Table 8 shows, the sodium concentration increased by a factor of 5-7 during the test. In addition it appeared in the PNL samples that sodium concentration was highest at the beginning of a test run early in the morning and decreased to lower values toward the end of the experiment. While there was general agreement between the ESC and PNL values, some large discrepancies were also apparent, especially for the data of 6-22-78. The PNL analysis of the samples taken by ESC were not consistent with either the ESC or PNL analyses of their own samples, respectively.

The ratio between magnesium to sodium were in fair agreement for all days except 6-22. There also appeared to be a general decrease in the mineral ion ratios Mg^{++}/Na^{+} , Ca^{++}/Na^{+} , and SO_4^{--}/Na^{+} during the experiment. Except for 6-15 and 6-16, the K^{+}/Na^{+} ratio was relatively constant. The Cl^{-}/Na^{+} ratio increased through 6-21 but abruptly decreased on 6-22.

An explanation to account for all of the observed changes in sodium concentration during a given test run and in the mineral ratios is lacking at the present time. Either makeup and/or blowdown rates were not as stated or the canal water was not uniformly mixed or the makeup water from Suisun Bay exhibits large diurnal variations in mineral ion concentration. The latter explanation is probably correct because of tidal action. Incoming tides would bring in saline water from San Francisco Bay while outgoing tides would result in dilution by fresh river water. Complete listings of mineral ion concentrations and mineral ion ratios for all samples are found in Appendix A, Cooling Water Mineral Analysis.

Based on the analysis of the IK samples, the sodium mass emission rates of the seven characterized cells varied in the range 1380 to 3890 $\mu g\ s^{-1}$. The average ratio of Mg^{++} to Na^{+} emission rates was 0.11 ± 0.02 , compared to the basin water concentration ratio of 0.15 ± 0.01 . An explanation for this difference cannot be given.

If no evaporation of droplets occurred in the fill region, then the mineral (Na^{+}) mass emission rates coupled with the basin water mineral (Na^{+}) concentration yield a liquid mass emission rate in the range 6.8 to 18.2 $g\ s^{-1}$. The corresponding range of values of liquid mass emission from

analysis of SP drift droplet spectra were 2.6 to 8.2 g s⁻¹. The ratio of IK to SP liquid madd emission values varied from 1.3 to 6.2 with an average value of 2.8, indicating that evaporation effects within the fill may be significant and that the mineral concentration of the drift droplets is higher than that of the circulating water (see Schrecker et al., 1975 for a discussion of similar findings in other measurement programs). The drift and mineral mass emission data are summarized in Table 9.

As discussed in detail by Webb (1979), considerable variation in mass emission rates (by as much as an order of magnitude) was found within an individual cell, from cell to cell (see also Table 9), and from day to day for the reference cells (cell 7 of each tower). Variations of these rates within a cell can be understood because of the dependence of drift emissions on updraft air speed, i.e., high updraft air speed points generally showed the highest flux values and the larger droplets, with the largest droplet observed in the 3200 to 3400 μm bin. The cell-to-cell variations appear to be related to droplet leakage within the plenum, as noted in the pretest. Day-to-day variations may also be the result of irregular droplet leakage. With reference to Table 9, it is noticed that the droplet emissions from the test cells all have mass median diameters (MMDs) greater than 500 μm , except for the reference cells, which have MMD values less than 100 μm . Since the reference cells were sampled with the 142-mm SP on a daily basis and whenever the cells were in operation, additional data was available for examining variations in the large droplet (>90 μm) emissions. When these data were included into the drift mass emission spectrum, the MMD values both increased to over 500 μm as seen in Table 9. It is not presently known whether the mass peaks greater than 100 μm (typically observed at 300 and 900 μm , respectively) are features that came and went on a daily basis or were a consequence of limited sample points and sample duration of the SPs.

Because of the variability of drift mass emission from cell to cell, a representative emission rate per cell was calculated by ESC using a weighted average of those cells judged during a pretest survey to have high, medium or low emissions. The representative drift mass emission spectrum is listed

TABLE 9. Pittsburgh Plant Cooling Tower Drift
and Mineral Mass Emission Rates (ESC)

Date	Test Cell (Tower Cell)	Pretest Rank	MME ¹ Rate ($\mu\text{g s}^{-1}$)		IK Based ² DME ³ (g s^{-1})	SP-Based DME ³ (g s^{-1})	Ratio of IK to SP Based	MMD ⁴ (μm)	Reference Cell Data Above 90 μm	
			Na ⁺	Mg ⁺⁺					DME ³ Rate (g s^{-1})	MMD ⁴ (μm)
6-15	1-7	Medium	1540	192	16.0	2.59	6.2	73	4.70	720
6-16	1-12	Medium	1910	171	18.2	4.57	4.0	785		
6-17	1-3	High	1830	194	14.7	6.76	2.2	721		
6-18	1-9	Low	1380	157	6.77	4.23	1.6	638		
6-20	2-7	Medium	2650	268	9.64	4.59	2.1	81.9	6.48	503
6-21	2-12	High	3670 ⁵	523 ⁵	10.8	8.17	1.3	507		
6-22	2-3	Medium	3890	294	8.34	4.08	2.0	692		
			Mg ⁺⁺ /Na ⁺ 0.11 $\pm$ 0.02							

¹MME = Mineral Mass Emission.

²Calculated using assumption that sodium concentration of drift droplets equals that of circulating water.

³DME = Drift Mass Emission.

⁴MMD = Mass Median Diameter.

⁵Based on interpolated basin water concentration values.

in Table 10 and is shown in Figure 12. The mass peak near 30 μm probably represents droplets from the fill that have passed through the drift eliminators while the mass peaks at 300 μm and beyond are probably the result of large droplets formed by leakage of water into the tower plenum.

The emission rate per cell was found to be 4.8 g s^{-1} resulting in a total emission rate of 124 g s^{-1} if all 26 cells are operating. The total emission rate corresponds to a drift fraction of 0.0006% for a total circulating water flow rate of $20 \text{ m}^3 \text{ s}^{-1}$. The measured drift rate is consistent with results of other measurement programs on modern cooling towers that have current drift eliminator design.

ESC made comparisons between the SP and the PILLS droplet measurement acquired on the same cell on the same day. The photographic measurements were taken considerably after the main drift study at the Pittsburgh Plant and, in view of the variability of droplet emissions discussed previously, there is some question as to how meaningful any comparison of results of the photographic method with those obtained by the SP and PILLS methods would be.

ESC found that emission values obtained by the PILLS and SP methods for the same droplet size category were in agreement in some instances but were in only fair to poor agreement in others. These differences are partly the result of the limited range of the PILLS and its smaller sampling volume. The latter is especially critical for large drops ($>300 \mu\text{m}$) in which the counting error is large compared with the SP system. A comparison of total emission values in the droplet size range 70 - 300 μm is given in Table 11 summed over equivalent measurement points (see Fig. 5) of cell 1-9 acquired on 6-18. Table 11 indicates that even in this droplet range, the PILLS system tends to underestimate the drift mass flux relative to the SP systems. The PILLS data were not used in final calculations of total cell drift mass emission rates.

Comparisons were also made between the photographic and SP techniques on the cell 1-7 but at considerably different times. The results presented in Appendix D, Summary of Calfran Droplet Data, were in a form that were

TABLE 10. Representative Drift Mass Emission Per Cell
as a Function of Droplet Size for the Pittsburgh
Plant Cooling Towers (ESC)

I	Drop Diameter/Interval				ΔDME ($\mu g\ s^{-1}$)	$\Delta DME/DME^1$ (%)
	d_l (μm)	d_u (μm)	Δd (μm)	d_c (μm)		
1	10	20	10	15	25,200	0.5
2	20	30	10	25	211,000	4.4
3	30	40	10	35	353,000	7.4
4	40	50	10	45	310,000	6.5
5	50	60	10	55	261,000	5.5
6	60	70	10	65	167,000	3.5
7	70	90	20	80	155,000	3.3
8	90	110	20	100	84,700	1.8
9	110	130	20	120	45,000	0.9
10	130	150	20	140	36,400	0.8
11	150	180	30	165	52,400	1.1
12	180	210	30	195	55,600	1.2
13	210	240	30	225	62,900	1.3
14	240	270	30	255	67,200	1.4
15	270	300	30	285	86,800	1.8
16	300	350	50	325	127,000	2.7
17	350	400	50	375	111,000	2.3
18	400	450	50	425	109,000	2.3
19	450	500	50	475	71,800	1.5
20	500	600	100	550	206,000	4.3
21	600	700	100	650	167,000	3.5
22	700	800	100	750	182,000	3.8
23	800	900	100	850	130,000	2.7
24	900	1000	100	950	81,600	1.7
25	1000	1200	200	1100	152,000	3.2
26	1200	1400	200	1300	158,000	3.3
27	1400	1600	200	1500	306,000	6.4
28	1600	1800	200	1700	105,000	2.2
29	1800	2000	200	1900	146,000	3.1
30	2000	2200	200	2100	192,000	4.0

TABLE 10. (Continued)

31	2200	2400	200	2300	100,000	2.1
32	2400	2600	200	2500	77,000	1.6
33	2600	2800	200	2700	145,000	3.0
34	2800	3000	200	2900	80,100	1.7
35	3000	3200	200	3100	83,000	1.7
36	3200	3400	200	3300	59,200	1.2
						<hr/> 99.7

Total Drift Mass Emission 4.76 gm/sec
 Mass Median Diameter 492 μ m

¹The summation of this column is not 100.0% due to rounding.

FIGURE 12. Representative Drift Mass Emission Spectrum Per Cell for the PG&E Pittsburgh Cooling Towers (ESC)

TABLE 11. Comparison of SP and PILLS Drift Mass Flux in the Droplet Size Range 70-300 μm . (ESC Data for Cell 1-9, 6-18-78)

Measurement Position ¹	Drift Mass Flux ($\mu\text{g.m}^{-2}.\text{s}^{-1}$)		Percent Difference SP - PILLS
	SP	PILLS	
1,6,7,12	26,450	20,940	+21
2,5,8,11	46,400	34,650	+25
3,4,9,10	9,930	10,500	- 6
Total	82,800	66,100	+20

¹See Fig. 5 for measurement position identification.

not convenient for a comparison with the ESC SP results. Aside from a few technical difficulties with regard to calibration and counting statistics, the droplet data indicated behavior similar to that reported by ESC, viz. mass median diameters of the droplet density size distributions were typically larger than 500 μm (although minimum droplet sizes were 300 and 100 μm respectively for the two magnifications used), and droplet densities varied considerably with location within the cell and from day to day at the same measurement points.

The Calfran droplet densities for each size range were converted to a drift mass flux by means of the ESC-acquired updraft air speed and drift droplet settling speed. In this form, the photographic data can be compared to the ESC SP data (see Table 12; see also tabulations in Appendix D). Individual drift mass flux values were at least consistent between the two methods; however there was no way of knowing whether the cooling towers were operating in similar modes during the two different test periods. This unfortunate circumstance illustrates the need for nearly simultaneous measurements in order to compare properly the various techniques.

TABLE 12. Comparison of SP (ESC) and Photographic (Calfran) Methods for Measurement of Drift Mass Flux for Droplets Larger Than 100 μm for Reference Cell 1-7 of the Pittsburgh Plant Cooling Towers

Diameter Lower (μm)	Range Upper (μm)	Drift Mass Flux ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)												
		ESC Data							Calfran Data					
		6-15 ¹	6-16 ¹	6-17 ¹	6-18 ¹	6-23 ¹	6-23	Avg	7-20	7-21	7-22	7-25	7-26	Avg
100	200	2320	2230	1240	1740	3300	4310	2520				323	304	314
200	300	2480	6180	2530	4630	3110	11470	5070				675	1560	1120
300	400	950	1490	1160	2460	2200	8960	2870	4990	5110	2720	221	1550	2120
400	500	1400	1080	1220	1430	1980	17600	4120	9960	3480	6260	452	1810	4390
500	600	810	1885	808	404	3000	22400	4880	13500	3070	3680	0	1600	4370
600	700	1330	670	665	1330	4670	23800	5410	12900	9660	6760	1260	0	6120
700	800	1030	0	1025	2050	6840	23100	5670	13200	12800	7100	1850	3690	7730
800	900	500	500	995	1990	5470	15600	4180	25000	5920	3950	2570	0	7490
900	1000	2090	1395	0	0	2780	6870	2190	12200	13100	0	8540	1710	7110
1000	1200	2150	4315	2160	1080	6470	8880	4180	49300	15700	4370	0	5680	15000
1200	1400	1780	0	1780	1780	5350	5860	2760	31300	11700	6420	0	7630	11420
1400	1600	2740	10900	0	0	8200	9010	5140	42100	32400	9150	5020	0	17700
1600	1800		0	9530	0	0	13100	3770	29900	0	45000	7770	0	16500
1800	2000		5550	5550	0	0		1850	29600	15400	29000	10000	0	16800
2000	2200				7500	7500		2500	71500	0	19200	0	12500	20640
2200	2400					0		0	15400	42200	46100			20700
2400	2600					0		0	53800	0				10800
2600	2800					0		0	19200	30700				9980
2800	3000					19750		3290	22600	0				4520
3000	3200								0	0				0
3200	3400								25600	37600				12600
Total (>100 μm)		19600	36200	28700	26400	80600	171000	60400	-	-	-	37700	38000	-
Total (>300 μm)		14800	27800	24900	20000	74210	155000	52800	482000	239000	189000	37700	36100	197000

¹ Positions 2 and 8 averaged to obtain value for position B.

METEOROLOGY

Meteorological conditions were quite similar during the test period. Generally fair weather prevailed with clear skies, warm temperatures and moderate to high winds. Since all the test runs, except for test run 3, 6-15-78, were conducted during the morning hours, surface temperatures increased from an average low value of about 15°C at the beginning of a test run to an average high of about 23°C at the end of it. Relative humidities decreased from ~75% to ~50% during the same time period. Winds generally increased by 1-3 m s⁻¹ with an average value during the test period of about 6 m s⁻¹. Wind direction was from the west (270°) during the first three test days, but was from the WSW (~245°) for the remainder of the test period. Standard deviations of wind direction were quite low, typically $\lesssim 10^\circ$.

The warmest and calmest day was on 6-17-78. Some cloudiness occurred during the late morning hours. Winds were noticeably lower, averaging ~4 m s⁻¹. Temperatures ranged from 17°C to 26°C with an average of around 20°C. The coolest day occurred on 6-20 (average temperature ~13°C); it was also the most windy (~8 m s⁻¹). Skies were cloudy (scattered) and relative humidity was high (~85%).

Averaged values of dry-bulb temperature, relative humidity, and wind speed and direction were computed and synthesized from data obtained from the 10-m meteorological tower, tethered balloon system and the PG&E on-plant meteorological facility.

Hourly and 10-min averaging periods were chosen. The hourly meteorological data are displayed in Table 13; the averages are centered on the hour. The 10-min averages are given in Appendix C, Meteorological Summaries.

Vertical profiles of temperature, wind and relative humidity were also derived from the tethered balloon system measurements. These data are also summarized in Appendix C. Generally, wind speeds were too great to effectively use the system.

TABLE 13. Hourly Average Meteorological Data
for the Pittsburgh Power Plant Site
During the June METER Drift Study

Date	Time(PST) ¹	Temp. (C°)	R.H.(%)	Wind Speed (ms ⁻¹)	Wind Direc.(°)
15 June	0700	14.6	65.7	4.5	258.3
	0800	16.8	57.7	4.8	256.7
	0900	19.0	50.0	4.7	251.7
	1000	20.7	46.3	4.5	206.7
	1100	21.8	45.7	4.7	281.7
	1200	22.4	45.7	5.6	295.0
	1300	23.0	43.7	6.2	298.3
	1400	23.5	41	6.8	300.4
	1500	25.2	43	6.8	295.6
	1600	26.3	40	6.8	275.3
	1700	26.8	30	6.3	248.9
	1800	24.7	35	7.2	219.6
16 June	0700	14.9	68.7	4.1	266.7
	0800	16.8	61.3	4.4	266.7
	0900	19.0	52.0	4.8	265.0
	1000	21.1	45.0	4.8	266.7
	1100	22.8	40.7	5.1	268.3
	1200	24.1	37.3	5.0	278.3
	1300	25.0	34.7	5.0	388.3
17 June	0700	17.4	59.0	2.7	156.7
	0800	18.7	56.7	2.1	191.7
	0900	20.2	56.3	3.0	253.3
	1000	21.3	55.7	4.1	290.4
	1100	22.8	54.7	5.0	295.0
	1200	24.3	47.0	5.4	292.5
	1300	26.1	36.7	5.4	292.5
18 June	0700	14.8	71.0	7.2	235.0
	0800	15.7	67.0	7.2	232.3
	0900	16.8	63.0	7.0	236.7
	1000	17.9	60.0	7.0	240.0
	1100	19.4	55.7	7.0	245.0
	1200	20.7	52.7	7.5	253.3
	1300	21.8	50.0	7.7	256.7
19 June	0700	14.9	80.3	4.3	267.5
	0800	17.2	71.3	4.1	260.0
	0900	19.4	63.0	4.4	253.3
	1000	21.7	54.7	4.5	253.3
	1100	23.0	53.0	5.4	268.3
	1200	23.8	53.0	6.2	285.0
	1300	24.1	52.3	5.9	298.4

TABLE 13. (Continued)

Date	Time (PST) ¹	Temp. (C°)	R.H.(%)	Wind Speed (ms ⁻¹)	Wind Direc.(°)
20 June	0700	12.9	85.3	7.2	237.1
	0800	12.6	87.7	7.2	237.4
	0900	12.6	90.0	7.5	240.0
	1000	13.3	86.7	8.0	242.3
	1100	14.6	80.0	7.7	247.0
	1200	15.7	71.7	7.5	245.0
	1300	17.2	65.0	6.9	244.4
21 June	0700	14.4	79.3	4.1	265.0
	0800	16.1	73.3	4.1	250.4
	0900	17.7	67.0	6.3	245.3
	1000	19.6	60.3	6.2	245.0
	1100	21.3	55.0	6.3	245.7
	1200	23.0	50.0	5.4	246.0
	1300	23.7	46.0	5.4	270.0
22 June	0700	14.6	72.4	6.3	211.4
	0800	15.7	69.5	5.6	227.0
	0900	16.8	67.3	6.8	247.5
	1000	18.5	60.4	6.8	245.0
	1100	20.7	55.2	6.3	246.4
	1200	22.4	49.1	6.3	252.4
	1300	23.0	48.0	8.1	255.8
23 June	0700	14.0	80.1	6.3	244.0
	0800	14.6	80.0	9.9	245.6
	0900	15.7	74.0	12.0	243.2
	1000	17.4	68.9	11.0	244.5
	1100	19.0	61.4	8.3	248.0
	1200	20.7	53.9	6.5	236.0
	1300	22.4	47.4	7.0	230.3
24 June	0700	13.4	75.0	9.0	235.0
	0800	14.6	68.6	6.5	249.7
	0900	16.8	61.4	8.3	238.0
	1000	18.5	52.3	9.0	256.0
	1100	20.2	47.1	7.7	250.2
	1200	22.4	42.3	7.2	248.0
	1300	23.1	39.7	7.0	254.7

¹ Averages centered on the hour.

DRIFT DEPOSITION

Droplet Deposition Patterns

The results of the SP interrogations for the first 6 test runs and the near tower test (test run x) are listed in Tables 14-20 and shown in Figs. 13-18. Detailed droplet spectra are found in Appendix E, Tables E1.1 - E1.X. Peak drift droplet mass deposition rates for each of the test runs are shown in Fig. 19 as a function of downwind distance.

Before discussing each individual test run, some additional comments on analysis procedures and interpretations not covered earlier are in order. In the tabulations and graphs, a range of values for the droplet mass deposition rates is given. This range of values arises from several considerations.

To begin with, a majority of the SP interrogations had been completed before the completion of the SP calibration study. For these interrogations, the relationship (calibration equation) between true droplet size and stain width or diameter was the curve supplied by Meyer for droplets settling at terminal velocity at normal incidence (see Fig. 8). Furthermore, measured stain widths were overestimated because the droplet stains and streaks were not all aligned along the mean axis of the SP. Several interrogation tests were carried out subsequent to the calibration study to examine this effect in detail. The results of these tests are shown in Fig. 20.

For the interrogation test the SP sample, 0A-2 (Tilt) of 6-21-78, was reanalyzed. ESC evaluated the droplet size distribution of this SP using their own analysis methods and calibration curve (terminal droplet settling velocity at normal incidence). Their results are shown in Fig. 20 as curve a. For comparison, the first PNL interrogation (10-27-78) results are shown as curve b (note that the ordinate explicitly shows a deposition rate, independent of analysis area). Several differences are immediately obvious; these are:

TABLE 14. Drift Droplet Deposition Patterns for Test Run 1, 6-16-78
(see Table E1.1 for detailed droplet spectra)

Sample ID	Sample Interval			SP Stain Analysis					Deposition Rate		
	Start (PDT)	Stop (PDT)	Δt (hr)	Area (m ²)	Method	Number	Mass L (μ g)	Mass U (μ g)	Number (m ⁻² ·hr ⁻¹)	Mass L (mg·m ⁻² ·hr ⁻¹)	Mass U (mg·m ⁻² ·hr ⁻¹)
UA	0845	1150	3.08			0	0	0	0	0	0
OA	0840	1147	3.12	.0507	F	16	334	373	101	2.1	2.4
OB _N -2	0830	0917	0.783	.0499	F	297	14900	41200	7600	381	1050
OB _N	0924	1114	1.83	.0500	F	91	3670	7860	995	40	86
OB _S -1	0835	0922	0.783	.0496	F	616	26800	56100	15900	690	1440
OB _S -2	0918	1046	1.47	.0500	A	704	37800	87400	9600	514	1190
OC	0823	1107	2.73	.0498	F	409	17900	37800	3010	132	278
OD	0825	1108	2.72	.0501	F	73	1880	3300	536	14	24
OE	0902	1203	3.02			0	0	0	0	0	0
1A	0823	1121	2.97	.0487	A	35	470	724	242	3.2	5.0
1B	0818	1113	2.92	.0506	F	118	5430	7740	800	37	52
1C-1	0813	0927	1.23	.0498	F	415	24400	54700	6780	400	890
1C-2	0928	1110	1.70	.0506	F	113	11100	27600	1310	129	321
1D	0808	1105	2.95	.0495	F	431	23200	44800	2950	159	307
1E	0750	1125	3.58	.0492	F	73	1670	2660	414	9.5	15
1F	0745	1130	3.75	.0493	A	21	210	319	114	1.1	1.7
1G	0753	1117	3.40	.0487	A	6	28	31	36	0.17	0.19
1I	0912	1204	2.85	.0482	A	35	871	1830	255	6.3	13
1J	0917	1212	2.92	.0487	A	2	17	22	27	0.12	0.16
2A	0829	1135	3.10	.0492		0	0	0	0	0	0
2B	0834	1140	3.10	.0497	A	1	1.8	2.5	6	0.012	0.016
2E	0805	1122	3.28	.0495	A	53	723	993	326	4.4	6.1
2F	0805	1121	3.27	.0491	A	20	766	1395	125	4.8	8.7
2G	0811	1126	3.25	.0497	A	1	1.8	2.5	6	0.011	0.015
2H	0810	1129	3.32	.0492	A	1	1.8	2.5	6	0.011	0.015
2I	0806	1126	3.33			0	0	0	0	0	0
2J	0802	1124	3.37			0	0	0	0	0	0
2K	0759	1119	3.33			0	0	0	0	0	0
3A	0754	1138	3.73	.0487	A	31	1150	2260	171	6.3	12
3B	0755	1140	3.75	.0484	A	24	762	1890	132	4.2	10.4
3C	0820	1135	3.25	.0495	A	8	124	160	50	0.77	1.0
3E	0815	1132	3.28			0	0	0	0	0	0
3F	0810	1128	3.30	.0498	A	1	40	56	6	0.24	0.34

TABLE 15. Drift Droplet Deposition Patterns for Test Run 2, 6-17-78
(see Table E1.2 for detailed droplet spectra)

Sample ID	Sample Interval			SP Stain Analysis					Deposition Rate		
	Start (PDT)	Stop (PDT)	Δt (hr)	Area (m^2)	Method	Number	Mass L (μg)	Mass U (μg)	Number ($m^{-2} \cdot hr^{-1}$)	Mass L ($mg \cdot m^{-2} \cdot hr^{-1}$)	Mass U ($mg \cdot m^{-2} \cdot hr^{-1}$)
0A	0945	1304	3.32			0	0	0	0	0	0
0BN	0941	1221	2.67			0	0	0	0	0	0
0C	0935	1308	3.55	.0490	A	2	68	96	11.5	0.39	0.55
1C	0842	1301	4.32			0	0	0	0	0	0
1D-1	0846	1001	1.25	.0483	A	630	17200	32100	10400	285	532
1D-2	1002	1239	2.62	.0496	A	215	9460	18700	1650	73	144
1E	0922	1243	3.35	.0495	F	150	2770	4070	905	17	25
1F	0930	1247	3.28	.0495	F	35	1790	4140	220	11	25
1AA						0	0	0	0	0	0
1AB	0907	1255	3.80			0	0	0	0	0	0
1AC	0903	1251	3.80			0	0	0	0	0	0
1AD	0852	1230	3.63	.0496	F	70	4230	10300	390	23	57
1AE	0923	1223	3.00	.0492	F	199	5840	10900	1350	40	74
1AF	1036	1306	2.50	.0482	F	5	129	201	41	1.1	1.7
2E	0858	1305	4.12			0	0	0	0	0	0
2F	0847	1308	4.35			0	0	0	0	0	0
2G	0851	1310	4.32	.0492	F	7	110	140	33	0.52	0.66
2H	0854	1313	4.32	.0495	F	8	179	265	37	0.84	1.24
3B	0912	1233	3.35			0	0	0	0	0	0
3C	0902	1243	3.68			0	0	0	0	0	0
3E	0906	1251	3.75			0	0	0	0	0	0

TABLE 16. Drift Droplet Deposition Patterns for Test Run 3, 6-15-78
(see Table E1.3 for detailed droplet spectra)

Sample ID	Sample Interval			SP Stain Analysis					Deposition Rate		
	Start (PDT)	Stop (PDT)	Δt (hr)	Area (m^2)	Method	Number	Mass L (μg)	Mass U (μg)	Number ($m^{-2} \cdot hr^{-1}$)	Mass L ($mg \cdot m^{-2} \cdot hr^{-1}$)	Mass U ($mg \cdot m^{-2} \cdot hr^{-1}$)
UA	1331	1528	1.93	.0498	F	1		56	10		0.6
OBN	1255	1515	2.33			0	0	0	0	0	0
OBS	1252	1510	2.30			0	0	0	0	0	0
OC	1246	1440	1.90	.0504	F	200	9550	20000	2090	100	210
OD	1240	1444	2.07	.0488	F	504	12900	21900	4990	128	217
OE	1236	1449	2.22			0	0	0	0	0	0
1C	1252	1517	2.42			0	0	0	0	0	0
1D	1250	1446	1.93	.0481	F	179	6940	14100	1930	75	152
1E	1245	1440	1.92	.0488	F	108	2870	5070	1150	31	54
1F	1240	1505	2.42			0	0	0	0	0	0
1G	1251	1506	2.25	.0484	F	17	440	722	156	4.0	6.6
1I	1231	1457	2.43	.0471	F	23	770	1430	201	6.7	12.5
1J	1234	1456	2.37	.0481	F	5	170	260	44	1.5	2.3
2B	1258	1513	2.25			0	0	0	0	0	0
2E	1301	1533	2.53			0	0	0	0	0	0
2F	1305	1535	2.50			0	0	0	0	0	0
2G	1305	1536	2.52			0	0	0	0	0	0
2H	1308	1547	2.65	.0476	F	7	370	660	55	2.9	5.2
2I	1338	1518	1.67			0	0	0	0	0	0
2J	1257	1514	2.28			0	0	0	0	0	0
3A	1310	1520	2.17			0	0	0	0	0	0
3B	1314	1525	2.18			0	0	0	0	0	0
3C	1308	1527	2.32			0	0	0	0	0	0
3E	1305	1523	2.30			0	0	0	0	0	0
3F	1302	1521	2.30			0	0	0	0	0	0

TABLE 17. Drift Droplet Deposition Patterns for Test Run 4, 6-21-78
(see Table E1.4 for detailed droplet spectra)

Sample ID	Sample Interval			SP Stain Analysis					Deposition Rate		
	Start (PDT)	Stop (PDT)	Δt (hr)	Area (m ²)	Method	Number	Mass L (μ g)	Mass U (μ g)	Number (m ⁻² ·hr ⁻¹)	Mass L (mg·m ⁻² ·hr ⁻¹)	Mass U (mg·m ⁻² ·hr ⁻¹)
OA-1	0842	0915	0.55	.0477	F	681	15900	26500	26000	610	1010
OA-2	0920	0959	0.65	.0464	F	649	15000	24700	21500	500	820
OA-3	1007	1118	1.18	.0472	F	697	17900	30900	12500	320	550
OA-4	1124	1246	1.37	.0470	F	139	3570	7740	2160	56	120
OBN	0908	1216	3.13	.0472	F	735	25400	53500	4970	172	360
OBS	0901	1221	3.33	.0480	F	129	8780	20400	810	55	128
1ZZ	1140	1252	1.20			0	0	0	0	0	0
1Z	1016	1258	2.70	.0475	F	13	220	290	101	1.7	2.3
1Y	0840	1247	4.12	.0484	F	40	910	1320	200	4.6	6.6
1A	0850	1252	4.03	.0475	F	22	630	1020	115	3.3	5.3
1B	0854	1255	4.02	.0467	F	18	460	710	96	2.5	3.8
1C	0900	1301	4.02	.0470	F	11	191	246	58	1.0	1.3
1AZ	0841	1247	4.10	.0474	F	21	590	900	108	3.0	4.6
1AA	0850	1253	4.05	.0472	F	16	460	800	84	2.4	4.2
1AB	0855	1258	4.05	.0468	F	23	670	1130	121	3.5	6.0
1AC	0901	1302	4.02	.0474	F	16	720	1290	84	3.8	6.8
2A	0908	1303	3.92	.0473	F	11	210	280	59	1.1	1.5
2B	0911	1307	3.78			0	0	0	0	0	0
OA-1 Tilt	0846	0915	0.48	.0481	F	1761	44900	90200	76000	1900	3900
OA-2 Tilt ¹	0919	0959	0.67	.0330	F	1373	35300	60300	62000	1600	2700
OA-2 Tilt ¹	0919	0959	0.67	.0333	F	1965	32100	77600	88000	1450	3500
OA-2 Tilt ¹	0919	0959	0.67	.0333	F	1890	28800	56800	85000	1300	2600
OA-2 Tilt ¹	0919	0959	0.67	.0353	F	4880	42200	85900	220000	1900	3900
OA-2 Tilt ¹	0919	0959	0.67	.0333	F	4200	33200	67400	189000	1500	3000
OA-2 Tilt ¹	0919	0959	0.67	.0333	ESC	3638	20500	-	164000	920	-
OA-3 Tilt	1007	1118	1.18	.0315	F	1433	30800	61800	38000	830	1700
OA-4 Tilt	1124	1245	1.35	.0479	F	254	6590	13100	3930	102	203

¹See text and Table E1.4 for discussion of these values.

TABLE 18. Drift Droplet Deposition Patterns for Test Run 5, 6-18-78
(see Table E1.5 for detailed droplet spectra)

Sample ID	Sample Interval			SP Stain Analysis					Deposition Rate		
	Start (PDT)	Stop (PDT)	Δt (hr)	Area (m^2)	Method	Number	Mass L (μg)	Mass U (μg)	Number ($m^{-2} \cdot hr^{-1}$)	Mass L ($mg \cdot m^{-2} \cdot hr^{-1}$)	Mass U ($mg \cdot m^{-2} \cdot hr^{-1}$)
0A	0819	1223	4.07			0	0	0	0	0	0
0C	0813	1215	4.03			0	0	0	0	0	0
1Z	0846	1229	3.72	.0465	F	9	120	159	52	0.69	0.92
1Y-1	0845	1039	1.90	.0460	F	367	13400	29200	4200	153	334
1Y-2	1043	1214	1.52	.0456	F	59	1280	1920	850	18	28
1A-1	0837	1012	1.58	.0469	F	477	18300	37100	6400	250	500
1A-2	1015	1128	1.22	.0451	F	418	17800	37700	7600	320	690
1A-3	1128	1208	0.67	.0454	F	150	4580	9230	4950	151	305
1B-1	0900	1007	1.12	.0456	F	715	26500	55600	14000	520	1090
1B-2	1009	1121	1.20	.0467	F	477	17200	33100	8500	310	590
1B-3	1122	1216	0.90	.0459	F	353	13000	34300	8500	310	830
1C	1000	1208	2.13	.0459	F	176	6780	15100	1800	69	154
1AZ	0831	1219	3.80	.0463	F	70	2160	4040	400	12	23
1AA-1	0837	1031	1.90	.0461	F	643	32700	71100	7300	370	810
1AA-2	1033	1222	1.82	.0454	F	160	5270	10300	1940	64	125
1AB	0928	1202	2.57	.0464	F	209	12100	27800	1750	101	233
2A	0829	1225	3.93	.0458	F	98	2780	4930	540	15	27
2B	0834	1229	3.92	.0461	F	230	7010	16000	1270	39	89

TABLE 19. Drift Droplet Deposition Patterns for Test Run 6, 6-22-78
(see Table E1.6 for detailed droplet spectra)

Sample ID	Sample Interval			SP Stain Analysis					Deposition Rate		
	Start (PDT)	Stop (PDT)	Δt (hr)	Area (m ²)	Method	Number	Mass L (μg)	Mass U (μg)	Number (m ⁻² ·hr ⁻¹)	Mass L (mg·m ⁻² ·hr ⁻¹)	Mass U (mg·m ⁻² ·hr ⁻¹)
OA-1	0820	0853	0.55	.0464	F	637	14300	25400	25000	560	1000
OA-2	0859	0955	0.93	.0466	F	1148	29900	58100	26400	690	1340
OA-3	1001	1052	0.85	.0457	F	767	14700	25900	19700	380	670
OA-4	1057	1146	0.82	.0463	F	577	10100	16700	15300	270	440
OBN-1	0808	0946	1.63	.0456	F	897	24400	48300	12000	330	650
OBN-2	0950	1045	0.92	.0462	F	1064	37200	80900	25100	880	1910
OBN-3	1047	1154	1.12	.0451	F	726	21900	43100	14400	430	850
OBS	0803	1159	3.93	.0468	F	37	520	760	201	2.8	4.1
1ZZ	0827	1204	3.62	.0455	F	693	16600	29300	4210	101	178
1Z	0759	1150	3.85	.0450	F	281	4930	7850	1620	28	45
1Y-1	0804	0938	1.57	.0456	F	712	12800	21400	9900	179	300
1Y-2	0941	1157	2.27	.0413	F	686	11700	18900	7300	125	202
1A-1	0808	0928	1.33	.0342	F	1112	32000	61600	24400	700	1350
1A-2	0934	1052	1.30	.0464	F	849	19500	33100	14100	320	550
1A-3	1108	1201	0.88	.0415	F	441	8700	15500	12000	240	420
1B-1	0812	0907	0.92	.0460	F	668	19800	39800	15800	470	940
1B-2	0918	1004	0.77	.0338	F	1037	32700	67400	40000	1260	2600
1B-3	1013	1054	0.68	.0450	F	788	30800	69500	25600	1000	2260
1C	0819	1210	3.85			0	0	0	0	0	0
1AZ	0814	1148	3.57	.0462	F	212	5030	8950	1290	31	54
1AA	0809	1113	3.07	.0461	F	1018	30900	60200	7200	220	425
1AB	0803	1155	3.87	.0464	F	130	3610	6180	720	20	34
1AC	0820	1200	3.67			0	0	0	0	0	0
2A	0819	1205	3.77	.0456	F	134	2870	4950	780	17	29
2B	0824	1209	3.75	.0458	F	331	10600	22100	1930	62	129
OA-1 Tilt	0820	0853	0.55	.0333	F	1333	34200	68100	73000	1870	3720
OA-2 Tilt	0859	0955	0.93	.0166	F	991	32100	64400	64000	2070	4160
OA-3 Tilt	1001	1052	0.85	.0342	F	1380	37300	74500	47400	1280	2560
OA-4 Tilt	1057	1146	0.82	.0232	F	1077	33700	50800	57000	1780	2680
1A Tilt	0934	1051	1.28	.0226	F	1067	29200	58500	36900	1010	2020
1B-1 Tilt	0918	1004	0.77	.0342	F	1607	61800	150000	61000	2360	5720
1B-2 Tilt	1013	1054	0.68	.0459	F	1091	56100	132000	34800	1790	4210
1B-3 Tilt	1105	1204	0.98	.0337	F	1395	69900	140000	42100	2110	4230

TABLE 20. Drift Droplet Deposition Patterns for Test Run X, 6-25-78
(see Table E1.X for detailed droplet spectra)

Sample ID	Sample Interval			SP Stain Analysis					Deposition Rate		
	Start (PDT)	Stop (PDT)	Δt (hr)	Area (m^2)	Method	Number	Mass L (μg)	Mass U (μg)	Number ($m^{-2} \cdot hr^{-1}$)	Mass L ($mg \cdot m^{-2} \cdot hr^{-1}$)	Mass U ($mg \cdot m^{-2} \cdot hr^{-1}$)
1-1-SU	0912	0942	0.50	.0134	F	21	510	770	3130	76	115
1-1-N	0826	0843	0.28	.0130	F	147	51000	143000	40500	14000	39000
1-1-S	0828	0844	0.27	.0130	F	129	14200	42400	37200	4100	12000
1-2-N	0832	0839	0.12	.0134	F	89	60000	168000	55000	37000	104000
1-2-S	0830	0837	0.12	.0131	F	284	34600	88800	185000	23000	58000
1-3-N	0848	0856	0.13	.0132	F	326	54400	145000	191000	32000	85000
1-3-S	0846	0854.5	0.14	.0135	F	231	45900	124000	121000	24000	65000
1-4-N	0851	0859	0.13	.0131	F	188	48000	124000	111000	28000	73000
1-7-N	0904	0909	.083	.0125	F	82	223000	63300	79000	21000	61000
1-7-S	0902	0906	.067	.0132	F	136	58000	161000	154000	66000	182000
1-13-G	0914	0944	0.50	.0134	F	111	25800	46800	17000	3900	7000
1-13-GS	0918	0942	0.40	.0131	F	112	38600	105000	21000	7400	20000

FIGURE 13. Drift Droplet Mass Deposition Pattern for Test Run 1, 6-16-78, with Both Towers Operating

FIGURE 14. Drift Droplet Mass Deposition Pattern for Test Run 2, 6-17-78, with Tower 7-1 Operating Only

FIGURE 15. Drift Droplet Mass Deposition Pattern for Test Run 3, 6-15-78, with Both Towers Operating

FIGURE 16. Drift Droplet Mass Deposition Pattern for Test Run 4, 6-21-78, with Tower 7-2 Operating Only

FIGURE 17. Drift Droplet Mass Deposition Pattern for Test Run 5, 6-18-78, with Tower 7-1 Operating Only

FIGURE 18. Drift Droplet Mass Deposition Pattern for Test Run 6, 6-22-78, with Both Towers Operating

FIGURE 19. Peak Drift Droplet Mass Deposition Rate as a Function of Downwind Distance for Test Runs 1-6

FIGURE 20. Comparison of Drift Droplet Size Spectra Obtained by Various Interrogations of SP Sample OA-2 (Tilt), 6-21-78. Curves a-d are discussed in the Text

- the ESC spectrum covers a larger size range, $\sim 20\text{--}1000\text{ }\mu\text{m}$ than the PNL spectrum, $\sim 150\text{--}1500\text{ }\mu\text{m}$;
- droplet count at the low end ($\sim 200\text{ }\mu\text{m}$) of the PNL spectrum is lower than the ESC values;
- although the shape of the curves are similar for diameter $\geq 300\text{ }\mu\text{m}$, the PNL curve is shifted to larger diameters by a factor of 1.5, which would result in a grossly larger estimate of droplet mass.

The PNL interrogation of 10-22-78 was corrected to the ESC calibration curve (see Fig. 8 for terminal droplet settling velocity at normal incidence). The results of this correction are shown as curve c which is nearly indistinguishable from curve b.

Results of the reanalysis of this same SP by PNL (4-10-79) over the size range, $50\text{--}1500\text{ }\mu\text{m}$ are shown as curve d. It is seen that the droplet counts were increased considerably below $400\text{ }\mu\text{m}$ with the extended range when compared to the earlier result (curve b). (The Quantimet operator noted that stain contrast had improved considerably between the October 1978 and April 1979 interrogations so that the smaller stains were easier to read.) The offset between the ESC and PNL curves by a factor of ~ 1.5 still exists, even though the number and the curve shape are more compatible. The reason for this difference does not appear to be related to differences in calibration curves but rather measurement procedure.

Since the ESC analysis method (light pen/minicomputer) differs considerably from the PNL chord width method (Quantimet/Feret), the differences are most likely the result of differences in measurement of the streak or stain widths. This condition also suggests that the directional distribution of stain axes on the SPs, which could not be accommodated by the automated PNL system, resulted in droplet spectra that were shifted towards larger droplets.

Short of a costly reanalysis of all of the SPs, it was decided to adjust the results of the interrogations and to interpret the original PNL measured spectra using the Meyer calibration as an upper bound on the droplet mass (mass U in Tables 14-20) and the adjusted spectra as a lower bound (mass L in Tables 14-20). The adjustment consisted of recomputing the stain size from the Meyer calibration, reducing the stain size by a factor which would bring curves a and d of Fig. 20 into congruence (this same factor was used throughout) and to use the calibration curve (Fig. 9) appropriate for the wind speed conditions encountered during a given test. The calibration curve is approximated by

$$D_d = A D_s^b ,$$

where

D_d = true droplet diameter

D_s = measured stain diameter or width

A,b = empirical constants to fit the data.

The empirical constants are found from Fig. 21 for the appropriate wind speed (see Appendix C for additional discussion). With these comments in mind, the individual test runs can be discussed.

Test Run 1, 6-16-78 (Fig. 13, Table 14). Both towers were operating during this run. Arcs 0, 1, 2 and 3 were set up for sampling. The drift plume centerline appeared to lie between 90° and 100° (recall that 0° is North). In Fig. 13, arc 0 is referenced to Tower 7-2 while the other arcs are referenced to Tower 7-1. The curve for arc 1 shows, in addition to the main peak at 95°, a smaller peak at ~160°. If this portion of the arc 1 curve is referenced instead to Tower 7-2, the peak shifts over to 110-120°. This result is also shown in Fig. 13 on the same vertical scale as for arc 2. It is apparent that this peak is the result of contributions from Tower 7-2.

FIGURE 21. Empirical Constants a and b for the Calibration Equation $D_d = A D_s^b$ as a Function of Wind Speed

Test Run 2, 6-17-78 (Fig. 14, Table 15). Only Tower 7-1 was operating. The drift plume centerline appeared to be 110° , in agreement with winds from the WNW. Arc 1A was installed in time for this test run in order to define drift entering the electrical switch yard area. No droplets were observed at arc 3.

Test Run 3, 6-15-78 (Fig. 15, Table 16). Chronologically this was the first test run and was the only afternoon test. During this run, both towers were operating. The mineral mass deposition collections were of poor quality but the droplet data showed a distinct separation between Towers 7-1 and 7-2, especially for arc 1. As above for test run 1, when arc 1 is referenced to Tower 7-1, a smaller second peak appears at $\sim 160^\circ$, which shifts to $\sim 120^\circ$ when referenced to Tower 7-2. With winds out of 300° , the expected centerline should be around 120° , which is observed.

Test Run 4, 6-21-78 (Fig. 16, Table 17). With only Tower 7-2 operating and the winds from the 245° direction, the drift plume was observed out to $3/4$ km with very few structural interferences.

Test Run 5, 6-18-78 (Fig. 17, Table 18). Again only single tower operation (7-1) with relatively high winds ($\sim 7 \text{ ms}^{-1}$) at $\sim 245^\circ$.

Test Run 6, 6-22-78 (Fig. 18, Table 19). Both towers were operating with winds at $\sim 6 \text{ ms}^{-1}$ from the 250° direction. Contributions from Tower 7-2 are barely apparent on the arc 1 curve near 40° (referenced to Tower 7-1).

Test Run X, 6-25-78 (Fig. 19, Table 20). The sampling positions for this near tower test (mostly on the fan deck) are shown in Fig. 22. No mineral mass deposition data has been analyzed for this run. Winds were at 5.4 ms^{-1} from the $270 \pm 10^\circ$ direction while the temperature averaged $15.6 \pm 1^\circ \text{C}$ with an relative humidity of $66 \pm 4\%$ during the test run.

The peak droplet mass deposition values in Fig. 19 for each test run as a function of downwind show remarkable similarities as well as differences. The slopes of the lines are roughly the same when both towers are operating and decrease exponentially at $\sim \exp(-10x)$, where x is the downwind distance. For single-tower operation the slopes are again similar

FIGURE 22. Sampling Geometry for the Near Tower Drift Test, Test Run X, 6-25-78, Tower 7-1. The Dots (•) Show the Sampling Locations; the Numbers Identify Them

but larger than the two-tower value, decreasing exponentially at $\sim \exp(-15x)$. In the cases where both towers were operating, it was also possible to infer values from Tower 7-2, as discussed above; these values are also included in Fig. 19.

Deposition values at .2 km are nearly a factor of 10 larger for test run 1 than for test run 3. Mean temperatures, relative humidities and wind speeds were 18.4 and 23.6°C, 55 and 43%, and 4.8 and 6.6 m s⁻¹, respectively during runs 1 and 3. Plant loads were 680 and 520 MWe, respectively, during the tests. Modeling studies would be required to discern which of these factors played a dominant role in the downwind drift deposition. Deposition values for the other test runs were found between these two extremes.

Mineral Ion Deposition Patterns

The results of chemical analysis of the bulk deposition samples for test runs 1-6 are shown in Figs. 23-28 for Na⁺ ion. Detailed listing of the mineral ion deposition rates are found in Appendix E, Tables E2.1-E2.6, for the ions SO₄²⁻, NO₃⁻, Cl⁻, Na⁺, K⁺, Ca⁺⁺ and Mg⁺⁺. Peak sodium drift mass deposition rates for each test run are shown in Figs. 29-31 as a function of downwind distance. (The conversion factor, 1 μg·m⁻²·hr⁻¹ = 0.72 kg·km⁻²·mo⁻¹, was used for the ordinate in Figs. 29-31.) The results for the test runs are grouped according to single or double tower operation.

Inspection of Figs. 23-31 and Tables E2.1-E2.6 for the mineral mass data in comparison to Figs. 13-19 for the droplet data shows that the mineral mass deposition was much more irregular and variable than the droplet deposition. This variability is mainly due to background deposition and sample contamination arising from a variety of sources. Since the droplets are detected by the SPs by virtue of their water content, only particles that contain water produce an image; these presumably must originate from the cooling towers. (Only a few examples of droplets arriving from sources other than the cooling towers were observed -- once from the spray canal and once from Suisun Bay.) Dry particles, drift or otherwise, produce no stain on the SPs.

FIGURE 23. Sodium Drift Mass Deposition Pattern for Test Run 1, 6-16-78, with Both Towers Operating

FIGURE 24. Sodium Drift Mass Deposition Pattern for Test Run 2, 6-17-78, with Tower 7-1 Operating Only

FIGURE 25. Sodium Drift Mass Deposition Pattern for Test Run 3, 6-15-78, with Both Towers Operating

FIGURE 26. Sodium Drift Mass Deposition Pattern for Test Run 4, 6-21-78, with Tower 7-2 Operating Only

FIGURE 27. Sodium Drift Mass Deposition Pattern for Test Run 5, 6-18-78, with Tower 7-1 Operating Only

FIGURE 28. Sodium Drift Mass Deposition Pattern for Test Run 6, 6-27-78, with Both Towers Operating

FIGURE 29. Sodium Drift Deposition Rate as a Function of Downwind Distance for Test Run 1, 6-16-78, with Both Towers Operating. Experimental Values are Compared to Those Calculated by ESC for a Droplet Salinity of a) 750 ppm and b) 250 ppm

FIGURE 30. Sodium Drift Deposition Rates as a Function of Downwind Distance for Test Runs 2, 4 and 5 for Single Tower Operation Only

FIGURE 31. Sodium Drift Deposition Rates as a Function of Downwind Distance for Test Runs 3 and 6, with Both Towers Operating

The bulk deposition collectors (buckets) however cannot distinguish whether or not the collected particles are wet or dry nor can they distinguish the origin of the deposited particles. Consequently the material collected in the buckets may arise from drift, background sources or local contamination such as dust from vehicular traffic or dust resuspended from the ground by wind gusts. As discussed earlier the samples were analyzed for a variety of potential tracer ions so that some redundancy would be available to distinguish drift from background. A description of the procedure used to separate drift from the background follows.

A special program was developed that maximizes a linear function specified by the user, subject to some set of linear constraints. The linear programming subroutine was implemented in the analysis. The function maximized was the sum of sixteen variables, a background mass and a deposited drift mass for each of the eight ions measured. When this function equaled the sum of all the masses in a bucket, then all the ions were accounted for, either as background or as deposited mass. The total mass in the bucket was decreased by the amount due to handling with any negative quantities set to zero. The handling masses were obtained by the average of six handling samples or blanks. Each sampling station was treated independently. All variables were taken to be greater than or equal to zero.

The linear constraints imposed were:

- For each ion the deposited mass from background plus the drift mass must be less than or equal to the total mass of that ion in the bucket. This constraint gave eight equations, one for each ion.
- The ion mass arising from background must be less than or equal to a maximum average background value. The maximum average background values were obtained by averaging the buckets assumed not to have any drift ion mass, which were usually buckets outside the plume trajectory. Again, the handling mass was subtracted from the maximum average background values. This gave another set of eight equations, one for each ion.

- Constraints on the ratio of the mass of Na to the other seven ions were also imposed. It was assumed that the ratios of the deposited drift ion masses in each bucket should be close to the ratios of the ion concentrations in the canal and basin water samples. An average value for this ratio was obtained by averaging the canal and basin samples taken on the day of each test (see Appendix A). A maximum value for these ratios was set at 20% above the average values, which gave seven equations, one for each of the seven ions ratioed to Na.
- A lower bound was set on the ratios also:
 - For NO_3 , NH_4 , and K, the lower bound was set at zero.
 - For SO_4 , Cl, Ca, and Mg, the lower bound was set at 20% below the average values.

This constraint gave seven equations, one for each ion ratioed to Na.

There were 31 equations in all, one maximizing equation and 30 constraint equations. The linear programming routine thus solved a set of 31 equations with 16 unknowns. The results of this analysis are listed in Tables E2.1-E2.6 for each of the test runs. It should be noted that in many instances the sum of the drift and background values for a given station does not equal the total for that sample. The residual not accounted for could be interpreted as additional background or additional drift and thus could provide a variance estimate for the drift mass value. It is noticed readily that bucket-to-bucket and station-to-station variability was quite large in many cases.

Run 1, 6-16-78 (Fig. 23). Sodium ion mineral mass deposition patterns for each arc resemble those for the droplet pattern of Fig. 13, except that the data are much more ragged as mentioned above. It appears that contributions from Tower 7-2 can be discerned in these data also. The

shadowing effect of the switchyards also appears on the data for arc 2. Patterns for the other major ions, SO_4^{--} , Cl^- , Ca^{++} and Mg^{++} , exhibit behaviour similar to that of sodium as a consequence of the linear programming analysis. The other ions, NO_3^- , NH_4^+ and K^+ , did not appear to provide suitable tracers of the drift. Little NO_3^- was found in the basin water, but variable amounts were found in the deposition buckets, indicating that it originated from nearby soil elements or sources upwind.

Run 2, 6-17-78 (Fig. 24). Drift patterns appear to be consistent with winds from the 285° direction. Anomalously large values for two stations on arc 1A are seen. No comments on potential contamination were noted. The deposition pattern for arc 2 (as was the case in run 1) appears to be too low, indicating possible interference from the 240-kv switchyard.

Run 3, 6-15-78 (Fig. 25). Mineral mass deposition collections for this test run were very poor as many of the receptor buckets blew out of their holders. (This occurrence prompted the use of strips of masking tape to secure the buckets in subsequent runs.) Consequently, while the droplet deposition patterns were of acceptable quality, the mineral mass data from this run were of poor quality. This run was analyzed primarily because of the droplet data.

Run 4, 6-21-78 (Fig. 26). The winds were from around the 250° direction, which meant that the only significant interference for the drift from Tower 7-2 was Tower 7-1; the electrical switchyards were for the most part outside (south) of the plume. Mineral mass drift deposition values appear to be too large for arc 2 (actually only station 2B showed any drift and this value appears to be too large).

Run 5, 6-18-78 (Fig. 27). Single tower (7-1) operation with relatively high winds ($\sim 7 \text{ ms}^{-1}$). Drift was observed out to about 0.4 km.

Run 6, 6-22-78 (Fig. 28). With both towers operating, the contribution from Tower 7-2 was barely discernible in the data for arc 1. The electrical switchyard should not have influenced the drift patterns appreciably.

Peak or plume centerline deposition rates as a function of distance are shown in Figure 29 for Na^+ . Also shown are predictions made by ESC with the ESC drift deposition model for two values of the droplet salinity and the measured drift flux from the cooling towers (see preceding sections). The salinity value of 250 ppm is an average basin water value found by ESC while the 750-ppm value is one determined by ESC using the IK and SP methods for the droplets leaving the tower.

The experimental values tend to lie within the boundaries of the two curves. From a comparison of the experimental values at 1/2 and 3/4 km alone it would appear that the switchyards could have reduced the drift deposition by as much as a factor of two. This would also appear to be the case when compared to the ESC model. Values for Tower 7-2 alone were obtained from arc 0 or estimated from the apparent contributions to arcs 1, 2 and 3. In general the values appear to be larger after the same distances than the apparent contribution from Tower 7-1; this indicates that, even though 3 fans were not operating, Tower 7-2 has a higher drift emission rate.

This apparent difference is also seen when the data for single tower operation are compared (see Fig. 30). In Fig. 30, deposition rates from Tower 7-2 (6-21-78) are larger than for the two cases for Tower 7-1 (6-17-78 and 6-18-78). The other two cases of two-tower operation (6-15-78 and 6-22-78) are shown in Fig. 31. The differences here probably represent the difference between morning and afternoon deposition rates, as a result of greater evaporation and consequently a larger fraction of nondepositing drift (dry particles) in the afternoon.

Similar deposition patterns were found for the other mineral ions, including Cl^- , SO_4^{--} , and Ca^{++} . Peak deposition rates had a distance dependence similar to the Na^+ . Water droplet mass deposition rate had a much steeper falloff with distance than the mineral mass; this is a reasonable expectation because of evaporation of the droplets as they travel downwind. Salinity values may be calculated from the measured peak

sodium mass and water mass deposition rates for each arc. These values for the various runs and arcs are given in Table 21. The range of values are consistent with the emission values.

The effect of decreasing relative humidity during the course of a test run was also observed with the sensitive papers. As an example, the peak droplet mass deposition rate for the 6-16 test at station 1C changed from a value of $400\text{--}890 \text{ mg}\cdot\text{m}^{-2} \text{ hr}^{-1}$ during the first 1.2 hr of the test to a value of $129\text{--}321 \text{ mg}\cdot\text{m}^{-2} \text{ hr}^{-1}$ during the next 1.7 hr. Similarly for the 6-17 test at station 1D, the droplet mass deposition rate changed from $285\text{--}532 \text{ mg}\cdot\text{m}^{-2} \text{ hr}^{-1}$ during the first 1.25 hr to $73\text{--}144 \text{ mg}\cdot\text{m}^{-2} \text{ hr}^{-1}$ during the final 2.6 hrs. Other examples are easily found in Tables 14-20.

TABLE 21. Mean Droplet Salinity Values as a Function of Downwind Distance for Each Test Run¹

Test Run No.	Date	Arc	Peak Droplet Mass Deposition Rate (mg·m ⁻² ·hr ⁻¹)	Peak Mineral Mass Deposition Rate (μg·m ⁻² ·hr ⁻¹)	Mean Droplet Na ⁺ Concentration (μg/ml or ppm)
1	6-16	0	500-1400	120-200	90-400
		1	400-900	120-200	130-500
		2	4-9	5-20	550-5000
		3	6-12	5-20	420-3000
2	6-17	1	100-500	30-50	60-500
		1A	40-75	35-55	470-1400
		2	.8-1.7	5-15	3000-dry
		3	0	5-20	dry
3	6-15	0	100-220	75-130	340-1300
		1	75-160	100-200	620-2700
		2	6-12	10-30	800-5000
		3	0	50-100	dry
4	6-21	0	300-1000	120-180	120-600
		1	4-6.6	30-80	4500-dry
		1A	3-6	30-80	5000-dry
		2	1-1.5	30-100	dry
5	6-18	1	300-1100	100-140	90-470
		1A	100-250	50-100	200-1000
		2	5-10	10-25	1000-5000
6	6-22	0	400-1300	120-180	90-450
		1	500-2500	200-300	80-600
		1A	200-450	200-280	440-1400
		2	100-200	40-100	200-1000

¹The range of salinity (Na⁺ concentration) values reflect the upper and lower mass bounds of the droplet data and the estimate variance for the mineral mass data.

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APPENDIX A

COOLING WATER MINERAL ANALYSIS

TABLE A1. Basin and Canal Water Mineral Ion Concentrations
During the June 1978 Pittsburgh Cooling Tower
Drift Study

Date	Time	Location ¹		Mineral Ion Concentration ² (μg/ml) or (ppm)							
		Tower	Cell	SO ₄ ⁻⁻	NO ₃ ⁻	Cl ⁻	NH ₄ ⁺	Na ⁺	K ⁺	Ca ⁺⁺	Mg ⁺⁺
6-15	1415	7-1	7	76	<1	108	1.8	93	7.4	17	15
	1420	7-2	7	85	<1	118	<1	111	32	17	15
	1425 ³	7-1	7	42	1.9	65	<1	48	7.5	12	7.9
	Average			68(23)	1(1)	97(28)	1(1)	84(32)	16(14)	15(3)	13(4)
6-16	0835 ³	7-1	12	99.5	<1	140	<1	123	5.4	20	16
	0945 ⁴	7-1	7	171(36)	<1	177(44)	20	146	62	18	16
	0946 ⁴	7-2	7	118(2)	<1	188(32)	19	94	<10	17	16
	0948 ^{4,5}	7-2		122(28)	<1	165(24)	11	116	14	17	16
	1055 ⁴	7-1	7	89(15)	<1	129(26)	24	151	54	18	16
	1157 ⁴	7-2	7	103(4)	<1	134(3)	20	152	36	19	16
	Average			117(29)	<1	156(25)	16(8)	130(23)	30(24)	18(1)	16
6-17	0740 ⁴	7-1	7	118(7)	<1	358(44)	<1	195	9.5	23	28
	0742 ^{4,5}	7-2		118(12)	<1	352(20)	<1	177	8.6	23	30
	0925 ³	7-1	3	69	<1	130	<1	109	4.4	15	13
	0950	7-1	7	89	<1	159	<1	97	5.5	19	19
	1130	7-1	7	73	<1	145	<1	120	4.7	18	18
	1131 ⁵	7-1		89	<1	163	<1	110	4.7	19	18
	Average			93(21)	<1	218(107)	<1	135(41)	6.2(22)	20(3)	21(7)

TABLE A1. (Continued)

6-18	0825	7-1	7	126	<1	417	<1	217	12.4	25	34
	0830 ⁶	7-1	9	138(18)	<1	424	<1	312	33	25	32
	0830 ³	7-1	9	101	1.9	512	<1	277	11	25	32
	0955 ³	7-1	9	36	<1	299	12	210	8.1	23	26
	1007	7-1	7	98	<1	278	<1	184	8.3	21	25
	1120	7-1	7	92	<1	239	<1	160	6.7	21	24
	1120 ^{4,5}	7-1		120(5)	<1	296(28)	<1	129	18	21	24
	<u>1220</u>	7-1	7	<u>101</u>	<u><1</u>	<u>213</u>	<u><1</u>	<u>147</u>	<u>6.8</u>	<u>20</u>	<u>22</u>
	Average			102(31)	<1	355(104)	2(4)	205(64)	13(9)	23(2)	27(5)
6-20	0936 ⁴	7-2	7	159(1)	<1	576(46)	<1	310	10	30	44
	0937 ^{4,5}	7-2		149(29)	<1	584(108)	<1	290	12	30	44
	1026	7-2	7	146	<1	532	<1	326	13	28	39
	1040 ³	7-2	7	130	2.6	367	<1	420	15	28	39
	<u>1154</u>	7-2	7	<u>108</u>	<u><1</u>	<u>374</u>	<u><1</u>	<u>256</u>	<u>8.6</u>	<u>28</u>	<u>34</u>
	Average			138(20)	1(1)	487(108)	<1	320(62)	12(3)	29(1)	40(4)
6-21	0730	7-1	7	191	<1	893	<1	506	16	35	57
	0732	7-2	7	219	<1	886	<1	432	18	34	56
	0734 ⁵	7-2		140	<1	478	4.4	330	18	27	37
	0827	7-2	7	165	<1	766	<1	466	14.3	36	58
	1053	7-2	7	190	<1	796	<1	420	11.4	32	51
	<u>1158</u>	7-2	7	<u>180</u>	<u>2.3</u>	<u>689</u>	<u>2.2</u>	<u>547</u>	<u>13</u>	<u>33</u>	<u>52</u>
	Average			181(27)	1(1)	751(154)	2(2)	450(75)	15(3)	33(3)	52(8)

TABLE A1, (Continued)

6-22	0630 ³	7-2	12	184	1.2	876	<1	493	14	35	56
	0904	7-1	7	193	3.8	942	1.1	820	47	38	66
	0912	7-2	7	194	3.4	933	<1	840	50	38	65
	0912 ⁵	7-2		157	1.9	641	<1	517	17	31	50
	0920 ³	7-2	3	200	<1	1050	<1	824	18	37	62
	1057	7-1	7	188	3.2	903	<1	590	21	37	64
	1100	7-2	7	187	2.6	931	<1	739	16	38	64
	Average			186(14)	2.4(11)	897(125)	<1	689(152)	26(15)	36(3)	61(6)
6-24	0756	7-1	7	228	3.4	1250	<1	813	33	43	80
	0857	7-1	7	204	3.4	1060	<1	895	43	42	70
	1001	7-1	7	190	3.1	910	<1	617	30	39	64
	1114	7-1	7	188	2.9	814	<1	606	22.5	38	59
	1115 ⁵	7-1		187	2.9	810	<1	483	24	38	59
	1215	7-1	7	182	2.2	770	<1	501	20	37	57
	Average			197(17)	3.0(4)	936(186)	<1	652(167)	29(9)	40(3)	65(9)

¹Unless noted otherwise, samples were taken at the bottom, center, south side (cold water) of the cooling tower.

²Shorthand notation for standard deviation used, e.g., 68(23) = 68 23, 6.2(22) = 6.2 2.2, etc.

³ESC water sample taken at the top (hot water) of the cooling tower, but analyzed by PNL.

⁴Repeated analysis of the same water sample.

⁵Canal water sample taken in the hot water leg.

⁶Split hot water sample with ESC, but analyzed separately from the ESC sample.

APPENDIX B

SAMPLING STATION IDENTIFICATION

Table B1. Sampling Station, line of sight to Cooling Towers
and photograph (negative) cross reference.

All photos taken on 14 June 1979 unless otherwise noted.

Figure No.	Station	Negative ID	Direction of Observation, Comment
B 1a	UUA	2-14	Upwind, Canal
b	UUA	2-12	Both Towers, Plant
c	UUB	2-16	Upwind, Canal
d	UUB	2-15	Both towers, Plant
B 2a	UA	2-11	Upwind, Canal
b	UA	2-10	Both towers
c	UB	2-18	Upwind, Canal
d	UB	2-17	Both towers
B 3a	OA	1-3	Tower 7-1
b	OA	1-4	Tower 7-2
c	OBN	3-7	Tower 7-2, Plant
d	OBN	3-8	Tower 7-2, Canal
B 4a	OBS	3-5	Tower 7-1
b	OBS	3-6	Tower 7-2
c	OC	3-4	Tower 7-1
d	OC	3-3	Tower 7-2
B 5a	OD	3-2	Tower 7-1
b	OD	2-21	Tower 7-2
c	OE	2-19	Tower 7-1
d	OE	2-20	Tower 7-2
B 6a	1ZZ	5-15	Tower 7-1, 6-24-79
b	1ZZ	5-14	Tower 7-2, 6-24-79
c	1X	5-17	Tower 7-1, 6-24-79
d	1X	5-16	Tower 7-2, 6-24-79
B 7a	1Z	4-11	Tower 7-1, 6-18-79
b	1Z	4-10	Tower 7-2, 6-18-79
c	1Z	4-12	Upwind, Suisun Bay, 6-18-79
d	1Y	4-13	Both towers, 6-18-79

Figure No.	Station	Negative ID	Direction of Observation, Comment
B 8a	1A	1-2	Both towers
b	1B	1-5	Both towers
c	1C	1-6	Both towers
d	1D	1-7	Both towers
B 9a	1E	1-10	Both towers
b	1E, 1F	3-17	Both towers, acoustic sounder, all sky camera, bolex camera.
c	1F	1-8	Both towers, but mostly 7-1
d	1F	1-9	Both towers, but mostly 7-2
B10a	1G	2-9	Tower 7-1
b	1G	2-8	Tower 7-2
c	1H	4-16	Tower 7-1, 6-19-79, not used in sampling program.
d	1H	4-20A	Tower 7-2, 6-19-79, not used in sampling program.
B11a	1I	3-14	Tower 7-1
b	1I	3-13	Tower 7-2
c	1J	3-12	Tower 7-1
d	1J	3-11	Tower 7-2
B12a	1AZ	4-9	Both towers, 6-18-79
b	1AA	4-8	Both towers, 6-18-79
c	1AB	4-7	Both towers, 6-18-79
d	1AC	4-6	Both towers, 6-18-79
B13a	1AD	4-5	Both towers, 6-18-79
b	1AE	4-4	Both towers, 6-18-79
c	1AF	4-3	Both towers, 6-18-79
d	1F	3-15	Both towers, PG&E Meteorology hut, cameras, acoustic sounder.
B14a	2A	1-11	Both towers
b	2B	1-12	Both towers
c	2E	1-13	Both towers, switchyard
d	2F	1-14	Both towers, switchyard
B15a	2G	1-15	Both towers, switchyard
b	2H	1-16	Both towers,
c	2I	2-4	Both towers
d	2J	2-5	Both towers

Figure No.	Station	Negative ID	Direction of Observation, Comment
B16a	2K	2-6	Tower 7-1
b	2K	2-7	Tower 7-2
c	3A	1-17	Both towers, switchyard
d	3B	1-18	Both towers, switchyard
B17a	3C	1-20	Both towers, switchyard
b	3E	2-2	Both towers, switchyard
c	3F	2-3	Both towers
d	1F	4-14	Both towers, Acoustic sounder

a

b

c

d

Figure B 1

a

b

c

d

Figure B 2

a

b

c

d

Figure B 3

a

b

c

d

Figure B 4

a

b

c

d

Figure B 5

a

b

c

d

Figure B 6

a

b

c

d

Figure B 7

a

b

c

d

Figure B 8

a

b

c

d

Figure B 9

a

b

c

d

Figure B 10

a

b

c

d

Figure B 11

a

b

c

d

Figure B 12

a

b

c

d

Figure B 13

a

b

c

d

Figure B 14

a

b

c

d

Figure B 15

a

b

c

d

Figure B 16

a

b

c

d

Figure B 17

APPENDIX C

METEOROLOGICAL SUMMARIES

TABLE C-1, Ten Minute Average, Meteorological Data for
the Pittsburg Power Plant during the June 1978
Meter Drift Study

Date	Time (PST)	Temp. (C°)	R.H.(%)	Wind Speed (ms ⁻¹)	Wind Direc.(°)
15 June	0700	M	M	M	M
	0710	M	M	M	M
	0720	M	M	M	M
	0730	M	M	M	M
	0740	M	M	M	M
	0750	15.6	63.2	4.1	260.2
	0800	16.2	61.4	4.5	257.1
	0810	16.9	60.7	4.5	253.2
	0820	17.2	57.1	4.7	262.1
	0830	17.3	56.0	4.9	250.4
	0840	M	M	M	M
	0850	M	M	M	M
	0900	19.1	52.2	4.7	260.3
	0910	19.4	50.4	4.1	254.1
	0920	19.6	49.7	5.2	250.1
	0930	20.0	48.4	4.5	250.6
	0940	20.1	47.2	4.7	260.3
	0950	20.2	46.3	4.1	267.4
	1000	20.5	46.0	5.2	271.3
	1010	20.9	45.9	4.6	264.3
	1020	21.2	45.7	4.5	268.2
	1030	21.3	45.5	4.4	265.4
	1040	21.4	46.0	4.6	270.4
	1050	21.5	45.0	4.8	269.3
	1100	21.5	45.8	4.1	281.2
	1110	21.7	46.1	5.0	290.4
	1120	21.9	45.7	5.2	285.4
	1130	22.0	45.0	4.9	276.1
	1140	22.3	45.0	5.5	284.1
	1150	22.4	45.2	6.1	292.1
	1200	22.5	45.0	5.9	300.4
	1210	M	M	M	M
	1220	M	M	M	M
	1230	M	M	M	M
	1240	M	M	M	M
	1250	M	M	M	M

Date	Time (PST)	Temp. (C°)	R.H.(%)	Wind Speed (ms ⁻¹)	Wind Direc.(°)
16 June	0700	14.8	67.4	4.1	262.7
	0710	15.2	69.3	4.3	268.5
	0720	15.2	68.4	4.4	270.3
	0730	15.4	67.2	5.0	280.1
	0740	15.5	67.7	4.9	264.5
	0750	15.7	65.1	4.5	260.5
	0800	15.7	63.2	4.5	269.3
	0810	16.3	60.8	4.0	266.7
	0820	16.8	59.4	4.1	270.1
	0830	17.0	59.0	4.2	265.3
	0840	17.5	57.4	4.6	265.8
	0850	17.7	56.3	4.3	270.4
	0900	18.2	55.2	4.9	269.8
	0910	18.8	54.1	4.8	264.3
	0920	19.4	51.7	4.5	268.4
	0930	19.9	50.3	4.3	269.3
	0940	20.1	50.0	4.2	269.8
	0950	20.6	49.8	4.5	268.4
	1000	21.0	48.0	4.9	268.3
	1010	21.5	46.1	4.8	268.0
	1020	21.3	45.3	4.8	265.1
	1030	21.8	44.0	4.7	264.0
	1040	21.9	43.1	4.8	275.0
	1050	22.3	41.7	5.0	280.0
	1100	22.9	40.3	5.0	268.3
	1110	22.8	38.8	5.0	260.4
	1120	23.5	38.0	5.1	265.3
	1130	23.6	37.3	5.1	270.4
	1140	23.6	37.4	5.2	270.3
	1150	23.8	37.0	4.7	272.4
	1200	24.4	36.5	5.0	280.5
	1210	24.6	36.0	5.1	278.6
	1220	24.4	35.2	5.1	290.4
	1230	25.0	35.0	5.0	306.4
	1240	25.2	34.3	5.0	289.3
	1250	25.1	34.7	5.0	285.3

Date	Time(PST)	Temp. (C°)	R.H.(%)	Wind Speed (ms ⁻¹)	Wind Direc.(°)
17 June	0700	17.2	59.4	2.5	159.2
	0710	17.7	58.5	2.8	180.4
	0720	17.9	58.6	2.4	160.3
	0730	17.9	58.0	2.0	205.3
	0740	18.3	57.4	3.1	181.4
	0750	18.5	57.0	2.7	191.4
	0800	18.4	56.7	2.9	196.7
	0810	18.6	56.6	2.0	175.6
	0820	18.9	56.0	1.8	185.3
	0830	19.1	56.2	1.7	196.3
	0840	19.0	57.1	1.9	210.5
	0850	19.3	56.4	2.4	230.6
	0900	19.4	56.0	2.0	237.4
	0910	19.4	55.8	3.5	252.4
	0920	20.0	56.3	3.3	294.7
	0930	20.4	56.7	3.0	264.3
	0940	20.5	56.1	3.0	265.7
	0950	20.6	55.9	2.7	270.3
	1000	20.5	55.6	3.6	294.4
	1010	20.9	55.1	3.4	310.1
	1020	21.5	55.3	4.6	305.4
	1030	21.9	55.7	4.5	290.5
	1040	22.3	55.6	4.0	295.6
	1050	22.6	54.9	5.6	300.4
	1100	22.6	54.7	5.5	300.7
	1110	22.8	54.8	4.9	290.8
	1120	23.0	54.9	5.2	295.6
	1130	23.4	54.7	5.0	293.2
	1140	23.7	52.4	5.4	290.1
	1150	23.9	50.3	5.3	285.4
	1200	24.0	49.6	4.9	292.5
	1210	24.2	48.1	5.7	290.7
	1220	24.8	47.0	5.2	298.4
	1230	24.9	46.0	5.4	295.6
	1240	25.4	43.1	5.5	292.0
	1250	25.5	42.0	5.5	286.0

Date	Time (PST)	Temp. (C°)	R.H.(%)	Wind Speed (ms ⁻¹)	Wind Direc.(°)
18 June	0700	14.8	71.3	7.0	240.7
	0710	14.9	70.4	7.2	238.3
	0720	14.8	70.8	6.9	239.4
	0730	15.0	70.0	7.3	230.3
	0740	14.9	69.2	7.4	228.6
	0750	M	M	M	M
	0800	M	M	M	M
	0810	M	M	M	M
	0820	M	M	M	M
	0830	M	M	M	M
	0840	M	M	M	M
	0850	M	M	M	M
	0900	M	M	M	M
	0910	M	M	M	M
	0920	M	M	M	M
	0930	M	M	M	M
	0940	M	M	M	M
	0950	M	M	M	M
	1000	M	M	M	M
	1010	M	M	M	M
	1020	M	M	M	M
	1030	17.9	58.2	7.0	247.3
	1040	18.5	56.4	6.9	250.4
	1050	19.3	55.7	7.1	243.2
	1100	M	M	M	M
	1110	M	M	M	M
	1120	20.3	54.0	7.1	245.0
	1130	20.7	53.9	7.5	247.1
	1140	20.5	53.0	8.0	245.6
	1150	20.9	52.5	7.1	249.4
	1200	21.0	52.4	8.0	250.6
	1210	21.1	52.0	8.0	255.3
	1220	21.7	51.6	7.5	256.7
	1230	21.6	51.4	7.6	249.4
	1240	21.8	50.7	7.7	255.7
	1250	21.8	50.2	8.6	260.3

Date	Time (PST)	Temp.(C°)	R.H.(%)	Wind Speed (ms ⁻¹)	Wind Direc.(°)
19 June	0700	14.8	85.6	4.6	280.5
	0710	14.7	83.4	4.5	259.7
	0720	15.3	81.7	4.4	267.4
	0730	15.9	80.3	4.3	260.3
	0740	16.1	78.4	4.1	274.3
	0750	16.4	76.3	4.5	267.3
	0800	16.8	75.2	4.3	253.4
	0810	17.4	70.4	4.2	255.8
	0820	17.5	69.8	4.3	259.4
	0830	17.6	65.4	4.2	260.3
	0840	17.9	67.8	4.6	265.4
	0850	18.2	63.2	5.4	249.4
	0900	18.1	61.0	5.5	247.8
	0910	18.7	59.2	5.0	253.7
	0920	19.2	58.4	4.5	254.8
	0930	19.7	57.3	4.6	255.7
	0940	19.9	53.2	4.7	253.6
	0950	20.1	54.1	5.0	267.8
	1000	20.6	53.8	4.8	272.9
	1010	21.4	53.6	4.5	253.3
	1020	21.5	52.4	5.0	265.5
	1030	21.8	53.0	5.3	257.8
	1040	22.3	52.7	6.4	264.7
	1050	22.8	53.4	5.5	272.3
	1100	22.9	55.6	6.0	285.3
	1110	23.4	53.4	5.3	290.4
	1120	23.8	52.6	4.9	304.3
	1130	24.0	53.0	5.2	312.4
	1140	24.1	54.7	6.0	285.6
	1150	23.9	52.1	6.5	290.4
	1200	24.2	50.7	6.3	286.3
	1210	24.5	52.8	7.4	287.4
	1220	24.7	52.7	7.0	290.4
	1230	25.0	52.6	6.3	304.4
	1240	25.3	53.4	6.9	306.8
	1250	25.0	54.1	6.8	310.4

Date	Time (PST)	Temp. (C°)	R.H.(%)	Wind Speed (ms ⁻¹)	Wind Direc.(°)
20 June	0700	M	M	M	M
	0710	M	M	M	M
	0720	M	M	M	M
	0730	M	M	M	M
	0740	M	M	M	M
	0750	M	M	M	M
	0800	M	M	M	M
	0810	M	M	M	M
	0820	M	M	M	M
	0830	M	M	M	M
	0840	M	M	M	M
	0850	M	M	M	M
	0900	M	M	M	M
	0910	M	M	M	M
	0920	12.7	68.4	7.7	240.7
	0930	13.1	67.9	7.9	242.6
	0940	12.6	67.0	8.3	239.6
	0950	12.8	65.3	8.0	242.4
	1000	13.0	66.4	7.5	250.6
	1010	13.3	64.2	8.5	249.6
	1020	13.5	62.4	8.7	243.4
	1030	13.7	60.3	7.9	248.7
	1040	14.2	59.8	8.0	242.6
	1050	14.1	57.4	7.7	247.4
	1100	14.6	55.3	7.9	255.3
	1110	15.3	54.2	8.0	256.4
	1120	15.4	54.9	6.8	244.3
	1130	15.0	55.7	7.3	248.8
	1140	15.1	53.4	7.2	243.6
	1150	15.9	52.4	7.7	243.7
	1200	16.2	50.6	7.7	244.8
	1210	16.3	49.8	8.4	243.4
	1220	16.7	48.7	6.3	249.6
	1230	17.4	47.3	6.9	240.6
	1240	17.7	45.3	7.0	239.8
	1250	18.0	42.4	6.9	237.6

Date	Time (PST)	Temp. (C°)	R.H.(%)	Wind Speed (ms ⁻¹)	Wind Direc.(°)
21 June	0700	14.7	80.6	4.1	265.3
	0710	14.8	79.4	4.3	264.4
	0720	14.6	78.3	4.5	280.7
	0730	15.0	78.0	5.0	265.7
	0740	15.8	77.6	4.6	249.3
	0750	16.3	74.2	4.8	250.4
	0800	16.4	70.3	4.9	257.3
	0810	16.5	69.8	5.2	253.2
	0820	16.8	68.4	4.0	256.4
	0830	17.0	68.7	4.0	240.7
	0840	17.2	68.0	5.2	245.6
	0850	17.9	67.7	6.4	252.3
	0900	18.0	67.6	7.8	245.8
	0910	18.2	67.1	8.2	246.3
	0920	18.1	66.2	7.0	242.4
	0930	18.4	66.0	6.5	248.7
	0940	18.7	65.4	6.3	245.6
	0950	19.0	65.0	6.0	245.8
	1000	19.3	63.2	7.4	250.6
	1010	19.4	63.0	6.5	259.7
	1020	19.8	61.4	6.3	233.8
	1030	19.7	60.0	6.2	239.8
	1040	20.0	59.3	5.5	247.8
	1050	20.6	58.7	5.5	249.4
	1100	21.0	57.4	5.0	245.3
	1110	21.1	56.4	7.0	246.3
	1120	21.0	56.8	7.1	243.3
	1130	21.6	54.2	7.3	245.8
	1140	21.5	53.4	6.4	246.3
	1150	22.7	50.7	5.5	248.4
	1200	23.0	50.6	5.4	249.3
	1210	23.2	50.4	5.0	260.4
	1220	23.5	49.8	5.7	269.7
	1230	24.4	47.3	5.3	275.3
	1240	24.8	46.4	5.2	280.4
	1250	24.9	45.2	5.1	275.3

Date	Time (PST)	Temp. (C°)	R.H.(%)	Wind Speed (ms ⁻¹)	Wind Direc.(°)
22 June	0700	14.3	79.4	6.7	190.7
	0710	14.8	75.3	6.3	210.3
	0720	15.0	76.4	6.0	220.4
	0730	15.2	76.0	5.2	218.7
	0740	15.0	75.0	5.8	225.6
	0750	15.6	73.1	5.0	230.4
	0800	15.7	70.4	5.6	228.6
	0810	15.9	69.3	5.5	219.6
	0820	16.2	68.1	6.3	230.4
	0830	16.3	67.4	6.2	226.3
	0840	16.3	67.3	7.0	230.4
	0850	16.5	66.4	6.1	239.8
	0900	16.8	65.3	5.4	245.6
	0910	17.0	63.2	5.3	256.3
	0920	17.3	61.4	5.2	255.2
	0930	17.4	59.7	6.8	250.4
	0940	17.8	52.7	7.3	250.3
	0950	18.0	56.4	7.0	256.4
	1000	18.2	53.2	6.3	258.7
	1010	18.6	50.4	7.5	260.3
	1020	18.9	50.6	6.0	243.2
	1030	19.3	49.8	6.8	240.4
	1040	19.8	47.3	6.3	247.8
	1050	19.8	47.4	6.2	246.3
	1100	20.0	46.3	6.0	245.1
	1110	20.3	45.3	5.0	249.2
	1120	20.9	45.0	5.1	247.3
	1130	21.4	44.5	6.0	250.4
	1140	21.8	43.8	6.2	252.3
	1150	22.3	41.4	6.3	269.3
	1200	22.9	42.0	6.3	260.4
	1210	23.1	41.6	6.3	255.7
	1220	23.2	41.0	5.0	256.8
	1230	23.4	39.8	5.2	253.4
	1240	24.0	39.6	5.1	252.4
	1250	23.9	38.0	5.1	256.6

Date	Time (PST)	Temp. (C°)	R.H.(%)	Wind Speed (ms ⁻¹)	Wind Direc.(°)
23 June	0700	14.0	83.6	6.0	248.6
	0710	14.6	82.1	6.3	250.3
	0720	14.5	80.7	6.5	249.3
	0730	15.0	81.0	7.4	260.4
	0740	15.0	80.6	8.3	243.4
	0750	14.9	80.5	8.4	245.8
	0800	15.6	79.3	8.7	250.6
	0810	15.8	79.8	9.3	247.4
	0820	16.0	79.4	9.8	247.6
	0830	16.1	78.3	10.6	240.3
	0840	M	M	M	M
	0850	M	M	M	M
	9000	M	M	M	M
	9100	M	M	M	M
	0920	M	M	M	M
	0930	M	M	M	M
	0940	M	M	M	M
	0950	M	M	M	M
	1000	17.3	70.0	12.0	243.6
	1010	17.9	69.3	11.6	245.8
	1020	18.3	68.4	10.5	250.6
	1030	18.6	68.0	9.4	245.7
	1040	18.6	67.3	12.7	245.8
	1050	18.8	67.5	10.3	250.6
	1100	19.3	67.0	9.6	240.0
	1110	19.4	66.5	8.5	239.8
	1120	M	M	M	M
	1130	M	M	M	M
	1140	M	M	M	M
	1150	M	M	M	M
	1200	M	M	M	M
	1210	M	M	M	M
	1220	20.7	56.4	6.8	237.0
	1230	21.3	55.0	6.9	225.6
	1240	22.4	53.2	7.3	230.6
	1250	23.4	50.6	7.2	233.4

Date	Time (PST)	Temp. (C°)	R.H. (%)	Wind Speed (ms ⁻¹)	Wind Direc. (°)
24 June	0700	13.0	79.3	10.6	235.9
	0710	13.3	79.0	10.8	240.6
	0720	13.8	78.4	9.7	249.8
	0730	14.0	78.0	9.9	250.6
	0740	14.1	75.6	9.0	245.7
	0750	14.1	74.2	8.5	247.3
	0800	14.3	73.1	7.4	247.8
	0810	14.6	71.6	7.3	249.4
	0820	14.8	70.0	7.0	250.6
	0830	15.0	68.4	6.1	252.3
	0840	15.2	68.0	6.7	248.4
	0850	15.8	66.9	7.2	240.6
	0900	16.2	66.1	8.4	235.4
	0910	16.6	64.2	8.8	230.0
	0920	16.8	62.1	8.0	228.0
	0930	17.4	60.4	8.3	242.3
	0940	17.8	58.6	8.8	248.6
	0950	18.0	55.4	8.9	257.4
	1000	18.6	53.1	9.6	260.3
	1010	18.8	50.4	9.7	270.4
	1020	19.3	49.7	9.7	268.3
	1030	19.6	48.4	8.6	243.4
	1040	20.0	48.0	8.5	250.6
	1050	20.4	47.6	8.0	255.6
	1100	20.5	47.0	7.7	260.3
	1110	20.6	46.5	7.7	254.3
	1120	20.8	46.0	7.8	253.2
	1130	21.0	45.7	7.8	240.6
	1140	21.2	44.8	7.7	258.7
	1150	21.8	44.8	8.0	248.3
	1200	22.3	43.6	7.2	254.3
	1210	22.8	42.7	7.3	240.6
	1220	23.0	42.0	7.0	241.6
	1230	23.4	41.9	6.4	250.4
	1240	23.8	40.6	7.0	250.2
	1250	24.0	40.0	7.0	255.2

TABLE C-2. Vertical Profiles Derived from
Tethered-Balloon System

<u>Date</u>	<u>Time(PST)</u>	<u>Height(m)</u>	<u>Temp(C°)</u>	<u>R.H.(%)</u>	<u>Wind Speed(ms⁻¹)</u>	<u>Wind Direct.(°)</u>	<u>Comment</u>
16 June	0858- 0901	2	19.6	49.0	3.0	271	one profile
		7	19.9	50.8	5.6	278	
		25	18.6	51.4	5.5	241	
		41	18.5	53.7	6.2	267	
	0943- 0948	12	20.9	40.4	6.6	224	two profiles
		22	20.6	50.4	6.2	244	
		35	20.7	58.2	5.9	270	
		52	20.6	57.0	5.9	269	
	1034- 1037	6	23.0	41.4	2.5	223	one profile
		39	23.4	44.9	4.2	293	
		60	21.2	50.1	6.2	302	
		78	22.6	64.1	7.6	49	
		108	22.1	59.9	4.7	271	
17 June	0730- 0744	9	18.0	65.2	2.4	276	two profiles
		18	17.8	65.7	2.3	299	
		33	17.9	65.4	2.0	322	
		58	17.6	67.3	2.2	338	
		81	17.5	64.6	1.7	340	
		100	17.6	60.7	1.3	17	
	0829- 0848	2.0	20.0	51.8	2.4	297	two profiles
		35	19.5	50.9	2.8	289	
		45	19.3	45.8	2.6	303	
		72	19.4	43.6	1.6	301	
		95	19.1	43.9	1.1	278	
		115	19.0	43.7	1.0	280	
	0940- 0943	16	21.0	56.1	5.1	323	one profile
		39	21.4	53.7	4.9	294	
		61	21.8	38.8	4.4	284	
		106	22.1	34.4	3.5	272	

<u>Date</u>	<u>Time(PST)</u>	<u>Height(m)</u>	<u>Temp(C°)</u>	<u>R.H.(%)</u>	<u>Wind Speed(ms⁻¹)</u>	<u>Wind Direct.(°)</u>	<u>Comment</u>
17 June	1047- 1058	20	21.6	59.9	6.3	316	two profiles
		38	21.9	53.9	6.5	302	
		57	23.0	34.6	5.4	298	
		79	23.7	33.6	5.5	296	
		95	23.1	32.5	5.1	295	
	1129- 1140	3	23.0	50.2	3.7	298	two profiles
		22	22.3	50.6	6.2	335	
		47	22.7	38.6	7.2	304	
		72	22.8	35.4	6.5	302	
		95	22.9	37.4	5.2	301	
		113	22.9	37.6	5.5	299	
21 June	0717- 0729	4	14.7	77.7	6.3	253	two profiles combined
		22	14.7	76.4	5.7	267	
		30	14.5	76.6	6.1	248	
		43	14.3	77.7	5.9	256	
		52	14.2	78.2	6.1	255	
		76	14.0	78.7	6.0	254	
		83	13.8	79.3	6.1	250	
		91	13.8	80.1	6.4	244	
		104	13.6	80.2	6.6	246	
		112	13.5	80.7	6.3	253	
	0850- 0859	6	15.3	75.5	8.2	227	two profiles combined
		31	15.6	70.8	9.6	225	
		55	15.5	71.1	8.5	242	
		73	15.3	71.6	9.5	224	
		90	15.2	72.2	9.1	233	
		115	14.8	71.8	9.2	228	
	0932- 0942	4	18.5	64.2	6.4	232	two profiles combined
		35	17.0	66.9	7.7	238	
		56	16.6	66.8	7.2	242	
		73	16.4	67.7	7.2	250	
		98	16.2	68.0	7.6	233	

<u>Date</u>	<u>Time (PST)</u>	<u>Height(m)</u>	<u>Temp(C°)</u>	<u>R.H.(%)</u>	<u>Wind Speed(ms⁻¹)</u>	<u>Wind Direct.(%)</u>	<u>Comment</u>
21 June	1015- 1023	7	18.6	61.9	5.3	226	two profiles combined
		20	18.4	62.4	7.5	233	
		49	17.7	64.5	7.8	241	
		74	17.6	64.8	6.8	244	
		96	17.2	65.9	7.2	240	
	1047- 1055	5	19.9	56.5	5.6	229	two profiles
		30	19.3	59.6	6.7	246	
		54	18.4	60.7	7.5	232	
		65	18.4	60.2	7.3	217	
		86	18.0	61.3	7.2	228	
	1149- 1202	112	17.8	62.3	6.4	233	two profiles
		17	20.7	52.8	7.3	240	
		34	20.1	54.3	7.1	233	
		43	19.9	55.0	7.1	249	
		63	19.8	54.5	6.5	254	
		78	19.9	54.2	6.9	238	
		94	19.5	55.8	5.8	256	
23 June	1418- 1424	5	26.8	36.4	5.9	238	one profile, up
		13	24.7	40.2	9.4	222	
		31	22.3	44.6	7.8	235	
		45	21.7	44.5	7.7	220	
		80	21.1	45.8	7.5	253	
		95	20.8	45.7	8.0	235	
		108	21.1	45.7	9.3	225	
		140	20.4	45.5	9.4	236	
	1520- 1524	4	23.7	52.7	6.5	291	one profile, up
		12	23.1	56.5	8.9	297	
		59	19.2	53.0	8.6	261	
		104	20.0	47.5	7.4	254	
		122	19.2	60.4	8.2	283	

<u>Date</u>	<u>Time(PST)</u>	<u>Height(m)</u>	<u>Temp(C°)</u>	<u>R.H. (%)</u>	<u>Wind Speed(ms⁻¹)</u>	<u>Wind Direct. (%)</u>	<u>Comment</u>
24 June	1512- 1518	5	25.9	39.5	4.0	230	one profile, up mode
		10	25.0	35.0	6.1	233	
		17	23.0	42.6	7.9	245	
		30	21.8	40.4	8.8	242	
		45	21.5	38.2	7.6	249	
		55	21.3	39.9	7.6	256	
		70	21.3	39.5	7.4	240	
		98	21.3	38.8	7.3	260	
		115	20.5	40.5	6.8	279	
		140	20.5	42.9	6.0	215	
		165	20.6	41.9	7.4	231	
	1707- 1738	2	24.6	40.4	3.0	235	two profiles combined some down time for battery change.
		20	23.0	38.0	8.9	285	
		48	22.2	34.0	8.2	277	
		62	22.1	33.5	9.2	306	
		88	21.9	33.6	8.2	302	
		115	21.5	34.5	9.2	298	
		140	21.3	34.7	8.7	282	
		175	21.0	35.7	8.8	287	
		210	20.8	36.3	8.3	280	

APPENDIX D

SUMMARY OF CALFRAN DROPLET DATA

Table D1. Supplementary drift emission data derived from
the Calfran measurements on the Pittsburgh
Cooling Towers during July 1978

Diameter		Date 7-20			Date 7-20			Date 7-20		
		Position A			Position B			Position C		
Lower (μm)	Upper (μm)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)
100	200									
200	300	1	3.9	29	12	47	518	2	7.9	23.4
300	400	8	86	596	44	475	4990	1	10.8	27.0
400	500	2	46	298	43	986	9960	1	22.9	48.2
500	600	6	251	1550	33	1380	13500			
600	700	1	69	394	20	1380	12900			
700	800	3	319	1690	14	1490	13200			
800	900	4	618	3030	19	2940	25000			
900	1000	0	0	0	7	1510	12200			
1000	1200	2	674	1780	18	6440	49300			
1200	1400	1	619	2040	8	4450	31300			
1400	1600				8	6310	42100			
1600	1800				4	4960	29900			
1800	2000				3	5320	29600			
2000	2200				6	13700	71500			
2200	2400				1	3270	15400			
2400	2600				3	12500	53800			
2600	2800				1	4680	19200			
2800	3000				1	6460	22600			
3000	3200				0	0	0			
3200	3400				1	9460	25600			
TOTALS		28	2690	12400	248	87800	483000	4	41.6	98.6

¹ ΔN = Total droplet count

² Δm = Total drift mass concentration or density

³DMF = Drift mass flux

Table D1. (Continued)

Diameter		Date <u>7-21</u>			Date <u>7-21</u>			Date <u>7-21</u>		
		Position A			Position B			Position C		
Lower (μm)	Upper (μm)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)
100	200									
200	300	2	12	87	12	71	778	3	18	53
300	400	4	65	447	30	486	5110	0	0	0
400	500	1	34	224	10	344	3480	0	0	0
500	600	0	0	0	5	314	3070	1	63	110
600	700	0	0	0	10	1040	9660			
700	800	1	159	845	9	1440	12800			
800	900				3	197	5920			
900	1000				5	1620	13100			
1000	1200				4	2025	15700			
1200	1400				2	1670	11700			
1400	1600				4	4470	32400			
1600	1800				0	0	0			
1800	2000				1	2800	15400			
2000	2200				0	0	0			
2200	2400				2	8610	42200			
2400	2600				0	0	0			
2600	2800				1	7860	30700			
2800	3000				0	0	0			
3000	3200				0	0	0			
3200	3400				1	13000	37600			
TOTALS		8	271	1600	99	46800	240000	4	81	163

¹ ΔN = Total droplet count

² Δm = Total drift mass concentration or density

³DMF = Drift mass flux

Table D1. (Continued)

Diameter		Date 7-21			Date 7-21			Date 7-21		
		Position D			Position E			Position F		
Lower (μm)	Upper (μm)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)
100	200									
200	300	2	12	29	4	24	236	6	35	263
300	400				6	97	924	23	373	2590
400	500				5	172	1570	18	620	4060
500	600				8	503	4400	11	692	4290
600	700				1	104	862	4	415	2390
700	800				3	478	3780	4	638	3410
800	900				4	929	6970	0	0	0
900	1000				0	0	0	2	648	2950
1000	1200				1	438	3020	0	0	0
1200	1400				1	738	4580	1	930	3120
1400	1600							2	2560	7780
1600	1800									
1800	2000									
2000	2200									
2200	2400									
2400	2600									
2600	2800									
2800	3000									
3000	3200									
3200	3400									
TOTALS:		2	12	29	33	3480	26300	71	6910	30900

¹ ΔN = Total droplet count

² Δm = Total drift mass concentration or density

³DMF = Drift mass flux

Table D1. (Continued)

Diameter		Date 7-22			Date 7-22			Date 7-22		
		Position A			Position B			Position C		
Lower (μm)	Upper (μm)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)
100	200									
200	300				7	41	454			
300	400	1	16	112	16	259	2720	3	49	122
400	500	2	69	448	18	620	6260			
500	600	3	189	1160	6	377	3680			
600	700				7	727	6760			
700	800				5	797	7100			
800	900				2	464	3950			
900	1000				0	0	0			
1000	1200				1	575	4370			
1200	1400				1	930	6420			
1400	1600				1	1410	9150			
1600	1800				4	7450	45000			
1800	2000				2	5190	29000			
2000	2200				1	3760	19200			
2200	2400				2	9810	46100			
2400	2600									
2600	2800									
2800	3000									
3000	3200									
3200	3400									
TOTALS:		6	274	1720	73	32400	190000	3	49	122

¹ ΔN = Total droplet count

² Δm = Total drift mass concentration or density

³DMF = Drift mass flux

Table D1, (Continued)

Diameter		Date 7-22			Date 7-22			Date 7-22		
		Position D			Position E			Position F		
Lower (μm)	Upper (μm)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)
100	200									
200	300	1	5.9	14.4	1	5.9	59	8	47	351
300	400				5	81	770	30	486	3380
400	500				7	241	2190	26	896	5870
500	600				2	126	1100	9	566	3510
600	700				2	208	1720	7	727	4180
700	800				1	159	1260	4	638	3410
800	900				0	0	0	5	1160	5750
900	1000				2	648	4600	1	324	1470
1000	1200				-	-	--	1	438	1900
1200	1400				-	-	--			
1400	1600				-	-	--			
1600	1800				-	-	--			
1800	2000				-	-	--			
2000	2200				-	-	--			
2200	2400				1	4910	18200			
2400	2600									
2600	2800									
2800	3000									
3000	3200									
3200	3400									
TOTALS:		1	5.9	14.4	21	6380	29,900	91	5280	59700

¹ ΔN = Total droplet count

² Δm = Total drift mass concentration or density

³DMF = Drift mass flux

Table D1. (Continued)

Diameter		Date <u>7-25</u>			Date <u>7-26</u>			Date _____		
		Position B			Position B			Position		
Lower (μm)	Upper (μm)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)	ΔN^1	Δm^2 ($\mu\text{g}\cdot\text{m}^{-3}$)	DMF ³ ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$)
100	200	34	28	323	32	27	304			
200	300	16	62	675	37	142	1560			
300	400	2	27	221	14	148	1550			
400	500	2	45	452	8	179	1810			
500	600	0	0	0	4	164	1600			
600	700	2	135	1260	0	0	0			
700	800	2	207	1850	4	415	3690			
800	900	2	302	2570	0	0	0			
900	1000	5	1050	8540	1	211	1710			
1000	1200	0	0	0	2	748	5680			
1200	1400	0	0	0	2	1085	7630			
1400	1600	1	749	5020	0	0	0			
1600	1800	1	1320	7770	0	0	0			
1800	2000	1	1820	10000	0	0	0			
2000	2200				1	2440	12500			
2200	2400									
2400	2600									
2600	2800									
2800	3000									
3000	3200									
3200	3400									
TOTALS:		71	5740	38700	108	5560	38000			

¹ ΔN = Total droplet count

² Δm = Total drift mass concentration or density

³DMF = Drift mass flux

APPENDIX E

DEPOSITION LISTINGS

TABLE E1.1. Drift Droplet Deposition, Test Run 1, 16 June 1978

Bin No.	D _L (μm)	D _U (μm)	D _M (μm)	Station OA				Station OBN-2				Station OBN			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126					10	18	10	25				
2	142	178	159					0	0	0	0				
3	178	224	200					86	860	86	860	35	350	35	350
4	224	282	252	6	60	6	60	0	0	62	1230	0	0	21	420
5	282	356	317	0		7	159								
6	356	448	399	7	200	2	79	62	1700	76	3000	21	590	16	630
7	448	563	502	3	113	1	56	76	4900	32	2085	16	1040	10	630
8	563	709	632					32	4200	20	2630	10	1250	7	1010
9	709	893	796					11	1750	7	2010	2	630	2	630
10	893	1124	1000					11	5300	2	1250	5	2200		
11	1124	1415	1260					5	4400	2	1770	2	1800		
12	1415	1780	1590					4	8500						
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				16	373	16	334	297	41200	297	14900	91	7860	91	3670

¹Meyer calibration

²ESC calibration plus adjustment

TABLE E1.1. (Continued)

Bin No.	D _L (μm)	D _U (μm)	D _M (μm)	Station OBS-1				Station OBS-2				Station OC			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159	31	55	31	77	159	280	159	400	10	18	10	25
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	215	2100	215	2130	117	970	117	970	150	1500	150	1500
5	282	356	317	0	0	119	2360	89	1520	149	2440	0	0	93	1840
6	356	448	399	119	3300	139	5490	100	3300	103	3610	93	2600	77	3040
7	448	563	502	139	8800	51	3240	63	4400	77	5170	77	5300	40	2670
8	563	709	632	51	6500	50	6790	77	10400	61	8200	40	5300	30	4340
9	709	893	796	38	9800	5	1570	48	12400	19	4950	17	4600	6	1610
10	893	1124	1000	12	5300	3	1250	24	12700	14	7480	16	7700	2	1070
11	1124	1415	1260	6	5700	2	2130	15	15900	5	4550	4	4000	0	0
12	1415	1780	1590	3	6000	1	1760	11	22000			1	1800	1	1760
13	1780	2240	2000	2	8500			1	3500			1	5000		
14	2240	2820	2520												
15	2820	3550	3170											1*	19800*
16	3550	4470	3990												
17	4470	5630	5020									1*	56000*		
Total				616	56100	616	26800	704	87400	704	37800	409	37800	409	17900

¹Meyer calibration²ESC calibration plus adjustment

*Not included in total

TABLE E1.1. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station OD				Station 1A*				Station 1B			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159												
3	178	224	200												
4	224	282	252	36	360	36	360	13	23	13	32				
5	282	356	317	0	0	16	320	0	0	0	0	42	420	42	420
6	356	448	399									0	0	23	455
7	448	563	502	16	450	15	590	10	76	10	76				
8	563	709	632	15	1020	5	300	4	62	5	76				
9	709	893	796	5	610	0	0	3	107	6	210	23	650	35	1380
10	893	1124	1000	0	0	1	310	4	296	1	79	35	2250	12	740
11	1124	1415	1260	0	0			1	160			12	1470	4	740
12	1415	1780	1590									2	540	2	1690
13	1780	2240	2000									3	1520		
14	2240	2820	2520	1	890										
15	2820	3550	3170									1	890		
16	3550	4470	3990												
17	4470	5630	5020												
Total				73	3300	73	1880	35	724	35	470	118	7740	118	5430

¹Meyer calibration²ESC calibration plus adjustment

*Area method

TABLE E1.1. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1C1				Station 1C2				Station 1D			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	6	11	6	15	3	5	3	7	13	23	13	32
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	112	1100	112	1100	19	190	19	190	100	1000	100	1000
5	282	356	317	0	0	103	2040	0	0	35	690	0	0	110	2180
6	356	448	399	103	2900	103	4070	35	980	29	1150	110	3100	106	4190
7	448	563	502	103	6800	39	2640	29	1830	8	540	106	6900	53	3510
8	563	709	632	39	5300	35	4800	8	1080	11	1680	53	7000	36	4730
9	708	893	796	25	6500	11	3360	5	1520	5	1390	27	6700	8	4200
10	893	1124	1000	11	5130	4	2120	8	4000	1	440	11	5300	4	2140
11	1124	1415	1260	12	11400	0	0	4	4000	0	0	8	7800	1	1250
12	1415	1780	1590	2	3500	2	4250	0	0	2	4980	2	3500	0	0
13	1780	2240	2000	1	5000			0	0			1	3500	1*	4970*
14	2240	2820	2520	1	7100			2	14000			0		1*	9910*
15	2820	3550	3170									1*	14000*		
16	3550	4470	3990									1*	28000*		
17	4470	5630	5020												
Total				415	54700	415	24400	113	27600	113	11100	431	44800	431	23200

¹Meyer calibration²ESC calibration plus adjustment

*Not included in total

TABLE E1.1. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1E				Station 1F (Area Method)				Station 1G (Area Method)			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	3	5	3	7	14	25	14	35	4	7	4	10
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	29	290	29	290	2	17	2	17	1	7	1	7
5	282	356	317	0	0	23	460	1	20	2	34	1	14	1	14
6	356	448	399	23	650	16	630	2	68	2	68				
7	448	563	502	16	970	1	60	1	79	1	56				
8	563	709	632	1	110	0	0	1	110						
9	709	893	796	0	0	1	220								
10	893	1124	1000	1	630							1*	630*	1*	220*
11	1124	1415	1260												
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				73	2660	73	1670	21	319	21	210	6	28	6	31

¹Meyer calibration²ESC calibration plus adjustment

* Not included in total.

TABLE E1.1. (Continued)

Bin No.	D _L (μm)	D _U (μm)	D _M (μm)	Station 1I				Station 1J (Area Method)				Station 2B (Area Method)			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159	17	30	17	42	1	1.8	1	2.5	1	1.8	1	2.5
3	178	224	200	0	0	0	0								
4	224	282	252	1	7	1	7								
5	282	356	317	4	80	6	40	1	20	1	14				
6	356	448	399	5	176	6	203								
7	448	563	502	3	189	2	135								
8	563	709	632	2	270	2	222								
9	709	893	796	2	450	1	222								
10	893	1124	1000	1	630										
11	1124	1415	1260												
12	1415	1780	1540												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				35	1830	35	871	2	22	2	17	1	1.8	1	2.5

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.1. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 2E (Area Method)				Station 2F (Area Method)				Station 2G & 2H (Area Method)			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	16	28	16	40	3	5	3	7	1,1	1.8,1.8	1,1	2.5,2.5
3	178	224	200	0	0	0	0	0	0	0	0				
4	224	282	252	13	106	13	106	3	27	3	27				
5	282	356	317	13	210	18	280	1	14	4	73				
6	356	448	399	6	180	5	186	5	163	5	175				
7	448	563	502	4	249	0	0	3	216	3	216				
8	563	708	632	0	0	1	111	3	430	2	268				
9	709	893	796	1	220			2	540						
10	893	1124	1000												
11	1124	1415	1260												
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				53	993	53	723	20	1395	20	766	1,1	1.8,1.8	1,1	2.5,2.5

¹Meyer calibration²ESC calibration

TABLE E1.1. (Continued)

Bin No.	D _L (μm)	D _U (μm)	D _M (μm)	Station 3A (Area Method)				Station 3B (Area Method)				Station 3C,3F (Area Method)			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159	5	9	5	12	7	12	7	17	1	2	1	2
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	5	35	5	35	4	37	4	37	2	20	2	20
5	282	356	317	4	80	8	136	2	28	6	108	3	54	4	62
6	356	448	399	6	189	6	214	4	110	1	40	1	28	1,1	40,40
7	448	563	502	4	296	3	214	1	56	4	135	1,1	56,56		
8	563	709	632	3	430	4	536	4	540	1	111				
9	709	893	796	3	770			1	220	1	314				
10	893	1124	1000	1	450			0							
11	1124	1415	1260					1	890						
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3440	4470	3990												
17	4470	5630	5020												
Total				31	2260	31	1150	24	1890	24	762	8,1	160,56	8,1	124,40

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.2. Drift Droplet Deposition Spectra, Test Run 2, 17 June 1978

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station OC (Area)				Station 1D-1 (Area)				Station 1D-2 (Area)			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126					173	310	173	430	2	5		
2	142	178	159					0	0	0	0	0	0	2	7
3	178	224	200					126	1050	126	1050	31	272	31	272
4	224	282	252					78	1360	137	2260	65	830	65	1030
5	282	356	317												
6	356	448	399	1	40	2	68	94	3100	110	3940	45	1550	73	2600
7	448	563	502	1	56			75	5000	44	2850	48	3300	17	1060
8	563	709	632					44	5700	34	4650	17	2090	21	2880
9	709	893	796					26	6800	3	670	18	4800	6	1610
10	893	1124	1000					11	5500	3	1330	6	3200		
11	1124	1415	1260					3	3800			3	2700		
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				2	96	2	68	630	32100	630	17180	215	18700	215	9460

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.2. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1E				Station 1F				Station 1AD			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	2	4	2	5	5	9	5	12	7	12	7	17
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	85	850	85	850	13	130	13	130	13	130	13	130
5	282	356	317	0	0	38	750	0	0	1	20	0	0	11	220
6	356	448	399	38	1100	21	830	1	28	9	356	11	310	18	710
7	448	563	502	21	1330	3	170	9	580	3	190	18	1150	9	570
8	563	709	632	3	340	1	160	3	380	3	470	9	1140	7	690
9	709	893	796	0				1	320	2	630	5	1300	4	1260
10	893	1124	1000	1	450			2	890			2	890	1	630
11	1124	1415	1260					2	1800			4	3600		
12	1415	1780	1590									1	1800		
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				150	4070	150	2770	36	4140	36	1790	70	10300	70	4230

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.2. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1AE				Station 1AF				Station 2G			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	7	12	7	17								
3	178	224	200	0	0	0	0								
4	224	282	252	76	760	76	760	1	10	1	10	3	30	3	30
5	282	356	317	0	0	64	1270	0	0	2	40	0	0	4	80
6	356	448	399	64	1800	36	1420	2	56	2	79	4	110		
7	448	563	502	36	2400	6	360	2	135						
8	563	709	632	6	720	8	1070								
9	709	893	796	5	1210	1	310								
10	893	1124	1000	3	1300	1	630								
11	1124	1415	1260	1	890										
12	1415	1780	1590	1	1800										
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				199	10900	199	5840	5	201	5	129	7	140	7	110

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.3. Drift Droplet Deposition Spectra, Test Run 3, 15 June 1978

Bin No.	D_L (μm)	D_U (μm)	D_M (μm)	Station OC				Station OD				Station ID			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159	12	21	12	30	32	57	32	30	6	11	6	15
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	57	570	57	570	184	1800	184	1800	64	640	64	640
5	282	356	317	0	0	43	850	0	0	134	2650	0	0	46	910
6	356	448	399	43	1200	41	1620	134	3800	113	4460	46	1300	38	1500
7	448	563	502	41	2850	18	1170	113	7400	27	1740	38	2400	11	730
8	563	709	632	28	2300	24	3310	27	3500	12	1560	11	1460	11	1500
9	709	893	796	14	3500	5	1110	9	2230	2	630	6	1420	1	310
10	893	1124	1000	14	7100	0	0	3	1300			5	2200	1	440
11	1124	1415	1260	0	0	1	890	2	1800			2	2190	1	890
12	1415	1780	1590	1	2500							1	2500		
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				200	20000	200	9550	504	21900	504	12900	179	14100	179	6940

¹Meyer calibration

²ESC calibration plus adjustment

TABLE E1.2. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station <u>2H</u>				Station _____				Station _____			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159												
3	178	224	200												
4	224	282	252	2	20	2	20								
5	282	356	317	0	0	4	80								
6	356	448	399	4	110	2	79								
7	448	563	502	2	135										
8	563	709	632												
9	709	893	796												
10	893	1124	1000												
11	1124	1415	1260												
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				8	265	8	179								

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.3. (Continued)

Bin No.	D_L (μm)	D_U (μm)	D_M (μm)	Station 1E				Station 1G				Station 1I			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159	10	18	10	25	1	2	1	2	1	2	1	2
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	37	370	37	370	4	40	4	40	5	50	5	50
5	282	356	317	0	0	29	570	0	0	6	120	0	0	9	180
6	356	448	399	29	810	23	910	6	170	5	200	9	250	6	240
7	448	563	502	23	1490	6	360	5	350	1	80	6	340	1	80
8	563	709	632	6	720	2	310	1	160			1	160	0	0
9	709	893	796	1	320	1	320					0	0	1	220
10	893	1124	1000	1	450							1	630		
11	1124	1415	1260	1	890										
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				108	5070	108	2870	17	722	17	440	23	1430	23	770

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.3. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1J				Station 2H				Station			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159												
3	178	224	200												
4	224	282	252												
5	282	356	317												
6	356	448	399												
7	448	563	502												
8	563	709	632												
9	709	893	796												
10	893	1124	1000												
11	1124	1415	1260												
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				5	260	5	170	7	660	7	370				

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.4. Drift Droplet Deposition Spectra, Test Run 4, 21 June 1978

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station OA-1 (Tilt)				Station ³ OA-2 (Tilt)				Station ⁴ OA-2 (Tilt)			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126			119	100			154	140			119	100
2	142	178	159	119	210	0	0	154	270	0	0	119	210	0	0
3	178	224	200	0	0	641	3190	0	0	496	2470	0	0	861	4280
4	224	282	252	641	6400	0	0	496	4900	0	0	861	8600	0	0
5	282	356	317	0	0	454	6360	0	0	355	4970	0	0	477	6680
6	356	448	399	454	13000	345	10900	355	10000	241	7680	477	13000	350	11230
7	448	563	502	345	21600	124	8000	241	15400	79	5240	350	22800	111	7000
8	563	709	632	124	16100	41	5330	79	10500	28	3570	111	14000	24	3260
9	709	893	796	41	10800	31	7990	28	7200	17	4420	24	6600	21	5310
10	893	1124	1000	31	16000	6	3020	17	8900	3	1510	21	10600	2	890
11	1124	1415	1260	6	6100			3	3100			2	1800		
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				1761	90200	1761	44900	1373	60300	1373	35300	1965	77600	1965	32100

¹Meyer calibration, droplet settling velocity only.

²ESC calibration, 45° impaction, 7.5 ms⁻¹.

³Original measurement (10-27-78).

⁴Remeasurement (4-10-79).

TABLE E1.4. (Continued)

Bin No.	D_L (μm)	D_U (μm)	D_M (μm)	Station ⁴ OS-2 (Tilt)				Station ⁶ OA-2 (Tilt)				Station ⁵ OA-2 (Tilt)			
				Number ⁵	Mass ⁵ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ⁵	Mass ⁵ (μg)	Number ²	Mass ² (μg)
1	112	142	126			126	110	954	1030	849	890	703	720	696	710
2	142	178	159	126	220	0	0	849	1790	718	1490	696	1430	939	1970
3	178	224	200	0	0	830	2920	718	3000	1048	4550	939	4000	767	3070
4	224	282	252	830	5900	448	4440	1048	9100	636	5150	767	6100	402	3230
5	282	356	317	448	8900	228	4510	636	10300	175	2450	402	6500	435	7410
6	356	448	399	228	9000	114	3190	175	4900	350	11200	435	14800	114	3190
7	448	563	502	114	6400	101	6510	350	32800	111	7000	114	6400	101	6510
8	563	709	632	101	13000	30	3610	111	14000	24	3260	101	13000	30	3610
9	709	893	796	30	7300	11	2630	24	6600	21	5310	30	7300	11	2630
10	893	1124	1000	11	5300	2	890	21	10600	2	890	11	5300	2	890
11	1124	1415	1260	2	1800			2	1800						
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				1890	56800	1890	28800	4888	85900	3934	42200	4200	67400	3504	33200

¹Meyer calibration, droplet settling velocity only.²ESC calibration, 45° impaction, 7.5 ms⁻¹.⁴Remeasurement (4-10-79).⁵ESC calibration, droplet settling velocity only.⁶Remeasurement (4-12-79), expanded lower range ($\sim \times 10$ magnification).

TABLE E1.4. (Continued)

Bin no.	D_L (μm)	D_U (μm)	D_M (μm)	Station ⁷ OA-2 (Tilt)				Station OA-3 (Tilt)				Station OA-4 (Tilt)			
				Number	Mass (μg)	Number	Mass (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126	1288	1250					129	110			9	8
2	142	178	159	1075	2430			129	230	0	0	9	16	0	0
3	178	224	200	580	2230			0	0	529	2630	0	0	97	482
4	224	282	252	281	2400			529	5300	0	0	97	970	0	0
5	282	356	317	257	4210			0	0	347	4860	0	0	55	770
6	356	448	399	105	3220			347	9800	305	9920	55	1500	64	2140
7	448	563	502	32	2080			305	19500	74	4680	64	4300	18	1170
8	563	709	632	18	2230			74	9400	31	3860	18	2300	5	600
9	709	893	796	2	440			31	7700	17	4330	5	1210	6	1420
10	893	1124	1000					17	8700	1	440	6	2830		
11	1124	1415	1260					1	890						
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				3638	20500			1433	61800	1433	30800	254	13100	254	6590

¹Meyer calibration, droplet settling velocity only.²ESC calibration, 45° impaction, 7.5 m.s⁻¹⁷ESC measurement with ESC calibration (normalized to equivalent area of 3, 4, 6 above).

TABLE E1.4. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station OA-1				Station OA-2				Station OA-3			
				Number ¹	Mass ¹ (μ g)	Number ³	Mass ³ (μ g)	Number ¹	Mass ¹ (μ g)	Number ³	Mass ³ (μ g)	Number ¹	Mass ¹ (μ g)	Number ³	Mass ³ (μ g)
1	112	142	126												
2	142	178	159	62	110	62	150	79	140	79	200	75	130	75	190
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	282	2800	282	2800	240	2400	240	2400	250	2500	250	2500
5	282	356	317	0	0	160	3170	0	0	161	3170	0	0	176	3490
6	356	448	399	160	4500	129	5100	161	4500	125	4940	176	4900	133	5250
7	448	563	502	129	8300	32	2130	125	8100	29	1920	133	8400	39	2590
8	563	709	632	32	4300	12	1610	29	3900	12	1700	39	5100	19	2570
9	709	893	796	8	1930	4	980	9	2490	3	670	12	2950	4	890
10	893	1124	1000	7	3700			6	3200			11	5600	1	440
11	1124	1415	1260	1	890							1	1300		
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				681	26500	681	15900	649	24700	649	15000	697	30900	697	17900

¹Meyer calibration³ESC calibration plus adjustment

TABLE E1.4. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station OA-4				Station OBN				Station OBS			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126					69	120	69	170				
2	142	178	159	11	20	11	30	0	0	0	0				
3	178	224	200	0	0	0	0	0	0	0	0				
4	224	282	252	49	490	49	490	238	2400	238	2400	31	31	31	310
5	282	356	317	0	0	35	690	0	0	177	3500	0	0	33	650
6	356	448	399	35	980	31	1220	177	5000	146	5770	33	930	27	1070
7	448	563	502	31	1910	10	670	146	9600	53	3560	27	1740	12	880
8	563	709	632	5	560	1	160	53	7100	35	4800	12	1740	15	2170
9	709	893	796	5	1100	1	310	27	7100	11	2810	9	2490	9	2370
10	893	1124	1000	2	1080			15	8000	4	640	11	5800	1	440
11	1124	1415	1260	1	1300			7	7400	2	1770	5	4900	1	890
12	1415	1780	1590					3	6800			1	2500		
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				139	7740	139	3570	735	53500	735	25400	129	20400	129	8780

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.4. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station <u>1Z</u>				Station <u>1Y</u>				Station <u>1A</u>			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159												
3	178	224	200												
4	224	282	252	4	40	4	40	16	160	16	160	6	60	6	60
5	282	356	317	0	0	9	180	0	0	11	220	0	0	7	140
6	356	448	399	9	250			11	310	12	470	7	200	6	240
7	448	563	502					12	740	1	56	6	380	3	190
8	563	709	632					1	110			3	380		
9	709	893	796												
10	893	1124	1000												
11	1124	1415	1260												
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				13	290	13	220	40	1320	40	910	22	1020	22	630

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.4. (Continued)

Bin No.	D_L (μm)	D_U (μm)	D_M (μm)	Station 1B				Station 1C				Station 1AZ			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159					1	2	1	2				
3	178	224	200					0	0	0	0				
4	224	282	252	7	70	7	70	5	50	5	50	6	60	6	60
5	282	356	317	0	0	6	120	0	0	3	60	0	0	7	140
6	356	448	399	6	170	4	160	3	84	2	79	7	200	7	280
7	448	563	502	4	250	0	0	2	110			7	420		
8	563	709	632	0	0	1	110			1*	160*			1	110
9	709	893	796	1	120							1	120		
10	893	1124	1000					1*	450*						
11	1124	1415	1260												
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				18	710	18	460	11	246	11	191	21	900	21	590

¹Meyer calibration.²ESC calibration plus adjustment.

*Not included in total.

TABLE E1.4. (Continued)

Bin No.	D_L (μm)	D_U (μm)	D_M (μm)	Station 1AA				Station 1AB				Station 1AC			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159	1	2	1	2								
3	178	224	200	0	0	0	0								
4	224	282	252	6	60	6	60	10	100	10	100	3	30	3	30
5	282	356	317	0	0	3	60	0	0	3	60	0	0	5	100
6	356	448	399	3	84	5	200	3	89	6	240	5	140	3	120
7	448	563	502	5	330	0	0	6	410	4	270	3	176	2	135
8	563	709	632	0	0	1	160	4	540			2	270	3	330
9	709	893	796	1	320							3	670		
10	893	1124	1000												
11	1124	1415	1260												
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				16	800	16	460	23	1130	23	670	16	1290	16	720

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.4. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station <u>2A</u>				Station _____				Station _____			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159												
3	178	224	200												
4	224	282	252												
5	282	356	317												
6	356	448	399												
7	448	563	502												
8	563	709	632												
9	709	893	796												
10	893	1124	1000												
11	1124	1415	1260												
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				11	280	11	210								

¹Meyer calibration

²ESC calibration plus adjustment

*Not included in total.

TABLE E1.5. Drift Droplet Deposition Spectra, Test Run 5, 18 June 1978

Bin No.	D _L (μm)	D _U (μm)	D _M (μm)	Station 1Z				Station 1Y-1				Station 1Y-2			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159												
3	178	224	200												
4	224	282	252	8	80	8	80								
5	282	356	317	0	0	0	0								
6	356	448	399	0	0	1	40								
7	448	563	502	1	79										
8	563	709	632												
9	709	893	796												
10	893	1124	1000												
11	1124	1415	1260												
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				9	159	9	120	367	29200	367	13400	59	1920	59	1280

¹Meyer calibration

²ESC calibration plus adjustment

*Not included in total

TABLE E1.5. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1A-1				Station 1A-2				Station 1A-3			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	46	82	46	115	34	60	34	85	26	46	26	65
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	124	1200	124	1200	125	1250	125	1250	41	410	41	410
5	282	356	317	0	0	109	2160	0	0	94	1860	0	0	43	850
6	356	448	399	109	3100	101	3990	94	2600	85	3360	43	1200	19	750
7	448	563	502	101	6700	58	3700	85	5800	34	2170	19	1180	10	630
8	563	709	632	58	7500	29	4050	34	4400	35	4990	10	1250	8	1210
9	709	893	796	18	4700	8	2050	20	5300	8	1960	2	540	3	670
10	893	1124	1000	16	8000	2	1070	21	10500	2	890	9	4600		
11	1124	1415	1260	4	4000			4	4300	1	1250				
12	1415	1780	1590	1	1800			0	0						
13	1780	2240	2000					1	3500						
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				477	37100	477	18300	418	37700	418	17800	150	9230	150	4580

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.5. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1B-1				Station 1B-2				Station 1B-3			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	167	380	167	420	112	200	112	280	104	180	104	260
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	165	1650	165	1650	128	1280	128	1280	83	830	83	830
5	282	356	317	0	0	142	2810	0	0	91	1800	0	0	59	1170
6	356	448	399	142	4000	119	4580	91	2600	79	3120	59	1700	49	1940
7	448	563	502	119	7700	56	3700	79	5300	31	2010	49	3300	31	2050
8	563	709	632	56	7400	49	6820	31	4000	27	3600	31	4100	16	1070
9	709	893	796	31	8000	11	2720	20	5000	4	1070	9	2120	5	1200
10	893	1124	1000	26	13000	5	2580	9	4400	4	2140	11	5600	4	1960
11	1124	1415	1260	6	6500	1	1250	4	4300	1	890	4	4690	2	2500
12	1415	1780	1590	2	3500			3	6000			1	1800		
13	1780	2240	2000	1	3500							2	7100		
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				715	55600	715	26500	477	33100	477	17200	353	34300	353	13000

¹Meyer calibration

²ESC calibration plus adjustment

TABLE E1.5. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1C				Station 1AZ				Station 1AA-1			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	58	100	58	140	10	18	10	25	63	110	63	160
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	42	420	42	420	22	220	22	220	152	1500	152	1500
5	282	356	317	0	0	20	400	0	0	16	320	0	0	126	2500
6	356	448	399	20	560	30	1180	16	450	11	435	126	3500	159	6280
7	448	563	502	30	1890	7	460	11	690	6	400	159	10600	65	4340
8	563	709	632	7	920	15	2200	6	810	4	540	65	8700	52	7150
9	709	893	796	6	1620	2	630	3	770	1	220	38	9900	17	4510
10	893	1124	1000	9	4000	1	440	2	1080			23	11900	5	2400
11	1124	1415	1260	3	3100	1	890					12	12100	4	3900
12	1415	1780	1590	1	2500							4	9300		
13	1780	2240	2000									1	3500		
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				176	15100	176	6780	70	4040	70	2160	643	71100	643	32700

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.5. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1AA-2				Station 1AB				Station 2A			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	28	50	28	70	15	27	15	40	11	20	11	27
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	38	380	38	380	60	600	60	600	27	270	27	270
5	282	356	317	0	0	36	710	0	0	49	970	0	0	27	535
6	356	448	399	36	1000	28	1110	49	1400	37	1460	27	760	23	910
7	448	563	502	28	1790	19	1240	37	2400	15	1020	23	1540	8	560
8	563	709	632	19	2500	9	1320	15	2080	20	2910	8	1130	1	160
9	709	893	796	4	1080	2	440	12	3300	8	1870	1	320	1	320
10	893	1124	1000	7	3500			15	8000	4	2320	0	0		
11	1124	1415	1260					2	2190	1	890	1	890		
12	1415	1780	1590					4	7800						
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				160	10300	160	5270	209	27800	209	12100	98	4930	98	2780

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.5. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station <u>2B</u>				Station _____				Station _____			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	17	30	17	40								
3	178	224	200	0	0	0	0								
4	224	282	252	67	670	67	670								
5	282	356	317	0	0	51	1010								
6	356	448	399	51	1400	57	2250								
7	448	563	502	57	3800	16	1030								
8	563	709	632	16	2050	18	940								
9	709	893	796	15	3650	4	1070								
10	893	1124	1000	5	2600										
11	1124	1415	1260	2	1800										
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				230	16000	230	7010								

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.6. Drift Droplet Deposition Spectra, Test Run 6, 22 June 1978

Bin No.	D_L (μm)	D_U (μm)	D_M (μm)	Station OA-1				Station OA-2				Station OA-3			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159	181	320	181	450	322	570	322	800	318	560	318	790
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	195	1950	195	1950	334	3300	334	3300	169	1700	169	1700
5	282	356	317	0	0	117	2320	0	0	235	4650	0	0	129	2550
6	356	448	399	117	3300	96	3800	235	6600	153	6040	129	3600	101	3990
7	448	563	502	96	6300	30	2020	153	9800	53	3420	101	6700	29	1960
8	563	709	632	30	4100	13	1810	53	6900	29	4050	29	4000	16	2100
9	709	893	796	11	3000	2	440	21	5700	16	4010	12	2950	4	980
10	893	1124	1000	4	2190	3	1510	19	10500	5	2400	7	3700	1	630
11	1124	1415	1260	2	2500			9	9400	1	1250	1	890		
12	1415	1780	1590	1	1800			1	1800			1	1800		
13	1780	2240	2000					1	3500						
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				637	25400	637	14300	1148	58100	1148	29900	767	25900	767	14700

¹Meyer calibration

²ESC calibration plus adjustment

TABLE E1.6. (Continued)

Bin No.	D_L (μm)	D_U (μm)	D_M (μm)	Station <u>OA-4</u>				Station <u>OBN-1</u>				Station <u>OBN-2</u>			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159	203	360	203	500	266	470	266	660	264	470	264	660
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	169	1700	169	1700	227	2300	227	2300	298	3000	298	3000
5	282	356	317	0	0	103	2040	0	0	181	3580	0	0	188	3720
6	356	448	399	103	2900	64	2530	181	5100	133	5250	188	5300	165	6520
7	448	563	502	64	4200	26	1730	133	8600	46	2890	165	11100	81	5420
8	563	709	632	26	3500	11	1410	46	5800	29	4050	81	10900	45	6560
9	709	893	796	7	1600	1	220	15	3800	9	2550	26	7200	11	3000
10	893	1124	1000	5	2430			17	8100	5	2220	24	11600	9	4900
11	1124	1415	1260					11	11600	1	890	10	10300	2	890
12	1415	1780	1590					1	2500			7	13900	1	2490
13	1780	2240	2000									0	0		
14	2240	2820	2520									1	7100		
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				577	16700	577	10100	897	48300	897	24400	1064	80900	1064	37200

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.6. (Continued)

Bin No.	D _L (μm)	D _U (μm)	D _M (μm)	Station <u>OBN-3</u>				Station <u>OBS</u>				Station <u>1ZZ</u>			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159	152	270	152	380	15	27	15	37	176	310	176	440
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	217	2200	217	2200	10	100	10	100	183	1800	183	1800
5	282	356	317	0	0	159	3150	0	0	5	100	0	0	151	2990
6	356	448	399	159	4500	113	4460	5	140	7	280	151	4200	121	4780
7	448	563	502	113	7400	36	2350	7	490			121	7800	36	2240
8	563	709	632	36	4700	38	5320					36	4500	21	2610
9	709	893	796	23	5900	6	1610					17	3930	3	850
10	893	1124	1000	18	8600	5	2400					5	2430	2	890
11	1124	1415	1260	7	7700							4	4300		
12	1415	1780	1590	1	1800										
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				726	43100	726	21900	37	760	37	520	693	29300	693	16600

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.6. (Continued)

Bin No.	D_L (μm)	D_U (μm)	D_M (μm)	Station 1Z				Station 1Y-1				Station 1Y-2			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159	84	150	84	210	127	230	127	320	267	470	267	660
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	92	920	42	920	264	2640	264	2640	185	1850	185	1850
5	282	356	317	0	0	49	970	0	0	179	3540	0	0	111	2200
6	356	448	399	49	1400	47	1860	179	5000	104	4110	111	3100	88	3480
7	448	563	502	47	3100	5	320	104	7000	28	1840	88	5700	24	1590
8	563	709	632	5	660	3	430	28	3700	10	1300	24	3200	9	1280
9	709	893	796	2	540	1	220	8	1930			8	2270	1	220
10	893	1124	1000	2	1080			2	890			2	1080	1	440
11	1124	1415	1260									1	1300		
12	1415	1780	1590												
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				281	7850	281	4930	712	21400	712	12800	686	18900	682	11700

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.6. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1A-1				Station 1A-2				Station 1A-3			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	313	560	313	780	189	340	189	470	165	290	165	410
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	250	2500	250	2500	240	2400	240	2400	106	1060	106	1060
5	282	356	317	0	0	227	4500	0	0	198	3920	0	0	85	1680
6	356	448	399	227	6400	183	7230	198	5600	160	6320	85	2400	59	2330
7	448	563	502	183	11800	86	5740	160	10400	42	2850	59	3900	12	780
8	563	709	632	86	11500	40	5590	42	5700	15	2030	12	1570	11	1500
9	709	893	796	29	7700	8	2140	13	3500	4	890	7	1730	3	940
10	893	1124	1000	15	7400	4	2320	6	3390	1	630	4	1800		
11	1124	1415	1260	5	4900	1	1250	0	0			3	2700		
12	1415	1780	1590	12	5300			1	1800						
13	1780	2240	2000	1	3500										
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				1112	61600	1112	32000	849	33100	849	19500	441	15500	441	8700

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.6. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1B-1				Station 1B-2				Station 1B-3			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	170	300	170	420	326	580	326	810	161	290	161	400
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	183	1800	183	1800	241	2400	241	2400	171	1700	171	1700
5	282	356	317	0	0	146	2890	0	0	177	3500	0	0	157	3110
6	356	448	399	146	4100	89	3520	177	5000	169	6680	157	4400	171	6750
7	448	563	502	89	5900	35	2230	169	10800	51	3420	171	11100	64	4280
8	563	709	632	35	4500	31	4360	51	6800	49	6770	64	8600	42	4400
9	709	893	796	21	5700	10	2590	32	8300	17	4790	25	6600	14	3570
10	893	1124	1000	16	8300	4	1960	23	11400	5	2220	26	13300	4	1960
11	1124	1415	1260	7	7400			16	16100	2	2130	8	8200	4	4640
12	1415	1780	1590	1	1800			1	2500			2	4300		
13	1780	2240	2000					1	3500			3	10000		
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				668	39800	668	19800	1037	67400	1037	32700	788	69500	788	30800

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.6. (Continued)

Bin No.	D_L (μm)	D_U (μm)	D_M (μm)	Station 1AZ				Station 1AA				Station 1AB			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159	58	100	58	140	213	380	213	530	32	60	32	80
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	52	520	52	520	289	2900	289	2900	25	250	25	250
5	282	356	317	0	0	53	1050	0	0	205	4000	0	0	31	610
6	356	448	399	53	1500	33	1300	205	5800	183	7230	31	870	28	1100
7	448	563	502	33	2200	8	540	183	12100	67	4430	28	1850	8	160
8	563	709	632	8	1080	6	850	67	8800	47	6600	8	990	5	690
9	709	893	796	6	1750	2	630	30	7900	9	2460	4	1080	1	220
10	893	1124	1000	0	0			21	10100	5	2760	2	1080		
11	1124	1415	1260	2	1800			7	6900						
12	1415	1780	1590					3	5300						
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				212	8950	212	5030	1018	60200	1018	30900	130	6180	130	3610

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.6. (Continued)

Bin No.	D_L (μm)	D_U (μm)	D_M (μm)	Station 2A				Station 2B				Station OA-1 (Tilt)			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ³	Mass ³ (μg)
E-38	1	112	142											91	80
	2	142	178	34	60	34	80	51	90	51	130	91	160	0	0
	3	178	224	0	0	0	0	0	0	0	0	0	0	470	2340
	4	224	282	39	390	39	390	94	940	94	940	470	4700	0	0
	5	282	356	0	0	30	590	0	0	79	1560	0	0	370	5180
	6	356	448	30	840	21	830	79	2200	70	2760	370	10000	260	8470
	7	448	563	21	1360	6	380	70	4400	12	740	260	17000	93	5970
	8	563	709	6	770	3	380	12	1470	17	2260	93	12000	28	3710
	9	709	893	2	450	1	220	14	3600	6	1610	28	7400	11	2720
	10	893	1124	10	1080			6	3200	2	630	11	5500	8	3910
	11	1124	1415					3	2700			8	7800	2	1770
	12	1415	1780					2	3500			2	3500		
	13	1780	2240												
	14	2240	2820												
	15	2820	3550												
	16	3550	4470												
	17	4470	5630												
Total				134	4950	134	2870	331	22100	331	10600	1333	68100	1333	34200

¹Meyer calibration²ESC calibration plus adjustment³ESC calibration, 45° impaction, 7.5 m·s⁻¹

TABLE E1.6. (Continued)

Bin No.	D _L (μm)	D _U (μm)	D _M (μm)	Station OA-2 (Tilt)				Station OA-3 (Tilt)				Station OA-4 (Tilt)			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126			109	100			176	160			191	170
2	142	178	159	109	180	0	0	176	310	0	0	191	340	0	0
3	178	224	200	0	0	329	1640	0	0	404	2010	0	0	292	1450
4	224	282	252	329	3300	0	0	404	4000	0	0	292	2900	0	0
5	282	356	317	0	0	214	3000	0	0	366	5120	0	0	255	3570
6	356	448	399	214	6000	195	6370	366	10000	276	8910	255	7200	213	6790
7	448	563	502	195	12800	85	5410	276	17900	89	5910	213	13600	66	4300
8	563	709	632	85	10900	29	3770	89	11900	41	5241	66	8700	32	4330
9	709	893	796	29	7600	21	5120	41	10500	22	5710	32	8700	21	8670
10	893	1124	1000	21	10200	7	4020	22	11500	5	2400	21	11200	6	3210
11	1124	1415	1260	7	8100	1	890	5	4900	0	0	6	6500	1	1250
12	1415	1780	1590	1	1800	1	1800	0	0	1	1800	1	2500		
13	1780	2240	2000	1	3500			1	3500						
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				991	64400	991	32100	1380	74500	1380	37300	1077	50800	1077	33700

¹Meyer calibration²ESC calibration, 45° impaction, 7.5 m.s⁻¹

TABLE E1.6. (Continued)

Bin No.	D_L (μm)	D_U (μm)	D_M (μm)	Station 1A (Tilt)				Station 1B-1 (Tilt)				Station 1B-2 (Tilt)			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126			231	200			328	290			222	200
2	142	178	159	231	410	0	0	328	580	0	0	222	390	0	0
3	178	224	200	0	0	233	1160	0	0	348	1730	0	0	215	1070
4	224	282	252	233	2300	0	0	348	3500	0	0	215	2100	0	0
5	282	356	317	0	0	217	3040	0	0	319	4470	0	0	185	2590
6	356	448	399	217	6100	253	8170	319	9000	329	10700	185	5200	239	8070
7	448	563	502	253	16300	76	5070	329	21000	133	8640	239	16200	104	6750
8	563	709	632	76	10200	35	4670	133	17300	65	8730	104	13500	60	7760
9	709	893	796	35	9400	18	4460	65	17100	51	12400	60	15600	40	10300
10	893	1124	1000	18	8900	3	1510	51	24500	21	12000	40	20400	10	5350
11	1124	1415	1260	3	3100	1	890	21	24300	10	9570	10	10700	10	11000
12	1415	1780	1590	1	1800			10	19000	2	1800	10	22100	6	12900
13	1780	2240	2000					2	7100	1	3500	6	26000		
14	2240	2820	2520					1	7100						
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total				1067	58500	1067	29200	1607	150000	1607	61800	1091	132000	1091	56100

¹Meyer calibration²ESC calibration, 45° impaction, 7.5 m·s⁻¹

TABLE E1.6. (Continued)

Bin No.	D_L (μm)	D_U (μm)	D_M (μm)	Station 1B-3 (Tilt)				Station _____				Station _____			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126			214	190								
2	142	178	159			0	0								
3	178	224	200			300	1490								
4	224	282	252			0	0								
5	282	356	317			278	3890								
6	356	448	399			298	9840								
7	448	563	502			149	9810								
8	563	709	632			70	9150								
9	709	893	796			52	13000								
10	893	1124	1000			27	13800								
11	1124	1415	1260			5	5150								
12	1415	1780	1590			2	3600								
13	1780	2240	2000												
14	2240	2820	2520												
15	2820	3550	3170												
16	3550	4470	3990												
17	4470	5630	5020												
Total						1395	69900								

¹Meyer calibration

²ESC calibration, 45° impaction, 7.5 m.s⁻¹

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TABLE E1.X. Drift Droplet Deposition Spectra, Test Run X, 25 June 1978 (Near Field Test)

Bin No.	D _L (μm)	D _U (μm)	D _M (μm)	Station 1-1-SU				Station 1-1-N				Station 1-1-S			
				Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)	Number ¹	Mass ¹ (μg)	Number ²	Mass ² (μg)
1	112	142	126												
2	142	178	159					17	30	17	40	9	20	9	20
3	178	224	200					0	0	0	0	0	0	0	0
4	224	282	252	8	80	8	80	45	450	45	450	37	370	37	370
5	282	356	317	0	0	8	160	0	0	33	650	0	0	29	570
6	356	448	399	8	220	4	160	33	930	28	1110	29	810	29	1150
7	448	563	502	4	250	0	0	28	1850	8	580	29	1780	3	540
8	563	709	632	0	0	1	110	8	1170	7	960	8	1080	7	1010
9	709	893	796	9	220			6	1620	0	0	4	1080	2	540
10	893	1124	1000					1	450	2	890	4	1930	5	2950
11	1124	1415	1260					2	2500	1	890	2	2190	2	2190
12	1415	1780	1590					1	2500	3	7500	5	9600	0	0
13	1780	2240	2000					0	0	1	5000	1	3500	0	0
14	2240	2820	2520					3	21000	0	0	0	0	1	7000
15	2820	3550	3170			1*	9910*	1	14000	2	33000	1	20000		
16	3550	4470	3990	1*	28000*	*		1	40000						
17	4470	5630	5020					1	56000						
Total				21	770	21	510	147	143000	147	51000	129	42400	129	14200

¹Meyer calibration

²ESC calibration plus adjustment

* Not included in total

TABLE E1.X. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1-2-N				Station 1-2-S				Station 1-3-N			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	9	20	9	20	18	30	18	40	27	50	27	70
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	25	250	25	250	79	790	79	790	96	960	96	960
5	282	356	317	0	0	11	220	0	0	64	1270	0	0	69	1370
6	356	448	399	11	310	11	440	64	1800	60	2370	69	1900	49	1940
7	448	563	502	11	760	5	330	60	3800	30	1900	49	3200	26	1680
8	563	709	632	5	660	10	1290	30	3800	16	2240	26	3400	28	3890
9	709	893	796	6	1300	1	320	13	3500	3	760	15	3800	10	2500
10	893	1124	1000	4	1800	6	3030	5	2600	4	2140	20	10200	7	3650
11	1124	1415	1260	5	5890	3	3020	3	3390	5	4790	7	7700	5	5160
12	1415	1780	1590	4	8500	3	6100	6	13500	2	4300	6	12800	2	3600
13	1780	2240	2000	3	13500	0	0	2	8500	2	7000	4	17100	6	22600
14	2240	2820	2520	1	7100	4	31000	3	27100	1	7000	5	50000	1	7000
15	2820	3550	3170	3	60000	1	14000	1	20000			2	34000		
16	3550	4470	3990	2	68000									1*	40000
17	4470	5630	5020									1*	110000*		
Total				89	168000	89	60000	284	88800	284	34600	326	145000	326	54400

¹Meyer calibration²ESC calibration plus adjustment

*Not included in total

TABLE E1.X. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1-3-S				Station 1-4-N				Station 1-7-N			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	27	50	27	70	16	30	16	40	2	4	2	5
3	178	224	200	0	0	0	0	0	0	0	0	0	0	0	0
4	224	282	252	68	680	68	680	61	610	61	610	15	150	15	150
5	282	356	317	0	0	54	1070	0	0	39	770	0	0	16	320
6	356	448	399	54	1500	32	1260	39	1100	24	950	16	450	13	510
7	448	563	502	32	1990	15	1000	24	1600	15	1090	13	820	9	620
8	563	709	632	15	1990	16	2100	15	2150	10	1340	9	1240	10	1390
9	709	893	796	12	2950	8	2240	7	1730	7	1920	6	1520	8	2150
10	893	1124	1000	7	3700	3	1700	6	3200	5	2580	8	4300	2	1070
11	1124	1415	1260	6	5700	3	3390	7	7400	3	3390	5	4900	2	1140
12	1415	1780	1590	3	6000	2	3500	3	6000	3	6760	2	4300	2	4300
13	1780	2240	2000	4	17100	1	5000	3	14600	3	14600	2	8500	3	10600
14	2240	2820	2520	0	0	1	9900	4	34000	2	14000	4	37100		
15	2820	3550	3170	1	14000	1	14000	3	54000						
16	3550	4470	3990	2	68000										
17	4470	5630	5020												
Total				231	124000	231	45900	188	124000	188	48000	82	63300	82	22300

¹Meyer calibration²ESC calibration plus adjustment

TABLE E1.X. (Continued)

Bin No.	D _L (μ m)	D _U (μ m)	D _M (μ m)	Station 1-7-S				Station 1-13-G				Station 1-13-GS			
				Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)	Number ¹	Mass ¹ (μ g)	Number ²	Mass ² (μ g)
1	112	142	126												
2	142	178	159	10	20	10	25	2	4	2	5				
3	178	224	200	0	0	0	0	0	0	0	0				
4	224	282	252	28	280	28	280	21	210	21	210	8	80	8	80
5	282	356	317	0	0	22	440	0	0	18	360	0	0	10	200
6	356	448	399	22	620	21	830	18	510	28	1110	10	280	23	910
7	448	563	502	21	1320	13	800	28	1790	7	480	23	1540	20	1440
8	563	709	632	13	1570	13	2000	7	970	16	2280	20	2870	21	3070
9	709	893	796	6	1820	6	1330	9	2400	7	1650	10	2700	10	2590
10	893	1124	1000	13	6900	10	4990	13	6900	7	4020	17	8700	8	4640
11	1124	1415	1260	7	8800	6	6040	3	11400	3	11400	6	6100	6	6100
12	1415	1780	1590	7	15300	3	6760	6	11400	2	4300	10	21000	3	6020
13	1780	2240	2000	3	12100	1	3520	3	12100	0	0	4	17100	3	13500
14	2240	2820	2520	3	24000	2	17000	1	7100	0	0	2	17100		
15	2820	3550	3170	1	20000	1	14000	0	0	1*	14000*	2	28000		
16	3550	4470	3990	2	68000			1*	40000*						
17	4470	5630	5020												
Total				136	161000	136	58000	111	46800	111	25800	112	105000	112	38600

¹Meyer calibration²ESC calibration plus adjustment

*Not included in total

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TABLE E2.1. Drift Mineral Mass Deposition Rates, Test Run 1, 16 June 1978

Sample Interval				Mass Deposition Rate ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{hr}^{-1}$)																				Notes Below	
Sample ID	Start (PDT)	Stop (PDT)	Δt (hr)	SO_4^{--}			NO_3^-			Cl^-			Na^+			K^+			Ca^{++}			Mg^{++}			
				Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	
UUA	0848	1152	3.07	58			51			75			37			8			37			5			
UUB	0852	1155	3.05	76			44			153			107			41			60			16			
UA	0845	1150	3.08	48			40			60			34			11			36			13			
UB	0856	1157	3.02	50			28			35			21			8			63			15			
OA	0840	1147	3.12	35	35	0	32	32	0	34	34	0	29	26	3	11	11	0	17	17	0	5	5	0	
OBN	0830	1115	2.75	278	40	128	78	27	0.9	123	23	100	138	26	112	35	11	24	1425	30	20	185	7	17	1
OBS	0835	1114	2.65	118	41	36	40	27	0.3	100	46	42	57	26	31	16	11	5	136	30	5	24	7	5	
OC1	0823	1110	2.78	1050			171			5370			1370			44			NA			NA			2
OC2	0823	1110	2.78	1190			143			4830			1480			71			NA			NA			2
OD	0824	1111	2.78	257	40	217	106	27	1.6	415	46	257	219	26	192	32	11	21	86	30	32	92	7	29	2
OE	0902	1201	2.98	27	27	0	21	21	0	33	33	0	26	26	0	15	11	1	19	19	0	5	5	0	
1A	0820	1120	3.00	93	41	1	53	27	< 1	54	46	1	19	19	0	5	5	0	42	30	<1	3	3	0	
1B	0816	1116	3.00	66	41	5	25	25	<.1	45	40	5	27	22	5	22	10	1	48	30	0.8	9	7	.7	
1C1	0811	1110	2.98	153	11	142	79	27	1	355	46	166	148	23	125	6	6	0	NA	--	--	NA	--	--	
1C2	0811	1110	2.98	308	41	220	95	27	1.6	440	46	259	217	23	194	10	10	0.4	289	30	33	92	7	29	
1D1	0805	1104	2.98	57	11	46	31	27	1.1	114	46	54	63	22	41	25	10	11	80	30	7	35	7	6	
1D2	0805	1104	2.98	85	26	59	36	27	0.4	126	46	69	74	22	52	13	10	3	NA	--	--	NA	--	--	
1E	0747	1124	3.62	30	30	0	20	20	0	11	11	0	9	9	0	4	4	0	24	24	0	8	7	0	
1F1	0743	1129	3.77	66	30	36	61	27	0.3	79	37	42	49	18	31	36	8	9	53	30	5	29	7	5	
1F2	0743	1129	3.77	67	41	25	51	27	0.2	122	46	29	40	18	22	29	8	6	65	30	3.7	30	7	3.2	
1G	0753	1117	3.40	96	41	19	35	27	0.1	52	36	16	36	20	16	27	9	5	71	30	2.7	5	3.6	1.6	
1I	0912	1204	2.87	41	41	0	18	18	0	32	32	0	18	18	0	27	10	0	26	26	0	4	7	0	
1J	0917	1213	2.93	57	41	0	21	21	0	63	46	<1	20	20	0	7	7	0	32	30	0	5	5	0	
2A	0826	1134	3.13	12	12	0	15	15	0	NA	--	--	1	1	0	5	5	0	10	10	0	1	1	0	
2B	0831	1139	3.13	32	32	0	27	27	0	82	46	<1	13	13	0	7	7	0	24	24	0	7	7	0	
2E	0804	1124	3.33	41	33	8	33	27	0.1	57	46	10	28	21	7	9	8.6	0.6	53	30	1.2	10	7	1.1	
2F1	0805	1123	3.30	46	41	5	32	27	<.1	20	19	1.2	22	21	1.5	15	10	0.4	28	28	0.2	7	7	0.2	
2F2	0805	1123	3.30	17	17	0	16	16	0	6	6	0	4	4	0	1	1	0	9	9	0	2	2	0	
2G1	0810	1127	3.28	43	41	0	16	16	0	6	6	0	10	10	0	39	11	0	16	16	0	6	6	0	
2G2	0810	1127	3.28	15	15	0	11	11	0	5	5	0	9	9	0	0	0	0	15	15	0	4	4	0	
2H1	0810	1128	3.30	36	30	6	51	27	<.1	37	32	5	26	21	5	12	10	1.5	46	30	0.9	15	7	0.8	
2H2	0810	1128	3.30	74	32	41	30	27	0.3	87	38	49	57	21	36	16	9	7	64	30	6	25	7	5.4	
2I	0807	1126	3.32	49	41	8	21	21	0	63	46	10	28	21	7	14	11	2	46	30	1.2	20	7	1.1	
2J	0803	1123	3.33	32	30	2	21	21	0	45	41	4	23	20	3	28	11	0.8	26	22	0.5	8	7	0.4	
2K	0758	1119	3.35	24	24	0	19	19	0	30	30	0	13	13	0	5	5	0	22	22	0	8	7	0	
3A	0753	1141	3.80	54	38	16	38	27	0.1	65	46	19	32	18	14	9	8	1.5	75	30	2.4	16	7	2.1	
3B	0755	1141	3.77	53	41	10	50	27	0.1	41	32	9	27	18	9	9	8	1.4	39	30	1.4	56	7	1.3	
3C	0820	1135	3.25	152	41	26	92	27	0.2	184	46	31	44	21	23	0	0	0	371	30	3.9	55	7	3.4	
3E1	0816	1132	3.27	36	10	26	27	27	0.2	74	43	31	44	21	23	28	11	6.5	71	30	3.9	22	7	3.4	
3E2	0816	1132	3.27	87	10	77	42	27	0.6	172	46	90	88	21	67	53	11	19	56	30	11	19	7	10	
3F	0810	1128	3.30	66	41	0	19	19	0	6	6	0	5	5	0	4	4	0	18	18	0	3	3	0	

¹Some contamination?²Dust contamination

TABLE E2.2. Drift Mineral Mass Deposition Rates, Test Run 2, 17 June 1978

Sample Interval				Mass Deposition Rate ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{hr}^{-1}$)																								See Notes Below
Sample ID	Start (PDT)	Stop (PDT)	Δt (hr)	SO_4^{--}			NO_3^-			Cl^-			Na^+			K^+			Ca^{++}			Mg^{++}						
				Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift				
OA	0945	1304	3.32	28			44			13			12			0			33			4						
OBN	0940	1223	2.72	13			42			10			6			5			7			1						
OBS	0939	1226	2.78	37			69			38			10			0			107			14						
OC	0935	1307	3.53	63			48			7			76			34			26			20						
1C1	0839	1300	4.35	17	17	0	27	27	0	0	0	0	2	2	0	0	0	0	19	19	0	2	2	0				
1C2	0839	1300	4.35	19	19	0	49	40	0	10	10	0	18	10	0	0	0	0	24	19	0	4	4	0				
1D1	0845	1237	3.87	91	22	33	96	40	.3	54	1	53	51	10	41	6	1	2.3	33	20	7	15	4	7.6				
1D2	0845	1237	3.87	55	22	31	120	40	.3	64	9	54	45	7	38	24	1	2.2	37	20	7	21	4	7.1				
1E	0855	1242	3.78	48	22	15	45	40	.1	95	10	35	25	7	18	0	0	0	26	20	3	8	4	3.4				
1F	0926	1246	3.33	28	22	0	44	40	0	8	8	0	13	10	0	0	0	0	23	20	0	5	4	0				
1AA	0910	1258	3.80	70	22	46	86	40	.5	87	10	77	64	7	56	12	1	3.1	80	20	10	16	4	11				
1AB	0903	1255	3.87	65	22	19	91	40	.2	32	1	31	30	7	23	0	0	0	49	20	4	11	4	4.3				
1AC1	0901	1250	3.82	32	22	0	37	37	0	0	0	0	4	4	0	0	0	0	11	11	0	2	2	0				
1AC2	0901	1250	3.82	73	22	4	61	40	<.1	8	2	6	11	7	4	0	0	0	32	20	.8	7	4	.8				
1AD1	0850	1230	3.67	71	22	28	52	40	.3	58	10	48	41	7	34	0	0	0	35	20	6	12	4	6.3				
1AD2	0850	1230	3.67	81	22	48	74	40	.5	80	3	77	66	7	59	3	0	.3	39	20	10	13	4	9				
1AF	1041	1305	2.40	27	22	5	40	40	0	11	2	9	18	10	8	2	1	.4	18	17	.8	6	4	.9				
2E	0857	1304	4.12	22	21	1	41	40	<.1	12	9	3	8	7	1	.6	.5	.1	16	16	.2	2	2	.2				
2F1	0846	1307	4.35	23	20	0	31	31	0	12	10	0	4	4	0	0	0	0	21	20	0	3	3	0				
2F2	0846	1307	4.35	17	8	9	40	40	.1	63	10	33	23	6	17	25	1	1	15	13	2	4	2	2				
2G1	0850	1309	4.32	35	22	0	55	40	0	30	10	0	4	4	0	0	0	0	18	18	0	4	4	0				
2G2	0850	1309	4.32	24	22	2	42	40	<.1	34	10	5	9	6	3	0	0	0	18	17	.3	4	3	.5				
2H	0853	1313	4.33	20	20	0	35	35	0	20	10	0	4	4	0	0	0	0	10	10	0	3	3	0				
3A	0915	1231	3.37	7290			62			39			173			14			56			39					1	
3B	0912	1232	3.33	1290			59			28			50			0			21			14					2	
3C	0902	1242	3.67	93	22	8	38	38	0	27	10	17	17	8	9	20	1	.5	18	17	1	3	2	1				
3E	0906	1251	3.75	41	22	12	59	40	.1	22	2	20	22	7	15	4	1	.8	34	20	3	7	4	2.8				

¹Acid contamination, pH = 3.26²Acid contamination

TABLE E2.3. Drift Mineral Mass Deposition Rates, Test Run 3, 15 June 1978

Sample Interval				Mass Deposition Rate ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{hr}^{-1}$)																								See Notes Below
Sample ID	Start (PDT)	Stop (PDT)	Δt (hr)	SO_4^{--}			NO_3^-			Cl^-			Na^+			K^+			Ca^{++}			Mg^{++}						
				Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift				
UUA	1332	3035	17.05	230			47			692			394			54			74			43			1			
UUB	1336	1534	1.97	2340			146			3340			2150			70			900			398						
UA	1331	1528	1.93	104			41			242			160			33			54			24						
UB	1337	3035	16.97	487			89			793			463			141			141			63			1			
OBN	1255	1515	2.33	76	60	14	65	65	0	77	46	20	43	26	17	2	2	0	30	28	2	12	10	2	2			
OBS	1252	1510	2.30	303	0	303	359	80	6	1050	46	435	343	26	317	18	5	13	1060	32	69	195	14	57				
OC1	1247	1440	1.88	1420	0	1420	408	80	36	6470	46	2820	2070	26	2030	58	6	52	670	32	450	595	14	367	3			
OC2	1247	1440	1.88	1285	0	1285	348	80	35	6140	46	2760	2370	26	1990	70	6	64	760	32	437	625	14	360	3			
OD	1241	1445	2.07	143	60	76	90	80	1.4	204	46	110	111	26	85	5	5	0	116	32	17	48	14	14				
OE	1236	1450	2.23	95	60	7	106	80	.1	57	46	10	35	26	9	5	5	0	49	32	2	20	14	1.3				
1C	1252	1513	2.35	95	20	74	82	80	1.4	165	46	107	105	26	79	5	5	.3	153	32	17	40	14	14	2			
1D1	1249	1445	1.93	209	0	209	199	80	4	212	0	212	379	26	230	27	6	21	302	32	50	191	14	42	4			
1D2	1249	1445	1.93	174	21	153	175	80	3	431	46	219	192	26	160	33	6	27	197	32	35	96	14	29	4			
1E	1244	1440	1.93	57	49	8	55	55	0	76	46	20	46	26	20	0	0	0	37	32	2	19	14	2	2			
1F1	1240	1503	2.38	1550	60	590	161	80	11	1040	46	850	639	26	610	72	5	67	506	32	134	225	14	110	5			
1E2	1240	1503	2.38	506	60	225	142	80	4	445	46	320	260	26	230	41	5	36	222	32	51	115	14	42	5			
1G	1251	1505	2.25	335	60	58	65	65	0	220	47	84	90	26	64	18	5	13	192	32	13	41	14	11	5			
1I	1230	1456	2.43	152	60	37	70	69	.6	94	46	48	67	26	38	7	5	2	64	32	7	3	0	3				
1J	1234	1456	2.37	173	60	62	95	80	1.1	173	46	89	90	26	64	29	8	15	54	32	15	42	14	12				
2B	1300	1515	2.25	260	60	100	113	80	1.8	245	46	147	132	26	106	8	5	3	192	32	24	61	14	20	6			
2E	1301	1531	2.50	44	41	3	54	54	0	49	43	6	31	26	5	0	0	0	87	32	1	16	14	.8				
2F	1305	1535	2.50	48	35	13	50	50	0	51	32	19	40	26	14	0	0	0	42	32	3	11	10	1.6				
2G1	1304	1537	2.55	101	60	41	40	40	0	114	46	60	68	26	42	0	0	0	79	32	9	19	11	8				
2G2	1304	1537	2.55	32	28	4	47	47	0	41	34	7	33	26	5	0	0	0	23	22	1	6	5	1				
2H1	1308	1540	2.53	1480	60	210	76	72	4	686	46	303	245	26	219	29	4	25	365	32	48	309	14	39	4			
2H2	1308	1540	2.53	989	60	230	89	80	4	552	46	334	267	26	241	18	4	14	365	32	53	155	14	43	4			
2I	1300	1516	2.27	357	60	280	72	70	2.5	642	46	408	323	26	294	11	5	6	258	32	64	113	14	53	2			
2J	1254	1510	2.27	1380	60	405	125	80	7	941	46	580	448	26	420	33	5	28	457	32	92	181	14	76	7			
2K1	1257	1513	2.27	8560	60	670	55	55	0	1340	46	960	722	26	690	60	5	55	632	32	150	644	14	125	4			
2K2	1257	1513	2.27	23	23	0	52	52	0	36	36	0	17	17	0	10	8	0	14	14	0	8	8	0				
3A	1310	1518	2.13	154	60	25	101	80	.5	108	46	38	55	26	29	6	5	.4	123	32	5	28	14	4.3				
3B	1314	1522	2.13	459	60	73	116	80	1.3	131	46	85	103	26	77	19	5	14	205	32	16	62	14	13	4			
3C	1308	1527	2.32	128	60	74	180	80	1.3	140	46	94	104	26	78	20	5	15	211	32	17	38	14	14	4			
3C2	1308	1527	2.32	618	60	4	819	90	0	33	28	5	24	20	4	8	7	.6	160	32	1	23	14	1	4			
3E1	1305	1524	2.32	150	57	93	127	80	1.7	238	46	135	124	26	98	1	1	0	130	32	21	52	14	17				
3E2	1305	1524	2.32	886	60	164	171	80	2.9	823	46	235	195	26	169	13	5	8	448	32	37	172	14	31	4			
3F	1302	1510	2.13	2050	60	40	334	80	.7	39	0	39	193	26	42	34	8	9	592	32	9	128	14	8	4			

¹On ground, picked up 6-16²1 on ground³Road traffic dust contamination⁴On ground⁵On ground at end⁶1 on ground at end⁷Dust contamination

TABLE E2.4. Drift Mineral Mass Deposition Rates, Test Run 4, 21 June 1978

Sample Interval				Mass Deposition Rate ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{hr}^{-1}$)																					See Notes Below
Sample ID	Start (PDT)	Stop (PDT)	Δt (hr)	SO_4^{--}			NO_3^-			Cl^-			Na^+			K^+			Ca^{++}			Mg^{++}			
				Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	
UUA1	0638	1642	10.07	288			177			408			325			10			131			66			1
UUA2	0638	1642	10.07	361			194			549			275			9			159			78			1
UUB	0644	1649	10.08	51			244			576			448			12			187			83			1
UA	0633	1638	10.08	114			177			256			218			3			75			45			1
UB	0646	1654	10.13	108			137			99			89			3			52			28			1
OA1	0840	1248	4.13	81	9	72	83	50	.6	202	0	202	164	22	142	13	2	6	36	23	13	24	7	17	1
OA2	0840	1248	4.13	62	0	62	57	50	.5	174	0	174	205	27	123	8	2	5	31	20	11	23	5	18	
OBN	0905	1219	3.23	233	40	75	112	50	.6	345	33	312	174	26	148	11	2	6	513	25	14	71	8	21	
GBS	0859	1228	3.50	60	37	23	35	35	0	122	31	91	71	24	47	7	2	2	41	25	4	17	8	7	
OC	0942	1316	3.57	370	40	5.4	215	50	<.1	947	33	23	35	24	11	27	2	.5	164	25	1.0	172	8	1.5	1
1ZZ	1136	1253	1.28	631	40	120	167	50	1	870	33	510	268	27	240	23	2	9	544	25	22	187	8	35	
1Z1	1017	1259	2.70	39	39	0	57	50	0	41	33	0	31	27	0	2	2	0	39	25	0	11	8	0	
1Z2	1017	1259	2.70	43	39	0	50	50	0	29	29	0	33	27	0	0	0	0	24	24	0	7	7	0	
1Y1	0841	1247	4.12	57	40	6	61	50	<.1	50	25	25	33	21	12	2	1	.5	54	25	1.1	17	8	1.7	
1Y2	0841	1247	4.12	68	40	15	66	50	.1	74	27	47	51	21	30	3	2	1.3	52	25	2.7	17	8	4	
1A1	0847	1254	4.12	106	40	12	70	50	.1	67	27	40	44	21	23	1	1	0	45	25	2.1	18	8	3.3	
1A2	0847	1254	4.12	54	40	6	53	50	<.1	57	33	24	32	21	11	0	0	0	41	25	1.0	14	8	1.6	
1B1	0855	1259	4.07	77	18	59	71	50	.5	247	27	220	139	21	118	3	1	2.3	72	25	11	NA	--	--	
1B2	0855	1259	4.07	NA	--	--	NA	--	--	NA	--	--	41	21	20	2	1	.9	NA	--	--	NA	--	--	
1C	0859	1302	4.05	214	40	95	190	50	.8	443	33	400	209	21	188	18	2	8	172	25	17	73	8	37	2
1AZ1	0838	1249	4.18	75	37	38	85	50	.3	226	33	160	96	21	75	6	2	3.3	105	25	7	38	8	11	
1AZ2	0838	1249	4.18	84	40	22	65	50	.2	186	33	94	65	21	44	11	2	1.9	94	25	4	30	8	6	1
1AA	0847	1254	4.12	169	40	6	126	50	<.1	422	33	26	12	0	12	9	2	.5	224	25	1.1	76	8	1.7	
1AB1	0852	1257	4.08	92	40	.5	98	50	0	163	33	2	1	0	1	3	2	.2	88	25	.1	37	8	.2	
1AB2	0852	1257	4.08	171	40	66	119	50	.6	273	27	247	152	21	131	28	2	6	129	25	12	50	8	19	
1AC	0859	1301	4.03	61	40	17	73	50	.1	85	27	58	54	21	33	3	2	1.4	48	25	3	22	8	5	
2A1	0907	1306	3.98	40	40	0	47	47	0	26	26	0	24	24	0	4	2	0	21	21	0	8	8	0	
2A2	0907	1306	3.98	39	39	0	40	40	0	36	33	0	18	18	0	0	0	0	16	16	0	7	7	0	
2B	0913	1306	3.88	194	40	48	78	50	.4	157	23	134	116	27	89	8	2	4	104	25	9	34	8	14	3

¹Sand
²Sand, insect
³Spider

TABLE E2.5. Drift Mineral Mass Deposition Rates, Test Run 5, 18 June 1978

Sample Interval				Mass Deposition Rate ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{hr}^{-1}$)																								See Notes Below
Sample ID	Start (PDT)	Stop (PDT)	Δt (hr)	SO_4^{--}			NO_3^-			Cl^-			Na^+			K^+			Ca^{++}			Mg^{++}						
				Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	
OA1	0816	1220	4.07	64			44			136			94			2			24			20						1
OA2	0816	1220	4.07	121			86			191			122			4			52			31						1
OC1	0811	1224	4.22	100			65			192			99			7			54			40						2
OC2	0811	1224	4.22	16			31			33			25			0			5			6						
1Z1	0844	1232	3.80	21	18	3	25	25	0	34	17	17	29	19	9	12	2	.6	10	9	.7	5	3	1.2				
1Z2	0844	1232	3.80	60	26	27	30	26	<.1	98	17	81	64	19	45	3	2	1.3	23	15	6	7	3	4.5				
1Y	0842	1216	3.57	67	26	28	41	26	.3	102	17	85	65	19	46	11	2	3.3	34	15	6	13	3	7				
1A1	0839	1208	3.48	46	23	23	26	26	0	93	17	76	61	19	42	15	2	3.0	25	15	5	12	3	6			2	
1A2	0839	1208	3.48	88	26	48	39	26	.4	142	17	125	95	19	76	7	2	4.6	53	15	10	20	3	12			2	
1B	0834	1214	3.67	88	17	71	32	26	.5	227	17	210	138	19	119	1	1	0	92	15	16	28	3	20			2	
1C1	0958	1210	2.20	111	1	110	87	26	1.1	302	17	283	218	19	199	13	2	10	107	15	26	47	3	32			1	
1C2	0958	1210	2.20	88	23	65	64	26	.6	199	17	180	125	19	106	8	2	5	68	15	14	32	3	17			1	
1AZ	0828	1223	3.92	25	22	3	22	22	0	30	17	10	26	19	5	1	1	0	11	11	0	6	3	.6				
1AA1	0835	1221	3.77	77	26	46	51	26	.5	161	17	144	96	19	77	1	1	0	68	15	10	26	3	12				
1AA2	0835	1221	3.77	101	26	57	51	26	.5	176	17	159	111	19	92	2	2	0	79	15	12	28	3	15			1	
1AB	0929	1205	2.60	46	20	26	28	26	.2	73	16	57	58	18	40	3	2	1	40	15	6	10	3	5			2	
1AC	1143	1235	0.87	94	26	29	52	26	.4	0	0	0	90	19	71	34	2	4	42	15	8	11	1	10				
2A	0827	1226	3.98	40	26	1	30	26	<.1	21	17	4	20	18	2	0	0	0	23	15	.2	4	3	.3				
2B1	0831	1228	3.95	49	26	11	26	26	<.1	48	15	33	37	19	18	7	2	1.3	32	15	2.2	6	3	2.6				
2B2	0831	1228	3.95	45	26	10	23	23	<.1	42	17	25	33	19	14	0	0	0	21	15	1.7	5	3	1.8				
UUA1*	0843	1416	5.55	17			45			0			16			0			12			1						
UUA2*	0843	1416	5.55	21			6			15			11			5			13			2						
UUB*	0855	1421	5.43	108			57			153			87			0			63			16						1

*Background sample taken 19 June 1978

¹Sand²Lint

TABLE E2.6. Drift Mineral Mass Deposition Rates, Test Run 6, 22 June 1978

Sample Interval				Mass Deposition Rate ($\mu\text{g}\cdot\text{m}^{-2}\cdot\text{hr}^{-1}$)																								See Notes Below
Sample ID	Start (PDT)	Stop (PDT)	Δt (hr)	SO_4^{--}			NO_3^-			Cl^-			Na^+			K^+			Ca^{++}			Mg^{++}						
				Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift	Total	Bkgd	Drift				
UUA1	0652	1431	7.65	486			178			870			317			11			195			95			1			
UUA2	0652	1431	7.65	431			174			722			273			6			172			80			1			
UA	0646	1429	7.72	186			173			503			263			1			112			50						
UB	0700	1437	7.62	77			54			147			74			11			41			26			1			
OA1	0816	1145	3.48	63	43	20	38	38	<.1	268	121	147	168	79	89	16	8	2.5	30	26	4	25	19	6				
OA2	0816	1145	3.48	65	40	25	49	48	.2	284	132	152	192	79	113	24	8	3.2	20	15	5	21	13	8				
OSN1	0809	1155	3.77	103	41	62	51	47	.3	401	124	277	255	79	176	24	8	5	100	57	12	44	21	19				
OSN2	0809	1155	3.77	86	45	41	36	36	<.1	326	124	202	195	79	116	15	8	3.3	70	57	8	34	21	13				
OS5	0804	1200	3.93	58	55	3	39	39	0	110	94	16	61	48	13	4	4	<.1	42	41	.6	21	19	1.4				
OE	0858	1220	3.37	123	71	3	102	47	<.1	197	132	25	92	79	13	1	1	0	50	49	.3	38	21	.5				
1ZZ	0829	1205	3.60	147	71	30	62	47	.2	389	132	135	157	79	78	19	8	2.2	118	57	5	52	21	8				
1Z	0800	1149	3.82	58	58	0	44	44	0	144	132	0	86	79	0	9	8	0	60	57	0	23	21	0				
1Y1	0805	1154	3.82	118	71	35	64	47	.2	307	132	175	177	77	100	8	6	2.0	97	57	7	39	21	11				
1Y2	0805	1154	3.82	125	71	35	72	47	.2	307	132	175	177	77	100	9	6	3.0	97	57	7	36	21	11				
1A1	0809	1200	3.85	94	54	40	38	38	.2	305	122	183	190	77	113	2	2	0	58	53	5	30	20	10				
1A2	0809	1200	3.85	119	59	60	69	47	.3	349	122	227	249	77	172	12	7	5	73	57	11	39	20	19				
1B	0813	1205	3.87	195	71	96	50	47	.5	566	121	445	350	77	273	11	6	5	116	57	18	65	21	30				
1C1	0815	1209	3.90	208	71	49	114	47	.3	417	132	248	217	76	141	12	8	4	133	57	9	67	21	15	1			
1C2	0815	1209	3.90	186	71	80	109	47	.4	475	120	355	304	76	228	92	8	7	135	57	15	75	21	25	1			
1AZ1	0811	1146	3.58	98	71	27	47	47	.2	264	132	131	157	79	78	4	4	0	116	57	5	37	21	8	1			
1AZ2	0811	1146	3.58	128	71	38	57	47	.2	343	132	191	189	79	110	21	8	3.1	135	57	7	46	21	11	1			
1AA1	0806	1151	3.77	171	71	94	62	47	.5	524	125	399	346	79	267	23	8	8	186	57	18	64	21	29	1			
1AA2	0806	1151	3.77	201	71	94	66	47	.5	614	132	469	346	79	267	71	8	8	186	57	18	64	21	29	1			
1AB	0804	1155	3.85	137	71	30	69	47	.2	305	132	148	161	77	84	25	8	2.5	117	57	5.5	48	21	9				
1AC1	0758	1158	4.00	84	65	19	66	47	.1	208	115	93	127	74	53	19	8	1.5	66	57	3.5	32	21	6				
1AC2	0758	1158	4.00	61	61	.2	39	39	0	124	122	1.2	75	74	.7	7	7	<.1	47	47	<.1	25	21	.1				
2A1	0817	1204	3.78	71	71	0	49	47	0	116	116	0	77	77	0	4	4	0	47	47	0	17	17	0				
2A2	0817	1204	3.78	74	71	0	51	47	0	103	103	0	67	67	0	5	5	0	54	54	0	19	19	0				
2B1	0821	1207	3.77	97	61	36	72	47	.2	236	118	118	180	78	102	11	8	3.0	106	57	7	53	21	11	1			
2B2	0821	1207	3.77	81	71	10	40	40	<.1	165	130	35	97	77	20	15	8	0.5	67	57	1.4	24	21	2				

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